19th INTERNATIONAL CONFERENCE

MANAGEMENT AND SAFETY

M&S 2024

Friday, June 14th, 2024 and Saturday, June 15th, 2024

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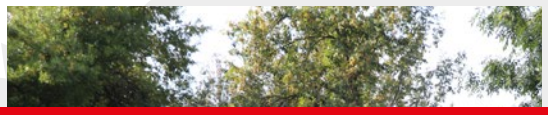

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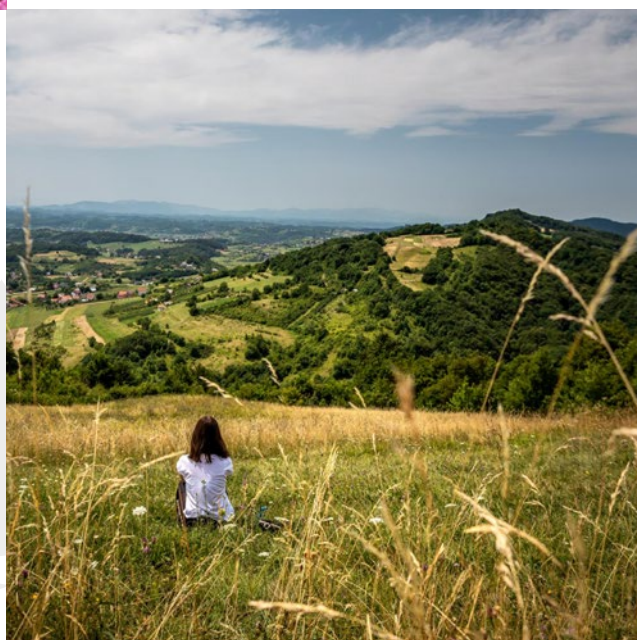

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1.
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Subject review
Invited lecture paper

Darko Palačić

HOW TO ASSESS THE RISKS OF APPLYING ARTIFICIAL INTELLIGENCE IN OCCUPATIONAL HEALTH AND SAFETY - MODELLING THE ASSESSMENT PROCESS

Abstract
The occupational health and safety management system is an essential support for the efficient development of business processes, regardless of whether it is a production or service activity. At a time of rapid technological development and application of increasingly sophisticated technology and work equipment, artificial intelligence (AI) is becoming an integral part of an increasing number of business processes. Like other technologies, AI brings with it new risks in terms of occupational health and safety. It is necessary to develop awareness of the application of AI from the aspect of new risks arising from its application. The key question is whether the existing method of occupational health and safety risk assessment can adequately identify and assess the risks of applying AI. The paper analyzes, on a theoretical level, certain specificities, and areas of application of AI in the occupational health and safety, as well as the risk assessment method prescribed in the Republic of Croatia. Through the discussion, the shortcomings of the existing risk assessment method are identified, and recommendations are given for improving the model of the risk assessment process for the application of AI in occupational health and safety. The conclusion provides an overview of the achieved goals of the research as well as recommendations for further empirical research.

Key words: artificial intelligence, modelling, occupational health and safety, process, risk assessment.

INTRODUCTION

The impact of artificial intelligence application on occupational health and safety

Artificial intelligence (AI) is increasingly playing an important role in decision-making and action environments. One of the key challenges here is the impact of artificial intelligence. This is an aspect that seems to be mostly neglected in discussions about the ethical issues of applying artificial intelligence. Artificial intelligence has an impact on work and safety at work. What is considered under the term influence of AI? Crompton [7] uses the name fallacy of objectivity for this and recognizes the difference between the intended and unintended influence of AI. Based on this, it can be determined that the impact of AI is problematic for our standard characterization and assessment of human-AI interaction.

The development of artificial intelligence brings with it numerous opportunities, but also risks arising from it. Artificial intelligence has a growing impact on employee health and safety. That is why the European Union is trying to ensure the adoption of appropriate regulations in order to respond to the new challenges brought by the development of AI. Concrete steps have recently been taken in this regard.

First, it is necessary to determine whether the current legislative proposals of the European legislator are sufficient to protect the health of employees from the risk of applying AI, and whether they ensure correct relations at the employer-employee level in the context of the right to safe and healthy working conditions and work ethics? [10]

The application of AI in work processes has a special significance due to the great possibility of different applications in different ways.

The influence of artificial intelligence on human work is most often reduced to the use of computer methods that rely on the collection and processing of data to undertake certain activities. It can also be applied to the coordination of machinery and industrial processes, workforce management (especially from a human resource perspective), risk-benefit assessment for clients, and staff safety analysis. [9]
Most importantly, AI can be used to evaluate employee performance [7]. The assessment of a potential future incident situation at work, an employee's illness, or the occurrence of an occupational disease after testing the employee's genes are also areas where AI is used [12].

Artificial intelligence can be used directly to improve the health of employees and can improve safety at work. Wearing an exoskeleton can improve worker productivity, promote health protection and additionally insure the worker against the risk of injury. An exoskeleton is a robot worn by a human in the form of a suit, constructed with an appropriate structure that improves the dynamics of the user's limbs and joints [21]. This also allows the employer to perform a biometric analysis of the worker and bring the worker back to full fitness after the injury. The exoskeleton also relieves pressure on the spine. Although there are many opportunities to use AI in the work process to support employee efficiency, there are also many challenges related to OHS. AI can positively impact the OHS risk management process, but there are risks associated with its use. The primary risk is still associated with the potential occurrence of workplace accidents that result in employee injury. Even exoskeletons equipped with artificial intelligence to assist a worker in mobility or rehabilitation can cause injury if they don't work properly. Therefore, it is advisable to establish an appropriate occupational health and safety policy when using them. [1] It is also not insignificant that robots equipped with artificial intelligence can generate new, previously unknown risks in the work environment during use. [8] One aspect of their use in the work process can be the problem of proper communication between these robots and workers, which can represent a real danger of workplace accidents. [8]

Thus, the connection and influence of AI with its application in OHS is evident. Due to the increase in the use of Ai, this impact will grow bigger every day. OHS management must consider the challenges, risks, and opportunities of applying AI in work. The safety of workers must come first.

Purpose and aim of the research

Risk assessment is an essential part of the occupational health and safety (OHS) process. Like other technologies, artificial intelligence (AI) brings with it new occupational health and safety risks. It is necessary to develop awareness of the application of AI from the aspect of new risks arising from its application. The key question is whether the existing risk assessment method for OHS can adequately identify and assess the risks of AI application.
The aim of the research is to analyze whether the existing method can effectively assess the risks of AI application, and based on the knowledge to model the assessment process in order to be able to assess the risks of AI application.

Research objectives

In accordance with the above research aim, the research objectives are:
- analyze and present the connection between AI and OHS
- analyze and present possible new OHS risks arising from the application of AI
- analyze and present the requirements of regulations for OHS risk assessment
- present a risk assessment model for the application of AI in OHS.

METHODS

Based on the identified problem, the set goal and tasks of scientific research, appropriate scientific methods were selected that make up the methodology of the work. For this purpose, several scientific methods are applied, which by their combination and sequence form a research methodology that should meet the requirements of the planned theoretical research.
From the selected scientific literature, the theoretical settings of AI application and OHS risk assessment were analyzed. The requirements related to OHS risk assessment are analyzed from the national legislation. A combination of deductive and inductive analysis is used to classify and summarize the

theoretical foundations of the research subject. The method of content analysis is used to analyze theoretical statements. The description method describes the essential features of the OHS risk assessment model caused by the application of AI. After analysis and comparison, essential properties are synthesized, conclusions are drawn and a model for assessing OHS risks caused by the application of AI is defined.

RESULTS AND DISCUSSION

The connection between artificial intelligence and occupational health and safety

A review of the scientific literature concludes that artificial intelligence is defined in different ways. [8] It is defined as the ability of a computerized system to make decisions instead of people [23], and its work is enabled by machine learning based on data processing [13]. There are various types of machine learning. There is the acquisition of knowledge based on observation and real interaction [6]. However, an AI system is a software system or part of a device that exhibits behavior that simulates intelligence by, among other things, collecting and processing data and analyzing and interpreting the environment. [15, 5] This system then makes autonomous decisions to a certain extent for a certain purpose. [10]

AI is increasingly used in work processes. In each work process, the required level of safety at work must be ensured so that the processes can be separated safely and permanently. All types of occupational risks can be associated with the application of AI, if it is applied in the process. Today, the source of accidents is no longer only traditional mechanized production but can also be digital network developments that monitor the work process. A worker may suffer physical injury due to the rush and time pressure resulting from managing the AI work process.

The psychosocial risks associated with AI, which can affect the mental health of employees, are very important. These risks are primarily manifested in employee stress related to the performance of work, mainly when the nature of work changes. Mental health is also affected by physical risks. Physical risks and psychosocial risks can be intertwined. [16] For example, lack of adequate rest during the day or week can cause mental illness. Research shows that even a few extra hours of work outside regular working hours can increase the risk of endangering an employee's health. The problem is particularly acute for remote employees who work from home using electronic communications, where the line between work and personal life becomes blurred. Lack of rest can also be a consequence of working longer hours due to fear of job loss due to new technologies. [2]

Psychosocial risks in the workplace can arise from algorithmic management in the work process that enables the control of employees, especially if the employees are aware that the employer controls their sensitive data. Employers can try to use artificial intelligence to gather information about the health status of employees to reduce the potential costs of sick leave. [3]

So, there are numerous benefits of applying AI with OHS. A special category of connectivity is that in which AI is directly used to create safe working conditions as a means of OHS.

Application of artificial intelligence - new risks in occupational health and safety

Risk is a complex concept that occurs in all areas of life, in private and business terms. Risk constantly accompanies all human activities, and exists in every business, and the probability that a certain risky event will occur depends on its nature. Risk refers to the future and future events. Risk management organises what cannot be organised, because individuals, corporations and governments have little choice but to do so. The risk management of everything holds out the promise of manageability in new areas. But it also implies a new way of allocating responsibility for decisions that must be made in potentially undecidable situations. OHS risk management is based on the principles, framework, and process. The purpose of risk management is the creation and protection of value. It improves performance, encourages innovation, and supports the achievement of objectives. Establishing a process that ensures hazard recognition is the primary goal of a progressive organization with a strong safety management program. The organization removes or reduces the risks associated with these hazards to the lowest possible and reasonable level. According to Palačić [19], OHS risks, in their different forms

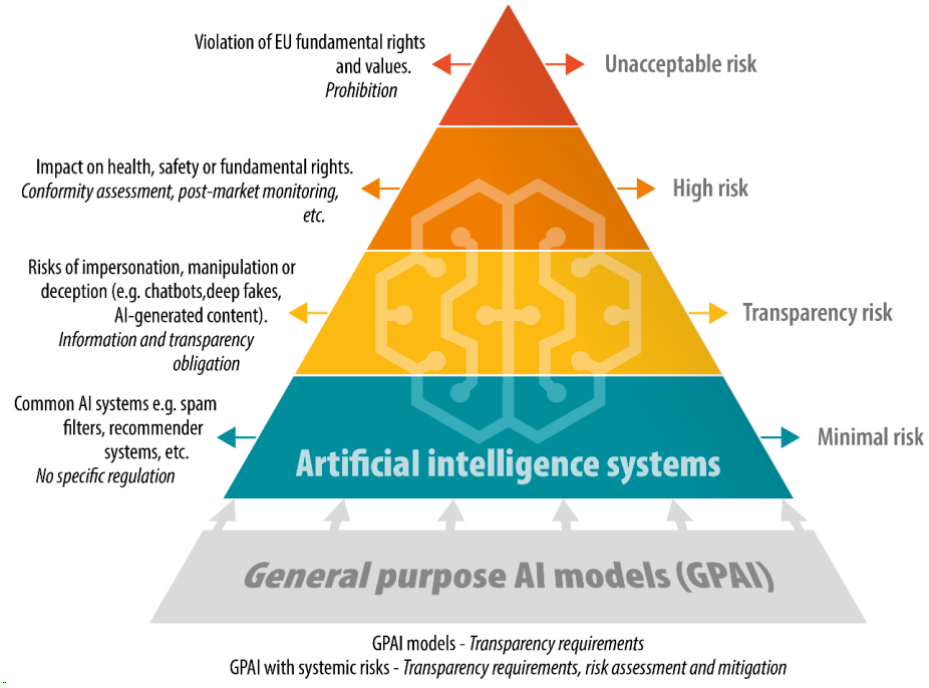
and inter-relationships, may be the subject of observation and management based on different perspectives. Although the concept of treating OHS risk has changed over time, it is clearly recognized in the scientific literature.

Risk includes the effects of any form of uncertainty. Uncertainty can lead to positive or negative consequences or both. Risk is often described in terms of sources of risk, potential events, their consequences, and certainty. An event can have multiple causes and lead to multiple consequences. Consequences can have different discrete values, be continuous variables, or be unknown. [4]

Yampolskiy [24] found that with the emergence, development and application of AI, skepticism about the risks of artificial intelligence has emerged. The scientific literature has already classified different types of skepticism according to the risk of artificial intelligence and analyzed their root causes. That skepticism should certainly be tempered, at least among AI researchers. Obviously, designing safe AI is a much more difficult problem than designing artificial intelligence, and thus will take more time. The actual time to human-level AI is irrelevant; it will always take more time to make such artificial intelligence human friendly. AI security researchers must be uncompromising in their intent to prove the safety of AI applications. Artificial intelligence security research definitely needs to receive higher priority and more resources, including funding and human capital.

European Union lawmakers reached a political agreement on the draft artificial intelligence (AI) act in December 2023. Proposed by the European Commission in April 2021, the draft AI act, the first binding worldwide horizontal regulation on AI, sets a common framework for the use and supply of AI systems in the EU. It offers a classification for AI systems with different requirements and obligations tailored on a 'risk-based approach'. Some AI systems presenting 'unacceptable' risks are prohibited. A wide range of 'high-risk' AI systems that can have a detrimental impact on people's health, safety or on their fundamental rights are authorized, but subject to a set of requirements and obligations to gain access to the EU market. AI systems posing limited risks because of their lack of transparency will be subject to information and transparency requirements, while AI systems presenting only minimal risk for people will not be subject to further obligations. The regulation also provides specific rules for general purpose AI (GPAI) models and lays down more stringent requirements for GPAI models with 'high-impact capabilities' that could pose a systemic risk and have a significant impact on the internal market. [17]

Figure 1. EU AI act risk-based approach



Source: Madiega, T.: Artificial intelligence act, EPRS | European Parliamentary Research Service, 2024. [20]

The EU Law on Artificial Intelligence (AIA) defines four risk categories: unacceptable, high, limited, and minimal. However, as these categories are statically dependent on the broad application areas of artificial intelligence, the magnitude of risk may be misjudged, and AIA may not be effectively implemented. This problem is particularly challenging when it comes to the regulation of general-purpose AI (GPAI), which has diverse and often unpredictable applications. It is necessary to apply context-specific assessments and apply risk categories to specify AI scenarios, not just application fields. This is possible by using a risk assessment model that integrates the AIA with the risk approach derived from the Intergovernmental Panel on Climate Change (IPCC) and related literature. This integrated model allows estimating the magnitude of AI risk by considering the interaction between (a) determinants of risk, (b) individual drivers of determinants, and (c) multiple types of risk. [18]

AI plays a key role in various aspects of the work process, changing the way tasks are performed and managed. AI, through computer methods that analyse and process data, enables actions that affect work dynamics. Therefore, AI technologies have made their way into occupational health, facilitating the examination of both structured and unstructured data. AI finds application in various fields, such as coordination of machines and industrial processes, workforce management (human resources), risk assessment, benefit analysis and personnel safety assessment. [22]

The application of AI requires a broad set of legal, ethical, and social considerations to be considered to develop the necessary solutions. Many organizations were found to face practical challenges in managing these considerations from a risk management perspective within AI governance. [11] That is why new risk assessment methodologies for the application of AI are needed within some specific areas, such as OHS. In relation to the rights of employees, Felländer et al. [11] identified eight areas of organizational risks:

- Violation of privacy - the right to privacy
- Enhanced discrimination - the right to fair treatment
- Violation of autonomy and independent decision-making - the right to autonomy
- Social exclusion and segregation - right to inclusion
- Harm to safety - the right to physical safety
- Harm to security of information - the right to information security
- Misinformation and disinformation - the right to information
- Prevention of access to public service - the right to access public services.

Before applying AI in OHS, it is necessary to think carefully about all aspects of the reliability of its application. It is to be expected that with the passage of time the application of AI becomes more and more reliable. However, in OHS, we talk about protecting health and safety at work and dealing with diseases, injuries, and other damage to health. Therefore, to protect the physical and mental state of the employee, there must be no mistakes. Therefore, it is necessary to identify and assess the risks arising from the application of AI. A mistake in the application of AI can lead to fatal consequences. The ethical and moral dimension of the correct use of artificial intelligence was already mentioned earlier. In fulfilling the basic purpose of OHS, the application of AI can be extremely useful, but it can also create new hazards and risks. Although artificial intelligence is already widely used in practice, caution is needed.

Considering that the application of AI is almost unlimited, its increasing application in all aspects of work is also expected in the future. Risk exists in every job and every activity; therefore, it also exists in the application of AI. The problem becomes greater if we talk about the application of AI in OHS because its application should primarily be in the function of risk prevention and mitigation. The use of work equipment that relies on the correct operation of AI also represents a risk. How reliable is the information we get by applying AI about the correct use of work equipment? The purpose of AI risk management in OSH is to increase the likelihood that an organization will achieve its OSH objectives by managing the probabilities of positive or negative events and consequences that are directly or indirectly caused using AI. In general, it can be said that the application of AI in occupational safety creates risks in two key areas. The first are work-related risks in general, and the second are work-related risks that can cause injuries and illnesses. The probability of conflicting and contradictory results of the application of A appears, as well as the probability of obtaining inconsistent results of the application

of AI in occupational safety. All this points to the conclusion that it is not necessary to understand that the application of AI creates new risks in multiple dimensions, and that we must deal with these risks.

Occupational health and safety risk assessment - Croatian regulatory requirements

To influence the reduction of work-related injuries, occupational diseases, work-related diseases, and disorders in the work process in Croatia, the Ordinance on risk assessment (N.N. no. 112/14, 129/19) prescribes risk assessment. The risk assessment in Croatia is a mandatory document in the field of occupational health and safety, and it depends on how and in what way the employer will carry out its work, and how it will protect the lives and safety of its workers as best as possible. [14]

This Ordinance prescribes the conditions, manner, and method of creating a risk assessment, i.e. the minimum requirements that must be met when assessing risks. The employer has the option of making a risk assessment independently or he can entrust the preparation of the assessment to persons authorized to make the risk assessment (authorized companies). Experts from different fields, workers, employer's authorized representatives and workers' commissioners must be involved in the preparation of the risk assessment. A risk assessment is made for all jobs that workers perform, regardless of the type of employment (permanent, temporary, etc.) at all locations where the jobs are performed. Risk assessment begins with determining the current situation and collecting the data necessary for analysis. The risk is assessed using a risk assessment matrix, and the goal of the risk assessment itself is to determine the dangers, harms and efforts to which workers are exposed during work, and to determine the measures that need to be taken to reduce workers' exposure to risk.
Three appendices are an integral part of the Ordinance:

- Appendix I - Risk assessment matrix for calculating the size of the risk, an explanation of what certain levels of probability and consequences imply
- Annex II - examples of jobs qualified as low risk
- Annex III - hazards, harms, and efforts at work and in connection with work, which serves as a guide when creating a risk assessment.

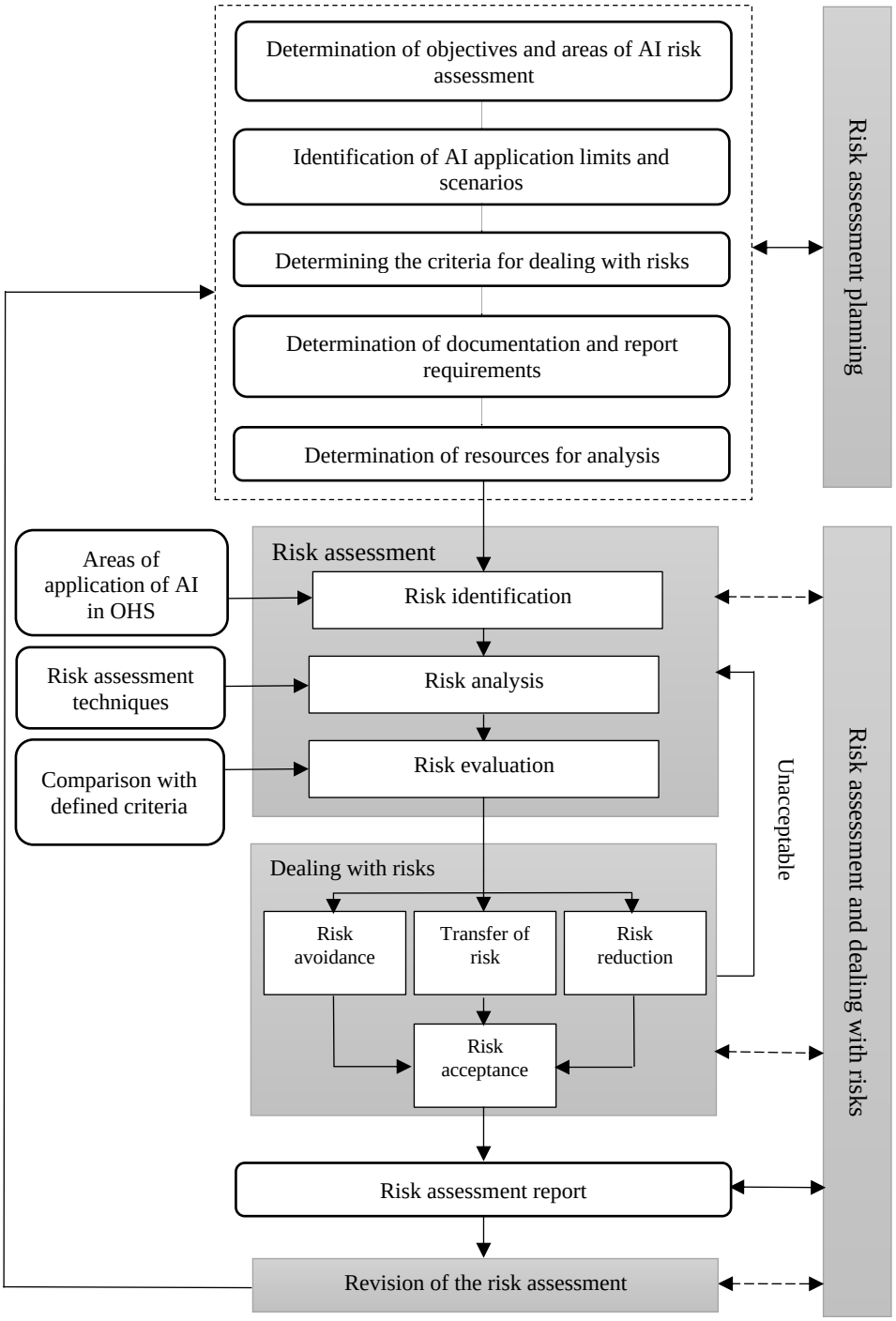
Based on the risk assessment and the determined measures that need to be taken, the employer is obliged to apply them, and in the future to undertake rules, measures, procedures, and activities to prevent and reduce risks. All the above is done with the aim of raising awareness among workers and raising the implementation of safety at work to a higher level. The risk assessment is the fundamental and most important document in OHS because further measures are prescribed based on the assessment results. As stated earlier, the OHS risk assessment technique used in Croatia is prescribed by the Ordinance on risk assessment (N.N. no. 112/14, 129/19). Making a risk assessment using the prescribed risk assessment matrix technique depends on the expertise and experience of occupational safety experts, which can often lead to a wrong assessment, and consequently to greater consequences. Consequences that do not only apply to fines, but mostly to the life and safety of workers. The first part of the risk assessment document refers to information about the employer (name, seat, activity); in the manner of implementation of safety at work; to information about the maker of the risk assessment and the collaborators who collaborated in making the assessment. The second part of the document refers to the technological work process; arranging the workplace; number of workers at workplaces by workplace.

In order to establish the risks arising from the worker's workplace, it is necessary to process the worker's job description in as much detail as possible, that is, to go through the worker's working day, daily tasks and through the tasks he performs occasionally; list the means of labour used by the worker; indicate exposure to harm; if the position requires a certain professional qualification of the worker. Based on all the above data, the size of the risk is calculated in accordance with the prescribed risk assessment matrix (Annex I of the Ordinance). The analysis and evaluation of the data collected in this way includes the application of basic occupational safety rules, special occupational safety rules and data analysis to assess the remaining risk at the worker's workplace. [14] The prescribed risk assessment technique implies a change in the risk matrix, which is very general (3 x 3), and therefore the result of that assessment is questionable. Unfortunately, practice shows that risk assessments are mostly documented only formally, without real benefit. This approach to creating a risk assessment, as well as the prescribed method, is practically insufficient for evaluating the application of AI in OHS.

Modeling the risk assessment process

Based on the analysis and presentation of the basic theoretical assumptions of AI, OHS and risk assessment, the proposal of a risk assessment model for the application of AI in OHS is presented below.

Figure 2. Model of the risk assessment process of the application of AI in OHS



Source: own

In addition to the above, when modeling the risk assessment process, the requirements of the EU Artificial Intelligence Act and the requirements of the ISO 31000:2018 Risk management - requirements standard were considered. Also, in defining this proposal for a risk assessment model, the requirements of individual risk assessment methods, which are presented in the standard IEC 31010:2019 Risk management - risk assessment techniques, were considered. In the previous chapters, there was also a discussion about the current shortcomings of the risk assessment method, which is being changed in

accordance with Croatian regulations. The presented model can help in further analysis and definition of the approach to risk assessment of the application of AI in OHS. It is particularly emphasized that the model is generic, that is, it can be applied to any type of organization, risks, number of workers, and the like. The process of assessing the risk assessment of the application of AI in OHS must be an integral part of the risk management of the application of AI in the entire company.

As is well known, risk exists in every job and every human activity. The probability that a certain risky event will occur depends on its nature and on other factors that influence its realization. The application of AI in work processes in general, and its application in OHS in particular, presents challenges. The damage that can occur due to the application of AI causing loss of profits or markets cannot be compared to the damage caused by the loss of human life caused by the application of AI in OHS processes. Therefore, already now, and in the future, it is extremely important to assess the risks of applying AI in OHS. OHS primarily serves to prevent unwanted events that can cause damage to health, injuries and fatalities at work. AI is already being used in OHS, and its application in the future has no limits. However, this should be approached with special caution and the risks that may arise due to the application of AI in different areas of OHS application should be assessed. Popov et al. [20] suggest what fundamental questions need to be asked for risk assessment to be effective. That suggestion needs to be refined when it comes to the application of Ai in OHS with the following basic questions:

- What can happen and why if we apply AI in the specific area of OHS (risk identification)?
- What consequences can arise from the application of AI?
- What is the probability of their future occurrence?
- Are there factors that reduce the consequences of the risk or reduce the probability of the risk?
- Is the level of risk tolerable or acceptable and does it require further treatment?

CONCLUSION

As it was said, risk exists in every business, and the probability that a certain risky event will occur depends on its nature. Risk refers to the future and future events. The use of AI in general has attracted a lot of attention from the point of view of new risks arising from its use. Already now, and in the future, it is extremely important to assess the risks of applying AI in OHS. OHS primarily serves to prevent unwanted events that can cause damage to health, injuries, and fatalities at work. AI is already being used in OHS, and its application in the future has no limits. However, this should be approached with special caution and the risks that may arise due to the application of AI in different areas of OHS application should be assessed. It can be concluded that the goals and objectives of this research have been achieved. The conducted research analyzed and presented the links between AI and OHS, possible new OHS risks arising from the application of AI, regulatory requirements related to risk assessment. In doing so, the available recent scientific literature and the special new EU Law on Artificial Intelligence were analysed. Finally, based on the entire analysis, a risk assessment model for the application of AI in OHS is presented. A discussion was held about everything and conclusions were drawn. The presented risk assessment model for the application of AI in OHS complements the prescribed requirements for creating a risk assessment by introducing new assessment elements. The interdependence of all the elements shown is significant. An error in risk assessment can have fatal consequences for the worker. A better and more specific technique of risk assessment must certainly be applied, than is being applied now. According to current knowledge, the risks of AI application have not yet been assessed in Croatia. In order to continue the research, it is necessary that the professional public first understands the significance of the uncertainty of the application of AI in OHS. Still too little is known about the risks arising from the application of AI in OHS. Further research is necessary.
In order to continue the research, it is necessary that the professional public first understands the significance of the uncertainty of the application of AI in OHS. Still too little is known about the risks arising from the application of AI in OHS. Further research is necessary.

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- The Law on Occupational Safety (N.N. no. 71/14, 118/14, 94/14, 96/18)

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2.
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ANALYSIS OF THE ISO/IEC 20000-1:2018 REQUIREMENTS IN THE CONTEXT OF DIGITALIZATION AND SAFETY

Abstract
Information technology influence is undoubtedly constant in everyday activities in the modern age. Everyday life tasks as well as business activities, as well as elements of safety, owe their continuity, quality and reliability to a large extent to a robust system of information technologies that work in the background of primary activities. In this sense, a special current and future challenge represents the management of information technologies from the aspect of service management. Bearing in mind that there are no detailed national instructions in this area, partly due to the fact that it is an area that has been developing recently, the appropriate guidelines for the service management system are international system standards, primarily ISO/IEC 20000-1:2018. For that reason, the goal of this work is to analyze the requirements of this system standard, with special reference to its importance in the safety system. The main conclusion of the paper indicates the insufficient application of this system standard in the Europe as well as in the countries of the Western Balkans, and that it is necessary to further strengthen the scientific and professional infrastructure in this area, as well as the popularization of the benefits that the application of this system standard brings.

Key words: standardization, system, information technology, service management, safety.

INTRODUCTION

Information technology (IT) plays an indispensable role in modern society across various domains, impacting individuals, businesses, governments, and the global community as a whole. Information technology is integral to the functioning of modern businesses. It streamlines processes, enhances productivity, and enables organizations to reach a wider audience through e-commerce, digital marketing, and customer relationship management systems [1]. Additionally, IT enables data-driven decision-making by providing analytics and business intelligence tools. Information technology drives economic growth by fostering innovation, entrepreneurship, and job creation. IT industries, including software development, cybersecurity, and cloud computing, contribute significantly to national economies and create employment opportunities. Additionally, governments leverage IT to provide citizen services, enhance public safety, and improve administrative efficiency. E-government initiatives, digital identity systems, and online portals enable citizens to access government services conveniently and securely [2]. From the standpoint of environmental safety information technology can contribute to environmental sustainability by enabling remote work, reducing the need for physical travel, optimizing energy consumption through smart grids and energy-efficient systems, and facilitating environmental monitoring and conservation efforts [3]. On the other hand, from the standpoint of occupational safety IT enables the implementation of sophisticated monitoring and surveillance systems to track workplace conditions and detect potential hazards in real-time. Sensors, cameras, and wearable devices can monitor environmental factors such as temperature, air quality, noise levels, and hazardous chemical concentrations. This data allows organizations to proactively identify risks and take preventive measures to ensure worker safety in collaborative manner [4]. IT systems can analyze large volumes of data collected from various sources to identify patterns, trends, and potential safety risks. Predictive analytics algorithms can forecast potential safety incidents based on historical data, enabling organizations to implement targeted interventions and preventive measures to mitigate risks before accidents occur. With no less importance is the fact that IT enables organizations to develop and implement robust emergency response and incident management plans. Emergency notification systems, mobile applications, and

digital signage can disseminate critical information and instructions to employees during emergencies such as fires, chemical spills, or medical emergencies. Furthermore, incident reporting and investigation software can streamline the documentation and analysis of safety incidents, facilitating root cause analysis and corrective action implementation to prevent recurrence [5]. In any case, common to all areas of application of information technologies, especially in the area of occupational and environmental safety, is that a high dose of reliability and continuity is required in the functioning of IT [6]. In this sense, a high reliability of information technology operative work in these areas can be achieved and maintained only by adequate management and maintenance implemented processes, for which there are numerous instructions, guides and specifications. In the context of a standardized approach in this area, the standardized IT service management system (SMS) described in the ISO/IEC 20000-1:2018 standard represents an adequate answer to numerous questions and challenges in the field of IT service management.

METHODS

For the purposes of this study, which is detailed in this document, a comprehensive combined-collaborative desktop research approach was employed. This method involved an exhaustive examination of relevant scholarly literature along with an exploration of relevant online standard databases [7, 8]. The objective was to analyse the varied experiences and methodologies adopted by diverse organizations operating within the realm of information technology service management. The findings of performed research process have been distilled into a summary report, focusing the essential components discerned in the domain of information technology service management. These components were identified through a synthesis of the data gathered, and are presented upon in the results section, supplemented by a comprehensive discussion. Moreover, this paper also offers an informative discourse on both contemporary challenges and prospective hurdles anticipated in the area of information technology service management. This discussion aims to provide insights into the evolving dynamics and complexities inherent to this field, addressing both present-day concerns and future trajectories.

RESULTS

The ISO/IEC 20000-1:2018 standard delineates the prerequisites for an organization to establish, execute, uphold, and continuously enhance a service management system (SMS). The stipulated requirements encompass the strategizing, structuring, transitioning, executing, and refining of services to fulfil service prerequisites and deliver value. This document serves multiple purposes:

- Assisting customers seeking services and necessitating assurance regarding their quality,
- Aiding customers in securing a uniform approach to the service lifecycle from all service providers, including those within a supply chain,
- Enabling organizations to showcase their proficiency in planning, designing, transitioning, delivering, and enhancing services,
- Facilitating organizations in monitoring, assessing, and revising their SMS and the provided services,
- Empowering organizations to ameliorate the planning, designing, transitioning, delivering, and enhancing of services through the efficient implementation and operation of an SMS,
- Providing a framework for organizations or other entities engaged in conformity assessments against the criteria outlined in the ISO/IEC 20000-1:2018 standard, and
- Supporting entities offering training or consultancy in service management.

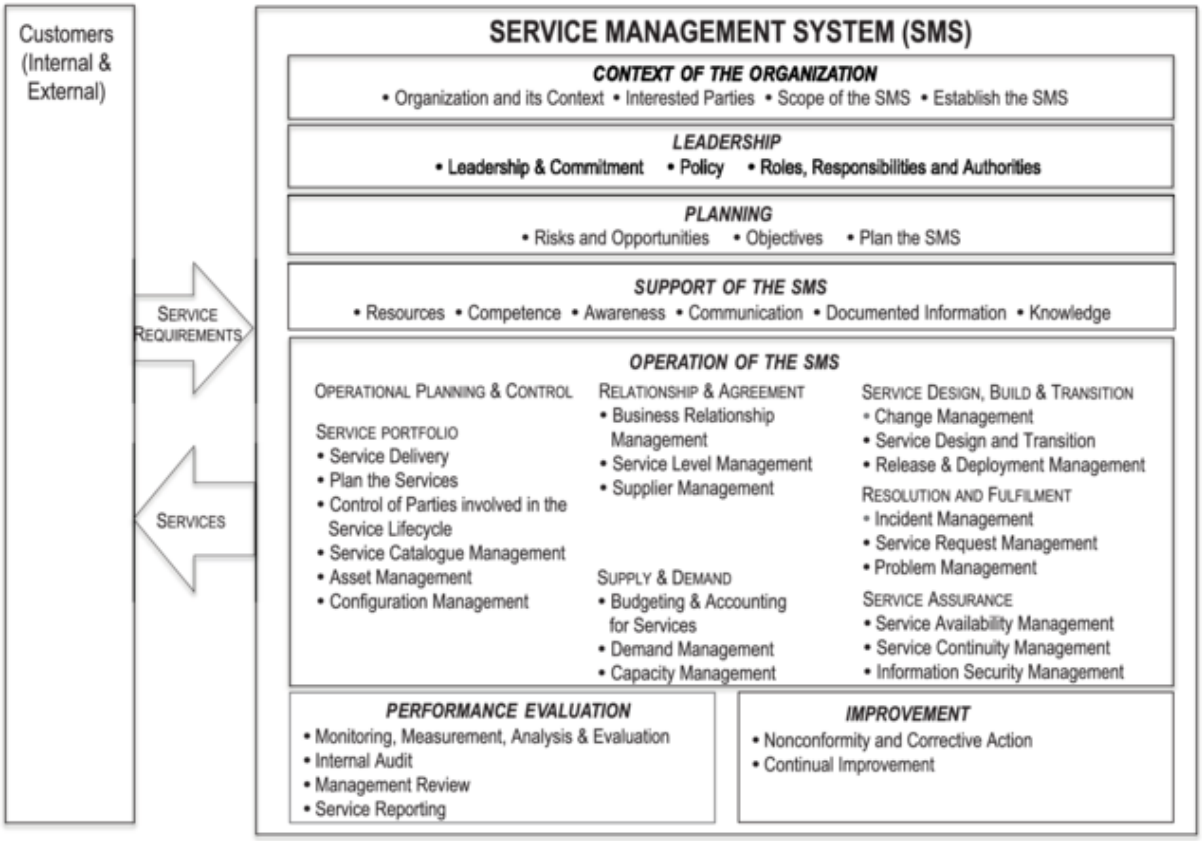
In the ISO/IEC 20000-1:2018 standard, the term "service" pertains to the services within the scope of the SMS, while the term "organization" refers to the entity within the SMS scope responsible for managing and delivering services to customers. This organization may be a component of a larger entity, such as a department within a corporate conglomerate. Additionally, an organization or segment thereof responsible for managing and delivering services to internal or external customers may also be referred a service provider. Any instances where the terms "service" or "organization" are used with different connotations are clearly distinguished in the ISO/IEC 20000-1:2018 standard.
The ISO/IEC 20000-1:2018 standard outlines the scope and objectives of the IT service management system. It defines the boundaries of the SMS within the organization and articulates its purpose, which

is to ensure the effective and efficient delivery of IT services that meet the needs and expectations of customers and other stakeholders. The ISO/IEC 20000-1:2018 standard requires organizations to establish a service management policy that articulates their commitment to delivering high-quality IT services and continuously improving service delivery processes. The policy should be aligned with the organization's overall objectives and communicated to all relevant stakeholders. ISO/IEC 20000-1:2018 mandates that organizations develop a comprehensive plan for implementing and managing the SMS. This includes defining roles, responsibilities, and authorities within the organization, as well as establishing processes, procedures, and controls to manage IT services effectively. Organizations are also required to allocate resources, set objectives, and establish metrics for measuring performance and evaluating the effectiveness of the SMS. The standard emphasizes the importance of designing IT services that meet the requirements and expectations of customers and stakeholders. It requires organizations to define service offerings, service level agreements (SLAs), and service catalogs, as well as establish processes for managing changes, releases, and transitions of IT services to ensure smooth deployment and operation [9].

DISCUSSION

ISO/IEC 20000-1:2018 prescribes processes and controls for the delivery and operation of IT services. This includes incident management, problem management, change management, service request management, and access management, among others. The standard also emphasizes the need for organizations to monitor, measure, and report on the performance of IT services to ensure compliance with SLAs and continuous improvement. One of the biggest benefits of applying this standard is that it provides a conceptual framework for the development and implementation of IT SMS, based on the well-known PDCA cycle of continuous improvement, as shown in Figure 1.

Figure 1. ISO/IEC 20000-1:2018 Service management system framework



Source: ISO/IEC 20000-1:2018 standard

In the wider context of the overall digitalization, the standardized IT service management system (SMS) described in the ISO/IEC 20000-1:2018 standard plays a critical role in supporting digitalization

initiatives by enhancing service quality, efficiency, risk management, agility, customer satisfaction, continuous improvement, compliance, and assurance. By adopting and adhering to the principles and practices outlined in the standard, organizations can effectively leverage digital technologies to drive innovation, improve business performance, and achieve sustainable growth in the digital age. Since digitalization often involves the implementation of complex IT systems and applications to automate processes and improve efficiency a standardized SMS provides a structured framework (Figure 1) for managing IT services, including service design, transition, delivery, and operations. By establishing standardized processes, procedures, and controls, organizations can streamline service delivery, minimize disruptions, and optimize resource utilization, leading to more efficient digitalization efforts. In the risk management context, digitalization introduces new risks and challenges related to cybersecurity, data privacy, compliance, and system reliability. A standardized SMS helps organizations identify, assess, and mitigate these risks by implementing robust controls and security measures. This ensures that digitalization initiatives are conducted in a secure and compliant manner, safeguarding sensitive information and protecting against potential threats and vulnerabilities [10].
In terms of the frequency of application of standardized SMS based on the ISO/IEC 20000-1:2018 standard, adequate numerical data can be obtained by analyzing ISO Surveys, where the extract of data for the countries of the Western Balkans in 2022 is given in Table 1.

Table 1. Number of valid ISO/IEC 20000-1:2018 certificates and sites in the Western Balkan countries and selected global countries for the 2022

Country	Certificates	Sites
Albania	8	7
Bulgaria	114	130
Bosnia and Herzegovina	2	3
Croatia	18	18
Greece	21	24
North Macedonia	32	32
Montenegro	2	2
Romania	64	91
Serbia	32	37
Slovenia	2	3
China	24152	24208
USA	360	477
India	314	942
Italy	192	354
Spain	172	361
United Kingdom	133	250
Czech Republic	117	126

Source: ISO Survey

By looking at the synthesized data, it is possible to notice a generally small trend in the application of the ISO/IEC 20000-1:2018 standard, especially in comparison with the traditionally highly prevalent ISO 9001, ISO 14001 and ISO 45001 certificates. On the other hand, through a comparative analysis of the available data, it is possible to come to the conclusion that the level of development of a certain national economy as well as the number of inhabitants does not play a decisive role in relation to the number of valid ISO/IEC 20000-1:2018 certificates. Thus, for example, North Macedonia, with a similar number of inhabitants as Slovenia or Bosnia and Herzegovina, has a far greater number of issued certificates. On the example of other EU countries, it is interesting to note that Greece, with a more developed economy than Bulgaria and a similar number of inhabitants as Bulgaria, has a far smaller number of organizations that apply the ISO/IEC 20000-1:2018 standard.
Globally, differences are observed that are even greater between countries. It is very striking that China leads in the context of the number of issued ISO/IEC 20000-1:2018 certificates, especially compared to

the USA, which is considered to be the cradle of the IT service management system. Moreover, the total number of certificates issued in the USA, India, Italy, Spain, UK, and the Czech Republic does not reach 10% of the certificates issued in China in 2022, which leaves room for some more detailed research. This short analysis gives us an unequivocal suggestion that in addition to the level of development, the culture of maintenance, recognition of the importance of the IT sector as well as trends in society is something that determines the representation and application of the ISO/IEC 20000-1:2018 standard.

CONCLUSION

To be concluded, ISO/IEC 20000-1:2018 establishes a standardized framework for organizations to establish, implement, maintain, and continually improve an IT service management system. By adopting the principles and practices outlined in the standard, organizations can enhance the quality, efficiency, and effectiveness of their IT service delivery processes, thereby contributing to improved customer satisfaction, business performance, and overall organizational success. ISO/IEC 20000-1:2018 provides a framework for organizations to demonstrate compliance with the standard's requirements and achieve certification of their SMS. Certification involves undergoing a formal assessment by an accredited certification body to verify that the organization's SMS conforms to the requirements of the standard. Achieving certification can enhance the organization's credibility, demonstrate its commitment to quality and customer satisfaction, and improve its competitiveness in the marketplace.

The standard places a strong emphasis on continual improvement as a fundamental principle of IT service management. Organizations are required to establish processes for identifying opportunities for improvement, implementing corrective and preventive actions, and measuring the effectiveness of improvement initiatives. This includes conducting regular internal audits and management reviews to assess the performance of the SMS and identify areas for enhancement. We always need to bear in mind that digitalization is an ongoing process that requires organizations to continuously innovate, optimize, and evolve their IT services and capabilities. A standardized SMS promotes a culture of continuous improvement by establishing processes for monitoring, measuring, and evaluating service performance. This enables organizations to identify opportunities for enhancement, implement corrective actions, and drive innovation to support digitalization objectives effectively.

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- ISO/IEC 19770-5, Information technology - IT asset management - Part 5: Overview and vocabulary
- ISO/IEC 20000-1:2018, Information technology - Service management - Part 1: Service management system requirements
- ISO/IEC 20000-3, Information technology - Service management - Part 3: Guidance on scope definition and applicability of ISO/IEC 20000-1
- ISO/IEC/TR 20000-5, Information technology - Service management - Part 5: Exemplar implementation plan for ISO/IEC 20000-1
- ISO/IEC 20000-6, Information technology - Service management - Part 6: Requirements for bodies providing audit and certification of service management systems
- ISO/IEC 20000-10, Information technology - Service management - Part 10: Concepts and vocabulary
- ISO/IEC/TR 20000-11, Information technology - Service management - Part 11: Guidance on the relationship between ISO/IEC 20000-1:2011 and service management frameworks
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CREATING VIRTUAL EDUCATIONAL CONTENT FOR TRAINING ON HEALTHY AND SAFE WORK

Abstract
Training for a healthy and safe work environment constitutes the foundation of preventive action in the field of occupational safety and health. In most countries, legal regulations mandate training obligations for safe and healthy work. To continually enhance the quality of training for healthy and safe work, it is necessary to provide high-quality educational materials. With the global digitization, advanced technologies have been introduced into the training process. Currently, the most developed technologies are Virtual Reality (VR) and Augmented Reality (AR), making them highly suitable for integration into the training process for healthy and safe work. This professional paper will showcase the current possibilities in creating educational materials for the purpose of utilizing VR and AR technology in training employees for healthy and safe work. The aim of the paper is to demonstrate ways in which educational materials can be created and present possibilities for implementation in the training process itself.

Key words: Virtual Reality (VR), Augmented Reality (AR), training for healthy and safe work.

INTRODUCTION

Training for safe and healthy work is a fundamental part of the occupational safety and health protection process. The education process must provide the necessary skills and knowledge to perform work tasks safely. During the training, workers become familiar with potential hazards and risks present in the workplace. This education also includes knowledge about ergonomics, handling equipment and tools, as well as proper movement and manipulation of loads. Training on safe and healthy work should be regular and tailored to the needs of the workplace. Education for safe work is a legal obligation of the employer, who should provide training for each worker at their workplace. The method of education is usually defined by regulations set forth by the competent government ministry. These trainings consist of both theoretical and practical components. The theoretical part involves familiarization with general occupational safety rules, obligations in the field of safety, and potential hazards in the workplace. Within the theoretical part of the education, educational materials such as specialized literature, audio, and video materials are used. The practical part of education for safe and healthy work involves the presentation of hazards and risks in the workplace during the work process. In the practical component, workers become acquainted with measures for preventing, eliminating, or reducing risks in the workplace. Training for safe and healthy work is conducted within the company premises or at the workplace itself. After each training session, it is necessary to conduct assessments of competence in both the theoretical and practical aspects. The development of new information technologies and significant changes in the field of work have led to the need for changes in traditional methods of education in various areas, including occupational safety and health.The emergence of new technologies is changing the approach to education, giving rise to various forms and models of e-learning. Among the technologies that significantly enhance and improve the quality of the education process in the field of occupational safety and health are augmented reality (AR) and virtual reality (VR), which are becoming increasingly accessible to potential users. This work aims to showcase the types of content that can be used for education through the use of VR and AR technology. Additionally, the paper demonstrates ways in which content for safety education can be created using VR and AR technology.

APPLICATION OF VR AND AR TECHNOLOGY IN OCCUPATIONAL HEALTH AND SAFETY EDUCATION

The application of AR and VR in occupational health and safety training is still not widely adopted because it's challenging to synchronize technological advancements with improvements in training methodologies. VR and AR technologies (Figure 1) have seen extensive use in gaming, with their application in this field being the primary focus for a long time. However, with the rapid development of audio-visual technologies, the IT sector, and the proliferation of mobile phones, there emerged needs and opportunities to utilize these technologies for other purposes. According to available data, apart from gaming, these technologies are most commonly used in the healthcare sector, education, and worker training.

Figure 1: Illustration of VR and AR Technologies

In recent years, an increasing number of researchers have been exploring the application of VR and AR technologies in the field of education, including occupational health and safety training. Studies have shown that VR is a suitable tool for designing safety training systems and researching human behavior in emergencies [1]. VR is increasingly being embraced in both its immersive and non-immersive versions for providing safety training in various industries and for different types of disasters. [2]. hen combined with gaming elements, VR can create high-quality safety education content that is more engaging and easier to learn. Many authors present comparisons in educational methods, highlighting the benefits of using VR and AR technologies [3]. A group of authors conducted a comparative analysis of three training methods: traditional methods (using printed instructions), multimedia instructions (utilizing audio-visual elements), and augmented reality [4]. Guidelines for education based on augmented reality applications are more effective solutions for training [5]. Augmented reality is applied in evacuation training, where the use of this technology achieves faster and easier preparation of people for rapid evacuation. With this mobile system, shelters are efficiently located, and people are evacuated [6]. The authors point out the advantages of virtual reality in conveying tacit knowledge and providing valuable environments for real experiences and the transfer of tacit knowledge. [7]. Using VR simulations that mimic real workplace environments, as well as simulating educational scenarios and situations that workers may encounter on the job, the acquired training experience is more relevant and useful for participants. The most common model of applying VR technology in health and safety training is through BIM (Building Information Modeling) software. The use of VR in game-based training can minimize the complexity of complex tasks and improve user interactions [8]. The best examples of using VR technology in game-based training are multi-user safety training systems for dismantling tower cranes at construction sites. [9]. The most widely used model of VR technology in training currently is BIM software, which has significant applications in the construction industry. The BIM software itself deals with the development and utilization of three-dimensional objects [8]. Unlike other VR models used in training, BIM-based VR relies on a model for repeating construction processes and operations, integrating safety training into construction [10].

In addition to all the advantages offered by education with VR and AR technologies in terms of flexibility, mobility (training can be conducted anywhere), repeatability, and relatively low equipment acquisition costs, certain drawbacks are still difficult to eliminate. The main drawback of this education system is the time required to create educational content. Additionally, creating high-quality educational content tailored to specific types of training can be challenging due to a lack of competent educators.

PRESENTATION OF CONTENT

Contents intended for education in the field of occupational health and safety using new technologies can be presented in immersive, semi-immersive, and non-immersive ways (Table 1). Immersive mode, in the context of virtual reality, involves generating a three-dimensional display that appears to surround the user; generally, it represents the immersion of a person in an activity in which they are currently participating. Non-immersive mode involves the user interacting with virtual content while their environment remains real.

Table 1. Ways of displaying educational content

	Non-Immersive System	Semi-Immersive System	Fully Immersive System
Input Devices	Mouse, Keyboard, Joystick	Joystick, Gloves, 3D Mouse	Gloves, Voice Commands
Output Devices	High-resolution Standard Monitor	Large Monitors, Large Projection Systems	Head-Mounted Display (HMD), CAVE
Resolution	High	High	Low-Medium
Immersiveness	None to Low	Medium-High	High
Interaction	Low	Medium	High
Cost	Low	High	Very High

In practice, educational content is displayed through computer simulations (non-immersive system), augmented reality (AR) technology (semi-immersive system), and virtual reality (VR) technology using VR headsets (fully immersive system)

METHOD OF CREATING EDUCATIONAL CONTENT

Creating educational content for occupational health and safety using VR and AR technology requires careful planning of each step of education and development to ensure effective learning. When designing such content, it is important to consider the user experience and the purpose of the content itself to ensure the interactivity and engagement of the learners.. Realistic scenarios can effectively depict hazards and risks in a workplace, thereby achieving high-quality education using VR and AR technology. Adaptability of content to different educational methods and the varying needs of workers undergoing training is key to success in education through these advanced technologies. Creating educational content for VR and AR technologies can be accomplished in several ways:

- 3D modeling and animation: By utilizing tools such as Blender, Maya, or Cinema 4D to create three-dimensional models of objects, locations, or characters, it is possible to generate educational VR content. After creating the models using the mentioned software tools, animations need to be applied to create an interactive educational environment;
- *Interactive programming: Using tools like Unity or Unreal Engine for programming interactive elements can yield educational VR content. These tools enable the creation of complex interactions such as object manipulation, task solving, or participation in simulations*;
- 360° video: By using cameras that record panoramic 360° footage, it's possible to create immersive videos or 360° tours that allow users to explore real-world or simulated scenarios. This is particularly useful for educating about specific work tasks;

- Simulations: By creating simulations in a CAM (Computer-Aided Manufacturing) program, users can experience imagined situations they wouldn't encounter otherwise, such as specific accidents, fires, or serious injuries;
- Creating interactive scenarios: To develop an interactive story or scenario that allows users to participate and make decisions affecting the outcome, a combination of the mentioned methods of creating educational content is necessary. Creating interactive scenarios is especially useful for education in the field of occupational health and safety, where experiential learning is encouraged.

For different technological methods of displaying educational content, it's necessary to select appropriate content creation methods. For presentation through 2D computer simulation, educational content is created by programming interactivity and simulations. Computer simulations can also employ 3D educational content, which is created through 3D modeling, animation, and simulation. An example of such creation of educational material is Building Information Modeling (BIM) software (Figure 2), which is widely used in the construction industry.

Figure 2. BIM Software

When displaying content in AR technology, it's best to create educational content by developing interactive scenarios and utilizing 3D modeling. Interactive content in AR technology is often presented on displays, while for 3D projection through AR glasses, 3D modeling is necessary. Immersive VR presentation of educational content requires the use of software for 3D modeling and animation. Currently, there are numerous software options available for creating educational content through 3D modeling and animation. These software tools offer various capabilities, so it's essential to know which software is suitable for creating specific content. Depending on the intended field of application, one software might excel in developing engineering applications but may not be ideal for creating games or films. The following software tools are commonly used for creating educational content:

- Amazon Sumerian (Figure 3) is a managed service and set of tools for building virtual reality and augmented reality applications. The service provides a web-based editor that allows developers to construct and animate 3D scenes without the need for specialized programming. With this software, it's possible to create mixed-reality applications in several steps. Users can import or upload 3D assets needed for creating educational content.

Figure 3. Creating a virtual space in Amazon Sumerian

- Blender (Figure 4) is open-source 3D creation software that supports nearly every aspect of 3D development. With powerful modeling, simulation, animation, and a range of other tools for complete 3D creation, Blender is full of useful features for creating interactive educational content. Due to its relatively straightforward usability, this software is widely used in VR and AR content creation.

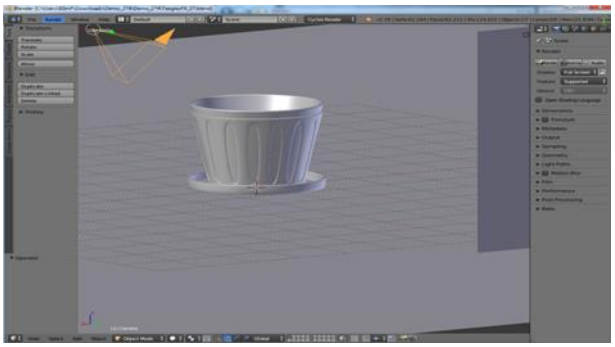

Figure 4. Model creation in Blender software

- Unity (Figure 5) is a cross-platform game development software developed by Unity Technologies. It supports various platforms such as computers, mobile devices, AR, and VR. This service is particularly popular for developing mobile games for iOS and Android. It's considered user-friendly for beginners and can be used to create both 2D and 3D content, as well as interactive simulations and other experiences. This software finds wide application in creating educational content in fields such as the automotive industry, architecture, engineering, construction, and occupational health and safety.

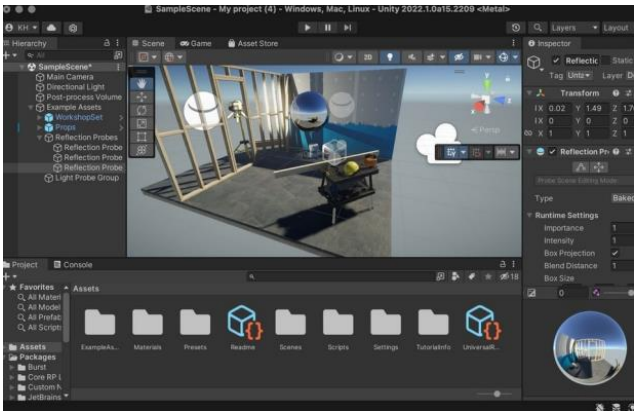

Figure 5. Content creation in Unity software

For creating educational content in VR technology, it's possible to use 360-degree panorama technology for content creation (Figure 6). This method of content creation doesn't require special software packages or specific computer skills; to create content, it's enough to capture a high-quality image or video in 360-degree technology. Using software packages (such as Thinglink) on the captured educational content in 360-degree panorama, it's possible to create interactive scenarios.

Figure 6. Display of created educational content for VR using 360-degree video

CONCLUSION

In this paper, an overview of using advanced VR and AR technologies in education for safe and healthy work has been provided, along with current possibilities for displaying educational content using these technologies. Immersive, semi-immersive, and non-immersive modes of content presentation also define the method of creation or the selection of software tools for content creation. The paper has presented ways in which it is currently possible to create educational content tailored to new technologies. Most educational content can be created using software tools for 3D modeling and animation. Quality educational content arises from a combination of the presented methods of creation, which can be termed the creation of interactive educational scenarios. In practice, the most prevalent software tool currently is BIM, designed for creating content in the construction industry. Challenges that may arise in creating educational content include the relatively small number of people trained to use the software tools for content creation. Additionally, software license constraints can pose a problem. The use of 360-degree technology can adequately create educational content intended for VR without requiring specialized computer skills during content creation. However, the limitation of this content creation method lies in its ability to create content only for existing work processes; it is not possible to depict a process beforehand. In the future, it is necessary to consider all aspects of displaying educational content and strive to use a single software for creating all content intended for education in the field of occupational health and safety. Such software, which would be widely used for creating educational content, would gradually become easier to use over time, reducing the necessary computer skills of the creator. This would allow educators to create content themselves.

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DIGITAL LABOR PLATFORMS – RISKS AND OPPORTUNITIES

Abstract
In recent years, digital technologies have entered into and radically transformed various industries, which shook the foundations of the traditional labor market. Digital work platforms provide new ways of employment, new forms of work and shape the workforce of the 21st century. This paper investigates the dynamics and impact of digital labor platforms on modern society, focusing on the identification of risks and the exploration of potential opportunities that these platforms provide, both to employers and employees. The analysis of those risks and opportunities provides a comprehensive overview of the impact of digital labor platforms on employers, employees, the state and society as a whole, exploring how these factors interrelate and shape the future of work. The conclusions of the research can serve as a basis for the development of policies and practices that support the sustainable development of the digital labor ecosystem.

Key words: digital labor platforms, risks, opportunities.

INTRODUCTION

In recent years, digital technologies have radically transformed and penetrated various industries, shaking the traditional foundations of labor markets. The revolution in information and communication technology, as well as the internet, have initiated a wave of new processes and products, stimulating competition and productivity growth. This has led to the rise of digital labor platforms as a new way to organize work and business [1].

Digital labor platforms have been the subject of interest of the International Labor Organization for some time. Since 2015, the ILO has been studying digital labor platforms considering the implications of this new form of work organization on workers and employment in general [2]. According to the data from the International Labor Organization, digital labor platforms have grown exponentially in the last decade, increasing from at least 142 in 2010 to over 777 in 2020.

Digital labor platforms are also the subject of interest of the European Union. The digitalization of various industries has transformed and decomposed labor markets and business sectors across the European Union, changing the nature, organization and conditions of work. It is considered that the central and most visible stakeholders in this digital transformation are digital labor platforms, which match clients' requests with workers offering required services [3].

EU-OSHA´s approach to digital platform work emphasizes those aspects that are more relevant to occupational safety and health. Digital platform workers are exposed to the same risk factors as those workers performing the same tasks in the traditional manner. However, such risk factors are increased by the organization of platform work. Exposure to physical risk factors depends on the fact whether digital platform work is performed on site or online, whereas psychosocial risks and work-related stress are associated with any type of platform work [4].

Considering the fact that digital platform work is recognized by the ILO and the EU, this paper analyzes the risks to occupational safety and health in this type of work. Concrete safety and health measures can be defined only when the potential dangers of such work are identified. Such an analysis is important in order to enable a high level of employee protection as the advantages of this type of work are numerous, both for employees and employers.

TYPES AND NUMBERS OF PLATFORMS

The main characteristics of platform work are [5]:

- Paid labour is organised through a digital labour platform.
- Specific tasks are performed or specific problems are solved.
- Algorithmic management based on digital technologies, is used to allocate, monitor and evaluate the work performed and the platform workers' behaviour and performance, including reliance on customer rating mechanisms.
- Three parties are involved, namely a digital labour platform, a client and a digital platform worker.
- There is a prevalence of non-standard working arrangements, and digital labour platforms tend to classify digital platform workers as self-employed in their terms and conditions.
- The risks, liabilities and responsibilities, including in the area of safety and health, are shifted onto digital platform workers.

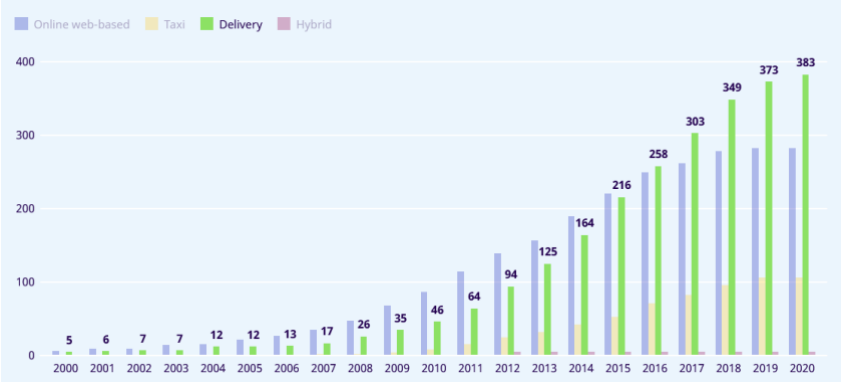
A digital platform worker is an individual person providing labour intermediated with a greater or lesser extent of control via a digital labour platform, regardless of that person's legal employment status. Platform workers can have the status of employee, self-employed or any third-category status.

A digital labour platform is an online facility or marketplace operating on digital technologies (including the use of mobile applications) that are owned or operated by an undertaking, facilitating the matching between the demand for and supply of labour provided by a platform worker [5]. Platforms matching the demand for and supply of goods are excluded (e.g. Airbnb, eBay), as are platforms whereby services are exchanged without remuneration. Labour provided directly to the platforms as employers (i.e. working for a platform), or in related satellite activities, do not fall under this definition.).

The emergence of the platform economy is one of the most important transformations in the business world. Digital labor platforms are an important component of the platform economy. They include both web-based platforms, where work is outsourced to a geographically dispersed crowd - "crowdwork" (for example, freelance and microtask services, competitive programming), and location-based applications, which allocate work to individuals in a specific geographical area, typically to perform local, service-oriented tasks (for example, taxi, delivery, domestic and care services) [1].

According to the ILO, since 2010, there has been a global five-fold rise in the number of digital labor platforms that facilitate online work or directly hire workers to provide taxi and delivery services [1]. ILO is also engaged in the research of the distribution of digital work platforms by type of activity. Thus, Picture 1 shows an increase in the number of such platforms, especially in the delivery sector. This increase has been observed since 2017.

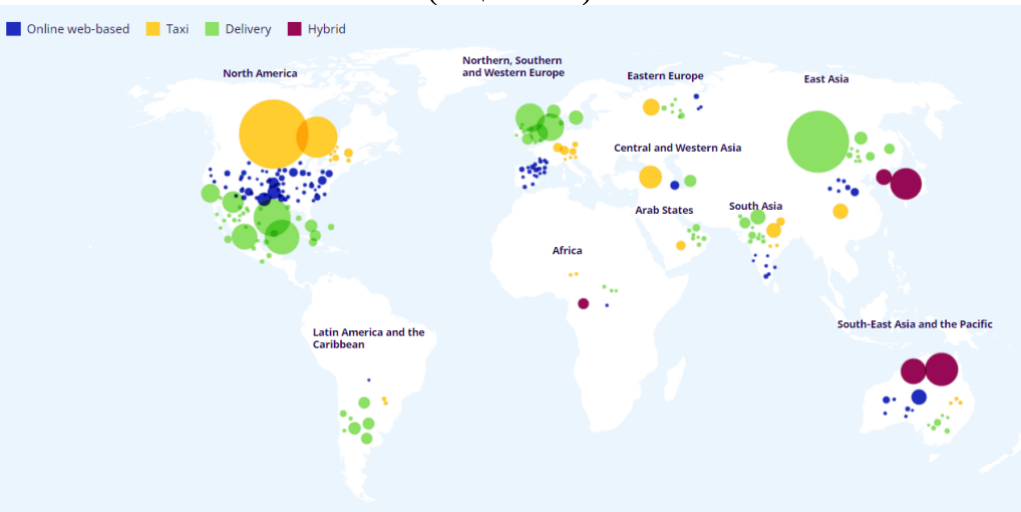
Picture 1. Number of active digital labor platforms in selected categories, globally



Source: [1]

The ILO statistics shows that the greatest share of global revenue from digital labor platforms is concentrated in North America, Asia and Europe. According to the data from 2019, estimated annual revenue of digital labor platforms in selected categories by regions (US$ million) confirms this fact. Picture 2 shows that North America generates most of its income from taxi and delivery services. In Europe, revenues from delivery services are dominant. In Eastern Europe, significant income is also generated from taxi services. Revenue from delivery services in absolutely dominant in Asia. Taxi services come second.

Picture 2. Estimated annual revenue of digital labor platforms, selected categories, by regions, 2019 (US$ million)



Source: [1]

OCCUPATIONAL SAFETY AND HEALTH RISKS

While many see technology as a key part of the solution to contemporary development challenges, new research points to its limitations in promoting development and structural transformation. For many, a central part of the solution to contemporary development challenges – including moving to a greener, digital economy – lies with technology. Digital technologies are changing organizations and conditions of work, including in low and lower middle-income economies, there is little evidence concerning whether, how and under what circumstances these changes can bring about development and structural transformation.

As digitalization advances, even well-educated and skilled workers are facing uncertain working conditions, both in terms of the content of work and the conditions under which they work, thus creating a sweatshop of digital labour.

Table 1 presents “level of control” dimension of digital labour platforms which is particularly relevant from an occupational safety and health perspective. First important issue is the status of employee which is the main factor in the application of employment regulations, including occupational and safety regulation. However, in practice, most digital platforms classify their platform workers as self-employed, despite a rising number of European courts deciding otherwise (albeit predominantly in the personal transport and (food) delivery sector). At the same time, this dimension is strongly interrelated to the reliance of most digital platforms on algorithmic management (and digital monitoring and surveillance) and the way that it shapes working conditions in digital platform work [5].

Two characteristics of digital platform work are key in this regard. First, digital platforms have to manage a workforce that is out of the direct sight of (human) supervisors. Second, many digital platform workers have a high level of flexibility in deciding when, where and how to work. In this situation, a digital platform controls the labour process to maximise the number of tasks completed on time and with good quality. What is unique in digital platform work is that decisions on managing the workforce in the areas of work allocation, work organisation and work evaluation are made on the basis of metrics and ratings (e.g. customer rating mechanisms), which are part of the algorithmic management process through which work is also monitored [5].

Although there is no uniform practice among digital platforms in terms of the pervasiveness in the deployment of such management techniques, initial indications suggest that there is a clear link between the degree of algorithmic control and the rise and exacerbation of occupational risks, in particular regarding the psychosocial well-being and mental health of digital platform workers.

Table 1. Platforms by level of control in various dimensions

Type	Work allocation	Work organisation	Work evaluation	Level of control by platform
1	High	High	High	**High**
2	Low	Moderate	Moderate	**Moderate**
3	High	Moderate	High	**High**
4	Low	Low	Moderate	**Low**

Source: [5]

When recording and analyzing the nature of risks of digital platform work regarding occupational safety and health, it should first be noted that there are "traditional risks" inherent in other types of work. Such risks are related to the issue of ergonomics, for example, non-physiological body positions - long sitting. Also, risks such as insufficient lighting belong to this category.
In digital platform work, special attention should be paid to the harmful effects of mental efforts that are causally related to the workplace and business activity, such as efforts during the performance of certain tasks that cause psychological burdens (stress, monotony, etc.) [6].
Also, the responsibility in receiving and transmitting information, use of appropriate knowledge and abilities, responsibility in rules of conduct, responsibility for rapid changes in work procedures, intensity of work, spatial conditions of the workplace, conflict situations, work with third parties and money, insufficient motivation for work, responsibility in management and the like can be identified as risks. For this type of work, occupational safety and health risks also include hazards related to the organization of work, such as longer working hours (overtime work), work in shifts, work at night, preparedness in case of interventions, and the like [7].
Platform workers also face isolation, work intensification, long working hours and digital monitoring and surveillance that can lead to high levels of stress. However, their employment status limits their access to protection. They face with ambiguous employment status, inadequate access to social protection, weak bargaining power, poor working conditions, and safety and health issues.
Since platform workers are usually self-employed workers, they are responsible for their own occupational safety and health. Platforms are not obliged to adopt measures to increase protection of platform workers.

INSTEAD OF CONCLUSION – OPPORTUNITIES OF DIGITAL LABOR PLATFORMS

Digital labor platforms create new opportunities for businesses and workers, for example for people who might have more difficulties to access the traditional labour market. Simply put, they involve work provided through, on, or mediated by an online platform.
Considering the fact that in recent years there has been an evident global increase in digital work, especially through digital labor platforms, we can draw the following conclusions based on the conducted research.
This work causes two types of occupational safety and health risks. Some are traditional and well-known, such as non-physiological body positions. Others are work-specific. These include night work, velocity in transmitting information and the like. Particular attention should be paid to the dangers of insufficient work-life balance [8] and the risk of presenteeism [9, 10].
In addition to the mentioned risks, the advantages of this work are clearly visible. For example, with such forms of work, it is often possible to have flexible working hours, which has numerous advantages for both employees and employers. Research shows that it enables better coordination of work and non-work duties, harmonized work and daily rhythm of rest, better training, better organization of free time. Such organization of work results in higher productivity and employer satisfaction with increased profits [11].
Another advantage of this type of work is that employees do not necessarily have to work from one location. They can work from any location in the world (e.g. even from public transport) when there are adequate conditions - availability of the internet, computer and the like [12]. This additionally enables workers to balance their professional and personal needs and interests.

Based on the above, we can conclude that there are some occupational safety and health risks that are inherent in digital platform work. However, considering all the advantages of this type of work for all subjects of the labor protection system, it can be concluded that it represents a great opportunity for improving working conditions, employers' profits, as well as employee satisfaction.

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DIGITAL OSH TOOLS AND SYSTEMS AND INTELLECTUAL PROPERTY PROTECTION

Abstract

The process of creating and developing a digital innovation, such as in occupational safety and health (OSH) tools and systems, requires investing significant resources. By protecting innovations through intellectual property titles, companies gain legal protection, which enables them to obtain a return on their investments. Several intellectual property titles are available. However, each is intended to protect a specific subject matter together with legal requirements as to what and how something can be protected. Innovations embodied in digital OSH tools and systems may vary significantly in nature and type. This paper aims at investigating the nature of innovation underlying digital OSH tools and systems with regard to identify IP-protectable subject matter. By doing so, types of intellectual property available for protecting such digital innovation will be investigated. Furthermore, the paper will address IP related issues that have to be considered when developing and employing an innovative digital OSH system and will highlight the importance of establishing the "freedom to operate".

Key words: digital safety system, digital innovation in safety tools, intellectual property rights, freedom to operate.

INTRODUCTION

Digital OSH tools and systems

Digitalization fundamentally redefines and changes our world, by using Information and Communication Technology (ICT) tools and systems to transform how things are done. Workplaces are by no means immune to the impact of digitalization. New tools and systems are emerging rapidly and transforming work as such, as well as influencing the occupational safety and health domain. A number of digital innovations focused on preventing accidents in the workplace, collecting data and analysing risks, as well as promoting safe practices are being utilized. Digital OSH (Occupational Safety and Health) tools and systems refer to any technology that uses digital information and communication to improve workplace safety and health and wellbeing of workers. Innovations that are a part of digital OSH tools and systems may vary significantly in nature and type. Digital OSH tools and systems have already received much attention within the work of the European Agency for Safety and Health at Work (EU-OSHA). EU-OSHA has released three policy briefs to address what they call smart digital monitoring systems, where it has embraced a definition that „digital OSH monitoring systems use digital technology to collect and analyse data in order to identify and assess risks, prevent and /or minimise harm, and promote occupational safety and health" [5]. Some of these tools and systems use sensors, wearables or cameras to collect real-time data on either workplace conditions or workers themselves. By monitoring these factors, potential hazards can be identified and addressed before accidents occur. These are referred to as proactive digital OSH monitoring systems, while reactive systems are those used to minimise the consequences of accidents or emergencies once they have occurred [4]. A number of digital OSH monitoring systems are enabled with new sensor technologies from wearables and smart personal protective equipment (PPE), to advanced PPE which are enriched with novel smart materials that act as sensors and react to environmental stimuli [7]. Wearables are electronic devices worn that can monitor workers health and well-being by tracking vital signs, stress indicators, micro-facial expressions and even tone and sentiment analysis [2] as well as their exposure to hazards or geolocation for rescue operation purposes. Once sensors are integrated in traditional PPE, we referred to it a smart PPE, which enables sensors being placed in locations ideal for monitoring work environment parameters. Smart PPE can also incorporate signalisation systems to alert workers of potential hazards,

and if combined with augmented reality technology, provide workers with OSH-related information. Traditional PPE can also be equipped with smart materials, which act as both sensors and actuators, such as materials with thermoregulation properties used in cooling-heating protective clothing [7]. Digital OSH monitoring systems can employ cameras or other technologies such as radiofrequency identification instead of sensors to monitor workplaces [3].

Within the realm of the broad definition as adopted by the EU-OSHA, we can also consider training tools as digital OSH monitoring systems since they are used for promoting safe practices and thereby promoting occupational safety and health. Online courses, digital training platforms as well as augmented (AR) or virtual (VR) reality can replace or complement traditional methods of training workers how to work safe. Real dangers that occur during the on-the-job training can be avoided by using VR computer-generated scenarios to replicate training scenarios, while AR overlays can project safety instructions and data directly onto a worker's field of vision, providing real-time guidance while they work [7].

Digital OSH monitoring systems also include management and reporting systems that use digital technology to collect and analyse data in order to identify and assess risks: from innovative OSH software for OSH record keeping and management of corrective actions to interactive risk assessment tools [1], and mobile safety applications which allow employers to report work-related injuries. Digital OSH monitoring systems are also those used for analysing huge amounts of data collected by digital OSH systems using sophisticated software, big data analyses and artificial intelligence [2].

Use of robotics and exoskeletons also needs to be mentioned as the usage of robots and drones helps keeping employees away from hazards and exoskeletons work as body-worn auxiliary devices designed to support and assist employees to perform some working tasks, while both may as well be used for monitoring activities [1].

Finally as many devices in a moder workplace need to be employed simultaneously digital OSH monitoring systems based on Internet of Things (IoT) technology are developed to prevent vehicle/person collisions [1] as well as personnel tracking which allows detecting when employees are near dangerous areas in which PPE equipment is required [7].

Although digital OSH tools and systems may come in many different shapes and sizes, and they use different technologies to collect, analyse, and utilize safety-related data, one thing they have in common is that they are usually based on some sort of digital innovation which they incorporate. Innovation rarely happens by itself. Creating innovative OSH tools and systems requires heavy investments in research and development.

Legal systems recognize the effort and ingenuity behind innovations and acknowledge the creator's contribution to society by affording protection through a legal framework of intellectual property rights (IPR). Provided an innovation meets the criteria for the specific type of intellectual property right the protection of which is being sought, inventions can gain exclusive rights for a certain period over their creation, allowing them to recoup their investment and to benefit from their work.

At the end of 19th century, countries around the world embraced the idea of protecting inventions and thereby encouraging development. A number of international treaties were negotiated and adopted with the aim of establishing and agreeing on certain minimum standards of IPR protection. The most common forms of IPR protection for innovations such as patents, trademarks, trade secrets and copyright have therefore been around for many years. Digitalization and emerging new technologies obviously have shaken our world quite extensively and intensively, yet the basic standards for IPR protection remain the same as when established some centuries ago. Digital innovations as well as innovation from any other field have to fit into and satisfy the requirements established for a specific IPR title in order to gain protection. One specific feature of the IPR framework is that intellectual property rights are strictly territorial rights and each country is free to decide whether certain IPR title can or cannot be granted and thereby gain protection in its territory. It should be noted from the outset that there is no IP title that would be protected universally. Although countries cooperate in many aspects of IPR protection, specifically by allowing application for protection of various intellectual property titles to be filed through the World Intellectual Property Organization (WIPO) within the realm of international treaties existing in the field, the territoriality of intellectual property rights protection remains indisputable and requirements under which countries afford intellectual property protection can be interpreted differently from country to country.

Identifying types of intellectual property available for protecting digital innovation embodied in various OSH tools allows creators to consider protecting such creative innovative OSH tools and systems with intellectual property rights, thereby gaining a temporary monopoly over their creation, which will allow

them to offset initial resource expenditure i.e. investments used to develop the innovation. Intellectual property rights are at first private rights: whether someone wishes to benefit from the protection afforded to such rights is up to them. Companies can decide not to secure and withhold any exclusive right in their inventions, however, at the same time, they must respect the rights granted to others, otherwise they risk litigation.

Intellectual Property Rights

There is no universally adopted definition of the term "intellectual property", however as the term comprises a set of rights which fall into this category, referring to different categories of intellectual property rights can adequately substitute a descriptive definition for the purposes of this research. The World Trade Organization Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), which is the most comprehensive multilateral agreement on intellectual property, defines that the term "intellectual property" refers to all categories of intellectual property that are the subject of that agreement [5]. In light of that, the safest and most accurate definition of the term is that "intellectual property" refers to copyright and related rights, trademarks, geographical indications, industrial designs, patents, layout-designs (topographies) of integrated circuits and protection of undisclosed information.
Each of these intellectual property titles that are available protects distinct objects of intangible creativity and inventiveness, thereby affording a different scope of protection. A legal framework established for each intellectual property title defines what is the protectable subject matter. The intellectual property protection strategy or whether any protection is available at all, depends on the nature of the innovation. In many cases, a combination of intellectual property titles might be used for a single innovation in order to achieve maximal protection.
A patent is an exclusive right granted for an invention that offers a new solution to a technical problem. Article 52 of the European patent convention states that patents are granted for any invention, in all fields of technology, provided that they are new, involve an inventive step and are susceptible of industrial application. This exclusive right includes the right to make, use, place on the market or sell the invention protected by the patent, for a limited period of time, in most countries - 20 years from the date of filing the patent application. After that period, the patented invention becomes a public good, available to everyone for use. Patents have to be acquired from an authorised body, and since patents are territorial rights, in order to gain protection in various jurisdictions, it will be necessary to file a patent application in each country and pay registration fees in each jurisdiction to secure protection. Patent applications will be examined as is prescribed by the relevant national law, but certain inventions are excluded from patentability. For example, under the TRIPS standard countries should exclude from patentability diagnostic, therapeutic and surgical methods for the treatment of humans or animals. As applicants are required to disclose the technical details of their invention to the extent that it enables the person skilled in the state of the art to make or use the invention in order to obtain patent protection and such descriptions are published, after a certain prescribed period of secrecy, patent registries serve as a valuable source of information on existing inventions which can be used for further technological progress.
Trademarks are intended to protect those elements that customers identify with a particular product. A trade mark differentiates an undertaking's products or services from everyone else's and may become the most valuable business asset. By protecting a sign under which a product or service is put on a market the technical aspects of a particular innovation can be protected indirectly, provided a strong association between the brand and the innovation is created in consumers' minds. Trademark protection lasts for 10 years but can be extended for an unlimited number of times for further 10 years periods. In that way, even though trademarks do not protect the innovation itself, once a patent expires, continued marketing can reinforce this association, making it more difficult for competitors to take over the market with generic products having identical technical aspects. Although securing trademark protection is strongly recommended, trademarks cannot be used to protect a digital innovation underlying digital OSH tools and systems itself, so they will not be further investigated in the scope of this research. Neither will geographical indications, since that intellectual property title is intended for the protection of authentic products which have certain qualities or a reputation linked to a particular location and can therefore not be used to protect digital innovations.
Industrial designs may be considered to protect certain features of a digital innovation, where such innovation is embodied in a unique shape of a product. Industrial designs protect the appearance of either the whole product or part of it, that results from its features, in particular, the lines, contours,

colours, shape, texture and/or materials of the product itself and/or its ornamentation. Therefore, it may not be used for protecting purely digital innovations, but if such innovation is also connected with some unique appearance of a physical product, it may be considered.
Copyright and related rights protect original works of authorship that are the result of intellectual or artistic expression, and as such can be used to protect certain aspects of a digital innovation. However, copyright does not protect the underlying concepts themselves or the idea behind any innovation or creation. It is only the specific expression of such an idea that is protected. Unlike with patents, no registration process is envisaged.
Another IP right that should also be considered are trade secrets. The protection of trade secrets does not create any exclusive right over the information that is held confidential, however, keeping certain information on how a digital innovation functions secret, can create a sort of factual monopoly and advantage over one's competitors, who cannot put the same tool or system on the market without the necessary information. There is no registration process envisaged and one can profit from commercialization of trade secrets for an unlimited time, i.e. as long as one keeps such information undisclosed.

METHODS

This paper aims at investigating the nature of innovation underlying digital OSH tools and systems in order to identify IP-protectable subject matter. In doing so, types of intellectual property available for protecting such digital innovation will be examined. A qualitative method will be used to gain a comprehensive understanding of the innovation underlying digital OSH tools and systems. Specifically, upon a literature review of the existing digital OSH tools and systems, its different components will be analysed in respect of the digital innovation underlying such digital OSH tools and system. Based on the analysis, core elements of digital innovation underlying such digital OSH tools and system will then be compared with the legal environment for protecting the following IP rights: patents, copyright, industrial designs and trade secrets in order to identify IP-protectable subject matter. The most suitable type of IP right(s) for protection of different digital OSH tools and system will be thus examined and determined. Furthermore, the paper will address IP-related issues that have to be considered when developing and employing an innovative digital OSH system and will highlight the importance of establishing the "freedom to operate".

RESULTS

Patents

Patents are exclusive rights for inventions that are novel, have an inventive step (i.e. non-obvious), and are industrially applicable. As already mentioned, inventions from all fields of technology may qualify for patent protection. However, there are some limitations as to what might be a patentable subject matter. As patents are territorial rights, these limitations may vary from jurisdiction to jurisdiction, but mere discoveries, theories or mathematical formulae are, as a rule, not patentable as such.
In Europe, Article 52(2) of the European Patent Convention (EPC) contains a non-exhaustive list of subject-matter which is not to be regarded as inventions. It states that "the following in particular shall not be regarded as inventions within the meaning of paragraph 1: (a) discoveries, scientific theories and mathematical methods; (b) aesthetic creations; (c) schemes, rules and methods for performing mental acts, playing games or doing business, and programs for computers; presentations of information." It should be emphasised that the subject-matter or activities on the list are excluded only if the patent application relates to them "as such".
Patents protect inventions that offer a new solution to a technical problem, and therefore in Europe, following the European Patent Office (EPO) Guidelines for Examination, the subject-matter for which protection is sought must have a "technical character", whether these inventions relate to a product, a process or an application, including inventions carried out using computers. The deliberations on patentability of inventions using digital technologies must clearly distinguish between computer software as such, which cannot be patented in Europe by direct application of Article 52 (2) of the EPC, from the so called "computer-implemented inventions". Hardware components as well as novel and inventive processes, even if the sequences of steps in these processes are carried out on a computer using software, are patentable. In other words, software devoid of any context is not patentable, whereas software running on a device which thereby creates some sort of further useful technical effect, may

well be patentable. In Europe, computer software on its own can be protected by copyright, but not by patents. The practice of the EPO Boards of Appeal was set in case T 1173/97 already in 1997, and clarifies that “a computer program product is not excluded from patentability under Article 52(2) and (3) EPC if, when it is run on a computer, it produces a further technical effect which goes beyond the "normal" physical interactions between program (software) and computer (hardware)”. Inventions that consist of such software, whether the software is loaded into memory, transmitted over a network or distributed on a data carrier, claim patent protection of a ‘computer program' or ‘computer program product' in addition to a computer-implemented method.

The United States are known to be more flexible on protecting software patents. While patent legislation in Europe focuses more on the technical innovation implemented through computers, in the United States patent law requirement for “technical character” does not exist and the question on patentability will be focused on strictly prohibiting patenting of abstract ideas. For many years the United States law merely required that the invention produced a “concrete, useful and tangible” result, which software-related invention usually do [9]. However, that drastically changed in 2014 with the US Supreme Court decision in Alice v. CLS Bank case, which made attaining such patents far more complex. For determining whether a particular software is patentable, it must not be directed to an “abstract idea.” If it is, then the patent application must claim some elements that “transform” the claimed invention into a patent-eligible invention. With endorsing a theory that the exceptions to patent eligibility (including the abstract idea exception) are substantive limitations meant to protect against overly broad patents, it remains possible, but not without challenges, to register software patents in the US, in particular if those are regarded as “narrow”[10]. This paper will hereafter focus on patentability from the European perspective.

A number of digital OSH monitoring systems that comprise new sensor technologies, such as wearables and smart personal protective equipment, would be considered patentable subject matter in Europe. The technology underlying these innovations generally comprises a series of steps to solve a technical problem and the process is carried out by using software. Provided that these method steps solve a technical problem in a novel and non-obvious manner, they may be patented, as this would be considered a computer-implemented invention. In these types of computer-implemented inventions, some method steps are performed outside a computer, by a sensor. A sensor is a specific technical means which measures some parameters. The signals received and produced by the sensors are used by the software to trigger a reaction which solves a technical problem. Inputs and outputs from physical devices are taken by a software and an innovative device operates according to parameters received and instructions given by a software.

Digital OSH monitoring systems that consist of wearable electronics integrated within the protective gloves for fire-fighters could illustrate such an example. The system integrates temperature sensors for monitoring human temperature on the back of the hand; a thermocouple for fast measurement of contact heat and a barometer for the detection of atmospheric pressure changes signals to fire-fighters when a dangerous situation occurs, through two miniature vibration motors embedded in a flexible part of the glove. In patent terms, this represents a method of generation of vibration signals in case of a dangerous situation, where sensors measure the parameters which define a dangerous situation, and according to such inputs and instructions a software operates vibration motors to generate vibration signals for fire-fighters. A patent application for such computer-implemented invention would feature a flow diagram for the method showing the decision steps in the process, and any interactions with devices and external inputs and outputs. A patent for such an invention would protect the combination of the devices and the computer carrying out the novel method. The method has steps which are executed by specific technical means (the sensors, the control device and the vibration motors), which therefore have to be defined in the device claim because they are essential features for executing the method. Such patent application would therefore claim patent protection in a method of generation of vibration signals in case of a dangerous situation for fire-fighters through their PPE (gloves), comprising: (1) receiving, in a control device, signals from sensors arranged to detect when heat or pressure changes and thereby a dangerous situation occurs, (2) generating vibration signals, by miniature vibration motors embedded in a flexible part of the glove, when a dangerous situation occurs. It would also consist of a second patent claim in a system for generation of vibration signals in case of a dangerous situation for fire-fighters, the system comprising sensors, the control device and vibration motors embedded in a flexible part of the glove, the sensors arranged to detect a dangerous situation, the control device arranged, to receive said signals and initiate vibration models, in case of a dangerous situation, and vibration motors to receive said signals and generate vibration signals. The third claim for this patent would then claim protection of a

computer program (product) comprising instructions which, when loaded and run on the system of claim 2, causes the control device to perform the corresponding steps of claim 1.

By constructing the patent claims in a same or similar vein as explained above, a number of digital OSH monitoring systems are in fact patented. One example is a patent granted for a wearable safety device for covering the body part of an operator of a machine tool with highly sensitive magnetic field sensors embedded within, which automatically and immediately stop the machine tool when it is too close to the operator's body parts [7].

Further examples of patented OSH monitoring systems can be found in the field of smart personal protective equipment. An example is the patent filed through the WIPO PCT system under number WO 2018/208254 for an invention called "the new generation safety glasses". It relates to new safety glasses that ensure usage and control of the safety glasses (which use is legally mandatory in terms of OSH) without leaving such use to the discretion of the employees. Such safety glasses prevent operation of the instrument used by the worker when the worker fails to put on the glasses, and reports such failure to the person in charge. Further, they daily store the data on glasses usage status and communicate such data to the person in charge.

Patenting technical inventions implemented wholly as computer programs is also possible according to EPO Guidelines for Examination, even if no method steps are performed outside a computer that would require specific technical means, such as sensors. A multi-step process for solving a technical problem may be patented even if the process is carried out using exclusively software and no method steps are performed outside a computer. Such inventions should contain a set of claims which start with a method claim (such as: "A method carried out by a computer comprising the following steps"), which defines the steps performed by a computer, or other data processing means capable of running software, to achieve the desired technical effect. The further technical effect is the crucial point in terms of patentability of these, as well as any other, inventions. Such inventions are patentable provided that the method is capable of bringing about, when running on or loaded into a computer, a further technical effect going beyond the "normal" physical interactions between the program (software) and the computer (hardware) on which it is run. Such technical effect may be a result, for example, of the control of an industrial process or the working of a piece of machinery. Any digital OSH monitoring system which would involve software programs for tracking machinery and equipment, including Internet of Things (IoT) technologies that would be developed for preventing vehicle/person collision, would be able to show such further technical effect. Conversely, innovative OHS software does not provide such further technical effect if it is developed for ensuring OHS data is stored and maintained digitally, incident reporting is performed digitally or risk assessment is made easier, since this application relates merely to "schemes, rules and methods for (...) doing business". These are not patentable since such new methods do not solve a technical, but rather an administrative problem.

Patenting novel smart materials which are being developed and are frequently used for advanced PPE is also an attractive option. However, identifying patent-protectable subject-matter and defining patent claims can be challenging when it comes to such advanced materials. As stated previously, patents protect inventions that offer a new solution to a technical problem, whether these inventions relate to a product, a process or an application. Product patent protects the product itself, whereas the process patent protects the process of obtaining something and not the product by which it is obtained. Ideally, if someone has developed a novel smart material, they may want to secure patent protection of such novel material as well the process of making it. Additionally, even if the purpose of developing such new material has been to create advanced PPE, the usage of such a material might have commercial perspective in other sectors as well, and therefore the protection of different uses of such materials should also be patented. In order to obtain a product patent for smart materials, the product claim has to be carefully drafted. One option would be to recite or explain the structural features which define such material. If this is not possible because the new material is a composite or an alloy, or if such structural definition would be too narrow to capture the true scope of the invention, a product-by-process claim can be made before the EPO. Such product-by-process claims are understood to be directed to the product itself, and not limited by the process used to make it. The technical content of the invention lies not in the process per se, but rather in the technical properties imparted to the product by the process. The claim may, for instance, take the form of "Product X obtainable by process Y" and it is still directed to the product *per se* and confers absolute protection upon the product. It is also possible to define the product with its parameters. This would be the case if the new smart material is defined in a patent claim with its characteristic values, for example: a new material with super-absorbing polymers having ability to absorb and retain specified amount of liquid per specified weight. In addition to an independent claim

for a given product, an independent claim for a use of said product can and is often made. One patent application would then finally contain three independent claims, where one would be the product claim for the new material with super-absorbing polymers, the other would be the process claim directed to the process of manufacturing this new material, and the third patent claim would indicate that, for example, such new material is applied under the tight protective clothing to prevent liquid sweat on the skin [7]. Some new, smart materials may require sensors and control units to function and are used as a part of a system embedded into the PPE. There are examples of smart materials which generate electricity as a consequence of certain optical stimuli are used in smart PPE as actuators in cooling-heating protective clothing or for user interfaces based on helmet-mounted displays [7]. In those examples patent application drafting requires constructing a patent claim, as explained in relation to computer-generated inventions.

Strong patenting activity is suggested by the European Patent Office, particularly in the field of fire-fighters' clothing with composite materials and multi-layered non-flammable fabrics continuously being developed and improved, as well as innovative features in garments, gloves and helmets to allow carriable equipment to be attached, integrated or stored, to incorporate sensors and/or some means of cooling.

Another point that needs to be made when discussing patentable subject-matter in relation to OSH monitoring systems is that innovation can also relate to a new use for an existing product or existing technology. As stated, patent will be granted for new, useful, and non-obvious inventions solving a technical problem. However, this does not mean only revolutionary and groundbreaking innovations are patentable. Improvements of pre-existing products and inventions, as well as the protection of the use of the product for a purpose other than previously known may be patented provided that such an improvement or such new use is novel, involves an inventive step (i.e. is not obvious) and has industrial application. When patenting such innovations, usually the biggest challenge is to overcome the test of whether such invention involves an inventive step. Here the issue is whether an average skilled person in the relevant field of technology could have arrived at the invention by modifying the prior art in the expectation of some improvement or advantage. Therefore, if an existing technology is merely applied in some additional field which would be an obvious application that any average skilled person would expect and anticipate, the invention is not patentable. However, if such improvement or application is not obvious as it involves an inventive step, it may be patented. The improvement could also consist of an alternative to a known apparatus or process which provides a similar effect or is more cost-effective.

Many digital OSH monitoring systems may use some digital technology which could be around for decades and still introduce a novel and non-obvious use or improvement of such technology when applied in the OSH field. This could be the case of digital OSH monitoring systems which use VR or AR technologies. Invention of these technologies dates back to 1960’s and has been commercially exploited in the gaming industry extensively. Applying VR to teaching workers how to work safely is yet another obvious application of such technologies, as they are used for training in many different fields. However, AR overlays can project safety instructions and data directly into a worker's field of vision, providing real-time guidance, while they work or provide information to the worker about hidden hazards like asbestos and gas pipelines in their work field [1], which might not be an obvious application of such technology and therefore patentable. A welding helmet which is used as PPE during manual welding process which would be integrated with an AR module to instruct the welder on welding gun positions or a fully transparent display positioned beneath a protective visor of an industrial helmet equipped with an AR module to project safety instructions or even early warning signals when combined with cameras and sensors [7] could be claimed to achieve a surprising or unexpected technical effect, and should not be considered obvious.

Exoskeletons are devices that are worn to support and assist movement, or augment the capabilities of the human body and represent another example of patentable subject-matter, provided that the requirements of novelty and inventiveness are satisfied. There are multiple types of exoskeletons and multiple applications for those devices, including in the OSH field. If a device is constructed to address a specific OSH-related use, which thereby solves a technical problem in a novel and non-obvious way, patent protection could be obtained. In the same vein, autonomous robots, operating robot arms or drones can be designed for performing certain specific hazardous tasks. If they thereby solve a technical problem in a new and inventive manner, such innovations may as well be patented.

AI technologies, including neural networks and deep learning, have also been known for a long time. Recently, they have developed dramatically and with the appearance of general-purpose AI models and generative AI, they tend to have an enormous impact in all technology fields. Digital OSH monitoring

systems that use AI technologies to prevent harm and predict accidents and emergencies are no exceptions. In terms of patenting such innovations it should be noted that AI is considered a branch of computer science, and therefore, inventions involving AI are considered computer-implemented inventions. Everything already said before in relation to patenting of computer-implemented inventions should also be observed in relation to inventions involving AI. AI is based on computational models and mathematical algorithms which are *per se* of an abstract nature. Nevertheless, patents may be granted when AI leaves the abstract realm by applying it to solve a technical problem in a field of technology. For example, the use of a neural network in a heart-monitoring wearable for the purpose of identifying irregular heartbeats makes a technical contribution. The classification of digital images, videos, audio or speech signals based on low-level features (e.g. edges or pixel attributes for images, de-noising, detecting persons in a digital image, estimating the quality of a transmitted digital audio signal) or providing a medical diagnosis by an automated system processing physiological measurements are other typical technical applications of AI mention in the EPO Guidelines for Examination. The patent claim is to be functionally limited to the technical purpose, by establishing a sufficient link between the technical purpose and the mathematical method steps, for example, by specifying how the input and the output of the sequence of mathematical steps relate to the technical purpose so that the mathematical method is causally linked to a technical effect.
Another legal requirement on granting patents might be of relevance here. Invention whose commercial exploitation would be contrary to "*ordre public*" or morality are excluded from patentability. This exception relates to cases where commercializing a given technology would be contrary to European legislative or otherwise democratically established policy (i.e., public policy) or norms accepted as fundamental to European society (i.e., public morality) [6]. When applying the public policy and morality exclusion on patentability on inventions involving AI, it should be noted that the recently enacted EU AI Act lays down horizontal rules on AI systems in Europe and defines certain particularly harmful AI practices which are defined as unacceptable risk and are therefore prohibited as contravening EU values. An AI system that is prohibited by the EU AI Act would not satisfy the public policy requirement and would therefore not be patentable. Other AI systems may be defined as “high-risk” and have to follow strict requirements envisaged by the EU AI Act to be placed on the market in Europe. A technology that does not satisfy the obligations for “high-risk AI Systems” under the AI Act would also not satisfy the public policy requirement and would therefore not be patentable. AI systems that create or expand facial recognition databases through the untargeted scraping of facial images from the internet or CCTV footage, are prohibited under the EU AI Act. AI systems to infer emotions of a natural person in the areas of workplace and education institutions are also prohibited except in cases where the use of the AI system is intended to be put in place or into the market for medical or safety reasons. It follows from the above that digital OSH monitoring systems that use facial recognition to identify workers that have not been trained properly to approach certain areas or tools or to detect if proper PPE is worn would therefore not be excluded from patentability under the public policy and morality exclusion as long as they are employed solely for safety reasons.

Copyright

In Europe, computer software on its own can be protected by copyright, but not by patents. In cases where no further technical effect is provided with OHS software, such software would not be patentable, but might still benefit from intellectual property protection in the form of copyright. However, the logic of protection and the scope of such protection is quite different than in case of protection gained through a registered patent. Copyright mainly focuses on protecting original works of authorship that are the result of intellectual or artistic expression. Copyright legislation understands software in terms of copyright-protected objects as any other literary work such as a novel or a poem. What is protected is the program source code which makes that computer program. Copyright protection safeguards the specific intellectual or artistic expression of one’s idea, but not the underlying concepts themselves. In the same vein in which the copyright on a novel protects the author's unique storyline and characters, but not the general idea of a story, the copyright on such software protects the unique source code, but not the general idea of what a software makes the computer do.
Even though the source code behind an innovative digital OSH monitoring system can be protected by copyright, this will not shield the core functionality or the concept behind such innovation. Unlike patents, there is no formal registration required to benefit from such protection. If the source code is original and creative, it is protected from the moment when it is created and fixed in a tangible form.

The developer retains exclusive rights on the source code underlying the digital OSH monitoring system from the moment it is coded. However, these exclusive rights relate to the right to reproduce, distribute, adapt, and publicly display such source code, but not to the exclusive use of the concept underlying that software.
Any creative element contained in or around a digital OSH monitoring system can also benefit from copyright protection. A creative expression can be found within the user interface (UI) of a digital OSH monitoring system, such as an artistic design or layout. In such a case, the creative elements of a digital interface are protected by copyright, but this protection does not extend to other non-creative elements or to the concept underlying such a digital OSH monitoring system. Audiovisual works linked to the innovation, such as instructional videos or animations or written instruction or documentation explaining the innovation's functionality are also protected if they can demonstrate originality and creativity. The level of creativity that is required for copyright protection may vary significantly between various jurisdictions. Original works of authorship are often part of digital training tools since training materials, as well as on-line courses and modules content, such as videos, text, graphics, and audio recordings, usually qualify for copyright protection.
Many digital OSH monitoring systems could be dependent on or be deployed for collecting data on workplace safety. Databases containing such data could also qualify for intellectual property protection. Examples such as a database to record accidents, near misses, and safety hazards reported by employees which allows for tracking trends, identifying recurring issues, and implementing preventative measures or records of completed safety inspections in different areas of the workplace, along with identified hazards and corrective actions taken come to mind [1]. Databases listing all equipment used in the workplace, including maintenance schedules, safety certifications, and any potential hazards associated with specific equipment or a central database for hazardous materials used in the workplace are also relevant examples [2]. When such databases are an original intellectual creation, copyright protection is available to protect the structure of such database, but not its content. However, the content of such database is also protected in Europe with a *sui generis* database rights. To benefit from the *sui generis* database right, one must prove that a substantial investment (financial, material and/or human) has been made in either, the obtaining, verification or presentation of the database content. The exclusive right granted prevents the extraction and/or reuse of the whole or a substantial part of the database's content for 15 years, starting either from the creation date or from when the database was first made publicly available.

Industrial designs

Industrial design rights protect the appearance of a product, i.e. the ornamental or aesthetic aspect of a product which results from the features of, in particular, the lines, contours, colours, shape, texture and/or materials of the product itself and/or its ornamentation. An industrial design may consist of three-dimensional features, such as the shape of an article, or two dimensional features, such as patterns, lines or colour. There are two kinds of designs in Europe: unregistered design and registered design rights which can be protected for the whole European union by the European Union Intellectual Property Office (EUIPO) or nationally, by Member States national authorities. For all, one of the main requirements for the protection is its novelty. Therefore, the right should be obtained by initiating adequate procedure or secured in case of unregistered designs before the product has been put into circulation or before the design has been made available to the public otherwise.
Unique design of any product which is used as a digital OSH monitoring system can be protected as industrial design. Unique shape of a robot, drone or of a piece of PPE like helmets, boots or similar could tend to appeal to the costumer or users with their appearance. Such unique appearance is therefore also protectable subject-matter. However, industrial design right protects only the appearance of a product as such, and not its functional aspects. Therefore, it does not grant any exclusive right on the functional aspect of such product and competing products can contain the same functional aspects as long as the unique appearance of the product is not used.
Even though industrial design right was initially envisaged for the protection of physical products such as three-dimensional objects, it can also be used to protect intangible or two-dimensional user interfaces (UIs). Designs of screen displays and icons, graphic user interfaces and other kinds of visible elements of digital innovations are also eligible for registration. When applying for registered industrial design following the EUIPO Designs Guidelines, these designs should be represented by a short sequence of views used to show a single animated design at different specific moments in time, in a clearly

understandable progression (snapshots) or with an animated graphical user interface (design of an interface).

Trade secrets

Protecting trade secrets is one of the obligations of countries under the TRIPS, where a definition of trade secrets is also given. Surprisingly, it is not patents, copyright, trademarks or designs but trade secrets that are the most common form of intellectual property businesses rely on to protect their competitive advantage [8]. There is no formal registration procedure envisaged and it does not grant any formal and exclusive intellectual property right to the trade secrets holder. However, as long as an information is not known publicly and remains secret and the holder has undertaken reasonable steps to keep its secrecy, provided that there is a value attached to such information because of the fact that they are secret, legal protection is assured in cases where such information would be disclosed in a manner contrary to honest commercial practices. Competitors may develop such information themselves independently and may even engage in reverse engineering to find out the information kept secret, but must not engage in unfair competition such as industrial espionage, bribing or similar to learn the content of such secret information.
If the core functionality of a digital innovation relies on algorithms or processes and methods that cannot be easily duplicated and are not self-evident, protection of trade secrets might also be considered. This involves taking reasonable steps to keep this information secret to prevent unauthorized disclosure or use. Such steps are undertaken by legal means, where confidentiality obligations are imposed by non-disclosure agreements, corporate confidentiality policies are enacted and physical and electronic security measures including disclosing information to employees on a need- to-know basis are adopted within a company. When a digital OSH monitoring system is an AI tool, the algorithm underlying such a tool can be held as a trade secret by its manufacturer. If patent protection is also available provided that the AI is applied to solve a technical problem in a field of technology, one must choose between the two. Patent protection requires disclosing the invention in the patent application. Therefore, if a patent application is filed and the algorithm underlying such digital OSH monitoring system is disclosed in the patent application, then the algorithm will not be secret anymore and protection of trade secrets is no longer available.

DISCUSSION

There is a great potential for protecting innovations underlying digital OSH monitoring systems with different intellectual property rights and thereby securing significant investments made to develop the innovation. Most digital OSH monitoring systems analyzed would qualify as "computer-implemented inventions" and are therefore patentable. However, to qualify for patent protection in each individual case, the invention has to be new, has to involve an inventive step and has to have industrial application. The requirements of novelty and inventiveness will be examined by patent granting authorities in relation to existing prior art consisting of not only prior patent applications or commercially available products on the market but also everything that can be found worldwide, physically or otherwise. Following the EPO Examination Guidelines that could be "everything made available to the public by means of a written or oral description, by use or in any other way, before the date of filing of the European patent application". Therefore, even if there is nothing similar on the market yet, it may still not be novel as many inventions never make it to the market for some reason. If the invention is in fact new and it solves a technical problem in a novel and non-obvious way to the person skilled in the art, the patent will be granted. The assumption is that no further obstacles for protection exist from the public policy and morality standpoint. However, in order to get to the point of registering a patent even if these basic requirements are satisfied, the process is quite costly and lengthy. Drafting of patent claims and the way in which the claims are constructed may be decisive in passing the patentability test, as well as later on for securing the adequate scope of patent protection. This requires the services of a patent attorney. Securing patent rights further requires payment of registration fees and since patents are territorial rights, the costs of fees and patent attorney services for each territory where the patent will be registered have to be taken into account. The complexity of the patent registration system as well as the cost issue often discourage inventors in patenting their innovations. A patent right is a private right and allows the holder to license the right to use the patent upon royalties payment and to prohibit anyone

else from using it without the holder's explicit authorizations. However, patent litigation is needed to secure this exclusive right against anyone that would breach patent rights, which is again complicated, expensive and might have to be initiated in many jurisdictions. For these reasons, companies may opt not to secure patent rights over their innovations underlying digital OSH monitoring systems.
Other intellectual property rights might be easier to obtain. Copyright protection requires no registration, trade secret protection is available if reasonable steps are undertaken to protect the confidentiality of such information and registration of industrial designs is usually not a costly process, it is simple as it requires showing the appearance of a product and not drafting patent claims. However, copyright protects the source code or some creative elements contained in a digital OSH monitoring system, but not the product, the method of functioning or the concept underlying such innovations. Industrial design registration might complement patent protection since it will ensure exclusivity over certain aesthetic components and the appearance of a product or the user interface of a digital OSH monitoring system, but again, not its functionality. Trade secrets might be an alternative to patent protection when the digital innovation is not self-evident from the product put on the market as it involves certain algorithms, such as in AI tools, that are a part of a digital OSH monitoring system. However trade secrets are not exclusive rights and therefore cannot be invoked against competitors that do not engage in unlawful acquisition, use and disclosure of such trade secrets who have developed the same tool in a honest and fair way.
Looking from the other side of the coin, since companies that have invested in research to develop innovative digital OSH monitoring systems might have secured intellectual property rights underlying these inventions, companies entering a market have to be aware of the potential risks of infringing such rights and consequently being sued. When developing or deploying new digital OSH monitoring tools and systems, companies should consult databases of patents applied for or registered in the field for two reasons. First, in doing so, they diligently investigate if there are patents already secured that might present an obstacle in terms of the company potentially being sued for patent infringement. Second, further development and research should be done in those area where no exclusive rights exists and which is therefore free to operate in. With the help of the international classification systems used to organize inventions by subject, patent searching is helpful not only in determining the above described "freedom to operate" but also in preventing investments in development only to end up reinventing or rediscovering something already known before. Patents developed in other areas might also be relevant as they might present an even better solution to a same or similar technical problem making the innovation commercially unprofitable.

CONCLUSION

Different types of intellectual property available for protecting digital innovations embodied in various OSH tools have been identified. Patent protection is available for inventions that are novel, have an inventive step (i.e. non-obvious), and are industrially applicable. However, computer programs are not patentable in Europe where the subject-matter for which protection is sought has to have a technical character in order to be patentable. Computer program products are however patentable if they produce a further technical effect. These are referred to as "computer-implemented inventions". OSH monitoring systems which are enabled with new sensor technologies consist of technology that comprises a series of steps to solve a technical problem and the process is carried out by using a software which is by definition considered a computer-implemented invention. Here the method has several steps which are executed by specific technical means and the patent claims have to be constructed accordingly. Even those digital OSH monitoring systems that are exclusively implemented by a computer and do not require specific technical means such as sensors are patentable as long as they define certain method steps to achieve the desired technical effect and not just the method for doing business which would not solve any technical problems, i.e. a computer program as such. Novel smart materials are patentable as product patents related to such novel materials, while the process of obtaining such material as well as an innovative use of such material might also be patentable.
Patenting a new use in OSH field for an existing product or existing technology is possible if such use is novel and non-obvious. Computer software *per se* can be protected as copyright. However exclusive rights on the source code are thereby acquired, but not to the exclusive concept underlying the software i.e. what such software does. Protection of the content of databases relating to workplace safety is available in Europe if a substantial investment has been made in creating the database. Industrial design protection may be considered to protect the unique shape of a piece of PPE, a robot or other products incorporating a digital OSH monitoring system as well as a user interface. Trade secrets might be an

attractive alternative to patent protection when the functionality of a digital innovation in an OSH monitoring system relies on algorithms or processes and methods which are not self-evident and can be kept confidential. Patenting a digital OSH monitoring system is challenged with high costs, drafting patent claims is very complex and the registration process is based on the principle of territoriality. Other intellectual property rights might be easier to obtain, but have a limited scope of protection in comparison to patents when digital OSH monitoring system are at issue. To avoid litigation before placing a digital OSH monitoring system on the market, the freedom to operate should be investigated as competitors might have already secured intellectual property right over their innovations.

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Tatjana Golubović

DIGITALIZATION IN CHEMICAL LABORATORIES: ADVANTAGES AND CHALLENGES

Abstract
The role of digitization in today's competitive working environment is becoming increasingly important. When it comes to modern laboratories, the improvement of technologies is also essential. Digitalization and automation of laboratories have diverse benefits, regardless of laboratory type or size. Digitalization of chemical laboratories involves the use of digital technology to collect data, automate processes, establish trends, and make better decisions. Effective laboratory digitalization requires connecting as many operations, instruments, people and systems as possible. When it comes to the advantages of digitalization, it is important to note increased efficiency and productivity, cost savings, increased flexibility and resilience, better inventory management, improvement of safety and health working conditions (installation of RFID-tags on chemicals, the installation of sensors for detecting chemical, physical, and biological hazards, etc.). The digitalization of chemical laboratories is a trend that is unavoidable due to its scientific advantages, still, it is accompanied by many challenges, such as the data converting, digital security, standardization of laboratories, etc.

Key words: chemical laboratories, digitalization, benefits, challenges.

INTRODUCTION

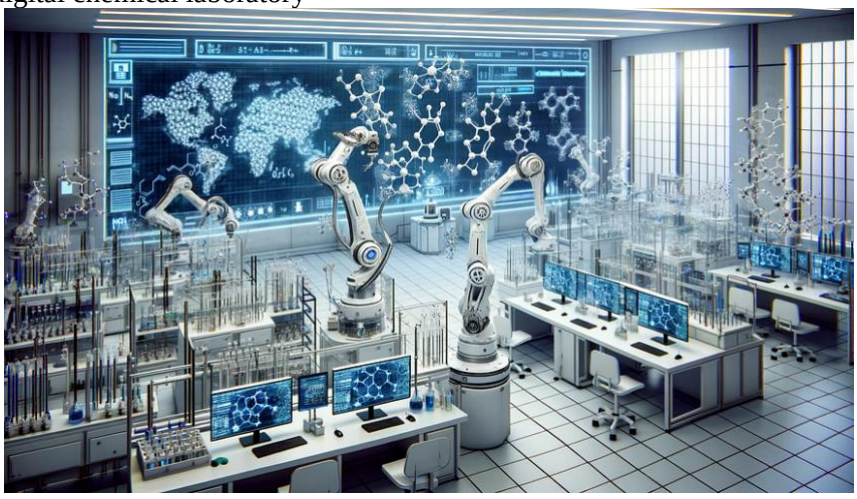
Digitalization is the process of moving to a digital business, through the usage of digital technologies to transform a business model and ensure novel income and value-producing possibilities. Following the global trends, enhancing laboratory digitalization is an important process. Digital development in the laboratory has the potential to basically change the laboratory work processes. Technological progress are possible in all types of laboratories (chemical laboratories, laboratories of quality control or research and development in the food industry, the pharmaceutical sector, and a wide variety of technological industries) [1]. Digital transformation is the driving force of the 4th Industrial revolution. Aapplication of Industry 4.0 in laboratories is referred as Lab 4.0. The transformation to Lab 4.0 requires processes that upgrade digital maturity. A variety of technologies in digitalized laboratory (robotics, artificial intelligence (AI), Big Data, clouds, and the Lean Lab concept) are helping to automate, simplify and optimize lab work. These technologies enable automated sample analysis, remote monitoring of experiments, as well as data sharing between connected lab devices [2]. Also, the concept of smart laboratory is important for safe work in the laboratory. The use of robotic to perform repetitive laboratory technical tasks can be used for research, product development and testing. The use of robotic and automated platforms (lab automation) can, at the same time, improve the reliability, reproducibility, traceability, and intensity of lab operations relative to manual approaches. As a result, lab automation can make a substantial contribution to improving the end-to-end innovation efficiency of academic labs, as well as labs in different corporations. Recently, applications of AI in chemistry have become increasingly well recived. However, it is obvious that growth has not been uniform in different areas of chemistry. AI tools are significant from discovering of new molecules to automating complex chemical synthesis and other reactions and procedures. According to relevant data, the international data market already grows six times faster than the entire IT sector. The arrival of the big data period in chemistry and the life sciences requires the progress of new computational analysis methods, significant both from the aspect of science and from the economic point of view. A large amounts of data can be stored in clouds and managed quickly and easily. To additional increase productivity in the laboratory, lab processes and procedures must be established on the concepts of lean management [3]. Despite the benefits brought by digitization, there are also a large number of challenges, such as: protection, security,

and integrity of data; lab staff are afraid of being replaced by systems and devices; standardization of laboratories refers to the establishment of uniform standards, procedures and protocols, etc.

DIGITAL TECHNOLOGIES INTEGRATED IN CHEMICAL LABORATORIES

The digital transformation of laboratories is a progressive process, that change the manner laboratories are designed, built and run. Several technologies are helping to drive this transformation, ranging from artificial intelligence (AI) to laboratory information management systems (LIMS).“An information management system (IMS) refers to any framework of software that facilitates the collection, storage, organization, and distribution of information“ [4].

Figure 1. The digital chemical laboratory



Source: [https://oluwafemidiakhoa.medium.com]

Robotics

Considering that chemistry experiments require considerable effort and time, are often demanding in terms of reproduction, and usually are conducted by chemists (human), there is a growing effort to realize self-driving labs (Figure 1). Self-driving laboratories combine artificial intelligence with automated robotic platforms to achive autonomous experimentation. In chemical laboratory, reliability and reproducibility are very importante. Errors (systematic or individual) have a significant impact. To minimize sources of error, robotics can help by automating standard activities. Also, automation can increase sample throughput, which means huge time savings. When it comes to challenges, they can be classified into two basic categories: cognitive processes and motor function. The challenge of replacing human cognitive processes comes from bringing machine learning algorithms into the “real chemistry world”, encountering unexpected or difficult to predict results, and trying to automate instruments that are designed to be used by humans [3,5,6]. The other category of challenge is replicating or replacing certain actions that are easy for humans due to fine motor skills and hand-eye coordination. It is important that chemistry robots are supplied with a plentiful repertoire of general and chemistry domain-specific perception and manipulation skills [7,8]. They must be capable to recognize transparent objects (glass-ware, liquids); the contents of vessels; monitor the state of chemical reactions (for example, they should detect when a solution is fully dissolved). Chemistry robots need to perform handling and manipulation of objects. Some limitations refer to restricted motion when picking up and transporting vials and beakers while avoiding spillage of their contents, etc. Generally speaking, the automation of every process or reaction may be unfeasible, or even not possible, because of instrument limitations. On the path to self-driving laboratories, combined approach is recommended. Namely, activities that human researchers perform in a well-organized and competent way that achieves maximum productivity are difficult for robots and vice versa. Processes, such as dispensing solids or extractions are relatively uncomplicated and easy for humans but currently present serious barrier for robotic systems. Also, human researchers can use their acquired knowledge to transfer the results between distinct experiments and predict the outcomes of completely new ones. Contrary, automated robotic systems can efficiently handle well-established experiments within their design tolerances. These systems provide highly reproducible results and collect large amounts of quantitative data. After the initial investment, self-

driving laboratories reduce the required human labor, enabling researchers more complex scientific tasks (formulating hypotheses, establishing of new experiments, and interpreting data). Self-driving laboratories increase safety by handling hazardous materials with minimal human exposure.

Artificial intelligence (AI)

Artificial intelligence refers to the ability of machines to behave in seemingly smart ways, making decisions in response to new inputs without being explicitly programmed to do so. The expansion of AI has led to progress in ability to process data, identify patterns, and make predictions faster and more accurately than ever before. AI can feasibly be applied in solutions of different problems in the field of chemical research and development, in case when complex relationships are provided in data sets. Chemical researchers use machine learning algorithms to systematically screen a large number of compound combinations to identify promising new candidates. AI can predict molecular structures, physical, chemical and toxicological properties, binding affinities, to focus testing on only the most promising options. This automated screening can significantly compress the early chemicals discovery process. One of the substantial challenges to successful implementation of AI involve preparing, accessing, integrating, and protecting data. In spite of the fact that AI represents a significant advance in research and development, it will supplement rather than replace the creativity, experience and intuition of human chemists. Finally, the combination of extensive AI computing capacity with human chemical expertise will give newly discovered opportunities to understand complex molecular phenomena and use this chemical knowledge to benefit fields ranging from pharmaceuticals to materials discovering [9,10].

Big Data

According to relevant data, the international data market already grows six times faster than the entire IT sector. An important point of Lab 4.0 is the integration of laboratory data with other data sources. Namely, in order to obtain new insights that can be critical in the development of different chemical compounds or other products linking laboratory values with diverse information is nessecery. Big Data aims to recognize patterns, correlations, trends, or even customer preferences, for which AI can be important. Big Data implies procurement, preparation, and data evaluation. The data sources considered for analysis must be relevant and estimated. To evaluate the collected and processed data, several analysis procedures are accessible. The choice depends on desired results. Considering the high risk of data loss, several security measures must be taken. These include checking systems are up to date, setting up a user management system, and implementing a data backup and recovery strategy. The arrival of the big data period in chemistry and the life sciences requires the progress of new computational analysis methods, significant both from the aspect of science and from the economic point of view [11,12].

Clouds

The cloud solution in Lab 4.0 has numerous advantages, such as space and cost-efficiency, not limited data storage, speed of operation, data security, reliability, backup, and recovery, data control, environmental friendliness, flexible work practices, etc. [13,14]. The move towards big data-driven chemistry has the possibility to intensify lab productivity and escalate scientific progress as much as it has done in other scientific fields (primarily medicine). As chemistry enters the “fourth paradigm” of scientific discovery, it will be essential to effectively store and manage data [15]. While cloud computing offers many benefits, it’s crucial to mention possible challenges. Data privacy, security, and compliance are major concerns. Also, concerns about data sovereignty and vendor lock-in demand careful judgment when choosing cloud service providers.

Lean Lab

The Lean Lab concept is a continuous improvement process in which employees should also be involved. A lean laboratory is one which is focused on testing products and materials to deliver results in the most efficient way in terms of cost or speed; primarily focused on improving measurable performance and reducing costs [16]. The goal of a lean laboratory is to use less effort, less resources and less time to test incoming samples. To further increase efficiency in the laboratory, lab procedures

and processes must be based on the principles of lean management. The goal is to improve the efficiency and quality of laboratory activities by reducing waste and optimizing processes. Systematic analysis, that include workflows, equipment, and materials, is used to identify places and processes where waste occurs. Consequently, adequate measures are defined to eliminate or reduce this waste.

LAB 4.0: OPPORTUNITIES FOR OCCUPATIONAL HEALTH AND SAFETY

In recent years, the application of IoT technologies to improve safety in chemical laboratories has been noticed. The use of these technologies is possible at different levels of organization in the laboratory. Monitoring technology, based on a sensors, supervises the progression or quality of something or someone during the time. In dangerous occupational environment where employees may be exposed to extreme heat, open flames, toxic gases, or hazardous chemicals, sensor embedded helmets and wrist bands, have the potential to help employees stay safe. Also, sensors can be used for continual monitoring of employee well-being (e.g. sudden anomalies, such as a heart attack, a fall, or gradual changes in stress level) (Figure 2). However, monitoring the health status of employees is a big challenge, especially in terms of protecting individual privacy. It is important to note that equipment conditions (machinery and facilities) can also be monitored.

Figure 2. Personal protective equipment (Smart PPE; Monitoring of human well-being)

Source: [17,18]

Another positive side of the application of Industry 4.0 concepts in the management of chemicals is the application of functional, industrial robots for an increasing number of tasks, including work with hazardous chemicals. These professional robots, which replace workers while performing hazardous operations in an unsafe area, are controlled by an operator. In addition, sensors in chemical laboratories can detect concentrations of chemical hazards and alert employees if limit values are exceeded. From a technological point of view, monitoring based on IoT technologies provides real-time alerts that indicate the need to introduce preventive measures to stop unsafe behavior, restore safety procedures, avoid injuries and allow an injured worker to seek help. From the aspect of safety management and accident prevention in chemical laboratories, four elements are key: physical access control; records of chemicals entering and leaving the laboratory; automatic detection of chemical accidents (e.g. gas leaks, fires, explosions). Starting from these elements, the safety management system in the chemical laboratory consists of four modules: IoT sensor, MSDS unit, alarm and control unit [17-20].

CONCLUSION

Digitization of the laboratory is a constantly improving process. Digital development in the laboratory has the potential to basically change the laboratory work processes through application of robotics, artificial intelligence, Big Data, clouds, and the Lean Lab concept, which help to automate, simplify and optimize laboratory work. Namely, digital laboratory integrate different technologies and methodologies to revolutionize scientific research and development, such as: smart infrastructure, emerging technologies, closed loop automation and robotic systems to perform routine tasks, specialized instruments that enable faster and more accurate data acquisition and analysis, inventory management, connectivity and IoT providing seamless data exchange and remote access to experiments and equipment. Progress in digitalization also brings numerous challenges relating to: standardization of

laboratories; data protection, security, and integrity; many lab staff are afraid of being replaced by systems and devices; etc. One of the significant challenges is preserving the health and safety of employees. In order to face emerging risks it will be necessary to regulate the preventive and protective measures that are focused on constant professional development and occupational health and safety training.

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7.
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DIGITAL SAFETY SYSTEMS IN VEHICLES

Abstract
Though forklifts have many applications, they are most commonly visible in warehouses and construction sites. It would be best if you lifted heavy boxes almost as large as shipping containers to high racks close to the ceiling. That can be dangerous. Construction sites also forever lift and move construction materials like stone, bricks, tiles, and wood. Losing balance with the heavy loads and packages falling poses serious dangers. Heavy boxes falling from high-up shelves on the wall pose risks to life and property. The driver can often not see ahead because of the massive load in front that blocks the vision. Safety systems have evolved well with the development of digital technology, and safety chances are greater nowadays. Hopefully, a dedicated installation of safety devices with greater awareness on the part of drivers will help control future disasters.

Keywords: Digital sensors device, safety device, accident, environment

INTRODUCTION

Driving is a very common activity in our daily life. In today's world, digital transformation has penetrated all walks of life. Digital transformation has fundamentally changed the behaviour of enterprises and consumers and brought tremendous pressure to traditional industries [1]. Digitalization of information could help avoid unpleasant situations by providing relevant information for car drivers, forklift drivers, truck drivers etc. This would significantly reduce the level of accidents, delays, financial losses, and injuries caused by incidents. The smart vehicle landscape relies heavily on wireless communication technologies that allow vehicles to communicate with other vehicles and the world around them. This increased connectivity promises enhanced safety features that could decrease the amount of accidents for drivers and pedestrians alike, but as with all digital technologies, the higher the connectivity, the more chance that bad actors have to exploit them.
Vehicle-to-Vehicle (V2V) communication is the sharing of data between vehicles with the aim of enhancing safety and optimizing various functions, including preventing collisions, coordinating groups of vehicles and facilitating cooperative driving. Increasingly, today’s vehicles feature driver assistance technologies, such as forward collision warning, automatic emergency braking, and vehicle safety communications. In the future, the deployment of driver assistance technologies may result in avoiding crashes altogether, particularly crashes attributed to human drivers’ choices.
The invention of the automobile forever changed how we travel, and vehicles are now an essential component in every citizen’s life. Unfortunately, driving can be incredibly dangerous, with 1.35 million people dying in car accidents yearly. Luckily, innovations in car safety technology are being created every year. As these systems become more commonplace, we can reduce fatal accidents and ensure that more drivers on the road stay safe.

METHODS

The method is used in this research to find changes in work and their consequences for safety. This research follows a method approach which collects and analyses information from research.

RESULTS

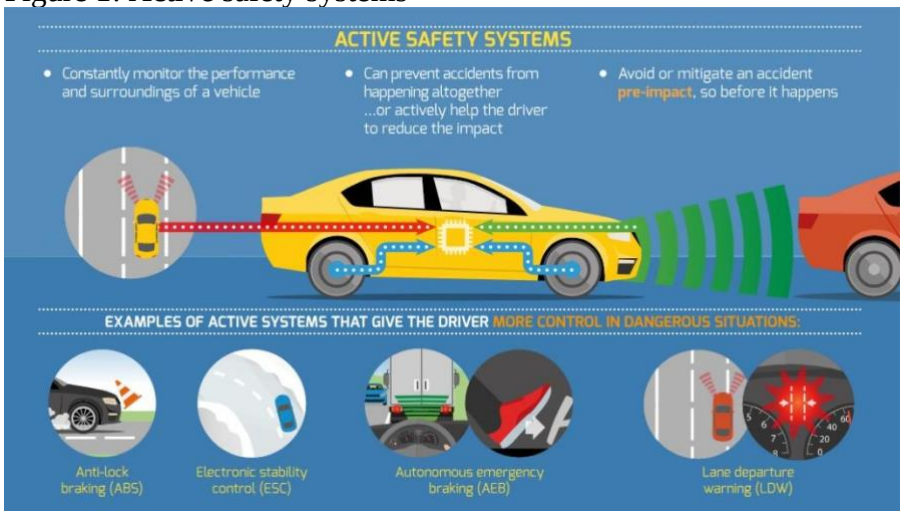
Safe vehicles

The EU automotive industry invests a large part of the sector's annual €54 billion R&D budget in making passenger cars and commercial vehicles even safer. Recent advances in vehicle safety have substantially reduced the number of accidents and related injuries over the last few decades. When looking at vehicle design, the measures to improve road safety can be classified into two categories: active safety and passive safety.

Types of systems in vehicles

Active safety systems

Figure 1: Active safety systems



Source: Source of figure [3]

• Constantly monitor the performance and surroundings of a vehicle

• Can prevent accidents from happening altogether …or actively help the driver to reduce the impact

• Avoid or mitigate an accident pre-impact, so before it can actually happen

Active safety technology can prevent accidents from happening altogether or at least actively help the driver to reduce the consequences of an emergency situation. To that end, various safety systems constantly monitor the performance and surroundings of a vehicle. Simply put, active safety systems avoid or mitigate an accident pre-impact, so before it can happen.

ANTI-LOCK BRAKING SYSTEMS (ABS)

ABS systems help to prevent the wheels of a vehicle from locking when braking heavily and enable the driver to keep steering

ELECTRONIC STABILITY CONTROL (ESC)

ESC helps to prevent a vehicle from skidding (sideways), and the driver from losing control while turning a corner. ESC technology can automatically activate the brakes to help steer the vehicle in the right direction

AUTONOMOUS EMERGENCY BRAKING (AEB) SYSTEMS

AEB systems start braking automatically if a collision is imminent and the driver is not taking any action (or not fast enough). AEB can detect a potential collision and activate the brakes to avoid it, or at least mitigate its impact.

LANE DEPARTURE WARNING (LDW) SYSTEMS

LDW systems warn the driver if he or she leaves a marked lane without using the indicator, or if the vehicle is drifting out of its travel lane.
LANE KEEPING ASSISTANCE (LKA) SYSTEMS
LKA systems apply torque to the steering wheel or pressure to the brakes when a lane departure is about to occur.
DROWSINESS AND ATTENTION DETECTION SYSTEMS
These assess the driver's alertness (for example by monitoring how long someone has been driving or by analysing how the steering wheel is being operated) and warn the driver to take a break when needed.
SPEED LIMIT INFORMATION (SLI) SYSTEMS
SLI systems inform the driver of the current speed limit by displaying it on the dashboard and/or navigation system. They use cameras to recognise road signs or use speed-limit data from the navigation system. Many SLI systems combine both.
TYRE PRESSURE MONITORING SYSTEMS (TPMS)
TPMS monitor the air pressure of a vehicle's tyres and reports this information in real-time to the driver, for example using a 'low pressure' warning light to indicate under-inflated tyres (which can cause accidents).
INTELLIGENT SPEED ASSISTANCE (ISA) SYSTEMS
ISA systems can actively prevent drivers from exceeding the speed limit using road sign recognition cameras and GPS-linked speed limit databases.

Passive safety systems
Figure 2: Passive safety systems

Source: Source of figure [3]

• Protect the occupants of a vehicle and other road users if a crash occurs
• Reduce the impact of an accident or the level of injury
• Mitigate the consequences of an accident during and after impact
Passive safety systems protect the occupants of a vehicle and other road users if a crash occurs. They do this by reducing the impact of an accident or the level of injury. In other words, passive safety technology is all about mitigating the consequences of an accident during and after impact.
AIRBAGS
Airbags are cushions that are inflated extremely quickly upon impact (and subsequently deflated) to protect passengers during a collision. They provide a soft restraint between the occupants and the vehicle interior during the crash, which can reduce or even prevent injuries. Early airbags protected front-seat occupants from frontal collisions. Since the turn of the century, they have combined with more advanced side-impact airbags as well.
SEATBELTS
Seatbelts (or safety belts) are restraint systems that keep passengers correctly positioned during an accident or sudden stop, thereby reducing the impact of the vehicle interior on the body and preventing people from being ejected. Seatbelts have significantly evolved since they were first introduced. Today's seatbelts are pretensioned: they are tightened almost instantly upon impact in order to prevent passengers from being jerked forward excessively.

DEFORMATION ZONES
Also known as crumple or crush zones, deformation zones take out the kinetic energy of a crash in a controlled way. This is done through specifically designed areas of the vehicle that deform and crumple during an accident to absorb the impact [3].

Forklifts play a crucial role in various industries, facilitating the movement of heavy loads efficiently. However, their improper use or negligence can lead to severe accidents, with collisions being a significant concern. Forklift collisions threaten the operators and jeopardize the safety of other workers in the vicinity.
Forklift collision avoidance systems are designed to prevent forklift overturning or colliding accidents in warehouses, manufacturing facilities, or storage
Forklift collisions represent serious accidents that may cause financial damage, injuries, and, unfortunately, fatalities. To understand forklift collisions, it is vital to understand the nature of the forklifts at the beginning.
Forklifts can reach significant speeds with exceptional acceleration and manoeuvrability. However, unlike cars, they only have breaks on the front. It makes forklifts hard to stop or slow down quickly. Forklifts are also designed to navigate tight spaces, narrow aisles, and busy work environments.
Forklift operator visibility is very limited due to the nature of forklift functionality. Lifting attachments are placed on the front of forklifts because the operator needs to see the load lifted and carried. Blind spots, obstructed views, and poor lighting conditions increase the challenge of detecting potential hazards, increasing the risk of collisions and forklift-related accidents.
Forklift collisions can occur for various reasons, often caused by human factors, environmental conditions, and operational challenges. Understanding these factors is crucial for implementing preventive measures and fostering a safer workplace environment.

What is a Forklift Collision Avoidance System?
A forklift collision avoidance system is a set of devices or sensors designed to enhance safety for the operators and pedestrians working around them. These devices detect potentially dangerous situations for forklift operators and pedestrians and warn them with audible or visual alerts to prevent any accident before it happens.
In addition, forklift collision avoidance systems could be arranged to automatically slow down the forklifts in designated areas, decreasing the risk of head-on collisions or overturns.
Another type of forklift collision prevention system, cameras, can be installed at the loading and unloading docks where there is a mixed type of forklifts, trucks, pedestrians, and other vehicles working together. With artificial cameras overseeing the predefined risky areas, the forklift collision prevention system works to detect pedestrians or forklifts and warns them in case of dangerous proximity.
Collision avoidance systems for forklifts use various technologies to cover different safety needs.
One of the most critical technologies used for forklift collision avoidance systems is Ultra-wide Band (UWB) technology. Sensors and wearable devices with UWB are utilized for information transmission across a wide bandwidth.
Together with the Internet of Things (IoT), which makes it possible for devices without an internet connection to communicate with each other, they make most of the forklift collision prevention systems. These devices can connect and detect dangerous proximities.

Types of Forklift Collision Avoidance Systems
Forklift collision prevention systems meet different safety requirements and are adaptable to specific industries' needs. Four major methods for forklift collision avoidance systems are as follows:

Zone-Based Slow Down
There are some high-risk areas, such as intersection points or congested areas at warehouses or production sites. Zone-based slow-down systems are available to avoid collisions in these areas.
Anchors are placed on the doors and communicate with the sensors on the forklifts. While the forklift is approaching, forklifts automatically slow down to a safe speed.
Forklift - Forklift Collision Avoidance
To prevent collisions between two forklifts or other heavy industrial material equipment, proximity sensors and sirens are placed on the equipment.

These sensors detect each other with UWB technology and limit forklifts' speed to a safe level while sirens alarm the forklift operators with audible and visual signs.

Forklift- AGV Collision Avoidance

Forklift-AGV or AMR collision prevention employs the same logic as forklift-forklift collision avoidance. When a forklift and an AGV are in close proximity, the system automatically limits the forklift's speed to a safe level, in addition to providing audible and visual warnings to alert forklift operators.

Forklift - Pedestrian Collision Avoidance

Forklift pedestrian accident prevention systems are divided into two: tagless or tag-based collision avoidance systems.

The proximity sensors detect pedestrians with wearable safety tags, and forklift operators are warned with a visual warning and alarms while the forklift is automatically slowed down.

Key Components of Forklift Collision Avoidance Systems

Forklift collision avoidance systems are generally a combination of sensors, communication devices, or software. The specific components may vary depending on the safety requirements of the company or the manufacturer of the system, but here are some of the most common key components of forklift collision avoidance systems to enhance safety:

Proximity Sensors

These sensors help to detect the distance of the objects around the forklifts or on their path. Different types of proximity sensors exist, such as ultrasonic, infrared, or radar sensors [4].

These sensors use ultrasonic or laser technology to detect objects in the forklift's path. When an object is detected, the system triggers an alarm or applies brakes automatically [5]

It is a smart system used in warehouse areas with its system supported by forklift proximity sensor IoT. Forklift proximity sensor technology is a smart device attached to the forklift to prevent potential accidents. In this system, the device attached to the forklift is used to warn the operator when the vehicle is close to an object. A forklift proximity sensor is a vision-based device that can be programmed to monitor and alert based on certain parameters such as distance and speed [8].

Table 1: Selection by detecting method

Selection by Detection Method			
Items requiring confirmation	**Inductive Proximity Sensors**	**Capacitive Proximity Sensors**	**Magnetic Proximity Sensors**
Sensing object	Metallic objects (iron, aluminum, brass, copper, etc.)	Metallic objects, resins, liquids, powders, etc.	Magnets
Electrical noise	Affected by positional relationship of power lines and signal lines, grounding of cabinet, etc. CE Marking (EC Directive compliance) Sensor covering material (metal, resin). Easily affected by noise when the cable is long.		Almost no effect.
Power supply	DC, AC, AC/DC, DC with no polarity, etc. Connection method, power supply voltage.		
Current consumption	Depends on the power supply, i.e., DC 2-wire models, DC 3-wire models, AC, etc. DC 2-wire models are effective for suppressing current consumption.		
Sensing distance	The sensing distance must be selected by considering the effects of factors such as the temperature, the sensing object, surrounding objects, and the mounting distance between Sensors. Refer to the set distance in the catalog specifications to determine the proper distance. When high precision sensing is required, use a Separate Amplifier model.		
Ambient environment	Temperature or humidity, or existence of water, oils, chemicals etc. Confirm that the degree of protection (refer to the *Degree of Protection*) matches the ambient environment.		
Physical vibration, shock	An extra margin must be provided in the sensing distance when selecting Sensors for use in environments subject to vibration and shock. To prevent Sensors from vibrating loose, refer to the catalog values for tightening torque during assembly.		
Assembly	Effects of tightening torque, Sensor size, number of wiring steps, cable length, distance between Sensors, surrounding objects. Check the effects of surrounding metallic and other objects, and the specifications for the mutual interference between Sensors.		

Source: Source of table [11]

Cameras

Camera technology is rapidly evolving, integrating AI, machine learning, and sophisticated image processing. Specifically designed for forklift collision prevention, these cameras possess the capability to detect pedestrians in the vicinity or along the forklift's path. Their adaptable nature allows for strategic placement on the forklift itself or walls, ensuring comprehensive surveillance of the surroundings. Operating in real-time with millisecond responsiveness, they swiftly initiate preventive measures.

Forklift Safety Lights
Forklift collision avoidance systems contain audible and visual signals to warn forklift operators and the pedestrian workers around them if there is a dangerous proximity. These could be forklift safety lights or sirens to notify pedestrians that a forklift is approaching or alarm the forklift operator if there is a dangerous proximity.

Collision Detection Software
Sensors on the forklifts transmit data to intelligent algorithms within the forklift safety unit to detect potential collisions. These algorithms can analyze the inputs sent by the sensors and trigger alarms.

Forklift Operator Interface
With a smart screen inside the cabin of the forklift, operators can get real-time information about their surroundings in case their vision is limited by the load they are carrying or the lighting conditions.

Integration with Forklift Controls
The forklift collision avoidance system may be integrated with the forklift's control system, allowing for automatic slow-downs or interventions to prevent collisions.

Forklift Telematics and Communication Systems
Forklift collision prevention systems can be integrated with communication modules to transmit data in real time. This data can then be accessed through a dashboard and facilitate remote monitoring and management of the forklift [4].
Some systems use Radio Frequency Identification (RFID) tags on objects and sensors on the forklift to create a digital map of the environment. The system then guides the operator to avoid collisions based on this map [5].
Blind Spot and Backup Cameras
Some standard lifts include blind spots and backup cameras. These devices can be mounted in the cabin control area, giving the driver an extra set of eyes that watch for hazards .

Laser Visual Aids
These aids can be installed and activated on a forklift's lifting mechanism. They serve as guidance lasers that promote accurate loading and unloading. Plus, they can help prevent pallet and shelf damage[7].

DISCUSSION

The implementation of Collision Avoidance Systems offers numerous benefits:

- Reduced Accidents: These systems drastically reduce the number of accidents and collisions in the workplace, thereby preventing injuries and damage to property.
- Increased Productivity: With a reduced risk of accidents, forklift operators can work more efficiently, leading to increased productivity.
- Cost Savings: Fewer accidents mean lower insurance premiums and reduced repair and maintenance costs [4].

Forklift monitoring systems also have the capability to control the speed of the forklift, allowing supervisors to set limits and adjust the speed of the forklift as needed. This helps to ensure that the forklift does not exceed the speed limit and that the driver is adhering to safety regulations. Additionally, these systems are able to detect if the driver is not following safety protocols, and can take action to prevent accidents .
Speed control for forklifts is a crucial safety measure that must be taken to ensure the safety of workers and the general public. Forklifts are powerful machines and can cause serious injury or death if operated carelessly. Even operators who are properly trained and experienced may not be able to control the speed of a forklift adequately without the aid of a speed control device.
Speed control devices can be used to limit the maximum speed of a forklift, as well as to monitor the speed and alert the operator if they are travelling too quickly. This can help prevent accidents and reduce the risk of injury or death. Many speed control devices also include additional safety features such as collision avoidance systems, which can help to reduce the risk of a collision between two forklifts [6].

The forklift proximity sensor aims to provide asset and pedestrian safety as a versatile system. Its primary advantage is that it gives a proximity warning, as the name suggests. Its versatile system can be used in different forklift types at the same time; order picker, stock chaser, narrow aisle, and more.
The main purpose of the forklift proximity sensor is to see what the driver cannot see. It constantly analyzes what is happening around the forklift. Thanks to its smart technology, it automatically alerts the operator when there is a problem or when an asset is too close. These alerts can be set according to audible or visual notifications. Let's look at other advantages of the forklift proximity sensor together.
Forklift proximity sensors aim to provide safety with automatic deceleration, independent of the operator. Forklifts that automatically slow down can stop if necessary thanks to smart AL sensors. When the forklift detects a pedestrian, a shelf, a wall, or any obstacle in its path, it slows down and comes to a complete stop. Since the response time of the technology is instantaneous, there are no delays during deceleration. Technology is advantageous when technology and driver's reaction times are compared. Proximity sensors, which are the ultimate in preventing forklift accidents, achieve great success in this sense [8].
Furthermore, sensor manufacturers offer solutions for measuring different conditions nowadays. For instance, the precise positioning of the fork can be supported by inductive proximity sensors while the fork height can be measured with wire draw encoders, laser scanners or magnetic sensors, and the distance to the unit to be retrieved with (infrared or ultrasonic) distance sensors. Also, the inclination of the fork is monitored by a tilt sensor, the remote access control to electronic doors is realized by RFID transponders as well as rear monitoring by laser scanners, and goods identification with the help of bar-code readers. As a result, there exist many further sensor technologies for different functions. (9)
Proximity sensing systems in their simplest form can be used to warn of plant equipment as it approaches set locations ie doorways, blind spots, and intersections. In its more complex form, pedestrians can be fitted with a transmitter or other device that warns plant operators of their proximity to the equipment and can even be used to reduce the speed of the equipment until at a safe distance. Again, this may not be appropriate in office locations but would certainly be within warehouse and production facilities [10].

CONCLUSION

The use of embedded systems in-vehicle applications has made possible current state-of-the-art safety systems that use high-tech sensors, actuators and microprocessors to provide adverse driving conditions. Technological efforts aim to prevent disasters and accidents before they occur, but this is not always possible and when one of the occurrences happens, it is extremely important that people, who should cope with it, have the right skills, knowledge and training to efficiently manage the problem. Current trends indicate the increasing importance of the use of adaptive systems. Remote sensing technology will play an important role in the development of intelligent vehicle systems in general.
The implementation of these safety features reflects a significant leap in automotive technology, effectively making vehicles safer. However, they are meant to assist drivers, not replace them. It's crucial to remember that no technology can replace a vigilant and focused driver, as responsible driving is still the cornerstone of road safety.
As technology continues to evolve, we can look forward to more innovative safety features that will further revolutionize the driving experience. The future of automotive safety is indeed exciting, with connected and autonomous vehicles set to take safety to unprecedented levels.

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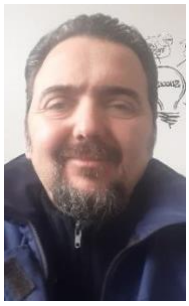

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EMPLOYEE WELLBEING IN THE DIGITIZATION AGE

Abstract
The workplace is changing at an exponential rate thanks to digital technology, and these changes reflect both on the quality of the workplace and the employee well-being. The term "employee well-being" refers to all aspects of an employee's life at work, from the general quality of the working environment and occupational safety to the physical and mental health of the employee and the employee's relationships with supervisors and coworkers. Companies should take into account their employees' emotional and mental health in addition to their physical health, as well as their social, organizational, career, and even financial well-being, as they recognize the value and necessity of a holistic approach. The paper examines the core issues, difficulties, and prospects for humanization at work and advancing employees' well-being in the digital age.

Key words: wellbeing, work, digitization, humanization at work

INTRODUCTION

Technological innovation is one of the main factors driving changes in the workplace. Similar to how automation in the past caused drastic changes in the form and content of work, digitization—the driving force behind the Fourth Industrial Revolution [1]—influences both the nature and content of work significantly today. The need for quick access to and handling of a growing volume of data that reflects the level of technical advancements is expanding rapidly. The primary forces behind economic growth are digitization and technical advancement, both of which are essential to the growth and long-term viability of businesses.[1] After the first computers were introduced more than sixty years ago, the digital revolution genuinely started, and it has seen several changes since then. With the goal of enhancing efficiency and automating operations across almost all industries and activities, processing ever-growing amounts of data and using information technology have gradually spread. Continued technical advancement has been the main driver of this trend.[2] Hence, digitization arose during the third industrial revolution, during which time data—or information—became essential to the operation of the economy. It changes into digital information with the advent of the fourth industrial revolution and takes on the same modes of transmission, storage, and communication [2].

Digitization is widespread and has shaped the world of the (post)modern. It affects every aspect of human existence, including politics, the economy, people's conduct, and their mental health [3]. The increasing and faster digitalization of modern society encompasses various aspects: production techniques (computerized business structures and industrial machinery), national security (digital warfare and equipment), public heritage preservation (architecture and art), and individual lives (health, banking, etc.) [4]. Thus, the topic of digital changes is getting more and more prevalent in our day and age. Our lives are being transformed by digitization in a way that is similar to the mid-1900s industrial revolution. It applies to every aspect of life [5], including the workplace and all employees, because, as stated by Schneider [6], decisions are based on digital data.
Thanks to digitization, it is now possible to conduct business globally and 'from home'. Significant changes are taking place in terms of work methods, job performance, and business management. New forms of employee engagement and the outsourcing of business functions outside the organization are

[1] Digitalizacija i tehnološki napredak – glavni pokretači ekonomskog rasta, https://investitor.me/2019/04/25/digitalizacija-i-tehnoloski-napredak-glavni-pokretaci-ekonomskog-rasta/
[2] Digitalna transformacija – ko, gde, šta, kako i zašto?, pdf.usaid.gov/pdf_docs/PA00W7DG.pdf

emerging. The focus shifts from production to ideas, innovation, customer experience, and intellectual property. Business models are evolving. The concept of ownership as we know it today will increasingly give way to the concept of the 'sharing' economy, based on the idea of accessing goods/services rather than owning them, in the near future.[3] The internet and the era of information and communication technology have opened up new opportunities for entrepreneurship, which is built on innovation and ongoing changes in market models, business procedures, and goods and services. E-government, e-banking, e-commerce, and the digitization of many service-related assets have a profound impact on how people live and conduct business. In order to maintain and improve competitive positions, digital transformation is now a crucial part of organizational reorganization.[4] Indeed, digital innovations are expected to fundamentally change the way products are designed and manufactured. This anticipates a shift in the overall work environment for both organizations and employees. This change can lead to positive effects on employee health, such as reducing physically demanding tasks, but it can also lead to an increase in psychosocial stressors [7].

The question of whether our lives would be better if machines replaced people in work roles is coming up more and more [8]. The amount of job automation and the development of a future society of abundance have been topics of discussion in economics and political economy for at least two centuries [9]. Over time, economists and political economists have advanced a futuristic picture of human flourishing and shorter workweeks thanks to technology. The same interest has reappeared in the present era [10-13]. Like in the past, there is a perception that new technologies could be used to advance society if they were handled well, possibly even by giving people more free time. Many writers, including Karl Marx, J.S. Mill, and J.M. Keynes, provide their opinions on how technology can—and should—be utilized to ease labor, according to a review of the literature. Marx critiqued capitalism's use of technology and proposed using it again in communism. While Keynes illustrated how technology may be utilized to build a post-capitalist world with more leisure time, Mill argued for using technology to lessen society's need for labor [8].

DIGITIZATION AND CHANGES IN THE SCOPE AND CHARACTER OF WORK

Digitization is the most recent change in the field of industrial relations. The workplace environment and working conditions have undergone tremendous change as a result of the Fourth Industrial Revolution, sometimes known as the digital revolution. The term "digitization" has multiple definitions in theory. The acceptance or expanded use of digital technology by different organizations, sectors, nations, etc. is the definition of digitization, put simply.[5] From a sociological perspective, any change in society that results directly from the application of digital technology in any field of human civilization is referred to as "digitization" in its broadest definition [14]. From an economic standpoint, digitization is the process of transforming and adapting company operations utilizing digital technologies in order to generate more money.[6] According to Schreckling & Steiger [15], digitization is the process of moving from analog to digital form. It is a process that is unavoidable, irreversible, exceedingly rapid, and ubiquitous. It is a phenomenon brought about by technical advancement, which in turn requires more advancements in technology [16]. In essence, it is about transforming information digitally.

Advances in technology bring about modifications in the production process, resulting in notable shifts in the type and scope of work. With the extensive integration of digital technology into work processes, digitization is the most recent stage in the long-term technological transformation of work. Increased productivity and efficiency as well as modifications to work practices, competencies, and organizational structures are all brought about by digitization. It drastically alters the workplace and necessitates the development of new occupational safety and health solutions. Both businesses and employees can benefit from the emergence of new technologies like artificial intelligence, robotics, the Internet of Things, algorithms, digital work platforms, and the growing number of remote workers. However, they also present new challenges and risks when it comes to occupational safety and health.[7]

[3] Preduzetništvo u eri digitalizacije, https://bba.edu.rs/2022/02/18/preduzetnistvo-u-eri-digitalizacije/
[4] Ibid.
[5] Digitalization and digitization, https://culturedigitally.org/2014/09/digitalization-and-digitization/
[6] Digitalization, https://www.gartner.com/en/information-technology/glossary/digitalization
[7] Digitalizacija rada, https://osha.europa.eu/hr/themes/digitalisation-work

Artificial intelligence and advanced robotics-based systems are revolutionizing the idea and practice of human labor, offering workers significant advantages and support, particularly when it comes to carrying out dangerous and hazardous activities. These systems are capable of performing specific tasks somewhat independently. Both the productivity of the company and the health and safety of the employees are greatly impacted by this. For example, these systems can handle high-risk or non-creative repetitive tasks associated with many common or emerging safety and health risks, freeing up workers to concentrate on low-risk, productive, and creative tasks. This eliminates the need for workers to operate in hazardous environments or perform dangerous tasks. Furthermore, paid labor conducted or managed through online platforms is referred to as "work through digital platforms". Platform work benefits workers by giving them employment opportunities in places where they are scarce, or for workers from marginalized groups. Any type of job agreement that involves using digital technologies to work from home or, more widely, outside the employer's facilities or at a fixed location is known as remote work, which offers a plethora of opportunities.[8]

Every social and economic aspect of life is changing due to digitization, which also has a big impact on jobs and work. It gives customers more options, boosts productivity, and delivers innovative services. One of the main pillars of competitiveness in the corporate and industrial environment is now digitization. For instance, the Ministry of Health in Serbia has been using the software solution IZIS, a central system, since 2016. IZIS functions as an information system intended to boost productivity, strengthen oversight, and generate cost savings. Centralized patient data in one location, e-health records, centralized waiting lists, and e-prescriptions have all been implemented. In addition, educational initiatives are being implemented, such the "Connected Schools" project, which presents digital classrooms and electronic journals.[9] Approximately 80,000 Serbian workers are estimated by the World Bank to be earning money online. Most of these professionals are young, between the ages of 26 and 30, and over half have completed higher education. The majority of Serbian internet workers have degrees in philology, economics, design, marketing, architecture, and engineering.[10] The research on Digitization of Work: Effects in Sectors in Serbia was provided based on a study by Nikolaus Preterhofer at the L&R Institute Austria. The automotive, travel, finance, healthcare, and trade industries were all included in the study. Expert exploratory interviews, online questionnaires, and in-depth interviews with chosen companies were used in the study's execution. According to the findings, 42% of respondents are neutral about digitization, while 45% of respondents are in favor of it. Most respondents stressed that they anticipated better job quality and greater efficiency. The challenges that have been highlighted include high investment prices and a lack of qualifications and knowledge among employees.[11]

Therefore, digitization brings significant economic benefits as well as substantial advantages for workers, including increased work efficiency and improved job quality. It introduces new ways to engage employees and outsources corporate operations to outside parties, providing employment opportunities for a larger number of workers, especially those living in poverty. It reduces physically demanding tasks for workers and moves them out of hazardous environments, freeing them from performing dangerous work tasks. Additionally, digitization leads to the emergence of new business models, ideas, innovations, and more.

HUMANIZATION OF WORK AS A PREREQUISITE FOR EMPLOYEE WELLBEING

As previously indicated, there are major technological and financial benefits to automation and mechanization of work, information technology, robotics, and digitization. Aside from relieving people of dangerous and heavy labor, one of these benefits is mass production, which makes it possible to satisfy the needs of a sizable population. These work methods have many drawbacks, though, including the simplification of tasks into simple operations; the rise of monotony, conflict, and stress; employee attachment to the workplace; alienation; poor communication; loss of creativity and individuality; and frequent work interruptions and employee turnover [17]. Furthermore, there are still a lot of occupational

[8] Digitalizacija rada, https://osha.europa.eu/hr/themes/digitalisation-work
[9] Dostojanstven rad u eri digitalizacije, https://sindikat.rs/2019/10/31/dostojanstven-rad-u-eri-digitalizacije/
[10] Radna prava u vrtlogu digitalne ekonomije, https://www.dnevnik.rs/ekonomija/naslovi/radna-prava-u-vrtlogu-digitalne-ekonomije-30-09-2018
[11] Dostojanstven rad u eri digitalizacije, https://sindikat.rs/2019/10/31/dostojanstven-rad-u-eri-digitalizacije/

safety and health issues that arise from the use of artificial intelligence-based systems in the workplace. These issues mostly arise from how these systems interact with humans and might cause unanticipated collisions, over-reliance on these systems, etc. But there are also issues with organizational and psychosocial factors.[12] Moreover, the problems encountered by employees working on digital platforms assume an extensive societal aspect. Because of the nature of their profession, they frequently are unable to put their social integration and personal well-being first [18].
We refer to this new worldwide issue for humanity as the "humanization of work", which has been brought about by significant changes in the means of labor in modern society, including digitization. Employees are exposed to a variety of risks and hazards associated with their line of work, including occupational diseases, injuries, and professional pathology. Employee vulnerability becomes more evident when aspirations to boost profit margins and cut profit expenses rise. Thus, the scientific-technological revolution and digitization are drawing more and more the attention and interest of labor sociologists, occupational safety engineers, ergonomists, economists, social ecologists, and others. The calls from civilizations for the humanization of work are growing stronger.

In contemporary production relations, there are two conflicting processes: humanization and dehumanization. The modern growth of productive forces and all technology advancements have made it possible for work to become more humanized overall. However, the same progress has also made the integrity of the working person more vulnerable. Research has demonstrated that the dehumanization of labor stems from the irreconcilable contrasts between digital and technological aspects and the fundamental qualities of humans as social and natural beings. Therefore, the process of developing human labor within its socio-technological framework is represented by the term "humanization of work" (Latin: humanitas, meaning "human, humane"). While social conditions (preserving moral, psychological, and physical integrity) are taken into account in order to provide better opportunities for completing work tasks, it also takes into account the humanization of working and physical conditions in the workplace [19].
There are a lot of unknowns associated with the Fourth Industrial Revolution, and the social and psychological effects of this new technological period call for prompt responses. New technologies that are extensively used in the computer era have required employees to adapt quickly—often faster than the employee is capable of doing so. As robotics gains traction in several industries and all sectors of the economy, the necessity for human labor is diminishing. An estimate of 3,150,000 robotic units were sold overall between the start of industrial robot applications in the early 1960s and the end of 2013. The International Federation of Robotics (IFR), which systematically tracks the advancement of robotics, particularly industrial robots and their useful applications, released these data. In the worldwide manufacturing sector, there are about 50 general-purpose industrial robots per every 10,000 workers.[13]

Consequently, a fundamental question regarding the possibility of humanizing human work naturally arises in light of the current trend of rising robot employment in industrial production, as well as the growth of information technologies, digitization, new materials, genetic engineering, etc. It is crucial to begin by acknowledging that humanized social relations rely on respect and concern for the integrity of human nature while tackling this sophisticated and complex subject. It is imperative to stress the strong link between the processes that characterize the growth of contemporary society and humanization. Without strongly held beliefs about the necessity and advancement of the humanization of labor, there can be no technological advancement, and vice versa [19].

CONCLUSION

Concerns and issues pertaining to workers' welfare in the context of digitization and the humanization of work have been discussed in recent years. Given that workplace hazards are on the rise and can have

[12] Digitalizacija rada, https://osha.europa.eu/hr/themes/digitalisation-work
[13] Robotika, www.ingkomora.org.rs/materijalpo/download/2015/PBPetrovic-ROBOTIKA.pdf

serious repercussions for both workers and society as a whole, it is essential to be concerned about the health and welfare of employees. According to statistical data, the costs of occupational diseases and injuries in the United States are far higher than those linked with illnesses like AIDS or Alzheimer's disease, and they are also comparable to the costs of treating cancer or cardiovascular diseases brought on by hazardous working circumstances. Numerous research' findings show how employee well-being affects a company's productivity.

Numerous opportunities for lowering occupational dangers and humanizing work are made possible by digitization. The type, method, and location of work are changing due to the growth of digital technologies like artificial intelligence, advanced robots, the Internet of Things, big data, etc. While tasks that were unsafe for human health can be replaced by artificial intelligence, there are also many psychological hazards associated with it. In this sense, concerns about reducing digitization's detrimental effects on workers' safety and health and optimizing the preventative opportunities provided by digital technologies are especially delicate in this day of digitalization.

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PARALLEL ANALYSIS OF NATIONAL REGULATIONS ON DIGITALIZATION AND OCCUPATIONAL SAFETY IN SERBIA AND REPUBLIC OF SRPSKA: A FOCUS ON DIGITALIZATION AND SAFETY KNOWLEDGE MANAGEMENT

Abstract
This paper aims to provide a comprehensive parallel analysis of the national regulations governing digitalization and occupational safety in the neighbouring regions of Serbia and the Republic of Srpska. The juxtaposition of these regulatory frameworks will shed light on the convergences, divergences, and potential areas for harmonization in the context of advancing digitalization and enhancing occupational safety measures. By scrutinizing the legal landscapes of both Serbia and the Republic of Srpska, the identify key regulatory nuances influencing the integration of digital tools and the management of safety knowledge within workplaces. The findings presented in this analysis intend to contribute valuable insights for policymakers, industry professionals, and researchers interested in fostering a balanced and forward-looking approach to digitalization and occupational safety. The research underscores the significance of proactive regulatory measures that facilitate the seamless integration of digital technologies while ensuring the well-being of the workforce through robust safety knowledge management practices.

Key words: national regulations, digitalization, occupational safety.

INTRODUCTION

Digitalization holds immense significance in the modern business landscape due to several key factors:

- Efficiency and Productivity: Digitalization streamlines processes, automates repetitive tasks, and enhances overall operational efficiency, leading to increased productivity.
- Data-driven Decision Making: The digital transformation allows businesses to collect and analyse vast amounts of data, facilitating informed decision-making and strategic planning.
- Global Connectivity: Digitalization breaks down geographical barriers, enabling businesses to operate on a global scale, reach new markets, and foster international collaboration.
- Innovation and Competitiveness: Companies embracing digital technologies are better positioned to innovate, adapt to market changes, and maintain competitiveness in rapidly evolving industries.

The relationship between digitalization and occupational safety is multifaceted, contributing to a safer work environment in various ways:

- Automation and Risk Reduction: Digital technologies automate hazardous tasks, reducing the exposure of workers to potentially dangerous situations and minimizing the risk of accidents.
- Real-time Monitoring and Response: IoT (Internet of Things) devices and sensors allow for real-time monitoring of workplace conditions, equipment performance, and employee well-being, enabling swift responses to potential safety issues.
- Training and Simulation: Virtual reality (VR) and augmented reality (AR) technologies provide immersive training experiences, allowing workers to practice safety procedures in realistic simulations without physical risk.
- Data Analytics for Safety Insights: Analysing data generated through digital systems can identify patterns and trends related to safety incidents, enabling proactive measures to prevent accidents [1,2,3].

National Regulations on Digitalization and Occupational Safety in Serbia

By contextualizing the analysis within the unique framework of Serbia, it can be provided a comprehensive understanding of how national regulations align with the broader business and safety landscape in the country.
When examining national regulations on digitalization and occupational safety in Serbia, it's crucial to consider the specific context and factors unique to the country:

1. The Law about Information Security ("Official Gazette of the RS", No. 6/2016, 94/2017 and 77/2019)
   This law regulates measures to protect against security risks in information and communication systems, responsibilities of legal entities when managing and using information and communication systems and protection personal data.
2. The Law on Electronic Document, Electronic Identification and Trust Services in Electronic Business ("Official Gazette of RS", No. 94/2017 and 52/2021)
   This law regulates electronic documents, electronic identification, and trusted services in electronic business.
3. Rulebook about the Closing Conditions for the Digitalization of Cultural Heritage ("Official Gazette of the RS", No. 76/2018)
   This rulebook regulates the detailed conditions, tasks, standards and processes of digitalization of cultural heritage, i.e. movable and immovable cultural assets, intangible cultural heritage and assets that enjoy prior protection.
4. The Strategy for the Development of Education and Upbringing in the Republic of Serbia until 2030 contains a special segment related to digital education. The main pillars of development are:
   - development of a unified education information system (JISP),
   - strengthening the capacity of schools for development planning with a focus on digital transformation,
   - improvement of students' digital competences through the application of innovative teaching and learning programs,
   - improvement of digital and pedagogical competences of teachers,
   - research and improvement of evaluation and monitoring systems in the field of digital education (https://prosveta.gov.rs/wp-content/uploads/2021/10/SROVRS-2030-1.pdf).
5. The Labor Law ("Official Gazette of RS" No. 24/2005, 61/2005, 54/2009, 32/2013, 75/2014, 13/2017-OUS, 113/2017 and 95/2018-authorized interpretation)
   This law regulates that the employer can deliver the decision on the use of annual leave and pay check report to the employee in electronic form.

Serbia has launched a program for spreading knowledge in the field of digital transformation called "Serbia Digitizes." The Office for Information Technologies and Electronic Administration is responsible for its implementation. Digitalization transforms the functioning of public administration, enhancing its efficiency, transparency, and quality of work. With eGovernment tool all administrative tasks can be handled online for matters related to documents, certificates, issues related to preschools, health insurance, and services related to urban planning, finances, and so on. The Office for IT and eGovernment has also established the State Data Canter, housing the key information and communication infrastructure of the Republic of Serbia. Due to this, the Serbian Chamber of Commerce has initiated the Canter for Digital Transformation (CDT), representing a project for the digital transformation of business.
Digitalization Sector in the Ministry of finance performs tasks related to implementation concerning information systems and registers under the Ministry's jurisdiction from the perspective of information technologies (digital invoices, etc.) (https://mfin.gov.rs/sr/o-ministarstvu-1/sektor-za-digitalizaciju-u-oblasti-finansija-1).

Integration of Digitalization and Occupational Safety

The swift evolution of digitalization is reshaping the landscape of work, necessitating innovative approaches to occupational safety and health. It is needed to advancing research that furnishes policymakers, researchers, and workplaces with reliable insights into the potential impacts of

digitalization on occupational safety. Technological advancements like artificial intelligence (AI), big data, collaborative robotics, the internet of things, algorithms, digital labour platforms, and the growing prevalence of remote work present both opportunities and challenges for workers and employers. Effectively addressing the associated risks and capitalizing on opportunities hinges on the judicious application, management, and regulation of these technologies within the broader context of social, political, and economic trends. Drawing from its foresight study on digitalization and occupational safety, EU-OSHA is currently executing a comprehensive research project titled 'OSH Overview' (2020-2023). The project centres its focus on key areas, including advanced robotics and artificial intelligence, worker management through artificial intelligence, digital platform work, smart digital systems, and remote work (https://osha.europa.eu/en/themes/digitalisation-work).

Digitalisation and occupational safety are interconnected in several ways:

- Remote Work: Digitalisation has enabled remote work, which has become increasingly prevalent due to the COVID-19 pandemic. This shift has brought about new considerations for occupational safety, such as ergonomics of home offices, mental health concerns due to isolation, and the need for clear communication of expectations and responsibilities.
- Health and Safety Technologies: Digital technologies can be used to improve occupational safety. For example, wearable devices can monitor workers' health and environmental conditions, while machine learning algorithms can predict potential safety risks.
- Training and Awareness: Digital platforms can be used to provide training and raise awareness about occupational safety practices. This is particularly relevant in Serbia, where the government is working to improve digital skills among the population.
- Regulatory Compliance: Digital tools can help businesses comply with occupational safety regulations. For example, they can be used to track incidents, manage safety audits, and ensure that safety standards are being met.
- Psychosocial Risks: The digitalisation of work can also introduce new psychosocial risks. For example, constant connectivity can lead to work intensification, blurring the boundaries between work and personal life. These factors can contribute to stress and other mental health issues, which are important aspects of occupational safety (https://cms.law/en/prt/publication/future-of-work/the-new-world-of-work-in-serbia; https://osha.europa.eu/sites/default/files/Digitalisation_and_OSH_EN.pdf).

METHODS

The aim of the paper was to present the current situation in the field of digitization in the Republic of Serbia and the Republic of Srpska, with special reference to the situation in the field of occupational safety, as well as an overview of national legislation. In this way, the possibility of exchanging experience and examples of good practice in this area was created, as well as knowledge management with the aim of improving the field of occupational safety as a whole.
The methods used were based on:

- analysis of the theoretical foundations of digital technologies and their application in industry and occupational safety,
- analysis of legal regulations,
- an overview of the current situation in the field of digitization,
- research synthesis in the form of conclusions.

RESULTS

State in Serbia

Administrative

Implementation of digital platforms are used for creating, storing, and accessing safety reports, manuals, guidelines, and training materials. Transition from traditional paper-based safety documentation to digital formats can be seen in new Law and rulebooks.
According to the Law on Occupational Safety and Health in terms of administration and digitalization, the following was introduced:

- the register of work injuries as a single, electronically managed database of work injuries,
- the license register as a unique, electronically managed database of issued, renewed and revoked licenses,
- employer can submit a report electronically on:
  - the beginning of their work,
  - operation of a separate unit,
  - to any change in the technological procedure, if these changes change the working conditions,
- the application in case of emergency works on infrastructure facilities to eliminate defects or a sudden and uncontrolled event on the facility can be submitted electronically by the employer,
- employer is obliged to keep the records defined by the Law, and can keep them in electronic form, except for one,
- employer must within 24 hours, and it can be electronically, report to the competent labour inspection and the competent authority for internal affairs any fatal, collective or serious injury at work, as well as any dangerous occurrence that could threaten the safety and health of employees,
- employer must within five working days, and it can be electronically, report to the competent labour inspectorate a minor injury at work due to which the employee is unable to work for more than three days,
- employer must within eight days from the expiration of the deadline for eliminating the identified deficiency or irregularity, notify the competent inspection, and it can be in electronic form.

The records from Law, more defined in Rulebook on records in the field of safety and health at work, are kept in written or electronic form, except for records on employees trained for safe and healthy work, which are kept only in written form. When records are kept in electronic form, the forms must have a qualified electronic signature in accordance with a special regulation ("Official Gazette of RS", No. 35/2023; "Official Gazette of RS", No. 62/2007 and 102/2015).

Current Digital Applications in Practice

Digital technologies automate safety protocols and procedures, such as software's available for the management of work safety affairs. This software solutions are to manage safety checklists, incident reporting, and emergency response plans, etc. https://www.slideshare.net/DAVIDTOMOVI/BZRPRO-SOFTVER-ZA-UPRAVLJANJE-POSLOVIMA-BEZBEDNOSTI-NA-RADU).
According to the Strategy of Safety and Health at Work in the Republic of Serbia, for the period from 2018 to 2022, the introduction of E-tools is planned to help micro and small businesses in implementing the requirements of occupational health and safety regulations ("Official Gazette of RS", No. 96/18).
New technologies affect all segments of life, one of the areas is the health system, where the digitalization process in Serbia began with the adoption of the Healthcare Digitalization Program 2022-2026. years. This is covered by occupational medicine, whereas expected communication between employers, doctors and employees should be facilitated (https://www.zdravlje.gov.rs/tekst/364590/program-digitalizacije-u-zdravstvenom-sistemu.php).
For example, today the report forms defined by Rulebook on Records in the Field of Safety and Health at Work are printed and issued in A4 format ("Official Gazette of RS", No. 62/2007 and 102/2015).

Future expected Digital Applications in Practice

Some of the applications shown below are already implemented in companies, but these are very rare situations. However, a wider application can be expected in the near future, given that they are already present on our market:

- Internet of Things (IoT) sensors to monitor environmental conditions in workplaces. This could include sensors measuring temperature, humidity, air quality, and noise levels in real-time.
- Integration of wearable devices equipped with sensors to monitor employee well-being and safety. Devices that detect fatigue, monitor vital signs, and provide alerts in case of potential health risks.

- Digital systems for real-time incident reporting. This involve mobile applications or online platforms that enable employees to quickly report safety concerns, accidents, or hazards, facilitating prompt responses.
- Use of virtual reality (VR) technology for immersive safety training to train employees in handling emergency situations, operating machinery safely, and practicing proper safety protocols.
- Digitalization integrated into predictive maintenance strategies, data analytics and achine learning are used to predict equipment failures, reducing the risk of accidents caused by malfunctioning machinery.
- Digital communication platforms for disseminating safety information in real-time. This include mobile apps, instant messaging systems, and other digital channels to ensure efficient communication during emergencies.

National Regulations and the Situation in the Field of Digitization and Occupational Safety in the Republic of Srpska

Initiatives have been launched in the Republic of Srpska (RS) and work is being done on the digital transformation of the state administration, economy and society as a whole. The work of the state administration is aimed at providing support to the digital economy and new technologies, with the aim of enabling more intensive and dynamic economic growth, while encouraging savings and optimal utilization of all resources and the maximum level of digital security.
The strategic framework of the Government for the period from 2019-2022 established the vision of the development of e-government of the Republic of Srpska through the implementation of coordinated activities of all public administration bodies focused on three priority areas of development, namely :

- building the infrastructure of modern information and communication technologies,
- e-service development,
- investment in human resources.

(https://www.vladars.net/sr-SP-Cyrl/Vlada/Ministarstva/mnk/Documents/Strategija%20e%20uprave%20pdf.pdf).

The information society of the Republic of Srpska, from the aspect of its administrative-governing organization, consists of the following areas: electronic administration, digital identities, information security, broadband internet, ICT industry, digitalization of the economy, as well as digital knowledge and skills making up the normative and administrative-governing framework of the Republic of Srpska complementary to the framework in the EU (https://vladars.rs/sr-SP-Cyrl/Vlada/Ministarstva/mnk/OM/Resori/ntr/Documents/MNV%2c%20strategija%2023%20-%2029.pdf).
The national legislative framework in the field of digitization in the Republic of Srpska is:

1. The Law on Electronic Business of the Republic of Srpska ("Official Gazette of RS" No. 59/09)
   This law regulates the provision of information society services, the responsibility of information society service providers, and rules regarding the conclusion of contracts in electronic form [4].
2. The Law on Electronic Document, Electronic Identification and Trust Services in Electronic Business ("Official Gazette of RS", No. 94/2017)
   This law regulates electronic document, electronic identification and trusted services in electronic business [4].
3. The Law on Critical Infrastructure ("Official Gazette of RS", No. 87/2018)
   This law regulates the critical infrastructure of the Republic of Srpska, the sectors of critical infrastructure in the Republic of Srpska, the management of critical infrastructures, the obligation to prepare a risk analysis, the security plan of facilities from the critical infrastructure sector, the security coordinator and the security manager for critical infrastructure, cooperation in the field of critical infrastructure, dealing with protected data, supervision over the implementation of this law, as well as misdemeanor provisions [4].
4. The Law on Information Security ("Official Gazette of RS", No. 70/2011)
   This law defines information security. The basic postulates of information security are defined, that is, the protection and validity of data in electronic form. Measures and standards of information security, data protection in the Government of the RS, as well as competent bodies

for adoption, implementation and supervision of measures and standards of information security are determined in more detail. Adoption of this law is a continuation of activities to create conditions for the use and maintenance of information in a secure environment [4].

5. The Law on Tax Procedure ("Official Gazette of RS", No. 78/2020)
   This law regulates the organization and jurisdiction of the Tax Administration of the Republika Srpska, the rights and obligations of taxpayers, tax procedure, payment of tax obligations, regular and forced collection of tax obligations and other ways of terminating tax obligations, tax control, special control, legal remedy procedure and supervision in the field of taxes in the Republic of Srpska [4].
6. The Law on Survey and Cadastre ("Official Gazette of the RS", No. 6/2012, 110/2016, 22/2018 - US decision, 62/2018, 95/2019 - US decision and 90/2023)
   This law regulates the administrative and professional tasks related to the survey and the procedure for the establishment, organization and management of the real estate cadastre, which also includes the digital archive, with the aim of long-term storage, protection and use of cadastral administration data.

The Ministry of Scientific and Technological Development, Higher Education and Information Society of the Republic of Srpska is, among other things, responsible for the development and implementation of the information society, development of strategies, legislative regulations, promotion of new technologies and other activities in the field of digital transformation of society as a whole. These activities will be realized through key strategic projects. For the development of the strategic goal "Development of the key IC (information communication) infrastructure of the information society", according to the current strategic determination, three strategic projects are foreseen:

- development of the key IC infrastructure of e-government,
- establishment of an integrated information security system in the RS,
- harmonization of the technical and organizational structure with the EU eIDAS regulations.

(https://vladars.rs/sr-SP-Cyrl/Vlada/Ministarstva/mnk/OM/Resori/ntr/Documents/MNV%2c%20strategija%2023%20-%2029.pdf)

Digitization is also present in RS education (primary and secondary school education): several legal and by-laws have been adopted that regulate the management of electronic pedagogical documentation in schools and the application of electronic enrollment in schools and distance learning; The Ministry of Education and Culture developed a textbook digitization plan in cooperation with the Institute for Textbooks and Teaching Aids; keeps records of school equipment and the number of active users for Microsoft Office 365 tools on the Ministry's platform and conducts regular evaluations of virtual classrooms, teaching and student behavior at the end of each semester and school year; work is being done to improve internet connection in schools; the teaching staff is continuously educated for the application of digital technologies in teaching [5].

In the field of higher education, digitization is present through the strategic goal of "Improving the quality of higher education and more efficient management of the development of the higher education system" and measures to achieve it:

- accreditation and modernization of study programs,
- further computerization and digitization of higher education,
- establishing a system for editing and classifying qualifications and regulated professions,
- improvement of the planning, monitoring and evaluation process in the higher education system, and further development of the higher education infrastructure,
- support for the development of inter-university, multidisciplinary and interdisciplinary studies,
- preservation and improvement of identity disciplines,
- as well as other goals of the strategic development framework (https://vladars.rs/sr-SP-Cyrl/Vlada/Ministarstva/mnk/OM/Resori/ntr/Documents/MNV%2c%20strategija%2023%20-%2029.pdf).

The importance of digitization for the RS economy is also recognized by the Chamber of Commerce of the Republic of Srpska. The Center for Digital Transformation was established with the aim of raising the level of competitiveness and innovation capacity of small and medium-sized enterprises (SMEs) by implementing digital technology in the economy. The services of the Center for Digital Transformation are:

- strategic approach to the digital transformation process,

- consulting support according to standardized methodology,
- informational and advisory services in the field of digital transformation,
- education - improving the knowledge and skills of employees in the economy,
- access to financing the digital transformation process,
- networking of SMEs with the domestic ICT sector,
- promotion of good practice examples of digital transformation in the industry, (https://komorars.ba/centar-za-digitalnu-transformaciju/).

The research conducted from mid-April to May 20, 2020 showed the current situation in the field of digitization of the Government and its services [6]. According to the same survey, the Ministry of Labor and Veterans' and Disability Protection (responsible for the area of work and occupational safety) uses the following services of the digital service of the RS Government: Microsoft licensing, e-mail, Active Directory, internet access service, internet (web) portal, electronic sessions, service Data Center, network as a service, working environment and computer network of the administrative center [6].

The field of occupational health and safety in many countries, including in the RS, is implemented through three organizational levels: the government and its institutions, business systems and the public sector as support for the previous two levels.
The legislative framework is adopted by the Government through its institutions, i.e. competent ministries (in the RS, the Ministry of Labor and Veterans and Disability Protection). In the RS, the legislative framework in the area of occupational health and safety is based on the Law on Occupational Safety, which was adopted in 2008 with amendments (in 2010) and by-laws (regulations), with the use of a part of by-laws from an earlier period which are not contrary to the Law on Occupational Safety. The entire legislation is available to users on the Ministry's website in digital format. Also available on the site are: forms for passing professional examinations in the field of occupational safety, forms for reporting injuries at work, list of licensed legal entities for occupational safety, strategic documents, published publications, interpretations of legal regulations, etc.
According to the analysis of the state of occupational safety in the Occupational Safety Strategy of the RS for the period from 2021 to 2024, the Law on Occupational Safety and all secondary legal acts adopted by the Ministry of Labor and Veterans' and Disability Protection in the past period are marked as partially harmonized (with European directives, conventions and standards), (https://vladars.rs/sr-SP-Cyrl/Vlada/Ministarstva/mpb/PPP/Documents/Стратегија%203НР%2020-2024%20годин.pdf).
According to the same strategic framework, the realization of an important step forward in the field of digitization through the establishment of the Central Register of Work Injuries, which also includes the electronic reporting of work injuries, is underway. The introduction of a single register of injuries at work should be the basis for monitoring the situation, analyzing and establishing a more effective policy of the Republic of Srpska in this area through numerous positive effects:

- fast, efficient and standardized - electronic reporting of injuries at work,
- reducing the costs of reporting injuries at work,
- availability of data on the source, cause and other aspects of injuries at work,
- the possibility of systematic data processing and analysis will be obtained, as well as the possibility of undertaking adequate and timely activities, (https://vladars.rs/sr-SP-Cyrl/Vlada/Ministarstva/mpb/PPP/Documents/Стратегија%203НР%2020-2024%20годин.pdf).

The improvement of the occupational health and safety system in the RS continues through strategic activities: harmonization with EU legislation, innovation of legal and by-laws of the Republic of Srpska, increase in the number of inspections over the application of regulations, implementation activities of the Central Register of Work Injuries, Occupational Diseases and Work-Related Diseases, and the constant development of social dialogue, especially important in overcoming unforeseen problems (eg the corona virus pandemic).

CONCLUSION

It is necessary that both urban and rural areas are covered by the same scope of digitalization coverage. Digitalisation has a significant impact on occupational safety. While it presents new challenges, it also offers opportunities to improve safety practices and create healthier work environment. Digitalisation is

not an end in itself, but a means to improve occupational safety. It's important to keep the needs of workers at the centre of these efforts.
Although there is a possibility of electronic documents in occupational health and safety as shown in paper, practice shows that inspections often interpret that all documents should be in paper form. So companies act accordingly, among other things due to significant fines, and they have to create and archive printed versions of all labor-legal and occupational safety documents.
Here are some suggestions for further development of digitalisation of occupational safety in Serbia and Republic of Srpska:
Invest in Digital Infrastructure: To support the digitalisation of occupational safety, it's crucial to have a robust digital infrastructure. This includes reliable internet connectivity, especially in remote areas, and access to digital devices for all workers.
Promote Digital Literacy: Workers need to be comfortable using digital tools. This requires ongoing training and education to ensure that all workers, regardless of their age or background, have the necessary digital skills.
Develop Digital Safety Tools: There are many digital tools that can enhance occupational safety, from wearable devices that monitor workers' health to machine learning algorithms that predict potential safety risks. Investing in the development and implementation of these tools can significantly improve occupational safety.
Regulate New Risks: Digitalisation can also introduce new risks, such as cyber threats that could compromise safety systems. It's important to update regulations to address these new risks and ensure that safety systems are secure.
Encourage Collaboration: Digitalisation should be a collaborative effort involving government agencies, businesses, trade unions, and workers. By working together, these stakeholders can ensure that digitalisation benefits everyone and improves occupational safety.
Research and Innovation: Encourage research into new digital technologies and their application in occupational safety. This could involve partnerships between academic institutions, industry, and government.

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REVOLUTION IN ENVIRONMENTAL PROTECTION: (BIO)CHEMICAL SENSORS IN THE DIGITAL SOCIETY

Abstract

(Bio)chemical sensors in synergy with digital technology represent one of the elements of the transformation in approaches to environmental protection. This approach brings several advantages in monitoring and analyzing data in real-time, and quick response to environmental challenges. Continuous development followed by innovations in the field of (bio)chemical sensors and their digital integration in environmental protection is aimed at achieving greater efficiency and automation. It is an extremely complex and dynamic process where the choice of the most reliable sensors is based on specific needs and application conditions. The implementation and digitalization of (new) systems enable more efficient work with data to increase sustainability and reduce negative impacts on the environment. It is clear that digitalization and environmental protection bring many benefits, but at the same time, it also brings certain challenges.

Key words: (bio)chemical sensors, digitalization, environmental protection, legislation, sustainability.

INTRODUCTION

The increased number of inhabitants on the planet has contributed, among other things, to increased pressure on the environment, due to increased needs for resources, and increased pollution due to a series of anthropogenic activities that pollute the natural environment. This wide range of contaminants comes from households, and human agricultural and industrial activities [1]. To protect the environment from contamination and reduce the impact of hostile elements and activities, it is necessary to use tools for monitoring and screening various environmental pollutants, such as sensors [2].

Through its development, digital economy interfered with different socioeconomic domains, through changes in communication methods, the development of new production methods, but also entrepreneurship, thus the transformation and development of digital technologies had a key impact not only on the process of industrialization, but on the entire economy and environment [3]. Some scientists, according to what was said earlier, believe that digitalization can be of decisive importance for solving global challenges in the context of climate change and environmental issues [3].

One of the biggest global challenges is certainly climate change, which manifests itself through changes in sea levels, the occurrence and frequency of forest fires, and the occurrence of extreme weather conditions. The above has resulted in greater political engagement around environmental issues at the global level. One of the leading approaches in combating this challenge is the reduction of greenhouse gas emissions, with the greatest attention being paid to the reduction of CO_2 emissions [3]. "The future of Europe depends on a healthy planet. EU countries are committed to achieving climate neutrality by 2050 and fulfilling their obligations under the Paris Agreement. The European Green Plan is the EU's strategy for achieving this goal for 2050" [4].

The need to edit and define important environmental policies, it is necessary to point out that there are a number of factors that are very important for the achievement of this goal: (i) information about the environment, (ii) information about the availability of (natural) resources, (iii) opportunities for prudent use and protection of resources, and (iv) management mechanisms in the domain of interaction between society and nature [1]. Today's era of globalization, characterized by economic and social growth, is inevitably accompanied by the increasing importance and contribution of digitization. However, as Xie et al. (2023) showed, this trend contrasts with research on the ecological implications of the digital economy, which are rare [3].

According to the available results of the conducted research, it was determined that about 22% of diseases worldwide, together with 23% of deaths, are a direct consequence of environmental pollution [3]. Various chemicals are continuously emitted into all environmental components and thus threaten

the health of people, and plant and animal species on a global level [2]. Modern technological society is focused on the identification and regulation of environmental pollution, where the public interest and appropriate legislation play a very important role, which can greatly contribute to better and more efficient environmental control [2].
As mentioned earlier, various harmful/waste chemicals are primarily the result of anthropogenic action, which clearly implies how important and crucial the regulation of environmental pollution is to assess the quality of the environment in rural and urban areas [2]. Environmental pollution monitoring requires fast, reliable, economical, and small devices. This need explains the recent trends in the development of biosensor devices for the detection of pollutants [5].
Environmental protection requires / implies digitization in such a way that, in addition to the process of accumulation, analysis and summarization of important environmental information, their availability and distribution to all interested parties is ensured [6]. According to Campbell et al. (2019), previous decisions on environmental protection, and all accompanying actions, were based on mere assumptions and incomplete data [5]. It is through the development of new systems and digitization in the environmental domain that a sufficient level of data exchange and insight needed to create favorable decisions regarding natural resource management, finance and changes in consumption and production methods would be achieved. In this way, the possibility for the transformation of social, political, and economic systems is ensured towards achieving greater ecological transparency and attainable sustainable development [5].
Lastly, the ultimate value of environmental screening and monitoring lies in its ability to enhance societal well-being by illuminating/clarifying the indivisible bond between the environment and human health. Transforming monitored data into actionable information and effectively communicating insights to the community, represent crucial steps in raising the level of citizens' awareness about the state of their environment and empowering them to enact positive change. In order to achieve the above, it is therefore crucial for one to know how to use the available tools, where digitization, which facilitates and speeds up the exchange of data and important information, is particularly important.

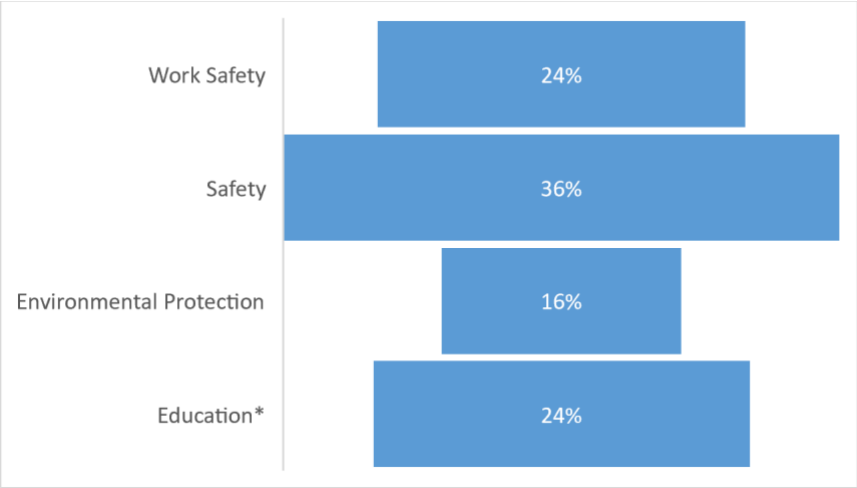
METHODS

For the purposes of creating this work, relevant scientific works were used, which were adequately cited in the literature section. The work itself is based on a survey conducted on a selected sample of people who work in occupational safety, security, environmental protection and education in this area, where it is important to emphasize that participation was voluntary and anonymous. In order to ensure a controlled sample of people engaged in the aforementioned jobs, a survey questionnaire was sent to 121 people, of which 82 participated in the research. The attached questionnaire consisted of 11 questions, which were closed type and a Likert scale was used for self-assessment of respondents. The survey was conducted online, via a Google form, through February 2024.

RESULTS AND DISCUSSION

As was written in the previous chapter, 121 people were invited to participate in the survey, and 82 of them voluntarily and anonymously participated in the survey, which is a share of about 68%. Although the interest of the participants is satisfactory, this information of about 32% of people who did not participate potentially indicates that: (i) they do not consider statistical data related to the issue of their work to be important, (ii) this topic is not significant for their field of work. It would certainly be good if, in the domain of occupational safety and health experts, a higher level of motivation to participate in such research was achieved, due to the achievement of more valid results that are crucial for a better understanding of existing challenges. The Republic of Croatia has a relatively small labor market (taking into account the data on the number of inhabitants, the working population, and the number of occupational safety experts) [7], so it can be concluded that the size of this relatively small sample has a certain significance.
As shown in Fig. 1, you can see that the largest share of respondents is engaged in work related to safety (36%), there is an equal number of respondents who are in the field of occupational safety and those who are engaged in the field of education in the domain of occupational safety and security (24%), while the smallest part of the respondents are employed in environmental protection jobs (16%).

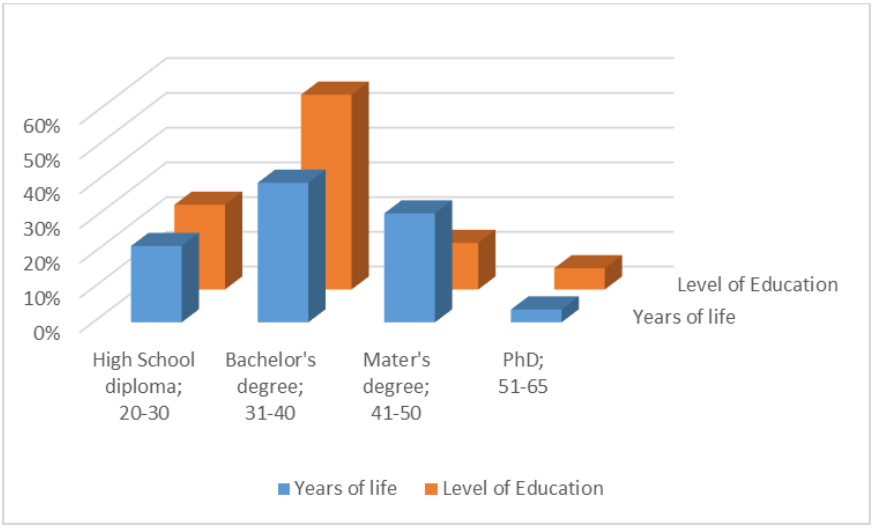
Figure 1. Overview of participants by field of work



Source: own source

Fig.2 provides a condensed view of the data related to the respondents' age and their highest level of education. The largest share of respondents are people aged 31-40, with a share of 40.2%, followed by those aged 41-50 with a share of 31.4%, then with a share of 22%, those aged from 20-30 years, and in the end representatives of the age group 51-65 were the least represented with a share of 3.7%. The above data will be very important for the discussion later.
When we talk about educational distribution, from Fig. 2, it can be seen that the leading share of respondents with a Bachelor's degree is 56.10%, and the least represented are respondents with a PhD degree at 6.1%. The above data are in line with expectations, given that most jobs in the field of occupational health and safety require a certain level of knowledge and competence, which can hardly be acquired through high school education, given the limited availability of specific educational programs at that level in the Republic Croatia.

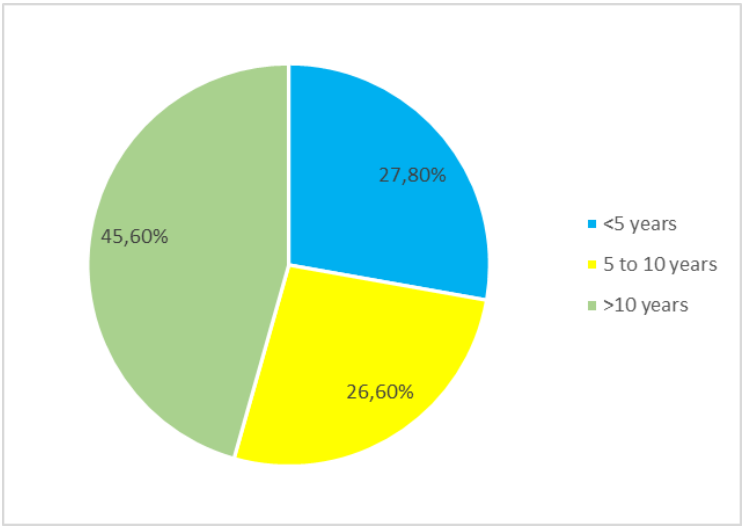
Figure 2. Age - educational distribution of respondents



Source: own source

An interesting fact relates to work experience, so in Fig. 3, it is evident that the largest share of respondents, 45.6% of them, have been engaged in the mentioned job for more than 10 years, while those with experience of less than 5 years and those of 5 to 10 years are equally represented with around 27%. This information is important in order to consider how reliable the respondents and their answers are when we talk about data related to jobs related to occupational safety and health.

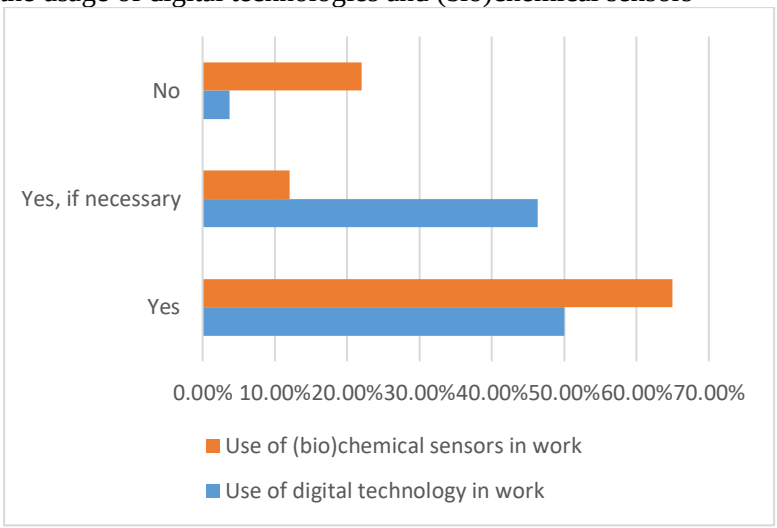
Figure 3. Professional experience in business



Source: own source

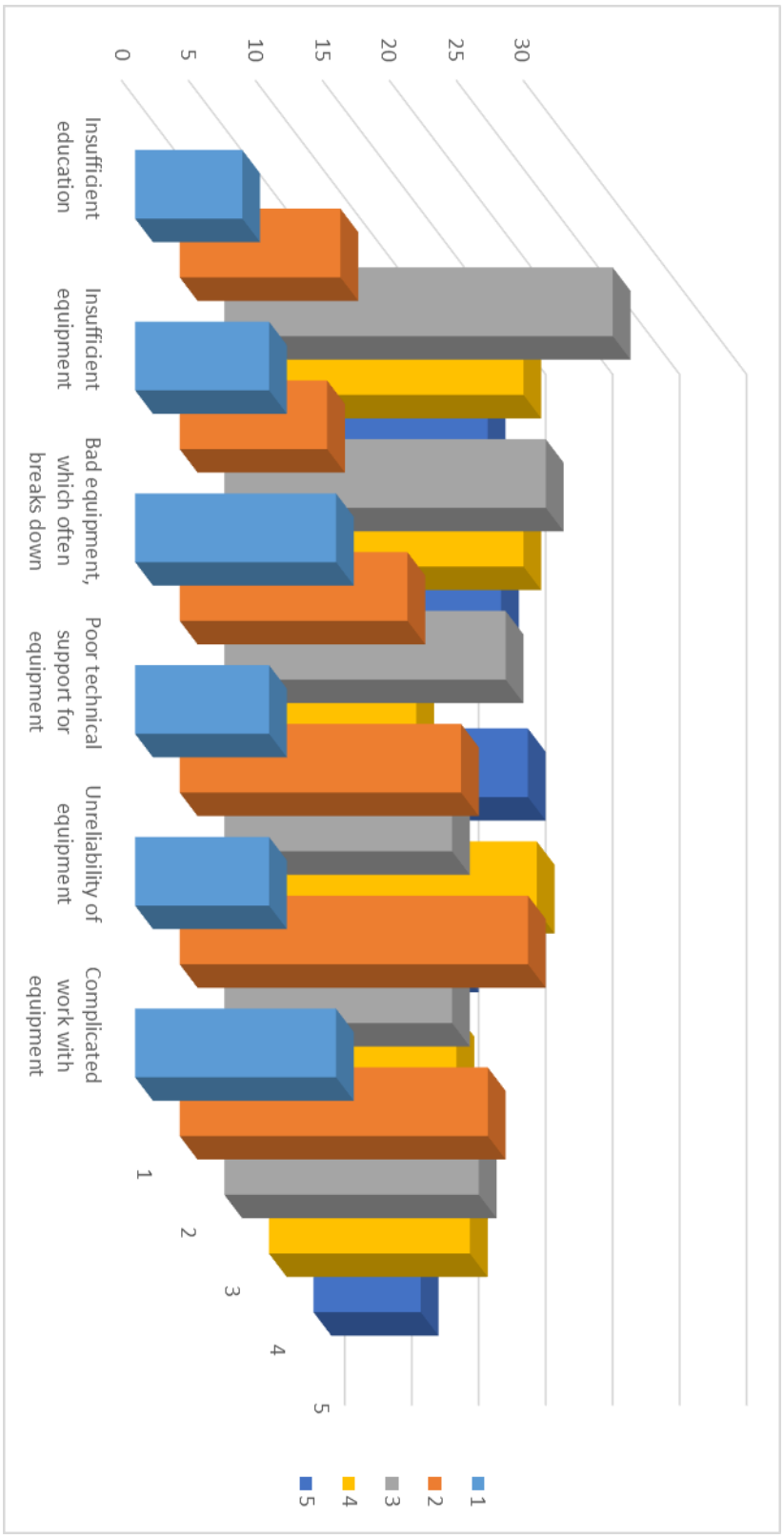
Data on the use of digital technologies and (bio)chemical sensors are very interesting and indicative, Fig.4. It can be seen that the majority of users constantly or when necessary use digital technology for work purposes, where these two groups make up a share of 96.3%. An additional interesting data is the share of 3.7% of respondents who do not use digital technologies for their work. For the reason that it is fully correlated with the previously presented data on 3.7% of respondents aged 56 to 65 years old Fig. 2, which supports the assumption that older respondents largely shy away from the use of digital technologies, which will be discussed further below.
Fig. 4 is significant due to the fact that as many as 65% of the respondents use (bio)chemical sensors in their work, and another 12% of them use (bio)chemical sensors when necessary, which supports what was written earlier about how important and useful (bio)chemical sensors are for monitoring various harmful/waste chemicals found in workplaces and/or working environment. Although it is a common opinion that this type of sensor is exclusively used preferentially for measurement and tests related to environmental protection, it is clear that their application is much wider, especially since the smallest proportion of respondents deals with environmental protection, as shown in Fig. 1. It is stated in accordance with expectations if we take into account the fact that various chemical hazards that are dangerous for the environment also represent a danger and risk for workers who are exposed to them.

Figure 4. Data on the usage of digital technologies and (bio)chemical sensors



Source: own source

Figure 5. Challenges with digital technologies



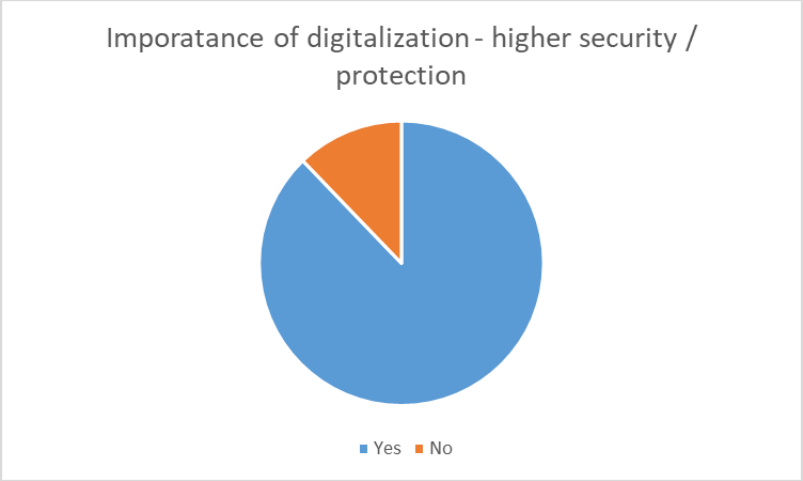
Source: own source

For the purposes of this work, it was interesting to see what challenges there are when we talk about the implementation and use of digital technologies in work, so it follows that the biggest problem is insufficient/inadequate education and insufficient equipment, which ultimately indicates that a certain number of respondents think that further complicates the job. Also, apart from the presented results, where the respondents at their own discretion using a Likert scale (1 – the least impact to 5 – the greatest

impact) Fig. 5, the respondents were able to write down the problems they encountered that were not listed; Among the responses, challenges with senior colleagues "who are poorly educated, unprepared to learn new things, and unmotivated" are at the forefront, which the majority of respondents consider "non-serious understanding of work by senior colleagues".

Digitization, according to 87.8% of respondents, contributes to greater security, i.e. a higher level of protection. The above indicates that the respondents are aware of the need to monitor and implement new technologies in their jobs, Fig. 6.

Figure 5. Digitization contributes to greater security, i.e. a higher level of protection.



Source: own source

When we talk about the tools used for work, 91.5% of respondents use desktop computers and MS Office, mobile phone applications (51.2%) and data analysis programs (50%) for their work needs. The least represented are AI (20.7%) and ML (2.4%), while 3.7% of respondents do not use any of the above, which is in accordance with the previously mentioned data.

CONCLUSION

This paper is interesting and useful for several reasons. Although we have a relatively small sample, it is certainly not negligible if we put it in the context of the size of the labor market in the Republic of Croatia and the number of jobs where experts in the field of occupational health and safety and environmental protection work. Precisely in order to ensure as representative results as possible, the survey was sent in a targeted manner to people who are reliably known to perform the above-mentioned jobs, as evidenced by the presented results. The response of 68% is satisfactory, but the following conclusions are imposed: (i) 32% of respondents do not consider this topic important, (ii) they do not recognize the importance of statistical data and therefore do not participate in surveys. This fact is very important not only for this but also for all further research, where we face the challenge of how to motivate experts in the field of occupational health and safety and environmental protection to greater engagement in terms of active participation in research about their workplaces and into challenges with which they are confronted. Additionally, this survey showed that (bio)chemical sensors are a very useful tool that is widely used in various workplaces that are not directly related to environmental protection. It is clear that the processes of monitoring and implementation of rapidly developing digital technologies are accompanied by certain challenges in workplaces, but despite this, they are represented in over 95% of workplaces in the mentioned domain.
When we talk about digitization, as the biggest problem respondents point out insufficient education and insufficient equipment, as well as challenges in the motivation and engagement of senior colleagues who resist these changes. Finally, the additional interesting information is the participation of environmental protection experts with a share of only 16%, which potentially raises the question of how interesting these jobs are and how much potential there is in view of all the climate challenges we are facing and the Green Policy that is being implemented at the level of the European Union, of which the

Republic of Croatia is a member. This last conclusion should be taken with a grain of salt, because the survey itself was sent to a target group of respondents, so perhaps the pool of these experts was not large enough to be included at the start.

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RISKS AND OPPORTUNITIES OF DIGITIZATION OF THE OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT SYSTEM

Abstract
In the time of incredibly fast technological development that brings with it technological progress, digitalization of all business processes has become more than a reality, it has become a necessity. Digitization implies the integration of digital technologies in all business processes, in all aspects of business, thereby creating new risks but also numerous opportunities for improvement and progress. The transformation brought about by the application of digitization changes the previous paradigms and radically changes the existing way of working. Occupational health and safety management, as a secondary business process, is a part of all work processes, and to integrate digital technologies, it is necessary to implement it in these processes as well. Accepting the numerous opportunities that digitalization brings, it is necessary to consider the negative effects on health and safety that appear under the influence of the application of digitalization. The first part of the paper presents the theoretical assumptions of digitization and health and occupational health and safety. The second part of the paper presents an overview of the results of the most significant analyses and research on the impact of digitization of the occupational health and safety management system. Risks and opportunities are highlighted and discussed. The discussion and conclusion provide recommendations for improving risk management and opportunities for digitization of the occupational health and safety management system.

Key words: digitization, opportunity, risk, management system, occupational health and safety.

INTRODUCTION

Digitalization and society

In today's society, digitization is not just a trend, but a powerful driver of change at all levels. From individual daily activities to global economic systems, digital technologies are transforming the way people live, work, and communicate. With technological progress comes the need for adaptation, to take advantage of all the advantages that digitization brings, but also to adequately manage the risks that may arise from such changes. "Digitalization has the potential to make safety and protection at work more effective and of higher quality". [32]

In all sectors of society, including the business sector, digitization has become a key factor in competitiveness. Business organizations recognize the importance of digital transformation to improve their processes, increase efficiency and achieve greater value for their clients and stakeholders. However, with these benefits come several challenges and risks, especially when it comes to occupational health and safety management.

In the context of OHS management systems, digitization can bring many benefits. The application of digital tools and technologies can make it easier to monitor working conditions, identify potential hazards and take preventive measures. Monitoring data in a real time frame can enable quick intervention in case of problems and reduce the risk of injuries at work. Also, digitalization can improve the efficiency of implementing employee training programs, providing interactive and customized materials that are more easily accessible to employees.

Despite these advantages, it is important to recognize the potential risks and challenges brought by the digitalization of safety management systems. Automation and the use of smart technologies can lead to a reduction in human interaction and supervision, which can increase the risk of accidents or technical failures. Also, digitalization can require new knowledge and skills from employees, which can represent an additional challenge for organizations.

Therefore, it is important to carry out a detailed analysis of the risks and opportunities brought by the digitalization of occupational health and safety management and to develop strategies for the efficient management of this process. This paper will explore the theoretical foundations of digitization and its impact on the security management system and provide an overview of the results of relevant research. Through the analysis of risks and opportunities, and recommendations for improving practice, the goal is to provide guidelines for the successful implementation of digital technologies in the security management system, while at the same time reducing potential negative effects.

Purpose and aim of the research

As a rule, the occupational health and safety management system is based on legal requirements and requirements of international standards. Occupational health and safety management, as a secondary business process, is a part of all work processes, and to integrate digital technologies, it is necessary to implement it in these processes as well. Therefore, it is necessary to clearly define what risks and opportunities the digitization of the OHS management system brings.

The primary goal of this research is to analyze existing knowledge about the risks and opportunities of digitizing the OHS management system. The goal will be achieved by researching the available literature and studying case studies.

Research objectives

According to the above defined aim of this research project, the following research objectives are set:
- analyze and present the basic theoretical concepts of occupational health and safety
- analyze and present the basic theoretical concept of digitization
- analyze and present the basic theoretical concept of risks and opportunities
- to identify the fundamental risks and opportunities of digitization of the OHS management system
- propose a way to effectively manage identified risks and opportunities.

METHODS

For the research to fulfill its purpose, the research method is applied. Considering the identified problem, set goals and tasks of this scientific research, appropriate scientific methods were chosen. The research methodology uses methods that meet the requirements of the planned theoretical research through their combination and sequence.

The fundamental concepts of occupational safety, digitization, risks, and opportunities are explored using the method of document study and content analysis. Basic concepts were analyzed from selected scientific literature. A combination of deductive and inductive analysis is used to classify and summarize the theoretical foundations of the research subject. The method of content analysis is used to analyze theoretical statements. By applying description methods, it describes essential features. After analysis and comparison, essential properties are synthesized, conclusions are drawn.

RESULTS AND DISCUSSION

Occupational health and safety management

Occupational health and safety (OHS) in practice is terminologically identified with occupational safety. Since security is the superior term to the term protection, it can be concluded that terminologically these two terms cannot represent and mean the same thing. [19]

Occupational health and safety (OHS) generally defined as the science of the anticipation, recognition, evaluation, and control of hazards arising in or from the workplace that could impair the health and well-being of workers, considering the possible impact on the surrounding communities and the general environment. This domain is necessarily vast, encompassing many disciplines and numerous workplace and environmental hazards. A wide range of structures, skills, knowledge, and analytical capacities are needed to coordinate and implement all "building blocks" that make up national OHS systems so that protection is extended to both workers and the environment. [2]

According to Kacian [13] safety at work is an interdisciplinary scientific and professional field (it leaves the domain of the existing structure of basic sciences and scientific disciplines) as well as a multidisciplinary field (because it forms a new field in which there are many scientific disciplines that touch and overlap). This multidisciplinary field is marked by: work organization, technique, technology, occupational medicine, ergonomics, anthropology, occupational safety law, pedagogy and andragogy, psychology, ecology, sociology, economics, etc.

Therefore, OHS can be defined as a system of technical, health, legal, psychological, pedagogical, and other activities, which detect and eliminate dangers and harms that can endanger the life and health of people at work. [20] On this basis, it is concluded that the purpose of safety at work is to create safe conditions to prevent injuries at work, occupational diseases, and accidents at work. In the theoretical definition of the concept of OHS, there is no unified position on what occupational safety is. Although it is defined differently by different authors, it can be said that neither definition is in contradiction with the other, so in essence they complement each other. The science of OHS aims to find measures and procedures that will exclude the causes that lead to injuries and occupational diseases at work. Injuries and occupational diseases in modern society lead to great harmful consequences, which are manifested primarily in the suffering experienced by the injured or the families of deceased workers, and then through the great economic losses suffered by society due to lost working days, treatment costs, recovery, etc. [8]

OHS is part of the organization of work and performance of the work process, and is achieved by performing occupational safety and applying the prescribed, agreed, as well as recognized rules of occupational safety and ordered measures and instructions of the employer. [7] The employer is responsible for the organization and implementation of occupational safety on the basis of objective responsibility, regardless of whether it has hired an occupational safety expert, or organized an occupational safety service or has contracted cooperation with an authorized person for occupational safety, institution or company for occupational safety. The management of OHS goes beyond the minimum requirements defined by the regulations in this area. [22]

The occupational health and safety management system is part of the overall system that realizes the management of health risks inherent in the organization's business activities. The system includes the organizational structure, planning, responsibility, practice, procedures, processes, resources for the development, application, implementation, review and maintenance of the organization's health and safety policy. [28] Therefore, the OHS management system can be different between organizations and between countries. [16]

The OHS management system is a continuous, adaptable process consisting of a series of related activities, phases, elements, and procedures that enables the normal flow and functioning of business processes and systems in which all persons participating in the organization's business processes must be included. OHS management is one of the more complex and responsible jobs in an organization that requires a lot of activity, attention and thinking from the organization's management. Optimum processes are created through the OHS management system through constant improvement, in which all factors that can make their contribution participate. [15] Through thoughtful application and guidance in the OHS management system, hazards are eliminated, i.e., the risks of basic hazards that occur in the business process are reduced.

Based on conducted research, Petersen describes the essential elements of security programs based on the behaviour of employees. Among others, the author believes that several factors influence the

construction of a safe working environment through motivating, encouraging a culture of safety, increasing worker participation and encouragement. [29]

The research carried out so far on individual elements of the OHS management system [5, 12, 23, 24, 25, 26] was created based on defined elements of an effective OHS management system. [27]

Economically, morally, and legally, occupational safety and health has become an important issue. Companies are attempting to remain profitable in an ever more competitive global economy. For these companies, addressing safety, health, and environmental issues may mean more than good business practice. For many companies, strong safety, health, and environmental programs may mean survival. [11] The human, social and economic costs of work-related accidents, injuries and illnesses and major industrial disasters have long been a concern at all levels, from individual workplaces to national and international. Measures and strategies intended to prevent, control, reduce or eliminate hazards and risks in workplaces are developed and applied continuously over the years to keep pace with technological and economic changes. However, despite continued, if slow, improvements, work-related injuries and illnesses are still far too common and their cost in terms of human suffering and economic burden remains significant. [2]

The management systems and characteristics required for success in OHS are the same as those required for success in any other area of industrial or commercial activity. Indeed, those organizations that are successful in business are usually those that have high standards of OHS. [9]

Occupational safety risk assessment is the basis for defining and implementing all occupational safety measures in an organization. The OHS management system must enable the effective implementation of risk assessment and all necessary measures. [3]

The theory of risks and opportunities

Even in prehistoric times, there was a risk of the impossibility of achieving basic living conditions when it was not known what to find in the day to eat, whether to catch an animal and etc. Nowadays, risks in everyday life there are various risks such as participation in traffic in which there is a real danger of a traffic accident, and so on. [33] Therefore, we can say that risk develops over time and that our daily activities have become increasingly insecure.

Risk is a complex concept that occurs in all areas of life, in private and business terms. Risk constantly accompanies all human activities. The concept of risk due to its ambiguity and complexity has always attracted the attention of scientists from various fields and branches of science. [21]
Risk has been approached from different aspects, so that even today there is no single definition of risk.

Risk is defined in many ways, of which the most significant are listed below:

- risk is the effect of uncertainty on objectives (an effect is a deviation from the expected - positive and/or negative) [ISO 31073:2022 Risk management — Vocabulary]
- risk is the effect of uncertainty [ISO 9000:2015 Quality management systems - Fundamentals and vocabulary]
- risk is the possibility of something bad happening at some time in the future; a situation that could be dangerous or have a bad result [Oxford English Dictionary]
- risk is a combination of the probability of an event and its consequences, and the consequences can be positive or negative [The Institute of Risk Management]
- risk is the degree of uncertainty [17]
- risk is the uncertainty of outcomes within the exposure range, which arises from a combination of the impact and probability of potential events [10]
- risk is the uncertainty of an event that could affect the achievement of objectives, the risk is measured in terms of consequences and probability [6]
- risk is a condition in which there is a possibility of a negative deviation from the desirable outcome that we expect or hope for. [23]

Risks, in their different forms and inter-relationships, may be the subject of observation and management based on different perspectives. [18] The main risk observation perspectives stem, from studies in the economic-corporate and production areas, and may be summarized as, strategic perspective, corporate governance perspective, financial perspective, and operational perspective. Therefore, it emerges that, with a view to detecting the many facets and forms under which they appear, risks should be simultaneously observed from many and different perspectives. [6] Although for a long time the prevailing view was about the negative connotation of risk, some authors (Mowbray et al. [17], Dickinson [10], Bannister et al. [4] and Carter [8]) defined risk by emphasizing the dual character of risk that can alternatively produce losses or gains, such as through elections and events that have financial consequences. We can conclude that, depending on the situation, a favourable event can turn into an unfavourable event and vice versa. Risk happens in the future. It may or may not happen.

The attempt to objectify the concepts of risk (or the concept of a favourable or unfavourable event) conflicts with the dominant logic of relativism. The conceptualization of risk should look at the concepts of favourable and unfavourable events, based on the recognition of their dynamic, subjective and ambivalent character. Therefore, an unfavourable event can be described as a negative deviation from the expected positive situation. Conversely, a favourable event is described as a positive deviation from an expected negative situation. [31] The consequences of risk can be negative (hazard risk) or positive (opportunity risk) or can lead to uncertainty. At the same time, danger includes a dangerous event and its negative consequences, as well as the causes behind that event, and an opportunity includes the possibility of improvement. [30] So, opportunities are positive risks. Since a risk is an event with a potential negative outcome, an opportunity is an event with a potential positive outcome.

Digitalization of occupational health and safety management system

Kashchena and Nesterenko [14] emphasize that "Research has shown that the latest information systems and technologies play a key role in digital transformation and the formation of a business model focused on the protection and sustainable development of the company.", which confirms the importance of the digitalization of security management systems in improving working conditions and reducing the risk of injuries in the workplace.

Sergeenko and colleagues [32] point out that "The benefits of digital transformation in the management of health and safety in the workplace are many". Safety management systems have undergone significant changes over the past decades, evolving from simple systems that only met legal obligations to a comprehensive and proactive approach that integrates health and safety concerns as a fundamental part of organizational operations. With the advent of digitization, data collection and analysis have become simpler, enabling organizations to manage risks related to workplace protection more transparently and efficiently. By introducing digital technologies into this process, organizations are provided with better insight, analysis and management of factors that affect the health and safety of their employees. However, when implementing digitization, it is important to consider how specific risks and opportunities manifest themselves within individual industries. One of the key advantages is that digital technologies enable the proactive implementation of occupational safety measures in real time.

Akyildiz [1] points out "how with new technologies and smart devices, digital applications focused on professional risks are being developed, including digital task analysis, dynamic risk assessment, real-time monitoring of employees and protection from unauthorized access." This enables companies to quickly respond to potential threats and changes in working conditions and to take appropriate measures to ensure the health and safety of workers. For example, various sensors in work processes can monitor noise, temperature, or the presence of hazardous substances, which allows employers to identify potential risks and take steps to reduce or eliminate them. Furthermore, digitization facilitates the automation of safety procedures such as reporting accidents or injuries at work. This simplifies these procedures, reduces the possibility of errors or delays, and ensures consistent adherence to workplace safety protocols. Also, digitization enables the collection and analysis of large amounts of data, which helps companies gain important information on trends related to the safety management system. By analyzing this information, companies can identify areas for improvement and implement targeted actions to prevent accidents and injuries in the workplace and promote a safer work environment.

Digitization of OHS management also improves communication and cooperation between interrelated parties. For example, digital platforms and applications can serve for a more transparent internal monitoring process, by sharing materials for employee training, access to instructions for safe work and other important information in the field of occupational safety.

It improves communication, promotes a culture of safety, and encourages the active participation of employees in discovering and solving issues related to safety at work. Furthermore, digitalization enables the application of preventive measures such as predictive analysis and training of workers in simulated scenarios. Such measures can help legal entities to anticipate and prevent potential hazards before they occur, thereby reducing the risk of accidents and injuries at work. In short, the digitization of the OHS management system provides legal entities with improved possibilities for monitoring, analyzing, and managing the situation. In addition, digitalization can improve the efficiency of implementing worker training programs, considering the diversity of the workforce. Interactive e-learning modules and various simulations enable workers to acquire the necessary knowledge and skills in a practical and efficient way. Also, digital platforms facilitate the monitoring and management of the worker training process, including the presence of foreign workers for whom the training process is a real challenge regarding sociocultural factors, to ensure that everyone is familiar with the correct execution of work procedures. Based on the mentioned sources, it is important to consider the specifics of different working environments of technological processes when implementing digitization in OHS management.

However, with these opportunities come certain risks. For example, the implementation of digitization can raise concerns about employee privacy and there is a risk of technical failures or hacker attacks that could compromise data integrity and workplace security. It is therefore crucial that organizations adopt appropriate security measures and policies to protect sensitive information and ensure a secure work environment. Introducing new technologies can be a complex process that requires expertise and resources. The digitization process can require significant investments in infrastructure and staff training, which is a deterrent – especially in small and medium-sized organizations.

Interoperability between different systems and technologies is also a fundamental challenge. Ensuring that new digital solutions can seamlessly communicate with organizations' existing software is key to a holistic approach to OSH management. Therefore, it is important that organizations plan the implementation of digitization in detail and provide the necessary resources and experts for the successful implementation of this process. From the aspect of science and practicality, the implementation of digital security in the workplace is a key step towards improving the safety and protection of workers. It is necessary to develop and apply new digital technologies in the field of workplace safety to establish an OHS regulatory system.

The introduction of digital technologies in OHS management is an important step towards improving the well-being of employees, preventing injuries and creating a safer working environment for all employees, including foreign workers. Digitization of the OHS management system brings many opportunities to improve working conditions. Reducing the risk of workplace injuries is essential for all organizations that want to successfully integrate digital technologies. To take full advantage of digital transformation, organizations need to carefully analyze the risks and implement appropriate measures. To reap the benefits of digitization while mitigating the challenges, organizations must adopt proactive strategies that emphasize stakeholder engagement, data security, flexibility, interoperability, and adaptability. Through careful planning and strategic investment, organizations can improve the effectiveness and resilience of their OSH management systems in the digital age.

Risks and opportunities of digitization of the occupational health and safety management system

As discussed earlier, in the context of OHS management systems, digitization can bring many benefits. The application of digital tools and technologies can make it easier to monitor working conditions, identify potential hazards and take preventive measures. Monitoring data in a real time frame can enable quick intervention in case of problems and reduce the risk of injuries at work. Also, digitalization can improve the efficiency of implementing employee training programs, providing interactive and customized materials that are more easily accessible to employees. Digitization of all process activities

carried out in OHS enables their effectiveness and efficiency and can significantly facilitate the work of OHS experts. In other words, the application of digitization creates numerous opportunities for improvements in all aspects of OHS implementation.

In addition to the mentioned advantages, it is important to recognize the potential risks and challenges brought by the digitalization of the OHS management system. Automation and the use of smart technologies can lead to a reduction in human interaction and supervision, which can increase the risk of accidents or technical failures. Also, digitalization can require new knowledge and skills from employees, which can represent an additional challenge for organizations. Given that we are working on the application of information technology, the risks of malicious software (viruses, etc.) and hacker attacks should not be ignored. This leads to the conclusion that in general there are information and cyber risks, as well as risks in personal data protection. Here we can talk about the risk of non-acceptance of digitization by the people who need to use it the most, OHS experts. Are the expert's computer-literate enough for digitizing OHS? How to overcome this gap? How to explain to employers the justification of investing in OHS digitization? All these are questions to which it is necessary to find answers as soon as possible.

Thinking about the risks and opportunities of OHS digitization in an organization should be carried out through consideration of the context of the organization itself, identification of key stakeholders and their needs and expectations.

Considering the context of the organization implies looking at external and internal issues that have or may have an impact on digitization. External issues, for example, may be the possibility of obtaining a state or other subsidy for digitalization, the requirement that reporting and sending data to the competent ministry be carried out using digital tools, etc. Internal issues may be the organization's readiness for such changes, the readiness or resistance of OHS experts to digitalization, possession of the necessary infrastructure, etc. Stakeholders, that is, interested parties in the process and application of OHS digitization may also have different expectations, but also influences on the actual implementation and application of OHS digitization.

Based on all the above, it is concluded that before the implementation of OHS digitalization, it is necessary to carry out a quality analysis of the risks and opportunities of OHS digitalization in a specific organization. Digitization of OHS is inevitable. It is already partially present, and its full arrival is at the door.

CONCLUSION

In all sectors of society, including the business sector, digitization has become a key factor in competitiveness. Business organizations recognize the importance of digital transformation to improve their processes, increase efficiency and achieve greater value for their clients and stakeholders. However, with these benefits come several challenges and risks, especially when it comes to occupational health and safety management. OHS is part of the organization of work and performance of the work process, and is achieved by performing occupational safety and applying the prescribed, agreed, as well as recognized rules of occupational safety and ordered measures and instructions of the employer. Therefore, the digitization of business processes includes the digitization of OHS management.

In the OHS management system, digitization can bring many advantages. The use of digital tools and technologies can facilitate the monitoring of working conditions, the recognition of potential hazards and the taking of preventive measures. Monitoring data in a real time frame can enable quick intervention in case of problems and reduce the risk of injuries at work. Also, digitization can improve the effectiveness of implementing employee training programs by providing interactive and customized materials that are more easily accessible to employees. Digitization of all process activities carried out in OHS enables their effectiveness and efficiency and can significantly facilitate the work of OHS experts. In other words, the application of digitization creates numerous opportunities for improvement in all aspects of the implementation of OHS. Thinking about the risks and opportunities of OHS

digitization in an organization should be carried out through consideration of the context of the organization itself, identification of key stakeholders and their needs and expectations.

It can be determined that the goals and objectives of this research have been achieved. The conducted research determined and analyzed the theoretical settings of occupational health and safety protection, digitalization of risks and opportunities. Also, the fundamental risks and opportunities of digitalization of the OHS management system were identified, and recommendations were given on how to manage them.

After this research, it is proposed to start empirical research on the issue of digitalization of OHS by segments and areas of application of digital tools. The results of such research could contribute to the effectiveness of further digitization processes of OHS management.

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Standards

- ISO 31073:2022 Risk management — Vocabulary
- ISO 9000:2015 Quality management systems - Fundamentals and vocabulary
- ISO 31000:2018, Risk Management – Guidelines

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RISK MANAGEMENT MODEL FOR THE APPLICATION OF ARTIFICIAL INTELLIGENCE IN OCCUPATIONAL HEALTH AND SAFETY

Abstract
The application of Artificial Intelligence (AI) becomes an integral part of all human activities, including the performance of tasks at the workplace. AI, with all its benefits and positive outcomes is here to stay and is already transforming every aspect of the workplace. However, how to build the trust in AI, how to trust the trustor, how to be safe and secure about the AI and what could be ethical challenges, are just some of the ongoing open questions still to be addressed. The application of AI in working activities must be safe, and therefore it is necessary to manage the risks that come from its application. Considering the options of wide application, the great possibilities of applying AI in occupational health and safety have also been recognized. The risks of applying AI must be assessed, and effective control measures must be implemented and maintained. Risk management is the basis of the overall management of occupational health and safety. The first part of the paper presents the AI theoretical concepts, theoretical concepts of risk management, theoretical concepts of occupational health and safety and the theoretical presentation of the risk management model. The second part of the paper describes the risk management model for AI application in the field of occupational health and safety. This risk management model includes identification of management scope, organization context, criteria, risk assessment, risk treatment, monitoring, review, communication, consultation, recording, reporting and risk review. In the discussion and conclusion, the possibilities, and recommendations for improving the risk management process of applying AI during work activities are presented.

Key words: artificial intelligence, model, occupational health and safety, risk management.

INTRODUCTION

New chapter in occupational health and safety - application of artificial intelligence

In recent years, the field of occupational health and safety (OHS) has witnessed a paradigm shift with the emergence of Artificial Intelligence (AI) as a powerful tool for enhancing workplace safety and well-being. This convergence marks a new chapter in the ongoing efforts to promote and maintain health and safety standards in diverse industrial settings. With AI-driven technologies revolutionizing traditional approaches to risk management, accident prevention, and employee training, organizations are poised to unlock unprecedented opportunities for improving workplace safety outcomes.
The application of AI in OHS represents a transformative leap forward, offering capabilities that were previously unimaginable. From data-driven decision-making and predictive analytics to real-time monitoring and virtual simulations, AI empowers organizations to proactively identify, assess, and mitigate safety risks, thereby fostering a culture of safety excellence. Moreover, AI-driven solutions enable adaptive risk management strategies, ensuring that OHS practices remain responsive and adaptive in the face of evolving workplace dynamics.
However, alongside its potential benefits, the integration of AI in OHS also presents unique challenges that must be addressed to maximize its effectiveness and ensure ethical, equitable outcomes. Issues such as data quality, bias, interpretability, and human-machine collaboration require careful consideration to mitigate potential risks and pitfalls associated with AI implementation.
As organizations embark on this new chapter in occupational health and safety, it is imperative to navigate these opportunities and challenges with a forward-thinking approach. By embracing the transformative potential of AI while prioritizing ethical considerations, data privacy, and human well-being, organizations can create safer, healthier, and more resilient workplaces for all employees.

In this context, this chapter explores the opportunities and challenges associated with the application of AI in occupational health and safety, shedding light on the transformative potential of AI-driven technologies and the critical considerations for their successful implementation in diverse industrial settings. Through a comprehensive examination of the latest research findings, case studies, and practical insights, this chapter aims to provide a holistic understanding of the role of AI in shaping the future of occupational health and safety practices.
No matter how tempting the application of AI seems, it brings new risks and uncertainties. What uncertainty is there that the application of AI in risk management will correctly identify and value risks? Can this uncertainty be reduced? How to identify the risks arising from the application of AI? The application of AI in OHS opens many new questions. One thing is certain, we have entered a new chapter of planning and implementation of OHS.

Purpose and aim of the research

Although the application of artificial intelligence brings many benefits, it also creates new challenges. Each challenge can pose a risk. These challenges become particularly pronounced when artificial intelligence is implemented in the realm of occupational health and safety. Considering the specifics, it is necessary to establish a robust model for effective management of these risks.
The primary objective of this research is to analyze and define a comprehensive risk management model for the application of artificial intelligence in occupational health and safety. By delving into the intricacies of AI integration within workplace safety protocols, this study aims to identify potential risks and develop proactive strategies to mitigate them, thereby ensuring the safe and responsible deployment of AI technologies in occupational settings.

Research objectives

According to the above defined aim of this research project, the following research objectives are set:
- analyze and present the basic theoretical concept of occupational health and safety.
- analyze and present the basic theoretical concept of artificial intelligence.
- analyze and present the basic theoretical concept of risk.
- describe the risk management model of the application of artificial intelligence in occupational health and safety, with its principles, framework, and processes.
- present a risk management model for the application of artificial intelligence in occupational health and safety.

METHODS

For the research to fulfill its purpose, the research method is applied. Considering the identified problem, set goals and tasks of this scientific research, appropriate scientific methods were chosen. The research methodology uses methods that meet the requirements of the planned theoretical research through their combination and sequence.
The basic concepts of occupational health and safety, artificial intelligence and risk are explored using the method of document study and content analysis. Basic concepts were analyzed from selected scientific literature. A combination of deductive and inductive analysis is used to classify and summarize the theoretical foundations of the research subject. The content analysis method is used to analyze theoretical assumptions. By applying description methods, it describes the essential features and the model for the application of artificial intelligence in occupational health and safety.
After the analysis and comparison, essential properties are synthesized, conclusions are drawn and a risk management model for the application of artificial intelligence in occupational health and safety is defined.

RESULTS AND DISCUSSION

Artificial Intelligence (AI)

Artificial Intelligence (AI) has emerged as a transformative force across various domains, revolutionizing conventional practices and introducing innovative solutions. In the realm of occupational health and safety (OHS), the application of AI stands poised to redefine traditional approaches to risk management, accident prevention, and overall workplace well-being. With over two

decades of research experience in this field, it is evident that AI holds significant promise in enhancing OHS protocols and fostering safer working environments. In particular, it is expected that AI will significantly change and impact several areas of the OHS such as:

1. Data-driven Decision Making: One of the primary contributions of AI in OHS lies in its ability to analyze vast amounts of data swiftly and accurately [1]. By leveraging machine learning algorithms, AI systems can detect patterns, identify potential hazards, and predict safety risks based on historical data, near-misses, and incident reports. This data-driven approach empowers organizations to make informed decisions regarding safety protocols, resource allocation, and preventive measures.

2. Predictive Analytics: AI-driven predictive analytics play a crucial role in forecasting potential occupational hazards before they escalate into accidents or injuries [2]. Through the analysis of various data sources such as sensor data, employee behavior patterns, and environmental factors, AI models can anticipate safety risks and preemptively implement interventions to mitigate them. This proactive approach not only minimizes workplace accidents but also enhances overall productivity and efficiency.

3. Real-time Monitoring and Intervention: AI-powered monitoring systems offer real-time insights into the OHS landscape, enabling continuous surveillance of workplace conditions and employee well-being [3]. By integrating sensors, wearable devices, and IoT technologies, AI platforms can detect deviations from safety norms, alert supervisors to potential emergencies, and even initiate automated responses in critical situations. This proactive monitoring capability ensures rapid intervention and timely assistance, thereby reducing the likelihood of accidents and ensuring prompt medical attention when needed.

4. Virtual Training and Simulation: AI-driven virtual reality (VR) and augmented reality (AR) simulations provide immersive training experiences for employees, allowing them to familiarize themselves with potential hazards and safety protocols in a risk-free environment [4]. These interactive simulations enable workers to practice emergency procedures, recognize safety hazards, and develop effective response strategies, thereby enhancing their preparedness and resilience in real-world scenarios. Additionally, AI algorithms can personalize training modules based on individual learning styles and performance metrics, optimizing the effectiveness of OHS training programs.

5. Adaptive Risk Management: AI facilitates adaptive risk management strategies by continuously learning from new data inputs and adjusting safety protocols accordingly [5]. Through iterative feedback loops and adaptive algorithms, AI systems can refine risk assessments, update safety guidelines, and adapt to evolving workplace dynamics in real-time. This dynamic approach to risk management ensures that OHS practices remain responsive and adaptive in the face of changing circumstances, thereby enhancing overall safety performance and resilience.

In conclusion, the application of the AI in the area of occupational health and safety represents a paradigm shift in how organizations approach risk management and workplace well-being [6]. By harnessing the power of data analytics, predictive modeling, real-time monitoring, virtual simulations, and adaptive algorithms, AI empowers organizations to proactively identify, assess, and mitigate safety risks, thereby fostering a culture of safety excellence and ensuring the health and well-being of workers in diverse industrial settings. As we continue to explore the potential of AI in OHS, it is imperative to prioritize ethical considerations, data privacy, and human-machine collaboration to maximize the benefits of this transformative technology while minimizing potential risks and pitfalls.

Challenges of Applying Artificial Intelligence in Occupational Health and Safety

While the application of Artificial Intelligence (AI) in occupational health and safety (OHS) holds immense potential, it also presents several challenges that need to be addressed to ensure its effective implementation and maximize its benefits. Unlike some other disciplines, AI challenges have to be addressed in a more cautious way as workplace safety and well-being are at stake. The following challenges are identified through past literature:

1. Data Quality and Accessibility: Ensuring the quality and accessibility of data poses a significant challenge in applying AI to OHS [6]. Fragmented, incomplete, or inconsistent data may hinder the effectiveness of AI algorithms in generating accurate insights and predictions. Moreover, issues related to data privacy, security, and interoperability may further complicate access to valuable datasets, limiting the potential of AI-driven solutions in OHS.

2. Bias and Fairness: AI algorithms are susceptible to biases inherent in the data they are trained on, which can perpetuate existing disparities and inequalities in the workplace [7]. Addressing bias and promoting fairness in AI systems require careful attention to data collection, algorithm design, and model evaluation to ensure equitable outcomes for all workers.

3. Interpretability and Trustworthiness: The black-box nature of many AI algorithms poses challenges in understanding how decisions are made, particularly in critical domains such as OHS [8]. Lack of interpretability may undermine trust in AI-driven recommendations and interventions, leading to skepticism and reluctance among stakeholders.

4. Ethical and Legal Considerations: Ethical and legal issues related to consent, transparency, accountability, and liability must be carefully navigated in the use of AI in OHS [9]. Clear guidelines, regulations, and ethical frameworks are needed to govern the ethical use of AI in OHS and safeguard the rights and well-being of workers.

5. Human-Machine Collaboration: Effective integration of AI into OHS practices requires seamless collaboration between humans and machines [10]. Building trust, providing adequate training, and fostering a culture of collaboration are essential for successful human-machine interaction in OHS.

All these challenges are not of small importance as they can directly or indirectly have important impact on the way the organizations perceive them which consequently can influence the decision to adopt the AI within the OHS context. In any case, the sensitiveness of the topic is omnipresent and carefully and gradual approach is needed to first of all, better understand the challenges and secondly, have clear framework on how to implement it within the organizational boundaries.

Occupational Health and Safety Risk Management

The scope of OHS has developed gradually but continuously in response to social, political, technological, and economic changes. In recent years, the globalization of the world's economies and the resulting consequences are understood as the greatest force of change in the world of work. This has its positive and negative consequences in OHS as well. There are numerous direct and indirect pressures that affect OHS in the world of work. According to Alli [11], OHS can generally be defined as the science of predicting, recognizing, assessing, and controlling the risks of hazards arising in the work process. This broad area encompasses many disciplines, which proves its multidisciplinary. To effectively implement OHS activities and processes, a wide range of structures, skills, knowledge and analytical capacities are needed for the coordination and implementation of all measures and procedures [11].

OHS becomes a very important issue economically, morally, and legally. In an increasingly competitive global economy, many companies are trying to make a profit. Issues of safety at work are becoming an integral part of the necessary conditions for business success [12]. OHS can also be defined as a system of legal, technical, health, psychological, pedagogical, and other activities that detect and eliminate risks of danger and harm that can endanger the life and health of people at work. Thus, the fundamental purpose of OHS is to create safe working conditions and prevent injuries at work, occupational diseases, and other accidents at work [13]. According to the WHO, occupational safety is part of the organization of work and performance of the work process and is achieved by performing occupational safety tasks and applying prescribed, agreed, as well as recognized occupational safety rules, as well as the employer's ordered measures and instructions [14].

An Occupational Health and Safety Management System (OHSMS) is a structured approach that enables organizations to effectively manage OHS risks. This system helps organizations to identify, assess and control possible risks from certain hazards to ensure a healthy and safe working environment for all employees. The goal of this system is to identify, analyse and mitigate OHS risks to protect the lives,

health and property of both employees and other stakeholders of the organization. The OHSMS must be part of the overall business system of an organization to achieve health risk management of specific business activities of the organization. OHSMS includes the organizational structure, planning, responsibilities, procedures, processes, resources, implementation, review, and maintenance of the organization's OHS policy.

There are numerous definitions of risk and risk management, but all of them have some common points. Risk is a potential problem. It may or may not happen. Risk is generally defined as a threat to the successful achievement of set goals. Risk refers to the future and future events. Risk does not happen now; it happens in the future. There is no job or activity in which there is no risk. Every business is a risky business. It's just a question of how risky a job is, or what level of risk there is. The probability that a certain risky event will occur depends on its nature. Of course, there are many factors that influence the realization of risk. More precisely, they affect the probability that a certain risk will materialize. Risk management is the method used to control, eliminate, or reduce the hazard within parameters of acceptability. It is unique to everyone, since there are no two people exactly alike in skills, knowledge, training, and abilities [15]. Also, risk management involves the coordinated activities to direct and control an organization regarding risk [16]. The purpose of OHS risk management is to increase the probability of achieving the required level of safety, i.e. achieving goals in safety, through the management of threats, hazards, and emergency situations. OHS risk management coordinates the activities that manage and control the organization regarding OHS risks.

Along with risk, one of the important concepts is uncertainty. There are different forms of uncertainty whose effects can have positive and/or negative consequences, and risk always includes their effects. In practice, we often describe and name risk in terms of risk sources, their consequences and certainty. An event can have several causes and result in several different consequences that may be previously unknown [17]. To categorize the types of uncertainty, it is usually divided into two types:

- aleatory uncertainty - uncertainty that recognizes the internal variability of some phenomena, which cannot be reduced by further data,
- epistemic uncertainty - uncertainty that generally results from a lack of knowledge and can therefore be reduced by collecting more data, refining models, improving sampling techniques, etc. [18].

Both types of uncertainty must be understood and kept in mind when dealing with the risks of applying AI in OHS.

Principles, Framework, and Process of Risk Management for the Application of AI in OHS

According to international standards and theoretical settings, risk management is based on principles, framework, and process. The fundamental purpose of risk management is to create and protect value. Risk management improves performance, encourages innovation, and supports the achievement of objectives. The OHS risk management principles provide guidance on the characteristics of effective and efficient OHS risk management, communicating its value and explaining its intent and purpose. The principles are the basis for risk management and should be considered when establishing an organization's risk management framework and processes for the application of AI in OHS. These principles should enable an organization to manage the effects of uncertainty on its OHS objectives [19]. The key principles of risk management for the application of AI in OHS are:

- risk management is an integral part of all organizational activities
- a structured and comprehensive approach to risk management contributes to consistent and comparable results
- risk management framework and process are customized and proportionate to the organization’s external and internal context related to its objectives
- appropriate and timely involvement of stakeholders enables their knowledge, views and perceptions to be considered
- risks can emerge, change or disappear as an organization’s external and internal context changes
- inputs to risk management are based on historical and current information, as well as on future expectations
- there is uncertainty in the application of AI
- human behaviour and culture significantly influence all aspects of risk management at each level and stage
- risk management is continually improved through learning and experience.

According to ISO 31000:2018, Risk management - Guidelines, the components of risk management framework for the application of AI in OHS are: leadership and commitment, integration, design, implementation, evaluation, and improvement. The purpose of risk management framework is to assist the organization in integrating risk management into significant activities and functions. What an effective risk management for the application of AI in OHS will be depending on its integration into the management of the entire organization, including decision-making [20].

Considering the specifics of AI application, the risk management process for the application of AI in OHS should be an integral part of management and decision-making and integrated into the structure, operations, and processes of the entire organization. Especially in parts of the organization where the application of AI is directly related to the prevention of incidents at work. This process can be applied at the strategic, operational, program or project level. If this process is not an integral part of corporate management, it is questionable what results will be achieved. The risk management process within an organization can be adapted to the achievement of objectives or to the external and internal context in which the management is applied. The risk management process for the application of AI in OHS includes the systematic application of policies, procedures, and practices to the activities of communicating and consulting, establishing context and assessing, treating, monitoring, reviewing, recording, and reporting on risks.

By reviewing the scientific literature and international standards for risk management, it is concluded that the risk management process of applying AI in OHS consists of the following elements:

- Communication and consultation with relevant external and internal stakeholders should take place in all steps of the risk management process.
- It is necessary to determine the scope of risk management activities, and the external and internal context that is relevant. Risk criteria should be specifically defined.
- Risk assessment implies the process of identification, analysis, and evaluation of risks. The purpose of risk identification is to find, recognize and describe risks. The purpose of risk analysis is to understand the nature of the risk, its characteristics and level. Risk evaluation implies a comparison of the results of the risk analysis with the established risk criteria.
- Risk treatment involves an iterative process of defining and selecting risk treatment options.
- Monitoring and review aim to ensure and improve the quality and efficiency of risk management processes, implementation, and outcomes.
- Documentation of risk management and reporting on it should be provided with adequate mechanisms.

Given that the implementation of OHS is subject to legal and other requirements, the importance of identifying these requirements should not be forgotten so that the risk management process is aligned with them.

The application of AI in OHS depends on the specifics of the individual OHS process and the purpose of applying AI. It is necessary to distinguish the specifics of the application of AI in the processes of education and training, risk assessment, application of personal protective equipment, use of work equipment, creation of safe working conditions and parameters of the working environment, etc. The purpose of the application of AI in each of these areas is different, so in risk management of the application of AI in OHS this should be considered.

Risk Management Model for the Application of AI in OHS

To effectively manage the risks of applying AI in the specific field of OHS, it is necessary to understand what implications its application can have. A mistake in the application of AI can lead to fatal consequences. The ethical and moral dimension of the correct use of AI is particularly emphasized here. Therefore, before applying AI in OHS, it is necessary to think carefully about all aspects of the reliability of its application. The advantage of AI is that it is constantly learning and upgrading its knowledge. Therefore, as a result, its changes become more and more accurate and effective over time. However, given that human lives (but also material goods) are being dealt with here, there is no room for mistakes. The fundamental purpose of OHS is to protect human life and health at work. The fundamental purpose of OHS is to protect human life and health at work. AI can be extremely useful, but it can also bring new problems, dangers, and risks. Although AI is already widely used in practice, it still needs to be used with caution. One mistake or omission can cause injuries at work.

So far, it has already been indicated in which areas of OHS AI can be applied. The application is almost unlimited, the only question is whether the organization has adequate resources for it. In the previous

chapters, the relevant specifics of the application of AI, as well as the relevant features of risk management, were presented in detail. As mentioned before, risk exists in every business and every activity. It also exists in the application of AI. And there is an even bigger problem if we are talking about the application of AI in OHS because its application should primarily be in the function of preventing and mitigating risks. So, here appears the possibility of conflicting and contradictory results of the application of AI, as well as the possibility of obtaining inconsistent results of the application of AI in OHS. We must be aware of this when applying AI in OHS.

The purpose of AI risk management in OHS is to increase the likelihood that the organization will achieve its OHS goals by managing the probabilities of positive or negative events and consequences that are directly or indirectly caused using AI. In general, it can be stated that the application of AI in OHS creates risks in two key areas. The first are risks related to work in general, and the second are risks of performing tasks that can cause injuries and illnesses.

AI plays a key role in various aspects of the work process, changing the way tasks are performed and managed. AI, through computer methods that analyse and process data, enables actions that affect work dynamics. Therefore, AI technologies have made their way into occupational health, facilitating the examination of both structured and unstructured data. AI finds application in various fields, such as coordination of machines and industrial processes, workforce management (human resources), risk assessment, benefit analysis and personnel safety assessment [21]. In this context, employers can apply different strategies and procedures with the aim of protecting workers, from providing information, training on hazards, implementing safety programs and applying personal protective equipment. Despite all the above, human error remains a significant cause of workplace accidents. In this area, AI can play a key role. Due to its ability to quickly process and analyse data, AI can effectively identify potential risks and dangers that people may go unnoticed. Here the question of uncertainty arises, has the AI identified all potential risks and dangers? Can OHS experts fully trust the accuracy of the results of applying AI in OHS?

Of course, the application of AI creates additional opportunities for increasing work efficiency, improving working conditions and preserving health.

The European Agency for Safety and Health at Work conducted a research project to determine the general risks for workers when receiving AI in OHS:

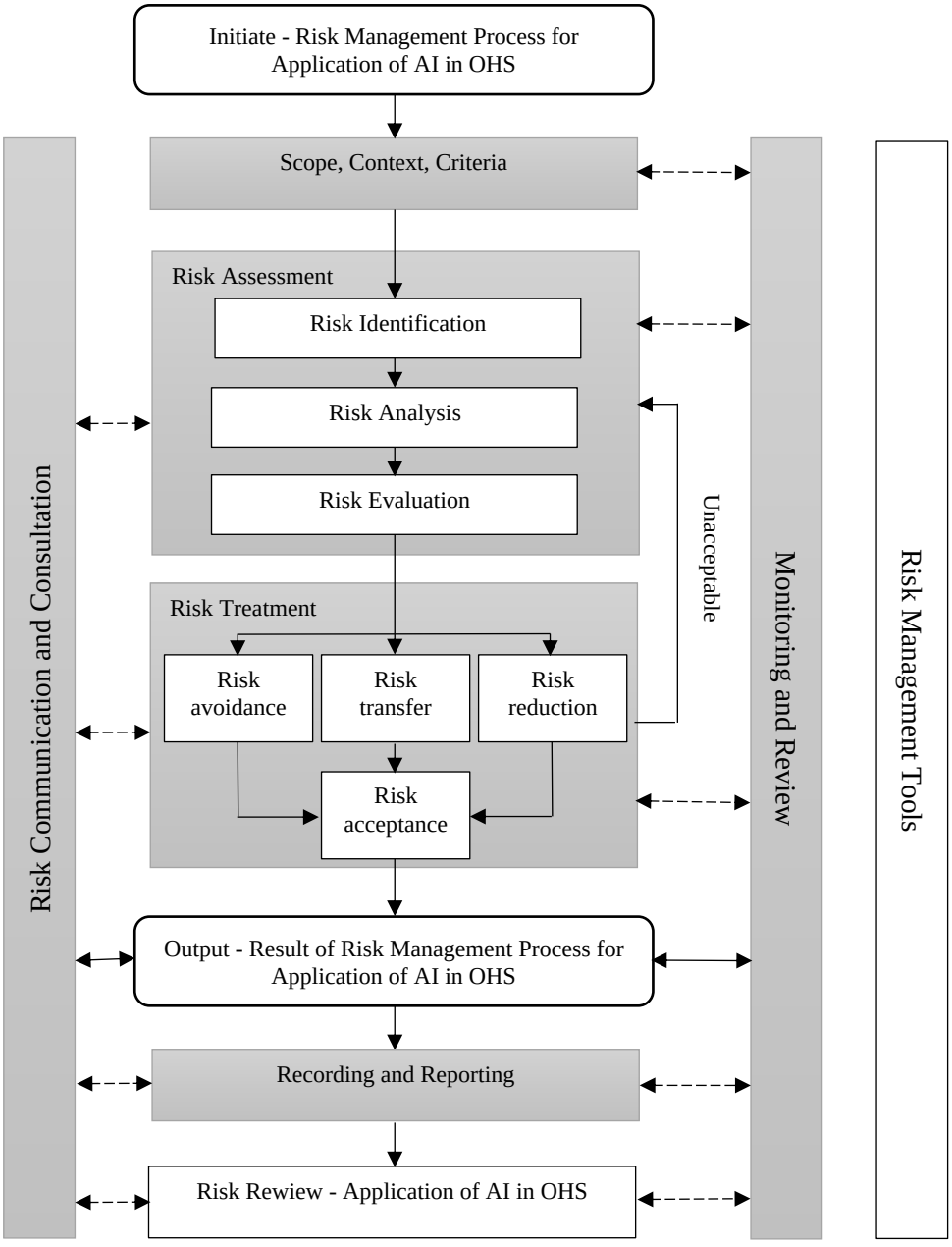
- Intensification of work
- Loss of job control and autonomy
- Dehumanisation of workers
- ‘Datafication’ of workers
- Worker discrimination and use of private and sensitive data
- Performance monitoring and impact on workers
- Worker rating systems
- Risky and unsafe worker behaviours
- Repetitive movements, awkward postures, and ergonomic issues
- Worker reskilling and deskilling
- Worker loneliness and social isolation
- Lack of transparency and trust
- Power asymmetry
- Malfunctioning and consequences for workers [22].

From all the above, it can be concluded that defining the scope, context and criteria is key to effective risk management. A good definition of the application area, an analysed context, and clearly defined criteria help to make risk identification effective. A risk that is not identified is not analysed later. The organization must analyse in detail the field of application of AI in OHS and define it. The key question is in which field of work AI is applied and which AI tools are applied. Although manufacturers of AI tools should take care of the safety of the application of that tool, it is necessary to review and check whether and what risks arise from the application of a particular AI tool. At the same time, it must be aware of all relevant internal and external issues, problems, interested parties and stakeholders that correspond in any way with this issue. It is about analysing the context of the organization. Defining the criteria is particularly important. Here, organizations should clearly define risk acceptance criteria. Criteria can be defined based on financial indicators, events, established errors or other consequences.

Considering that this is about the application of AI, there may be a few open questions that need to be answered to understand the issue of risk management of the application of AI in OHS.

Based on the analysis and presentation of the theoretical settings of AI, OHS and risk management, the risk management model of the application of AI in OHS is presented below.

Figure 1. Risk management model for the application of AI in OHS



Source: own source

The presented model is generic, that is, it can be applied to any type of organization, activity, risk, number of employees, etc. However, it is necessary to know the requirements of national legislation, which differ from one country to another. There are numerous situations in OHS where implementation directly depends on the relevant legal requirements.

CONCLUSION

It can be concluded that the objectives of this research have been met. The theoretical concepts of occupational health and safety, AI and risk were analyzed and presented. The risk management model for the application of AI in OHS is descriptive and presented.

We are witnessing the strong development of AI in all areas, including the application of OHS. The application of AI in OHS represents a transformative leap forward, offering capabilities that were previously unimaginable. Nevertheless, new technologies always create new risks. Although this is a technology that can significantly help in controlling existing risks at work, its application itself opens the possibility of new risks. In this sense, it is necessary to manage the risk of applying AI in OHS.
The specificity of the risk management model of the application of AI in OHS lies in the uncertainty of the accuracy of the results of the application of AI. Of course, there are other risks that are presented in the text of this article. However, the consequences that can arise due to the application of incorrect AI results can be fatal, i.e. people can be seriously injured and can die. In contrast, the consequences of applying AI results that are wrong, in some other fields, can be financial loss or job loss. Human life is more valuable than any financial loss.

It is also necessary to emphasize that the implementation of OHS is prescribed by national legislation that differs and is not identical in different countries, even within the EU. The application of different legal requirements is an additional challenge for the application of AI in OHS.
Given that this is a relatively new field, and that new AI tools are being created every day, which are complemented by new knowledge, it is proposed to initiate empirical research into risk management of the application of AI in OHS.

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SAFETY WORKPLACE THROUGH DIGITALIZATION

Abstract
The Industrial Revolution is reshaping the procedures and the manufacturing environments through the digitalization process. The digitalization process can change according to specific solutions, and it is able to modify manufacturing systems and production areas. The employees are directly affected by the transformation of the working environment, manufacturing tools, and working conditions and by the increasing need for new competencies. Crucial to identify emerging hazards concerning the health and safety of the employees to ensure a conscious and safe digital transformation for everyone who is involved. The aim is to present key mechanisms for shaping the safety culture of high-reliability organizations through digital transformation, which is now a key challenge for the entire global economy. It is important to define the place and role of digital transformation in shaping the safety culture of organizations. The issues of the safety culture and digital transformation of organizations seem to be important aspects resulting from technological progress in the area of digitalization.

Key words: Digitalization of processes, safety workplace, hazards, employees health.

INTRODUCTION

Technology has revolutionized work safety, offering a myriad of effective solutions to minimize risks and create safer workplaces. Mobile apps provide instant access to safety resources, while smart tech offers advanced monitoring to detect potential hazards. Digitalization is rapidly changing the world of work and requires new and updated occupational safety and health (OSH) solutions. The research programme of the European Agency for Safety and Health (EU-OSHA) aims to provide policy-makers, researchers and workplaces with reliable information on the potential impacts of digitalization on OSH so they can take timely and effective action to ensure workers are safe and healthy.
The emergence of technologies such as artificial intelligence (AI), big data, collaborative robotics, the internet of things, algorithms, digital labour platforms and, at the same time, an important increase in the population working remotely brings opportunities for workers and employers but also new challenges and risks for OSH. Addressing the challenges and risks and maximising the opportunities depends on how technologies are applied, managed and regulated in the context of social, political and economic trends.
When digitalizing processes, it means that some digital technologies are being used in the processes and managing data digitally, in order to convert processes into processes more efficient, more productive, more profitable and with greater customer satisfaction in their digital and physical experience with the company. Therefore, digitalization allows the use of digital information to optimize business results and create new revenue, optimize costs, new customer experience.

METHODS

The method is used in this research to find changes in work and their consequences for safety. This research follows a method approach which collects and analyses information from research.

RESULTS

Digitalization is a critical catalyst for the increased ubiquity and increased level of detail of standardisation.

Using digital technologies can increase worker safety by reducing risks in some tasks, such as robotics replacing humans in dangerous work environments.
Examples of digitalization in healthcare include:
- using robotics during surgeries
- e-prescribing
- helpdesk applications
The HSE makes use of digital technology. It provides more opportunities but also raises concerns about workplace safety and health. To ensure worker safety, a human-centred approach is needed in the design, implementation and use of digital technologies.
Successful digital transformation at work requires a proactive approach to safety and health.

The campaign priorities for the HSE include:
- better understanding of how to use digital technology safely
- increasing awareness of digitalization and its implications for occupational safety and health
- providing information on new and emerging risks relating to the digital transformation of work
- promoting risk assessments
- providing resources to enable healthy and safe digital transformation of work [1].
For companies beginning their digital transformation, here are key points to consider:

- Standardize operational process safety on location. With standardization at an administrative control level, companies can maintain documents such as plans, permits and workflows more efficiently.
- Identify differences among all the sites. It is worth the effort to try and reach a common denominator. Through standardized technology, documents can be distributed digitally to all employees.
- Make sure strong Wi-Fi signals are available. Signals need to reach all the access points in the field. Routers and bandwidth must be able to handle dozens of new devices. At the same time, the best software companies help mitigate this issue by offering offline-capable solutions for documents such as permits to work.
- Provide employees with mobile devices. When all workers are connected, everyone has access to the same safety regulations wherever they are.

In addition to infrastructure issues, having adequate IT support typically presents the second-largest challenge to digital transformation in the workplace. Managers and end-users tend to have little to no control over implementations and continuous development from an IT maintenance perspective.

Choosing a Technology Solution
When organizations have hundreds of employees conducting their work on paper processes, they need to allocate vast resources to get everything right. Yet for companies that still use manual or semi-manual processes, a digital transformation may seem intimidating.
To increase user adoption, enterprises are advised to choose a specialist technology solution that is advanced, yet easy to use. By selecting a digital solution with cloud and on-premise capabilities, companies are able to:

- Improve communication across critical areas. Teams immediately have all the information they need for the day, from permits to other work orders, on their mobile devices and push notifications. They also have access to the operators around them.
- Provide simultaneous access to information. For a digital worker in operations and maintenance, mornings begin with logging in to the system, instead of spending time getting the papers they require. Out in the field, the relevant data is right in front of them.
- Avoid scope creep. Digitalization projects need to be managed well to be successful. Out-of-the-box foundation packages for e-permitting and control of work help avoid scope creep (additions to the project, which can cause cost or time overruns) and scope change (alterations to the project, which can also impact budget and timelines). Where flexibility is needed, a cloud-based SaaS solution allows companies to adapt and expand their capabilities in a structured way.

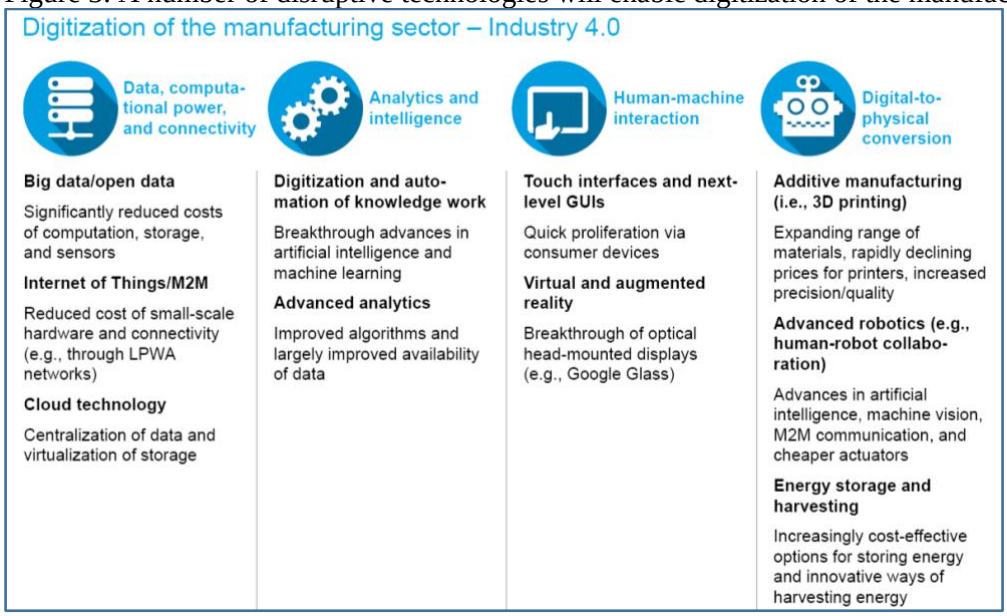
Across almost all industries, digitalization has accelerated at a remarkable pace in recent years. With the direction that many industries are headed, companies may prefer to replace their legacy paper-based system with digital technologies [7].
Raising the topic of a fourth industrial revolution immediately prompts many questions: What does Industry 4.0 really mean? What does digitization entail for manufacturing? How profound will its

impact be on our value pools? What are the near-term business opportunities for my company? Some clients also ask whether the term is simply hype. This myriad of mixed reactions reveals the intense uncertainty associated both with what Industry 4.0 is and how companies should respond to the changing industrial environment.

To clarify terms at the outset, McKinsey defines Industry 4.0 as the digitization of the manufacturing sector, with embedded sensors in virtually all product components and manufacturing equipment, ubiquitous cyber-physical systems, and analysis of all relevant data. It is driven by four clusters of disruptive technologies. The first consists of data, computational power, and connectivity – low-power, wide-area networks are one example . Analytics and intelligence form the second, while human-machine interaction is the third, comprising, for instance, touch interfaces and augmented reality. Digital-to-physical conversion is the fourth: advanced robotics and 3D printing are two examples. All of these enablers are at a tipping point today – now is the time for manufacturing companies to decide how to respond to them.

The disruptive technologies of Industry 4.0, such as IT-enabled manufacturing and increased computing capacity, hold the promise of smart factories that are highly efficient and increasingly data-integrated. Data is the core driver: leaders across industries are leveraging data and analytics to achieve a step change in value creation. A big data/advanced analytics approach can result in a 20 to 25 percent increase in production volume and up to a 45 percent reduction in downtime. There are four clusters of technologies that need to be examined (Figure 1). Different drivers are leading to an acceleration of use on a large scale for each of these clusters [4].

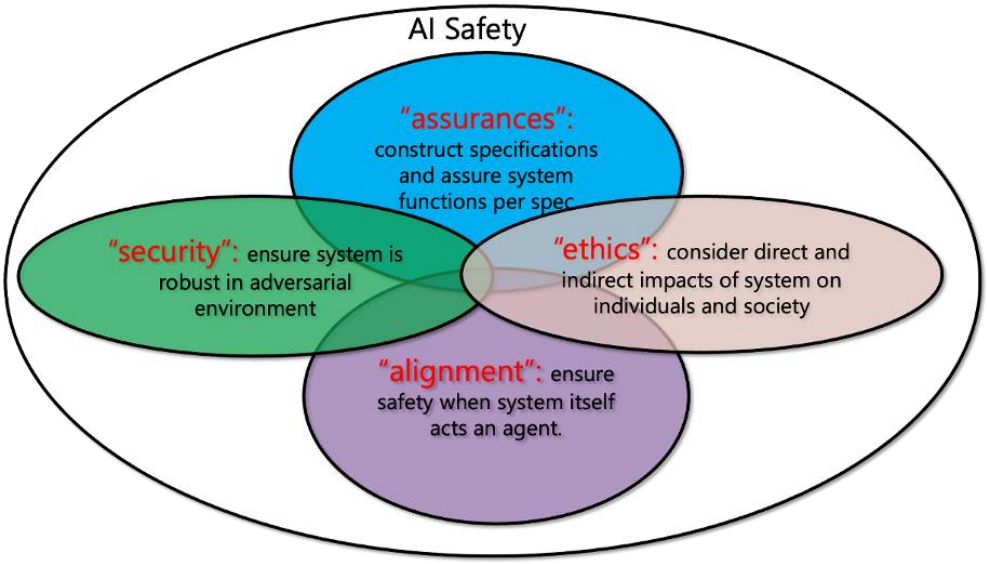
Figure 3: A number of disruptive technologies will enable digitization of the manufacturing sector



Source: Source of figure [4]

Artificial intelligence (AI) offers the potential for innovative and exciting developments in the workplace through the increasing availability of data and big data and the capacity to process data through algorithms, leading to widespread and profound changes in how work is done. AI is used in a range of applications and tools for assisted work and data analytics, allowing the automation of increasingly complex tasks, as well as automated or semi-automated workplace decision-making and management. The applications of AI in working processes range from cobots2, wearable technologies and assistive tablets on production assembly lines, chatbots in factories, warehouses and call centres, and smart personal protective equipment (PPE), to algorithmic processes in human resource (HR) applications such as people analytics and gamification. AI may create opportunities but also new challenges for occupational safety and health (OSH), its management and regulation. Most of the discussion around AI is about the quantity of jobs, but it should also be about job quality, and OSH is a key aspect of this. Robots embedding AI are becoming mobile, smart and collaborative. Their use removes workers from hazardous situations and the quality of work is improved by handing repetitive tasks to fast, accurate and tireless machines. Cobots can also facilitate access to work for many people (ageing workers or those with disabilities) and collaborate with human workers in a shared workspace.

Figure 4: Thoughts on AI safety



Source: Source of figure [9]

New forms of AI-based monitoring of workers may also provide an opportunity to improve OSH surveillance, reduce exposure to various risk factors, including harassment and violence, and provide early warnings of stress, health problems and fatigue. Real-time advice tailored to the individual can influence workers' behaviour and improve safety and health. AI-based monitoring could support evidence-based prevention, advanced workplace risk assessment and more efficient, risk-based, targeted OSH inspections. Information could be used by organizations to identify OSH issues, including psychosocial risks, and where OSH interventions are required at the organizational level [3].
Artificial intelligence plays a crucial role in various aspects of the work process, revolutionizing how tasks are performed and managed. Through computational methods that analyze and process data, AI enables specific actions that impact labor dynamics. This technology finds application in diverse areas, such as coordinating machinery and industrial processes, workforce management (especially from a human resources [HR] perspective), customer risk assessment, benefits analysis, and staff safety evaluation [2].
The traditional safety strategy is to separate robots and humans completely by isolating robots behind fences and stopping the robot immediately if anything goes wrong, thus minimizing the contact between robots and workers, collaborative robots introduce new concepts, such as collaborative operation, collaborative work-space (a shared space where worker and robot can perform tasks concurrently), and collaborative robot.
Instead of completely stopping the robot in the presence of humans it can keep performing its operations with a decreased speed. Our two-fold safety strategy consists of:
1. An offline safety analysis: performs a simulation-based quantitative safety assessment of the scenarios. It evaluates the high-level plans (high-level task descriptions for the robots), generated by the system before sending it to the robots.
2. An online safety analysis: creates the safety field around the robots within the robot control loop at runtime. It uses the sensors' data and performs risk assessments to calculate the risks. Based on the calculated risk values, it generates 3-layered safety fields around the robot. These fields are dynamic in size, and their sizes are computed based on the risk assessments and on both the environmental and operational context of the robot

Collaborative scenarios
Our use case is an automated warehouse where autonomous robots and humans work together in a shared environment to perform logistics management operations. The high-level task is to load trucks with products. Multiple robots pick up products from the shelves and deliver them to conveyor belts, that in turn take the products to the trucks. Robots can move freely in the environment to perform the tasks and are equipped with a robotic arm for pickup operations. Humans interact with shelves by placing or moving products on them. Thus, the shelves and warehouse floor are shared among humans

and robots, presenting a collaborative workspace and a collaborative scenario, as shown in Figure 1. Here, the human and the robot can come into close interactions with each other, thus leading to severe safety risks. Other situations can include human intervention when a product is dropped by the robot and a human comes to clean up or for the maintenance of a broken robot. Proper procedures must be adopted and safety must be ensured during this operation.

Figure 3. Illustration of robots in the warehouse and the dynamic safety fields

Source: Source of figure [5]

The blue cube is the recharging station, the small boxes in red, green and brown are products on the shelf, and a white square on the floor next to the conveyor belt is a way-point. The green (clear), yellow (warning) and red (critical) circles are the safety zones around the robot [5].

Comparing the issues of the safety culture and digital transformation of high reliability organizations seems to be an important cognitive aspect resulting from technological progress in the area of the digital economy. The determinants resulting from digital transformation processes should be taken into account in shaping safety culture due to the change in the nature of work and the role of safety-critical workers when the share of digital solutions in operational processes is increasing. The socio-technological system in which high-reliability organizations operate is organized in such a way that all technical, operational and organizational aspects, including the participation of many entities involved in the operation of this complex system, are coherent. This coherence can be achieved through the implementation and use of effective and efficient solutions in the digital economy.

The Safety of the Technical Systems of High-Reliability Organizations

The safety of technical systems results from the tight architecture of these systems. This includes the safety and security aspects of technical systems. The principles of building safe technical systems are a compendium of knowledge for organizations in need of implementing unique solutions that determine their search for sources of competitiveness, efficiency and reliability. This triad may not only allow for survival in difficult market conditions but can also ensure the dynamic development and building of competitive potential and competitive advantage while maintaining the operational capacity equipped with safe organizational processes [6].

DISCUSSION

The first industrial revolution occurred because of mechanization. The second was made possible by mass production and the assembly line. The third, it is said, happened based on computerization, automation, and lean management. Currently what is known as Industrie 4.0 involves:

• Big data: Gathering more data can lead to savings and smarter decision-making. McKinsey and Company gave the example of an African gold mine which “found ways to capture more data from its sensors. New data showed some unsuspected fluctuations in oxygen levels during leaching, a key process. Fixing this increased yield by 3.7 per cent, worth up to USD 20 million annually”.

• Advanced analytics: Stronger analysis can dramatically improve product development" and lead to savings and profit.
• Human-machine interfaces: This includes the use of augmented reality where "pickers" wear headsets that present vital information on a see-through display, helping them locate items more quickly and precisely. Headsets free up hands and lower rates of mistakes.
• Digital-to-physical transfer: This involves the use of 3-D printing and rapid prototyping to minimize ties to the market (Local Motors, Vauxhall and GM involved).

Why Digitalization Is Key to Safety, Efficiency and Productivity

Instead of allowing events to cascade into a worst-case scenario, enterprises can begin to implement best practices. In the Safety Report, 71% of ORM and PSM managers indicate that technology solutions help them reduce their vulnerability to near misses and major hazard events. Through digital technologies, companies can monitor safety barriers and other safeguards while optimizing workflows. Workplaces become safer.

Best practices also include integrating work-order processes in other systems. Preventative maintenance can auto-generate all of the work orders. Scheduling in the operations room becomes more efficient. Companies can also exhibit best practices by integrating digital permitting in enterprise resource planning (ERP) and computerized maintenance management systems (CMMS). Having everything in one place and easily accessible enhances productivity.

When implementing digital tools, getting the infrastructure in place could be the first obstacle. Getting users on board might be another hurdle to clear. Yet the effort pays off. Connecting workers and processes digitally provides a true picture of the operational reality and helps manage risks. This enables greater safety, efficiency and productivity, all good reasons for delivering a digital transformation in the workspace [7].

How to Digitalize the Workplace

Digitalization has the potential to improve workplace safety and health. Below are 4 steps that can be taken to digitalize the workplace.

Measure the Workplace Outcomes

Before you begin, you need to measure workplace outcomes. In order to comply with regulations by the Occupational Safety and Health Administration (OSHA), define the safety and health objectives, and collect data on the workplace. The areas where changes should be focused are the exposure to hazards and the achievement of the policy and goals.

Use Digital Tools to Improve the Workspace

After measuring workplace outcomes, use digital tools or software to manage and improve health and safety in a workspace. The Internet of Things (IoT) and Artificial Intelligence/ Machine Learning are two main tools that can help you in this regard.

For example, the IoT can help improve safety and health outcomes in the workplace by providing real-time information on exposure to hazards through exposure monitoring devices and exposure control devices.

Create an Environment that Fosters Continuous Improvement

Create a culture in the organization where employees are encouraged to speak up if they come across hazards in the workplace. Also, ensure that you have a mechanism to monitor the outcomes and take corrective action.

Communicate the Progress

Communicate the progress that you have made to the employees and the stakeholders. This will help in creating a positive work environment. Maintaining a safe and secure working environment can be a challenge in any organization. However, taking some of the aforementioned steps will help you get there [8].

CONCLUSION

Digitalization leads to new challenges in safety research and management: the vulnerability to cyber-attacks, remote control and monitoring of processes, intractable couplings and dependencies between systems, to name but a few. These are all important topics. Our main concern here is how digitalization changes the ways that work is governed by rationalistic description and prescription, increasing the level of detail possible and the power exercised by governing systems. Our warning about digitalization has to do with the potential of allowing for unprecedented levels of standardization and a powerful way of 'hard coding' compliance into the technologies that support the execution and audit-based control of work processes. Weber's dystopian 'iron cage of rationality' would today certainly be a digital cage of rationality. We are not blind to the upside of digitalization, but as safety researchers, it is our job to take the role of 'party poopers' in innovation processes and major societal changes. As part of the next generation of safety researchers, it is also our job to view major societal and technological changes in light of our existing theoretical frameworks, considering the match between established theories and new developments. In this case, we find that the classic tension between compliance and situational adaptation is more relevant than ever. The role of operational history that we find relevant for maintaining safety in practice is also relevant for theory. While it might be a sign that the new generation of safety researchers is already growing old, we underline that our quest for new theories and perspectives on safety should be wary of tapping old wines into new bottles. Understanding the present is always contingent on our understanding of the past, and this should be borne in mind by all generations of safety researchers.

Digital transformation processes are taking place in many sectors of the economy and include specific organizations such as the high reliability organization. The ranking of criteria describing the safety culture of a high reliability organization in the context of the digital transformation showed that the main priorities are focused on monitoring the needs of employees and other stakeholders, monitoring occupational risks, consulting workers on occupational safety issues and monitoring hazardous situations in safety-critical processes.

Digital transformation is now a key challenge for many sectors of the economy and affects many aspects of the functioning of an organization. The processes of digital transformation are also important in the context of shaping organizational culture where changes in behavior determine other ways of building interpersonal relationships, especially in socio-technological systems. Safety culture within the framework of complex system theories is fundamental to ensure the sustainable development of organizations where many activities should be integrally coherent and shared by key personnel underpinning the smooth operation of the organization.

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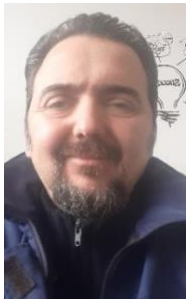

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THE ADVANTAGES AND PITFALLS OF THE PATH TO IMPROVEMENT IN THE OVERALL MANAGEMENT OF THE ORGANISATION IN THE FIELD OF OCCUPATIONAL SAFETY AND HEALTH IN THE PROCESS OF DIGITISATION

Abstract
This article presents the latest findings on digitisation processes in business and the public sector with a view to demystifying the digitisation process itself.
The aim of this article is to present the concept of integrating digital competences in a holistic way to continuously create opportunities for improvement in the whole vertical of occupational safety and health management in technologically advanced companies and organisations.
The process of digital competences and digital transition is presented. The paper also focuses on the occupational health and safety and supply chains aspects of data privacy and security, made possible in particular by two newer blockchain technologies. The blockchain technologies presented in this work are the Etherium platform and IOTA. Tangle is an innovative type of distributed ledger technology (DLT).

Key words: digitisation, competences, transition, blockchain technology, supply chain management.

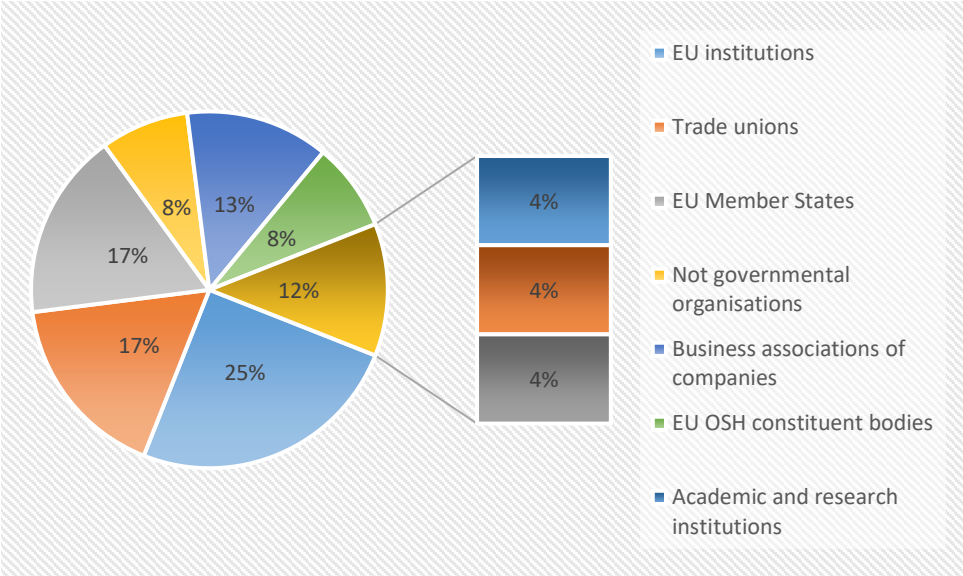
INTRODUCTION

The digitisation of society, businesses and organisations (e.g. public administration) is one of the most overarching challenges of our time. The scale of digitisation is visible in the emergence of ubiquitous connectivity to the internet, new digital platforms and concepts such as digital twins, the algorithmic power to process massive amounts of data measured in exa-bytes. The digital breakthroughs we have witnessed in the last five years have transformed society and business in a major way, and change is happening much faster than in the past[1].

The generation of ever-increasing amounts of data by devices and users, linked to their behaviour, creates good opportunities for advanced and innovative products and services. However, there are also questions about the security and integrity of storing, processing and analysing massive amounts of data. The problem is the theft and manipulation of data by criminal gangs. In the simplest terms, digitisation can be thought of as the transition from an analogue to a digital environment. [3].

The process of moving from an analogue to a digital environment can be largely illusory and not necessarily a true mapping of the real world. The concept of creating digital twins is about simplification, because otherwise the amount of data would be so vast that it could not be processed and processed in real time. This kind of world is very far removed from our evolutionary experience and knowledge.

Chart 1. Share of EU digitisation stakeholders.



Source of Chart1. Share of EU digitisation stakeholders [5].

The issue of changes in the world of work, resulting from the combined impact of technological progress, demographic change, climate change and globalisation, was the most frequently raised issue in stakeholder contributions [5].

An effective digital transition requires an upgrade of digital literacy, which was included in the European Commission's roadmap for lifelong learning as early as 2006 [5, 6]. The need for effective use of the new technologies of Industry 4.0 requires employees to be flexible or to make effective use of ICT tools in order to achieve the highest possible level of added value to the final product, where the embedded knowledge is enhanced. Companies oriented in this way are not only followers of new technological solutions and breakthroughs, but can also be key niche players on a global scale (e.g. CargoX, a company based in Ljubljana). Achieving such a high level of cutting-edge IT technologies is not easy and requires a high degree of responsiveness and continuous adaptation. The key is not technology per se, but highly motivated employees who are proficient in general digital literacy and digital competences as well as in their core profession.

The document issued by the EU OSHA entitled; "Digital platform work and occupational safety and health: overview of regulation, policies, practices and research" is a comprehensive report on 'digital platform work' for the field of occupational safety and health. The document provides an overview of regulations, policies, practices and research in the field of occupational safety and health. It presents various aspects of working on digital platforms, including the policy context, the challenges in the field of occupational safety and health, and the impact of digital platforms and algorithmic management on workers' safety and health. The report discusses the Bologna Charter, which addresses occupational safety and health issues for workers on digital platforms, and the challenges related to the qualifications of workers working on platforms, including employment relationships. It also presents a taxonomy of digital work platforms based on the form of work provision, the level of skills required and the level of supervision. In addition, it discusses the occupational safety and health risks associated with different types of work on different digital platforms, such as working in a specific location within an organisation or company and working online. tasks, and the factors that increase these risks. The report highlights professional isolation, work-life balance and social support as important issues related to the psychosocial risks associated with working on platforms. In addition, it highlights the impact of algorithmic management on workers' safety and health, which involves continuous monitoring of workers' behaviour and performance and the levelling of organisational structures. The document provides a comprehensive overview of the challenges and opportunities in the field of occupational safety and health related to digital platform work, making it a valuable resource for understanding the complexities of this evolving work environment [24].

Slovenia is in the process of digital transformation. Digital transformation is part of a broader Recovery and Resilience Plan that addresses the challenges of digitisation related to public administration (gov.si). Various reforms and investments are being implemented under this plan, including the digitisation of internal security (gov.si). The aim of these efforts is to create the environment for a successful digital transformation, to improve eGovernment, to strengthen digital skills and to increase cyber security. In December 2022, the Government of the Republic of Slovenia adopted the Digital Public Services Strategy 2030 [2]. This strategy pursues a vision of citizen- and business-centric digital public services that enable citizens and businesses to interact with the state in an integrated, coordinated, secure and efficient manner.

The Strategy identifies three strategic priorities [2]:

1. By 2030, all key public services will be online and accessible to all users.
2. At least 80% of key public services that are digitally accessible will also be delivered digitally.
3. At least 80% of public service users will use a digital identity.

The strategy addresses both natural persons and business entities. The experience of the pandemic has shown the need for digitisation in all areas, including public administration.

The Open Data Slovenia portal publishes two data on people with digital literacy skills for information and data literacy for 2021 and 2023 [25]. The data has a classification code A1 according to the portal's methodology.

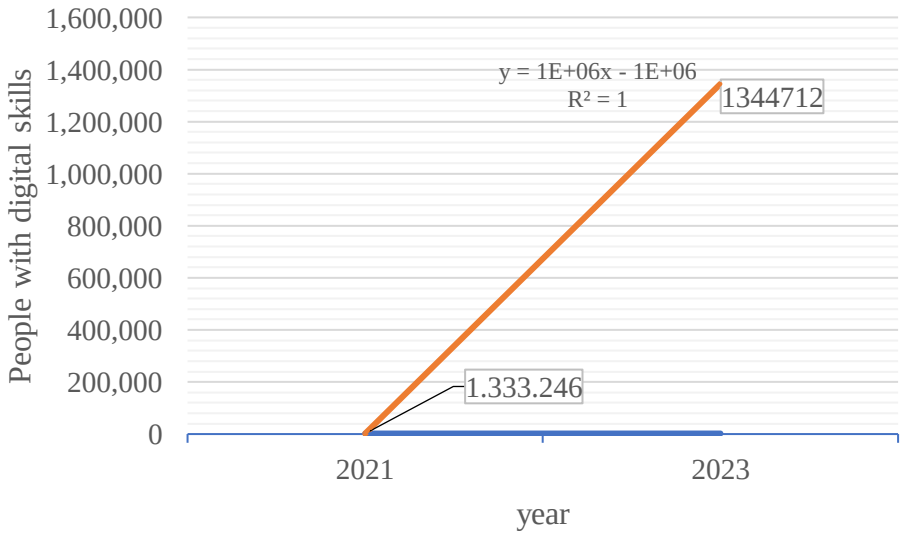
Table 1. Persons with digital skills for information and data literacy in the Republic of Slovenia for the period 2021-2023.

Year	Number of persons A1
2021	1.333.246
2023	1.344.712

Legend:
A1 People with digital skills for information and data literacy

Source of table 1. Persons with digital skills for information and data literacy in the Republic of Slovenia for the period 2021-2023 [25].

Chart 2. Persons with digital skills for information and data literacy in the Republic of Slovenia for the period 2021-2023.



Source of chart 2: Persons with digital skills for information and data literacy in the Republic of Slovenia for the period 2021-2023. [25] .

Table 1 shows a moderate growth trend in the number of people with digital skills for information and data literacy for the period 2021 to 2023. Chart 2 also shows the regression line. At the moment, we only have two data points and we cannot use them to predict the growth or decline trend of people with digital skills for information and data literacy.

It is better to use the term digital transformation instead of digitalisation, because we are still in a period of transition. The concepts of digitalisation and digital business are not identical and it is essential to be able to distinguish between them. Štempihar [21] explains digitalisation as the use of new digital technologies such as cloud storage, the Internet of Things and mass data in business processes.

Digitisation in a company depends on the industry in which the company operates, both from a historical and a societal perspective. Some companies, by the nature of their work, are automatically more oriented towards digital business, which to a large extent covers all segments of work organisation, logistics, relations with suppliers in supply chains and customers. General examples of such companies are: automotive, aerospace, chemicals, pharmaceuticals and a large proportion of service industries.

DE4A was a pilot project [4] led by the following EU Member States (Spain, the Netherlands, Belgium, Slovenia, Lithuania, Austria, Sweden, Portugal, Denmark, Greece, Romania) and is aligned with the EU eGovernment Strategic Action Plan 2016-2020, the Tallinn Declaration and the EIF Implementation Strategy and the European Strategy for the Implementation of the Interoperability Framework.

The project aimed at creating a culture of co-creation, transparency, accountability, trust and sought to implement the digital principles of once-only and relevance-only through state-of-the-art, usable and high-quality fully online processes accessible through the Single Digital Gateway (SDG).

The aim of the project was to facilitate the transition to European Digital Public Services (EDPS), which are delivered across borders, across sectors and with different actors, building trust in public institutions, increasing efficiency and reducing administrative burdens and costs.

The focus of the project is to create an open and comprehensive platform for public administration and innovation with full compliance with regulations such as GDPR, eIDAS, Services Directives, establishing a culture of co-creation, transparency, accountability and trust.

Digital competences as an upgrade of digital literacy

Digital competences are the set of knowledge, skills and competences needed to use digital technologies effectively [2]. They enable effective task performance, communication and collaboration between employees, increase productivity and improve business results [3].

Digital competences refer to different areas of digital technology use, including the use of computers and mobile devices, data management, digital marketing, mastery of online tools and services, and the use of different software tools[3].

In addition to technical skills, they include general digital literacy, such as the ability to search for information online, critical thinking, online safety and privacy management, and the ability to manage information effectively [3, 4].

Digital technologies have become one of the key enablers of business in today's fast-changing business environment. Employees with strong digital competencies are able to adapt quickly to new technologies and use digital tools effectively, enabling a company to remain competitive [3, 4]. In addition, digital competencies increase employee productivity by enabling efficient task performance, fast data processing and increased mobility at work [3, 4].

Digital transition

Digital technologies can provide workers, including disabled or older workers, and their employers with digital solutions to support their health and well-being. They can also improve workers' health and safety by taking over dangerous and monotonous tasks.

But these developments can also create new risks or worsen existing risks to workers' physical and mental health. The Covid 19 pandemic led to almost 40 % of workers starting to telework full-time literally overnight. Together with other teleworking trends, such as constant connectivity, lack of social interaction and increased use of information and communication technology (ICT), this can lead to psychosocial and ergonomic risks [5].

As part of the new strategic framework [6], the Commission will review, inter alia, the Workplaces Directive and the Display Screen Equipment Directive by the year 2023.

The potential of digitalisation in the enterprise

In order to get an overview of the digitalisation potential of a company, an analysis of the digital environment [8, 21], which includes elements of digital logic (Figure 1), should be carried out at the earliest possible stage.

The analysis serves as a foundation for an overall digital landscape strategy in the company. All internal processes, customer-facing applications, applications supporting all logistics processes and all suppliers in the entire chain are examined [8, 21].

Figure 1. Elements of digital logic.

Source of Figure1. Elements of digital logic [8, 21].

The question is whether it is possible to update the existing business model or whether a completely new business model should be introduced because the old one may be so outdated that it cannot be updated to follow the current trends in business models for a particular activity or industry.

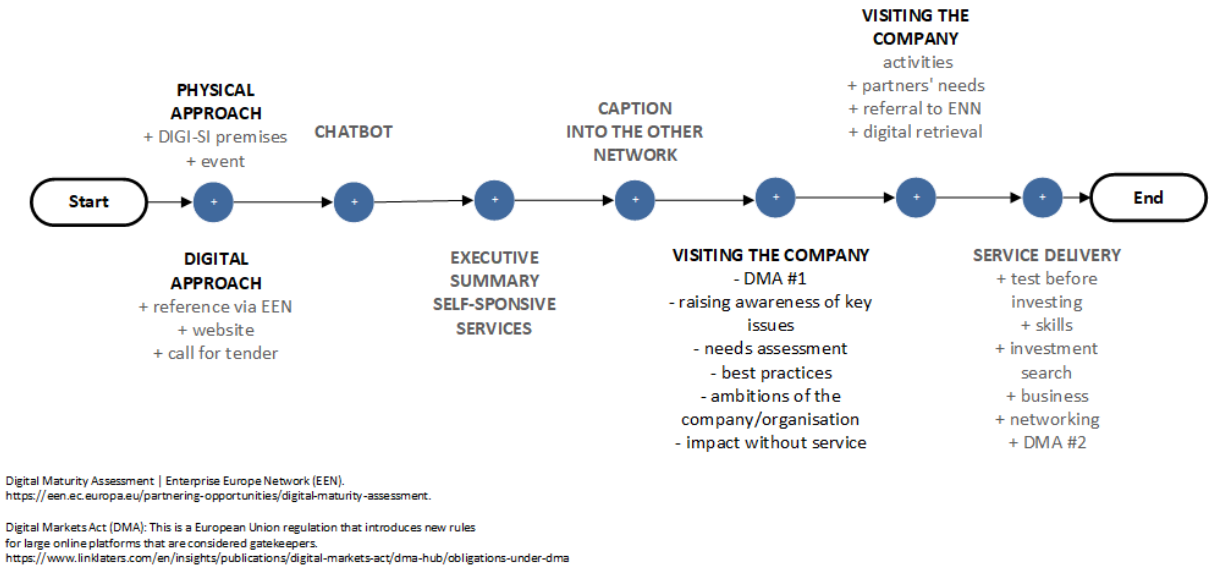
The analysis of the environment is carried out using digital logic in the company or organisation.

METHODS

The digital transformation journey of companies or organisations (public administrations)

In the digital transformation path of companies, organisations (public administrations), it is necessary to take into account both the physical and the digital approach in the digitisation process [9].

Figure 2. Physical and digital approaches in the digitisation or digital transformation process.



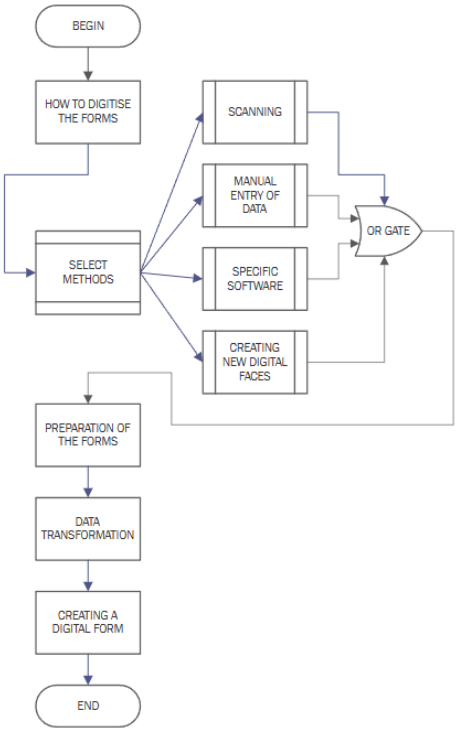
Source of Figure 2. Physical and digital approaches in the digitisation or digital transformation process [9]

In the digital transformation process, both a physical and a digital approach to the digitisation process can be chosen (Figure 2). Which of the two paths is chosen depends on whether or not the company has already embarked on a digital transformation journey. It also depends on the industry in which the company or organisation operates.

Digitisation of forms

Digitising forms can be a great way to streamline processes, improve efficiency and reduce errors [23]. The process is best illustrated by the flowchart in Figure 3:

Figure 3: The process of digitising forms.



Source of Figure 3. The process of digitising forms own source.

Scanning: involves scanning paper forms and using Optical Character Recognition (OCR) software to convert the text into digital format.
Manual data entry: a slower, more error-prone process, but necessary for forms with handwritten text or complex layouts that OCR cannot handle
Use dedicated software: Dedicated form digitisation software can automate much of the process, including pre-filling data from existing databases and capturing information from scanned images.
Creating new digital forms: this process requires new forms to be created from scratch using online form builders or specialised software. This process allows for maximum flexibility but requires technical know-how and experience.

Testing of forms and transition to production environment

Test the functionality and accuracy of the newly designed digital forms. Train users to access and complete the forms. Integrate digital forms into existing systems as necessary.

Additional considerations in the process of digitising forms:

1. **Security:** make sure digital forms are secure and protect sensitive data.
2. **Accessibility:** make sure the forms are accessible to disabled users. Data validation: Implement rules to ensure that users enter valid data.
3. **Workflow integration**: consider how forms will be integrated into existing workflows.

By following the digitisation flowchart, and in particular by choosing the right method for your needs, you can successfully digitise your forms. The advantage is a more efficient operation with fewer errors, while creating the conditions for a paperless environment, which also means a significantly reduced paper footprint.

Supply chain management

In the case of digitalisation of occupational health and safety, the supply chain or delivery process means, for example, delivering personal protective equipment, fire extinguishers when we need them and only keeping a minimum stock ourselves. We expect suppliers and external partners in the supply chain to respond as quickly as possible. This may include servicing personal protective equipment, servicing fire extinguishers or providing training and skills testing as required by the Occupational Health and Safety Act. Typically, supply chains consist of several channels. The process of supply chains of goods and services is multi-level and involves a larger group of suppliers, which can become a complex process [10, 11].

Blockchain technology [7], [13], [14], [15], [21], [22], together with a back-end database of suppliers, goods and services, provides a transparent view of contractual obligations and the status of goods and services provided by suppliers or external partners in the supply chain [10, 11]. In addition to this data, shipment status data (tracking from supplier via carrier to parent company or organisation) is also stored uniquely (unambiguously). As each transaction is recorded in a blockchain, the process is more transparent than the classical approach. The linked blocks create a secure record that is practically very difficult to falsify.
Implementing blockchain technology in an enterprise is a complex process that requires careful planning and execution [16, 17], [21, 22]. The implementation of blockchain technology [12] is a lengthy process that involves:

1. **Understanding blockchain technology**: before you start implementation, it is important to understand how the technology works.

   The technology is based on a chain of opaque algorithms on which the sum of data about a transaction is written - it could be a transfer of an amount, an executable contract or the transfer of other data. Each transaction is given its own block - an algorithm that is queued with other algorithms to form a blockchain system that conveys information about the currency, its value, its past and present owners. The concept was first introduced in 2008 by a person nicknamed Satoshi Nakamoto.

   The third generation of blockchain technology is a new technology that aims to upgrade the entire system of blockchain technology 1.0 developed by Satoshi Nakamoto and also blockchain technology 2.0 based on the Etherium platform principle. One of the leading companies is IOTA. IOTA uses the Tangle system [11].

2. Identify use cases: find out where blockchain technology could bring the most value in your business.

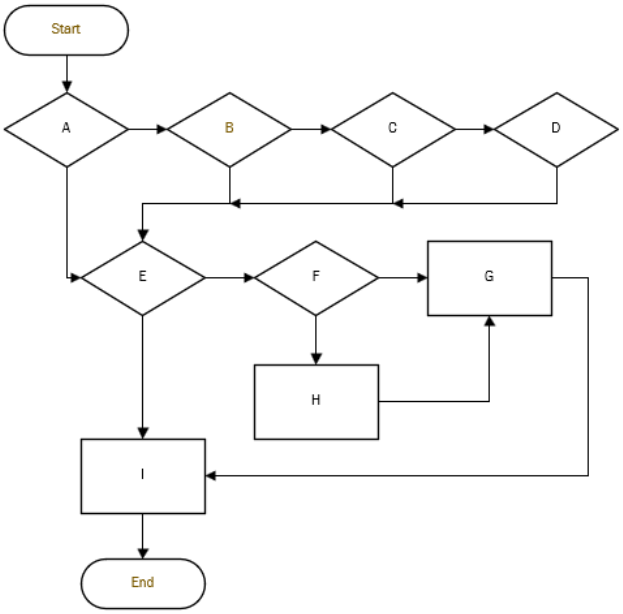
   An example of good practice is the company CargoX [10], [11] from Ljubljana, Slovenia, which has developed an application that allows the digital creation of different types of documents with full or partial IT support. Documents can be signed and the digital transfer of ownership to the intended recipient can be carried out. For the digital transfer of ownership of e-documents, only the first transfer of the document is paid, which is the transfer of the Bill of Lading (B/L) to CargoX. The service includes full digital support.

CargoX was one of the first companies to offer a smart waybill (eB/L). The advantage of eB/L is:

- immediate change of ownership,
- immediate transfer of the document,
- no possibility of loss or theft of the document,
- archiving included, and
- automation through cargo data.

3. ***Prototyping***: prototype a solution using blockchain technology to test its effectiveness.

Figure 4. Diagram showing how blockchain technology can improve supply chain efficiency and reliability.



Source of Figure 4. Diagram showing how blockchain technology can improve supply chain efficiency and reliability. Adapted from [21, 22].

Legend (Figure 4):

A: Does your current business process/product/service depend on a manual process and does it require paperwork?
Q: Is full traceability of your product a key challenge and does it take time?
C: Are there risks associated with multiple stakeholders, for example lack of access to accurate data?
D: Do you intend to create a new business area using blockchain functions?
E: Can traditional supply chain management software solve/help with a few adjustments?
F: Does your IT architecture allow you to integrate a blockchain solution in your company with minimal effort?
G: Implementing blockchain
H: Redesigning IT architecture to facilitate integration
I: You may not need blockchain
The process of implementing blockchain technology starts by answering all the questions in the flow chart in Figure 3 step by step.

The blockchain tracking process is as follows [22]:

1. When a supplier sends a product, it creates a block of data containing information about the product, such as the product number, quantity and date of dispatch.
2. This block of data is then sent to the blockchain network, where it is verified and validated by all participants in the network.
3. Once a block is validated, it is added to the blockchains.
4. When a product reaches the next step in the supply chain, a new block of data can be created by the recipient containing information about the new status of the product.
5. This block of data is then sent to the blockchain network, where it is verified and validated by all participants in the network.
6. Once a block is validated, it is added to the blockchains.

This process is repeated every time a product moves further up the supply chain. This creates a continuous product history that is accessible to everyone involved in the supply chain.

4. ***Test and improve***: test the prototype and improve it based on feedback.
It then needs to be assessed whether a traditional supply chain management (SCM) or a supply chain management (SCM) system can meet these needs. If not, it should be assessed whether blockchain technology can solve such problems.

5. ***Implementation***: once you are satisfied with the performance of the prototype, you can implement it in your business processes.
If the management of a company or organisation decides to implement blockchain, the appropriate technology and solution must be chosen. There are several different blockchain platforms that can be used for supply chains. Etherium is a decentralised platform that allows the creation of so-called smart contracts. It can be most simply described as a decentralised high-performance cluster running on a proprietary blockchain algorithm that has been created to overcome the limitations of the algorithm on which Bitcoin is based. The encoding of data on the Ethereum platform is based on an identical process to Bitcoin, the main difference being the programming code, which is automated and protects the execution of pre-programmed orders. The Ethereum network successfully completed the Dencun upgrade in March 2024, which is expected to radically reduce transaction fees on layer-2 networks. This is the biggest change since September 2022, when ether became based on stakes instead of proof of work [26].

6. ***Maintenance, upgrade and monitoring***: blockchain technology is constantly evolving, so it is important to maintain and upgrade the system regularly.
Once implemented, a blockchain solution must be developed to meet the specific needs of your business. This may involve developing new applications or customising existing applications.
Once in use, the blockchain must be monitored and controlled to ensure that it is working properly. The monitoring process should include collecting usage data, running tests and responding to problems.
It is also important to check whether there is a legal basis for implementing blockchain technology in your company. Please note that this procedure is only a general framework and may vary depending on the specific needs of your company. For more detailed information, you should contact an expert in blockchain technology, who can be found mainly in the research sector.

The blockchain can improve the efficiency and reliability of the supply chain in several ways:

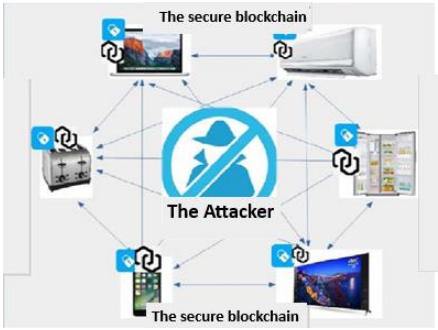
- **Reduces the need for printing on paper and manual work.** Blockchain tracking allows companies to track their products digitally, which can reduce the need for paper and manual labour.
- **Improves transparency.** Blockchain tracking allows companies to see where their products are at any given time. Real-time tracking can help companies improve the efficiency of their supply chains by making it quicker and easier to track their products.
- **Reduces the risk of fraud.** The blockchain uses proof-of-conduct technology that can help reduce the risk of fraud in the supply chain.

Blockchain 2.0 and 3.0 technology is still at an early stage of deployment in companies and organisations, but has the potential to significantly improve the efficiency and reliability of supply chains. Blockchain technology can have a positive impact on the visibility of the entire multi-level supply chain.

Internet of Things (IoT) environment

An IoT environment can best be thought of as a hub that senses information from different types of sensors, connected to each other either wired or wirelessly. The most problematic point of IoT devices is ensuring data security and privacy. In the case of occupational health and safety, this technology could be used, for example, in smart packaging for storage and multimodal transport of hazardous substances. The integration of IoT technology with Blockchain technologies from version 1.0 to 3.0 is recommended because it provides more security for sensory data and helps to ensure data security and privacy [18, 19].
If we decide to implement IoT technology in our company or organisation, we start by collecting data from various sources such as employees, existing IT infrastructure including sensors that are part of the machines or the environment.

Figure 5. IoT devices secured with blockchain technology.



Source of Figure 5. IoT devices secured with blockchain technology [21].

IOTA Tangle [20] is an innovative type of distributed ledger technology (DLT) , which is specifically designed for the Internet of Things (IoT) environment. Unlike traditional blockchain models, IOTA technology is based on a new type of DLT.
Tangle has been developed to enable fee-free micro-transactions for the growing ecosystem of IoT devices. IoT devices include products such as smart devices, security systems, computer peripherals, wearable technology, routers that have Wi-Fi connections, blue tooth network connections (Bluetooth) or near field communication (NFC).

Tangle uses a proof-of-work (PoW) system to authenticate transactions in the distributed ledger. Its PoW system is similar to the one used by Bitcoin, but uses less energy and is less time consuming. Due to the interconnected nature of the Tangle architecture, full verification across the entire ledger is not required. Instead, all parties verify transactions at the same time, which reduces the energy and time required to complete all transactions at any given time. IOTA Tangle is a unique DLT designed for the IoT environment, offering high scalability, no fees and near-instantaneous transfers. The weakness of the system was that PoW alone was not sufficient to protect against a massive, coordinated attack.

RESULTS

To perform a SWOT Analysis we should look at current **strengths** and **weaknesses** and from all dimensions, on the other side we should look at current **opportunities** and **threats** as related to external factors.

Table 2. SWOT Analysis in the process of digital transformation

The strengths	**The weaknesses**
1. **Efficiency and Reliability:** Blockchain technology improves supply chain efficiency by reducing manual work, improving transparency, and enabling real-time product tracking. 2. **Transparency:** Blockchain provides companies with visibility into their supply chains, enhancing operational efficiency by allowing product tracking at any time. 3. **Fraud Reduction:** Blockchain helps reduce fraud risk in the supply chain through proof-of-conduct technology, ensuring greater security and trust. 4. **Potential for Improvement:** Blockchain 2.0 and 3.0 technologies could significantly enhance supply chain efficiency and reliability, positively impacting supply chain visibility. 5. **Data Security and Privacy:** In the IoT environment, the integration of IoT technology with blockchain technologies enhances sensory data security, safeguarding data privacy and integrity. 6. Innovative Technology: IOTA Tangle, a unique Distributed Ledger Technology (DLT) designed for IoT, enables fee-free micro-transactions, high scalability, and near-instantaneous transfers, making it a promising technology for IoT applications.	1. **The weaknesses of the IOTA Tangle system:** designed for the Internet of Things (IoT) environment, include its vulnerability to massive, coordinated attacks due to the inadequacy of Proof of Work (PoW) alone to provide sufficient protection. This weakness has been identified in the system, highlighting a potential security concern.
The opportunities	**The threats**
1. **Digital Transformation**: The document presents opportunities for companies or organizations on their digital transformation journey, focusing on digitizing forms, supply chain management, and integrating blockchain technology and IoT. 2. **Digitizing Forms:** Opportunities include streamlining processes, improving efficiency, and reducing errors through digitizing forms using scanning, manual data entry, dedicated software, and creating new digital forms. 3. **Supply Chain Management**: In supply chain management, opportunities lie in enhancing transparency, reducing manual work, improving tracking efficiency, and minimizing the risk of fraud through the implementation of blockchain technology.	1. **Security Risks:** Ensuring the security of digital forms and protecting sensitive data is a critical concern during the digitization process1. 2. **Data Privacy Concerns:** With the digitization of forms, there is a need to address data privacy issues to safeguard user information1. 3. **Accessibility Challenges:** Ensuring that digital forms are accessible to disabled users is an important consideration in the digitization process1. 4. **Supply Chain Vulnerabilities:** The digitalization of supply chains introduces risks related to the timely delivery of goods and services, as well as the complexity of managing multi-level supply chains1. 5. **Blockchain Implementation Challenges**: Implementing blockchain technology in supply

4. **IoT and Blockchain Integration:** The integration of IoT technology with blockchain technologies like IOTA Tangle offers enhanced data security and privacy for sensory data in various applications such as smart packaging for hazardous substances storage and transport. 5. **Overall Aim:** These opportunities collectively aim to enhance operational efficiency, transparency, and security across different business processes.	chain management requires careful planning and execution due to its complexity and the need for understanding the technology and identifying suitable use cases1. 6. These threats highlight the importance of addressing security, privacy, accessibility, and operational challenges when undertaking digital transformation and implementing technologies like blockchain in organizational processes. 7. The threat of the system IOTA was that PoW alone was not sufficient to protect against a massive and coordinated attack.

CONCLUSION

The aim of this article was to present the latest findings on digitisation processes in business and the public sector. The advantage of adopting the latest findings in the field of digitisation or digital transition is certainly that it will make the company or organisation more resilient to challenges in the market. The digitisation process will not necessarily lead to redundancies in companies and the public sector. It is likely that there will be a need for professional retraining, which can be a stress factor for both managers and employees.

Before a company or an organisation or a public sector decides to go the whole way in adopting blockchain technology, the first step is to carry out a SWOT analysis, where we outline all the essential strengths and weaknesses, opportunities and threats. Without a well addressed SWOT analysis, a digitisation project and blockchain technology is almost certainly doomed to failure. In this process, the company or organisation may turn to external partners or research organisations such as universities and research institutes.

In the field of occupational safety and health, the literature has so far focused on the interaction between man, the environment and the machine. With the introduction of new blockchain technologies and generative artificial intelligence, the aforementioned interaction is expanding into new areas. It is essential to include psychology and the humanities in the field of occupational safety and health. The human being or the worker must remain the central pillar, using new technologies to make progress and not to discriminate against or discredit fellow human beings or colleagues.

It is also essential to alert the management of companies and organisations to the pitfalls and negative consequences of the digital transition, which have the effect of reducing social inclusion. People are and will continue to be social beings. One of the key negative consequences of digital transformation is that the complex digital environment distances us from genuine positive relationships. Good relations between management and employees are crucial if the digitisation process is to succeed holistically. Management needs to take a good look at the technical, organisational, security, sociological and other risks.

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THE IMPACT OF DIGITALIZATION ON HUMAN HEALTH: EFFECTS OF TIME, YEARS OF EXPERIENCE AND STRESS

Abstract
The aim of this research is to better understand the impact of digitalization on employees' health and the effects of time, years of experience, and stress. The research was based on the analysis of existing literature and a case study within a medical company.
The results of this research show significant risks that can negatively affect the health of employees. These risks are even more pronounced in the context of Covid-19, where employees spend more time at the computer.
Additionally, this research was able to prove several hypotheses that clarify some of the factors influencing employees' health in a digital environment, such as the effect of time, years of experience, and stress. In conclusion, we were able to confirm some previous knowledge and deepen previous research, providing a better understanding of the effects of time on employees' stress and fatigue levels, as well as the impact of years of experience on fatigue and stress.

Key words: artificial intelligence, human-AI collaboration, human health.

INTRODUCTION

In today's globalized world, there are over 2 billion computers available while the number of connected devices exceeds 10 billion [1]. The exponential growth of computers and the number of connected devices is associated with technological progress and the digital transformation of all layers of society, companies, and the overall global economy.
Despite the numerous advantages that computers have brought to employees, from increased productivity to the acceleration of various processes, there are also certain drawbacks primarily related to the impact of computer work on human health [2].
If we compare computer work today with that of about 15 years ago, it can be noticed that today's computer work has become much more automated than before.
For example, today it is possible to perform more tasks without leaving the workplace: phone calls can be made via zoom application, archiving is done directly on the computer, exchanging information via chat programs like Skype, etc. For all these actions a few years ago, it was necessary to perform several other activities such as going to a colleague or physical archiving. In short, digitization and business improvement have tied workers to the physical workplace to a much greater extent than before.
Another negative factor that adversely affected the health of employees is the Covid19 pandemic, which has largely changed the modern understanding of what the work environment should look like, and some paradigms that were previously difficult to apply have become the new normal and accepted within organizations. This has led to new issues related to the effects and risks of computer work on employee health.
In this context, individuals are forced to stay at the same workplace, sit in the same position, which leads to less movement, less physical activity, and consequently to a direct negative impact on human health.
However, besides the aforementioned factors and context that have greatly had a negative impact on health due to computer work, there are a number of other elements that can also have negative effects when working with computers.
The effect of time spent working on a computer certainly represents an important element to consider. Namely, if an employee has just started working compared to someone who has been working with computers for many years, the negative factors should have a different effect on the employee's health. Likewise, experience in the workplace can have an additional impact. Experience in this context can

have causal links, more or less, if a person knows or is familiar, through their previous experience, with possible health consequences.
Finally, stress is also one of the factors that can significantly have negative effects on human health when working with computers.
This paper analyzes the impact of computer work on human health, taking into account the effect of time, years of employee experience, and stress levels.
Additionally, this paper demonstrates some risks and consequences that may be harmful to human health. It provides a brief overview regarding the Covid19 situation, which has largely "disrupted" the current situation where employees came to physical workplaces that provided them with certain conditions in accordance with existing regulations.
Considering that the Covid19 pandemic has officially ended, current trends that have emerged in the new post-Covid19 world are also noted, where there is a transition to hybrid workplaces, bringing new challenges in defining ergonomic guidelines as well as identifying the consequences that such practices may have on employee health.
For example, "Zoom fatigue" is just one of those trends that can negatively affect mental fatigue that may arise when video calls are frequent. Also, the fact that one needs to be in front of the camera or technical issues further contribute to the fatigue caused by technology.
The next chapter reviews past literature.

LITERATURE REVIEW

Hazards of Computer Work

Hales and colleagues reported that around 22% of users experience musculoskeletal problems, such as neck pain, back pain, shoulder problems, and/or carpal tunnel syndrome (CTS) [1, 4]. Poor workstation design or work environment, bad posture, and prolonged sitting at the desk can exacerbate such issues. Prolonged sitting reduces blood circulation in muscles, tendons, and ligaments, sometimes leading to stiffness and pain [5, 6]. In a year-long study, they found that one in eight computer professionals suffers from carpal tunnel syndrome, attributing computer mouse as the main cause of the disorder and tingling/numbness in the right hand associated with mouse usage time, but not keyboard usage time [7]. Gerr and colleagues conducted research on computer users to identify the effects of computer use on potential risks related to neck or musculoskeletal symptoms in shoulders, hands, etc. [8]. The study was conducted on 632 individuals who were new employees in jobs requiring more than 15 hours per week of computer work. All respondents were followed for 3 years. The study concluded that hand or arm pain, neck, or shoulder pain were most common among computer users. Interestingly, the study found that more than 50% of computer users reported problems during the first year of starting a new job. However, researchers concluded in their study that there is insufficient epidemiological evidence linking computer work to these same health problems [9]. Similar conclusions can be seen when discussing the issue of radiation emitted by computers. Previous studies have not provided enough evidence of a causal relationship [10]. In the 21st century, there is increasing talk about Computer Vision Syndrome (CVS), which represents an eye condition caused by long periods of uninterrupted screen viewing. Some symptoms of computer vision syndrome include headaches, blurred vision, neck pain, fatigue, eye strain, irritated and dry eyes, and problems refocusing the gaze. CVS is defined as a combination of eye and visual problems attributed to computer use [11]. Studies have shown that various psychological disturbances can also occur during computer work, such as:

- Headaches,
- Fatigue,
- Irritability,
- Exhaustion, and
- Depression and sadness.

As well as various psychosomatic disorders:

- Heart palpitations,
- Sweating,
- Diabetes,
- Peptic ulcer,
- High blood pressure, and

- etc. All these phenomena are directly related to stress as a consequence of computer work, which can lead to serious impairments of physical and mental health [12]. Other possible consequences may include burnout, loss of motivation for performing work tasks, etc.

Hybrid Workplace

The Covid19 pandemic, likely one of the worst pandemics in modern history, also had a huge impact on occupational health and safety. According to research, employees "face numerous serious threats to their health at work, from those related to direct exposure to the virus to those reflecting conflicts between work and family demands" [13]. In this context, it can be stated that all organizations had to adapt to a new way of working in a very short time, and therefore the health of employees in the context of computer work certainly was not a priority. Covid19 brought a new definition of the workplace, and what was not possible before the pandemic became a reality overnight. Various, relatively few, studies have confirmed that stress is one of the factors that has dramatically increased [14]. Other studies have found numerous negative effects on employee health during hybrid work, such as worsening sleep quality, physical activity, diet, mood, and quality of life [15]. Overall, the impact of the Covid19 pandemic, which has only recently officially ended, is still insufficiently researched. In the post-Covid19 world, many companies have transitioned to a hybrid work model, which represents a new way of functioning. As a conclusion, it is considered that Covid19 has brought about significant changes in understanding the impact of computer work on human health. It is important to mention only some of the changes. All communication has shifted to the digital world - we have moved from organizing meetings, seminars to online Zoom meetings and webinars. Ergonomically designed offices have been replaced with uncontrolled home office environments. Although Covid19 is behind us, the effects of that temporary and forced transition to the digital environment and the office from "home" will surely come due. If there is anything positive from that experience, it can certainly be said that it is a better understanding of the work environment and increased awareness of the level of impact of computer work on employee health. Controlled work environment as such is something that has worked for many years. However, jobs in remote workplaces are associated with prolonged computer work, where a number of different challenges can be noticed, such as: prolonged sitting, which represents static exertion, or repetitive movements associated with dynamic exertion [16]. The Republic of Croatia has only recently regulated work from home and remote work, although in these two cases, the conditions prescribed by occupational health and safety rules have been applied in various ways. What is interesting is that the European Agency for Safety and Health at Work (EU OSHA) has published non-binding guidelines on how and in what way the workplace can be adapted in the context of the Covid19 pandemic. "The nature and scope of restrictions, such as suspension of work in non-essential activities, vary among Member States and sectors, but a significant portion of workers must either work from home or, if they cannot perform their job remotely, stay home often with an agreement on substitute income" (EU OSHA Recommendations, COVID-19, 2020.). In general, these recommendations relate to the assessment of risks to employees and guidelines for what safe teleworking should look like. One of the interesting guidelines is to encourage workers to take a break every 30 minutes to stand up and move around. In any case, the hybrid workplace as such is something that will surely pose various challenges for both employees and employers for some time to come. From all that has been stated, it can be concluded that it is the duty of the employer to "provide the worker with safe working conditions, and the obligation of the worker to comply with all safety and health measures in accordance with special regulations and other regulations".

What is particularly interesting in the context of work ability is how and in what way the effects of time, years of experience, or stress can influence work ability.
In the context of computer work, compared to some economic activities, primarily sources of hazards that manifest as efforts are discussed. Some authors discuss efforts that are primarily visible in this case, such as asthenopia, verbal, or psychophysiological, which are most manifested through stress [18]. Stress can represent an extremely serious condition that can threaten one's integrity [19]. Stress is a factor that is neither easy to identify nor to put into the context of work ability. Some external stressors such as noise, dirt, or poor ergonomic conditions are easier and simpler to recognize, however, some internal stressors representing psychosocial stressors are much more difficult to identify [20]. Stress is mostly defined as a psychosocial phenomenon not related to any specific external stressor (e.g., noise) but more to the work environment itself. In other words, stress in this context refers to the general

negative effect that stress in the work environment has on the employee. As an example of this internal stress, related to the job itself, stressors related to working with people, inability to perform work tasks, pressure from other employees, etc., are mentioned. On the other hand, the effect of time and work experience, which are two closely related dimensions, are also considered significant elements that can have more or less negative impacts on the employee. An interesting study was conducted on a sample of 1,532 employees investigating perceived professional stress among some employees in Nigeria as a consequence of work experience and educational qualification [21]. The results of the study showed that employees with more work experience expressed significantly higher levels of professional stress than their colleagues with less work experience. A similar study was conducted in Iran on a sample of 236 IT professionals, and it showed a positive effect between the level of stress and gender and work experience [22]. In that context, it is expected that the effect of time and years of experience can have a negative impact on employee health. In other words, the effect of time, which can be defined as the time spent at the workplace in one workday or workweek, can negatively affect employee health. It is expected that people who spend less time working on computers will have fewer negative effects on their health, while a person who, for example, spends 8 hours in front of a computer can expect greater negative consequences. Similarly, work experience can also be a factor that can determine this balance of work ability because it is expected that people with more work experience (for example, a person with 20 years of work experience) should be more aware and better acquainted with potential hazards of computer work and activities that can be done to reduce or mitigate them to acceptable levels).

Hypotheses

According to previous literature, we can understand that the effects of time, years of experience, and stress are significant factors that influence the negative impact of computer work on human health.

a) **Effect of time** It is assumed that the effect of time or the time spent in the working week may have a greater or lesser negative effect on the level of fatigue. Also, it is assumed that the level of stress will be higher the more time an employee spends working on the computer. Previous research suggests that stress is causally linked to the effect of time, leading to the following hypotheses [27, 28]:

- H1a. The effect of time has a negative effect on the level of employee fatigue.
- H1b. The effect of time has a negative effect on the level of employee stress.

b) **Years of experience** Although years of experience might suggest an automatic connection between employee experience and the negative impact on human health, it is expected that more experienced employees are better able to control stress and fatigue levels due to their experience. Previous research has partially confirmed this assumption (for example, [28]). It is believed that years of experience have a positive effect on the level of employee stress and fatigue, as it is expected that individuals with more experience can better control fatigue and stress. In this context, the following hypotheses are posed:

- H2a. Greater experience has a positive effect on the level of employee fatigue.
- H2b. Greater experience has a positive effect on the level of employee stress.

c) Stress is one of those elements that are not easily measurable because there is no device, test, or measuring instrument that can measure the level of employee stress. Some other factors, such as noise level, can be easily measured and thus quantified. The level of stress or stress itself is often a subjective way of assessing stress. In this case, we are talking about the perception of stress, which the employee determines themselves, and it may not necessarily be a consequence of computer work. However, it is assumed that employees who spend more time working on the computer have a higher level of stress that negatively affects their fatigue. Therefore, the following hypothesis is proposed:

- H3. Perceived higher levels of stress have a negative effect on the level of employee fatigue.

d) **Other elements:** Regarding other elements such as noise, adjustable chair, adjustable screen, lighting, etc., instead of hypothesizing, analytical processing of employee surveys is undertaken, with conclusions drawn based on the results obtained. Hypotheses can also be made for the same, but it is considered that most of these effects imply subjective factors to draw objective conclusions. Also taken into account is the fact that for most of these elements, employees working in the same companies usually have the same working conditions, so it is difficult to expect different results. For example, it is

expected that if one employee from the same company has an adjustable screen, all other employees have an adjustable screen. Therefore, statistical processing of hypotheses would not make much sense.

METHODS

The aim of this research is to analyze the impact of computer work on human health in the context of the effect of time, years of employee experience, and the level of stress.
Additionally, this study examines some of the risks associated with computer work, with a focus on the potential consequences for human health. This research primarily encompasses employed individuals who spend a certain amount of time working with computers in the workplace.
The problem under investigation relates to the insufficient understanding of the impact of computer work when additional variables such as the effect of time, years of experience, or stress level are added to that impact. This study attempts to clarify whether there is a causal relationship between these variables and the effects they have on computer work.

Research questions

Within the conducted research, the following scientific questions are posed:

1. What effect does the passage of time have on the level of employee fatigue and stress?
2. What is the effect of experience on the level of employee fatigue and stress?
3. Does a higher level of stress have a negative effect on the level of employee fatigue? In addition to these questions, for which corresponding hypotheses are formulated, responses to other questions related to the effects of other variables such as lighting levels, screen adjustability, or ergonomic chairs were obtained through an employee survey.

Population and data collection

The study targets employed individuals, and the survey was sent to employees from various companies with different profiles. Most of the respondents work in companies that have up to a hundred employees. It is important to note that certain parameters such as company size or the number of employees were not taken into account when selecting companies or employee.

This study primarily relies on both primary and secondary sources of data. The following data sources were utilized:

1. Analysis of existing literature on the topic of the study.
2. Field research.

Various data sources are used, such as scientific databases (e.g., Google Scholar, Scopus, Elsevier, etc.). Initially, Google Scholar is utilized to search for all scientific papers related to the topic. For Google Scholar, certain keywords in English are used, such as "impact of work stress on occupational health" or "impact of work experience on occupational health working remotely," etc.

Regarding field research, a questionnaire is developed using Google Forms in various companies.
The questionnaire is composed of sixteen questions sent to employees of different companies.
When formulating the questionnaire, no restrictions were placed on the size of the company or the type of employees.
The survey questions are designed to gather information to verify the truthfulness of the previously formulated hypotheses.
As for the questions themselves, the survey includes both Yes/No questions and questions measured on a Likert scale of 1 to 7 (a Likert scale is an ordinal scale expressing a positive or negative attitude toward an object of the attitude). The Likert scale represents a way of measuring someone's opinion on a scale of values.

Method used

For testing hypotheses, linear regression is utilized.
Linear regression is a type of statistical analysis used to predict the relationship between two variables. It assumes a linear relationship between the independent variable and the dependent variable and aims to find the line that best fits that relationship.
In linear regression, observations are assumed to be the result of random deviations from the underlying relationship between the dependent variable and the independent variable.

Limitations

The first limitation associated with this study is the fact that only four different companies participated in the survey, which may affect the generalization of the results. Additionally, the number of employees from each company was not equal, which could not be directly controlled.
Furthermore, the research method is primarily quantitative, which largely limits the interpretation of some research results. Since a Likert scale was used to evaluate some questions in the questionnaire, it can be assumed that interpretations of the level of feelings may vary from person to person.
Finally, the goal of the study was not to extensively focus on or address all prevention measures that can be implemented in accordance with regulations, recommendations, and various positive practices, but rather to provide a brief overview by offering general guidelines.

RESULTS

In this study, two sources of data were utilized:

1. Analysis of existing literature on the topic of the study.
2. Field research.

The following chapters analyze the results:

Impact of Computer Work on Employee Health
From the previous analysis of existing literature on the impact of computer work on employee health, it can be seen that scientific evidence in some areas is contradictory. While some studies show, for example, negative effects of computer use on potential risks related to neck problems or musculoskeletal symptoms of the shoulder (Gerr et al., 2002), others could not confirm the same causal relationship.
Of particular concern is the occurrence of Computer Vision Syndrome (CVS), which represents an eye condition caused by long continuous periods of staring at a computer screen. CVS mainly occurs due to:

- Poor room lighting,
- Glare from the digital screen,
- Improper viewing distance, either too close or too far,
- Poor sitting posture,
- Unresolved vision problems,
- Reduced blinking frequency.

Overall, the risks associated with computer work, especially in the context of Covid19, have become even more pronounced as employees have been forced to spend even more time at the computer and use fewer necessary breaks that would allow for at least partial immediate recovery or alleviation of symptoms.

Field Survey Results
To better analyze the impact of computer work on employee health, a survey was conducted on 50 employees in various legal entities.
The aim of the survey was to better understand working conditions and obtain opinions from employees on the extent to which they are satisfied with workplace lighting, noise levels, and how much fatigue they feel at the end of the day.
Additionally, hypotheses were formulated, which will be confirmed or refuted through the surveys: whether the effect of time, years of experience, and stress affect employee health and, if so, to what extent.

Demographic Data

Out of 50 surveys sent, we received 36 responses, representing 72%. From Table 2, it can be seen that there were a total of 36 employees, of which 19 were women (52.8%) and 17 were men (47.2%). The average age was 43.3 years.

In Figure 1, it can be seen that 20 individuals, or 55.6%, use visual aids, while the chair is adjustable for the vast majority of employees, 86.1% or 31 respondents (Figure 2).

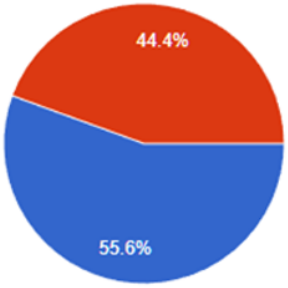

Figure 1.

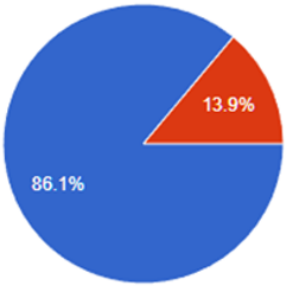

Figure 2.

Figure 3 shows slightly different statistical data, where the chair backrest is adjustable for inclination for 26 or 72.2% of employees, while the screen cannot be adjusted for 10 employees (27.8%).

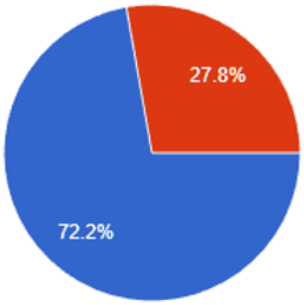

Figure 3.

Similar statistics can be observed for the screen in Figure 4., where the screen is adjustable for 75% or 27 employees.

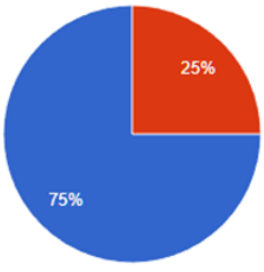

Figure 4.

In Figure 5, it can be seen that 83.3% of employees have a footrest.

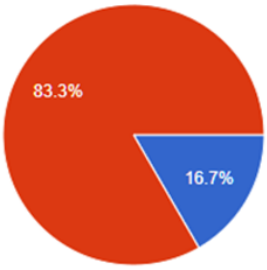

Figure 5.

Interestingly, the factors that have the most significant impact on employee health in the context of safe work, according to the survey results, are as follows: stress has by far the greatest effect (77.8%), followed by the amount of time spent at the workplace (30.6%), years of tenure/experience (13.9%), noise level (11.1%), and lighting (2.8%).

As for the estimated level of stress (Figure 6), it can be concluded that over 56% of employees have a stress level higher than 5, indicating high to very high stress levels.

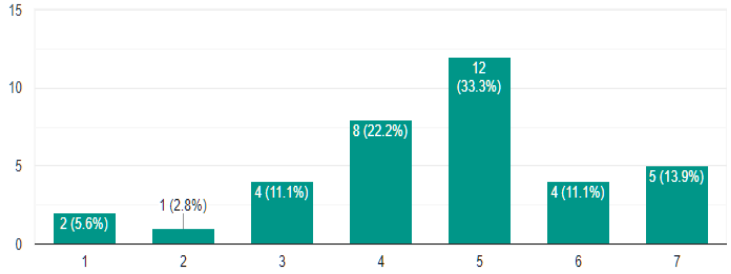

Figure 6.

It is also interesting to note that 50.8% of respondents work 8 hours a day on computer work. Similarly, the survey results suggest (Figure 13) that the level of fatigue at the end of the day is not very high. Only 5.6% of employees feel very tired at the end of the day.

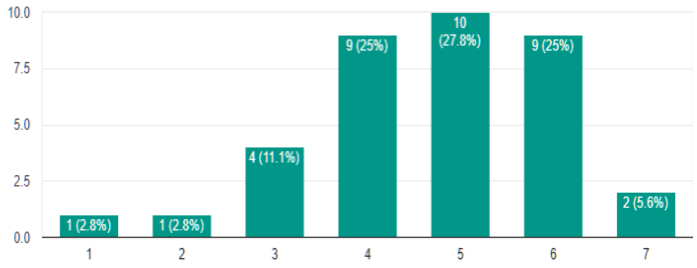

Figure 7.

Regarding the lighting of the workplace, according to the results, the lighting is satisfactory and therefore does not have a negative effect on the employees. In Figure 8, we see the estimated total work experience in computer work. The average for all employees is 16.2 years, indicating that these are employees with a solid amount of work experience.

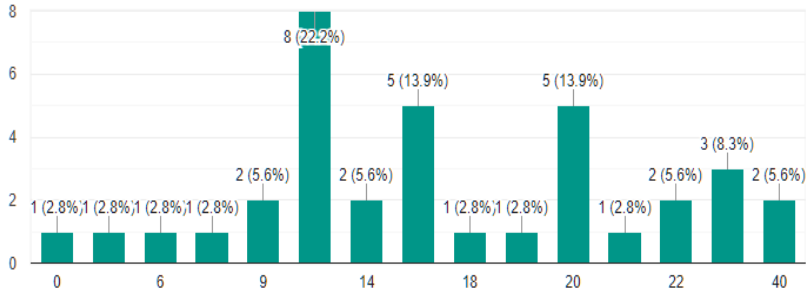

Figure 8.

Results of Hypothesis Testing

Based on the previous discussion, the following hypotheses were formulated:
H1a. The effect of time has a negative effect on employees' fatigue level.
H1b. The effect of time has a negative effect on employees' stress level.
H2a. Greater experience has a positive effect on employees' fatigue level.
H2b. Greater experience has a positive effect on employees' stress level.
H3. Perceived higher stress level has a negative effect on employees' fatigue level.

Linear regression is used to test the hypotheses. The results of testing hypotheses H1a and H1b are visible in Figure 16a and Figure 16b. It can be concluded that the effect of time does not have an effect on employees' fatigue level, while the effect of time has a direct effect on employees' stress level. In other words, hypothesis H1a is not confirmed, while hypothesis H1b is confirmed.

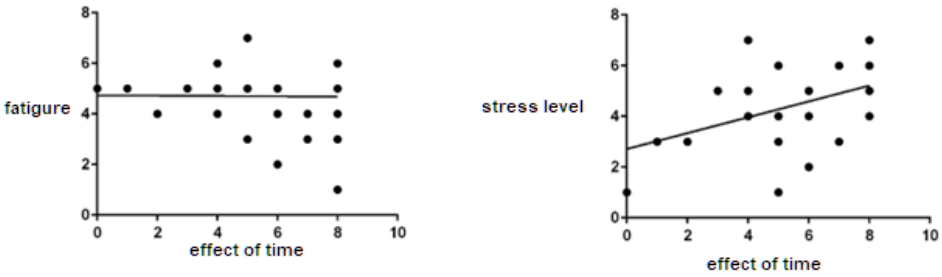

Figure 9. Results of hypotheses testing

The results of testing hypotheses H2a and H2b are shown in Figure9 which demonstrates that with greater experience comes less fatigue. Also, it is concluded that with greater experience comes less stress. Therefore, hypotheses H2a and H2b are confirmed.

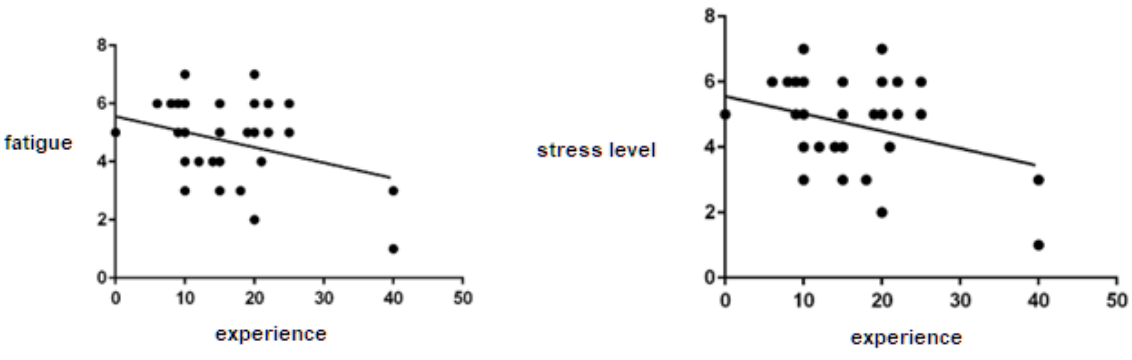

Figure 10.

The result of hypothesis H3 suggests that there is a positive correlation between higher levels of stress and employee fatigue.

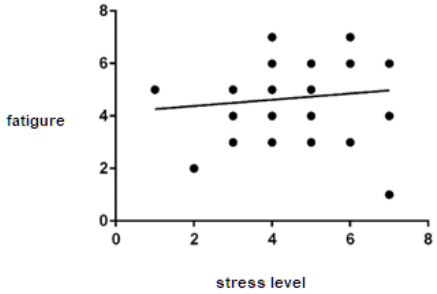

Figure 11.

Hence, hypothesis H3 has been confirmed.

DISCUSSION

Based on the field research conducted in various companies and analyses of previous studies on the impact of computer work on employees' health in the context of the effects of time, years of experience, and stress, it can be seen that the influence of computer work is a complex issue that requires deeper analysis and a broader approach.

Analysis of Previous Studies

The analysis of previous studies indicates that there are numerous health problems and negative effects associated with computer work. During the Covid-19 pandemic, this trend likely worsened as many employees were forced to spend more time in front of computers due to reduced physical interactions with colleagues, which moved into the virtual realm. Of course, additional comparative studies are needed to confirm this hypothesis, but it is conceivable that the negative effects on employee health will only be felt in the future. Previous research has also confirmed the obvious cause-and-effect relationship between various stressors such as noise, stress, or other factors, and their negative impact on employee health. However, different studies have also confirmed that some stressors, such as stress levels, are not easy to measure and some of them boil down to measuring the perception of fatigue or stress levels. It is interesting that previous research has identified a range of different factors that can have positive or negative effects on employee health when working on computers. Additionally, extraordinary situations like the Covid-19 context can have unpredictable consequences that are difficult to measure or quantify, making them relatively challenging to analyze and process.

Survey

The survey conducted within different companies showed that employees are generally satisfied with various elements such as noise or lighting, which could negatively affect their health. Additionally, employees generally have good working conditions such as adjustable screens, office chairs, and footrests. Interestingly, stress is by far the number one factor (77.8%) that most affects employee health. This is, on one hand, an expected outcome as other studies have confirmed similar results, but on the other hand, it was expected that a similar result would be found for the amount of time spent at the workplace. However, only 30.6% of employees consider the amount of time spent at the workplace to be a factor directly affecting employee health. This is reflected in hypothesis H1a, which was not confirmed. In other words, fatigue at the workplace cannot be explained through the effect of time. On the other hand, hypothesis H1b was confirmed, explaining that the effect of time is correlated with the level of stress. Therefore, the more time spent at the workplace, the higher the stress levels. Such an outcome was expected and it confirms previous research. Furthermore, hypotheses H2a and H2b were

confirmed, suggesting that experience has an impact on fatigue and stress. This means that the more experience an employee has, the lower the fatigue and stress levels. This conclusion suggests that employees with more years of work experience better manage fatigue and stress. Of course, it would be interesting to further understand whether this is simply related to work ethic, with more experienced employees being able to afford to work less, i.e., better manage their time, or whether it means that these employees simply know when to stop and better manage stress and fatigue. Finally, hypothesis H3 was confirmed, as expected, although the correlation was less pronounced. It is concluded that a higher level of stress causes greater fatigue. This is also in line with previous findings and similar studies. Regarding the survey results, a couple of interesting observations from employees' comments stand out. For example, one participant wrote: "In addition to ergonomically designed workstations, it is important to take more breaks, at least 5 minutes every 50 minutes, to reduce eye strain, exercise, and the most important factor is positive work environment, teamwork, and appropriate amount of work tasks." This comment is interesting from several aspects. Firstly, the employee mentions ergonomically designed workstations and frequent breaks, and as the most important factor, a positive work environment. This confirms that work ability is particularly important as it can have a direct impact on health. In any case, it can be concluded that companies can do a lot to ensure better working conditions, from introducing ergonomic elements to the workplace to practicing various techniques (for example, the 20-20-20 technique for resting the eyes where the gaze is diverted from the screen every 20 minutes and something is viewed at a distance of 20 steps for 20 seconds), which can reduce or alleviate the negative consequences on employee health.

CONCLUSION

The results of this study prove that there are significant risks that can negatively impact employee health. These same risks are further exacerbated in the context of Covid-19, where employees spend more time on computers. Additionally, this study has managed to prove several hypotheses that clarify some of the factors that can influence employee health when working on computers, such as the effect of time, years of experience, and stress.

The survey results confirm some of the previous findings but also deepen previous research, providing better insights into the effects of the time spent on the level of stress and fatigue of employees, as well as the effects of years of experience on fatigue and stress. It has been confirmed that a higher level of stress has an effect on the level of fatigue. An interesting conclusion of this research is that employees with more work experience better control the stressors around them. This can be explained by the fact that the experiential component can significantly help with self-control and evidently contribute significantly to improving employee health when working on computers.

Further research, as a continuation of this study, would be necessary for a better understanding of the causal relationship between employee stress and fatigue in different companies, industries, and under conditions that the employer has already provided.

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TOWARDS DIGITALIZATION OF THE OCCUPATIONAL SAFETY RISK MANAGEMENT PROCESS: OPPORTUNITIES AND THREATS

Abstract
Digitalization represents a process or strategy of applying various digital technologies and digitized data in order to improve the business process, making it more efficient and effective, as well as more adaptable to disturbances in a changing environment. In the context of occupational safety, a very important element of the management system is the risk management process. It contains risk assessment, whose dynamic nature enables constant monitoring, communication, and risk treatment, with appropriate recording and reporting of performed activities. The process defined in this way is suitable for digitalization, which can be done in several stages. Documenting risks as risk assessment results, creating regulations and procedures for performing work activities, and reporting on outcomes are fundamental. The introduction of modern technologies in the field of monitoring the state of the working environment, as well as monitoring safety outcomes, personalized communication and reporting on achieved results and potential hazards, personalized training and warning about potential risks, can further improve the safety system. The potential dangers are reflected in the impossibility to properly perceive the shortcomings of the applied technologies and their impact on the perception and behaviour of employees.

Key words: digitalization, risk management, process approach, occupational safety.

INTRODUCTION

Various innovations in the working environment have led to the improvement of the efficiency of production processes, but at the same time, they have caused various negative effects on the living and working environment. Automation led to a significant improvement in the output indicators of production processes, but it exposed employees to new dangers that threatened their health and even their lives.

Although, over time, numerous improvements were introduced into production systems, which made them safer for employees, the problems of safety and health at work have not lost their importance even today. This is particularly evidenced by the still large number of workplace injuries and work-related fatalities. The system of safety and health at work has, over time, developed in response to the growing need to ensure optimal conditions in the working environment. Risk management is a key element of a successful occupational health and safety (OHS) system.

Numerous improvements in production systems are the result of automation, so it is, with reason, seen as a potential incentive for the improvement of the safety system. As part of the decade of digitalization, the EU has set numerous goals until 2030, some of which are particularly optimistic [1], [2]. The dynamic environment of the organizational system implies that organizational goals are adapted to current needs and opportunities, and digitalization is seen as a tool that will enable faster organizational changes.

Digital innovations are present in all areas of human activity, from education through industry and commerce to everyday life and entertainment. In many areas, these innovations have led to a significant improvement in the efficiency and effectiveness of work, primarily from the point of view of storage and much faster retrieval of necessary data. The introduction of automation, primarily in production, has led to significant improvements in system performance. The importance of digitalization was particularly highlighted during the COVID-19 pandemic, when numerous social systems remained functional only and exclusively thanks to the use of digital technologies, which was especially characteristic for the continuation of educational activities.

RISK MANAGEMENT

Risk is a significant and unavoidable factor in a person's daily life, considering the fact that every decision, private or business, carries with it a certain risk. Risks are also present in all spheres of social activity. There are problems related to safety at work in numerous industrial activities, in which there are dangers that endanger the lives of employees.
Risk management has a supporting role in achieving the required system quality [3]. Its goal is to maintain the quality of the safety system even in the event of a possible realisation of risky events.

The process of risk management

The process of risk management implies the systematic application of policies, procedures, and practices in the activities of communication and consultation, establishment of context and assessment, treatment, monitoring, review, recording, and reporting on risk [3]. Key components of occupational safety risk management are presented in Table 1.

Table 1. Key components of occupational safety risk management

Component	Brief description
Risk identification	Identifying and documenting potential hazards and risks present in the workplace
Risk assessment	Evaluating the likelihood and potential consequences of identified risks to obtain risk level and prioritize risks
Risk mitigation	Implementing corresponding measures to control and reduce identified risks to an acceptable level and avoid adverse outcomes
Monitoring and review	Monitoring the implementation of risk mitigation measures and reviewing the risk management process
Continuous improvement	Adaptation to changing conditions and risks, as well as active participation of employees

Source: Based on [3], [4], [5], and own research

In the ISO 31000:2018 standard, the risk management process is no longer presented as a series of related activities (as presented in the ISO 31000:2009 version), but as a set of iterative steps (phases). They are undertaken in a coordinated manner, but not necessarily in a strict sequence. This process includes the following stages: defining the scope, context, and criteria; risk assessment (identification, analysis, and evaluation); risk treatment; monitoring and review; communication and consultation; recording and reporting.
Before starting any risk-related activities, it is necessary to know the system, that is, the organization in which the risk management process should be established. It involves understanding the organisation's strategy, purpose, and goals. Risk identification is carried out with the aim of creating a list of sources and causes of risk, as well as events that can affect the achievement of defined goals. Risk analysis is the process of understanding the nature of risk and determining the level of risk. It provides a basis for risk assessment and for decisions on risk management. Risk evaluation involves comparing the level of risk determined in the analysis process with the risk criteria defined in the criteria determination procedure in order to determine the significance of the risk.
Dealing with risk (risk treatment) is the process of applying measures that influence the size of the risk. Through monitoring, changes in parameters can be registered in a timely manner, trends of changes and their impact on risk can be assessed, and responsible persons or teams can be informed about this. Communication and consultation are important aspects of the risk management process because they ensure that all entities involved in this process understand the decisions and actions related to risk. The risk management process should be documented. The basic documents for risk management should be plans and programs. A documented risk management process is an essential aspect of safety management.
The specific properties of the risk management system, and above all, the need for data collection and processing, make this system suitable for digitalization. From the initial digitization of existing paper documents through the automation of certain processes, the application of digital technologies can lead to improved performance of these systems.

DIGITALIZATION

Digitization is the transformation of analogue representations into digital ones that are appropriate for use on digital devices such as computers, tablets, or smartphones. Instead of paper versions of documents, forms, and various types of reports, their digital alternatives are used. The next step is digitalization. The application of different digital technologies additionally improves organisational processes. This enables better organisation of data, their interconnection, and coordination, as well as the possibility of additional processing that was not possible with data available in their basic, non-digital form. Further development of new business systems and different workflow integrations can additionally transform an organisation digitally.

Digital technologies

The dynamics help maintain occupational safety risk management system effectiveness, efficiency, and adaptability in addressing evolving workplace hazards and changing environmental conditions. It makes systems adaptable to changing conditions, continuously improvable, resilient, and flexible. It also makes employees more engaged and active and supports their creativity and innovativeness, fostering a culture of innovation. Dynamics in the risk management system enable organisations to anticipate and prevent potential risks before they turn into accidental events.

Digitalization significantly improves the dynamics of the occupational safety management system by enhancing its ability to address workplace hazards and changing working conditions. Sensors, both standard and wearable, and Internet of Things (IoT) equipment collect data from the workplace environment, such as working conditions, employees' behaviour, and equipment performance. Virtual reality simulations are used to analyse hazardous scenarios and test mitigation strategies. Real-time data collection helps in analysing workplace conditions and incidents. With the support of mobile applications and communication tools, employees can easily report incidents or safety hazards, receive alerts and notifications, and browse safety manuals in real time.

Several digital technologies can help occupational safety risk management systems be more efficient. Some examples are presented in Table 2.

Table 2. Representative technologies and their application in risk management

Technology	**Application**
IoT sensors	Monitoring environmental properties in the workplace
Video surveillance	Identification of risky behaviour and hazards
Geospatial analysis	Visualisation and mapping hazards or hotspots in the workplace
Wearable technology	Personal equipment with sensors for physiological patterns identification
Mobile applications	For reporting hazards and incidents in real-time using tablets or phones
Data analysis	Intelligent identification of trends and anomalies

Source: Based on [4], [6], [7], [8], and own research

Predictive analytic tools additionally improve forecasting of potential safety risks and defining priorities according to available data and performance indicators. Digitalization provides the tools needed to adapt quickly to changing conditions, identify emerging risks, and implement effective risk management strategies based on the best available data in real-time.

DISCUSSION

The development of information and communication technologies also affects safety systems [6], as well as knowledge management in them [9]. Various trends in the development of information and communication technologies have not bypassed risk management systems either. By introducing new technologies into these systems, we are working to improve the timely identification of risks and the prevention of the consequences of adverse events. Numerous authors have considered problems in safety systems and the risk management process, as well as the ways in which digitization and the application of information technologies can help in the process of solving these problems [6], [7], [10]. At the same time, industries that in the past have not enjoyed too many benefits from technological development from the point of view of improving safety outcome indicators, such as, for example, construction or coal mining, are particularly important [11], [12]. The overall process significantly helps in improving the dynamic characteristics of the occupational risk management system. This is achieved by improving

agility and speed of response to changed conditions in the environment. A digital roadmap as a strategic plan helps with the implementation and functioning of a system using digital technologies and tools.
In addition to positive effects, the introduction of new technologies implies the emergence of new risks and challenges that should be taken into account in the context of the performance of the safety system, including employee competencies [9], [13]. Consideration of the performance of the safety system led to the identification and use of various indicators, indirect and direct. Innovation in the field of safety is especially important in the context of frequent applications in a dynamic environment, as it enables addressing risks [4], [14]. The modern approach to risk assessment is largely based on monitoring dynamic characteristics, which are the basis for performance assessment [5], [15]. By identifying the key performance indicators of the system using appropriate methods, a more detailed analysis of the system can be performed and enable better management [16]. Special attention should be paid to increasing the digital competences of employees so that they are able to fully use the benefits of technology, as well as to see their limitations in the right way, from documentation systems, through protective equipment, to data analysis systems and decision support [9], [14], [15], [17].
The dynamics in the occupational safety risk management system is crucial for maintaining effectiveness, adaptability, and responsiveness in identifying workplace hazards and changing conditions. The dynamic risk management system enables organisations to adapt to changes over time and implement mitigation measures [3], [5]. Continuous improvement and adequate response to changes are the basis for maintaining a successful risk management system over time and in compliance with legislative requirements. Quick adaptability to changes in the environment and the active participation of employees in all stages of risk management make the organisation more resilient. Also, innovation is encouraged, while the creative action of individuals further improves the performance of the existing risk management system and enables better preventive action aimed at preventing the occurrence of unwanted events and identifying potential early warning signs of possible risks.

CONCLUSION

The introduction of digital technologies in OHS risk management offers different benefits. Among others, they cause improved workplace monitoring and data collection, communication, data analytics, and employee engagement. Effective use of digital technologies can improve the OHS system and overall safety outcomes. However, there are some challenges too. The initial investments could be high. They include the development of infrastructure and software, as well as the training of employees. This could be a problem for organisations with limited resources and previous technical experience. The existing obsolete systems could cause problems with data compatibility. Technical failures, inadequate precision, or malfunctions could put employees at risk if no alternatives exist. Resistance to traditional methods, a lack of understanding or inadequate change management strategies is something that organisations have to deal with. Many ethical implications are related to privacy during data collection, analysis, and sharing. Organisations have to consider potential problems so that they can achieve OHS goals through digitalization and the transformation of risk management processes.

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Standards

- International Organization for Standardization: **EN ISO 31000:2018**, Risk management - Guidelines
- International Organization for Standardization: **EN ISO 31073:2022**, Risk management - Vocabulary

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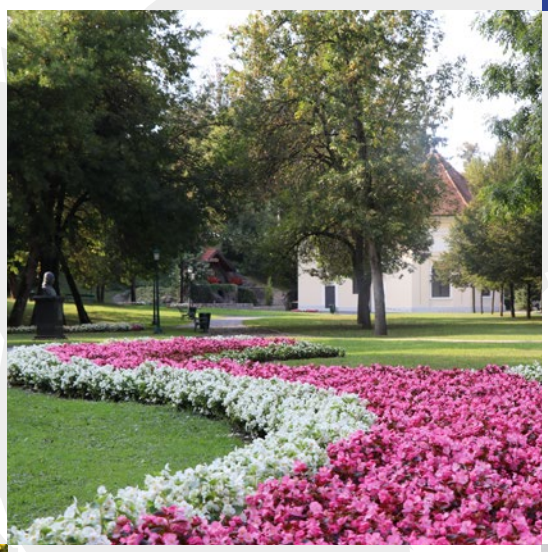

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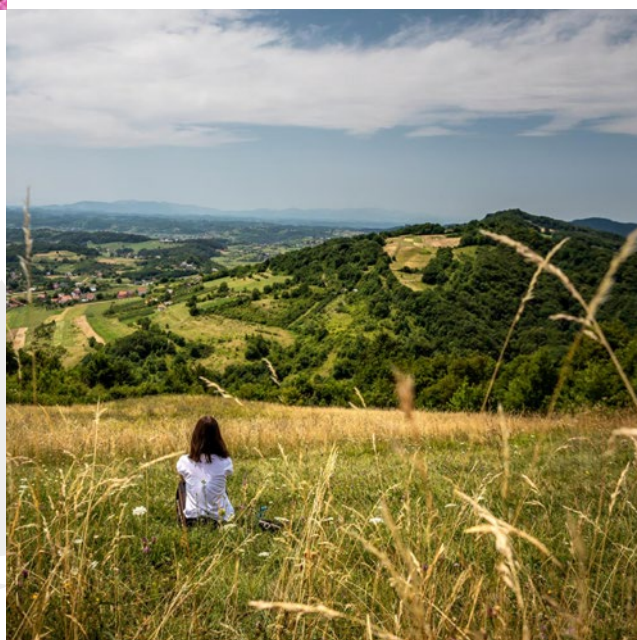
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