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Integration of digitalization into occupational health and safety and its applicability: a literature review

Cengiz Akyıldız

Department of Occupational Health and Safety, Üsküdar University, Istanbul, Turkey

ABSTRACT

The primary aim of this study is to review the transformation of occupational health and safety (OHS) practices in the digital age, particularly in light of the onset of Industry 4.0. The study seeks to understand the emergence of OHS 4.0 methodologies and their implications for enhancing performance, reducing risks, and addressing workplace challenges. The overarching objective is to explore the innovations in the OHS domain influenced by digitalization and ascertain the benefits and challenges of integrating digital methodologies into OHS practices. A comprehensive literature review was conducted, scanning multiple sources to gather insights on the innovations brought about by digitalization in the OHS domain. The study further analyzed contemporary research and application areas of new technologies in occupational health and safety. Findings from the study confirm that the integration of digital technologies into the OHS domain can lead to a significant reduction in workplace accidents. However, as workplaces embrace digital processes, new types of risks emerge for employees. In adapting to digitalization, there are recognized challenges in areas like privacy, security, clarity, and responsibility. Digitalization has redefined the landscape of OHS, ushering in an era of OHS 4.0. While the digital methodologies offer significant advantages in reducing workplace accidents and enhancing performance, they also present new risks and challenges. As the workplace undergoes rapid changes due to technological advancements, there's a pressing need to develop OHS approaches that align with the demands of the modern age, ensuring that health and safety remain paramount amidst uncertainties in applicability.

Keywords: Digitalization in occupational health, industry 4.0 and safety, modern workplace risks, technological adaptation challenges, transformation in work practices

The COVID-19 pandemic has placed technology at the heart of human life; during the pandemic, technology has been used in all processes ranging from education, health, shopping, and work life, with the aim of protecting and ensuring the continuity of business processes from the outbreak [1]. In this context, digitalization has become a commonly heard concept [2].

Digitalization is one of the most significant technological advances and intervenes in every aspect of life [3]. Besides daily life, it is a phenomenon that restructures many sectors in the business world, changing various service and business models and providing convenience [4].

The usual development process of work and working conditions has gained momentum with Industry

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Address for correspondence: *Cengiz Akyıldız, Senior Instructur, Üsküdar University, Department of Occupational Health and Safety, Altunizade, Üniversite Sok., No:14, 34662 Üsküdar, İstanbul, Turkey. E-mail: cengiz9299@hotmail.com, Phone: +90 216 400 22 22*

4.0 and the digital transformation process [1]; industrial models have changed, and the concepts of time and space have disappeared. With massive advancements in internet technologies such as the Internet of Things (IoT), augmented reality, and cloud computing, digital environments have brought the world to the brink of a profound transformation, becoming applications in today's digital world [5]. New technological terms, employment platforms, new professions, different management understandings, and various robotic applications have also entered the digital transformation process [6-8].

After the Covid-19 pandemic, digital transformation is no longer a choice but a necessity [9]. In this regard, the transformation of occupational health and safety (OHS) practices is inevitable [10]. As in many fields of work, the OHS field is affected by technological advancements [11]. Overcoming encountered challenges, reducing costs, and increasing safety require technological developments [12]. Indeed, OHS is very conducive to innovations and technology use [13]. The phrases commonly associated with OHS, such as "wear your helmet" or "wear your gloves," are now replaced by entirely different concepts, and perspectives on OHS are changing [12].

OHS covers processes of identifying risks at workplaces and taking control measures for these risks; it is a proactive and multidisciplinary field [13-15]. The primary goal in OHS is to ensure the safety of both employees and the enterprise [14, 15]. To achieve this goal, Industry 4.0 technologies are used to prevent occupational accidents [16]. However, the digitalization of OHS processes cannot be realized instantly to improve overall OHS performance. Solutions provided by digital OHS technologies, expressed as OHS 4.0, are supports that will enhance and improve the existing activities of organizations [10, 14]. In this context, the benefits of new technologies can be maximized to reduce occupational risks [17].

Despite offering many opportunities, digitalization has brought new challenges [17]. Legal gaps have started to arise in the OHS field during the process [8]. This study aims to address the integration of digitalization into the OHS field and the resulting positive and negative aspects for both work life and employees. The study includes recommendations on digital new technologies in the OHS field, the new risks they bring, the advantages and challenges of new processes, and potential solutions.

Digitalization is a renewal process that shows sociological, cultural, and economic change in parallel with technological developments [18]. In simple terms, it is the transfer of an entity or object to the digital environment. For example, it is about transferring all the information and accumulation that businesses have to the digital environment and managing it under new conditions, with new opportunities and problems [19]. Digitalization is not a new phenomenon and has existed for decades. A handwritten text being converted into digital form can be given as an example [20]. Especially with the invention and spread of the internet, digitalization has become one of the most critical concepts of our era [19]; information technologies (IT) have been a driving force in this transformation. IT has paved the way for the present situation with the technological tools it offers [21].

The essence of this change and transformation is the ability to perform tasks faster, more effectively, and cheaply thanks to the technological advancements, alongside recording information instantly, processing it very quickly, and using it in decision-making processes [7]. Today, all information and documents that cause time loss and spatial loss, archived in a primitive way in analog systems, have given way to a process that offers digital resources with the help of current technology and tools. Thus, digitalized information and documents have become more easily accessible and shareable, maximizing material and time savings [4].

Another concept that needs to be emphasized after digitalization is digital transformation [20]. Digital transformation is a rapidly evolving process that brings innovations, covering the past, present, and future, and is efficient [22]. It is continuous and dynamic [23]. Digital transformation not only applies new technologies but also changes working methods to evaluate new opportunities. With the increasing effect of digitalization in daily life and corporate life, all processes and organizations are expected to adapt to the rapidly changing structure [22]. In this context, digital transformation accelerates digitalization steps by helping organizations cope better with change and quickly adapt to developments in the ongoing process [24].

Research plays a critical role in understanding the implications and ramifications of large-scale phenomena, such as the digital transformation resulting from the COVID-19 pandemic. It provides insights into the mechanisms of such changes and offers potential solutions to anticipated challenges. In the context of this study, the research sheds light on how digital transformation impacts occupational health and safety, thus assisting stakeholders in preparing and adjusting for the evolving landscape of the work environment. The research's value extends beyond mere observation, enabling proactive strategies to maximize the benefits and mitigate the risks associated with digital transformation.

LITERATURE RESEARCH

This study is prepared in the form of a compilation and aims to identify uncertainties, challenges, and risks related to the integration and applicability of digitalization in occupational health and safety, and to provide solutions. To achieve this, articles, theses, reports, and papers published in peer-reviewed scientific journals in English or Turkish between 2018 and 2023 focusing on the topic of "Digitalization and Occupational Health and Safety" have been examined. Databases such as Google Scholar, PUBMED, and YÖK Thesis Center were scanned online within this scope. The research was conducted using keywords such as "Digitalization," "Digital Transformation," "Digital Technologies," "Industry 4.0," "Occupational Health and Safety," "New Technologies in Occupational Safety," "OHS 4.0," and "Digital Solutions in Occupational Accidents." Comprehensive literature review was conducted, titles and abstracts were considered to eliminate similar studies, all relevant sources were read, and additional studies related to the topic were identified by considering the reference lists of the accessed studies. In total, 50 studies have been included in the compilation.

RESULTS

Digital Occupational Health and Safety Technologies: OHS 4.0

OHS 4.0 is a new concept that aims to maximize the harmony between humans and machines by integrating the basic building blocks of Industry 4.0 and digital transformation processes into the field of occupational health and safety [13, 25]. OHS 4.0 technologies are utilized to prevent potential accidents and illnesses, targeting a safer workplace and employee safety. The damages caused by workplace accidents and occupational diseases have not only economic consequences but also institutional and societal impacts. With new technologies and smart devices, digital applications are being developed to focus on occupational risks, including digital task analysis, dynamic risk assessment, real-time monitoring of employees, and protection against unauthorized access [14, 26]. Additionally, digital technologies bring opportunities such as labor market access for vulnerable groups of workers [17]. The components of digital occupational health and safety technologies within the scope of OHS 4.0 are discussed below [10, 13, 25].

Internet of Things (IoT)

IoT is the way devices interact with each other over the internet, mostly wirelessly. Through IoT, various information is shared in real-time between devices and can be controlled remotely [27]. IoT enables real-time observations and events to be directly recorded in an OHS management system and online OHS records, providing instant access to information as needed [28]. In the field of OHS, IoT is used especially for personnel tracking. For instance, in coal mining, personnel tracking with IoT allows for real-time location identification during accidents, enabling rapid response and access [13]. Similarly, solutions using IoT technology have been developed for tasks such as preventing vehicle/person collisions and collecting data through inactivity sensors for lone workers [10].

IoT Components

Radiofrequency Identification (RFID)

RFID, a component of IoT technology, is used to identify living beings and objects using radio waves. It prevents unauthorized equipment usage and unauthorized actions by individuals, in addition to preventing collisions or falls that workers may encounter in the workplace [15, 29].

Real-Time Location System (RTLS)

RTLS enables continuous monitoring and identi-

fication of the locations of objects and employees in the workplace, helping to prevent risks and accidents by ensuring that equipment and workers are where they are supposed to be [14, 15].

Augmented Reality (AR)

Augmented reality combines computer-generated data such as sound and graphics with the physical environment, creating an enhanced perception that blends with the real world [30]. AR applications have ushered in an innovative era in OHS training, removing many constraints such as physical locations and equipment. AR allows for activities that are difficult to simulate theoretically, such as emergency response, case analysis, fire training, and working at heights, to be conveyed to employees in a virtual environment for improved performance [10, 13]. For example, workers can practice and visually learn the workings of machines without direct interaction, thus reducing risk levels. This way, risks can be experienced beforehand, creating a safer working environment and saving time and costs in terms of training and safety [15, 17]. Additionally, AR can provide information about hidden hazards like asbestos, electrical cables, and gas pipelines [17, 28].

Artificial Intelligence (AI)-Enhanced Security Systems

Artificial intelligence is a computer program designed to acquire information similar to human cognition [31]. The interaction among robotic systems is made possible through AI [25]. Many technologies are used in conjunction with AI algorithms and are being continuously improved. For instance, AI-powered image processing technology allows camera images to be processed based on the requested content, enabling early warnings and proactive measures. Software placed in cameras can trigger alert systems when flame images are detected, aiding in fire detection [10]. Furthermore, digital AI technologies allow real-time analysis of workers using mobile devices, wearable technologies, and personal protective equipment (PPE), both within and outside the workplace. While transparency with data is crucial when using these systems, they offer opportunities to enhance OHS audits, support evidence-based prevention, and increase audit efficiency when used correctly [17, 32]. Microsoft's AI-powered safety monitoring system tracks employees and their activities, vehicle and equipment usage in real-time, detects risks in hazardous areas, and alerts authorized personnel. This software aims to maximize workplace safety and prevent work accidents [33].

Cloud Computing

Cloud computing is a computing system that enables shared information sharing over the internet, rather than using device memory [34]. Technologies like big data and IoT are realized through cloud computing [25], and training programs can also be based on cloud computing [29]. With data from wearable devices transmitted to the cloud, all employees can be alerted in case of potential accidents, enabling instant intervention. All data is recorded to prevent future risks, and sensor data from tags is transferred to the cloud data system for storage and processing. This allows for visualization of results and presentation to authorized personnel. This system allows rapid resolution of incidents and reduction of accident rates [15].

Big Data Analysis

Big data is a technology model that can analyze complex data sets using advanced algorithms and high technology [18]. It enables data to be analyzed at an advanced level compared to traditional tools and can process and combine data from different systems, databases, or websites even if they are not compatible [35]. Big data analysis is significant in terms of OHS as it provides opportunities such as measurement, prediction, goal setting, decision support in OHS, planning the future, and determining action plans [10, 25, 28].

Smart Robot Usage

The use of robotics will be revolutionary in fields such as mining/tunneling, underwater/closed-space operations, or hazardous tasks involving human lives. Particularly, autonomous robots with programmable intelligence can communicate with each other, conduct analyses without the need for an operator, and perform various tasks [25]. Smart robots improve the quality of work and keep employees away from hazards by working in collaboration with humans, enhancing efficiency. For example, drones with camera systems can minimize the risk of falls from heights during inspections, and applications for tasks like lifting heavy

objects are expanding with autonomous robots [10].

Personal Data and Process Security System

The security of personal data, including health records, is gaining importance, bringing up new developments in the field of OHS [10]. Process safety systems are important in processes with a potential for significant industrial accidents, preventing deviations through safety barriers, and managing and controlling risks. By providing preventive measures in hazardous situations, pressure and flow sensors allow monitoring of processes [25].

Innovative OHS Software

Organizations are developing software to ensure "process safety" in line with production processes and to enhance OHS performance. In recent years, various software programs have been developed for digital work permits, digital risk assessments, and tracking machinery and equipment, among other areas. Additionally, software that processes and stores OHS data continues to develop [10]. OHS software systems allow tasks such as e-signatures and health examinations to be conducted using computers, phones, and tablets, enabling OHS professionals to manage documents digitally [34]. The IBM Maximo software, integrated with AI, IoT, and cloud technologies, allows for comprehensive management of facilities and employees. Real-time access to data from various devices (such as IoT-enabled wearable devices and mobile phones) and sensors enables the detection of violations, predictions, and monitoring using advanced analytical analyses. As a result, the system facilitates the identification and elimination of hazards [14].

Advantages and Disadvantages of Industry 4.0 Technologies in Occupational Health and Safety

In addition to the advantages of Industry 4.0 technologies, it is also necessary to mention some of their disadvantages. In this regard, based on the literature review conducted, the advantages and disadvantages of Industry 4.0 technologies are presented in Table 1.

Wearable Digital Occupational Health and Safety Technologies

Wearable Devices and Smart Personal Protective Equipment (PPE)

In jobs where exposure to hazardous substances is a concern, such as those involving hazardous materials, robotic or remote-controlled units can prevent direct exposure to these substances. However, in tasks where employees themselves need to perform actions, wearable technologies come into play. For instance, through the Internet of Things (IoT), employees can be monitored using online and wearable cables, ensuring that their health status and performance are continually monitored. In fact, by detecting brain signals, interfaces can be generated to prevent individuals from entering hazardous situations when their focus shifts [28] thereby reducing the response time in case of a potential accident. Sensors can detect movements like standing or sitting, as well as psychological states of employees [29, 36].

Embedded monitoring devices within Smart PPE offer real-time monitoring of hazards, enabling early warnings about harmful exposures. They can also provide personalized real-time recommendations to positively influence an employee's behavior, thereby enhancing their health and safety [17, 28]. The sensors within Smart PPE collect information and alerts, transmitting them to employees and authorities. When unusual behaviors are detected, all the gathered data is communicated to relevant units through the cloud [15]. These insights can aid organizations in anticipating potential OHS issues and determining areas where OHS interventions are necessary [17, 28].

Exoskeletons

Exoskeletons are auxiliary devices worn on the body designed to monitor real-time body postures and movements, reduce the load on the musculoskeletal system by performing manual lifting tasks, and support employees. They are used to assist physically impaired workers and prevent work-related musculoskeletal disorders. Digitally enabled exoskeletons can perform manual tasks from an OHS perspective, reducing the occurrence of injuries and aiding operators in improving their postures. Additionally, exoskeletons have the potential to reduce physical efforts, thereby decreasing work fatigue and increasing productivity [17, 36].

Despite the benefits, exoskeletons can introduce new risks from an OHS perspective. For instance, if exoskeletons malfunction, workers could become trapped or injured. The long-term physiological, biomechanical, and psychosocial effects of exoskeleton

Table 1. Advantages and disadvantages of industry 4.0 technologies

Component	Advantages	Disadvantages	References
IoT-based personnel and vehicle tracking systems	Reduces negative interactions with personnel and vehicles, enhances field control/efficiency. Enables person identification in emergencies, identifies and prevents inappropriate situations. Vehicle tracking systems allow tracking of rule-compliant vehicle usage, duration, location, and speed.	Privacy and security concerns; lack of protection against service continuity and integrity issues, and malicious software attacks.	[25, 29, 36]
AI-supported security measures	Reduces exposure to risks including harassment and violence, offers early warning for fatigue and stress, provides personalized real-time advice, influences employee behavior, decreases risk and workplace accidents, improves occupational health and safety audits.	Can lead to fatal consequences in situations that occur beyond human control and require initiative.	[25]
Robotic use in hazardous tasks	Mitigates risks, eliminates personal errors, removes employees from dangerous work environments (e.g., chemical, biological), reduces workplace accidents, offers healthier operations with shorter exposure.	Detrimental effects on employee mental health (performance pressure), reduces human interaction and socialization.	[17, 28]
Augmented reality applications	Provides effective and qualified personnel training, offers new perspectives and awareness in occupational health and safety, increases awareness of risks among employees, includes instructions to mitigate human errors.	Reliability depends on the continuity, quality, and timeliness of information sources.	[25, 28]
Big data analysis	Enables perpetual digital record-keeping, facilitating continuous improvement and risk reduction. Allows retrospective accident data analysis and comparison with other facilities.	Challenges in maintaining control and privacy.	[15, 25]
Cloud computing	Eliminates hardware issues, offers high accessibility, and flexible structure that does not require memory alterations.	Challenges in data management, reliability and efficiency issues due to factors like communication in the clouds.	[15, 35]
Personal data security systems	Ensures secure data provisioning and prevents data leakage, enhances employee and business partner satisfaction.	High labor requirements and costs.	[15]
Process safety systems	Eliminates human errors, minimizes risks, ensures facility/employee safety, provides risk-mitigating solutions.	-	[15]
Innovative OHS software	Enhances reporting, analysis, centralized employee management, time management, document tracking, corrective and preventive activity control, traceability, ease of access with digital storage, increased accessibility through training modules, facilitates tracking, data/archive management, process standardization, easy data sharing.	Potential privacy issues due to remote accessibility.	[15, 34]

usage are still unknown. Therefore, personal precautions are considered the last resort in the control hierarchy, similar to other measures [17].

Risks Associated with Digital Occupational Health and Safety Applications and Emerging Risks

Digitalization brings about unexpected hazards that require new solutions and approaches, while also amplifying existing hazards [37]. In this context, OHS risks will evolve. New working styles that accompany new technologies can lead to safety and ethical concerns. Monitoring technologies can induce stress and anxiety due to concerns about privacy violations. Especially in terms of OHS risks, factors such as performance pressure affecting mental health, reduced social interactions, prolonged working without breaks leading to musculoskeletal issues, and cardiovascular diseases can arise [17, 32]. Within this framework, the existing and emerging risks associated with Industry 4.0 OHS technologies are provided in Table 2.

Remote work requires significant responsibilities for OHS professionals, and it should not be forgotten that remote workers may require more frequent monitoring and support [38]. Furthermore, adjustments to regulations related to changing risk factors [13], continuous monitoring of these risk factors by employers, and seeking solutions for emerging risks are essential [34].

Effects of Digital Occupational Health and Safety Applications on Work Life and Employees

With digital technologies, the requirement for physical presence at the workplace is diminishing [34]. Flexible working arrangements are being adopted, allowing data to be archived on digital platforms, and mobile communication resources are always accessible. As a result, remote and flexible work styles such as working from home are becoming increasingly common [4]. Consequently, the number of employees in offices is expected to increase, leading to a rise in workplace accidents and occupational diseases. Thus, occupational health and safety measures need to be applied in office settings that function as workplaces. The increasing number of people working from home may also raise discussions about what kind of OHS measures employees should take in their homes [35].

Table 2. Existing and emerging risks associated with digital occupational health and safety applications

Existing Risks	Emerging Risks
Physical Risks	Privacy and Security
Chemical Risks	Work Accidents
Biological Risks	Occupational Diseases
Ergonomic Risks	Skilled Workforce Shortage
Psychosocial Risks	Risks Related to Online Work

Effects of Digital OHS Applications on Employees

Positive Effects

Digital OHS technologies' monitoring of employees is seen as a significant advancement in preventing potential accidents. For instance, augmented reality applications can provide information and experience to employees about how to act in hazardous situations, and technologies like big data and IoT can analyze information rapidly to prevent numerous potential risks and diseases [14]. Moreover, by utilizing robots and exoskeletons for manual tasks, especially older and disabled employees can continue their tasks with reduced physical effort. Additionally, diseases resulting from sedentary lifestyles and situations like traffic accidents that remote workers might face can be prevented [28].

Negative Effects

The rapid pace of technological change requires employees to learn quickly and continuously. Not only do employees need to know how to use technology, but they also need to possess the relevant skills for new work methods. Changing work models and job nature could mean workers have more responsibility for their own learning and training needs. Smart robots constantly learning might pressure employees to keep up with the pace and level of work, leading to a high level of performance pressure. Furthermore, AI-supported digital monitoring technologies can cause stress and feelings of insecurity, negatively impacting employees' mental health [17, 28, 34]. Overreliance on robots or exoskeletons for manual tasks can lead to reduced physical fitness, resulting in muscle, bone, or joint loss [28]. Additionally, prolonged screen time is believed to cause certain occupational diseases, par-

ticularly affecting the eyes (as shown in Table 2). Moreover, psychological ailments like stress, often referred to as the "disease of our time," are likely to become more widespread [34]. According to research by the European Foundation for the Improvement of Living and Working Conditions and the International Labour Organization in 2017, remote workers experience not only increased stress levels but also blurred lines between free time and work hours [38].

DISCUSSION

While digital technologies offer significant innovations, they also bring about new challenges due to changes in work processes [37]. Within this scope, based on a review of the literature, the challenges in digitalization for occupational health and safety can be listed as follows [28, 34, 38].

Inadequate regulations, as technology becomes increasingly complex, there are very few government policies available for the safe integration of technologies like robotics into workplaces.

Elimination of location and time constraints in work through new working methods, as 24/7 flexible work becomes more common, employees will become more scattered and diverse, making OHS inspections and regulations more challenging. Employers will have less control and influence over factors affecting employees.

Lack of awareness among managers about issues and inadequate risk assessment, new situations creating new risks will require new solutions. Without considering the impact of digital technology and work processes, applying old methods to new processes can create difficulties. For example, infrastructure designed for old technology might not be suitable for new technology, leading to unforeseen risks.

Excessive workload and increased mental strain with modern technology, the pressure of being accessible 24/7, intensified work processes, changing expectations of managers and customers, overtime, uncertainties, and the use of artificial intelligence or autonomous machines can cause stress among employees and hinder their engagement.

Internal collaboration problems within companies and ambiguity of responsibilities; the ambiguity of digitalization strategies, lack of clear communication to employees, unclear definition of responsibilities for outputs, errors, or consequences of new processes (such as uncertainty about those responsible for OHS) can create challenges within the company.

Lack of transparency and clarity along with inadequate data protection; transparency and clarity issues may arise regarding new working models and processes, and the increase in data may lead to gaps in data protection and security.

Those responsible for OHS must adapt to technology in line with the developments that occur. In the coming years, employers and employees will not be able to see each other, and therefore, OHS services will also be provided remotely. In this case, the issue of cyber attacks will negatively affect OHS. It is expected that in the coming years, cybersecurity experts will be included in OHS teams; however, it is observed that companies working in the technology field or using technology now employ cybersecurity experts and make significant investments in this area [34].

In situations where security is at risk, the issue of cybersecurity becomes significant regarding the potential of hackers taking control. This pertains to the control and communication of business processes and devices over the internet (such as GPS technology, IoT systems, wireless networks, central databases, etc.) [28]. In this context, a cybersecurity expert is an individual who has received training to protect the electronic information systems of the company from both external world attacks and internal attacks. Cybersecurity experts will work in coordination with OHS experts to ensure internal workplace safety [32].

The following proposed solutions can help mitigate the challenges brought about by digitalization on occupational health and safety [28, 34, 37]:

- (a) Ethical framework for proper management and behavioral rules should be established for digitalization; adjustments should be made regarding clear boundaries, transparent processes, manageable workloads, effective communication, reliable information, and feedback.
- (b) A regulatory framework should be established to clarify OHS obligations and responsibilities for new systems and working methods; responsibilities should be redefined and clearly stated.
- (c) Training for employees; two-way exchange of knowledge and experience should be established to enable employees to enhance their competencies and

creativity as needed, and communication and feedback practices should be adjusted.

- (d) Effective OHS services should be provided to all employees in the digital business world; OHS processes should be organized, taking into account features such as new types of work such as daily work, job sharing, or freelance work.
- (e) Employee participation in the design and implementation of digitalization strategies; employees should be given the freedom to make their decisions and follow their ideas, and resources should be made available.
- (f) A strong 'design for prevention' approach that combines the human factor and employee-centered design should be adopted.
- (g) Comprehensive risk assessment taking into account all factors and their interactions; processes should be evaluated, working conditions should be enhanced, and special data should be given importance.
- (h) Increasing awareness for the rethinking and reshaping of previous knowledge and processes; new approaches should be developed, and occupational safety awareness should be strengthened by including everyone in the process.

To bring current technologies into OHS applications, a multidisciplinary approach including expertise from engineers, IT specialists, psychologists, ergonomists, social and occupational scientists, medical practitioners, and designers should be adopted [12]. Collaboration should be established among academics, industry, social partners, and governments [17]. In this context, the European Agency for Safety and Health at Work (EU-OSHA) has been conducting comprehensive studies on OHS and digitalization since 2016, aiming to maximize the opportunities offered by digitalization and to create healthier and safer workplaces for everyone in digital workspaces [17, 34].

The COVID-19 pandemic, felt globally, has shifted many priorities, with digitalization being one of the most talked-about subjects. Especially with Industry 4.0, digital technologies have begun to be used in the field of occupational health and safety. With the integration of digitalization into occupational health and safety, it is clear that along with opportunities, challenges will be encountered. In this context, it is believed that transitioning to OHS practices unplanned may not be possible, but with the right and effective approach, digital occupational health and safety processes will have a positive impact. Indeed, protecting against the negative effects of risks and challenges brought about by digital OHS applications and establishing the necessary infrastructure to achieve the desired goal seems likely to take place in the long term.

On the other hand, along with new technologies, both personal hazards such as unsafe behaviors of employees and unsafe conditions will be eliminated. As a result, by minimizing risks, work accidents will decrease significantly. Therefore, for effective occupational health and safety technologies that ensure both the safety of businesses and the health of employees, it is concluded that new approaches and processes suitable for the digital age, considering all factors and designing new technologies with employee-centered approaches due to their negative effects on employees, need to be developed.

CONCLUSION

In conclusion, digitization offers both opportunities and new challenges in the field of occupational health and safety. These challenges range from inadequate regulations to unsafe employee behaviors and the shortcomings in adapting to technology. However, various solutions are available to overcome these challenges. Managing digitization within an ethical framework, providing education and involvement for employees, and implementing regulations that enhance safety are key steps in transitioning occupational health and safety to the digital age. This process requires collaboration across a wide spectrum of expertise, from engineers to psychologists, occupational health specialists to designers. Organizations like the European Agency for Safety and Health at Work (EU-OSHA) also contribute significantly to this area. Therefore, it is evident that a continuous effort is essential to guide the transformation brought by digitization in the safest and healthiest manner possible.

Authors' Contribution

Study Conception: CA; Study Design: CA; Supervision: CA; Funding: N/A; Materials: N/A; Data Collection and/or Processing: CA; Statistical Analysis and/or Data Interpretation: CA; Literature Review: CA; Manuscript Preparation: CA and Critical Review: CA.

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