CYBERGOGY TOOLS AND TECHNOLOGIES AIDED AWARENESS IN SAFETY AND HEALTH MANAGEMENT

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ABSTRACT

Digital transformation is being implemented across various sectors to enhance user experiences and improve understanding of processes within resources and outcomes. This includes fostering a safety culture and incorporating occupational safety and health programs, training, and tools to identify and address good and bad safety practices. New emerging technologies have the potential to address challenges in this area and establish best practices for a safe and healthy environment. Computer graphics, emerging technologies, computational dynamics, and simulation have been aggressively adopted since the onset of the COVID-19 pandemic. The state of the art explores the role of digital technology transformation in identifying hazards and assessing risks for occupational safety and health management across different sectors. Due to these current issues, numerous emerging technologies are converging into digital solutions for the future generation. Immerging technologies are expected to revolutionise people understandings and views of the world and its objects, allowing individuals to perceive, and experience environments in new and enriched ways that will benefit safety and health awareness. As a result, digital transformation holds significant educational and developmental potential, aided user experience by engaging learners and enhancing the self-determination process with cybergogy tools in hazard management and risk assessment for safety and health practices.

Keywords: *Digital transformation, Safety and health, Immerging technologies, Cybergogy.*

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1.0 INTRODUCTION

The Fourth Industrial Revolution and digital transformation are significantly impacting various sectors, including training, education, healthcare, manufacturing, and aerospace. Digitization refers to the transition from analogue to digital formats, while digitalization is defined as “the restructuring of many aspects of social life around digital communication and media infrastructures”[1]. Digital design and application technologies play a crucial

role in enhancing human understanding in areas such as learning, training, engineering practices, and quality control. This process necessitates a specific set of skills in utilizing innovative digital technologies to boost economic performance and elevate the quality of life, as noted by Chenic et al.[2]. A successful digital transformation demands a comprehensive perspective on the factors that motivate or enable changes within organizations, as well as the impacts these changes have on the broader context of various operational aspects and fields. A digital transformation strategy seeks to fully harness new technologies and their opportunities more effectively and innovatively in the future.

1.1 Digital Transformation

Digital Transformation represents a profound and comprehensive process of change that is driven by the application of innovative digital technologies. This transformation is further supported by a strategic leveraging of essential resources and capabilities, with the ultimate aim of fundamentally enhancing an organization's operations and outcomes, as articulated by Gong & Ribiere [3]. A key development in this arena is the concept of the smart factory, introduced by Damiani et al. [4]. This concept envisions an environment where physical and digital systems are seamlessly integrated, facilitating rapid product development cycles and greater operational efficiency. In terms of specific technological applications, Yew et al. [5] have examined the role of immersive technologies, particularly the application of augmented reality (AR) within manufacturing systems. Their research highlights how AR can significantly improve the way workers perceive, understand, and interact with information, thereby enabling diverse groups of employees to engage more effectively with critical manufacturing software, such as CAD/CAM systems.

Further emphasizing the human element in this technological landscape, Sobral [6] has conducted a study that highlights the crucial role of human reliability in the context of industrial risk assessment. This perspective underscores that the effectiveness of safety protocols and risk management strategies cannot solely rely on the performance of physical assets but must also consider the human factors involved. Building upon this idea, Fischer et al. [7] explored the incorporation of immersive technologies specifically augmented and virtual realities (A/V) into workforce training. Their findings demonstrate that such technologies not only improve the training experience but also enhance the interaction between humans and machines, ultimately leading to a more skilled and responsive workforce.

Moreover, Milea [8] pointed out the transformative potential of digital tools in reshaping Occupational Safety and Health (OSH) management practices. However, he cautioned that a thorough consideration of how these tools integrate into existing frameworks and their implications for human factors is essential to maximize their effectiveness and benefit. Lastly, Smith [9] articulated that the gains associated with digital transformation such as enhanced efficiency, productivity, and competitiveness for employers are substantial and cannot be overlooked. Additionally, advancements in Occupational Safety and Health (OSH) not only bolster worker well-being but also significantly enhance the profitability and competitive edge of organizations. Consequently, it is logical to assert that integrating digital technology can lead to improved occupational safety and health for workers, ultimately creating added value for companies navigating this evolving landscape.

1.2 Digital Tools and Technologies

The rapid advancement of high-powered computers and cutting-edge information technology has dramatically accelerated the digitalization of fundamental processes across a myriad of industries. This transformation not only enhances reliability but also significantly reduces the risks associated with direct human exposure during potentially hazardous operations. A pivotal catalyst of this digital revolution is Industry 4.0, which signifies the fourth industrialization wave within the manufacturing sector. This phase is

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characterized by the widespread application of innovative technologies that facilitate the establishment and management of crucial business processes, as detailed in the work of Castagnoli et al. [10]. The digital era is distinguished by the emergence of disruptive technologies, which include sophisticated analytics, the Internet of Things (IoT), artificial intelligence (AI), blockchain technology, robotic automation, and various immersive technologies. Digital tools are defined as online platforms or software applications that empower businesses and individuals to perform tasks in a rapid and optimized manner—tasks that would typically take a significantly longer time to accomplish without these technological advancements.

The category of digital technologies encompasses a diverse range of devices and systems. This includes personal computing devices like laptops and tablets, various digital tools such as cameras, calculators, and digital toys, as well as complex systems like specialized software and mobile applications. Moreover, it embraces augmented and virtual reality technologies, alongside less tangible assets such as global internet connectivity. In the context of higher education, research conducted by Perini, M. [11] has highlighted the challenges that digital tools pose for academic professionals. These challenges necessitate critical thinking and innovative approaches, as digital tools play a pivotal role in fostering innovation, enhancing learning experiences, and boosting student engagement within academic institutions. They also offer unique opportunities for student learning that extend beyond conventional classroom settings. Smith [9] emphasized that to unlock the full potential of digital tools, automation, robotization, and other advanced technologies aimed at improving occupational safety and health (OSH), it is crucial to cultivate an environment ripe for innovation. This encompasses fostering new work methodologies, encouraging creative ideation, and adopting a positive mindset towards change and adaptation.

Furthermore, Yuyin & Yuhang [12] proposed the implementation of high-tech devices capable of generating virtual imaging technologies based on HTML5 artificial environments. Such technologies are designed to enhance the performance of digital painting systems, leveraging interactive virtualized technologies to provide more dynamic and engaging creative experiences. This comprehensive approach to integrating technology into both industry and education showcases the profound impact that digital advancements can have in reshaping processes, enhancing safety, and promoting creativity. Studies from EU-OSHA have demonstrated, platform workers may experience worse OSH management, including poor or lacking risk assessment, lack of access to OSH information, training, services, support and personal protective equipment (PPE), EU-OSHA [13,14,15 & 16]. Digitalization has redefined the landscape of OSH, ushering in an era of OSH 4.0. A digital methodologies have offered significant advantages in reducing workplace accidents and enhancing performance, but present new risks and challenges.

2.0 OCCUPATIONAL SAFETY AND HEALTH

As the modern workplace experiences transformative shifts driven by technological innovation, there is an urgent call to develop Occupational Safety and Health (OSH) strategies that are in harmony with contemporary demands. This evolution is essential to ensure that the health and safety of workers remain a top priority, particularly in the face of uncertainties regarding the applicability of existing measures. OSH is a comprehensive field that focuses on the protection of both workers and work environments, drawing from multiple disciplines to enhance safety and well-being. Central to this field is the process of risk assessment, which is not merely a guideline but an obligatory step in implementing effective OSH practices. This process is crucial for identifying and evaluating potential risks associated with various workplace hazards. It involves analyzing existing control measures and making informed decisions on whether identified risks can be mitigated to an acceptable level. The International Labour Organization (ILO) [17] has outlined that Occupational Health and Safety (OHS) encompasses broader responsibilities: safeguarding

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workers and their environments, decreasing the occurrence of workplace accidents, minimizing the gap in critical information, and raising employee awareness all from a multidisciplinary perspective.

This imperative for enhanced safety measures has been underscored by the United Nations (UN) through the establishment of the 17 Sustainable Development Goals (SDGs) in September 2015 [18]. This ambitious agenda aims for inclusive and sustainable development worldwide, in line with the principle of "leaving no one behind." Yet, the challenges posed by the COVID-19 pandemic cast doubt on the feasibility of achieving these goals by the targeted year of 2030. Key factors such as human rights, labour market dynamics, employee benefits, and workplace safety are essential to sustainable development, especially within the private sectors. Notably, worker safety and health play a critical role in influencing an organization's economic performance. Moreover, research conducted by Pandey & Pal [19] has illuminated how the pandemic has prompted individuals to increasingly depend on digital connectivity, as measures like social distancing, quarantine, and strict movement regulations have come into play. OSH encompasses a broad spectrum of health and safety considerations in the workplace, prioritizing the proactive prevention of hazards, as highlighted by Eurofound [20].

As we navigate these changing landscapes, the fundamental processes of OSH management involved risk assessment and management have garnered considerable significance, particularly in light of recent regulatory and legal requirements as established by Sousa et al. [21] Zanko & Dawson [22] have highlighted the necessity of identifying sources of risk and implementing control measures before any incidents occur. The critical steps in effective OSH management include identifying potential hazards, assessing the potential harm and its implications, evaluating risks, determining necessary precautions, documenting significant findings, and regularly reviewing and updating assessments as required. . Numerous studies in the realm of risk assessment and management have referenced international standards, such as those set by the ISO, which provide guidelines and protocols for developing standard operating procedures in hazardous environments.

Currently, many of these frameworks were grounded in traditional methods, often requiring a cognitive understanding that is not always adaptable to rapidly changing conditions or unforeseen circumstances. The advent of the Fourth Industrial Revolution and ongoing digital transformation has further reshaped the workplace, with technologies such as 5G, artificial intelligence, big data, augmented reality, and smart tools becoming increasingly intertwined with both economic activities and social interactionsIdentifying the hazards, deciding any harm and the consequences, evaluating the risks and deciding on precautions, recording significant findings, and reviewing the assessment and updating if necessary were the crucial steps to be taken for the OSH management and practices, for example as Figure 1.

Figure 1: The use of mixed reality to improve worker safety during trench excavation using Microsoft Hololens

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3.0 DIGITALIZING IN SAFETY AND HEALTH MANAGEMENT

A cooperative of digital technologies in the workplace will produce visualizing and stimulating prospects to enhance understanding and preventive action could be taken earlier. The digital systems within organizations have been synthesised by [9] as Figure 2 involves remote or hybrid work, working on digital platforms, work automation and robotics, artificial intelligence and smart digital systems.

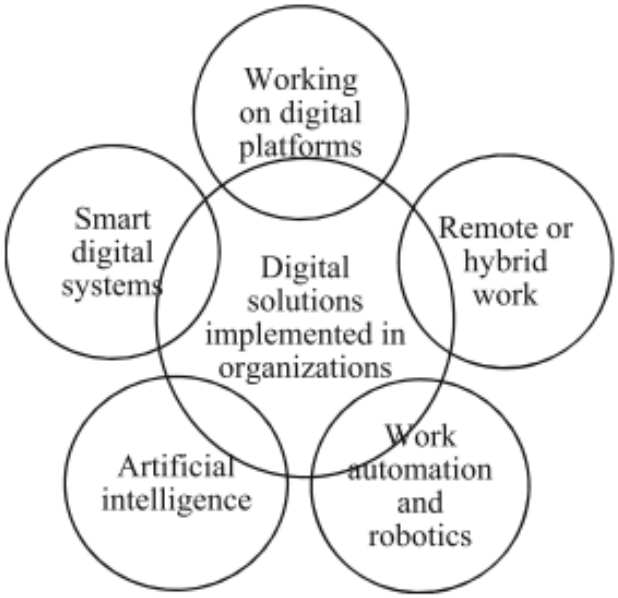

Figure 2: The elements of a digital system implemented in organizations [9]

In OSH management, working with digital solutions such as emerging technologies could represent real-world work scenarios without risk. The utilization of digital tools such as wearables, sensors, and mobile apps has become increasingly prevalent in various domains, including those of the International Labour Organization (ILO) (ILO, 2021). In addition, it is worth noting that digital technologies have the potential to provide comprehensive training and education on occupational safety and health. Eurofound [23] stated that digital platforms facilitate immersive training experiences and continuous learning on OSH, ensuring that employees are well-equipped to adhere to safety protocols. Immersive technologies like virtual applications offer effective information and instructions through features such as real-time visualization, risk-free visualization, and mobility as determined thru case study project by Bachche [24].

3.1 Immersive Technologies

The immersive technologies as described by Abbas *et al.*[25],[26] are technologies that were used for the simulation of the real-world environment and activities to deliver a sense of immersion in the simulated environment. Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR) have been described by Khan *et al.*[27] were the used application and currently being developed and this immersive technologies come under the umbrella term 'extended reality' (XR). According to Berg & Vance [28] , VR is described as a collection of technologies that allow individuals to explore a world beyond reality in an immersive way. Any VR system is linked to three essential aspects: Immersion, Interaction and Visual Realism. Aziz *et al.*[29] reviewed the possibility of implementing a VR training platform for maintenance in the oil and gas industry. Milgram & Kishno [30] have introduced the reality-virtuality continuum that defines mixed reality and identified a series

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of variations of technologically modified forms of reality that correspond to today's augmented and virtual reality technologies as Figure 3.

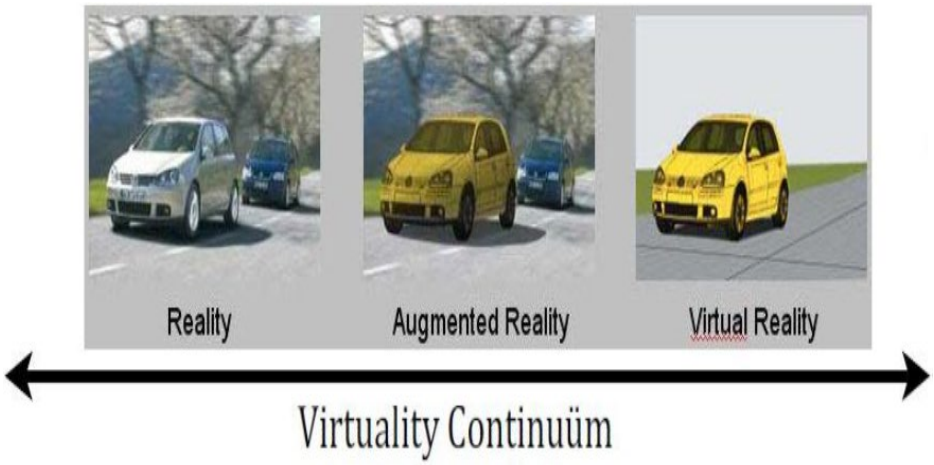

Figure 3: A virtuality continuum, Milgram and Kishino [30]

AR has gained great interest recently, especially in industrial applications, due to cheaper devices and the large possibilities offered by this technology. Numbers of apps developers and researchers have been discovering pragmatic theories and applications for the adoption of AR application technology in academic and the corporate management. AR is defined as a system that has the following properties: (a) combines real and virtual objects, (b) is interactive in real-time, and (c) is registered in three dimensions as defined by Bejczy [31]. Digitalization is increasingly recognized as a valuable tool for enhancing occupational safety and health (OSH) within manufacturing settings. Rani *et al.* [32] have identified the capabilities of AR as new emerging technologies that will improve machining operations to embrace Industry 4.0 (I4.0) for product precision, cost, and maintenance. The emerging technologies expand and enhance with the Mixed Reality (MR) environments which contain a combination of real and virtual-world information. MR can be utilised for visualising information, remote collaboration, human-machine interface, design tools as well as education and training. Juraschek *et al.* [33] developed two major fields to fulfil the learning factories' demand and one would be the level of empowerment among users to work with MR in industrial applications.

3.2 Immersive Technologies in Safety and Health

Digitalization is increasingly recognized as a valuable tool for enhancing occupational safety and health (OSH) within manufacturing settings. Experts have agreed that the immersive technologies system can improve the efficacy of training by utilizing an immersive environment where users can better perceive hazards and safety-critical situations. A conceptual model has been proposed by Revolti [34] on the application development of dynamic and digital models in augmented reality wearable, and human-centred systems for workers' training and real-time risk management as Figure 4.

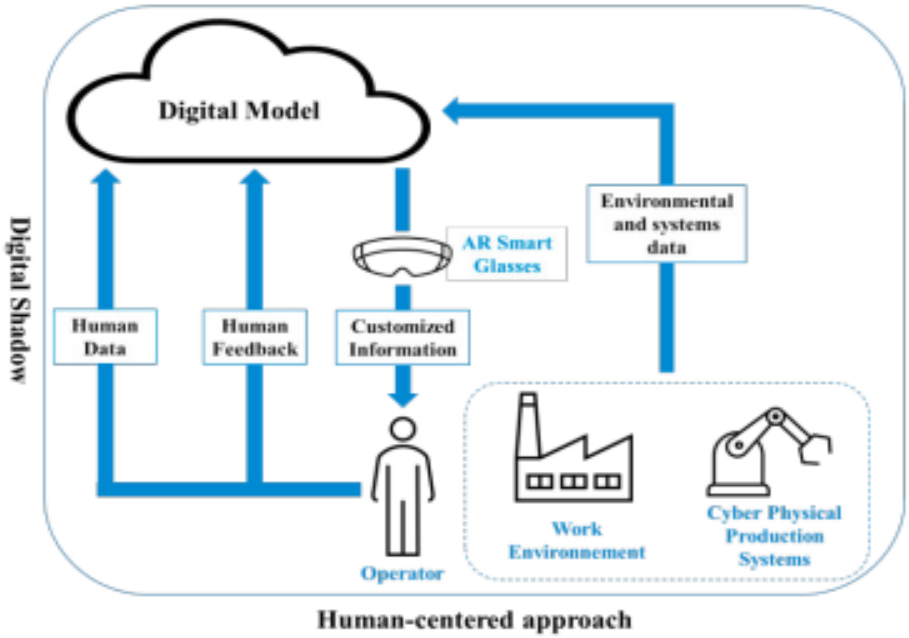

Figure 4: A proposed dynamic and digital conceptual model [33]

Virtual reality training has also demonstrated effectiveness in enhancing OSH knowledge and attitudes as stated by Siha *et al.* [35]. However,. Daniela & Ioan [36] discovered its effective to use necessitates appropriate training to ensure workers' safe and efficient utilization of digital technologies. Garg *et al* [37] reviewed that digital technologies can be used to improve OHS training, risk assessment, and incident reporting. Carrier & Moulds [38] concluded that humans are at the centre of this digital transformation by offering multi-faceted recommendations, emphasizing the need for an interdisciplinary approach. The use of ICT (Information and Communication Technology) has created a new teaching and learning concept in education pedagogy known as cybergogy.

4.0 CYBERGOGY LEARNING DOMAIN

The central elements of cybergogy, was the intention of combining the fundamentals of both pedagogy and andragogy and the arrival of the new approach for learning, a framework that was built by Wang & Kang [39]. Cybergogy focuses on helping students from young to adults to learn easily through the virtual environment and immersive technologies.Froyd *et al.* [40] coined the term “Cybergogy” as a descriptive label for the strategies for creating engaged learning online and has three overlapping/intersecting domains: cognitive, emotive, and social as Figure 5.

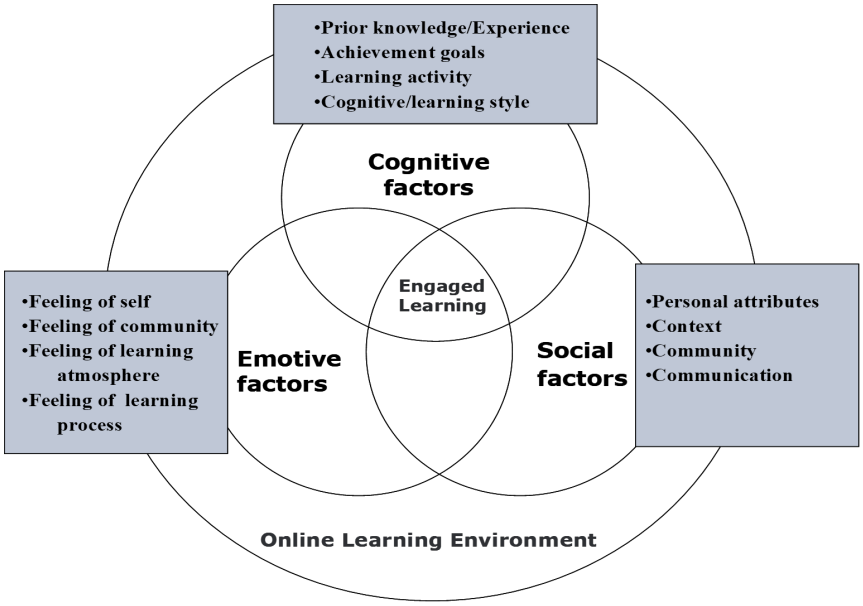

Figure 4: The "MM" model: cybergogy for engaged learning [40]

Five major shifts have been identified by Froyd et al.[40] in engineering education and the 5th shift indicates that technologies (e.g., the Internet, intelligent tutors, personal computers, and simulations) have been predicted to transform education for over 50 years. Every instructor or educator becomes fulfilled when learners are engaged in the whole learning process and they can achieve the set goals for the session. The transforming of the digital revolution acquired the pace of change necessitates continuous skilling and reskilling, through lifelong learning. Digital education customizes the experience to what the person needs at a particular moment in time.

5.0 DISCUSSION

Digital transformation is no longer a choice; it is being rapidly adopted across various sectors to significantly enhance user experiences and deepen the understanding of processes related to resources and outcomes. To achieve this, fostering a culture of safety is essential, which can be accomplished by integrating robust occupational safety and health (OSH) programs, comprehensive training, and advanced tools specifically designed to identify both effective and ineffective safety practices. As demonstrated by Haidarravy et al. [41], OSH practices play a critical role in influencing the well-being of workers and the overall performance of organizations.

The emergence of innovative technologies stands to address existing challenges in this field and create best practices for ensuring a safe and healthy environment. Since the COVID-19 pandemic, we have witnessed a remarkable adoption of computer graphics, emerging technologies, computational dynamics, and simulation. However, the full potential of digital transformation to identify hazards and assess risks in occupational safety and health management remains largely untapped within many institutions. A variety of converging technologies are poised to deliver groundbreaking digital solutions for the future.

These advancements not only promise to revolutionize our understanding of our surroundings but also empower individuals to perceive, hear, and engage with their environments in enriched and meaningful ways. This shift will undoubtedly elevate safety and health awareness. Immersive technologies such as virtual reality (VR), augmented reality (AR), mixed reality (MR), and extended reality (XR) possess immense educational

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and developmental potential. By actively engaging learners and enhancing self-determination through cybergogy tools, these technologies can transform hazard management and risk assessment practices, ultimately leading to a safer, healthier workplace for everyone.

6.0 CONCLUSION

This article examines the current advancements in immersive technology across various fields, emphasizing its application in managing Occupational Safety and Health (OSH) issues. Overall, OSH plays a crucial role in preventing and safeguarding workers from occupational accidents and diseases. The author has identified the optimal approach through a digital platform designed for Hazard Identification, Risk Assessment, and Control Measurement (HIRARC), which is presently in the application development phase. This digital transformation, enhanced by immersive technologies, provides a rich experiential learning process that supports the development of psychomotor skills. It aims to serve as a motivational tool for learning while enhancing cognitive abilities, persistence, and overall competencies in human performance.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interest regarding the publication of this paper.

REFERENCES

[1] Brennen, J. S., & Kreiss, D. (2016). Digitalization. *The International Encyclopedia of Communication Theory and Philosophy*, 1–11.
[2] Chenic, A. S., *et al.* (2023). The impact of digitalization on macroeconomic indicators in the new industrial age. *Electronics (Switzerland), 12*(7), 1612.
[3] Gong, C., & Ribiere, V. (2021). Developing a unified definition of digital transformation. *Technovation, 102*, 102217.
[4] Damiani, L., *et al.* (2018). Augmented and virtual reality applications in industrial systems: A qualitative review towards the industry 4.0 era. *IFAC-PapersOnLine, 51*(11), 624–630.
[5] Yew, A. W. W., Ong, S. K., & Nee, A. Y. C. (2016). Towards a griddable distributed manufacturing system with augmented reality interfaces. *Robotics and Computer-Integrated Manufacturing, 39*, 43–55.
[6] Sobral, J. (2018). Understanding human error in industry. *7th International Symposium on Industrial Engineering*.
[7] Fischer, C., *et al.* (2016). Enabling live data controlled manual assembly processes by worker information system and nearfield localization system. *Procedia CIRP, 55*, 242–247.
[8] Milea, A. B. (2024). Digitalization of work and its impact on worker safety and health.
[9] Smith, R. (2019, March 9). *Innovative, creative and adaptable: How to keep pace with the digital transformation*. Belgium: ILO.
[10] Castagnoli, R., Büchi, G., & Cugno, M. (2022). Evolution of industry 4.0 and international business: A systematic literature review and a research agenda. *European Management Journal, 40*(5), 572–589.
[11] Perini, M. (2015). Digital tools for learning, engagement, and research: An argument for student affairs and academic libraries. *Journal of Student Affairs, 15*(12).
[12] Wang, Y., & Chen, Y. (2021). Influence of virtual imaging technology based on html5 technology on digital painting. *Microprocessors and Microsystems, 82*, 103855.

[13] EU-OSHA. (2019). *OSH and the future of work: Benefits and risks of artificial intelligence tools in workplaces*. https://osha.europa.eu/sites/default/files/2021-11/OSH_future_of_work_artificial_intelligence.pdf
[14] EU-OSHA. (2021). *Digital platform work and occupational safety and health: A review*. https://osha.europa.eu/sites/default/files/2021-11/OSH_policies_online_platform_economy.pdf
[15] EU-OSHA. (2021b). *Occupational safety and health in digital platform work: Lessons from regulations, policies, actions and initiatives*. https://osha.europa.eu/sites/default/files/2022-02/Digital_platform_work_Review_policies_initiatives.pdf
[16] EU-OSHA. (2022). *Digital platform work and occupational safety and health: Overview of regulation, policies, practices and research*. https://osha.europa.eu/sites/default/files/2022-03/Digital_platform_work_OSH_policies_report_0.pdf
[17] International Labour Organization. (2019). *Safety and health at the heart of the future of work: Building on 100 years of experience.*
[18] UN Sustainable Development Group. (2024). *Leave no one behind*. https://unsdg.un.org/2030-agenda/universal-values/leave-no-one-behind
[19] De', R., Pandey, N., & Pal, A. (2020). Impact of digital surge during Covid-19 pandemic: A viewpoint on research and practice. *International Journal of Information Management, 55*, 102171.
[20] Eurofound. (2020). *Digitalisation and the future of work*.
[21] Sousa, V., Almeida, N. M., & Dias, L. A. (2015). Risk-based management of occupational safety and health in the construction industry–Part 2: Quantitative model. *Safety Science, 74*, 184–194.
[22] Zanko, M., & Dawson, P. (2012). Occupational health and safety management in organizations: A review. *International Journal of Management Reviews, 14*(3), 328–344.
[23] Eurofound. (2018). *Future of work and occupational safety and health*. https://www.eurofound.europa.eu/publications/report/2018/future-of-work-and-occupational-safety-and-health
[24] Bachche, P. (2023). *Digitalization and safety - A case study of a large company's digitalization*.
[25] Abbas, A., *et al.* (2019). Effectiveness of immersive virtual reality-based communication for construction projects. *Journal of Construction Engineering and Management, 145*(11), 04019063.
[26] Abbas, A., Seo, J., & Kim, M. (2020). Impact of mobile augmented reality system on cognitive behavior and performance during rebar inspection tasks. *Journal of Computing in Civil Engineering, 34*(6), 04020050.
[27] Khan, A., *et al.* (2021). Integration of BIM and immersive technologies for AEC: A systematic review. *Automation in Construction, 125*, 103640.
[28] Berg, L. P., & Vance, J. M. (2017). Industry use of virtual reality in product design and manufacturing: A survey. *Virtual Reality, 21*(1), 1–17.
[29] Aziz, F. A., Abdullah, Farooq, & Win, L. L. (2018). Using marker-based augmented reality for training in the automotive industry. *International Journal of Recent Technology and Engineering, 7*(4S), 118–121.
[30] Milgram, P., & Kishino, F. (1994). A taxonomy of mixed reality visual displays. *IEICE Transactions on Information and Systems, E77-D*(12), 1321–1329.
[31] Bejczy, A. K. (1997). Virtual reality in manufacturing. In L. M. Camarinha-Matos (Ed.), *Re-engineering for sustainable industrial production* (pp. 73–86). Springer.
[32] Abdul Rani, N., *et al.* (2020). Augmented reality: Capabilities and challenges in machining industry aligned with industry 4.0. *Advances in Materials and Processing Technologies, 6*(1), 1–9.
[33] Juraschek, M., *et al.* (2018). Mixed reality in learning factories. *Procedia Manufacturing, 23*, 153–158.
[34] Revolti, A. (2023). A human-centered conceptual model for integrating augmented reality and dynamic digital models to reduce occupational risks in industrial contexts. *Procedia Computer Science, 217*, 765–773.
[35] Siha, S. M., Lee, E. J., & Shin, Y. J. (2019). Effects of virtual reality training on occupational safety knowledge and attitude: A quasi-experimental study. *International Journal of Environmental Research and Public Health, 16*(24), 4927.
[36] Gherasim, D., & Gherasim, I. (2021). Digitalization and occupational safety and health in industry 4.0. *International Journal of Environmental Research and Public Health, 18*(6), 2966.
[37] Garg, R., Kaushik, A., & Mathur, D. (2021). Role of digitalization and virtual reality in occupational health and safety: A review. *Journal of Safety Research, 79*, 61–74.
[38] Carrier, S. I., & Moulds, L. D. (2003, November). *Pedagogy, andragogy, and cybergogy: Exploring best-practice paradigm for online teaching and learning* [Conference presentation]. 9th Annual Sloan-C/ALN Conference.
[39] Wang, M., & Kang, M. (2006). Cybergogy for engaged learning: A framework for creating learner engagement through information. In *Engaged learning with emerging technologies* (pp. 225–253). Springer.
[40] Froyd, J. E., Wankat, P. C., & Smith, K. A. (2012). Five major shifts in 100 years of engineering education. *Proceedings of the IEEE, 100*(Special Centennial Issue), 1344–1360.
[41] Haidarravy, S., *et al.* (2023). Occupational safety and health: A systematic literature review (SLR). *Journal of Occupational Safety and Health, 2*(4), 625–642.

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