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SYSTEMATIC REVIEW

Artificial intelligence tools for safety and health systems at work

Herramientas de la inteligencia artificial para los sistemas de seguridad y salud en el trabajo

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ABSTRACT

A systematic review of the literature was carried out, key technologies such as machine learning, computer vision, wearable devices and intelligent monitoring systems are identified. These tools are applied in accident prevention, continuous monitoring of workers' health, automation of surveillance and improvement of safety training. The implementation of predictive AI makes it possible to identify risks and prevent accidents, reducing the incident rate and improving safety. Wearable devices and biometric sensors are effective in the early detection of occupational diseases and musculoskeletal disorders. Additionally, automating surveillance with computer vision optimizes compliance with safety standards, such as the use of personal protective equipment (PPE), easing the operational burden on security managers. Despite its benefits, the implementation faces ethical and technical challenges, such as data privacy, algorithm transparency, and worker training. The need to develop clear regulations and an ethical approach in the adoption of AI is highlighted. In conclusion, AI tools have great potential to transform occupational health and safety systems, but it is essential to address ethical challenges and technicians to guarantee its responsible and effective implementation.

Keywords: Artificial Intelligence; Occupational Health; Industrial Safety; Management System.

RESUMEN

Se realizó una revisión sistemática de la literatura, se identifican tecnologías clave como el aprendizaje automático, la visión artificial, los dispositivos wearables y los sistemas de monitoreo inteligente. Estas herramientas se aplican en la prevención de accidentes, el monitoreo continuo de la salud de los trabajadores, la automatización de la vigilancia y la mejora de la formación en seguridad. La implementación de IA predictiva permite identificar riesgos y prevenir accidentes, reduciendo la tasa de incidentes y mejorando la seguridad. Los dispositivos wearables y sensores biométricos son efectivos en la detección temprana de enfermedades ocupacionales y trastornos musculoesqueléticos. Además, la automatización de la vigilancia con visión artificial optimiza el cumplimiento de normas de seguridad, como el uso de equipos de protección personal (EPP), aliviando la carga operativa de los gestores de seguridad. A pesar de sus beneficios, la implementación enfrenta desafíos éticos y técnicos, como la privacidad de los datos, la transparencia de los

algoritmos y la capacitación de los trabajadores. Se destaca la necesidad de desarrollar normativas claras y un enfoque ético en la adopción de la IA. En conclusión, las herramientas de IA tienen un gran potencial para transformar los sistemas de seguridad y salud en el trabajo, pero es esencial abordar los desafíos éticos y técnicos para garantizar su implementación responsable y efectiva.

Palabras clave: Inteligencia Artificial; Salud Laboral; Seguridad Industrial; Sistema de Gestión.

INTRODUCTION

Artificial Intelligence (AI) has emerged as one of the most powerful tools for transforming various sectors, and the field of occupational health and safety is no exception (Jarota, 2023; Granados, 2022). Through technologies such as machine learning, computer vision, and smart devices, AI provides innovative solutions for occupational risk management and worker protection (Macías, 2022; Vallejo et al., 2022; Pishgar et al., 2021). According to Asto et al. (2024), the ability of AI to process large volumes of data in real time and learn from it has proven to be fundamental in creating predictive systems for the prevention of workplace accidents.

Occupational safety has always been a priority issue in various industries due to the inherent risks of work activities. However, despite advances in regulations and protocols, workplace accidents remain a significant concern (Habli et al., 2020). According to Riquelme and Pereira (2024), traditional monitoring and prevention technologies have limitations in predicting accidents and optimizing risk management. This is where AI plays a crucial role, as it enables the analysis of complex patterns and the early identification of risks that would otherwise go unnoticed.

On the other hand, occupational health has been an area that has received increasing attention due to the adverse effects of working conditions on the health of employees (Constantin et al., 2024; García, 2022; Ross & Spates, 2020). Stress, musculoskeletal disorders, and illnesses related to exposure to hazardous substances are just some problems affecting workers worldwide (Ávila, 2024; Ellahham et al., 2020). Cadillo (2023) highlights that AI tools, such as wearables, enable continuous monitoring of employees' health conditions, facilitating the early detection of problems and the implementation of preventive measures. These advances contribute to reducing occupational illnesses and improving the overall well-being of workers.

The use of AI in scenario simulation and automation of surveillance has also revolutionized safety training and real-time supervision. Machine vision technologies and remote monitoring systems allow instantaneously identifying safety violations and dangerous behavior (Abella, 2024; El-Helaly, 2024; Shah & Mishra, 2024). According to Espada (2024) and Espitia et al. (2020), these technologies improve supervision and allow for immediate interventions that minimize the risk of serious accidents. In addition, predictive simulations and training in virtual environments offer a more dynamic and realistic approach to employee training in emergencies.

In this context, this article aims to analyze the main AI tools used in occupational health and safety systems, evaluate their impact on improving working conditions, and explore their potential for creating safer and healthier work environments. The article will discuss the current applications of AI in accident prevention, health monitoring, surveillance automation, and improved employee training. In addition, the ethical and technical challenges faced by implementing these tools in work environments will be addressed, as suggested by Viña (2024), who highlights the need for clear regulations and an ethical approach to implementing AI in the workplace.

METHOD

A systematic literature review was carried out to identify and analyze the leading Artificial Intelligence (AI) tools applied in occupational health and safety systems. The review focused on articles, technical reports, and case studies published between 2014 and 2024 to identify the most relevant technologies in the field and their current applications.

Regarding the analysis of the impacts of AI on occupational safety, a qualitative approach was used to evaluate the applications of tools such as machine learning, artificial vision, and intelligent monitoring systems in the prevention of occupational accidents. This methodology allows us to understand how these technologies can improve risk identification and facilitate early intervention in dangerous situations. Area-Moreira et al. (2024) emphasize that this type of qualitative analysis is fundamental for evaluating the practical impact of AI, as it allows us to identify patterns of effectiveness in applying these technologies in the workplace.

To evaluate the improvement in working conditions, a quantitative approach was used based on the analysis of data from previous studies that report metrics on the reduction of accidents and occupational illnesses after the implementation of AI tools. The analysis included variables such as the reduction of the accident rate, improvements in workers' health, and the effectiveness of safety training programs.

Regarding monitoring workers' health, the implementation of wearable devices and biometric sensors equipped with AI was analyzed, allowing the monitoring of health parameters in real time. Information was collected on the use of these devices in different industrial sectors and their relationship with the early detection of occupational diseases, such as musculoskeletal disorders and work-related stress. This analysis was based on studies like that of Caro-Delgado et al. (2020), who found that personal monitoring devices significantly reduce occupational diseases through early intervention based on biometric data.

The methodology also focused on the automation of surveillance. It explored applications of machine vision systems for real-time monitoring of compliance with safety regulations, such as using personal protective equipment (PPE). It also carried out comparative analyses of case studies in which these technologies were implemented in high-risk industries. Tropiano and Noguera (2024) argue that the automation of surveillance improves safety at work and optimizes supervision processes, reducing the operational burden on occupational safety managers.

Finally, the ethical and technical challenges faced by implementing AI tools in the workplace were addressed. To this end, studies were reviewed that analyze concerns related to data privacy, algorithm transparency, and worker training in using these technologies. In line with the proposals of Gallent-Torres et al. (2024), the study highlights the importance of developing clear regulations and an ethical approach to ensure that the adoption of AI in occupational health and safety is responsible and beneficial for all involved.

RESULTS AND DISCUSSION

One of the key findings of the analysis is the use of predictive AI tools to improve workplace safety. A review of the selected studies revealed that machine learning and computer vision are essential technologies for the early identification of risks and the prevention of accidents in the workplace (Fisher et al., 2023). The use of these systems makes it possible to detect patterns in historical and real-time data that indicate high-risk situations, such as worker fatigue, exposure to hazardous substances, or unsafe behavior. According to Viña (2024) and Market al. (2022), qualitative analysis of these systems highlights the effectiveness of AI in proactive intervention in the face of potential accidents, significantly improving safety.

Furthermore, real-time monitoring through smart sensors and wearable devices has proven to be an effective tool for the early detection of health-related risk factors (Ispășoiu et al., 2024). These devices make it possible to monitor physiological indicators such as heart rate, body temperature, and level of exertion, which facilitates intervention in case a worker finds themselves in a potentially dangerous situation. The studies by Ullauri et al. (2024) and Howard (2019) confirm that implementing these systems has reduced the number of accidents and improved emergency response, optimizing employee safety. Table 1 shows an extract from Technologies related to artificial intelligence.

Table 1. List of AI technologies

AI technology	Application in Occupational Safety	Observed Impact
Machine Learning	Predicting occupational hazards based on historical and real-time data	Reduction of workplace accidents through proactive interventions (del Toro & Alfonso, 2023)
Artificial Vision	Monitoring employee behavior in real time	Improvement in the identification of unsafe behavior (Rosa et al., 2024)
Wearable devices	Continuous monitoring of workers' health	Early detection of health problems, which reduces occupational illnesses (Pérez et al., 2022)

The quantitative analysis of the studies reviewed provides clear evidence of AI's positive impact on improving working conditions. Implementing tools such as machine learning has made it possible to identify patterns in worker behavior and working conditions, facilitating the improvement of work processes and the reduction of accidents (Lee et al., 2020; Macrae, 2019). According to Jiménez (2021), AI-based systems have proven effective in accident prevention and optimizing overall working conditions, improving ergonomics, and reducing employee fatigue.

The automation of surveillance has also had a considerable impact. The use of artificial vision systems makes it possible to monitor compliance with safety regulations, such as the use of personal protective equipment (PPE), in real-time (Niehaus et al., 2022). This automation reduces the operational burden on supervisors, allowing immediate intervention if workers fail to comply with safety regulations. Mosquera et al. (2018) state that this technology not only improves safety but also contributes to the operational efficiency of organizations.

Although AI tools offer great benefits, they also present several ethical and technical challenges that must

be addressed to ensure their effective and responsible implementation in the workplace (Silić & Palačić, 2024). One of the main challenges identified is data privacy management, especially in the context of wearable devices that collect personal data on workers' health (Conica et al., 2024). As Bolívar and Hinojosa (2023) point out, it is essential to establish clear regulations for the protection of sensitive information and to guarantee transparency in the use of this data.

Another important challenge is training employees in the use of AI tools. Adopting these technologies requires adequate training to ensure workers understand how to use AI devices and systems effectively (Koutroumpinas et al., 2021). A lack of training can lead to resistance or errors in implementation, which could counteract the potential benefits of the technology. Herrera (2021) suggests that specific training programs should be developed that address both the technical and ethical aspects of AI in the workplace.

CONCLUSION

In short, AI tools have great potential to transform occupational health and safety systems, improve accident prevention, optimize worker health monitoring, and automate surveillance processes. However, for these benefits to be fully realized, addressing the ethical and technical challenges associated with their implementation is crucial. The protection of personal data, transparency in the use of algorithms, and adequate worker training are key aspects to guarantee a successful adoption of AI in the work environment.

As AI technologies evolve, their impact on occupational health and safety is expected to grow, offering new solutions to traditional occupational safety problems. However, to maximize these benefits, a comprehensive approach combining technological innovation with ethical and responsible management will be needed.

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