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THE FUTURE OF OCCUPATIONAL HEALTH AND SAFETY: BIBLIOMETRIC ANALYSIS & NARATIVE REVIEW OF AI IMPLEMENTATION IN INDUSTRY 5.0

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ABSTRACT

The research studied how Artificial Intelligence (AI) is applied to Occupational Health and Safety (OHS) during the industry 5.0 period. Through a bibliometric method and complemented with a narrative review, this study systematically investigates the existing literature with a focus on trends, challenges, and opportunities brought about by the implementation of AI in workplace safety. Based on analysis of 383 publications released from well-renowned journals covering previous 5 years time frame, it was concluded that AI is pivotal in enhancing all industrial sectors' safety mechanisms. The findings indicate that AI technology can significantly enhance the safety of work environments and can lead to better health outcomes through predictive analysis and continuous monitoring. Even so, the study also uncovered major gaps, particularly regarding fair access to the benefits of AI society-wide and by industry sector. The findings of this study highlight the potential for AI to enhance OSH but recognise an urgent need for cross-disciplinary research in this field to fill the identified gaps and confirm an inclusive approach. These findings make an important contribution to the ongoing discussion on AI in OSH, as well as providing valuable insights for researchers, policymakers, and industry practitioners seeking to create a safer and more sustainable work environment.

Keywords: Artificial Intelligence, Occupational Health and Safety, Industry 5.0.

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Penelitian ini mempelajari bagaimana Kecerdasan Buatan (Artificial Intelligence/AI) diterapkan pada Kesehatan dan Keselamatan Kerja (K3) selama periode industri 5.0. Melalui metode bibliometrik dan dilengkapi dengan tinjauan naratif, penelitian ini secara sistematis menyelidiki literatur yang ada dengan fokus pada tren, tantangan, dan peluang yang ditimbulkan oleh penerapan AI dalam keselamatan di tempat kerja. Berdasarkan analisis terhadap 383 publikasi yang dirilis dari jurnal-jurnal ternama yang mencakup jangka waktu 5 tahun terakhir, disimpulkan bahwa AI sangat penting dalam meningkatkan mekanisme keselamatan di semua sektor industri. Temuan ini menunjukkan bahwa teknologi AI dapat secara signifikan meningkatkan keamanan lingkungan kerja dan dapat menghasilkan hasil kesehatan yang lebih baik melalui analisis prediktif dan pemantauan berkelanjutan. Meski begitu, studi ini juga menemukan kesenjangan besar, terutama terkait akses yang adil terhadap manfaat AI di seluruh masyarakat dan sektor industri. Temuan penelitian ini menyoroti potensi AI untuk meningkatkan K3, tetapi mengakui adanya kebutuhan mendesak untuk penelitian lintas disiplin ilmu di bidang ini untuk mengisi kesenjangan yang teridentifikasi dan mengkonfirmasi pendekatan yang inklusif. Temuan ini memberikan kontribusi penting untuk diskusi yang sedang berlangsung tentang AI dalam K3, serta memberikan wawasan yang berharga bagi para peneliti, pembuat kebijakan, dan praktisi industri yang ingin menciptakan lingkungan kerja yang lebih aman dan berkelanjutan.

Kata Kunci: Kecerdasan Buatan, Kesehatan dan Keselamatan Kerja, Industri 5.0.

1. INTRODUCTION

Against the backdrop of non-stop digital transformation, the industry is shifting from Industry 4.0 to Industry 5.0 evolution in Industry 4.0, focused on creating the ideal partnership between humans and smart machines. At the heart of this revolution is changing the OHS paradigms, which becomes less a matter of traditional policies and more a matter of advanced technologies such as Artificial Intelligence (AI) [1]. This is because the background consists of the high incidence of work accidents and health risks in the implementation of OSH standards. AI as a risk prediction tool, real-time monitoring, and operational decision support are penetrating to transform the OSH management system to modernise with surrounding environment. The interconnectedness of AI with these forces is still developing and imperfect a situation rife with complexities that stretch from ethics to the capacity of technical infrastructure. Thus, deep study of a responsive and sustainable AI operationalization strategy in the Industry 5.0 workplace is necessary to maintain harmony between innovation and worker protection [2]. Such changes can bring a lot of productivity but also create a forward-looking OSH system capable of adapting to the work environment.

It is a serious global public health issue, as an estimated 2.78 million workers die from work-related accidents or illnesses each year. Meanwhile, approximately 374 million people suffer non-fatal work accidents each year leaving permanent or temporary disability and loss of income. Other factors that contribute to these incidents also creates a huge economic burden, not only to the workers and their families, but also decreases overall productivity and increases companies's operational costs and the health care system [3]. Such data underscores the need for innovation in occupational safety practices. According to [4], using artificial intelligence (AI) can improve on productivity by 40 percent or more by reducing human error in operational decision making. These technologies are trained on data until 10.2023. The use of AI technology can greatly assist in the prevention of labor risks by identifying possible dangers, predicting accidents, and monitoring the state of workers in real-time. Several international firms have now successfully employed AI to process sensor data and video footage to drastically decrease the accident rate. Nevertheless, this technology is still not uniformly adopted, particularly in developing countries, and there is a lack of academic evidence on how effective or challenging it is to incorporate AI into work safety.

Predictive capabilities, real-time health and safety monitoring systems, and development of strategies to reduce OSH risks have introduced a paradigm shift in the OSH field by Artificial Intelligence (AI). It reduces accident prevalence on site and encourages more proactive hazard control [5]. Incorporating AI into critical safety systems, such as a Bayesian network and a deep neural network has proven to help secure industrial sectors [6]. The use of AI in OSH is an industry characteristic. This technology is used in developing any sensors to detect potential hazards. On the other hand, the construction sector is focused on detecting hazardous events, and the agriculture industry applies AI in combination with actuators and sensors for moving workers out of the dangerous zone [7].

The variety in implementation demonstrates how AI can be customized to address particular OSH challenges. While this has been beneficial, it has also led to the unequal distribution of advantages when it comes to AI. While AI use is promising for OSH, it is far from being evenly distributed across the different levels within our societies, economic sectors as well as geographical regions, potentially exacerbating social inequalities. Hence it requires collective interdisciplinary study to establish equitable access for the benefits

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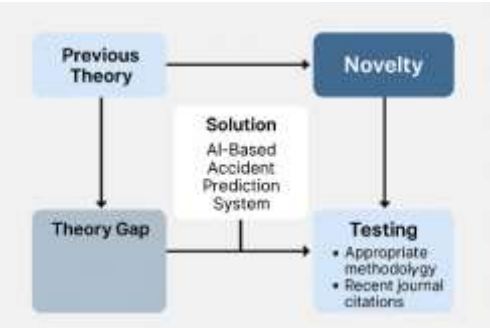
while tackling the gap in its technology implementation [8]. OSH is a field that will cause great development in AI in the future, developing innovative research and solutions to circumvent current barriers. There should be a better perception of the beneficial (and complex) role of AI in OSH to be able to optimise the protection of workers [7]. Also, the appropriate selection of machine learning methods for OSH issues can increase the viability of this technology [9]. As AI technology continues to advance, its contribution to a safer and more sustainable work environment is predicted to become increasingly vital.

Table 1. Table of Research Gaps

No	Author(s)	Weakness	Description
1	[5]	Lack of in-depth quantitative analysis of the available data.	They do not use bibliomteric narative review methods in their studies
2	[7]	Limited to articles published in English and in the Scopus database.	
3	[10]	Limited to specific sectors and does not cover all AI applications in OSH.	
4	[9]	No specific data on the weaknesses of machine learning methods in occupational safety and health.	

The analysis in Table 1: Table of Research Gaps shows that only a few studies existed on the relationship between AI and OSH, and that these were methodologically weak and had significant limitations in the approaches used. For instance, although [5] study is a systematic review on barriers to the use of AI in OSH, it neither includes a bibliometric review or a thorough quantitative examination of the literature, so their conclusions are weakly based on a robust empirical database. Conversely, [7] restrict their review of the literature to English-language articles available in the Scopus database, failing to consider studies published in other languages or relevant alternative data sources. On the other hand, [10] are limited by targeting a precise industrial section and thus do not provide a comprehensive overview of the use of AI in OHS throughout sectors. In addition, [9] do not certainly criticise the technical limitations of machine learning processes below the context of occupational safety, an issue of average significance within the Industry five.0 generation. Hence, this study aims to fill such gaps by offering a more nuanced and multidimensional bibliometric and narrative.

This research serves as a systematic response to the fragmentation of understanding and theoretical gaps in the current literature on AI-based OSH. Although much research explores AI applications, holistic syntheses to map the development of this field and uncover uncharted areas are still limited. To address this, a bibliometric approach was introduced as an innovative method to evaluate and visualise the AI research landscape in OSH in a structured manner. As seen in the framework diagram, the process starts from the analysis of existing theory, which is then broken down to identify research gaps, especially the lack of a comprehensive understanding of the equitable implementation of AI and methodological inconsistencies. The proposed solution, as depicted in the core part of the diagram, is the development of an *AI-based Accident Prediction System*, which is a research breakthrough by filling knowledge gaps while expanding on previous findings. The framework then moves into the validation phase, where the solution is tested using a rigorous methodology and supported by references from current leading publications. This integrative flow from gap identification, solution innovation, to empirical testing confirms the contribution of the research and the significance of bibliometric analysis in clarifying the direction of AI application development for OSH in the future.



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Image 1. Framework Diagram

The core objective of this study is to critically examine the integration of Artificial Intelligence (AI) in Occupational Safety and Health (OSH) in the Industry 5.0 era through a narrative and bibliometric approach. This study is designed to map the latest trends, key actors, and research networks related to the utilisation of AI in OSH, while identifying research gaps and opportunities for future development. By combining literature synthesis and bibliometric analysis, this research provides a holistic understanding of the contribution of AI in creating a human-oriented, adaptive, and sustainable work environment. The research contribution covers two main aspects. First, it presents a structured review of the academic development of AI in OHS, making it easier for stakeholders to assess the direction and maturity of existing studies. Second, it presents strategic recommendations for academics, regulators, and industry players by revealing areas that have been under-explored, such as improving worker safety, risk prediction, and proactive risk management in accordance with Industry 5.0 principles. Thus, this research not only enriches academic discussions but also encourages practical innovation in global OSH systems.

2. LITERATURE REVIEW

The interaction between AI and OSH is increasingly crucial in improving workplace safety and hazard anticipation. As the work environment becomes more digitalised, AI-based systems open up opportunities for real-time monitoring and proactive risk mitigation. This literature review outlines the basic concepts, historical evolution, and weaknesses in the application of AI for OSH. While the ability for machine learning and predictive analytics to estimate risk through a variety of studies has been established, the nature of its implementation across industries suggests the methodology and purposes have a wide range of variances that could question its matter of effectiveness. By reviewing recent publications, this chapter underlines the gap in theory and empirical evidence prompting the implementation of artificial intelligence-based accident prediction systems as a novel solution to enhance workplace safety standards.

Table 2. Basic Concept Table

Concept	Brief Explanation	Main References
Artificial Intelligence (AI)	Computer systems capable of mimicking human intelligence to perform tasks such as learning, reasoning, and decision-making.	[11], [12], [13]
Occupational Health and Safety (OHS)	A set of policies and procedures to protect the health and safety of workers in the workplace.	[5], [14], [15]
AI in OHS	The use of AI to identify risks, predict accidents, and enhance workplace safety systems.	[5], [16], [17]
Machine Learning	A branch of AI that enables systems to learn from historical data to make predictions.	[13], [18], [19]
Predictive Analytics	Techniques for analyzing past data to predict future events, including workplace accidents.	[19], [20], [21]

Artificial Intelligence (AI) has not only penetrated but also transformed industries in the way businesses confront complex problems, such as in Occupational Health and Safety (OHS). AI, referring to computer systems that imitate human cognition by learning, thinking, and solving problems [11], [13] creates opportunities for preventive safety management. AI plays a role in OHS, which consists of organized efforts to guarantee employees' health and safety (El Bouchikhi et al., 2024; Shah & Mishra, 2024), assisting to foster safer and more responsive workplace conditions. For example, the use of ai-enabled tools in organizational health and safety settings include potential risk identification, workplace accident prediction, and general safety mechanism enhancement (De Micco et al., 2025; Yang et al., 2024). In this area, Machine Learning acts as a facilitator, as it allows systems to examine past information, detect patterns, and make applicable predictions regarding workplace risks [19]. Building on this is Predictive Analytics that offers data-driven predictions to anticipate possible safety incidents in order to improve future prevention activities [19], [21]. Collectively, they create a robust architecture for not only reconsidering the nature of safety in contemporary workplaces but also for informing new models such as AI-enabled predictive systems, with the potential to revolutionize OHS in both theory and practice.

AI adoption across multiple sectors has significantly altered organizational approaches to address convoluted issues also in the domain of Occupational Health and Safety (OHS). Artificial Intelligence (AI), which is a computing system that mimics human like intelligence through machine learning, reasoning and decision making [11], [13], bring new opportunities for anticipation-based safety management. In OSH, referring to systematic endeavors to protect the life and health of workers (El Bouchikhi et al., 2024; Shah & Mishra,

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2024), AI plays an important role in the implementation of a more reactive and secure workspace. AI has been applied to OSH in areas such as detecting potential risks, forecasting of work accidents, and optimizing safety protection mechanisms (De Micco et al., 2025; Yang et al., 2024). This is where Machine Learning has become extremely important as it allows analyzing past data, recognizing patterns, and even predicting risks and hazards that allow it to materialize in the workplace [19]. This is complemented by Predictive Analysis, which uses data to generate predictions that can help anticipate safety incidents in the future, and improve prevention practices [19], [21]. The combination of these ideas creates a unique structure and is the basis for safety management reform in the current modern workplaces and the development of AI-based prediction systems increasing the theoretical and practical aspect of OSH.

Table 3. Historical Development Table of AI in OHS

Year	Key Developments	References
2015	The beginning of utilizing sensor data for monitoring workplace safety.	[22]
2018	Implementation of Machine Learning for predicting accidents based on historical workplace accident data.	[23]
2020	Integration of AI with IoT (Internet of Things) for real-time risk detection in the workplace.	[24]
2021	Increased adoption of AI in the construction and manufacturing industries for automating safety systems.	[7]
2023	Emphasis on issues of AI distribution fairness in workplace safety, as well as the need for multidisciplinary research.	[8]

The use of AI in Occupational Health and Safety (OHS) is an ongoing story, where the integration of technology in workplace safety systems has been progressive. In 2015, the journey started using sensor data to keeping track of safety conditions, which initiates the evolution of data-driven safety management [22]. The focus of this first phase was to collect real-time data from the work environment, so that the immediate risk could be determined. Come 2018, Machine Learning had evolved to offer predictive models capable of interrogating historical, time-stamped accident data to identify patterns and predict potential crashes, an indication of a shift from passive to active safety [23]. This also increased the capacity of organizations to detect threats ahead of the event. The most impactful transition which changed the entire risk management scenario came in 2020, with the interconnection of Artificial Intelligence and Internet of Things (IoT) [24], enabling the real-time detection and response to risk in interconnected workplace systems. This lush innovation delivered enhanced accuracy and aspect to safety surveillance. Especially in sectors where there is a high risk, such as construction and manufacturing, businesses increasingly adopted artificial intelligence in their practices in 2021, with automated safety systems becoming more prevalent [7]. In 2023, researchers started responding to equity concerns, as they noted that the advantages of AI in OHS should be distributed to all beneficiaries and backed by multidisciplinary research endeavors [8].

As with any new technology, AI is slowly making its appearance in Occupational Health and Safety (OHS) practices. The first stage since 2015 is the stage of safety monitoring based on sensor data [22], which is generally considered as the foundation of data-based management. This stage concerns "real time" data collection for direct risk identification. In 2018, with the help of Machine Learning, predictive models were developed for checking the accident history and estimating possible accidents known as predictive models [23] which changes the safety approach from the reactive approach to the proactive approach. This marked a pivotal year of 2020, in terms of the incorporation of AI and the Internet of Things (IoT), which allows the detection of risk and real-time response within connected work systems [24]. This novelty enhances the accuracy and efficiency of safety monitoring. AI adoption is growing in high-risk sectors, such as construction and manufacturing, where automated safety systems are increasingly prevalent [7]. From October 2023, research topics evolve to focus on Equality, placing emphasis on the fair distribution of AI benefits, and the need for multidisciplinary research support [8].

3Table 4. Identification of Theory Gap

No	Authors & Year	Theory/Concept	Methodology	Results	Strengths	Weaknesses
1	[7]	REDECA Framework	Review of 260 AI papers across five sectors using the REDECA framework	Identified unique attributes and research focus in oil/gas, mining,	Highlights strengths and opportunities for AI in OSH across various industries.	Limited understanding of AI's role in OSH; gaps in research identified.

No	Authors & Year	Theory/Concept	Methodology	Results	Strengths	Weaknesses
				transportation, construction, and agriculture sectors.		
2	[9]	Machine Learning in OSH	Systematic review protocol using PRISMA guidelines	Aims to identify ML methods in OSH and their effectiveness in various occupational settings.	Comprehensive approach to identifying ML applications in OSH; addresses research gaps.	Excludes non-English publications; may miss relevant studies in other languages.
3	[10]	AI and Cloud Computing in CI	Bibliometric and systematic review approach	Identified research hotspots, gaps, and future directions in AI applications in cloud computing in construction.	Provides valuable insights for researchers and practitioners in the construction industry.	Limited to articles published in Scopus; may not cover all relevant literature.
4	[5]	AI in Occupational Health and Safety	Literature review of AI-driven technologies in occupational health	AI technologies are reshaping workplace safety, offering predictive insights and risk mitigation strategies.	Highlights the transformative potential of AI in improving workplace safety and health.	Lacks systematic summarization of AI applications; may not cover all occupational diseases.

Existing research on AI implementation in OHS remains a work in progress. For instance, REDECA framework that explores AI in five sectors, does not offer a detailed exploration about operational aspects of AI in OHS [7]. Meanwhile, [9] performed a systematic review of machine learning in OHS using PRISMA guidelines, but neglected nonEnglish literature which could introduce some other unique contexts. [10] target the AI in construction with Scopus data in their bibliometric analysis, which is an underestimation of the literature. Shah & Mishra (2024) review the margins of access to AI in occupational safety without placing structured or for that matter classified applications. In this regard, the paper employs narrative reviewthe best available method to build conceptual models of emergent subjects [25] with quantitative bibliometric analysis [26] to map research patterns, theme clusters, and knowledge gaps. The integration of these approaches provides the foundation for an AI-Driven predictive framework for the achievement of theorized research gaps.

3. METODOLOGI PENELITIAN

Our study aims to combine bibliometric analysis that maps the scientific literature development on Artificial Intelligence (AI) applications in Occupational Health and Safety (OHS) and a systematic narrative review. The mixed approach seeks a comprehensive identification of trends, challenges and development opportunities, while deepening the interpretation of academic contents. A query retrieval was conducted on data on Scopus database with limiting publication time as the last 5 years (years 2021–2025). Accredited journals describing AI implementation in OSH were prioritized, to guarantee validity, sustainability, and depiction of frontier advancements in this domain. The literature search was carried out by entering combinations of keywords, including but not limited to ‘Artificial Intelligence in occupational safety’, AI-driven workplace health systems’, and words associated with Industry 5.0 on ScienceDirect. This strategy aimed to gather articles covering AI technologies in enhancing OSH systems in the digital era. The literature selection was carried out in two stages:

p-ISSN : 2808-909X e-ISSN : 2798-2505

1. Initial Screening: Two researchers independently evaluate the relevance of articles based on the title and abstract.
2. In-depth Evaluation: Articles that pass the first stage are assessed for quality by reading the full text, with criteria focusing on AI in OSH and a clear methodology. Low-quality or off-topic publications are excluded, so that only studies that meet academic standards are included.

Selected data is extracted focusing on key variables such as research objectives, AI algorithm types, main results, and study limitations. Thematic analysis is then applied to uncover thematic patterns, research gaps, and dominant trends. A comparative matrix is used to group articles based on method, contribution, and theme, resulting in a holistic mapping of the AI in OHS research landscape. This research utilises two main tools:

1. Mendeley: For reference management and automatic citations to ensure consistency of academic format.
2. VOSviewer: For bibliometric analysis and visualisation, including mapping of author collaboration networks, keyword distribution, and research topic concentration. This tool facilitates the identification of research clusters and global collaboration patterns.
3. The combination of these tools enables the execution of systematic, accurate, and informative research, as well as supporting the visualisation of the dynamics of AI development in OSH graphically.

4. HASIL DAN PEMBAHASAN

4.1 Results

The development of research in the field of Occupational Health and Safety (OHS) integrated with Artificial Intelligence (AI) within the framework of Industry 5.0 has shown a growth trend over the past decade. Based on the data presented in Table 1, scientific publications addressing this topic began to increase significantly starting in 2019. The highest growth occurred in 2022, with 6 publications, accounting for 23.08% of the total reviewed studies. This surge indicates a growing awareness among researchers of the importance of AI implementation in creating safer, more adaptive, and human-centered work environments in the industry 5.0 era. Other notable years include 2023, with 5 publications (19.23%), and 2021, with 4 publications (15.38%). Although 2020 and 2019 each recorded only 3 publications (11.54%), these years mark the initial momentum of the topic's rise in academic interest. Overall, the trend reflects that the integration of AI into OHS systems is no longer a concept of the distant future—it is becoming a central focus of contemporary scholarly discourse, in line with the industrial shift toward smarter and more sustainable operations.

Table 5. Table of Research Years

Year	Total	Percentage (%)
2021	65	6.98%
2022	99	10.63%
2023	147	15.79%
2024	383	41.14%
2025	237	25.46%

To understand the thematic focus of the research in greater depth, it is important to analyse the specific domain that explores the application of AI-based Occupational Health and Safety (OHS) in the context of Industry 5.0. The results of the domain analysis show that the integration of Artificial Intelligence in OHS covers a variety of interdisciplinary fields. Based on Table 5, the *engineering science* domain is the most dominant with a contribution of 7 articles (26.92% of the total studies), indicating that AI innovation in safety systems is largely driven by applied technological breakthroughs. This is followed by the *computer science* domain with 5 studies (19.23%), which represents the technical foundation in the development of AI algorithms and data processing in the work environment. Other domains such as *Environmental Science* and *Social* Science each accounted for 3 studies (11.54%), emphasising the increased attention to the aspects of sustainability, human factors, and social implications of AI adoption. These findings reinforce the multidisciplinary nature of AI-based OSH research while emphasising the urgency of collaboration across academic domains to address the complexity of challenges in the Industry 5.0 era.

Table 6. Table of Research Domains

Subject Area	Jumlah	Persentase (%)
Medicine and Dentistry	220	23.63%

p-ISSN : 2808-909X e-ISSN : 2798-2505

Engineering	153	16.43%
Environmental Science	120	12.89%
Social Sciences	102	10.96%
Computer Science	87	9.34%
Decision Sciences	56	6.01%
Business, Management and Accounting	53	5.69%
Energy	53	5.69%
Biochemistry, Genetics and Molecular Biology	44	4.73%
Nursing and Health Professions	43	4.62%

The analysis of the authors' collaboration structure, as visualised in Figure 6, provides an in-depth review of the research collaboration network in the application of AI for Occupational Health and Safety (OHS) in Industry 5.0. This visualisation reveals that Soeteman-Hernandez, Iya G. emerges as the most centrally connected researcher, with a dominant name in the collaboration network. His central position reflects a key role in influencing academic discourse and building cross-institutional collaboration. The size and location of his author's nodes indicate high publication productivity and collaboration intensity, which are indicators of academic influence and active participation in team-based research. Its presence in several thematic clusters indicates that its work is not limited to one subfield but rather bridges areas such as AI-based safety systems and health risk prediction models. This connectivity pattern confirms its role as an integrator that unites previously separate research clusters, strengthening cross-disciplinary synergies in the field of AI-based OSH.

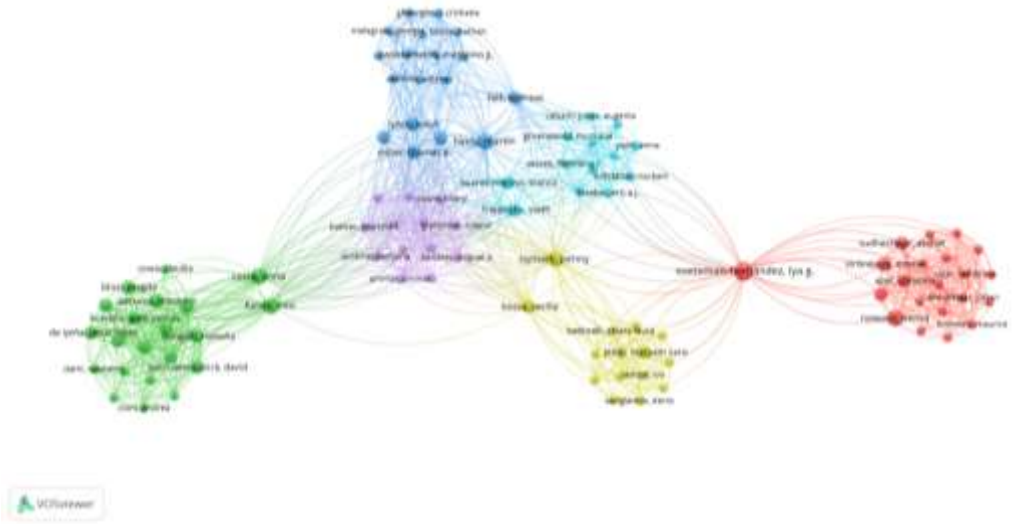


Image 2. Author Mapping

The dominance of Soeteman-Hernandez, Iya G. in mapping collaborations of authors not only highlights their academic productivity but also underlines the urgency of planned research collaborations in this field. Network visualisation shows that authors collaborating with Soeteman-Hernandez tend to form close and interrelated networks, which facilitate the exchange of insights and encourage the acceleration of innovation. This pattern of writing collaboration reflects the latest trend in modern research, where academic impact is often enhanced through strategic partnerships between researchers. However, the overall collaboration network is still limited, with many authors belonging to isolated or loosely connected groups. This indicates that although some researchers play a key role, the field in general still requires more comprehensive collaboration. Expanding the scope of collaboration across geographical boundaries and disciplines, especially by involving less affected institutions, can increase the inclusiveness and effectiveness of the application of AI-based solutions for work safety. Along with the Industry 5.0 transformation, the role of researchers with extensive networks such as Soeteman-Hernandez is crucial in uniting and promoting the global research agenda. Their presence not only strengthens the integration of knowledge across disciplines but also acts as a catalyst for the creation of a more collaborative and sustainable research ecosystem.

Based on Figure 2, the visualisation of keyword mapping reveals the core themes that dominate the academic discourse related to the application of Artificial Intelligence (AI) in the field of Occupational Health and

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Safety (OHS) in the era of Industry 5.0. The word ‘artificial intelligence’ appears as a central term, marking its position as a foundation in the innovation of occupational safety systems. Its dominance is symptomatic of the change that artificial intelligence introduces through predictive analytics, real-time monitoring and autonomous systems to minimize risk. The term ‘machine learning’ also stands out, suggesting that a lot of works concentrate on developing algorithmic models that can learn from field data to establish potential hazards or prevent worksite accidents. The relationship of the two terms in various literature is quite "close", which leads to research that is not only theoretical, but highlights the applicative aspect more. This highlights that AI can concretely solve the issue of making the workplace more effective and safer, not merely an abstract idea.

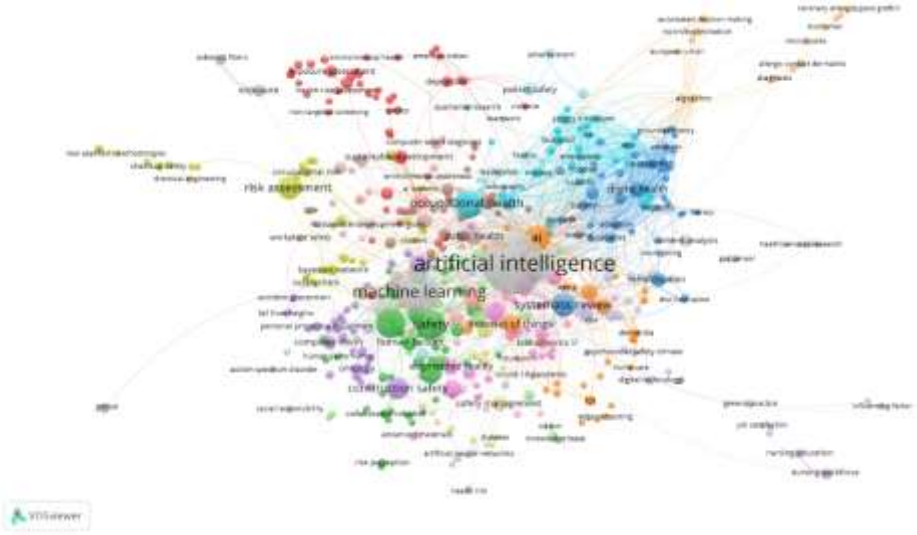


Image 3. Keyword Mapping

We can also see in the keyword mapping analysis, besides the main theme surrounding AI, a few essential areas where we can apply it: "safety", "construction safety", "occupational health". The presence of these keywords suggests a research interest in higher risk industries, where the expectation is that AI adoption will generate tangible and quantifiable solutions. The usage of the term “construction safety” shows the importance and emphasising on avoiding injuries and utilising the project site using digital intelligence-based technology. Conversely, “occupational health” emphasizes a holistic view of worker welfare, including not just physical safety, but mental health and ergonomic modifications to the workplace as well. And the popular keyword “Internet of Things (IoT)” above just underlines how device connectivity is changing the modern safety landscape. IoT provides the underlying infrastructure for data collection, cross-device collaboration, and real-time feedback that refine the decisions made by AI. This practical cooperation pattern in all forms represents the synergy between smart and connected technologies, as well as human-oriented safety principles. This further strengthens AI and IoT as the backbone of innovation in creating work protection standards based on industry 5.0 such that technological efficiency does not conflict with the sustainability of human resources.

4.2 Discussion

Basic Concepts of AI in OHS

Through its implementation, AI has revolutionized OSH with regards to risk assessment, monitoring, and compliance across multiple industrial sectors. Real-time hazards detection and response involve technologies like visual recognition, sensor networks, and machine learning algorithms [27]. Using this application, businesses can detect possible risks sooner and act to prevent it. For instance, AI-based systems can monitor the work environment and identify hazardous conditions before they lead to incidents, allowing for a reduction in accidents [28]. Therefore AI helps in creating a more secure and efficient workplace.

A significant milestone pertaining to the integration of AI with OSH systems is the REDECA framework [29] that brings together AI technology and OSH processes to improve the accuracy of risk identification and injury prevention. Companies take proactive preventive measures with help from innovations like drones, robots and predictive analytics. Such as drones that monitor work areas that can't be accessed, and robots that supplants workers in high-risk jobs. This technology helps to decrease the probability of an accident and also further implement the safety mindset by reinforcing the pre-defined measures [30].

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While AI has great potential, its use in OSH is hampered by challenges, including high cost, a lack of qualified personnel, and ethical concerns. Unfortunately, most companies struggle to adopt this technology due to a lack of time and intelligence [31]. Nonetheless, AI still holds the promise of making something like that safer, particularly in high-risk industries like construction, mining, oil and gas. By advancing and implementing AI, industries will enable a better environment in terms of productivity while reducing risks to employees [32].

History and Development of AI in OHS

The use of Artificial Intelligence (AI) in occupational health and safety (OHS) has seen a revolution from the first generation of fuzzy logic systems used to dependent safety programmes to the sophisticated applications seen in high-risk sectors today. In the first place, fuzzy logic systems laid the foundation for reviewing safety protocols that allowed for better identification of the loopholes in organisations prevention mechanisms [33]. Yet as technology progresses, the emphasis in development is now in a more holistic direction, harnessing the sophistication of AI to fortify safeguards. With this change also comes a stronger appreciation for innovative technology to enhance the quality of worker safety and health [9].

IoT sensors are connected to AI technology today, enabling real-time monitoring, predictive analytics, and preventive risk management. This system allows for constant surveillance of workplace conditions and the ability to quickly respond to threats before they escalate into a significant incident [34]. Technologies like computer vision aid in the identification of unsafe conditions while drones can conduct high-risk tasks, minimizing direct exposure of human workers to hazards [35]. However, personalized AI-based employee training enhances safety awareness, leading to stronger preparation among workers to meet and overcome potential dangers.

The REDECA framework is a prime example of the potential impact of AI in predicting and managing industries' risk exposure and highlights the need for a systematic approach to hazards [36]. By using data processed through AI, firms can more clearly identify potential hazards and create suitable control measures. This underscores the effectiveness of this technology as evidenced through recorded metrics of reduced workplace incidents and improved quality of safety protocols [37]. The increase in AI adoption in numerous industries is facilitating the development of innovative OSH practices and paving the way for safer, efficient, and sustainable workplaces in the future.

Growing Trends in AI Research in OHS

In the past 5 years, the volume of scientific research on the application of artificial intelligence (AI) to Occupational Health and Safety (OHS) has expanded quickly [1]. Data suggests the highest spikes in those priorities are in 2022 (10.63%) and 2024 (41.14%), which indicates a shift in priorities among educators and industry actors for the development of technology-based adaptive work settings. The above changes correspond with the philosophy of Industry 5.0, emphasising a partnership between human and machines, where AI becomes an integral part of safety decision making in real-time rather than just a supporting tool [38]. Several factors are driving this trend. First, advances in AI technology, such as machine learning and predictive analytics, are improving the ability to detect safety risks early [39], [40], [41]. Second, global awareness of OSH is increasing post-COVID-19 pandemic, driving the adoption of data-driven safety systems [42], [43], [44]. Third, ESG policy and certification requirements necessitate that companies implement transparent and measurable technological solutions [45], [46]. Although the development of literature reflects an increasingly tangible academic contribution, the explosion of publications also poses challenges in identifying relevant and quality research. Therefore, in addition to marking quantitative progress, this trend demands a structured approach to synthesising research findings into the practical implementation of AI-based OSH systems.

Contributor Mapping and the Power of Scientific Collaboration

Mapping contributors in bibliometric analysis is the key to identifying the main actors influencing the development of science in a particular field. In this study, the author collaboration network reveals that Soeteman-Hernandez, Iya G. occupies a central position in research related to the application of AI for Occupational Health and Safety (OHS). Beyond that, he has collaborated with a wide network, which reflects his character as not only an active researcher, but also as a bridge between research groups that revolve around different themes and methodologies evidenced by his high research productivity. This unique position allows him to bridge theoretical and practical science, facilitating the convergence of fields including engineering, computer science, and occupational health.

However, the collaboration map also highlights a small number of researchers who either work in isolation or have limited connections to others, suggesting fragmentation in the scientific community. This underscores a couple of points: (1) multidisciplinary collaboration enhances the innovation potential in such complex

fields as AI in OSH, (2) there are still participation gaps regarding institutions in developing countries that are not yet present in the global network.

These findings highlight the necessity for cross-country and cross-sector collaboration initiatives like establishing research consortia to ensure the development of an inclusive and sustainable framework. It will not only broaden the distribution of resources and research capacity but also ensure that academic discoveries can be translated more effectively into industrial policy and practice. Therefore, structured collaboration catalyzes the translation of AI research in OSH from the traditional ivory tower setting into tangible real-world solutions.

Keyword Focus and Thematic Tendencies

So, keyword analysis is fundamental in bibliometric studies because it can indicate the main themes or dominant trends in research direction in each field. In the field of bridging Artificial Intelligence (AI) and Occupational Health and Safety (OHS), the mapping outcomes have confirmed that terms like 'artificial intelligence' and 'machine learning' are central to the keyword network, validating the finding that academics are still revolutionizing their innovations around core technology aspects. In addition, the emergence of keywords such as 'construction safety', 'occupational health', and 'Internet of Things (IoT)' shows that the AI approach to OSH is widely applied in high-risk and infrastructure-based sectors. These findings reflect not only thematic trends, but also the rapidly growing direction of practical AI applications. This is understandable given that sectors such as construction and transportation are complex work environments with significant accident risks, making them ideal test sites for the application of predictive and automated technologies.

Furthermore, the dominance of these technical keywords suggests that research in the field of AI-OHS is still very much focused on technology, with a strong emphasis on system efficiency and automated detection capabilities. However, this trend also indicates a potential gap in attention to non-technical aspects, such as the social, psychological, or cultural impact of AI implementation in occupational safety. Although technology integration is important, human and ethical challenges also need attention, such as how technology is accepted by workers, and how data privacy and fairness of benefit distribution can be guaranteed. Therefore, in the future, a more balanced and holistic research approach is needed, one that not only highlights the sophistication of technology, but also places humans at the centre of the safety system. An interdisciplinary approach between technology, occupational psychology, and public policy will be key to expanding the benefits of AI in various industrial sectors in an inclusive and sustainable manner.

5. CONCLUSION

This study emphasises the crucial role of Artificial Intelligence (AI) in transforming Occupational Health and Safety (OHS) in line with the development of Industry 5.0. As industry moves towards a more integrated and human-centred approach, the application of AI is a key factor in improving the safety of the work environment. AI can also help predict potential hazards by monitoring the conditions under which a worker is working in real-time, which supports proactive risk management strategies to prevent accidents from occurring and prevent work-related health problems. The growing number of scientific papers indicates awareness of the role of AI in creating adaptative work environments, particularly for sectors with high risks like construction, mining, and manufacturing.

However, this study also identifies substantial gaps in existing literature, especially around the uneven distribution of AI benefits across social classes and industrial sectors. The study highlights the necessity of a cross-disciplinary focus on the inclusion of AI gains in OSH for all actors, at the same time addressing current inequalities. As a result, the study suggests setting up an AI-based Accident Prediction System as an original concept that provides an extra layer of protection and fosters a safety culture at the workplace.

With the evolution of AI technology, utilizing it in OSH approaches is not simply a technical upgration but rather a strategic imperative to safeguard the health of employees. A balanced strategy blending solutions from AI technology with human factors will optimise the benefits of AI in occupational safety, say research. Through an examination of current trends, challenges and opportunities, this study informs the discussion of AI in OSH and lays the foundations for more resilient and sustainable occupational safety management.

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