Anadolu Türk Eğitim Dergisi
Anatolian TurkishJournal of Education
ISSN:2867-5314

Yıl/Year: 2023 Cilt/Volume: 5 Sayı/Issue: 2 ss/pp. 79-106

Makale Geliş Tarihi: 08/12/2023
Makale Kabul Tarihi: 26/12/2023
Makale YayınTarihi: 31/12/2023
Makale Türü: Orijinal Araştırma Makalesi

BİBLİYOMETRİK ANALİZ VE YAPAY ZEKAYLA GELİŞTİRİLMİŞ LİTERATÜR TARAMASI: İŞ SAĞLIĞI VE GÜVENLİĞİ EĞİTİMİNDE LİTERATÜR BOŞLUĞUNUN BELİRLENMESİ*

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Özet

Bu çalışma, iş sağlığı ve güvenliği eğitiminin bibliyometrik analizini ve literatür değerlendirmesini yapmak üzere GPT-4, Claude AI ve Bard Chat'ten gelen verileri sentezlemeyi amaçlayarak bu alandaki literatür boşluğunu tespit etmeyi amaçlamaktadır. Çok disiplinli iş sağlığı ve güvenliği araştırmaları eğitim, işyeri güvenliği, mesleki gelişim, sağlık hizmetleri, refah ve teknolojik sonuçları kapsar. Bu çalışmanın bulguları, pratik güvenlik uygulamalarını, küresel bakış açılarını ve iş sağlığı eğitiminde teknolojinin artan kullanımını vurgulamaktadır. Araştırmaya göre kapsayıcı işgücü girişimleri, ruh sağlığı çerçeveleri ve politika geliştirme konuları ilgili literatür boşluğunu oluşturmaktadır. Araştırmada kullanılan yeni yapay zeka destekli metodolojinin, çalışmadaki bibliyometrik yöntemleri geliştirdiği düşünülmektedir. Yapay zeka analizindeki önyargıları, dilsel ve coğrafi engelleri ve ampirik doğrulama çalışmanının sınırlılığını oluşturmakla beraber bu çalışma, iş sağlığı ve güvenliği eğitiminde yapay zeka destekli sürekli araştırma ve uyarlamanın gerekliliğini vurgulamaktadır.

Anahtar Kelimeler: İş sağlığı ve güvenliği eğitimi, Bibliyometrik analiz, Yapay zeka destekli literatür taraması

BIBLIOMETRIC ANALYSIS AND AI-ENHANCED LITERATURE REVIEW: IDENTIFYING RESEARCH GAPS IN OCCUPATIONAL HEALTH AND SAFETY EDUCATION

Abstract

This study aims to identify the literature gap in this field by synthesizing data from GPT-4, Claude AI and Bard Chat to conduct bibliometric analysis and literature evaluation of occupational health and safety training. Multidisciplinary occupational health and safety research covers education, workplace safety, professional development, healthcare, welfare and technological outcomes. The findings of this study highlight practical safety implications, global perspectives, and the increasing use of technology in occupational health education. According to the research, inclusive workforce initiatives, mental health frameworks and policy development issues constitute the relevant literature gap. It is thought that the new artificial intelligence-supported methodology used in the research improves the bibliometric methods in the study. While addressing biases in AI analysis, linguistic and geographical barriers, and the limitations of empirical validation work, this study highlights the need for continued AI-supported research and adaptation in occupational health and safety education.

Keywords: Occupational Health and Safety Education, Bibliometric Analysis, AI-Assisted Literature Review

Atıf / Citation

Duran, V. ve Aydın, E. (2023). Bibliyometrik Analiz ve Yapay Zekayla Geliştirilmiş Literatür Taramasi: İş Sağliği ve Güvenliği Eğitiminde Literatür Boşluğunun Belirlenmesi. *Anadolu Türk Eğitim Dergisi*, *5* (2), 79-106.

Duran, V. & Aydın, E. (2023). Bibliometric Analysıs and AI-Enhanced Lıterature Review: Identifying Research Gaps in Occupational Health and Safety Education, *AnatolianTurkEducationJournal*, *5* (2), 79-106.

- Bu çalışmada "Yükseköğretim Kurumları Bilimsel Araştırma ve Yayın Etiği Yönergesi" kapsamında uyulması belirtilen tüm kurallara uyulmuştur.

Introduction

In the realm of scientific data examination and evaluation, bibliometric analysis is a frequently employed and rigorous method. Through this approach, we may analyze the complex evolutionary intricacies of a certain industry while also illuminating the burgeoning domains within that classification. (Donthu et. al 2021). The first approach involved creating bibliographic summaries of academic works or publications with a high number of citations. These summaries were organized into different categories, such as collections by authors, bibliographies by country, or by subject. The range of themes in publication trends varied from general to more detailed topics. This process also looked at geographic or institutional aspects and performance indicators that showed progress over time. Furthermore, it encompassed a wide array of research areas, literature, and authorship. The materials analyzed included a diverse array of formats like journal articles, books, theses, patents, and reports, often referred to as "grey literature." (Ellegaard and Wallin, 2015). In the literature, there are several papers providing complete bibliometric overviews in many research areas, including management, economics, health economics, fuzzy research, innovation, entrepreneurship , international business and pricing research (Merigó and Yang, 2017).

This paper aims to comprehensively examine the field of Occupational Health and Safety Education by leveraging advanced bibliometric techniques and content analysis. The analysis focuses on the systematic examination of titles, abstracts, and author keywords using a combination of innovative AI tools, including GPT-4, Claude AI, and Bard Chat. The significance of this study is heightened by the incorporation of these cutting-edge AI technologies. GPT-4, the latest iteration of OpenAI's Generative Pre-trained Transformer models, utilizes deep learning to produce text that is strikingly similar to human conversation. This tool is instrumental in analyzing and interpreting complex datasets. Claude AI, developed by Anthropic, is another potent AI assistant employed in this research. Using its advanced language model, it provides valuable insights into textual data. Bard, Google's experimental AI chat service, further enriches the study with its internet-sourced information, providing a diverse range of data points for analysis. Additionally, the paper utilizes Voyant Tools, a web-based environment designed for the intricate reading and analysis of texts. This tool is very useful because it provides a comprehensive platform for text analysis, which contributes to its overall benefits.

Content analysis, a central method in this research, involves a meticulous process of coding, theme identification, and pattern recognition. This method is essential for the subjective interpretation of text data, as noted by Hsieh & Shannon (2005). The research employs the Web of Science (WoS) database to gather relevant information, aiming to pinpoint the most significant and influential works in Occupational Health and Safety Education and identify gaps in the existing literature. The study delves into the landscape of Occupational Health and Safety Education, identifying key articles, authors, and trends over time through bibliometric analysis. By utilizing Voyant Tools to examine titles, author keywords, and abstracts, as well as by analyzing them with GPT-4, the research provides a comprehensive perspective of the topic. This paper's unique addition is that it makes use of artificial intelligence tools such as GPT-4, Claude AI, and Bard Chat, all of which were developed under the review of the authors. Siiman et al. (2023) have emphasized that AI-assisted qualitative analysis has the potential to increase transparency in the coding of qualitative data. This is accomplished by encouraging human analysts to report AI prompts that agree with their interpretations of the data. These prompts can then be reused by other researchers. Using a shared AI model as a mediator among coders might create consensus more rapidly in the early coding stage, according to Gao et al. (2023). However, it could potentially impair the variety of the final code; this is something that should be considered. Regarding the use of artificial intelligence to facilitate human-to-human collaboration in a variety of collaborative qualitative analysis (CQA) settings, they also underline the importance of taking into account the level of independence. Therefore, it is thought that the use of these techniques in this research not only helps to improve comprehension of the context and significance of the themes and keywords that have been found, but they also contribute to the identification of gaps in the current body of literature. The chatbots' suggestions for missing literature are thoroughly categorized, and common topics identified by at least two chatbots are merged into a single theme. This approach provides a systematic method for identifying and addressing research gaps. In conclusion, this paper introduces an innovative method for analyzing Occupational Health and Safety Education literature, merging advanced AI tools with traditional bibliometric techniques and content analysis, supervised by the authors. It offers a fresh perspective on

the field, emphasizing significant trends, authors, and literature gaps. This comprehensive approach establishes a new benchmark for research in this area, leading to more informed and thorough future studies.

Method

For the purpose of finding and assessing research that is associated with occupational health and safety education, we carried out a comprehensive evaluation of the research that is publicly accessible on the web of science. After doing a search for the phrase "occupational health and safety education," we used purposive sampling to get the results. The analysis process is summarized as follows:

1. **Bibliometric Analysis with Web of Science for the topic of occupational health and safety education**: We looked at the landscape of the study field, identifying important articles, authors, and trends that have developed over time.

2. **Extracting Titles, author keywords, and abstracts and Using Voyant Tools:** Using Voyant Tools, we were able to find commonly occurring keywords and subjects by analyzing titles, author keywords, and abstracts.

3. **Analysis with GPT-4 and other AI chatbots:** To provide context and relevance to the discovered keywords and subjects, we integrated GPT-4 and other AI chatbots into our analysis.

4. **Seeking Suggestions for Literature Gaps from Chatbots (GPT-4, Claude AI, and Bard Chat):** Our investigation was enhanced by the use of GPT-4, Claude AI, and Bard Chat which offered insights into the context and importance of the subjects and keywords that were identified.

5. **Categorizing the Keywords Suggested by Different Chatbots:** The keywords for the missing literature that have been proposed by various chatbots are grouped together into a new category if a common term is shared by at least two chatbots. When discussing the keywords for the literature that is missing, this type of situation arises.

6. **Finding Common Themes for the Missing Gaps in the Literature Proposed by Different Chatbots for Titles, Author Keywords, and Abstract Dimensions**: When analyzing the categories for the missing literature that have been proposed by several chatbots for each dimension, if there is a common category that is shared by at least two chatbots, then these categories are combined together into a theme.

7. **Making a Literature Review Based on the Identified Gaps:** The chatbots provided us with a list of gaps in the existing literature, which we used to guide our review of the existing literature in the google scholar based on the relevant keyword and seek suggestions.

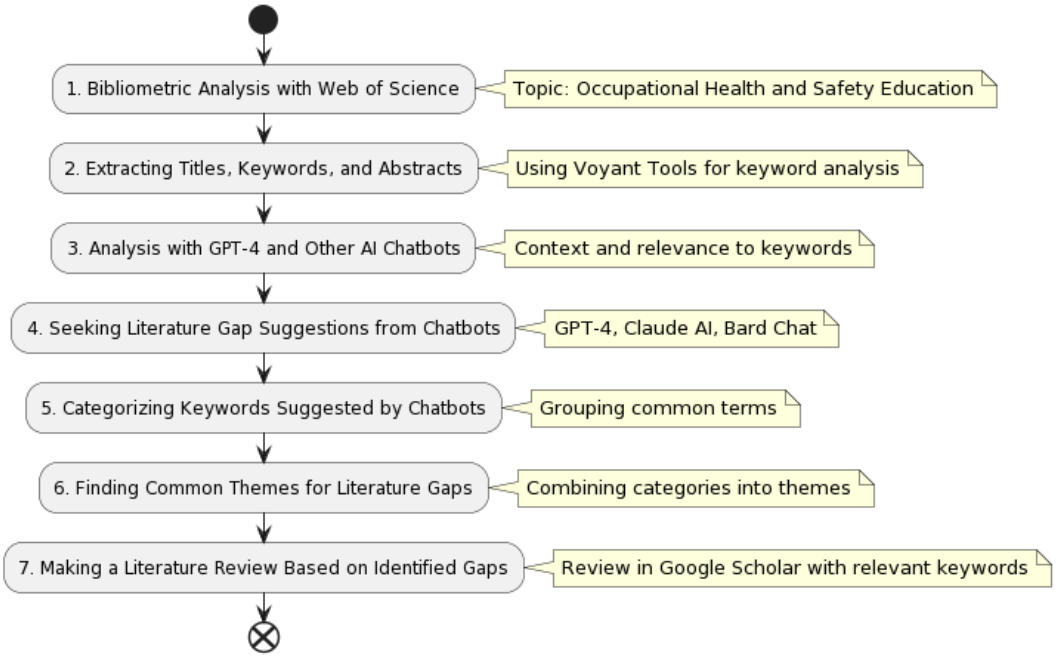

Figure 1. The representation of the analysis process

In our study we used GPT-4 and Quibot as paraphraser and interpreter in sometimes.

Limitations

Although this study provides useful insights into workplace health and safety education, it has several limitations. Although innovative, our use of bibliometric analysis and AI-driven literature review approaches may have limited our research to published and indexed academic sources. Grey literature—unpublished studies, reports, and expert opinions—may provide additional viewpoints or contradict our findings. Second, AI chatbots like GPT-4, Claude AI, and Bard Chat can efficiently analyze and synthesize literature, but their training data and algorithms may add biases. These biases could affect data interpretation and study theme identification, skewing analysis toward more commonly discussed topics and away from less-explored regions.

Findings

3.1. General Biibliometric Results of the Articles

According to general bibliometric results of the articles by the web of science analysis tools, it was found that there are 127 records regarding the “occupational health and safety education”, a few key points stand out (Figure 2):

1. Articles make up the largest share, accounting for 63 records which is 49.6% of the total. This indicates that articles are the most common document type in this dataset.

2. Proceeding Papers are the second most common type, making up 58 records or 45.7%. Together, Articles and Proceeding Papers account for over 95% of the documents.

3. Review Articles, Book Chapters, and Early Access documents make up a much smaller portion - just 4.7% for Review Articles and 0.8% each for Book Chapters and Early Access. So these types of documents are relatively uncommon or rare in this dataset.

4. The data suggests a focus or bias in this collection of documents favoring articles and proceedings over other document types like book chapters and reviews.

A dynamic area in which new research is constantly presented and published is suggested by the fact that articles and proceeding papers make up the majority of the publications. The limited number of review

articles may suggest that there is a possible deficiency in the existing body of literature for complete synthesis of the research that has been conducted. When it comes to specialized academic fields, where journals and conferences are the principal venues for distribution, book chapters and early access materials are rather infrequent. This is typical of the situation

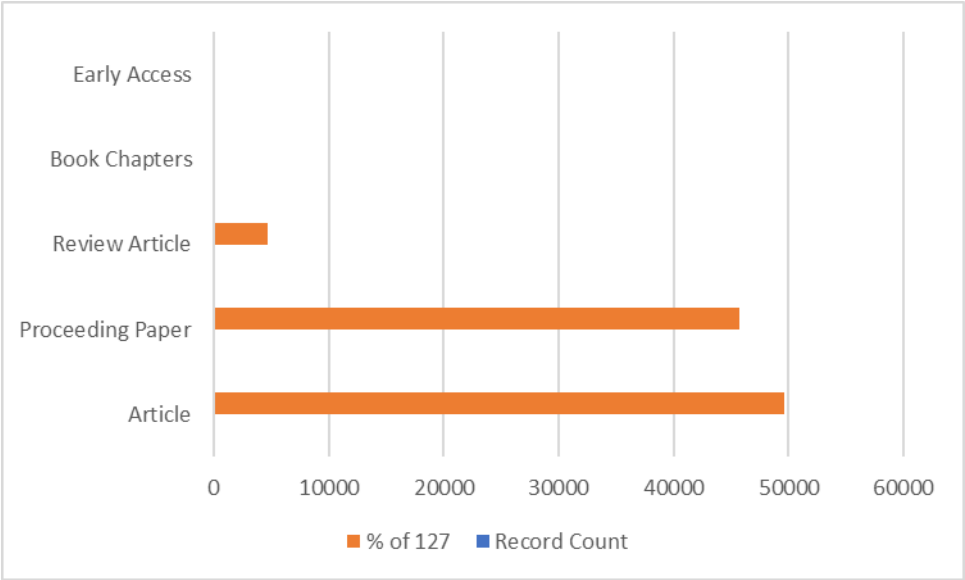

Figure 2. Article types

The figure 3 displays a data set with publication years on the x-axis, ranging from 1995 to about 2023, and record count on the y-axis, which appears to range from 0 to above 20. The equation for the trend line is given as (y = 0.4485x - 896.46) with an (R^2) value of (0.4322). The trend line represents a linear regression model that attempts to predict the record count based on the publication year. The positive coefficient of (0.4485) indicates an upward trend over time, suggesting an increase in the number of records as the years progress. However, the (R^2) value of 0.4322 suggests that only about 43.22% of the variability in the record count is explained by the model, which is a moderate fit. The graph shows variability in the number of records per year, with some years experiencing peaks and others experiencing lower counts. The peak around 2019 is particularly noticeable, with a sharp increase to a record count of 22, followed by a decrease in subsequent years. The trend over time seems to suggest a general increase in the number of publications related to the searched term with some fluctuations. The spike in 2019 could be due to a variety of factors, such as increased interest in the subject, a relevant event, or simply more publications being indexed that year. After 2019, there's a drop followed by a stabilization in the record count. It would be interesting to investigate the context behind these fluctuations for a more comprehensive understanding.

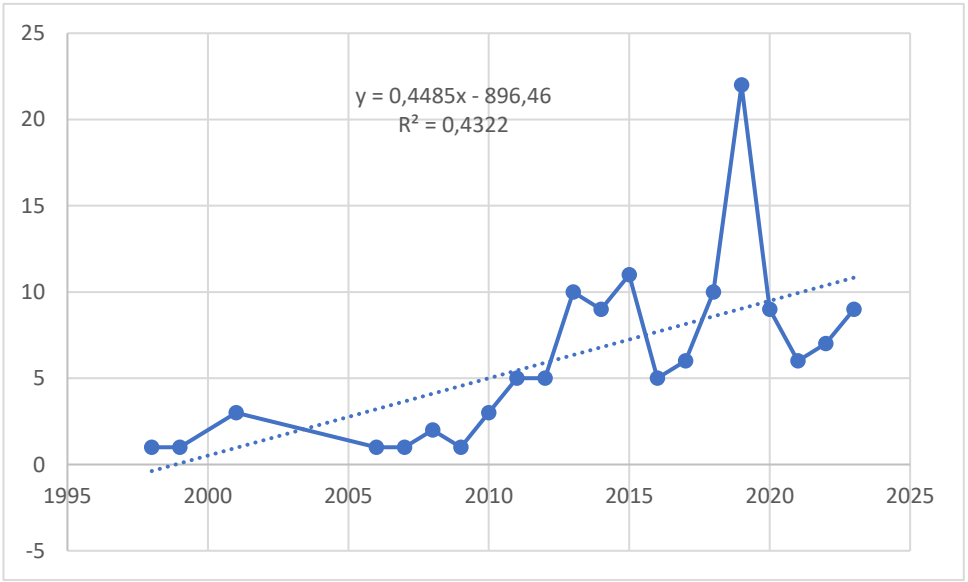

Figure 2. Publications by years

The bibliometric data on "occupational health and safety education" across various Web of Science indexes shows that a significant portion of the literature is captured in conference proceedings, with the "Conference Proceedings Citation Index – Social Science & Humanities (CPCI-SSH)" holding 44.094% of the total 127 records. This is followed by the "Emerging Sources Citation Index (ESCI)" with 31.496%, indicating a considerable volume of newer or less-established journals contributing to the field. The "Social Sciences Citation Index (SSCI)" encompasses 16.535% and the "Science Citation Index Expanded (SCI-EXPANDED)" includes 15.748%, suggesting that occupational health and safety education research is recognized in both social science and more traditional science disciplines. Fewer records appear in the "Conference Proceedings Citation Index – Science (CPCI-S)" with 7.087%, and only a minimal presence is noted in the "Book Citation Index – Social Sciences & Humanities (BKCI-SSH)" with 0.787%, reflecting that books are a less common medium for this research area. The distribution of records across these indices highlights the interdisciplinary nature of the field, spanning social sciences, humanities, and scientific disciplines, with a particular emphasis on conference proceedings (Table 1).

Table 1.

Publications in web of science indexes

Web of Science Index	Record Count	% of 127
Conference Proceedings Citation Index – Social Science & Humanities (CPCI-SSH)	56	44.094
Emerging Sources Citation Index (ESCI)	40	31.496
Social Sciences Citation Index (SSCI)	21	16.535
Science Citation Index Expanded (SCI-EXPANDED)	20	15.748
Conference Proceedings Citation Index – Science (CPCI-S)	9	7.087
Book Citation Index – Social Sciences & Humanities (BKCI-SSH)	1	0.787

The bibliometric analysis of the term "occupational health and safety education" across various Web of Science categories reveals interesting trends and distribution across disciplines (Table 2):

1. **Overlap with Scientific Disciplines**: "Education Scientific Disciplines" accounts for 29.921% of the records, suggesting a considerable intersection of occupational health and safety education with various scientific disciplines. This could imply the integration of this topic within science education or the application of scientific methods to study it.

2. **Public Health and Environmental Relevance**: The category "Public Environmental Occupational Health" with 6.299% shows the relevance of occupational health and safety in public health and environmental studies, highlighting its impact on broader health and environmental issues.

3. **Multidisciplinary Engineering and Nursing Involvement**: The presence in "Engineering Multidisciplinary" (5.512%) and "Nursing" (4.724%) categories suggests that occupational health and safety is an important topic in these fields, possibly due to the practical implications in workplace safety and health care.

4. **Intersection with Social Sciences and Management**: The involvement of "Social Sciences Interdisciplinary" (3.937%) and "Management" (3.150%) indicates that occupational health and safety education also touches on social science perspectives and management practices.

5. **Educational Psychology and Health Care Sciences**: Both "Psychology Educational" and "Health Care Sciences Services" have a presence (3.150% and 2.362%, respectively), pointing to the psychological aspects of occupational health and safety education and its relevance in health care service delivery.

6. **Other Diverse Fields**: Lower percentages in fields like "Computer Science," "Surgery," "Business," "Chemistry," "Ergonomics," "Social Issues," "Urban Studies," and "Veterinary Sciences" reflect a broad, albeit less pronounced, interest in occupational health and safety across a wide range of disciplines.

Table 2.

Publications in web of science categories

Web of Science Categories	Record Count	% of 127
Education Educational Research	98	77.165
Education Scientific Disciplines	38	29.921
Public Environmental Occupational Health	8	6.299
Engineering Multidisciplinary	7	5.512
Nursing	6	4.724
Social Sciences Interdisciplinary	5	3.937
Management	4	3.150
Psychology Educational	4	3.150
Health Care Sciences Services	3	2.362
Computer Science Interdisciplinary Applications	2	1.575
Surgery	2	1.575
Business	1	0,787
Chemistry Multidisciplinary	1	0,787
Computer Science Theory Methods	1	0,787
Engineering Chemical	1	0,787
Ergonomics	1	0,787
Social Issues	1	0,787
Urban Studies	1	0,787
Veterinary Sciences	1	0,787

This bibliometric study demonstrates that occupational health and safety education is primarily a subject of interest in the field of educational research, and that it has major intersections with the fields of public health, engineering, nursing, and the social sciences. The extensive awareness of its significance in a variety of facets of society and professional sectors is highlighted by the multidisciplinary interest that has led to this recognition.

The bibliometric analysis on occupational health and safety education across 127 records reveals a multidisciplinary interest with the majority of citations in "Safety & Maintenance" (22.047%) and "Education & Educational Research" (9.449%), indicating a strong emphasis on both practical safety applications and pedagogical approaches in the field (Table 3). Notable attention is also given to "Nursing" (7.087%) and "Management" (4.724%), reflecting the importance of occupational health in healthcare and organizational contexts. While diverse topics like "Back Pain," "HIV," and "Transportation" are also represented, indicating the broad reach of occupational health and safety issues, a significant portion of records (15.748%) do not specify the topic, suggesting a wider scope of interest not captured by the primary categories. This breadth underscores the relevance of occupational health and safety education across various aspects of work, health, and education sectors.

Table 3.

Publications in citation topics meso

Citation Topics Meso	Record Count	% of 127
4.237 Safety & Maintenance	28	22.047
6.11 Education & Educational Research	12	9.449
1.14 Nursing	9	7.087
6.3 Management	6	4.724
1.129 Back Pain	5	3.937
1.66 Hiv	4	3.150
4.183 Transportation	4	3.150
1.136 Autism & Development Disorders	2	1.575
1.156 Healthcare Policy	2	1.575
4.284 Human Computer Interaction	2	1.575
4.322 Remote Research & Education	2	1.575
1.100 Substance Abuse	1	0.787
1.117 Pharmacology & Toxicology	1	0.787
1.150 Hearing Loss	1	0.787
1.217 Parasitology - Malaria, Toxoplasmosis & Coccidiosis	1	0.787
1.218 Autonomic Regulation	1	0.787
1.23 Antibiotics & Antimicrobials	1	0.787
1.231 Vitamin Metabolism	1	0.787
1.243 Kidney Diseases	1	0.787
1.246 Diarrheal Diseases	1	0.787
1.273 Health Literacy & Telemedicine	1	0.787
1.307 Laboratory Medicine	1	0.787
1.44 Nutrition & Dietetics	1	0.787
1.65 Allergy	1	0.787
1.7 Neuroscanning	1	0.787

Showing 25 out of 42 entries

20 record(s) (15.748%) do not contain data in the field being analyzed

In a detailed bibliometric analysis of occupational health and safety education (table 4), the term "Safety Climate" emerges as the most cited micro-topic with 27 records (21.260%), indicating a significant research focus on the perception of safety within organizations. Other specific areas like "Low Back Pain," "Nursing," "Road Safety," and "Job Satisfaction" each hold a smaller yet meaningful presence, suggesting targeted studies on these aspects within the occupational health and safety education realm. Specialized topics such as "Needlestick Injuries," "Occupational Therapy," and various educational subfields also surface, though less frequently, reflecting the nuanced and specialized research within the field. This micro-level

analysis further reveals a diverse array of focused studies, from "Augmented Reality" to "Sign Comprehension" and "Academic Entrepreneurship," each contributing to the detailed mosaic of occupational health and safety education. However, a noteworthy portion of the records (15.748%) lacks specificity in the topic, pointing to a broader span of interests that extend beyond the outlined categories, thus highlighting the extensive reach and complexity of the field.

Table 4.

Publications in citation topics micro

Citation Topics Micro	Record Count	% of 127
4.237.911 Safety Climate	27	21.260
1.129.98 Low Back Pain	5	3.937
1.14.265 Nursing	4	3.150
4.183.669 Road Safety	4	3.150
6.3.48 Job Satisfaction	4	3.150
1.66.1773 Needlestick Injuries	3	2.362
1.136.2030 Occupational Therapy	2	1.575
1.14.1359 Interprofessional Education	2	1.575
1.14.849 Surgical Education	2	1.575
4.284.1027 Augmented Reality	2	1.575
4.322.2384 Sign Comprehension	2	1.575
6.11.1094 Medical Education	2	1.575
6.11.1506 Engineering Education	2	1.575
6.11.666 Intergenerational Mobility	2	1.575
6.3.1467 Academic Entrepreneurship	2	1.575
1.100.375 Alcohol	1	0.787
1.117.2199 Ifosfamide	1	0.787
1.14.288 Medication Errors	1	0.787
1.150.1538 Road Traffic Noise	1	0.787
1.156.1502 Indigenous Education	1	0.787
1.156.436 Self-rated Health	1	0.787
1.217.59 Malaria	1	0.787
1.218.933 Cardiac Rehabilitation	1	0.787
1.23.173 Staphylococcus Aureus	1	0.787
1.231.1938 Kynurenine	1	0.787
Showing 25 out of 57 entries		
20 record(s) (15.748%) do not contain data in the field being analyzed		

3.1. Descriptive Results of The Titles and Content Analysis of Them for Gap Identification in the Literature

Most frequent words in the titles that was scanned by voyant tools[†] are found to be:

safety (55); health (52); education (46); occupational (45); students (20); training (18); work (11); teachers (11); learning (11); prevention (10); study (9); workplace (8); service (8); engineering (8); educational (8); risk (7); development (7); construction (7); analysis (7); workers (6); university (6); teaching (6); professional (6); practices (6); management (6); implementation (6); chemical (6); care (6); schools (5); role (5); research (5); pre (5); nursing (5); knowledge (5); higher (5); handling (5); future (5); based (5); assessment (5); technology (4); school (4); review (4); ohs (4); innovative (4); experience (4); engineers (4); curriculum (4); culture (4); courses (4); approach (4); view (3); universities (3); transfer (3); teacher (3); skills (3); sector (3); risks (3); relationship (3); reality (3).

[†] https://voyant-tools.org/

The frequency of words in the titles scanned by Voyant Tools suggests several key themes and focuses in the body of work being analyzed. Here are some inferences:

1. Primary Focus on Safety, Health, and Education: The most frequently occurring words are 'safety', 'health', and 'education'. This indicates a strong emphasis on these topics, possibly in a professional or academic context.

2. Occupational and Professional Settings: The presence of words like 'occupational', 'workplace', 'workers', 'professional', and 'management' suggests that the content is heavily oriented towards occupational health and safety, and professional education.

3. Specific Focus on Educational Settings: Words such as 'students', 'teachers', 'learning', 'schools', 'teaching', 'university', and 'curriculum' imply a significant focus on educational settings, possibly exploring how safety and health are addressed in these environments.

4. Training and Development Themes: The occurrence of 'training', 'development', 'teaching', and 'learning' indicates an emphasis on the processes of educating or training individuals, particularly in safety and health-related areas.

5. Engineering and Technical Aspects: The presence of 'engineering', 'technology', 'chemical', and 'construction' points to a technical or engineering focus, likely related to safety and health in these specific fields.

6. Risk Management and Prevention: The words 'risk', 'prevention', 'safety', and 'health' suggest a strong orientation towards risk management and preventive measures in various contexts.

7. Research and Academic Inquiry: Terms like 'study', 'research', 'analysis', and 'review' indicate academic or research-oriented work, likely exploring the aforementioned themes in a scholarly context.

8. Sector-Specific Studies: The presence of words specific to certain sectors like 'nursing', 'engineering', 'educational', and 'occupational' implies studies or discussions tailored to these particular fields.

9. Implementation and Practices: Words like 'implementation' and 'practices' suggest a focus on the practical application of theories or strategies in the realms of safety, health, and education.

10. Cultural and Innovative Aspects: The occurrence of 'culture', 'innovative', and 'approach' indicates an exploration of cultural aspects or innovative approaches within these themes.

As for the the occupational health and safety themes, we found the floowing themes (Table 5)

Educational Focus in Safety and Health: It is especially important for younger and less experienced workers to get effective safety education and training in order to create a sense of danger awareness and safe work practices. The purpose of this topic would be to investigate new instructional approaches and assess the retention of information over different time periods.

Occupational Health and Safety Context: By gaining an understanding of occupational health and safety trends that are specific to both industries and populations, it is possible to develop risk reduction and prevention strategies that are more tailored. The purpose of this theme is to investigate injury patterns, exposure hazards, and health consequences across a variety of workplace populations and industries.

Technical and Engineering Aspects: Advancements in technology and engineering controls provide opportunities to detect hazards, monitor exposures, and reduce safety risks. This theme analyzes the application of novel platforms, equipment designs, and digital tools for improved workplace health and safety.

Research, Academic Inquiry, and Sector-Specific Studies: Academic research elucidates underlying contributors to occupational injuries and validates the long-term efficacy of preventative interventions,

often focusing on high-risk industries. This theme reviews empirical safety studies and data-driven risk models for informing evidence-based practice.

Practical Implementation and Innovative Approaches: Translating safety research into practice requires adaptable and creative solutions for implementation within diverse organizational contexts. This theme explores practical methods for encouraging safety culture and analyzing program effectiveness at the frontline.

Table 5.

Themes, categories and codes for the titles

Themes	Category	Codes
Educational Focus in Safety and Health	Primary Focus on Safety, Health, and Education	'safety', 'health', 'education'
	Specific Focus on Educational Settings	'students', 'teachers', 'learning', 'schools', 'teaching', 'university', 'curriculum'
	Training and Development Themes	'training', 'development', 'teaching', 'learning'
Occupational Health and Safety Context	Occupational and Professional Settings	'occupational', 'workplace', 'workers', 'professional', 'management'
	Risk Management and Prevention	'risk', 'prevention', 'safety', 'health'
Technical and Engineering Aspects	Engineering and Technical Aspects	'engineering', 'technology', 'chemical', 'construction'
Research, Academic Inquiry, and Sector-Specific Studies	Research and Academic Inquiry	'study', 'research', 'analysis', 'review'
	Sector-Specific Studies	'nursing', 'engineering', 'educational', 'occupational'
Practical Implementation and Innovative Approaches	Implementation and Practices	'implementation', 'practices'
	Cultural and Innovative Aspects	'culture', 'innovative', 'approach'

The topics (Table 6) provided by voyant tools listed cover a wide range of themes, predominantly centered on education, health and safety, and professional development. These topics appear to be geared towards academic, vocational, and professional training programs. To organize them more coherently, they can be categorized into several key themes:

1. Education and Training Methods:

- Innovations in teaching methods, such as experiential learning, simulation-based training, and interactive teaching.

- Development of curricula in various fields, including environmental studies, health education, engineering, and computer science.

- Use of technology in education, including online modules, computer-aided learning, and augmented reality.

2. Health and Wellness:

- Focus on mental health care, occupational health, and wellness programs.

- Covid-19's impact on health education and prevention strategies.

- Handling and prevention of hazards in healthcare, such as needlestick injuries and chemical handling.

3. Safety and Risk Management:

- Occupational health and safety (OHS) practices, including the implementation of OHSAS 18001 standards.

- Prevention of workplace accidents and injuries, with a focus on sectors like mining, construction, and healthcare.

- Risk assessment and management in various professional settings.

4. Professional Development and Competency:

- Training programs for specific professions, such as teachers, nurses, engineers, and electricians.

- Development of competencies and skills in areas like ergonomics, project management, and compliance.

- Continuous professional development, including workshops, seminars, and certification programs.

5. Research and Innovation:

- Exploration of new methods and technologies in fields like nanotechnology, geriatrics, and pharmacology.

- Academic research approaches, including Delphi studies, case studies, and experimental research.

- Emphasis on interdisciplinary and cross-sectoral research collaborations.

6. Social and Environmental Issues:

- Environmental education, including topics like waste management, sustainability, and climate change.

- Addressing social issues in education, such as cultural sensitivity, gender inclusivity, and dealing with violence.

- Integration of societal challenges into educational curricula and professional training.

A holistic approach to modern education and professional training is reflected in these themes, which place an emphasis on practical skills, safety, wellness, and adaptability to new technology and changes in society. It is likely that they are applicable to the development of courses, workshops, or seminars at the professional or college level, with the goal of providing students and professionals with the information and skills necessary to meet the problems of both the present and the future.

Table 6.

Some sample of the topics given by Voyant tools for the keywords among 100 terms and 100 topics

developing college activity students modalities developers nue method workshop ohsas wellness mainstrea m importance workshops forward human service accidents
effect indonesia using hazardous expectancy covid corner experiential nanotra changes revising prevention
driving polish promotion case graphical resource investigation delphi radiation selection peer specialists me tropolis planned teachers professionals

field electricians role chemical shaping inform objectivization pilot handling anatomy tomorrow's environ ment way results strategies posh mainstream vision systems education

health education knowledge vocational study adopting researcher simulated intervention receiving simulato r mining zabol osh engineers company exercise programme analysis

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If there is a common keyword that is shared by at least two chatbots, then these keywords are put together under a new name, which is presented in Table 7. This is done when we examine the keywords that have been offered by different chatbots for the missing pieces of literature. The keywords "Policy and Legislation Policy," "Regulation and Compliance Policy," and "Policy and Regulatory Framework Analysis" are grouped into "Comprehensive Regulatory and Policy Management Framework". Global and Cultural Perspectives are the same keyword for each column. An encompassing name that integrates "Psychological and Mental Health Aspects," "Mental Health and Wellbeing," "Health Promotion Frameworks," and "Intersection with Public/Environmental Health," is given as "Holistic Mental Health and Public Wellbeing Framework" (Table 7).

Table 7.

Gaps in the literature proposed by different chatbots based on the titles

GPT4	Clause	bard
Interdisciplinary and Collaborative Approaches	Mental health and wellbeing	Global Perspectives
Policy and Legislation	Vulnerable worker populations	Comparative Analysis
Global and Cultural Perspectives	Workplace violence and harassment	Longitudinal Studies
Socioeconomic Factors	Emerging risks	Cost-Benefit Analysis
Technological Disruption and Future Trends	Policy, regulation and compliance	Policy and Regulatory Framework Analysis
Sustainability and Environmental Health	Economics of occupational safety	Stakeholder Perspectives
Psychological and Mental Health Aspects	Global/comparative perspectives	
Ethical and Moral Considerations	Health promotion frameworks	
Leadership and Management in Education and Health	Intersection with public/environmental health	
Inclusivity and Accessibility		

3.2. Descriptive Results fort he Author Keywords and Content Analysis of Them for Gap Identification in the Literature

Most frequent words fort he author keywrods in the corpus are found to be:

safety (77); education (75); health (71); occupational (55); training (24); learning (24); risk (11); work (10); workplace (9); engineering (9); teaching (8); school (8); management (8); chemical (8); vocational (7); teacher (7); schools (7); ohs (7); students (6); culture (6); assessment (6); university (5); therapy (5); student (5); service (5); prevention (5); osh (5); medical (5); knowledge (5); curriculum (5); behavior (5); approach (5); workers (4); technology (4); research (4); reality (4); qualitative (4); public (4); professional (4); labour (4); integrated (4); graduate (4); care (4); based (4); virtual (3); theory (3); stress (3); skills (3); satisfaction (3); protective (3); process (3); policies (3); nursing (3); nurse (3); mining (3); life (3); kindergarten (3); job (3); innovation (3)

There is an indication that the corpus covers a wide range of subjects concerning occupational safety and health, workplace safety, professional development, and healthcare, with a special emphasis on education and prevention. Here's a summary of the key themes:

- **Occupational Safety and Health Education:** The prominence of terms like "safety," "education," "health," "occupational," "training," and "learning" highlights the central focus on occupational safety and health education. This suggests that the corpus emphasizes the importance of preparing individuals for safe and healthy work environments.
- **Workplace Safety and Risk Management:** The presence of terms like "workplace," "risk," "engineering," "management," "assessment," "prevention," "protective," and "process" indicates a strong emphasis on workplace safety and risk management strategies. This suggests that the corpus addresses the identification, evaluation, and control of workplace hazards to prevent injuries and illnesses.
- **Professional Development and Skills:** The inclusion of terms like "teacher," "school," "vocational," "curriculum," "knowledge," "behavior," "approach," "workers," "technology," "research," "skills," "satisfaction," and "innovation" suggests a focus on professional development and skills enhancement. This indicates that the corpus addresses the importance of continuous learning and skill development for workers in various fields.
- **Healthcare and Wellbeing:** The presence of terms like "therapy," "student," "service," "medical," "nursing," "nurse," "stress," and "life" highlights the consideration of healthcare and wellbeing aspects. This suggests that the corpus addresses the overall health and well-being of individuals in the workplace and educational settings.

Overall, the keywords reveal a multifaceted research landscape, with a strong emphasis on education, training, health, and safety within various occupational contexts, underpinned by an interest in risk management, sector-specific issues, and the use of technology in OHS education and practice.

The topics (Table 8) provided by voyant tools represent a broad and diverse range of research areas within the field of occupational health and safety (OHS). These topics can be categorized into several key themes:

1. **Educational Methods and Learning Environments:**

- Focus on learning methods (e.g., online, adult learning, vocational education).

- Educational settings (e.g., schools, universities, kindergarten) and specific educational programs (e.g., undergraduate, postgraduate, master programs).

- Curriculum development and assessment methodologies.

- Specialized education for specific professions (e.g., nursing, engineering, teaching).

2. **Workplace Safety and Health Management:**

- Safety management systems and practices.

- Prevention and control of workplace hazards.

- Occupational health and wellness programs.

- Stress management and psychological aspects of workplace health.

- Safety in specific sectors (e.g., mining, construction, healthcare).

3. **Technology and Innovation in OHS:**

- Use of technology (e.g., virtual reality, simulation, digital tools) in training and hazard assessment.

- Innovative approaches to safety and health education.

- The impact of technological advancements on workplace safety.

4. **Cultural, Social, and Behavioral Aspects:**

- The role of culture and social factors in workplace safety.
- Behavioral aspects of safety and risk management.
- The impact of diversity and globalization on OHS practices.

5. **Specific Health and Safety Topics:**

- Prevention and management of specific risks (e.g., chemical hazards, musculoskeletal injuries, burnout).
- Health and safety in specific contexts (e.g., indoor environments, laboratories, schools).
- Occupational diseases and health issues (e.g., immunodeficiency, alcoholism, mental health).

6. **Regulatory, Policy, and Compliance Issues:**

- Compliance with safety regulations and standards (e.g., OHSAS 18001, GHS).
- Policy development and implementation in OHS.
- Legal and ethical aspects of occupational health and safety.

7. **Methodological Approaches:**

- Qualitative and quantitative research methods.
- Text and discourse analysis.
- Participatory and collaborative research approaches.
- Comparative and cross-cultural studies.

8. **Professional and Vocational Development:**

- Professional competencies and skills development.
- Continuous professional education and training.
- Career paths and professional roles in OHS.

Each of these themes represents a significant area of research within the OHS field, reflecting the multidisciplinary nature of this domain. The topics also highlight the need for ongoing research and development to address the complex and evolving challenges in ensuring workplace safety and health.

Table 8.

Some sample of topics given by Voyant tools for the author keywords among 100 terms and 100 topics

research sector project diversity global wellness
fuzzy supervision indoor preventive methodology text assessment prevention social
portfolio gottfredson's regime engineering
master online australia delphi
learning vocational prevention kindergarten body organisation healthcare personnel important underg raduate
student workers allied method curriculum paramedic mental educational pesticides oriented aid

When we examine the keywords for the missing literature that have been suggested by various chatbots, we come to the conclusion that if there is a term that is shared by at least two chatbots, then these keywords are put together under a new name, which is presented in Table 9. "The 'Holistic Mental Health and Public Wellbeing Framework' is a comprehensive name that integrates themes such as 'Psychological and Mental Health Aspects,' 'Mental Health and Wellbeing,' 'Health Promotion Frameworks,' and the 'Intersection with Public/Environmental Health.'" "The term 'Next-Generation Occupational Health and Safety' aptly encompasses topics like 'Advanced Data Analytics and Big Data in Occupational Health and Safety (OHS),' 'Remote Work and Telecommuting,' and 'Emerging Technologies and Future Trends.'" "The name 'Globalization Dynamics and Standards' effectively encapsulates the themes of 'Impact of Globalization and International Standards,' 'Global Perspectives,' and 'Comparative Analysis.'" "For a name that brings together 'Vulnerable and Marginalized Groups' with 'Diversity and Inclusion in the Workplace,' the term 'Inclusive Workplace Strategies for Vulnerable and Marginalized Groups' is proposed

Table 9.

Gaps in the literature proposed by different chatbots based on the author keywords

GPT 4	Claude AI	Bard
Mental Health and Psychosocial Factors	Mental health and psychosocial issues	Global Perspectives and Comparative Analysis
Impact of Globalization and International Standards	Vulnerable and marginalized groups	Longitudinal Studies and Cost-Benefit Analysis
Environmental Impact and Sustainability	Economics, compliance, and policy	Policy and Regulatory Framework Analysis
Advanced Data Analytics and Big Data in OHS	Emerging risks	Stakeholder Perspectives and Community Engagement
Remote Work and Telecommuting	Health promotion frameworks	Emerging Technologies and Future Trends
Diversity and Inclusion in the Workplace	Intersection with public health	Interdisciplinary and Cross-Sectoral Research Collaboration
Aging Workforce		
Small and Medium Enterprises (SMEs)		
Emergency Preparedness and Crisis Management		
Ethical Considerations in OHS		

3.3. Descriptive Results of The Abstracts and Content Analysis of Them for Gap Identification in the Literature

Most frequent words for the author abstracts in the corpus are found to be:

safety (246); health (235); education (190); occupational (168); students (97); work (96); knowledge (88); training (86); study (70); research (62); ohs (57); teachers (56); workplace (55); school (50); results (49); based (45); risk (43); prevention (41); working (38); skills (38); paper (37); learning (36); workers (35); university (35); level (34); educational (33); schools (32); important (31); future (31); related (30); process

(30); development (30); practice (29); osh (29); methods (29); factors (29); care (29); accidents (29); management (28); professional (26); field (26); engineering (26); chemical (26); nursing (25); different (25)

Based on the frequency of words in the author abstracts of the corpus, we can infer several key themes and areas of focus in the research:

1. Safety and Health : The prominence of 'safety' and 'health' indicates a central focus on these topics, likely in the context of occupational health and safety (OHS). This suggests a strong emphasis on maintaining and improving health and safety standards in various environments.

2. Educational Context: A significant number of mentions relate to educational settings and participants (students, teachers, schools, universities). This suggests a focus on education in OHS, possibly including both the education of OHS professionals and the integration of OHS principles into general education.

3. Occupational Focus: These terms indicate that a large part of the research is oriented towards occupational settings, examining health and safety issues in the context of work and workplaces.

4. Knowledge and Training : The frequency of these words suggests a focus on the acquisition and dissemination of knowledge and skills, particularly in relation to training programs and educational methods in OHS.

5. Research and Study: These terms indicate a strong research orientation within the corpus, with an emphasis on studying and researching various aspects of OHS.

6. Specific Areas of OHS : Specific OHS topics like accidents, risk, and prevention are frequently mentioned, indicating a focus on these critical areas within the field.

7. Development and Future Orientation: Words like 'future' and 'development' suggest forward-looking research, potentially exploring new directions, innovations, or emerging challenges in OHS.

8. Professional and Management Aspects: The mention of professional and management aspects indicates an interest in the professional development of individuals in OHS roles and the management of OHS within organizations.

9. Sector-Specific Focus: The presence of terms like 'engineering', 'chemical', and 'nursing' suggests that some of the research is focused on OHS within these specific sectors.

10. Factors and Processes: The mention of factors and processes indicates a concern with understanding the various elements that influence OHS and how they interact within different contexts.

These themes reflect a comprehensive and multidimensional approach to occupational health and safety education and research, covering a wide range of topics from practical applications to theoretical studies, and spanning various professional and educational contexts.

The topics in Table 10 provided by voyant tools present a complex and multifaceted view of various aspects of occupational health and safety (OHS), education, risk management, workplace dynamics, and socio-cultural influences. To provide a clearer understanding, these topics can be categorized and summarized as follows:

1. **Occupational Health and Safety (OHS) and Risk Management**:
    - Emphasis on the prevention of workplace accidents and injuries, and the importance of risk assessment and management strategies.
    - The role of safety protocols and compliance with OHS regulations in different industries, including the impact of legislation and organizational policies.
    - Exploration of factors influencing safety culture in the workplace, including staff attitudes, training, and education.

2. **Educational Strategies and Learning Processes**:
    - Investigation into effective teaching methods and curricula, especially in vocational education and training (VET) and higher education.
    - The impact of experiential learning, practical training, and collaborative learning approaches on student engagement and knowledge acquisition.
    - Addressing the needs of diverse learners, including migrants and students with special requirements, in educational settings.
3. **Workplace Dynamics and Employee Well-being**:
    - Analysis of factors affecting employee well-being, including work-related stressors, job satisfaction, and the influence of organizational culture.
    - Strategies for fostering a harmonious and productive work environment, with a focus on professional collaboration and teamwork.
    - The role of leadership and management in shaping workplace practices and employee experiences.
4. **Socio-Cultural Influences and Global Perspectives**:
    - Exploration of how cultural and linguistic diversity affects workplace dynamics and education systems.
    - The impact of globalization and immigration on labor markets, education, and workplace integration.
    - Understanding the role of gender, age, and social factors in shaping career paths, educational opportunities, and workplace experiences.
5. **Research Methodologies and Theoretical Frameworks**:
    - Use of various research methods, including qualitative and quantitative analyses, to study occupational and educational phenomena.
    - Theoretical approaches to understanding workplace safety, learning processes, and socio-cultural dynamics.
    - Development of new models and frameworks to better understand and address challenges in OHS, education, and workplace management.
6. **Policy Development and Implementation**:
    - The role of government and institutional policies in shaping education and workplace safety standards.
    - Strategies for implementing effective policies and practices in diverse contexts, including schools, universities, and workplaces.
    - Examination of national and international regulations and guidelines, and their impact on local practices.

These topics highlight the complexity and interconnectedness of issues related to workplace safety, education, and societal dynamics. They represent key areas of interest for researchers, policymakers, educators, and professionals seeking to improve workplace environments, educational outcomes, and societal integration in a rapidly changing global landscape.

Table 10.

Some sample of the topics given by Voyant tools for the abstracts among 100 terms and 100 topics

culture process accidents risks interviewed influenced subjects willingness courses thinking needs conclusion derived
plan key assess obligatory vision realization harmonious depth noted context footwear
injured life staff solve application mean liberal selection professional collaboration analyzes
workplace granada treatment deployment hazards strictly strategies
obtained equal intention commitment taking introducing chemistry subjected high field
paper field factors public legislation sustainable evidence conception focused organizational uk vary educational points mental companies

When we look at the keywords fort he missing literature proposed by different chatbots if there is a common keyword at least shared by two chatbots these keywords are grouped into a new name as given in Table 11. "The 'Holistic Mental Health and Public Wellbeing Framework' is a comprehensive title that encompasses 'Psychological and Mental Health Aspects,' 'Mental Health and Emotional Well-being in the Workplace,' 'Health Promotion Frameworks,' and the 'Intersection with Public/Environmental Health,' along with aspects of 'Mental Health and Psychology.'". "The term 'Next-Generation Occupational Health and Safety' is designed to integrate 'Technological Advancements and Digital Transformation' with 'Emerging Technologies and Future Trends.'". "A comprehensive title, 'Diversity and Social Justice for Vulnerable Populations,' brings together the concepts of 'Diversity, Equity, and Inclusion,' 'Social Justice and Equity Considerations,' and 'Vulnerable Populations and Marginalized Groups.'". "The concept of 'Economic and Financial Aspects of Occupational Health and Safety (OHS)' combined with 'Economics and Policy' can be encapsulated in the title 'Financial Dimensions of Workplace Safety.'"

Table 11.

Gaps in the literature proposed by different chatbots based on the abstracts

GPT 4	Claude AI	Bard
1. Technological Advancements and Digital Transformation	Intersection with public health	Emerging Technologies and Future Trends
2. Mental Health and Emotional Well-being in the Workplace	Health promotion frameworks	Vulnerable Populations and Marginalized Groups
3. Climate Change and Environmental Health	Social justice and equity considerations	Psychosocial Workplace Hazards and Mental Health
4. Remote Work and Telecommuting	Economics and policy	Intercultural Communication and Conflict Resolution
5. Economic and Financial Aspects of OHS	Mental health and psychology	Evidence-Based Policymaking and Practice
6. Diversity, Equity, and Inclusion	Adapting to change	Community Engagement and Empowerment
7. Legal and Ethical Challenges	Interdisciplinary research	
8. Aging Workforce		
9. Integration of Soft Skills and Interpersonal Dynamics		
10. Long-term Impact and Sustainability of OHS Initiatives		

3.4. Literature Review for Directing Future Research Areas

The themes in Table 12 suggest a range of topics that have been identified as requiring more in-depth exploration and study. When we examined the common themes identified by various chatbots in their proposals for titles, author keywords, and abstract dimensions in missing literature. We identified at least three themes that were repeated twice or more in each dimension. Based on this, we decided to conduct a literature research focusing on these subjects: 'Holistic Mental Health and Public Wellbeing Framework,' 'Inclusive Workplace Strategies for Vulnerable and Marginalized Groups,' and 'Global and Cultural Perspectives.'

Table 12.

The common themes for the missing literature proposed by different chatbots for titles, author keywords and abstracts dimensions

Titles	Author keywords	Abstracts
"Holistic Mental Health and Public Wellbeing Framework"	"Holistic Mental Health and Public Wellbeing Framework"	"Holistic Mental Health and Public Wellbeing Framework"
-	“Next-Generation Occupational Health and Safety"	“Next-Generation Occupational Health and Safety"
-	"Inclusive Workplace Strategies for Vulnerable and Marginalized Groups".	“Diversity and Social Justice for Vulnerable Populations".
“Global and Cultural Perspectives”	"Globalization Dynamics and Standards”	-
"Comprehensive Regulatory and Policy Management Framework"		
		“Financial Dimensions of Workplace Safety.,”

3.4.1.Holistic Mental Health and Public Wellbeing Framework

The findings draw upon a range of studies that collectively paint a comprehensive picture of the current state of mental health in the workplace, the complexities of well-being in the context of public policy, the evolution of workplace studies in response to global challenges like COVID-19, proactive management strategies for mental health, holistic health approaches, global perspectives on job satisfaction, standards for psychological risk management, and the role of public mental health in occupational health.

Definition of Well-being and Public Policy: Schulte et al. (2015) address the complexities in defining and operationalizing 'well-being' in occupational contexts and public policy. They explore the various dimensions of well-being and the challenges in measuring and assuming responsibility for it. The need for a unified approach to evaluate work and non-work variables related to worker health and safety is highlighted. Bulut (2022) emphasizes the underrepresentation of occupational disease as a subject of academic study in Turkey, noting its low level of attention. To address this issue, Bulut suggests the creation of dedicated departments within educational institutions focusing specifically on occupational diseases. This initiative would facilitate deeper investigation and understanding of these diseases. Moreover, the author advocates for the publication of academic papers centered on occupational diseases, which would contribute significantly to raising awareness, improving prevention, and enhancing treatment methods in this field. According to Keçeci (2020b), Turkey reports few occupational diseases. Legal and medical rules, inspection and inspection system failures, and a lack of knowledge and education of involved parties are among the causes for the low incidence of occupational diseases recorded in Turkey. Ağar and Kızıltan (2022) stressed the possibility of occupational illness prevention. Employers and workers should get extensive information and training

on employee rights. In order to improve employees' physical and mental health, ergonomics specialists must be hired in office-heavy businesses, gyms must be established, employees who go to the gym must work less hours, and non-gym workplaces must provide sports allowances.

Evolution of Workplace Studies: Sorensen et al. (2021) update the conceptual framework for studying workplace evolution in the context of socio-political-economic factors. They emphasize the importance of a systems-level approach to prioritize research and enhance worker safety, health, and welfare, particularly in response to emerging challenges like COVID-19.

Proactive Management of Mental Health: Joyce (2013) advocates for a proactive approach to mental health management in the workplace, emphasizing the crucial role of line managers. This approach entails recognizing employees as valuable assets, assessing psychosocial risks, and promoting health and wellbeing, including flexible work arrangements for those with minor conditions.

Holistic Health Approach: The concept of holistic health, encompassing mental, physical, spiritual, and social well-being, is extensively discussed in various studies (Brassey et al. 2023, November 2). Petrie et al. (2018) present a framework for employers to foster mentally healthy workplaces, comprising strategies like work design, organizational resilience, employee resilience, early help-seeking, and support for recovery. Lizano, He, and Leake (2021) also developed a comprehensive worker well-being framework based on Engel's biopsychosocial model of health, addressing a gap in the literature.

Global Perspectives on Job Satisfaction: A global survey by the McKinsey Health Institute surveyed employees across 30 countries, revealing a strong link between job satisfaction and overall well-being. The survey underscores the need for organizations to create work environments that support comprehensive employee health (Brassey et al. 2023, November 2).

Standards for Psychological Risks Management: The introduction of PAS1010 by the British Standards Institution (BSI) in 2011 marked a significant step in managing psychological risks in occupational health and safety. This was followed by similar guidelines and standards in Canada, Australia, and the first global standard published in 2021. However, Jain et al. (2021) note that implementation and coverage of these measures remain inadequate. Based on age-adjusted mental health prevalence, Kim et al. (2006) found that nonstandard employees were more likely to be mentally ill. After controlling for socioeconomic status (education, occupational class, and income) and health habits, nonstandard work status was linked to poor mental health (smoking, alcohol consumption, and exercise). However, gender affected the connection between nonstandard work and mental health.

Public Mental Health and Occupational Health: Blissard Barnes and Henderson (2018) highlight the critical role of public mental health and its impact on the working population. They stress the importance of occupational health (OH) teams in improving public mental health in the workplace and call for OH to involve management in adopting a public mental health agenda.

The review of these various aspects of mental health in occupational settings underscores the critical importance of a holistic and proactive approach to mental health and well-being in the workplace. The research highlights the need for organizations to recognize the complex interplay between individual health behaviors, socio-economic factors, and workplace environments in shaping employee mental health. The integration of public mental health into occupational health policies, the development of comprehensive frameworks for mental well-being, and the global perspective on job satisfaction and employee health reflect a growing awareness of the multifaceted nature of mental health in the workplace. However, the findings also reveal gaps in the implementation and coverage of psychological risk management measures, indicating a need for continued focus and improvement in this area. The collective insights from these studies point towards a future where mental health is not just an individual concern but a fundamental aspect of organizational health, necessitating a collaborative, interdisciplinary approach to ensure the well-being of the workforce in a rapidly changing global work environment.

3.4.2.Inclusive Workplace Strategies for Vulnerable and Marginalized Groups

Inclusive Workplace Strategies for Vulnerable and Marginalized Groups include creating inclusive policies, providing diversity and inclusion training, and implementing mentorship programs. These strategies

aim to address the unique challenges faced by vulnerable and marginalized groups in the workplace and ensure equal opportunities for career growth and success. Additionally, fostering a supportive and inclusive work environment can help these individuals feel valued and respected, ultimately leading to increased productivity and employee satisfaction. As noted by Signoretti (2021), it can be suggested that in tough economic times, vulnerable workers can lose out as employers prioritize cost savings over inclusiveness. Strong labor laws and institutions are needed to protect such groups when the normal dynamics of employer-union-worker relations fail them. The identities and needs of minorities end up overlooked if dependent solely on market mechanisms. Vulnerable workers suffer, diversity commitments weaken, and protective institutions/laws are crucial in difficult labor markets.

It is important to identify the vulnerable workers and groups in this respect. As emphasized by Restubag et. al. (2021) there are increased scholarship on understudied vulnerable workers including 1) workers with chronic illness, 2) workers with mental illness, 3) immigrants and migrants, 4) refugees, 5) victims of violence, and 6) ex-offenders. Therefore, the first thing that they do is address the problem of definitional clarity, establish a distinction between vulnerable workers and vulnerable work, and provide an interactionist perspective on the concept of vulnerable workers. Such a deifinition is important because, by focusing on workers with chronic illness, researchers can explore the unique challenges and needs these individuals face in the workplace. Similarly, studying workers with mental illness can shed light on the barriers they encounter in accessing employment opportunities and the necessary support systems. Understanding the experiences of immigrants and migrants in the labor market can help identify ways to promote their integration and protect their rights. Furthermore, investigating the specific vulnerabilities faced by refugees can lead to the development of targeted interventions to enhance their employment prospects. Additionally, examining the experiences of victims of violence and ex-offenders can contribute to the development of strategies for their successful reintegration into the workforce. Overall, this increased scholarship on various vulnerable worker groups will help inform policies and practices that promote inclusivity and support in the workplace.

Ioannidou and Parma (2022)examined the relationship between job-related education, formal or nonformal, and the welfare system in 14 European countries facing technological automation. The chance of low-educated and low-skilled workers training and learning varied widely across the 14 countries. Due to their professions, they had few possibilities to participate in such activities. The workers who needed training the most were the least likely to receive it and comprehend the importance of workplace education. In response to the challenges of increasing discrepancies in workplace learning opportunities, Hwang and Yoon (2023) suggested workplace learning as an area that needs more attention from multidisciplinary perspectives to support the needs of disadvantaged populations. Therefore, it is important to the consequences faced by individuals who are unable to receive adequate training due to their professions, and how it affects their career prospects and overall quality of life. Moreover, One can analyze the various factors that contribute to the lack of opportunities for training among those who need it most, such as financial constraints, job insecurity, or inadequate support systems Discussing the potential solutions to improve access to workplace learning for low-educated and low-skilled workers, such as implementing government subsidies or grants for training programs, partnering with community organizations to provide support and resources, or promoting employer-led initiatives to prioritize employee development can also be suggested.

Fassinger (2008) outlines how systemic barriers and challenges affect diverse workers' vocational behavior. Fassinger (2008) describes both external barriers (like discriminatory educational and occupational practices, hostile work environments) and internal barriers (such as internalized oppression, which undermines self-confidence and aspirations). These barriers can be either active (direct and overt, like biased evaluations or inequitable salary distributions) or passive (indirect, like a lack of mentors or resources). Disadvantages can range from major issues (like impoverished schools or harassment) to seemingly minor ones (such as occupational stereotyping). These intersections present distinct obstacles for each worker, compromising mental and financial health. Fassinger (2008) stresses addressing all workplace barriers, highlighting varied group issues in future sections. By conducting scientific research on the benefits of diversity and the role of psychology in advocating for policy change, psychologists can provide crucial evidence to support legislative and policy changes that promote equal opportunities and economic benefits for all individuals in the workforce. Ultimately, psychology has the potential to act as a powerful agent of social change by influencing policy implementation and challenging the financial burdens that hinder workplace diversity and equality. Therefore, . one could explore the obstacles faced by workers in various

industries that can negatively impact their mental and financial health. This could include factors such as low wages, lack of benefits, job insecurity, or discrimination. Another topic to delve into is Fassinger's emphasis on addressing workplace barriers for diverse groups. Building upon the importance of scientific research, one could also explore the role of occupational health psychology in promoting well-being in the workplace. This could involve studying the impact of work-related stress, burnout, and job satisfaction on employee mental health and productivity.

Lyons (2019) emphasizes that despite efforts to bridge the digital divide, connectivity deployment, digital skills acquisition in formal and non-formal education, and skills training to the labor market remain important problems. Without strategies to address the digital divide impacting disadvantaged communities, inequalities and unemployment would rise, affecting societies as a whole. They therefore suggest that, the private sector, academia, and civil society must reassess strategic frameworks for digital inclusion to examine hurdles to digital exclusion for disadvantaged and vulnerable populations, including impediments to digital knowledge, skills training, and prospective employment, governments. One can explore how companies can play a key role in bridging the gap by investing in infrastructure, offering affordable access to technology, and providing skills training programs. Also, one can examine how academic institutions can partner with businesses to develop innovative solutions for digital inclusion, such as curriculum development focused on emerging technologies or research collaborations aimed at understanding barriers faced by disadvantaged populations. Furthermore, one can highlight the need for civil society organizations to advocate for digital empowerment and raise awareness about the importance of digital inclusion.

The findings emphasize the complexity and urgency of implementing inclusive workplace strategies for vulnerable and marginalized groups. In tough economic times, the risk of overlooking the needs of these workers increases, as employers may prioritize cost-saving measures over inclusivity. The findings underscores the necessity of strong labor laws and institutions to protect vulnerable workers, particularly when traditional employer-union-worker dynamics fail to address their needs. An increased focus on diverse vulnerable worker groups, such as those with chronic illnesses, mental health issues, immigrants, migrants, refugees, victims of violence, and ex-offenders, reveals the multifaceted nature of workplace vulnerabilities. The findings highlights the need for greater definitional clarity and a deeper understanding of the challenges these groups face. Additionally, it brings to light the discrepancies in workplace learning opportunities, particularly for low-educated and low-skilled workers, and the systemic barriers that diverse workers face in their vocational paths. The findings further points out the significance of digital inclusion and the role of various sectors in bridging the digital divide.

3.4.3.Global and Cultural Perspectives

The global occupational health perspective is essential for understanding and addressing the health and safety needs of workers around the world. This perspective encompasses a broad range of factors, including cultural, social, and economic influences on occupational health. It recognizes the importance of promoting healthier workplaces, preventing occupational diseases and injuries, and ensuring access to quality healthcare for all workers, regardless of their location or occupation. By adopting a global occupational health perspective, we can work towards creating safer and more sustainable working environments for everyone. In this respect, Chirico (2019) found that 64% of 85 countries do not require psychological risk assessment and prevention in workplace safety and health laws. The analysis also showed a frequent gap between industrialized and developing nations in similar legislation. Within developed countries, Scandinavian occupational health and safety cultures differed from others. The report also noted that many countries only criminalize workplace violence if it violates moral or religious norms. This study shows that psychosocial hazards and workplace violence rules vary widely across countries, resulting in differing worker protections and global health impacts. Taking this into consideration, it is also possible to investigate the influence that different psychological risk assessment and preventive tactics have on the laws that govern workplace safety and health in various nations. Another research approach that might be considered is the investigation of the factors that contribute to the disparity that exists between industrialized nations and developing nations in terms of legislation concerning the assessment and prevention of psychological risks present in the workplace. It is possible to investigate the ramifications of criminalizing violence in the workplace solely if it breaches moral or religious principles, including the effects that this would have on worker rights all over the world.

According to the findings of Jilcha and Kitaw (2016), despite the fact that there are relatively growing research trends in the field of workplace safety and health regulation, there is a dearth of studies that focus on integrated and universal management systems. A further finding of the research is that there are gaps that call for more research areas. The following areas were identified: differences in safety culture (dynamic state of culture) that have an effect on the workplace; research methodologies that approach variation in a way that is not holistic; performance measurement of workplace approaches that are unstable; the impact of technological innovation on workplace safety; the absence of a clear distinction between developing and developed countries' safety management systems; the absence of multidisciplinary researches; and the lack of an impact of management's system integration. Therefore one can examine how differences in safety culture affect workplace incidents offers insights into the efficacy of safety practices. Advancing research methodologies will allow for a deeper understanding of the diverse factors that influence workplace safety also. Developing robust tools to measure performance in dynamic work environments could be crucial for future researches, especially in industries with fluctuating conditions. Implementing effective safety training programs can also be key topic for focusing on educating workers and tailoring training to specific needs.

In conclusion, the global perspective on occupational health is vital for addressing the diverse health and safety needs of workers worldwide. This viewpoint considers the myriad of cultural, social, and economic factors impacting occupational health, advocating for healthier workplaces and equitable access to quality healthcare. Investigating these aspects will not only provide deeper insights into workplace safety practices but also contribute significantly to creating safer and more efficient working environments globally. Hence, advancing our understanding and implementation of global occupational health perspectives is essential for the well-being and safety of the workforce worldwide.

3.4.4. Next-Generation Occupational Health and Safety

Next-Generation Occupational Health and Safety aims to integrate advanced technologies and data-driven approaches to enhance workplace safety. This includes the use of wearable devices and sensors to monitor workers' health and detect potential hazards in real-time. Additionally, the implementation of artificial intelligence and machine learning algorithms can help analyze vast amounts of data to identify patterns and trends, enabling proactive measures to prevent accidents. By combining these innovative solutions with global occupational health perspectives, we can revolutionize workplace safety and ensure the well-being of workers worldwide. Patel et al. (2021) studied commercial wearable technology and connected worker systems in various work contexts. These technologies improve worker ergonomics, situational awareness, injury prevention, workflow efficiency, and physical and mental wellbeing. Most technologies evaluate biomechanical and physiological information to assess human performance. However, intelligent systems using brain wave sensing, biofeedback, and human-in-the-loop models are being created to monitor and manage mental health issues like stress, emotions, and mental states. Manufacturers can expand their business by using these new tools to predict and prevent occupational dangers. These gadgets must undergo independent, third-party validation before widespread workplace deployment. Consumers of this technology must compare it to other solutions and tools. Future research should explore the integration and advancement of intelligent systems in managing mental health within workplace environments. This includes an in-depth analysis of how emerging technologies, such as brain wave sensing and biofeedback, are transforming the monitoring and management of mental health issues. The focus should be on understanding the efficacy of these technologies in detecting and addressing stress, emotional responses, and various mental states, and how they can be incorporated seamlessly into daily work routines for proactive mental health care.

Lee et al. (2015) examined smart characteristics needed for next-generation PPE for firefighters in Australia, Korea, Japan, and the US. Among smart features, 27% of Korean and 30% of U.S. firefighters prioritized ‘a location tracking system'. However, 43% of Japanese firefighters picked ‘an automatic body cooling system' and 21% of Australian firefighters chose both. These countries commonly ranked ‘a location monitoring system', ‘an autonomous body cooling system', ‘a wireless communication system', and ‘a vision support system' in order of priority. The least liked were ‘an automatic body warming system' and ‘a voice recording system'. There is a crucial need for research on the implementation and efficacy of location tracking systems in personal protective equipment (PPE) for firefighters, especially in the context of Korea and the United States. The Importance of a Location Tracking System in Next-Generation PPE for Firefighters could be an important topic for the literature. Exploring the demand for an automatic body cooling system and the significance of prioritizing multiple smart features in australian firefighting could be important topics for

future researches. Additionally, investigating the integration of multiple smart features, such as real-time monitoring and communication capabilities, would provide valuable insights into enhancing the efficiency and effectiveness of firefighting operations.

Søvold et al. (2021) examined how wearable technology and linked worker solutions are enhancing ergonomics, situational awareness, injury risk management, workflow efficiency, and healthy behaviors in various work situations. Using brain wave sensing, biofeedback, and human-in-the-loop models, emerging intelligent systems are actively monitoring and managing mental health (e.g., stress, emotions, states of mind). Most gadgets track human performance. These intelligent systems can forecast a number of occupational danger scenarios for appropriate action, giving device makers enough opportunity to increase their client base. Device makers must undergo independent third-party testing to ensure product dependability for workplace technology adoption.

In conclusion, the transition toward Next-Generation Occupational Health and Safety, which incorporates cutting-edge technologies such as wearable devices, artificial intelligence, and machine learning, is causing a revolution in the field of workplace safety. It should come as no surprise that there is a need for greater research into the effectiveness of these technologies, particularly in the field of mental health management and in specialized applications such as firefighting.

4.Discussion/Conclusion

This analysis underscores the importance of occupational health and safety education across various facets of society and professional sectors, with a strong emphasis on articles and proceedings, and a multidisciplinary approach. The bibliometric study of "occupational health and safety education" reveals several key insights:

1. **Document Types**: Articles and proceeding papers dominate the literature, together comprising over 95% of the 127 records. Review articles, book chapters, and early access documents are much less common.
2. **Publication Trends**: A linear regression model shows an overall upward trend in publications from 1995 to 2023, with some variability and a notable peak in 2019.
3. **Index Distribution**: Most literature is found in conference proceedings and emerging sources, with significant representation in both social science and scientific disciplines.
4. **Interdisciplinary Interest**: The field intersects with various disciplines, including public health, engineering, nursing, and the social sciences, highlighting its multidisciplinary nature.
5. **Micro-Topics**: "Safety Climate" is the most cited micro-topic, reflecting a strong focus on organizational safety perceptions. Other specific areas include low back pain, nursing, road safety, and job satisfaction, among other

In parallel with this study, Keçeci (2020a) analyzed 1585 postgraduate theses on Occupational Health and Safety (OHS) from 1986 to 2020, finding that 1496 were master's and 89 were doctoral theses. The study revealed that 18% of these theses were written before 2013, with a significant increase to 82% after 2013, likely influenced by the implementation of the Occupational Health and Safety Law. Doctoral research focused mainly on public health, labor economics, industrial engineering, law, and accidents, while lesser-studied areas included tourism, forestry, geodesy, maritime, and public relations. The master's thesis subjects with the highest number of studies are public health, labor economics and industrial relations, law, civil engineering and industrial engineering, and family medicine, anthropology, fisheries technology, banking, food and hygiene technology, nutrition and dietetics and leather engineering.

This study has revealed significant insights into the field of occupational health and safety education, emphasizing its multidisciplinary nature and the diverse range of topics it encompasses. Our bibliometric analysis and literature review, aided by the innovative use of AI chatbots like GPT-4, Claude AI, and Bard Chat, have identified key gaps and emerging themes in the existing literature. These themes span various aspects of occupational health and safety, including educational methods, workplace safety, professional development, healthcare and wellbeing, and the impact of technology. Furthermore, the integration of

technology in occupational health and safety is becoming increasingly important, with emerging themes related to the use of artificial intelligence, virtual reality, and wearable devices to enhance workplace safety.

We have observed a predominant focus on practical safety applications and pedagogical approaches, reflecting the importance of occupational health in healthcare, educational, and organizational contexts. The research also highlights the significance of global and cultural perspectives in understanding and addressing occupational health challenges. The role of technology, particularly in the next generation of occupational health and safety, is underscored, suggesting a future trend towards more technologically integrated and data-driven approaches. Our findings indicate a need for further research in areas such as inclusive workplace strategies for vulnerable and marginalized groups, mental health and wellbeing frameworks, and the development of comprehensive regulatory and policy management frameworks. These areas are crucial for advancing knowledge and practice in occupational health and safety education and ensuring a safe, healthy, and productive workforce.

This study's innovative approach to literature review, combining traditional bibliometric methods with AI-driven analysis, has provided a more nuanced understanding of the current state of occupational health and safety education. It has opened new avenues for future research and highlighted the importance of interdisciplinary collaboration and the integration of emerging technologies in advancing the field. The incorporation of AI-driven analysis has allowed for a comprehensive examination of a vast amount of literature, identifying key trends, gaps, and areas of improvement in occupational health and safety education.

In conclusion, the dynamic and evolving landscape of occupational health and safety education requires continuous exploration and adaptation. As we move forward, it is imperative to address the identified gaps and emerging themes to develop more effective, inclusive, and technologically advanced occupational health and safety education and practices. This will not only enhance workplace safety but also contribute significantly to the overall well-being and productivity of the global workforce.

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