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The Global Research Trends on Safety Culture Over the Last Decade: A Bibliometric Analysis

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Abstract: Safety culture is becoming increasingly popular in many industries to reduce the risk of major disasters and workplace accidents. This study applies bibliometric analysis to create a structured overview of the traits and advancements in safety culture. The Web of Science Core Collection was used to conduct a bibliometric analysis of scientific articles to identify the research characteristics and development trends in the safety culture research domain. In general, 755 articles on safety culture with 2171 authors, 254 sources, 77 countries, and 967 organizations were listed between 2013 and the first seven months of 2023. The collected data were mapped by VOSviewer and presented with the help of diagrams and graphs. From the 64 research in 2013 to the most recent 110 publications in 2022, the number of studies on safety culture has risen substantially. The three countries that contributed the most to the literature on safety culture research were the USA, China, and Australia. Fu, Kines, and Feng are the most prolific authors, while Fang, Feng, and Fu are the most cited authors in safety culture publications. The subjects with great popularity in the safety culture, as determined by keyword frequency, are safety climate, safety performance, safety, safety management, and human factors. The information provided in this study paints a clear picture of the research advancements made in safety culture analysis.

Keywords: safety culture, bibliometric analysis, VOSviewer, occupational health and safety, occupational safety.

As tendências globais de pesquisa sobre a cultura de segurança na última década: uma análise bibliométrica

Resumo: A cultura de segurança está se tornando cada vez mais popular em muitas indústrias para reduzir o risco de grandes desastres e acidentes de trabalho. Este estudo aplica uma análise bibliométrica para criar uma visão estruturada das características e avanços na cultura de segurança. A Coleção Principal da Web of Science foi utilizada para realizar uma análise bibliométrica de artigos científicos a fim de identificar as características de pesquisa e as tendências de desenvolvimento no domínio da pesquisa sobre cultura de segurança. No geral, foram listados 755 artigos sobre cultura de segurança, totalizando 2171 autores, 254 fontes, 77 países e 967 organizações entre 2013 e os primeiros sete meses de 2023. Os dados coletados foram mapeados pelo VOSviewer e apresentados com a ajuda de diagramas e gráficos. De 64 pesquisas em 2013 para as mais recentes 110 publicações em 2022, o número de estudos sobre cultura de segurança aumentou substancialmente. Os três países que mais contribuíram para a literatura sobre pesquisa em cultura de segurança foram os EUA, China e Austrália. Fu, Kines e Feng são os autores mais prolíficos, enquanto Fang, Feng e Fu são os autores mais citados em publicações sobre cultura de segurança. Os temas com grande popularidade na cultura de segurança, conforme determinado pela frequência de palavras-chave, são clima de segurança, desempenho de segurança, segurança, gestão de segurança, e fator humano. As informações fornecidas neste estudo pintam um quadro claro dos avanços na análise da cultura de segurança.

Palavras-chave: cultura de segurança, análise bibliométrica, VOSviewer, saúde e segurança ocupacional, segurança ocupacional.

1.Introduction

Safety culture, a significant part of organizational culture, is known to influence employees' perceptions, attitudes, and behaviour in connection to the organization's continued performance in terms of health and safety (Cooper, 2000). The concept of safety culture was first introduced in the accident review held after the Chernobyl disaster published by the International Atomic Energy Agency (IAEA, 1986) (Morrow et al., 2014; Yorio et al., 2019). This report underscored the critical role of the human factor in ensuring safety, attributing part of the Chernobyl disaster to deficiencies in safety culture within the former Soviet nuclear industry and the Chernobyl factory (IAEA, 1986). After that, there has been a noticeable increase in interest in the studies of safety culture. The increase is caused by the fact that safety culture is viewed in many sectors as a way to lower workplace accidents (Fernández-Muñiz et al., 2007; Nunen et al., 2018). Despite significant advancements in technology and occupational health and safety management systems, the key to further improvements lies in fostering a robust safety culture within the workplace. This emphasis on a safety-oriented mind-set has proven effective in notably reducing the occurrence of accidents (Kim et al., 2016).

The literature contains many different definitions of safety culture. For example, Kennedy and Kirwan (1998, p.251) defined it as "Safety culture is a sub-element of the overall organisational culture. It is an abstract concept which is underpinned by the amalgamation of individual and group perceptions, thought processes, feelings and behaviour which in turn gives rise to the particular way of doing things in the organisation". According to Cooper (2002, p.31), "safety culture is a subcomponent of corporate culture, which alludes to individual, job and organizational features that affect and influence safety". Glendon and Stanton (2000) define safety culture as encompassing attitudes, behaviours, norms, values, personal responsibilities, and various human resources elements such as training and development. These various definitions that are being taken into consideration do share certain similarities:

- The term "safety culture" refers to the values held by all individuals within a group or organization.
- The management and supervisory systems are only one aspect of safety culture, which also addresses formal safety concerns in an organization.
- The importance of everyone's input is emphasized in safety culture.
- An organization's safety culture impacts how its employees behave at work.
- Safety culture indicates the correlation indicator between security achievement and reward systems.
- It indicates a desire to learn from errors, incidents, or accidents within the organization.
- It is stable, enduring, and change-resistant (Wiegmann et al., 2002).

Many industries have assigned a significantly more important role to safety culture in safety management. In high-risk socio-technical systems, safety culture has been identified as a critical component affecting the overall level of safety in businesses. It offers a worldwide characterization of certain behavioural preconditions that are common to disasters and accidents (Martyka & Lebecki, 2014). Recently, in determination to understand the causes of industrial accidents, a lot of research has focused on the safety cultures in high-risk industries. For example, based on statistics on repeated accident patterns in coal mine accidents and the determinations of the safety culture dimension, 67 typical major accidents were analysed to find the shortcomings in the safety culture. Specifically, the study focused on how departments, safety involvement, safety

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communication, and supervision climate influence and enhance the safety culture to further decrease industrial accidents (Zhang et al., 2020). Another research was addressed using a survey administered to the nuclear power plants in the United States, responses from 63 nuclear power plant sites. Correlations suggested statistically significant relationships between safety culture, as measured by the survey, and multiple nuclear power plant performance indicators (Morrow et al., 2014). Another study reported 120 fatal confined space accidents that occurred between 2008 and 2018 in China, and the results show that inadequate safety culture is the principal cause of accidents (Xia et al., 2021). Moreover, the realization that safety culture plays an important role in preventing occupational accidents has led to numerous attempts to define and evaluate safety culture in many organizations (Cooper, 2000; Patterson, 2002; Havold, 2005).

The research topic of safety culture is a complicated subject in terms of its content and multidimensionality. Numerous efforts have been committed to developing and testing models and theories to frame the concept (Geller, 1994). It is possible to distinguish between two groups by analysing an organization's safety culture indicators. One is the organizational effects of safety culture, which deals with the specific elements of a safety management system (Guldenmund, 2000; Cooper, 2000; Martyka & Lebecki, 2014). The management's safety culture is characterized by indicators that are identified through field research. The other category is made up of individual qualities that show up as belief systems, attitudes, social norms, and patterns of accepted behaviour. These markers describe the safety culture of workers at all levels, including managers (Martyka & Lebecki, 2014).

Bibliometric analysis is characterized as a statistical and quantitative tool used for analysing research publications (Liu et al., 2018). It enables the measurement of the growth of literature in specific subjects and assesses the impact of individual research results. This method proves to be a valuable choice for evaluating trends in research activities (Gao et al., 2019). Bibliometric studies have gained widespread acceptance across various academic disciplines, encompassing fields such as management, economics, accounting, consumer studies, promotions, and entrepreneurship (Gao et al., 2021). Bibliometric methods typically assess research trends through the publication outputs of authors, countries, research institutes, journals, and research fields, or through citation analysis (Li et al., 2009; Li & Zhao, 2015). Bibliometric analysis has the capability to unveil the most recent breakthroughs, current research trajectories, and predominant themes within a specific research domain. Moreover, bibliometric analysis plays a vital role in the decision-making process associated with the field of science. It is extensively employed for ranking applications for academic positions and assessing the performance of journals, countries, and institutions (Nunen et al., 2018). Bibliometric analysis has been introduced in many science research area, such as: Human reliability research (Tao et al., 2020), construction safety management (Liang et al., 2018; Akinlolu et al., 2022), behaviour-based safety (Abd Aziz et al., 2022), occupational health and safety management (Wang et al., 2020), safety science (Merigo et al., 2019).

Safety culture is a fascinating and highly relevant topic for bibliometric examination. Its complexity and the steadily increasing rate of publications make it an ideal subject for such analysis (Nunen et al., 2018). This descriptive article offers a comprehensive macro-level overview of the characteristics of safety culture publications through bibliometric analysis. The data presented in this paper serves to paint a clear and insightful picture of the academic advancements made in the field of safety culture analysis. Furthermore, it

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can serve as a valuable resource for academics and professionals, assisting them in identifying the primary influencers in various aspects of safety culture analysis, including authors, journals, countries, institutions, and references. The increasing emphasis on safety culture in various industries underscores the importance of understanding the trends and developments in this area. By delving deeper into the data, we can gain a more nuanced understanding of the evolution of safety culture analysis and identify areas that require further exploration.

2. Methodology

The study retrieved the necessary data from the Web of Science (WoS) Core Collection. The WoS has been selected as the preferred database due to its extensive collection of citations and abstracts from high-quality and influential scientific research. Additionally, it offers the convenient feature of exporting bibliographic information, making it compatible with various widely used bibliometric applications (Yang et al., 2013; Hou et al., 2021). For this research, the term "safety culture" was used as the search topic. Quotation marks have been incorporated into the search term to refine and narrow down the results. This technique helps to find exact phrases or terms, ensuring greater accuracy and relevance in the search process. The research was conducted at WoS between 2013 and the first seven months of 2023. Since the documents were obtained in the seventh month of 2023, the aim is to observe trends up to the start date of the study. Also, to provide the right level of detail for the analysis, safety & maintenance, which is listed under the citation topics meso hierarchy, was selected. It is important to note that the study excludes the patient safety culture in nursing, which has 1329 articles. An essential metric for determining the trajectory of development in a scientific study discipline or topic is peer-reviewed publications. Because of this reason, only peer-reviewed journal articles are taken into consideration in this study. Fig. 1 shows the search method. Finally, a total of 755 documents were collected from the WoS database and analysed. In Fig. 2, the steps used to find the final data are shown.

Fig. 1 Search method in WoS

The bibliometric approach is used as a quantitative analysis technique to determine the present status and development trend in many disciplines (Liu et al., 2018; Donthu et al., 2021). In this study, a widely used free bibliometric analysis software VOSviewer was used to analyse and visualize publications related to "safety culture" in author, country, citation, keywords, etc. (https://www.vosviewer.com/download). It is a software program that is accessible for free. The size and font of the circ show the number of occurrences, the colours stand in for clusters, and the distance between two circs indicates how closely

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linked and similar they are to one another. Larger labels and circles indicate an item's significance. The density view is extremely useful for getting an understanding of a map's structure and for highlighting its most important parts (Van Eck & Waltman, 2010).

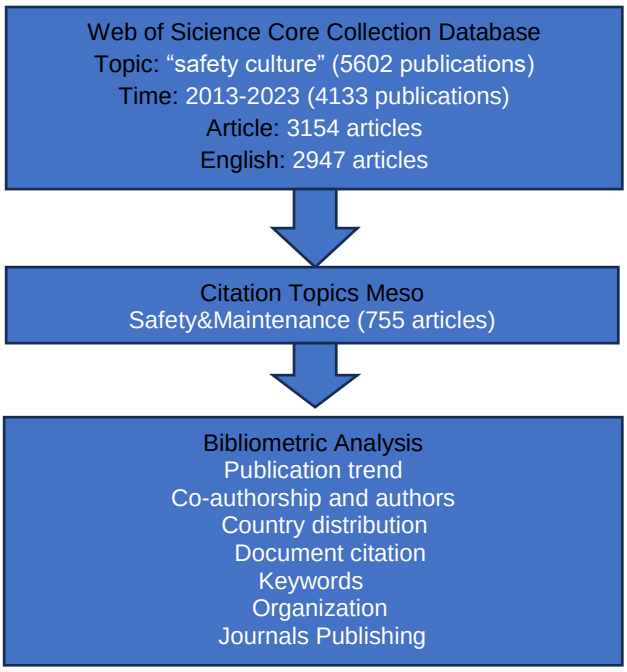

Fig. 2 The steps of final data

3. Results and Discussion

3.1. Publication trend in the safety culture field

The frequency distribution of the 755 publications that were chosen is presented in Fig. 3. according to the year of publication. An undulate trend was observed between 2013 and 2018. The number of publications has shown an increasing trend from 2018 to 2022. The number of publications reach a peak in 2022 (110 articles). The observed trend can be ascribed to the growing recognition of the significance of safety culture and the commitment of numerous scientists to research in safety studies. The rising number of publications indicates a heightened awareness and emphasis on safety culture. Since only seven months were considered in this study, only 34 articles were published in 2023. Between 2013 and 2022, there could be an average of 72 publications every year. Numerous studies have demonstrated the need to popularize the concept of safety culture in workplaces, including various industries such as nuclear power plants, oil and gas, maritime operations, etc., to prevent and mitigate accidents. For example, Arslan et al. (2016) provide a new safety culture assessment and improvement framework to enhance maritime safety in the maritime sector.

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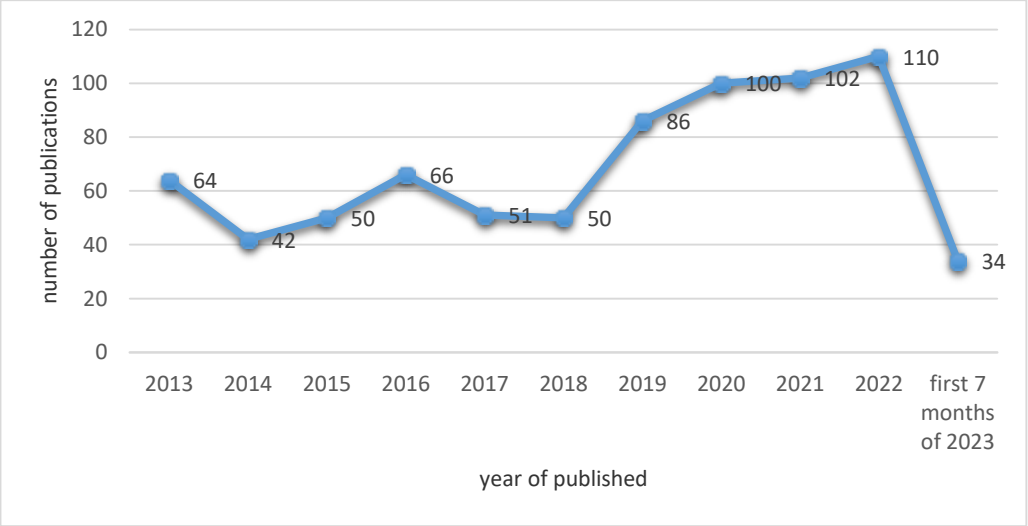

Fig. 3. Number of publications by publication year

3.2. Co-authorship and authors analysis

In this section, the collaboration networks of authors are examined to determine the trends in the safety culture field evolution and identify effective writers, and performance of innovative countries. VOSviewer was used to analyze the collaboration style of the authors who published on safety culture. There were a total of 2171 different authors who contributed to the 755 articles. Each author has written at least one paper on this topic. Additionally, there are no included who are not linked to other authors in the network. The size of the circles represents the number of publications, while the lines connecting two authors indicate their collaboration. Collaboration clusters are denoted by different colors, with the cooperation network revealing the presence of nine significant author clusters. Pete Kines, Gerard I.J.M Zwetsloot, Frank Guldenmund, and Ahmad S.N. Isha are the principal researchers in the network. One of these primary researchers is associated with other researchers. The result of this author's cooperation network is displayed in Figure 4.

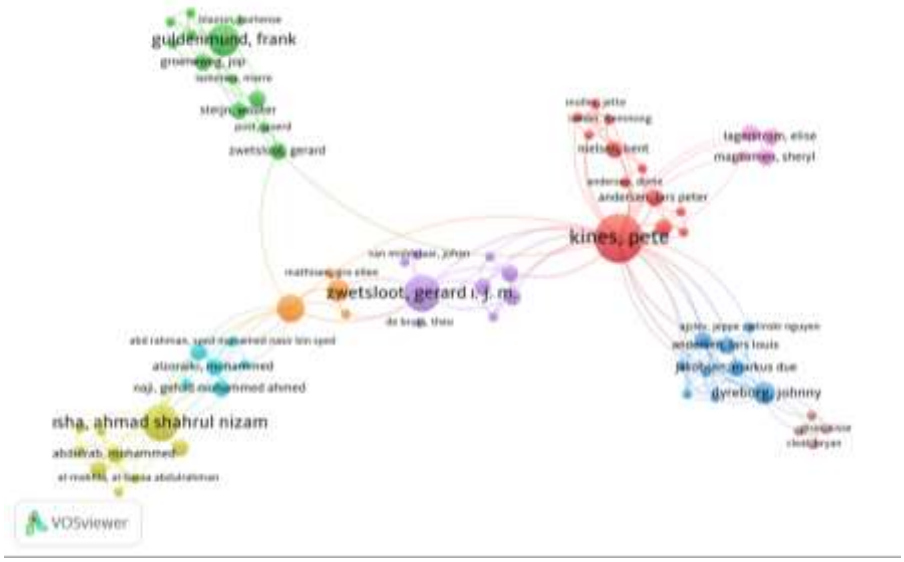

Fig. 4. Co-Authorship network in safety culture

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Table 1. presents the top 10 authors who have published the most about safety culture. The ranking is determined by the author's overall productivity, not by authorship sequence. With ten articles, Gui Fu from China University of Mining and Technology (Beijing) has published the most on the subject of safety culture, followed by Pete Kines from National Research Centre for the Working Environment and Yingbing Feng from Western Sydney University, who each have nine publications. According to citations, Dongping Fang (328), Yingbing Feng (285), and Gui Fu (242) are the researchers who have contributed the most to the field of safety culture. China has the most publications with 16, making it the most productive nation. Australia comes second with 15 articles, and England comes third with 14. The top ten authors are from China, England, and Australia, with equal amounts.

Table 1. Top-10 safety culture authors by productivity

Number	Authors	Documents	Citations	Country	Organization
1	Gui Fu	10	242	China	China University of Mining and Technology (Beijing)
2	Pete Kines	9	227	Denmark	National Research Centre for the Working Environment
3	Yingbin Feng	9	285	Australia	Western Sydney University
4	Tom W. Reader	8	208	England	London School of Economics
5	Genserik Reniers	7	28	Belgium	University of Antwerp
6	Gerard I.J.M Zwetsloot	6	120	England	University of Nottingham
7	Tor-olav Naevestad	6	52	Norway	Institute of Transport Economics
8	Ahmad S.N. Isha	6	53	Malaysia	Universiti Teknologi PETRONAS
9	Dongping Fang	6	328	China	Tsinghua University
10	Susanne Bahn	6	139	Australia	Edith Cowan University

3.3. Country distribution analysis

To gain insights into the geographical distribution of safety culture articles, an analysis was conducted based on the affiliations of the authors. The findings revealed that articles on safety culture have been published in 77 different countries. Consequently, Table 2 displays the top 10 most prolific countries, measured by the total number of documents. The United States leads the list with 159 articles, accounting for 20.51% of the total, followed by China, Australia, and England with 90 (11.61%), 73 (9.41%), and 71 (9.16%) articles, respectively. Notably, these top three countries are situated on different continents. Nunen et al. (2018) found that in safety culture research between 1900 and 2015, the United States was most productive in the first place. Similarly, Li et al. (2022) concluded in their bibliographic comparative study on safety culture and safety climate that the most productive top 10 included the United States in the first position and Austria in the third position on safety culture. The United States maintains its first-place position.

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Table 2. The top 10 most productive countries of safety culture

Number*	Country	Documents	Citations	Total Link Strenght
1	USA	159	2132	285
2	China	90	1549	254
3	Australia	73	1326	254
4	England	71	1142	263
5	Iran	45	363	138
6	Norway	33	510	79
6	Canada	33	423	78
7	Italy	31	424	60
8	Netherlands	10	255	100
9	Malaysia	27	202	76
10	Türkiye	26	176	43

** The ranking number of equally active country is the same.*

Additionally, VOSviewer was used to reveal the collaboration relationships between countries in the field of safety culture. The network's countries of affiliation published at least one publication on the subject. The network excludes countries that are not linked to one another. The result of the co-authorship network of countries is presented in Fig. 5. According to this, the USA, Australia, China, and England have numerous cooperation with other countries. The line's thickness can be used to indicate how frequently co-authorship cooperation takes place with each country.

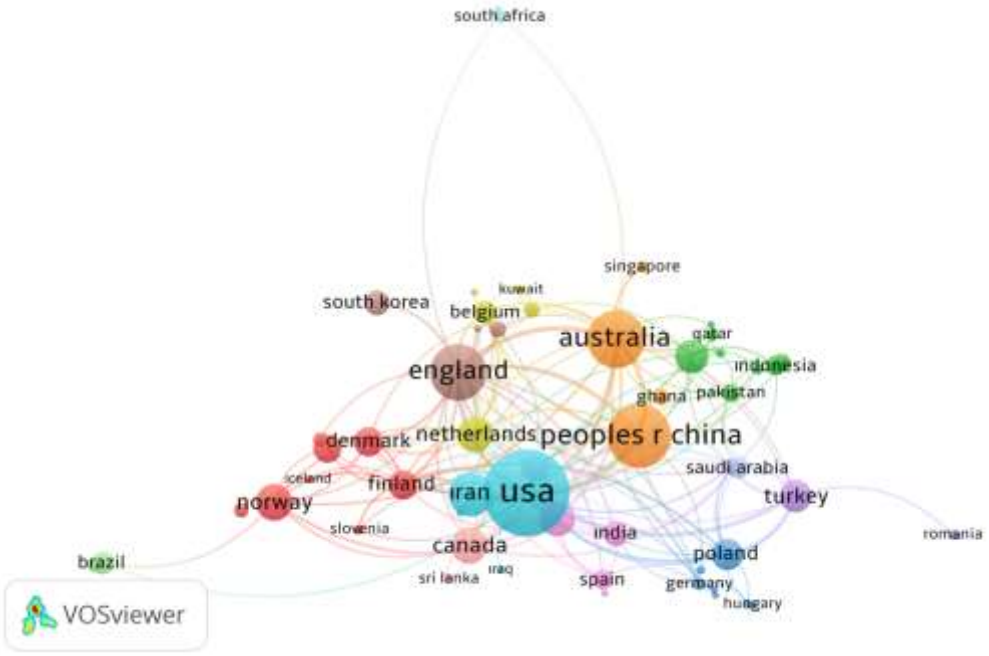

Fig. 5. Co-authorship network of countries

At the same time, Fig. 6. shows the citation network of countries. Countries that have published at least five documents and more articles were selected. USA, China, Australia,

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and England have the top with 2132, 1549, 1326 and 1142 citations, respectively. The USA is at the top of the number of publications and citations on safety culture. In this map, it is seen that the most cited countries are on different continents.

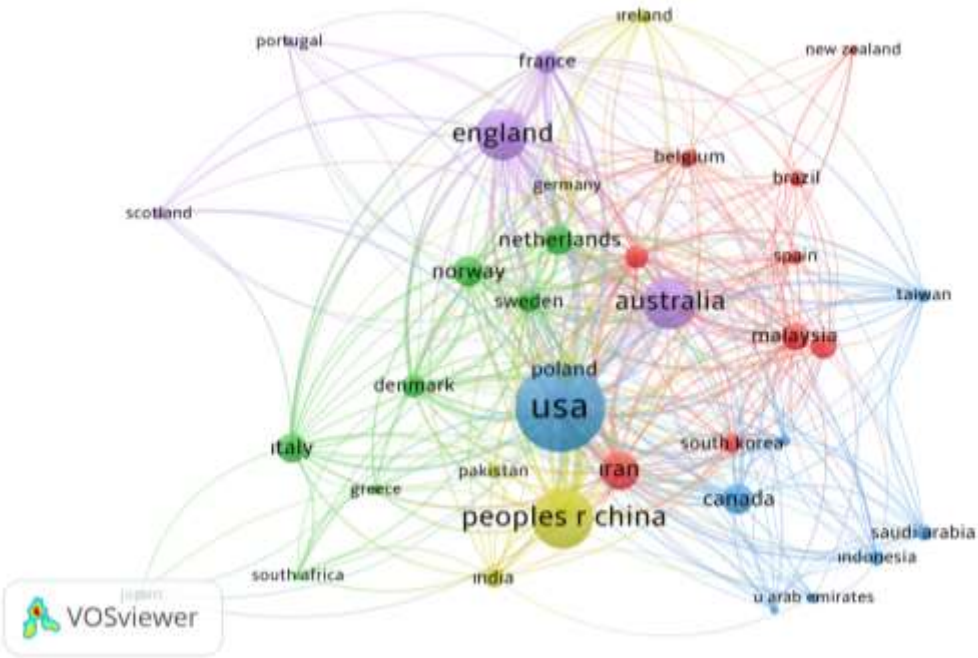

Fig. 6. Citation networks of countries

3.4. Document citation analysis

Following a search on the Web of Science using the keyword "safety culture," a total of 755 publications were identified. In Table 3, the top 10 most influential articles in the field of "safety culture" are presented, ranked by the number of citations they have received. Notably, three out of these ten highly cited papers were published in 2013, two in 2014, and one each in 2015, 2016, 2017, 2018, and 2020.

Table 3. The most important 10 articles which have highest citations

Number	Authors Name	Title	Year	Citation
1	Chauvin, C., Lardjane, S., Morel, G., Clostermann, J. P., Langard, B.	Human and organisational factors in maritime accidents: Analysis of collisions at sea using the HFACS	2013	321
2	Akhtar, M. J., Utne, I. B.	Human fatigue's effect on the risk of maritime groundings – A Bayesian Network modeling approach	2014	153
3	Fang, D., Wu, H.	Development of a Safety Culture Interaction (SCI) model for construction projects.	2013	146
4	Hofmann, D. A., Burke, M. J., Zohar, D.	100 years of occupational safety research: From basic protections and work analysis to a multilevel view of workplace safety and risk.	2017	141
5	Seo, H. C., Lee, Y. S., Kim, J. J., Jee, N. Y.	Analyzing safety behaviors of temporary construction workers using structural equation modeling.	2015	125
6	Bahn, S.	Workplace hazard identification and management: The case of an underground mining operation.	2013	119

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Number	Authors Name	Title	Year	Citation
7	Wang, L., Cao, Q., Zhou, L.	Research on the influencing factors in coal mine production safety based on the combination of DEMATEL and ISM.	2018	116
8	Graziano, A., Teixeira, A. P., Soares, C. G.	Classification of human errors in grounding and collision accidents using the TRACEr taxonomy.	2016	99
9	Nielsen, K. J.	Improving safety culture through the health and safety organization: A case study.	2014	82
10	Shneiderman, B.	Bridging the gap between ethics and practice: guidelines for reliable, safe, and trustworthy human-centered AI systems.	2020	80

Furthermore, documents related to safety culture that have garnered a minimum of 10 citations are visualized in Figure 7. Each node in the figure represents a publication, with the size of the node reflecting the number of citations the reference has received. It's evident that the three most cited articles are authored by Chauvin et al. (2013), Akhtar et al. (2014), and Fang et al. (2013), with respective citation counts of 321, 153, and 146.

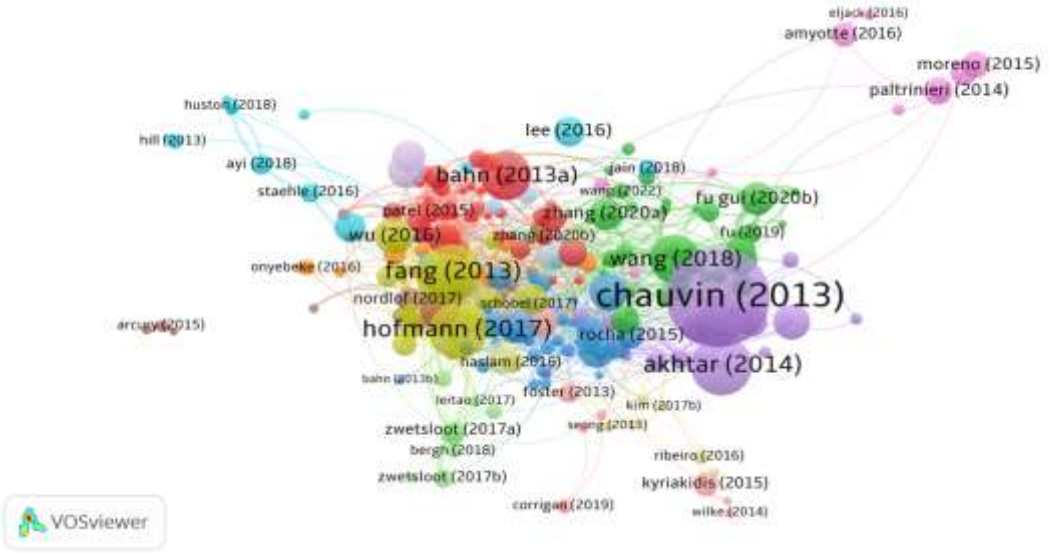

Fig. 7. Map of bibliographic coupling with documents

3.5. Keywords Analysis

Keywords serve as the essence of publication content, and the analysis of keywords aims to identify significant research topics. The co-occurrence network of keywords is employed to represent research themes. Keywords that are more frequently used are depicted with larger circles and text fonts. The lines connecting keywords indicate the strength of their correlation (Tao et al., 2020). Fig. 8 shows the co-occurrence author keywords network analysis of safety culture articles (minimum number of occurrences is 5 and the threshold is 78). It is evident from this figure that the keywords "safety climate," "safety performance," "safety," and "safety management" appear in descending order of frequency. Safety climate encompasses the collective perceptions and beliefs held by workers regarding safety in their workplace. It's important to note that "safety culture" and "safety climate" are interconnected concepts frequently used in the field of occupational health and safety to describe the attitudes, beliefs, practices, and perceptions related to

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safety within an organization (Guldenmund, 2000). Safety performance is contingent on workers adhering to preventive measures and actively contributing suggestions to enhance working conditions (Fernández-Muñiz et al., 2007).

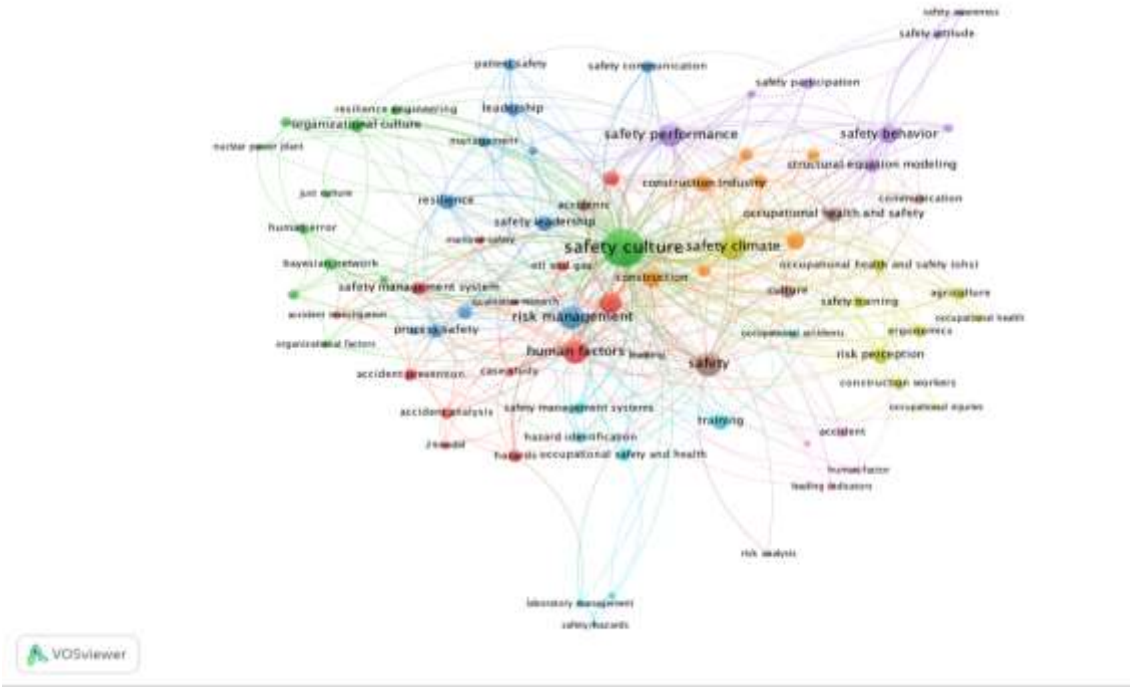

Fig. 8. Co-occurrence map of keywords

3.6. Organization Analysis

The documents of different organizations were further analyzed to understand the information on the most influential organizations in the safety culture domain using the authors' affiliations. The results show that there are 967 organizations publishing safety culture studies. The top five organizations that contribute to safety culture research are given in Table 4. Delft University Technology from the Netherlands is the most active organization associated with safety culture study over the world, followed by China University Mining and Technology-Beijing and China University Mining and Technology from China with 13 publications. The other four organizations, The National Research Centre for the Working Environment (Denmark), Tsinghua University (China), Griffith University (Australia), and Edith Cowan University (Australia) have published 11, 9, 9 and 8 publications related to safety culture, respectively. Furthermore, three of the most seven productive institutions come from China. Delft University Technology was ranked 10th in Nunen et al., (2018) study, but it is observed ranked first in safety culture publications published in this study.

In the realm of citation metrics, Tsinghua University in China stands out as the frontrunner with an impressive count of 348 citations. Following closely in the second position is China University of Mining and Technology-Beijing, also in China, with 310 citations. Claiming the third position is The National Research Centre for the Working Environment in Denmark, which has accumulated a noteworthy 258 citations. Notably, two of the top five most productive institutions hail from China, underscoring the nation's prominence in academic impact and research contributions.

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Table 4. The most important 5 organizations which have highest publication

Number*	Organization	Publication	Citations	Country
1	Delft University Technology	15	104	Netherlands
2	China University Mining and Technology-Beijing	13	310	China
2	China University Mining and Technology	13	217	China
3	The National Research Centre for the Working Environment	11	258	Denmark
4	Tsinghua University	9	348	China
4	Griffith University	9	198	Australia
5	Edith Cowan University	8	148	Australia

** The ranking number of equally active organization is the same.*

3.7. Journals Publishing Analysis

From 2013 to 2023, a total of 254 journals have contributed to the field of safety culture studies. Table 5 provides an overview of the top 10 most active journals in publishing safety culture-related documents. It's evident that "Safety Science" stands out as the most prolific journal, accounting for 131 publications, or 17.35% of the total. In their comparative research in 1900-2013, Li and Hale (2016) concluded that the Safety Science journal prioritizes topics related to safety culture, management, and the epidemiology of accidents. By combining this study, it can be thought that the Safety Science journal has prioritized safety culture research from 1900 to the present. Following closely is "International Journal of Occupational Safety and Ergonomics" with 29 publications (3.84%), " Journal of Loss Prevention in the Process Industries" with 27 publications (3.57%), "Process Safety Progress" with 26 publications (3.44%), "International Journal of Environmental Research and Public Health" with 22 publications (2.91%).

Table 5: The top tem most active journals that produce articles about safety culture

No	Source Title	Number of Documents	Citations
1	Safety Science	131	2961
2	International Journal of Occupational Safety and Ergonomics	29	120
3	Journal of Loss Prevention in the Process Industries	27	410
4	Process Safety Progress	26	102
5	International Journal of Environmental Research and Public Health	22	164
6	Journal of Chemical Health & Safety	16	217
7	Sustainability	15	80
7	Safety	15	85
8	Journal of Safety Research	14	347
8	Safety and Health at Work	14	215
9	Journal of Construction Engineering and Management	13	333
10	Process Safety and Environmental Protection	12	340

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With a notable resemblance to this study, in Nunen et al. (2018) research on safety culture between 1900 and 2015, the journal rankings contributing to the field place Safety Science and Process Safety Progress in the first and fourth positions, respectively. In terms of influence, among the top 10 most productive journals, "Safety Science" maintains a dominant position in safety culture research with citations of 2961. "Journal of Loss Prevention in the Process Industries" follows with citations of 410, and "Journal of Safety Research" holds citations of 347, while "Process Safety and Environmental Protection" garners citations of 340.

Altogether, the 755 articles found their way into a total of 254 distinct sources. This figure signifies a broad spectrum of research themes and underscores the multidisciplinary nature of safety culture studies. Out of the 254 journals, 169 (66.53%) published only a single paper related to safety culture, while 35 journals (13.77%) contributed only two publications on this subject. Notably, 12 journals (4.72%) made a significant impact by producing twelve or more publications on the topic. These twelve journals are in the top ten comprising just 4.72% of 254 journals focusing on safety culture, contributing to 44.23% of the total (334 out of 755 articles).

Like any research, this study has limitations that offer opportunities for future improvements. Firstly, concerning data sources, the study concentrated on the WoS database due to its comprehensive data coverage, high data quality, and suitability for bibliometric analysis. However, the absence of other databases in this bibliometric review addressed potential limitations of the research. While the Web of Science is one of the most comprehensive global databases, it does not include all publications in the field of safety culture research. Future iterations of this study could gain from incorporating data from additional databases, expanding the examination of safety culture. Regarding the study's results, the bibliometric analysis relied on English articles. This approach may introduce biases and deviations in the study's outcomes, as it excludes literature in other languages. For instance, the exclusion of articles by Chinese scholars in Chinese may impact the research centrality. With this limitation, future research could include data in different languages (such as Chinese, Spanish, French, etc.) to conduct a more inclusive and cross-cultural bibliometric review of safety culture. This step aims to enhance the generalizability and reliability of the study's results.

4. Conclusions

This paper presents an evaluation of the global research trends in safety culture publications spanning the period between 2013 and the first seven months of 2023. The study encompasses 755 safety culture articles, involving 2171 authors, 254 sources, originating from 77 different countries or territories, and affiliated with 967 organizations. This research, it was conducted a bibliometric analysis using VOSviewer based on a dataset comprising 755 articles from the WoS Core Collection database. The primary aim of this analysis was to unveil the evolution and growth of safety culture research by exploring various facets of the field, including document types, countries, institutions, journals, authorship, citations, and keywords.

Overall, the number of publications in the safety culture research domain has exhibited significant growth. It was with 64 publications in 2013 and surged to 110 articles in 2022. Safety culture has witnessed significant attention in research over the past decade, with a notable surge in publication activity. In addition, recent developments

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indicate a potential increase in scientific output within this field. The forthcoming years will reveal whether this upward trajectory in publication volume will persist.

The analyses have furnished insights into the pioneering figures within this research domain:

-Significantly, the United States, China, Australia, England, and Iran have emerged as the leading nations in terms of productivity in safety culture-related documents. These countries have also forged strong collaborative ties with others. Furthermore, the co-authorship network highlights that the USA, Australia, China, and England exhibit extensive cooperation in this field.

-There are 254 journals dedicated to publishing safety culture-related documents, with "Safety Science," "International Journal of Occupational Safety and Ergonomics" "Journal of Loss Prevention in the Process Industries," "Process Safety Progress," and "International Journal of Environmental Research and Public Health" ranking among the five most active journals in this domain.

-Several prominent authors, including Fu, Kines, and Fang have made significant contributions to safety culture publications. Gui Fu from China University of Mining and Technology (Beijing) has published the most on the subject of safety culture. The cooperation network reveals, that Pete Kines, Gerard I.J.M Zwetsloot, Frank Guldenmund, and Ahmad S.N. Isha emerging as the key researchers in this network. The most cited paper is from Chauvin et al. (2013).

-An analysis of keyword co-occurrences revealed several research hotspots, including safety climate, safety performance, safety, and safety management.

-Delft University of Technology in the Netherlands stands out as the most proactive institution globally in the realm of safety culture research.

-The journal "Safety Science" plays a principal role in the publication of safety culture research.

Finally, the analysis of safety culture publications has provided valuable insights into the evolution of this field. The growth in publication over the years, the significant contributions of specific countries and institutions, and the prominence of journals and authors all reflect the dynamic nature of safety culture research. The identified research hotspots and evolving themes underscore the shift from theoretical aspects to practical applications. By delving deeper into the available data, we can attain a more nuanced comprehension of how safety culture research has evolved and, in doing so, pinpoint areas that warrant further exploration. As safety culture continues to gain prominence in the global discourse, the insights gleaned from this analysis pave the way for informed decision-making and targeted interventions. The dynamic nature of safety culture research calls for ongoing exploration and adaptation to address emerging challenges and foster a culture of safety that transcends geographical and disciplinary boundaries. This study lays the foundation for future endeavors that can contribute to enhancing safety practices and ultimately create safer work environments worldwide.

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