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Review

Trends in Safety Culture Research: A Scopus Analysis

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Abstract: Safety culture plays a vital role in creating safer work environments, making its understanding important. This paper comprehensively analyzes safety culture research trends through a bibliometric study using the Scopus database. This study provided a full insight by analyzing 7058 papers published between 1978 and 2023, employing the PRISMA method and VOSviewer 1.6.19 for bibliometric mapping. The USA, England, China, and Australia are the leading contributors, with Johns Hopkins University being the most active institution. Approximately 75% of publications are co-authored, indicating strong collaboration in this field. Guldenmund (2000) is the most referenced work in safety culture research. Based on the results, this work identifies significant geographical gaps, particularly in Oceania, South America, the Middle East, Southeast Asia, and Africa, as well as underexplored sectors such as transportation, logistics, energy, sports, education, and construction. The COVID-19 pandemic has profoundly impacted research in this area, particularly healthcare, while potentially diverting attention from other critical sectors. This study contributes a fresh perspective on the trends of safety culture research, offering valuable insights for scholars and practitioners. Additionally, it highlights the importance of interdisciplinary collaboration in addressing the unique challenges faced by safety culture across diverse industries and regions.

Keywords: safety culture; bibliometric analysis; organizational safety; patient safety and healthcare

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1. Introduction

The importance of a safety culture has grown in recent years across all sectors [1]. Safety culture studies have recently attracted more attention [2]. The complexity of the topic has led to disagreements on its definition, causes, effects, and indicators [3,4]. There are two distinct schools of thought within the study of safety culture: one that focuses on organizations and their safety practices from a theoretical perspective and another that is more patient-and healthcare-centric and grounded in reality [2]. According to Bautista-Bernal, Quintana-García [5], a safety culture extends beyond personal beliefs and attitudes and includes things like proactive risk management, safe practices adopted at all levels of the organization, good communication, ongoing training, and collective responsibility. As

a component of the organization's larger culture, safety culture influences how everyone thinks and feels about health and safety on the job [6].

Given the complexity of safety culture as a subject matter, it is necessary to classify important developments and future directions for research in this area. By looking at the distribution and frequency of publications throughout time, researchers may learn how interest and priority areas have changed. According to Van Nunen, Li [2] there has been little agreement over the origin, definition, and effects of safety culture up until now. Furthermore, safety culture is an interdisciplinary study subject. The idea first appeared in the nuclear sector. Despite this, there are many more applications for the idea of safety culture outside of only enhancing organizational safety [7]. Therefore, bibliometric analysis may evaluate the effect of individual studies, writers, or journals on safety culture by looking at citation counts and other metrics. Finding seminal works and pioneers in a field may be aided by this. Anthropologists, psychologists, engineers, and sociologists are among the fields that have investigated safety culture [3]. Various methods for investigating and evaluating safety culture have emerged as a consequence of this interdisciplinary emphasis. The ever-increasing publishing pace and inherent complexity of safety culture make it a prime candidate for bibliometric study.

Bibliometric analysis is a method that allows for a high-level summary of extensive scholarly literature. One way to track the evolution and distinctive features of a field's scientific output is to do a quantitative study of its publication history [8]. Authors, journals, nations, and institutions may all have their research habits and output evaluated using bibliometric methodologies, which can also reveal and quantify patterns of collaboration [9]. It is possible to determine which nations, journals, publications, and organizations have significantly impacted a certain subject. The subject categories assigned to publications and the number of journals covering a certain topic provide insight into the diversity of research subjects and the interdisciplinary nature of a research area. In a particular area of study, bibliometrics can show you the most recent findings, future paths, and hot subjects [10]. Additionally, bibliometric research might reveal regional and content-wise knowledge gaps within a particular field of study [11]. In addition, scientific decision-making may greatly benefit from bibliometrics. Many academics use it to rate publications, nations, and organizations, and it also ranks job applications. Policymakers and funding organizations may also use bibliometric statistics to help them allocate funds for research [12].

Based on the literature review, there is a need to conduct a bibliometric analysis utilizing the Scopus database to investigate safety culture in more detail, as stated by Van Nunen, Li [2]. There was only one previous study using Scopus data; however, it addressed the issue in a specific sector, which is the construction sector [13]. At the same time, many trends and events occurred that previous studies overlooked. Consequently, this investigation used the Scopus database, which included a broad spectrum of data.

Therefore, the current study draws attention to significant gaps in the literature on safety culture studies worldwide. To broaden the scope of safety culture research on a global and industry level, this gap analysis offers fresh and novel suggestions for future research. Therefore, this study's analysis uncovered a straightforward research question: How has safety culture research evolved across different sectors and regions, and what are the emerging trends considering global events?

Safety Culture

Safety culture is defined as encompassing all aspects of organizational culture that influence risk-related behaviors and attitudes. Additionally, safety culture includes the values, perceptions, attitudes, and behaviors of individuals and groups that assess the

commitment to health and safety management within an organization [14]. Six core elements contribute to a strong and effective safety culture:

- **Management Leadership:** Effective safety culture relies on strong leadership. When management shows a clear dedication to safety, employees are more inclined to value and participate in safe work practices. Leadership commitment is reflected in policy development, resource allocation, and decision-making that emphasizes safety over productivity pressures [15].
- **Worker Participation:** Engaging workers in safety programs enhances their sense of ownership and responsibility for workplace safety. When employees are involved in safety decision-making, risk assessments, and safety committees, they become more vigilant and proactive in hazard identification [16].
- **Health and Safety Training (Competency):** A well-trained workforce is essential for maintaining a strong safety culture. Training ensures that employees are aware of workplace hazards, safety procedures, emergency responses, and best practices [17].
- **Hazard Prevention and Control:** Identifying, evaluating, and controlling workplace hazards is crucial for preventing accidents and ensuring a safe working environment. Organizations must implement risk assessments, engineering controls, administrative controls, and the use of personal protective equipment (PPE) [18,19].
- **Worksite Analysis:** Worksite analysis involves conducting regular safety inspections, audits, and risk assessments to identify potential hazards. This systematic evaluation helps in implementing corrective actions before incidents occur [20].
- **Continual Improvement:** A strong safety culture requires continuous monitoring, learning from past incidents, and improving safety policies and procedures. Organizations should analyze near-misses, conduct regular reviews, and incorporate feedback into their safety programs [21,22].

These six elements are essential for cultivating a strong safety culture. Organizations that prioritize these components experience reduced accident rates, improved employee morale, and better regulatory compliance. By promoting a proactive approach to safety, workplaces can foster a culture where safety is not merely a policy but a collective responsibility.

2. Methodology

The present investigation used bibliometric analysis to conduct an exhaustive evaluation of the existing body of literature. The literature was acquired from the Scopus database, which, in comparison to other databases such as Web of Science and PubMed, has a more comprehensive collection of journals and scientific publications [23,24].

The selection criteria were based on the PRISMA protocol [25]. The PRISMA method (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) is a popular framework aimed at enhancing the transparency and reproducibility of systematic reviews and meta-analyses. It offers a checklist and flow diagram to standardize reporting, which ensures thorough documentation of search strategies, study selection processes, and data synthesis methods [26]. PRISMA emphasizes methodological rigor, particularly in minimizing bias and enhancing the reliability of conclusions [27]. PRISMA has been used in many previous studies alongside bibliometric analysis [28,29].

An emphasis was placed on the phrase "safety culture," and a search was conducted to identify articles with this term in their titles, abstracts, and keyword categories. A total of 8297 documents were initially identified. These documents included research articles, reviews, book chapters, and more materials that also cover all fields. These documents were subsequently refined based on several criteria; (i) the timeframe for the search was set from 1978 to 2023; (ii) the document type was restricted to articles, review papers, conference papers, and conference reviews; and (iii) the language was exclusively English. As a result,

7058 papers met these criteria, as depicted in Figure 1. Thus, 7058 papers were ultimately deemed eligible for further analysis.

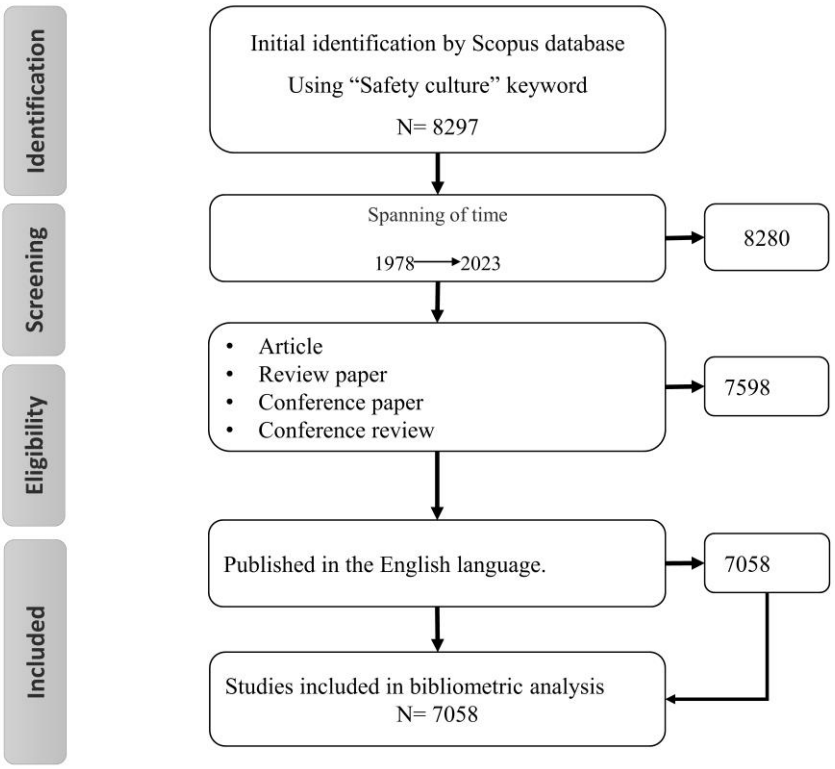


Figure 1. Method flow.

After obtaining a sample of relevant literature, we conducted a scientometric analysis. With rapid technological advancements, scientometric analysis can now be efficiently carried out using various available software tools.

VOSviewer 1.6.19 was used in this investigation because of its outstanding text-mining skills and its ability to handle large networks effectively [30]. VOSviewer 1.6.19 is becoming more popular in several disciplines [31,32]. This research analyzed the collected articles from many perspectives, including scholarly journals, authors, keywords, citations, and nations. According to Ren et al.'s viewpoint [33], these five features are regarded as the main elements of scientometric analysis, offering researchers a concise summary of the present research status. The key measures that have the most importance are average publication by year, documents, average citations, and average normalized citations [34]. It is vital to note that the final three measures are interconnected. To compute the average citations, divide the total number of citations by the number of documents. In addition, average normalized citations are a measure of the number of citations that have been modified to account for variables such as journal, author, keyword, document, or country. The calculation includes dividing the total number of citations by the average number received in a given year; a higher score implies a more substantial effect [34].

3. Results

3.1. Trend of Increasing Publication

The number of peer-reviewed articles is a key metric for evaluating the progression of a scientific research field or topic. Figure 2 illustrates a steady increase in safety culture publications since 1978, when only one article on the subject was published. Before 2001, the volume of publications remained limited, with fewer than 50 articles per year. However, since 2002, there has been a consistent annual increase, except for a decline in 2014. Another decrease occurred in

2022, with a total of 584 publications, following a peak of 592 in 2021. This downward trend continued into 2023, though the reasons behind the decline remain unclear.

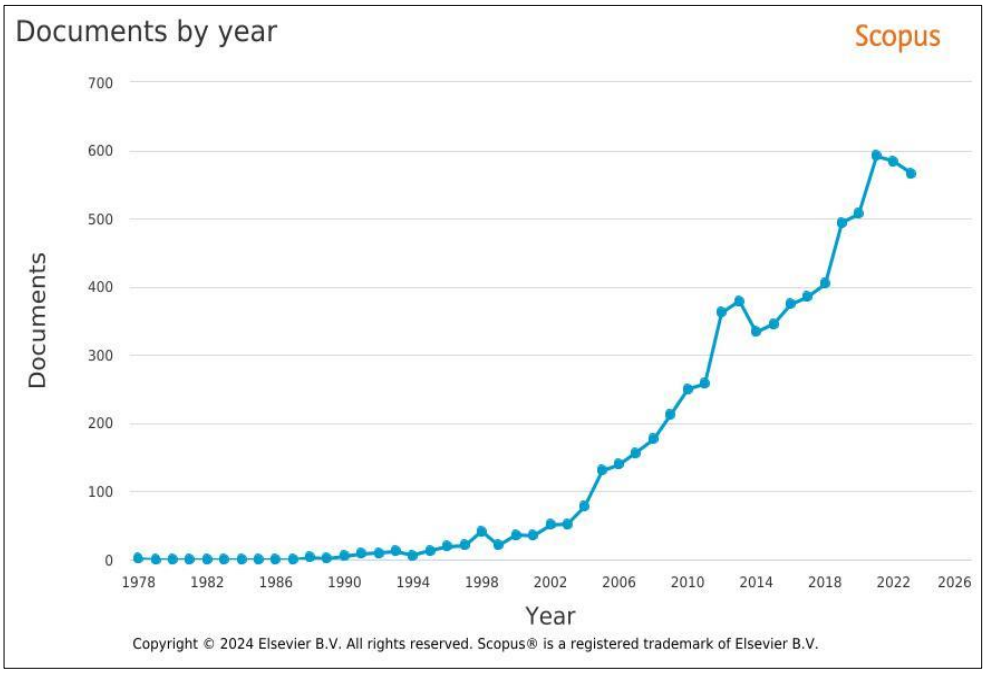


Figure 2. Documents by year.

The growth of scientific publications in a particular field can be analyzed using Price's law [35], which describes four phases in the development of a research area: (1) the precursors' phase, where a small group of scientists pioneers the field; (2) the exponential growth phase, marked by increasing interest and exploration of various aspects of the topic; (3) the knowledge consolidation phase; and (4) the maturity phase, characterized by a significant decline in publications as the field becomes fully explored [36]. However, it is uncertain whether safety culture research has reached this final stage. The field continues to lack consensus on the definition, scope, and implications of safety culture. Figure 2 presents the distribution of publications by year.

It can be concluded that research on safety culture has gained importance over time. It took about 22 years (from 1978 to 2008) to reach the milestone of 1000 published articles on safety culture. However, between 2009 and 2023, the number of publications surged to over 7058, reflecting a substantial growth in research activity. The study by Li and Hale [8] provides a useful perspective for evaluating this upward trend in safety culture publications compared to other research topics.

3.2. Cited Analysis

The citation process consists of two key methods. The first method involves knowledge intake, commonly known as citing behavior within a publication. This refers to the references included in an article, a process known as "citing analysis," which will be discussed in the following section. The second method pertains to knowledge output, where a publication is cited by other works that use it as a reference. This type of analysis is referred to as "cited analysis" [37]. The cited analysis provides insight into the impact of safety culture research by measuring how often these publications are referenced in other Scopus-indexed articles.

A total of 32,087 citations were recorded across the 7058 safety culture articles, with each article referencing other publications. During data extraction, it was found that 16.9%

of the publications (n = 1194/7058) had never been cited. On average, each article received 4.5 citations. Only 1.11% (n = 78/7058) of the papers were cited 50 times or more, while just 0.25% (n = 18/7058) were cited at least 100 times.

Many believe that the citation count of a publication signifies its impact, recognition, and quality [12]. However, several scholars [38,39] argue that citation frequency does not necessarily indicate the quality of a publication but rather its visibility within the research community. Moreover, there is a rising recognition that books and articles published in open-access journals tend to receive more citations [40].

Table 1 presents the ten most highly cited publications in safety culture research. Among them, Guldenmund's work, The Nature of Safety Culture: A Review of Theory and Research, remains the most cited, accumulating 1241 citations as of 31 December 2023, since its publication in 2000. The publication that receives the most average annual citations is Safety Attitudes Questionnaire: Psychometric Properties, Benchmarking Data, and Emerging Research by Sexton, John B. [41], and his team. Since its publication in 2006, this article has garnered an average of 71 citations each year.

Among the ten most frequently cited articles, the USA had the second-highest number of publications, with three. However, it led in total citations, amassing 2312. The United Kingdom ranked first in terms of publication count, contributing four articles, which collectively received 2087 citations. Meanwhile, the Netherlands, China, and Switzerland each had one publication. Regarding journal prominence, *Safety Science* featured three of the top-cited articles, while *Work and Stress* had two.

There is a strong correlation between an article's citation count and the time elapsed since its publication [2]. Older publications generally have a higher likelihood of accumulating citations compared to more recent ones. However, this does not preclude newer publications from having a significant impact on the field [42]. For instance, the most recently published article in the top ten, from 2013, has already received 446 citations, whereas the oldest, published in 1998, has been cited 406 times.

Table 1. The top ten safety culture publications that are most often cited.

No.	Title	Authors	Country of the First Author	Journal Name (IF)	Published Year	Cited Times	Annually Average Citations	Topic
1	The nature of safety culture: A review of theory and research	Guldenmund, F.W. [3]	Netherlands	*Safety Science* (6.1)	2000	1241	53.9	Organizational safety
2	The Safety Attitudes Questionnaire: Psychometric properties, benchmarking data, and emerging research	Sexton, John B. et al. [41]	United States	*BMC Health Services Research* (2.8)	2006	1207	71	Healthcare patient safety
3	Towards a model of safety culture	Cooper M.D. [43]	United Kingdom	*Safety Science* (6.1)	2000	803	34.91	Organizational safety
4	Safety culture assessment: A tool for improving patient safety in healthcare organizations	Nieva V.F. et al. [44]	United States	*Quality and Safety in Health Care* (2.160)	2003	659	32.95	Healthcare organizations
5	Role of hand hygiene in healthcare-associated infection prevention	Allegranzi B. et al. [45]	Switzerland	*Journal of Hospital Infection* (6.9)	2009	630	45	Healthcare patient safety
6	Safety in shipping: The human element	Hetherington, Catherine et al. [46]	United Kingdom	*Journal of Safety Research* (4.1)	2006	488	28.7	Maritime safety
7	High-reliability health care: Getting there from here	Chassin, Mark R. et al. [47]	United States	*Milbank Quarterly* (6.6)	2013	446	44.6	Healthcare
8	Safety culture: Philosopher's stone or man of straw?	Cox, Sue et al. [48]	United Kingdom	*Work and Stress* (6.1)	1998	430	17.2	Organizational safety

Table 1. *Cont.*

No.	Title	Authors	Country of the First Author	Journal Name (IF)	Published Year	Cited Times	Annually Average Citations	Topic
9	The nature of safety culture: A survey of the state-of-the-art	Choudhry, Rafiq M. et al. [49]	China	*Safety Science* (6.1)	2007	418	26.13	Organizational safety
10	Achieving a safe culture: Theory and practice	Reason, James [50]	United Kingdom	*Work and Stress* (6.1)	1998	406	16.24	Organizational safety

3.3. Citing and Co-Citation Analysis

The citation analysis reveals the total number of references across the 7058 articles on safety culture. Altogether, these publications cited 151,362 references from various sources, with 32,087 being unique references.

Co-citation analysis investigates the connection between two publications by evaluating their frequency of citation together, offering an overview of key references within the field. A higher number of shared citations between two publications suggests a greater degree of similarity [37]. According to the citation study, 32,087 distinct references were used in safety culture research. The co-citation relationships were analyzed and visualized using VOSviewer 1.6.19. For a reference to feature in the co-citation map, it must have been cited at least ten times across the bibliographies of the 7058 safety culture studies articles. Among 120,123 distinct references, only 274 met this threshold. Figure 3 illustrates the results of the co-citation analysis.

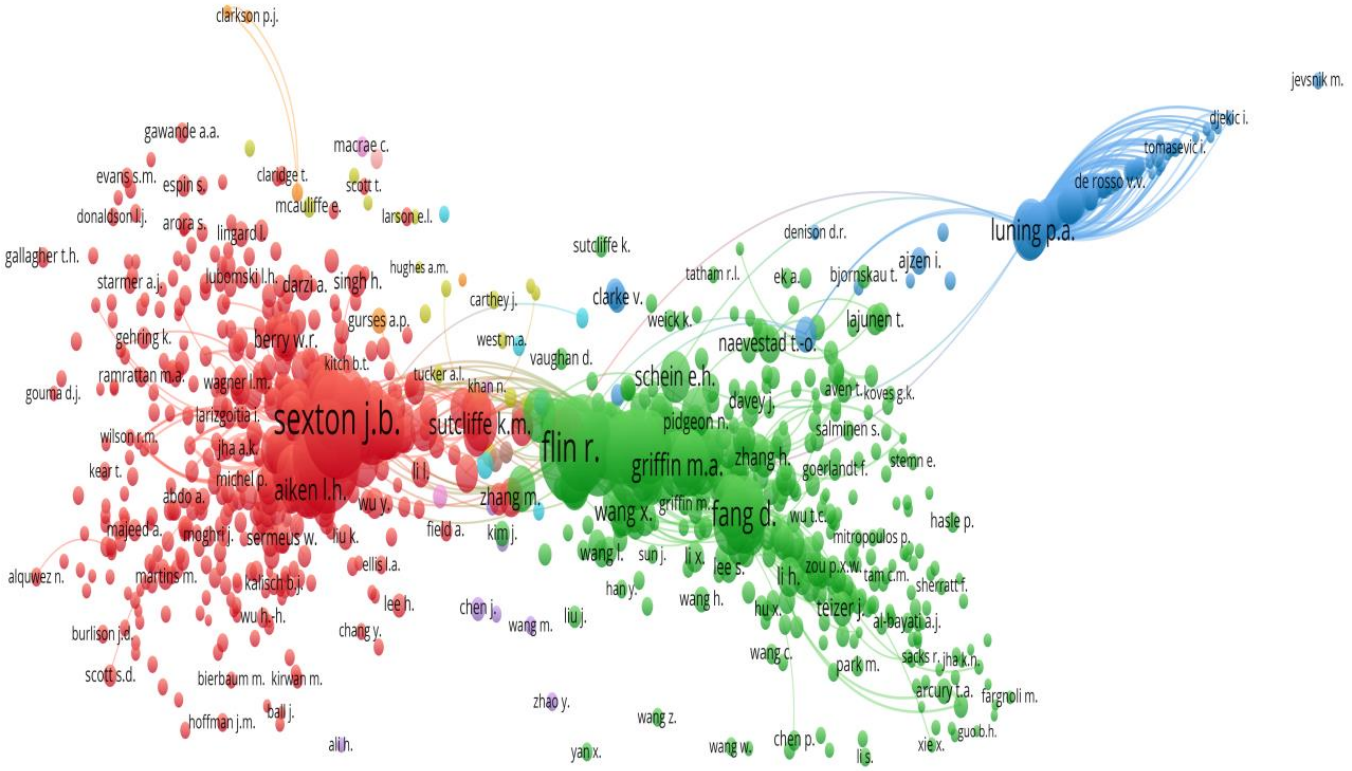


Figure 3. Safety culture publications' highly cited references co-citation analysis.

In the co-citation map, the size of each circle represents the number of citations, with larger circles indicating higher citation counts within safety culture research. The proximity between two articles reflects the strength of their co-citation relationship—a shorter distance suggests a stronger connection and greater thematic similarity. Publications that share the same color belong to a common research theme. The co-citation map reveals ten distinct

clusters corresponding to different areas of safety culture research, including food safety, industrial safety, patient safety, and healthcare safety.

The cited sources in safety culture publications can be categorized into two groups: (1) sources that are part of the 7058 safety culture publications and (2) sources originating from other primary research fields but still relevant to the concept of safety culture.

3.4. Subject Categories

Every journal indexed in Scopus is classified under at least one subject category, corresponding to a specific field of study. Scopus comprises 27 broad subject areas, and every article published in a journal is automatically assigned the same category as the journal.

The 7058 articles on safety culture span all 27 primary subject areas, highlighting the field's interdisciplinary nature and diversity. The wide distribution of publications across different disciplines reflects the broad scope of safety culture research. Among these categories, 1.18% had fewer than ten publications, 4.20% had fewer than thirty, and 13.77% had fewer than one hundred. Notably, 56 categories—accounting for 80.83% of the total—contained at least 100 publications.

Figure 4 presents the 11 most frequently assigned Scopus subject categories for safety culture research. The legend provides the titles of these top categories and their corresponding total count of safety culture publications each. Medicine had the highest representation, accounting for 34.0% of all publications, followed by Nursing at 15.2%. Engineering contributed 12.1% of the total articles, while Social Sciences comprised 10.5%. Additionally, Business, Management, and Accounting accounted for 4.9% of published work in this domain.

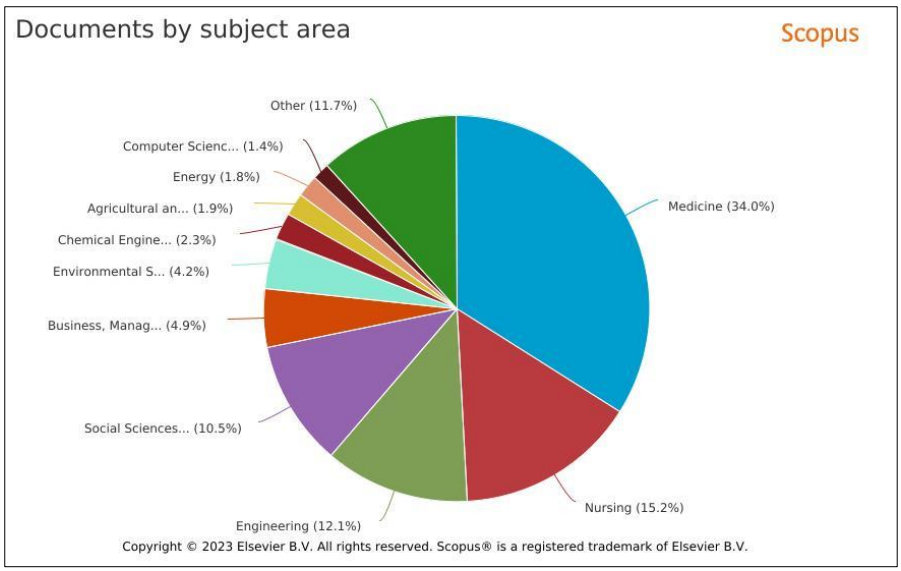


Figure 4. Top 10 Scopus topic categories for safety culture articles.

3.5. Terms Analysis

Analyzing the terminology utilized in the abstracts and titles of safety culture articles provides valuable perception into key research themes and evolving trends within the field. The terms were analyzed and visualized using VOSviewer 1.6.19. First, we extracted all noun phrases from the abstracts and titles of the 7058 safety culture studies articles. General terms such as article and test names, as well as study types (e.g., cross-sectional, longitudinal) and country names, were excluded. Furthermore, spelling variations like safety behavior and safety behavior were standardized. Only terms found in a minimum of five publications were included in the final analysis. Among the 1804 extracted terms, 1497 met these criteria.

Figure 5 presents the results of the term analysis. The size of each circle represents the frequency of a term, with larger circles indicating higher occurrences in safety culture publications. The spatial arrangement of words reflects their interconnectedness—closer proximity suggests a stronger association. This relationship is determined by counting the co-occurrence of terms in abstracts and titles [51].

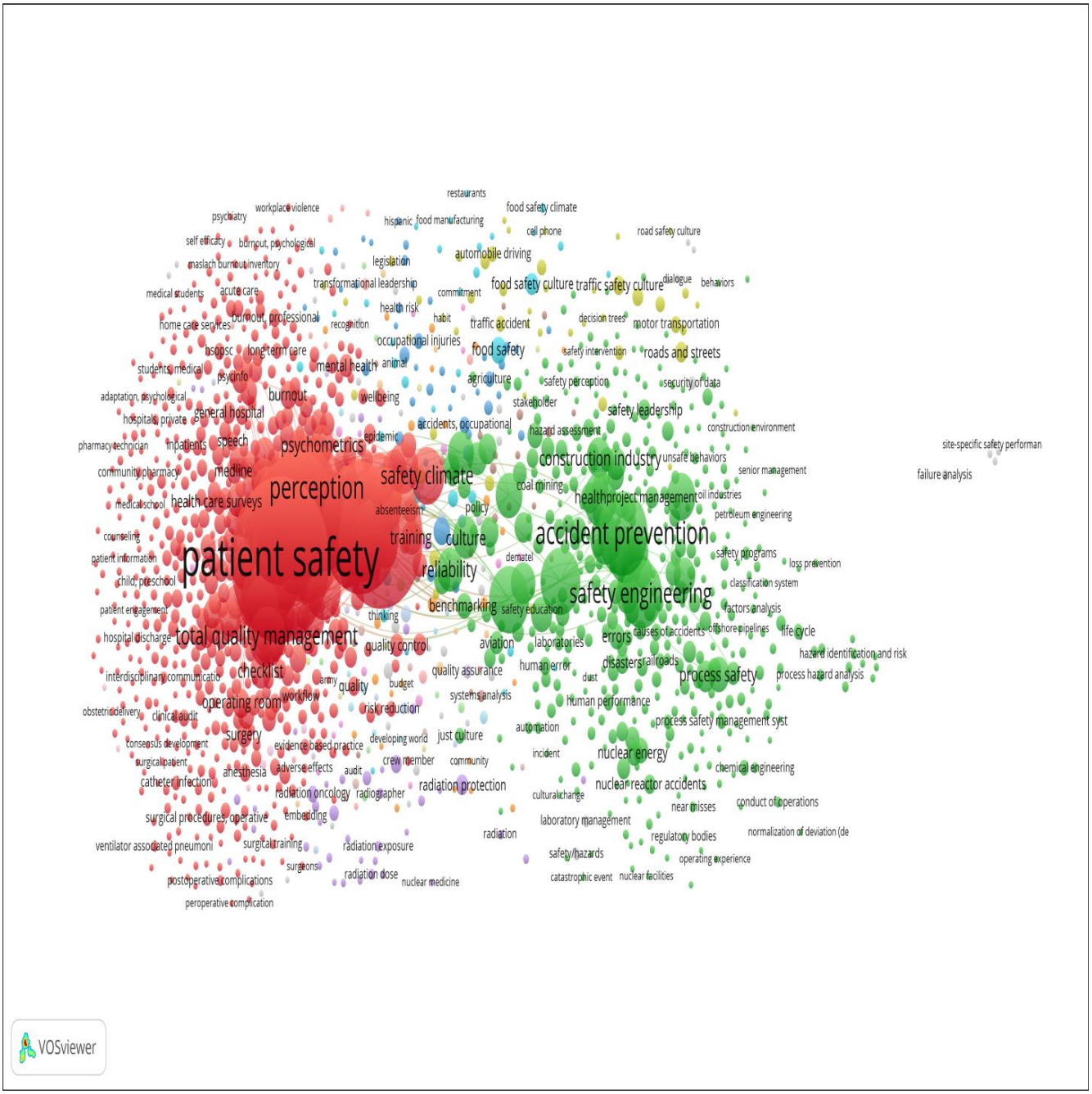


Figure 5. Terms used in publications on safety culture.

Different colors represent distinct thematic clusters. The word map highlights two primary clusters: one on the right (green cluster) and one on the left (red cluster). The green cluster includes frequently used terms such as *risk assessment*, *accident prevention*, *safety performance*, *safety engineering*, *mistakes*, and *risks*. Meanwhile, the red cluster predominantly features terms related to *patient safety*, *healthcare quality*, *safety environment*, *nursing*, and *safety training*.

Figure 6 illustrates the chronological distribution of safety culture research over the past six years. The color of a term represents its average publication year, calculated as the mean publication year of all articles in which the term appears. Red circles indicate terms that were more prevalent in 2023, while blue circles correspond to those commonly used in 2018.

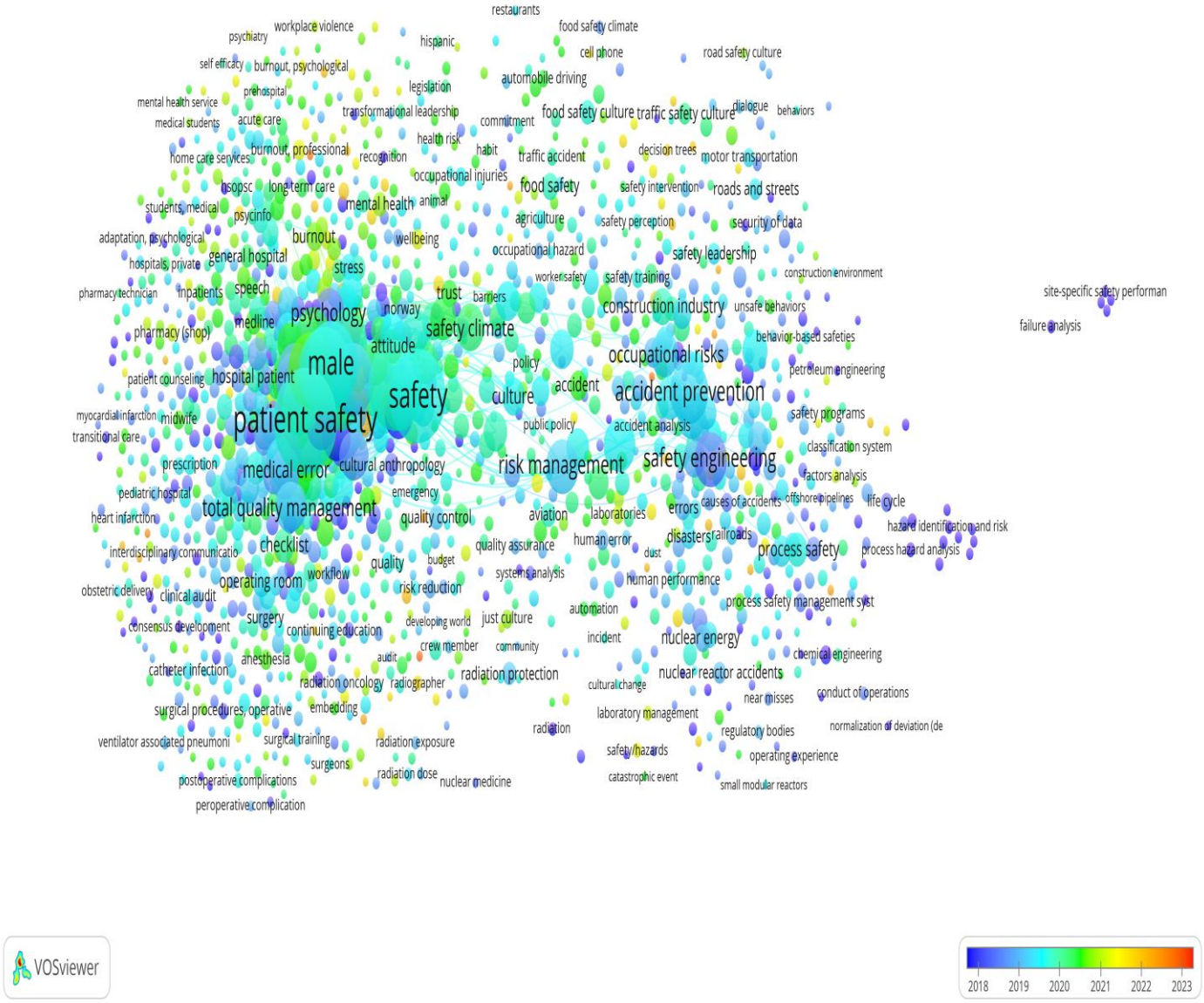


Figure 6. Safety culture publications' term analysis with time information.

A temporal analysis of published studies reveals shifting research priorities. In 2018, the focus was largely on *organizational safety*, with key themes including *health*, *personal attitude*, *error*, and *psychology*. Between 2019 and 2020, research increasingly emphasized *healthcare safety*, particularly in areas such as *patient safety*, *patient safety culture*, *nursing staff*, *work environment*, and *accident prevention*. In recent years, there has been a notable rise in research on healthcare and patient safety, particularly concerning topics such as *COVID-19*, *pandemic*, *burnout*, and *hilarious safety*—terms that have emerged prominently since 2020.

Overall, the temporal distribution of terms indicates a shift away from a general focus on *organizational safety culture*, with a concurrent decline in studies emphasizing *technical aspects*. Instead, research has increasingly centered on *human factors*, such as *safety climate*, *job satisfaction*, and *workload*, which have become more frequently studied than technology-

related topics. The COVID-19 pandemic has further amplified interest in safety culture within healthcare, as highlighted in studies by [52,53].

Despite this growing emphasis on *healthcare and patient safety*, this does not imply a diminished interest in *organizational culture*. Research in this area remains active and necessary. However, healthcare-related publications are currently receiving increased attention and priority.

3.6. Authors and Their Cooperation

A total of 7058 papers on safety culture were authored by 12,571 distinct individuals. The majority of these authors contributed to only one publication, with 83.5% (10,453 out of 12,571) being credited for a single article on the topic.

A smaller proportion of authors contributed to multiple publications. Specifically, 21.9% (2752 authors) were acknowledged in at least two articles, while 9.5% (1197 authors) were credited with three publications. Four publications were authored by 4.5% (572 authors), whereas 2.8% (355 authors) contributed to five publications. A total of 2.6% (330 authors) were recognized for six publications, and 1.44% (182 authors) contributed to seven articles. Additionally, 0.95% (120 authors) were associated with eight publications.

Notably, a small group of highly productive researchers contributed to a significant share of the literature. A total of 3.5% (450 authors) were credited with nine or more publications. This pattern aligns with findings from other research fields, such as those presented by Liu and Zhan [38], which indicate that a select group of prolific authors is responsible for a substantial proportion of publications within a given subject area.

The names of the ten most prolific authors in safety culture research are presented in Table 2 and visualized in Figure 7.

Table 2. Top 10 safety culture authors by productivity.

No.	Author	Country	Documents	Citations	Average Citations per Publication	Number of Publications as First Author
1	Kirwan, B.	France	29	614	21.5	9
2	Nævestad, T.O.	Norway	28	382	13.6	27
3	Thomas, E.J.	United States	28	2489	88.9	1
4	Mearns, K.	United Kingdom	27	1393	51.6	7
5	Wu, H.H.	Japan	25	234	9.4	1
6	Fu, G.	China	24	553	23.04	4
7	Huang, C.H.	China	23	214	9.30	8
8	Lee, Y.C.	Taiwan	23	230	10	8
9	Pronovost, P.J.	United States	22	1504	68.4	3
10	Flin, R.	United Kingdom	21	2483	118.24	2

Table 2 and Figure 7 display the rankings of the ten most prolific authors in the field of safety culture, based on data sourced from Scopus. The rankings are determined by the total number of publications each author has contributed to, regardless of their position in the author list. Kirwan, B. leads with 29 articles, followed closely by Naevestad, T.O., who has published 28 papers. The average number of citations per publication for these top ten authors ranges from 9.4 to 118.24, reflecting notable variation in their citation impact.

There is also considerable variation among the top authors in terms of their first-author publications. Naevestad, T.O. authored the most first-author papers, with 27 publications, while Thomas, E.J. and Wu, H.H. each contributed just one publication as the first author.

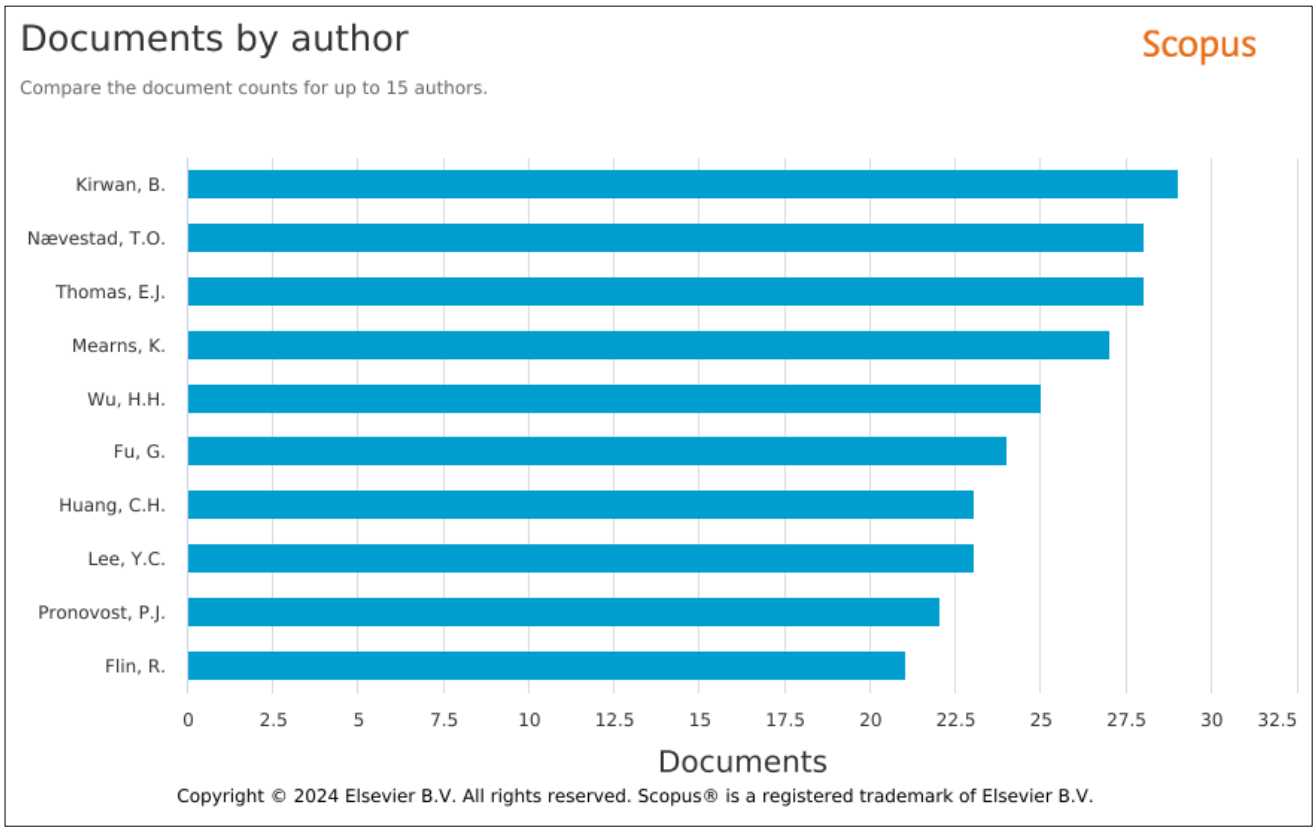


Figure 7. Top 10 safety culture authors by productivity.

The collaboration patterns among these authors were analyzed using VOSviewer 1.6.19 to explore their co-authorship networks. Each author in the network has written at least one article on safety culture, and only those authors who have collaborated with others are included. Figure 8 illustrates the results of this analysis, where the size of the circles is proportional to the number of publications authored by each individual. The lines connecting the circles represent collaborations between authors, and the colors indicate clusters of related authors.

The analysis identifies twenty prominent clusters of researchers, with Wu, H.H., Sexton, Thomas, E.J., and Fu being the key figures in the network. Other authors are linked to one of these central researchers, showing the collaborative nature of safety culture research. However, it is important to note a potential limitation in author identification. Authors with identical names or those using multiple aliases (e.g., due to changes in marital status) may not be fully differentiated. To address this issue, [39] suggests the implementation of a unique digital identification system, such as ORCID, to ensure consistent author identification.

The prevalence of collaborative research in the safety culture field is evident, with around 75% of all papers being co-authored. This high rate of collaboration suggests a strong network among researchers working on the same subject, providing ample opportunities for future collaboration, as noted by Wang, Pan [10].

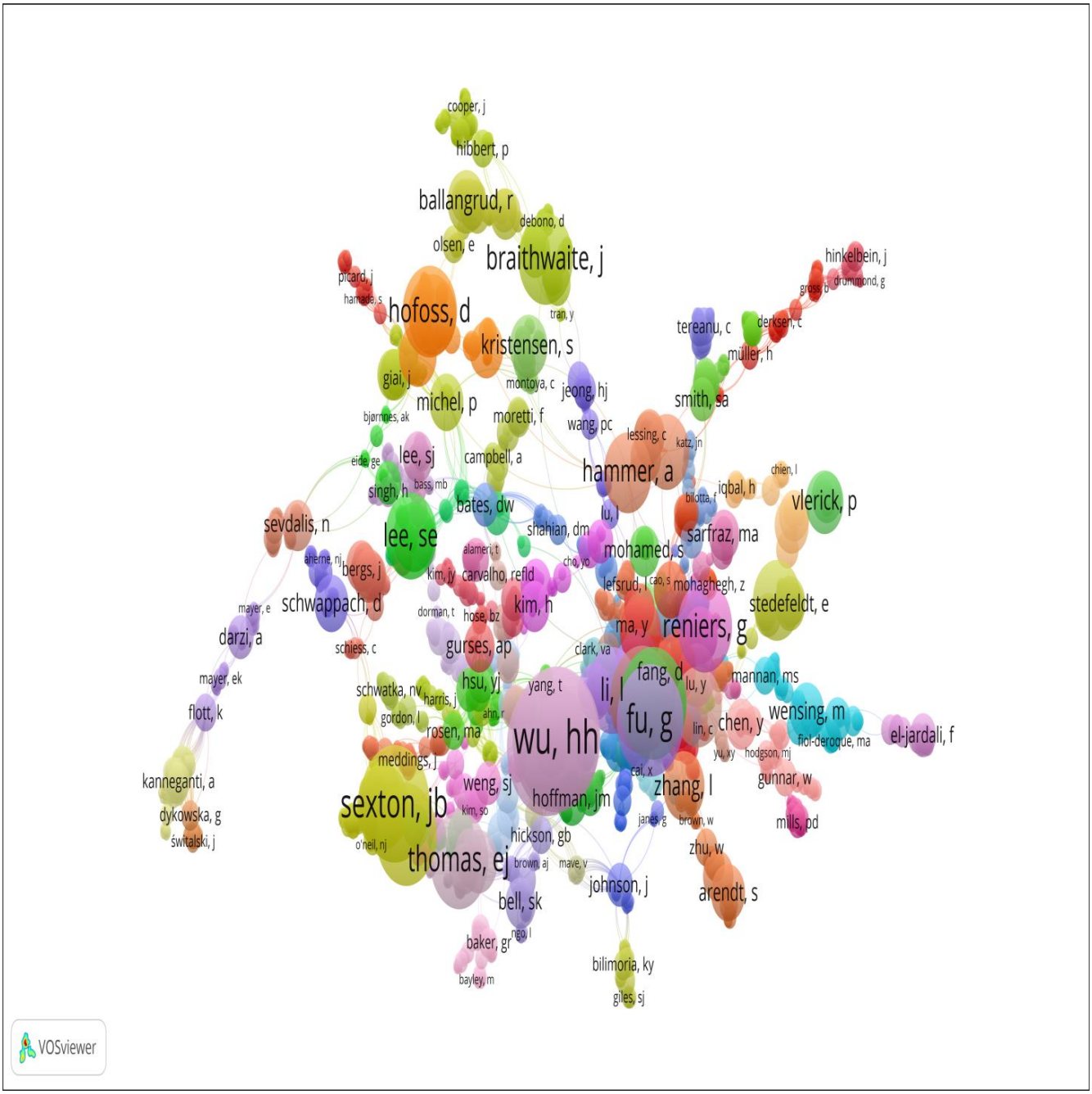


Figure 8. Authors' network in safety culture research.

3.7. Countries

Each article was assigned to a specific country and institution based on the authors' reported addresses in the Scopus database. Out of the total publications, 311 lacked information on the country, while 4859 were linked to a specific country or territory.

Research on safety culture spans 232 distinct countries or territories. Notably, 111 nations (47.8% of the total) have contributed ten or fewer publications, while 64 countries (27.8%) have produced between 11 and 40 publications. In contrast, 57 countries (24.8%) have authored over 41 publications on safety culture. The United States leads with the highest number of publications, totaling 2053, followed by the United Kingdom (774), China (382), Australia (379), Canada (299), and Brazil (263). Figure 9 illustrates the ten most prolific nations and territories in safety culture research.

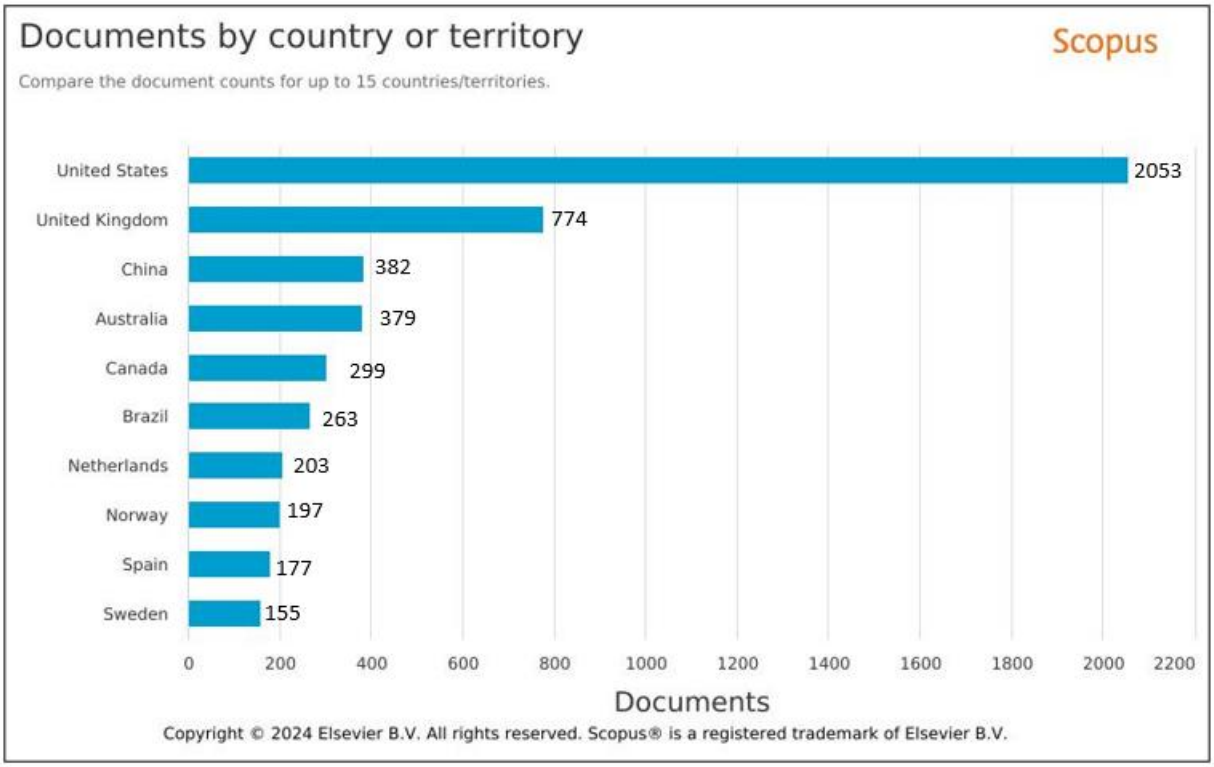


Figure 9. Countries that have the most published in the field of safety culture study.

The correlation between economic development and investment in scientific research is apparent, with highly industrialized nations such as the United States, United Kingdom, and Canada consistently ranking among the top contributors to safety culture publications. This trend reflects their strong academic standing and prominence across various scientific disciplines [54,55].

A total of 232 territories and nations are represented in the 7058 publications on safety culture. It is important to note that individual authors may be affiliated with multiple countries or territories, and publications can involve co-authors from different regions. Using VOSviewer 1.6.19, the co-authorship network across nations and territories was analyzed, focusing on safety culture publications. Only countries and territories that have contributed at least five publications to the field were included in the analysis, while those with no connections to other regions were excluded.

Figure 10 visualizes the collaborative network across nations and territories. Circle sizes represent the quantity of publications, while link thickness denotes the strength of collaboration. The colors represent different partnership clusters. Two primary clusters are evident. The first, centered around the United States, is home to several research centers focused on safety culture, such as the National Institute for Occupational Safety and Health (NIOSH). NIOSH has been instrumental in studying safety culture's impact on workplace safety. The U.S. Department of Energy (DOE) has also published safety culture standards, emphasizing the importance of maintaining a secure work environment. Additionally, the U.S. Occupational Safety and Health Administration (OSHA) has developed guidance materials on safety culture, including a Safety and Health Management System (SHMS) that highlights its importance.

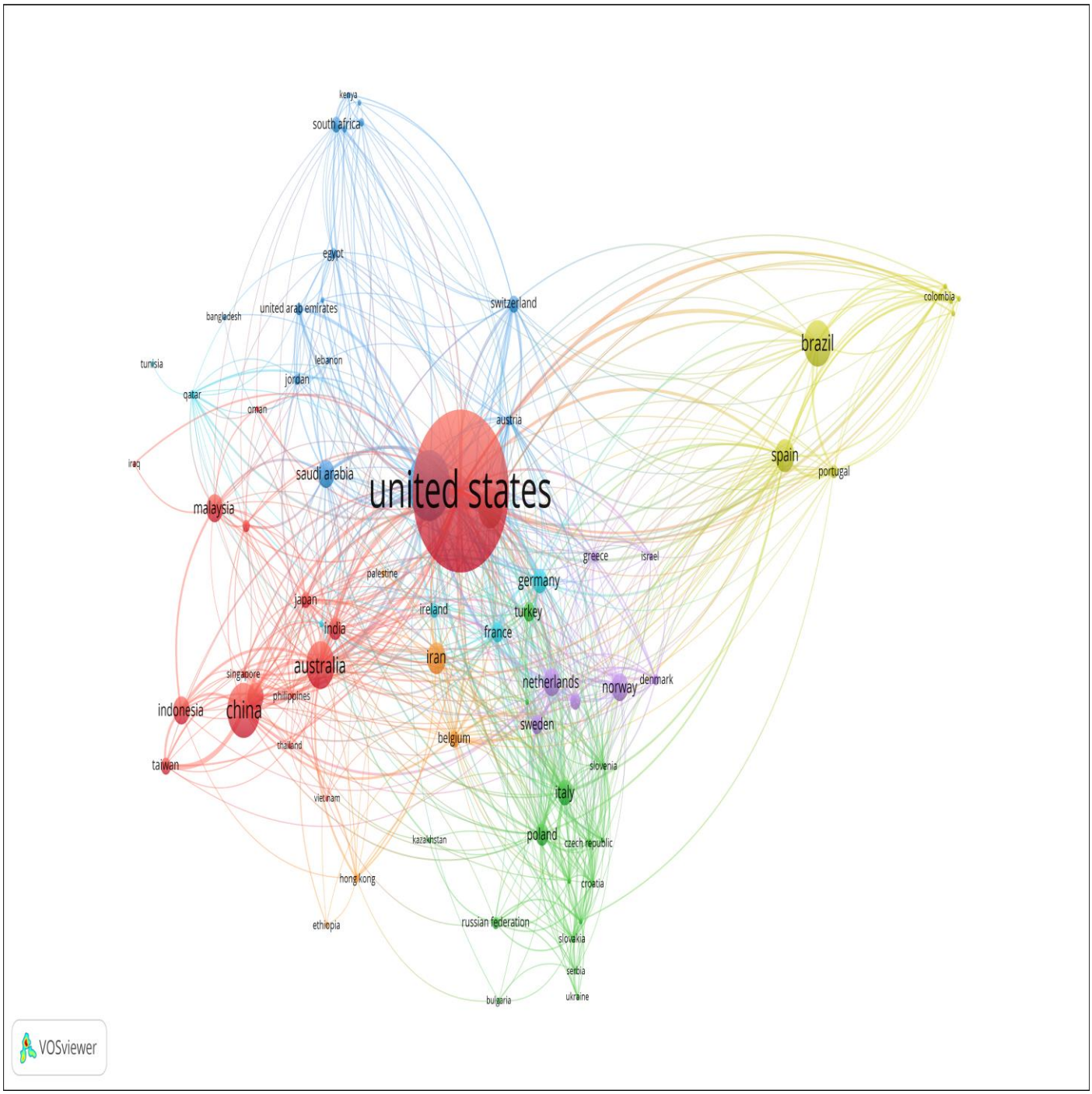


Figure 10. Countries and territories publishing on safety culture.

The first cluster predominantly consists of Western and Southern European countries, the Middle East, Southeast Asia, North America, and South Africa. The second cluster, centered on the UK, is influenced by strong contributions from Saudi Arabia, South Africa, and Switzerland. Canada also plays a significant role in collaborative efforts, partnering with Australia, China, and Germany. As observed in other fields of scientific research, countries that frequently collaborate tend to be geographically close and are typically among the most prolific in terms of publication output, according to Zheng, Wang [56].

3.8. Journals That Publish Articles on Safety Culture

A total of 7058 articles on safety culture were published across 1365 distinct journals, highlighting the interdisciplinary nature of the topic and the wide array of research areas it encompasses. Of these journals, 82 (62.4%) published only one article on safety culture, while 198 journals (14.6%) published just two. Additionally, 85 journals (6.2%) published three articles, and 67 journals (4.9%) published four. A total of 39 journals (2.8%) published five articles, while 91% of the journals, or 124 in total, published six or more articles on the subject.

Table 2 shows the ten most prolific journals in safety culture research, accounting for 13.7% of all published articles on the subject (968 out of 7058). Two prominent journals in this field are *Safety Science*, with 231 articles, and the *Journal of Patient Safety*, with 145 articles. Table 3 shows that the category "Health Care Sciences and Services" is represented five times among the top 10 journals, highlighting the strong emphasis on healthcare-related safety culture in the industry literature.

Table 3. The top ten journals published on safety culture topics.

No.	Journal Name	Publications Number	Impact Factor	Journal's Subject Categories
1	*Safety Science*	231	6.1	- Operations Research and Management Science - Engineering, Industrial
2	*Journal Of Patient Safety*	145	2.2	- Health Policy and Services - Healthcare Sciences and Services
3	*BMC Health Services Research*	116	2.8	- Healthcare Sciences and Services
4	*BMJ Quality and Safety*	89	5.7	- Health Policy and Services - Healthcare Sciences and Services
5	*International Journal of Environmental Research and Public Health*	89	4.614	- Public, Environmental and Occupational Health - Public, Environmental and Occupational Health - Environmental Sciences
6	*Institution Of Chemical Engineers Symposium Series*	69	-	- Chemical Engineering - Engineering
7	*Process Safety Progress*	63	1.0	- Engineering, Chemical
8	*Advances In Intelligent Systems and Computing*	57	-	- Computer Science - Control And Systems Engineering
9	*International Journal for Quality in Health Care*	57	2.6	- Health Policy and Services - Healthcare Sciences and Services
10	*Journal Of Safety Research*	52	4.1	- Transportation - Ergonomics - Public, Environmental and Occupational Health - Social Sciences, Interdisciplinary

VOSviewer 1.6.19 was employed to analyze the collaboration patterns, also referred to as citation sources, among journal publications related to safety culture. The network includes journals that have published at least 10 articles on the subject. Notably, some journals in the network are not connected to others within the network. Three primary collaborative groups can be identified: the first group centers around the *Journal of Patient Safety*, the second group around *Safety Science*, and the third group around the *International Journal of Environmental Research and Public Health*, as illustrated in Figure 11.

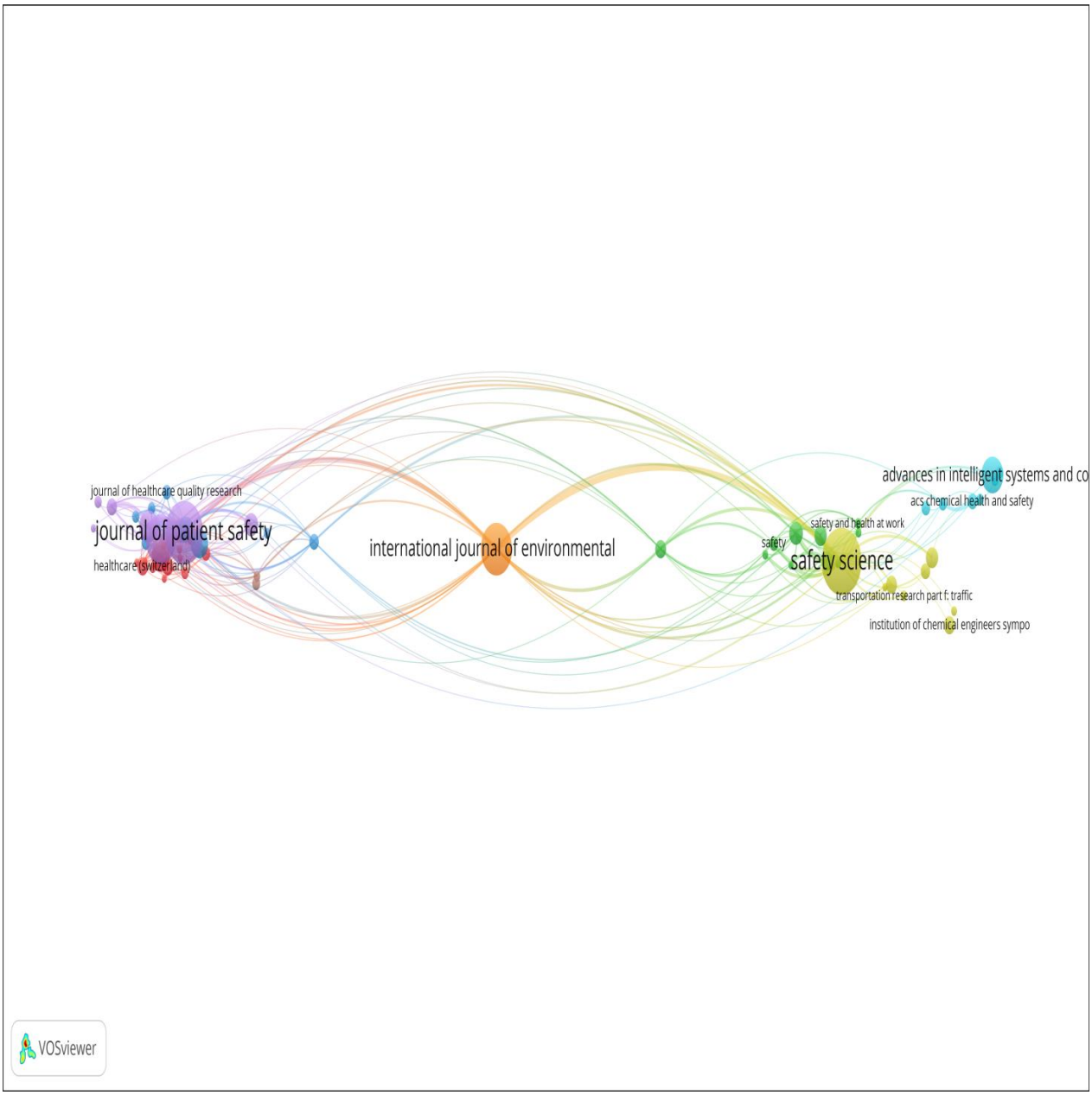


Figure 11. Top ten journals that are currently publishing on safety culture.

3.9. Institutions

The 7058 publications that provided details on the institutions involved in the research were authored by 10,230 distinct research institutions. It is important to note that a single author may be affiliated with multiple institutions, or a publication may have multiple authors from various institutions. A significant majority, 93.9% (n = 9612), of these institutions

participated in just one publication, while 4.9% (n = 498) contributed to two publications. Only 0.22% (n = 22) of institutions were involved in 10 or more publications on safety culture.

Table 4 highlights the top ten most prolific institutions in safety culture research. Among these, the United States, Canada, the Netherlands, and the United Kingdom stand out as the most productive countries. Johns Hopkins University leads the list with 107 articles on the subject. Interestingly, all of the top ten institutions are universities, as shown in Table 4.

Table 4. Top ten most productive organizations that write on safety culture.

No.	Affiliation	Publications Number	Country
1	Johns Hopkins University	107	USA
2	Harvard Medical School	51	USA
3	University of Toronto	50	Canada
4	Delft University of Technology	48	The Netherlands
5	The University of Manchester	46	UK
6	University of Aberdeen	46	Scotland
7	China University of Mining & Technology, Beijing	45	China
8	Norges Teknisk-Naturvitenskapelige Universitet	44	Norway
9	University of Michigan, Ann Arbor	44	USA
10	University of Stavanger	41	Norway

An intriguing approach to analyzing the 10,230 institutions engaged in safety culture research is to categorize them as either academic (e.g., universities and colleges) or private (e.g., hospitals and industries). This distinction could provide insight into whether safety culture research is more prevalent in academic settings or firmly embedded within industry and private institutions. However, this classification process is time-consuming, as such information is not readily available in the Scopus database and would require manual verification for each institution.

4. Discussion

This study provides a thorough assessment of the general research patterns for the issue of safety culture in publications from 1978 to 2023. The analysis is based on data obtained from Scopus's database. Since 1978, there has been a steady rise in the publication's number on safety culture, with a significant surge occurring around 2002. There were variations in the number of publications, reaching a high in 2021 and seeing a little decline in 2022 and 2023, which might indicate a moment of maturity for the field of research. While the number of publications on safety culture varies from year to year, there is usually a consistent rising trend. This research encompasses 7058 papers pertaining to safety culture, which include 12,675 authors, 1365 journals, 232 nations or territories, and 1032 institutions.

Based on these findings, the concept of safety culture may be categorized into "healthcare and safety of patients" and "safety culture in organizations". The sphere of healthcare and patient safety has mostly emphasized empirical study, while the organizational safety culture primarily emphasizes theoretical investigations. Therefore, the safety culture in the healthcare sector surpasses the organization. Notably, the recent emergence of COVID-19 has further amplified the significance of safety culture in the healthcare sector. Bibliometric analysis reveals distinct research clusters in safety culture studies:

1. Healthcare and Patient Safety: This cluster has seen an exponential rise, particularly in the last two decades, emphasizing risk management, patient safety measures, and institutional policies.
2. Workplace and Organizational Safety Culture: Research has evolved from technical compliance-focused studies to more human-centered approaches, considering leadership, employee perceptions, and behavioral safety frameworks.
3. Sector-Specific Safety Culture: While healthcare dominates the field, other emerging domains include transportation, construction, and industrial safety.
4. Regional Disparities: Safety culture research is geographically imbalanced, with most contributions from the USA, UK, Canada, and the Netherlands, while regions such as Southeast Asia, South America, and Africa remain underrepresented.

The power-law distribution encompasses a wide range of aspects in safety culture publications, as shown by bibliometric studies conducted in various fields [2,9]:

- Approximately 83.5% of the writers have only been acknowledged for one publication related to the subject of safety culture. A total of 3.5% are attributed to nine articles and maybe more.
- Out of the journals that are published on the subject, 62.4% of them only published one paper. Of these journals, 9.1% published six or more papers on the topic of safety culture.
- Out of the territories or nations that have published on safety culture topics, 47.8% have published 10 or fewer publications. In total, 27.8% of countries or territories, which is 64, have produced between 11 and 40 publications. Additionally, 24.8% of countries or territories, which is 57 in total, have published more than 41 publications.
- Out of all institutions, 93.9% exclusively took part in one publication, whereas 4.9% (n = 498) exclusively participated in two publications. Out of the total number of organizations, only 22 (0.22%) have published 10 or more publications about safety culture.
- The top five most productive institutions were located in the United States, Canada, the The Netherlands, and the UK.
- The mean number of citations per publication is 4.5. During the data extraction process, 16.9% of publications were not referenced. Out of a total of 7058 instances, 1.11% (n = 78) were referenced 50 times or more, and 0.25% were quoted 100 times or more.

Additionally, the analysis revealed who is at the forefront of this field of study:

- Kirwan and Naevestad are the writers with the highest productivity. Spill figures in the collaborative network of writers are linked to other authors, either directly or indirectly. Kirwan, B., is associated with France and has authored 29 publications about organizational safety culture. Nævestad, T. O., is associated with Norway and has authored 28 publications on the subject of organizational safety culture.
- The work authored by Guldenmund [3] has received the greatest number of citations, with a total of 1241 citations. On the other hand, the paper by Sexton et al. [42] has the highest average number of citations per year, with an average of 71%.
- *Safety Science* and the *Journal of Patient Safety* are prominent publications in the discipline, with 231 and 145 articles, respectively. Safety science journals are the primary publications that focus on themes related to safety culture.
- The text consists of a bullet point. The United States of America had the highest number of publications, with the United Kingdom, Australia, and Brazil following closely after. The cooperation network of the USA mostly encompasses Western and Southern European nations, the Middle East, Southeast Asia, North America, and South Africa. The second-largest donor to the UK comprises three other significant countries: Saudi Arabia, South Africa, and Switzerland. Canada is the third nation with significant partnerships with three other contributors: Australia, China, and Germany.

- The key institution is Johns Hopkins University in the United States. The five most prolific institutions were in the USA, Canada, Netherlands, and the United Kingdom.

This bibliometric analysis yields promising findings. Publications about safety culture have seen a significant amount of collaborative research, including papers written by several authors. Furthermore, a wide range of journals have been published on the subject, and a wide range of subject categories have been allocated to publications concerned with safety culture. This demonstrates the interdisciplinary character of safety culture research and the different study issues that have been investigated.

Multiple issues were noted for consideration. Geographical imbalance exists in safety culture studies, with little participation from Oceania, South America, the Middle East, Southeast Asia, and Africa. Future research should promote regional studies, utilizing local databases and collaborations for a globally representative understanding of safety culture.

Furthermore, research on organizational safety culture is shifting its focus from technical factors to human dimensions, which are essential but do not undermine the significance of technological features. Future research should pursue a balanced strategy that combines human elements with technological factors to create comprehensive safety frameworks.

The prioritization of applied research in healthcare leads to a lack of focus on theoretical studies and research in non-healthcare organizational contexts. Future work should promote theoretical contributions and conceptual models that can be applied across various industries rather than confined to healthcare settings.

Furthermore, there is a dearth of studies on diverse topics such as safety culture in transportation and logistics, safety culture in sports and recreation, safety culture in the energy sector, safety culture in education institutions, and safety culture in construction. Future research should examine underrepresented sectors and conduct safety culture analyses to identify challenges and best practices in various fields.

4.1. Comparative Analysis Across Sectors and Regions

4.1.1. Sectoral Comparison

The bibliometric analysis reveals substantial differences in the focus and volume of safety culture research across sectors. The healthcare sector overwhelmingly dominates the literature, accounting for over 50% of publications, particularly after the emergence of the COVID-19 pandemic. Research in this domain often emphasizes human factors, patient safety, leadership, communication, and burnout management. Conversely, sectors such as transportation, construction, energy, logistics, education, and sports are significantly underrepresented. When present, studies in these sectors tend to focus more on compliance with technical standards and risk assessments, with less emphasis on organizational behavior, safety leadership, or psychological factors. We present the following findings regarding the different sectors:

- Healthcare: Highly represented, with studies exploring patient safety culture, infection control, and staff well-being—intensified by COVID-19.
- Transportation: Limited studies, focusing mainly on operational safety, hazard prevention, and human error in maritime and aviation sectors.
- Construction and Energy: Research primarily addresses regulatory compliance, hazard identification, and safety performance indicators. There is limited focus on cultivating proactive safety cultures or leadership roles in fostering safety.
- Education and Sports: These sectors are nearly absent in safety culture literature, despite increasing global attention to safety in academic and athletic settings.

4.1.2. Regional Comparison

The geographical distribution of safety culture research is uneven. High-income regions like North America (especially the USA and Canada), Western Europe (UK, The Netherlands), and Australia dominate the field. These regions often focus on advanced topics such as high-reliability organizations, safety leadership, and patient-centered safety approaches.

On the other hand, regions such as Southeast Asia, South America, the Middle East, and Africa contribute comparatively fewer publications. Studies from these regions are often descriptive, focusing on basic safety compliance, regulations, and awareness rather than advanced frameworks or interventions. We summarize our findings relating to these regions below:

- North America and Western Europe: Emphasize human factors, leadership, and system safety approaches in healthcare and industrial settings.
- Asia (China, Japan, Southeast Asia): Focus on industrial safety, mining, and manufacturing sectors, with growing but still limited attention to healthcare safety.
- Middle East and Africa: Emerging focus on healthcare safety culture; however, studies are relatively few and often lack rigorous methodological designs or theoretical frameworks.
- South America: Sparse literature, primarily descriptive studies focusing on basic occupational health and safety issues.

4.2. Limitations

Although this study provided numerous theoretical contributions, it is crucial to acknowledge and discuss the limitations and shortcomings of this bibliometric analysis. Firstly, bibliometric analysis relies on quantitative methodologies, which do not facilitate the interpretation of the content or quality of publications. Additionally, the analysis is constrained by the existing classifications in Scopus. One limitation of using Scopus is the exclusion of non-indexed sources, such as local journals, industry reports, and gray literature, which may contain relevant insights into safety culture. However, Scopus remains one of the most comprehensive academic databases, covering a vast array of peer-reviewed journals and conference proceedings, ensuring the inclusion of high-quality and impactful research. Another potential limitation is language bias, as Scopus primarily indexes English-language publications. This may lead to the underrepresentation of studies published in other languages. Nevertheless, since most high-impact safety culture research is published in internationally recognized journals, the effect of this bias on the study's findings is minimal. Finally, this study offers a quantitative bibliometric analysis of safety culture research, focusing on publication trends, citations, and thematic areas. However, it does not provide in-depth qualitative insights into the organizational, cultural, or contextual factors influencing these trends. Future research should employ qualitative methods, such as systematic reviews or case studies, to explore these dimensions and provide a deeper understanding of safety culture across different sectors and regions.

5. Conclusions

This bibliometric analysis of safety culture research from 1978 to 2023 reveals significant trends, gaps, and areas needing further investigation. There is a geographic imbalance in safety culture studies, particularly lacking in Oceania, South America, the Middle East, Southeast Asia, and Africa. Furthermore, industries such as transportation, logistics, energy, sports, education, and construction are underrepresented. Future research should aim to explore these neglected areas for a complete understanding of safety culture.

The study also emphasizes how the COVID-19 pandemic has highlighted the critical role of safety culture, especially within healthcare. Moreover, safety culture research

encompasses various disciplines, including anthropology, psychology, engineering, and sociology. Integrating diverse viewpoints, methods, and theoretical frameworks enriches the understanding of safety culture. Using an extensive Scopus dataset and thorough bibliometric analysis, this work offers important insights into the present state of safety culture research and its prospective directions.

Future studies should address several gaps and opportunities. Research on safety culture has largely focused on healthcare, neglecting critical areas such as transportation, energy, sports, and education. Expanding research into these sectors can enhance safety frameworks. Additionally, most studies emphasize healthcare and engineering, with limited integration of social sciences to explore cultural and psychological aspects of safety. Addressing this gap would provide a more holistic understanding of safety culture. Regional representation remains imbalanced, with limited research from Southeast Asia, Latin America, and Africa. More localized studies are needed to develop context-specific safety frameworks. Furthermore, while human behavior research has gained prominence, it should not overshadow technological advancements in safety systems. A balanced approach integrating both human and technological factors is crucial for developing comprehensive safety solutions.

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