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A Bibliometric Perspective of Safety Awareness Research in 48 Years

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Abstract

Safety awareness refers to an individual's ability to recognize potential hazards and take proactive measures to prevent accidents or injuries. It involves being alert to risks and hazards in the environment, and understanding the importance of following safety protocols and procedures. This study aims to explore safety awareness-related publishing patterns and rank the most used author keywords in the Scopus and Web of Science (WoS) databases. The eminent software, ScientoPy and VOSviewer, are used to run and execute relevant publication data retrieved from Scopus and WoS. The results showed a positive trend in the growth of safety awarenss literature in both databases since 1974. The top three research areas that dominate this topic are "engineering", "public, environmental & occupational health", and "computer science". Based on the country analysis, China has become an active publisher, followed by United States and United Kingdom. Importantly, this study emphasised the scholarly communication practices prevalent in safety awareness research have impressively propagated. The trends will assist researchers in recognising the various fields in identifying the core areas, proactive institutions, and core source titles published in this knowledge for supplementary investigation. Besides, by examining the most popular keywords, the results of this study enable researchers to discover the possibility for future research that may be conducted, particularly concerning the annual growth rates, which have been trending in the last five years.

1. Introduction

Safety awareness refers to the understanding and recognition of potential hazards and risks in a given environment, along with the ability to take proactive measures to prevent accidents or injuries. According to Manik *et al*. (2021), it involves being alert to potential dangers and hazards, and following established safety protocols and procedures to reduce the risk of harm to oneself and others. Therefore, safety awareness is an essential component of personal and professional responsibility, and can be enhanced through education, training, and ongoing attention to one's surroundings.

Safety awareness can be applied to a wide range of situations, such as working in hazardous environments, driving a vehicle, or engaging in recreational activities. With that, by developing a strong sense of safety awareness, individuals can reduce the likelihood of accidents and injuries, and create a safer environment for themselves and others (Kamaruddin & Isa, 2022) [12]. According to Nor & Selamat (2020) [15]; Yahya (2019) [25], safety awareness is important to reducing the risk of accidents and injuries, creating a safe environment, enhancing productivity, reducing costs and compliance with regulations. Overall, safety awareness is crucial for creating a safe and healthy environment for individuals and organizations.

It is challenging for researchers to evaluate the material's current grasp, usefulness, and future direction due to the volume of information and the never-ending publication of the study on any research topic (Abdullah & Sofyan, 2023) [3]. It is, thus, in order to address the issue of excessive information availability and the breadth of different research topics, specific methodologies, such as bibliometric analysis, assist scholars and researchers in gaining a broad or even microscopic view of the overall progress and steady and continuous flow status (Gazali *et al*., 2021) [11]. Information retrieval is crucial to the cross-disciplinary field; this process can analyse aspects of information science and publication trend analysis. The bibliometric technique visualises vast publishing outputs necessary for deriving valid conclusions, such as the evolution of publications, study fields, and influential authors (Sofyan & Abdullah, 2022) [22].

Bibliometrics made it easier for researchers to identify research gaps, emerging research prospects, and significant research areas (Abdullah & Othman, 2022) [2]. It indirectly enables them to summarise the significant trends of a particular study field. In terms of safety awareness, there is still no researcher who has produced a bibliometric study related to safety awareness in detail. Nevertheless, past researchers have undertaken minimal bibliometric investigation with only subtopic of safety awareness. This clearly shows that research on safety awareness is still understudied. This study used Scopus and Web of Science (WoS) databases and was executed using ScientoPy to accomplish bibliometric analysis. The current study's primary goal was to identify patterns in safety awareness-focused publications.

2. Data and Methods

Fig 1 depicts the data processing sequence in this analysis based on Abdullah (2022) [1]. It consists of a systematic strategy that has been divided into three primary parts. First, the title should be determined, and the datasets be developed and gathered. The second phase involves integrating the databases and obtaining the ScientoPy-analysable parameters. In the last stage, ScientoPy and VOSviewer parameters are used to evaluate and analyse the results.
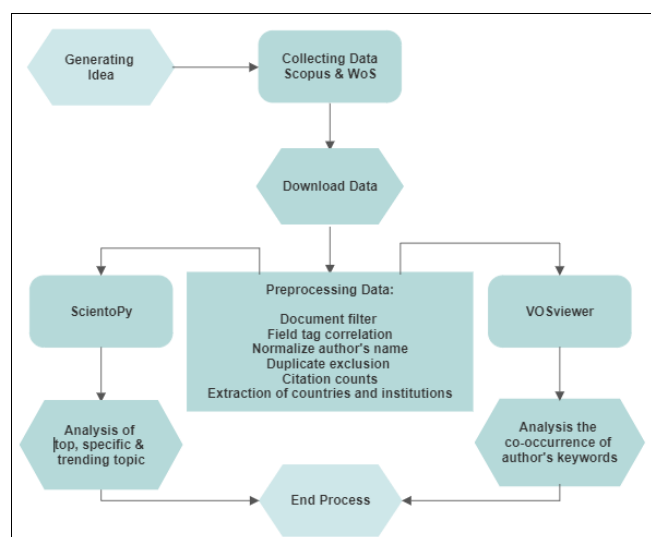
Fig 1: Bibliometric Workflow (Abdullah, 2022) [1]

Given the multifaceted nature of the studied topic, the literature on safety awareness is spread across many different fields. As a result, it was necessary to use accessible and numerous bibliographic databases to search for and find pertinent material on this subject. As a result, the two primary databases, Scopus and Web of Science (WoS), were used to collect the data for this study. The Scopus and WoS database is preferred since it is a multidisciplinary database with more articles in social science, education-related journals, management and other documents in various academic disciplines (Sweileh, 2022; Visser et al., 2021) [23, 24]. The Scopus and WoS databases also attract most scholars to obtain publications for their review purposes (Abdullah et al., 2023). These databases span multiple fields (Martín-Martín et al., 2021) [14], and searching them would aid researchers in locating the most significant number of citations on safety awareness primary sources for bibliometric studies (Pranckutė, 2021) [17]. After

defining the databases, the search query "safety awareness" was chosen. The following fields were scanned for topic-related terms: all. This inquiry was completed on March 20, 2023.

During the second stage, ScientoPy was used to preprocess the data. The secondary dataset is then established for the following analysis stage. ScientoPy uses the following criteria during the pre-processing steps; (i) normalising the author's name: it is replaced with a semicolon for metadata retrieved from the Scopus database, it is stripped of dots, commas, and special characters for metadata retrieved from both databases, and (ii) removing duplicate samples with the same title and authors (Ruiz-Rosero et al., 2019) [20]. The pre-processing information is recorded in Table 1. Based on Table 1, the ScientoPy pre-processing script prioritises Scopus documents over WoS documents; after duplicate removal, there are more papers in WoS databases than in Scopus. This study used a raw source dataset of 2704 papers from the WoS and Scopus databases. In this study, 107 of the 2704 loaded papers were eliminated due to ScientoPy's analysis focusing exclusively on five types of publications: (i) conference papers, (ii) articles, (iii) reviews, (iv) proceeding papers, and (v) articles in press (Ruiz-Rosero et al., 2019) [20]. Thus, other publications such as books, letters, and errata were omitted. Following data reconciliation, this study examined 1723 papers from both databases, containing 1052 papers from WoS and 671 papers from Scopus, removing 870 from Scopus and 4 duplicate papers from WoS.

Table 1: Information on Initial Data Analysis

Information	Number	Percentage (%)
Loaded papers	2704	
Omitted papers by document type	107	4.00
Total papers after omitted papers removed	2597	
Loaded papers from WoS	1056	40.70
Loaded papers from Scopus	1541	59.30
Duplicated papers found	874	33.70
Removed duplicated papers from WoS	4	0.40
Removed duplicated papers from Scopus	870	56.50
Duplicated documents with different cited by	540	61.80
Total papers after duplicate removal	1723	
Papers from WoS	1052	61.10
Papers from Scopus	671	38.90

ScientoPy is a free, open-source scientometric analysis program built on Python that sorts data according to the most well-liked, specific, and trending topics. Scholars around the world use many bibliometric software programmes intending to provide information to readers with various interesting infographics and graphical visualisations (Roslan et al., 2023) [18]. Even if several software programmes are available for conducting bibliometric analysis, choosing a solution that corresponds to the study objectives and questions is essential. This emphasises assessing the research questions before selecting a software application. The success of software in bibliometric analysis ultimately depends on the researcher's capacity to answer the research questions posed in the study (Abdullah et al., 2023; Roslan et al., 2023 [18]).

In this study, two software programmes were utilised: ScientoPy and VOSviewer. ScientoPy is an open-source Python software developed by Ruiz-Rosero et al. (2017) [21]

and subsequently tested for usability and effectiveness in a later study by Ruiz-Rosero et al. (2019) [20]. Pabon et al. (2020) [16] demonstrated that this software helps detect and eliminate duplicate datasets and clean up non-standard data formats. ScientoPy, as demonstrated by Ruiz-Rosero et al. (2019) [20], can automatically categorise and report on the top themes based on author or index keywords, as well as identify the most prolific authors and countries involved in the research, using bibliographical information. VOSviewer is another piece of software used to map the co-occurrence of authors' keywords. VOSviewer is a software application that assists in constructing and visualising bibliometric networks (Abdullah et al., 2020; Roslan et al., 2023) [4, 18]. Finally, the 1723-piece data set was analysed, and the necessary statistical reports, graphs, and tables were generated using bibliometric data visualisation tools, ScientoPy and VOSviewer.

3. Result and Discussion
Publication Growth
The number of peer-reviewed publications is an excellent indicator of a scientific topic's growth. Since 1995, Fig 2 demonstrates a significant increase in articles on safety awareness. Compared to Scopus, WoS publications have grown steadily, with a sharp rise after 2019. Based on its recognition in scientific publications for a wide range of research fields, WoS has been identified as a leading data source. Also, Scopus is constantly updated and is favoured by many researchers in various research domains. From the data in Table 2, it shows the latest five years for publications in Wos and Scopus. From 2018 to 2022, it was discovered that Scopus produced more than 93 publications in average, whereas WoS produced below 50 publications in average. The year 2021 shows the highest number of publications for Scopus which is 60 papers, while for WoS, the year 2022 has shown the highest achievement which is 116 papers. The increased interest in safety awareness research in both databases shows that this topic is crucial in advancing safety and awareness issue research. According to Arifin et al. (2021) [9], employees should have a high level of awareness regarding safety because it can prevent employees from the risk of accidents. Indirectly, research on safety awareness has gained more attention in recent years to discover the best argument for improving an awareness for employees and employee safety in order that employees are always alert when doing work.
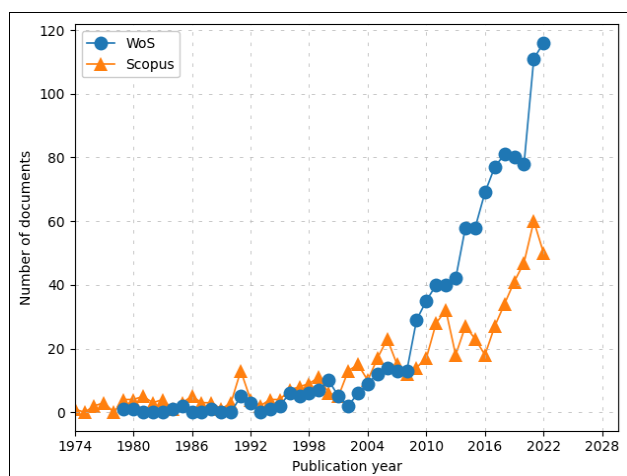

Fig 2: Timeline Graph of Safety Awareness Research

Table 2: Five Years Publication Trends of Safety Awareness Research

Publication	2018	2019	2020	2021	2022
WoS	81	80	78	111	116
Scopus	34	41	47	60	50

Subject Areas
Likewise, it is critical to conduct a review of relevant research articles. This strategy enables the essential disciplines in which research on safety awareness has been undertaken to be identified. Fig 3 depicts an evolution graph of the top ten subject areas that can be used to categorise safety awareness research in the Scopus and WoS databases. Engineering has been identified as the most extensively investigated field, with over 300 publications. Another fascinating subject is Public, Environmental & Occupational Health, and the third-ranked subject area is Computer Science. From the data in Table 3, showing the latest five years for publication trends from 2018 to 2022, it was found that Engineering produced with an average of 22.8, while for Public, Environmental & Occupational Health with an average of 16.6 papers produced, and for Computer Science just produced an average of 11.2 papers. According to the data in Table 3, the year 2020 and 2021 shows the highest number of papers for Engineering which is 25 papers, while for Public, Environmental & Occupational Health, the year 2022 has shown the highest among other years which is 24 papers, followed by Computer Science show in 2018 and 2019 the highest with 17 papers.
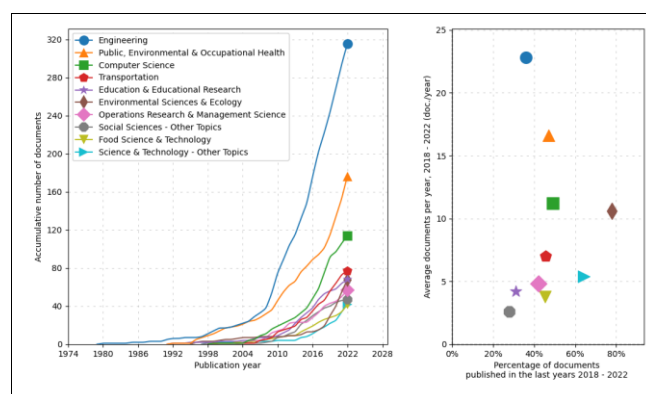

Fig 3: Subject Evolution Graph of Safety Awareness Research, based on 48 years of publication trends

Table 3: Five Years on Top Three Subject Areas of Safety Awareness Research

Publication	2018	2019	2020	2021	2022	Average
Engineering	20	22	25	25	22	22.8
Public, Environmental & Occupational Health	7	14	19	19	24	16.6
Computer Science	17	17	5	9	8	11.2

Publishing Countries
Since 1974, safety awareness research has been conducted in various countries. Fig 4 shows the country word cloud of safety awareness research. Based on fig 4, it shows that the red cluster is closely related to other countries. Australia in the middle, has more connections than other countries. Based on the Fig 5, China, United States and United Kingdom were identified as the top three publishing countries in safety awareness research. However, the three lowest-ranked countries are South Africa, Japan and

Netherlands. There are still not many countries that contribute towards the publication of safety awareness research. Thus, the study of safety awareness should be explored deeper and further in many countries.
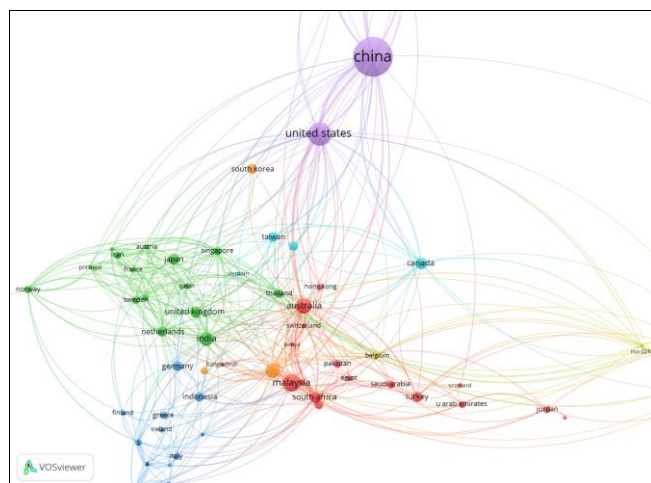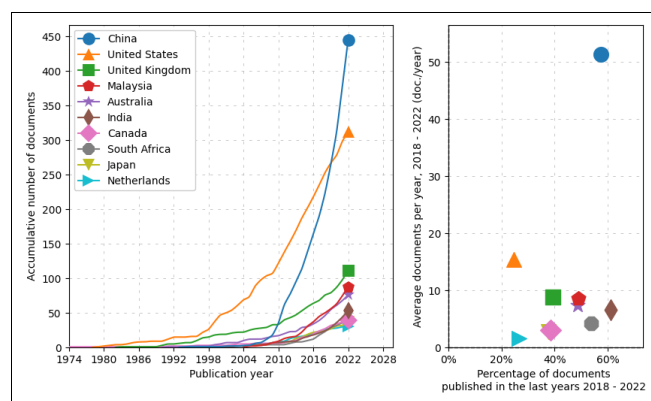

Fig 4: Word Cloud for Publishing Countries

Fig 5: Country Evolution Graph of Safety Awareness Research, based on 48 years of publication trends

Sources Titles
The information in Fig 6 pertains to the most influential source titles in safety awareness research, which are ranked according to the number of publications. A list of ten sources is included, along with the 48 years and the last five years' trending percentages.
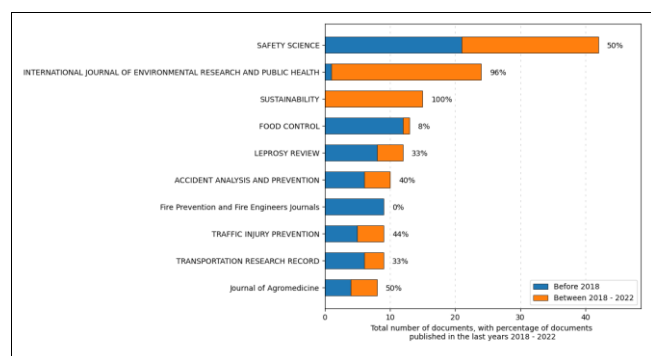

Fig 6: Source Title Bar Trends of Safety Awareness Research, based on 48 years of publication

According to Fig 6, Safety Science was ranked first in safety awareness research publications with 42 publications, followed by International Journal of Environmental

Research and Public Health with 24 publications and the Sustainability with 15 publications. All three-source title was the most active journal and remained the most influential in safety awareness research, with the possibility plans to maintain further publications for the future. Notably, the Sustainability has been the proactive source title in the last five years, with 100% of publications released from 2018 to 2022. Also, the compelling source title in the previous five years is International Journal of Environmental Research and Public Health, with 96% of publications. This data is the most up-to-date source for readers and future researchers seeking the most up-to-date studies on safety awareness.

Institutional Analysis
Fig 7 pertains to the top ten institutions that publish academic works on safety awareness. The scholars from The Hong Kong Polytechnic University (PolyU) in China were credited with the most publications, with 17 publications. The second institution is Southeast University in China and Tsinghua University in China is ranked third in this study. An intriguing feature of the top ten institutions in 48 years is that eight institution are from China. Thus, Jiangsu University is the most active for the last 5 years with 86% of publications. This shows that publications related to safety awareness are still growing over time.
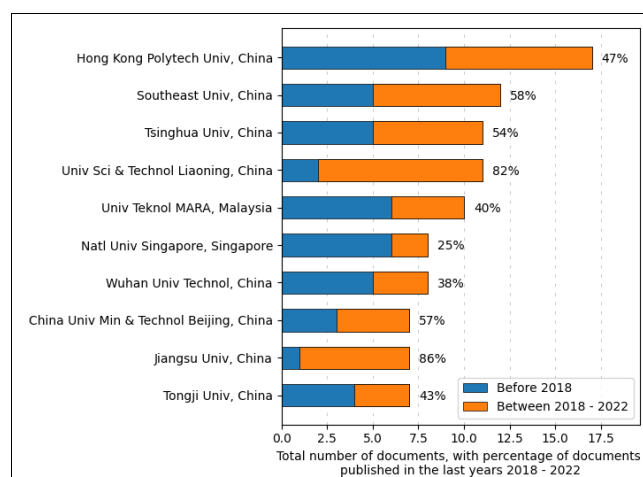

**Fig 7:** Institutional Bar Trends of Safety Awareness Research, based on 48 years of publication

Author Keywords
Analysis Author keywords refer to the terms used by authors to represent the content of their documents accurately. Most authors mention their study topic as a keyword in their document. The authors' keywords aided readers and future researchers in identifying the publications' significant ideas and arguments (Roslan *et al*., 2023) [18]. Numerous electronic search engines, databases, and journal websites use author keywords to identify and deliver relevant articles to prospective readers. Readers need to understand that keywords produce links to other relevant publications (Abdullah *et al*., 2022) [2]. In this case, Scientopy might track the evolution of a study topic or search argument using the authors' keywords. This section analyses the authors' top keywords in previous research on safety awareness. In order to complete the procedure, the authors' keywords were used to find research trends. It has been suggested to use an appropriate term, such as "safety awareness". These manual

tasks assist in organising data and eliminating term duplication, resulting in more robust results.

Fig 8 exhibits 10 previously researched keywords. As illustrated in Fig 8, the top three used term is "safety awareness," followed by "safety" and "food safety". Data processing was given importance to this broad phrase directly related to the subject. Important keywords are made available to assist readers and future researchers in determining which ones to employ while conducting document analysis (Abdullah *et al.*, 2022) [2]. While Fig 8 illustrates the first 10 keywords, ScientoPy enables us to view an infinite number of keywords (Ruiz-Rosero *et al.*, 2019) [20]. Also, Fig 8 displays the percentage of documents published in the preceding five years (2018– 2022) to illustrate a relative increase. We can observe from this indicator that "patient safety" has the highest proportion (62%). It is self-evident that the issue has increased significantly over the last five years compared to other keywords. Additionally, "safety awareness" itself has been a hot topic, with 42 (41%) publications published from 2018 to 2022. Thus, this study depicted that patient safety, awareness and safety culture has sparked scholars' curiosity.
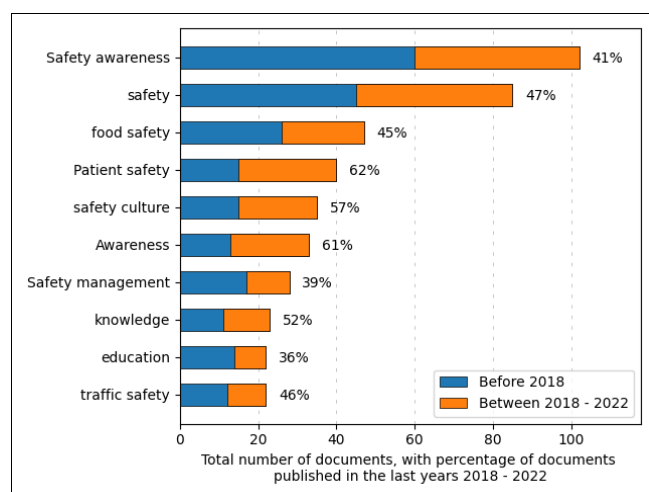

Fig 8: Author Keywords Bar Trends of Safety Awareness Research, based on 48 years of publication

Furthermore, this study used cluster mapping to ascertain the co-occurrence of the authors' keywords to denote themes or issues relevant to safety awareness (see Fig 9). Before using the VOSViewer to generate a network map, the dataset was pre-processed with SientoPy (a combination of Scopus and WoS metadata). Additionally, this study used a thesaurus file to map the co-occurrence of the authors' terms before mapping them. Concatenating related terms, spelling variants, and singular or plural terms requires the use of the thesaurus file.

Based on Fig 9, it can be deduced that the most frequently used keywords were "safety awareness", "safety", "food safety", "patient safety", and "safety management". These keywords are inextricably linked. The keyword "safety awareness" was grouped in the same clusters (red colours) with "safety climate", and "safety behavior". "Safety awareness" is also closely linked to "safety climate". Based on this map, safety awareness research is also focused on safety behavior and safety culture, which is should be a priority at all levels of safety organization management. Therefore, organizations should improve their efficiency to ensure employee safety awareness at a high level and at the

same time also enhance the good name of the organization (Anwar & Abdullah, 2021; Roslan *et al.*, 2022) [8, 19]. Additionally, conditions conducive to organization commitment in manage safety to employee may encourage this approach. Importantly, this study shows that research on safety awareness is not limited to the safety culture but has attracted the interest of scholars in the safety management research sector.
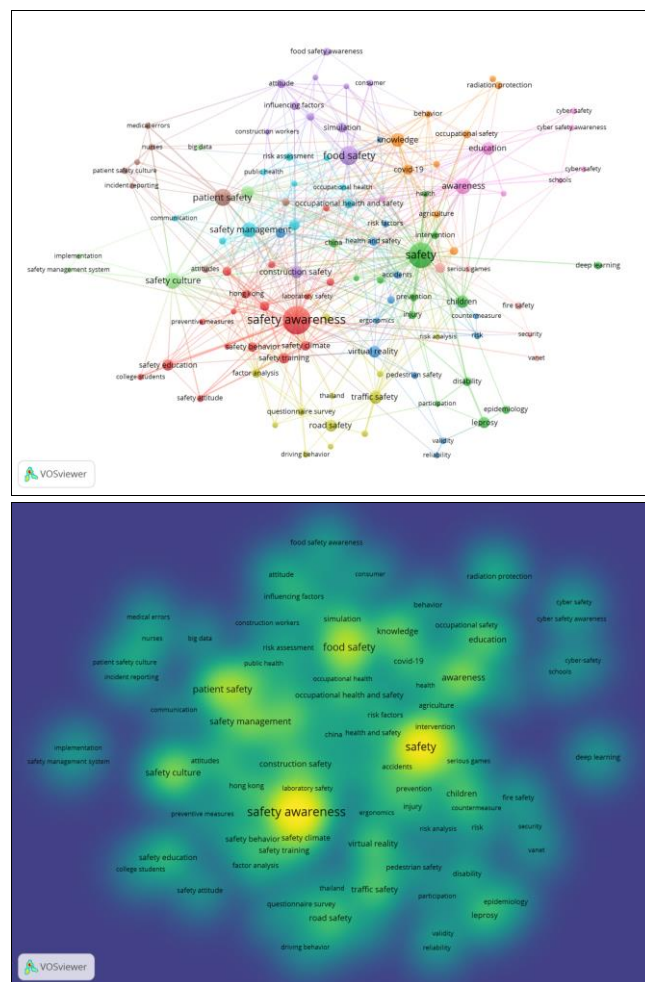
Fig 9: Network Visualisation of The Co-occurrence of Authors' Keywords

4. Conclusion

Positive states about safety awareness were found to be related to safety culture, even though it was found that people might thinking to cope with their outlook and knowing how people make decisions regarding their supported for develop of their trust. Therefore, it is important to know the relationship of this study with the important of awareness found in a safety. This research looks at how often specific articles are published and how often they use certain keywords to determine safety awareness.

The results indicated that publications on safety awareness have increased significantly since 1995. Notably, WoS publications have expanded consistently compared to Scopus, with a sharp increase following 2019. With over 300 publications, Engineering has been identified as the most thoroughly explored research area. China, United States and United Kingdom have been designated as the research area's top three publishing countries. Safety Science was the most often published source title pertaining

to safety awareness, followed by International Journal of Environmental Research and Public Health and Sustainability. With 17 publications, scholars from Hong Kong Polytechnic University (PolyU) in China were credited with the most active institution. The keyword "safety awareness" is the most frequently used by previous researchers, followed by "safety" and "food safety". Safety awareness was clustered in the same group with "safety climate" and "safety behavior". Remarkably, "safety awareness" and "safety" are inextricably intertwined.

Certain limitations to this study may help direct future studies. Publications in the Scopus and WoS databases were analysed and mapped for this research. As a result, the findings of this study were limited to deducing the most critical themes or keywords associated with safety awareness studies found in those databases. Therefore, if future research wishes to expand on the foundation or address broad subjects, a systematic literature review or meta-analysis is recommended to provide the most relevant evidence synthesis possible. Nonetheless, scholarly dissemination in the safety awareness research field is provided to potential readers and future researchers keen on this topic.

This study provides a novel perspective by demonstrating that research on safety awareness is not restricted to safety culture but has drawn scholars to explore safety awareness within the framework of safety behavior, which transcends research areas. Therefore, the study will aid researchers from various fields in identifying essential publication trend factors for systematically disseminating safety awareness research. In addition, this study's findings motivate researchers to collaborate and develop new research paradigms for evaluating safety awareness by analysing the most often-used terms through empirical studies.

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