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Mapping of literature on safety knowledge research using ScientoPy and VOSviewer

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A. Conception and design of the study
B. Acquisition of data
C. Analysis and interpretation of data
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Abstract. A study scope that emphasises safety knowledge is essential for providing individuals with the information they need to work safely and follow existing safety regulations. This study examines the evolution of safety knowledge research based on publications productivity, subject areas, proactive authors, energetic research institutions, and the primary authors' keywords. This study deliberates the bibliometric analysis of previous publications pertinent to safety knowledge research by using the Scopus and Web of Science (WoS) databases. This study found a significant increase in safety knowledge publications, with WoS publications outpacing Scopus in growth explicitly in 2012. "Food Science and Technology" has been the most thoroughly researched field. Also, this study revealed that "Food Science and Technology" became the primary focus of safety knowledge research. Osaili, T.M., and Jevnik, M., are acknowledged as proactive contributors to safety knowledge research. Jordan University of Science and Technology in Irbid, Jordan, dominated the number of publications. This study discovered that content analysis through the analysis of authors' keywords is principally focused on "food safety", "attitudes", and "practises", which are closely related and provide a meaningful relationship. This bibliometric analysis concludes that the safety knowledge research output is considerable. This bibliometric analysis provides an overview of safety knowledge research, which may accommodate practitioners and researchers interested in expanding or discovering a new understanding of this subject and establishing robust safety knowledge research theories and practices.

Keywords: safety knowledge; bibliometric; Scopus; Web of Science

INTRODUCTION

Previous studies have shown that risky behaviour is the primary contributor to accidents that occur on the job in all fields and sectors (Abdullah, 2022). This scenario demonstrates that behavioural studies are essential to resolving challenges and problems associated with managing occupational safety and health. Consequently, safety education and training were able to reduce risky and unsafe behaviour (Loosemore & Malouf, 2019). In addition to the traditional practice of face-to-face knowledge sharing, the enormous effect of modern technologies such as social media is also helpful in addressing the individuals with better safety instruction and knowledge (Yao et al., 2021). Strictly speaking, safety knowledge and safe behaviours are the framework or scope of the research that complement one another. Safety knowledge can be defined as a reasonable belief that boosts a person's capacity to manage recognised risks efficiently per acceptable risk levels (Dong et al., 2018).

Safety knowledge is vital for giving safety information, such as techniques to improve laboratory safety for students. Therefore, safety knowledge assessments relating to Globally Harmonized System (GHS) classification and pictograms should be administered at all levels of education (Wu et al., 2020). This aspect of safety education should be fostered within educational institutions, i.e., before an individual enters the workforce. This field of study was also deemed essential in managing food safety. A survey conducted by Odeyemi et al. (2019) found that throughout Africa, Cameroonian consumers have the slightest knowledge about food safety compared to those in Ghana and Nigeria. Similarly, the study discovered that Iranian consumers have the most nuanced understanding of food safety in Asia compared to Malaysia and Pakistan. In addition, they found that 89% of respondents were aware of food poisoning, while 304 consumed foods left at room temperature for an extended period. Odeyemi et al. (2019) observed substantial differences in food safety knowledge, attitudes, and practises of African and Asian consumers.

Despite advances in safety performance over the past three decades, the construction industry still has an injury-and-illness rate nearly five times higher than the average for all industries. This disproportionate number of injuries and illnesses has been attributed, in part, to the dynamic, complicated, and temporary nature of construction projects. According to a case study conducted by Hallowell (2012), construction organisations acquire safety knowledge from various internal and external sources but have ineffective knowledge storage and transfer systems, which hinders the workforce's ability to develop critical understanding to solve urgent safety-related issues. Despite technical developments in information and knowledge management in the building and construction sector, there is still no relationship between safety management and information models, which is a source of concern for safety knowledge in construction (Zhang et al., 2015).

In both the present and the past, the lack or inadequate implementation of occupational health and safety management systems is the root cause of most catastrophic accidents in worldwide enterprises. Zhao et al. (2021) discovered that safety attitudes and leaders directly affect the perception of risk probability and severity. In contrast, they mentioned that safety knowledge has an immediate positive impact on the perception of risk severity but not the perception of risk probability. Basahel (2021) found

that safety leadership and attitude characteristics, in addition to their interactions, predicted safety motivation and knowledge. In addition, these factors affected safety participation and compliance through the knowledge and motivation of workers. Workers' safety motivation and knowledge positively influenced participation and compliance. According to Kao et al. (2019), the association between safety knowledge and safety behaviours is partially mediated by worker safety attitudes. In addition, when supervisors had positive safety attitudes, the direct association between worker safety attitudes and safety behaviours and the indirect relationship between safety knowledge and safety behaviours were more favourable than when supervisors had negative safety attitudes.

This study aims to examine the evolution of safety knowledge publication based on publications productivity, subject areas, proactive authors, energetic research institutions, and the primary authors' keywords. Bibliometric safety knowledge research is limited in previous studies. Based on the bibliometric analysis, Wang et al. (2020) classified 4,852 journal articles on occupational safety and health management using a mapping of knowledge areas. They also identified that risk assessment or management at the organisational level has constantly been researching hotspots, and the relationship between safety culture, illness absence, and safety performance, among other aspects, have become significant study subjects in the past year. Abdullah and Abd Aziz (2020) conducted bibliometric research on safety knowledge and discovered that occupational health and safety management increasingly depend on safety information. Their research found pertinent data and key integrated domains of study, adopting consistent findings for the practical application of workplace safety knowledge. Abdullah and Aziz (2020) analysed a bibliometric safety knowledge using VOSviewer and a single database, Scopus. This study used Scopus and Web of Science (WoS) databases to analyse safety knowledge research. In addition, ScientoPy and VOSviewer are utilised in this study to investigate the progress of safety knowledge publication.

METHODOLOGY

Data collection and retrieval

A bibliometric analysis is a method for understanding the nature of a study in a specific field based on the existing pieces of literature. It facilitates the examination and integration of established research directions and the comprehension of emergent trends (Abdullah, 2021b). This technique isolates bibliometrics from the review paper, addressing recent advancements and possible directions for a particular area (Abdullah, 2021a, b). Diverse disciplines, including public health, social sciences, and management, have published academic works on safety knowledge (Abdullah & Abd Aziz, 2020). Therefore, multidisciplinary databases must be used to search and identify the literature associated with safety knowledge. To acquire a list of high-quality and often cited papers, it is also essential to conduct searches in databases with a high impact factor. As a result, Scopus and WoS have been selected as databases that meet these requirements.

This study extracted safety knowledge-related metadata from Scopus and WoS using the keyword "Safety Knowledge" within publication title searches. This search was conducted in March 2022. This study does not specify a timeframe for retrieving metadata. The comprehensive metadata that has been retrieved from both databases is 909. The

number of omitted metadata is 81, equivalent to 8.9%. ScientoPy is set by default to analyse a few types of documents, such as conference papers, articles, review papers, and proceeding papers. Thus, other records were omitted. The total number of copies after the omission is 828, specifically 462 (55.80%) Scopus publications and 366 (44.20%) WoS publications.

Data analysis

After collecting metadata from the Scopus and WoS databases, the next step is to confirm that the data is clean by removing any overlapping or redundant metadata. ScientoPy is used to do a pre-processing stage for this procedure. ScientoPy is a free, open-source Python tool for scientometric data analysis that categorises the most popular, particular, and trending topics (Ruiz-Rosero et al., 2017; Sofyan & Abdullah, 2022). During the pre-processing phase, ScientoPy employs the following criteria: (i) normalise the author's name by replacing it with a semicolon for metadata collected from the Scopus database and stripping it of periods, commas, and special characters for metadata taken from both databases; and (ii) delete duplicate samples with the same title and author (Ruiz-Roseroet al., 2019).

Table 1 depicts the number of metadata after pre-processing phase. Based on Table 1, there are 328 duplicated papers found in the Scopus database. Also, during the pre-processing stage, there are 219 documents found to be repeated with different cited. Finally, the results yielded validated publications consisting of 134 from Scopus and 366 from WoS. The total number of validated publications used in this study is 500 publications. In order to carry out bibliometric analysis, the number of validated publications is supposed to reach the threshold of at least 300 papers, and this study had met the minimum requirement (Donthu et al., 2021).

Table 1. A Brief of Pre-processed Metadata

Information	Number of Publication	Percentage (%)
Duplicated papers found	328	39.60%
Removed duplicated papers from WoS	0	0.00%
Removed duplicated papers from Scopus	328	71.00%
Duplicated documents with different cited by	219	66.80%
Total papers after removing duplicates	500	
Papers from WoS	366	73.20%
Papers from Scopus	134	26.80%

After obtaining the validated metadata, the next stage is to run the bibliometric analysis using ScientoPy and VOSviewer. This study employs ScientoPy to analyse the growth and current research patterns associated with safety knowledge. According to Ruiz-Rosero et al. (2019), ScientoPy comprises five visual graphics forms: timeline, bar, bar trends, evolution, and word cloud, to visualise study-specific characteristics. Nevertheless, the author applied the timeline and word cloud graph to explain the results of this study. VOSviewer is used to construct bibliometric mapping to investigate the co-occurrence of authors' keywords. According to Van Eck and Waltman (2010), VOSviewer includes visual components derived from mapping techniques that convert Comma Separated Values (CSV) data to diagrams or clusters. Thus, mapping algorithms enable researchers to analyse

specific data such as authors, locations, institutions, citations, co-citations, and other elements of refinement (Abd Aziz et al., 2020).

RESULT AND DISCUSSION

This study is intended to scrutinise the progression of safety knowledge publication based on the following parameters (designated by the subtopic of the results). In the current study, results and discussion are portrayed to provide potential readers and future researchers with valuable knowledge input for their references. The word cloud diagram indicated that the larger the font size, the greater the frequency of its occurrence. The timeline and word cloud graphs are produced using ScientoPy. And a diagram of the co-occurrence of authors' keywords is created using VOSviewer.

Publications Productivity

Monitoring publishing trends annually might help uncover research subjects. And therefore, potential readers and future researchers must comprehend a study's theme. In addition, it may attract future researchers interested in refining the characteristics that determine the growth or decline of an annual publication (Abdullah & Sofyan, 2022). After 2012, Figure 1 illustrates a substantial increase in safety knowledge publications, with WoS publications growing steadily compared to Scopus. It has been established that WoS is a leading data source based on its prominence in scientific publications for a vast array of academic disciplines. In addition, WoS is frequently updated and favoured by researchers across numerous academic fields. The increasing research interest in safety knowledge in both databases indicated this topic's significance for advancing safety and health issues research. Therefore, the importance of safety knowledge must be grasped, and efficient communication channels, platforms for knowledge sharing, and incentive mechanisms must be developed to build a culture of knowledge sharing in safety (Ni et al., 2020).

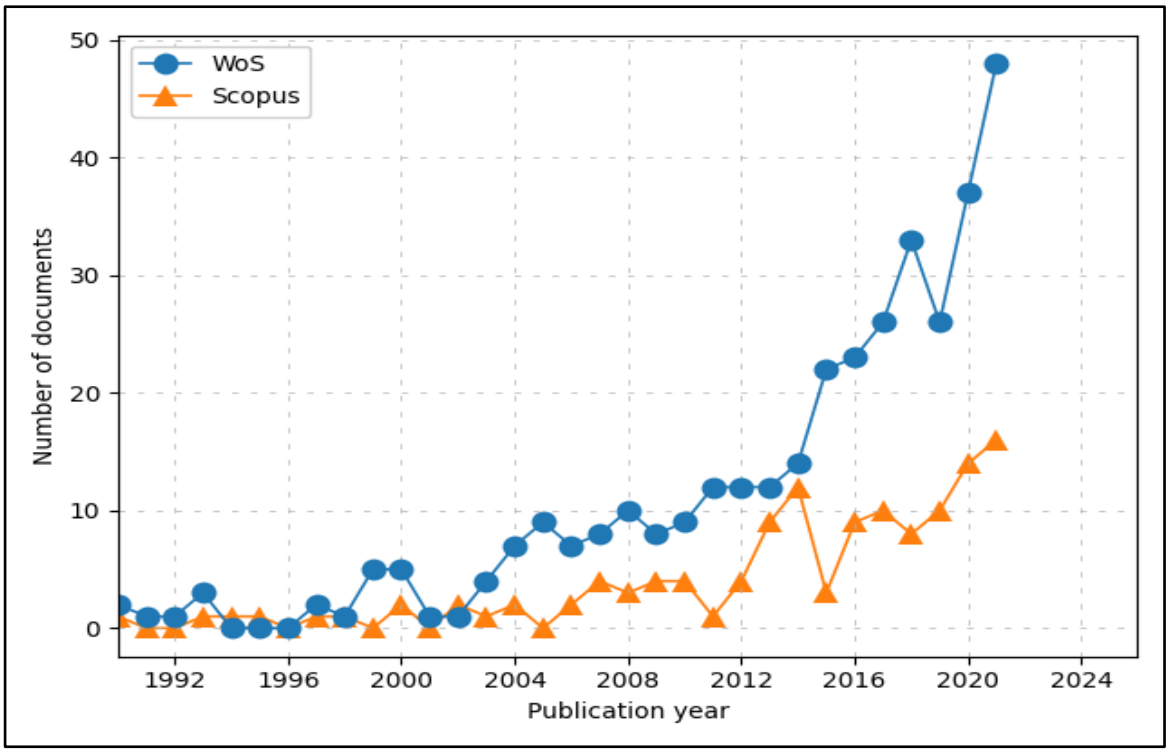

Figure 1. Timeline graph of publication productivity

Subject Areas

It is vital to review relevant research publications since this permits the identification of the essential fields in which research on safety knowledge has been conducted. The top ten subject categories that can be utilised to classify safety knowledge research from the Scopus and WoS databases are depicted in Figure 2. Based on Figure 2, "Food Science and Technology" has been identified as the most extensively investigated field. This result demonstrated that safety research became primarily focused on food science. It is proof that foods consumed in food service outlets have been identified as significant sources of foodborne outbreaks and have been documented in the national statistics of several countries, such as the United Kingdom, Taiwan, and Malaysia (Al-Kandari et al., 2019). Recognising that knowledge is vital for safe food handling, numerous researchers have concentrated on enhancing consumer food safety knowledge (Ayaz et al., 2018).

The second subject area is "Public, Environmental, and Occupational Health". It is anticipated that a lack of safety understanding will be the leading cause of rising workplace accidents. Liu et al. (2020) found that safety knowledge strongly mediates the causative association between Occupational Health and Safety Management Frameworks (OHSMF), workplace accidents, and injuries. Also, the authors discovered that safety training is a strong predictor of safety knowledge, work-related injuries, and workplace accidents. Therefore, government and industry players should invest in frequent safety training and orientations to increase worker safety understanding.

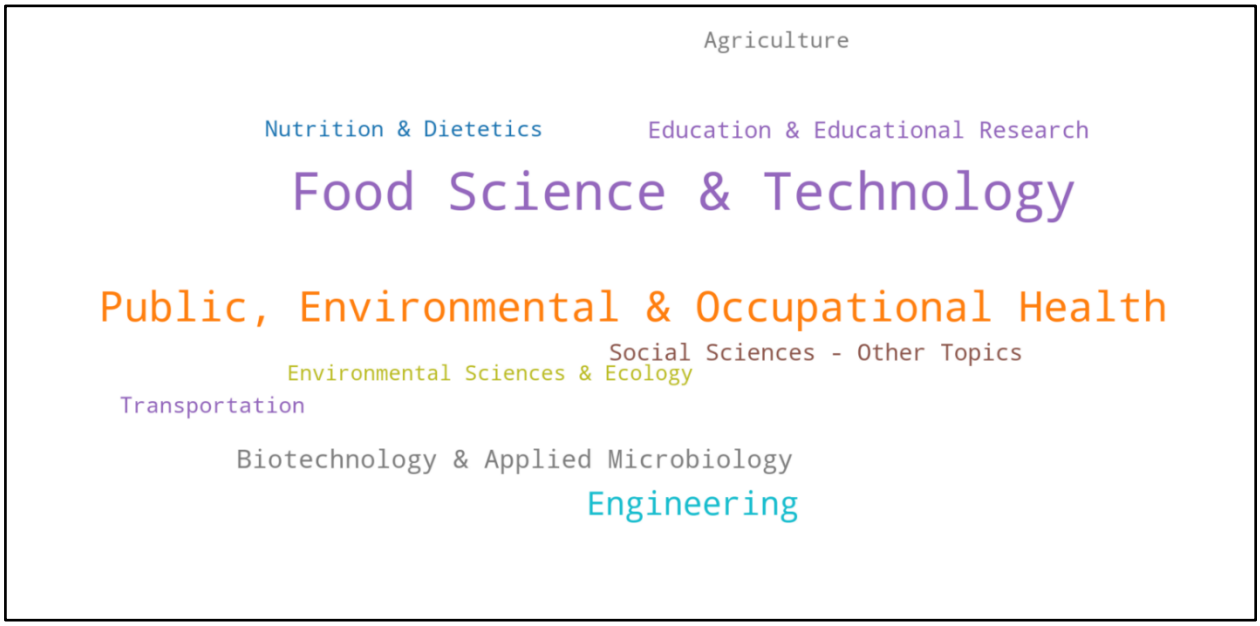

Figure 2. Word cloud graph of subject areas

Proactive Authors

Figure 3 represents the top ten authors with the number of publications concerning safety knowledge research on both databases. The thickness of the words depicted a higher frequency it is. In this study, Osaili, T.M is recognised as a proactive author with eight publications. Based on the author extended results in ScientoPy, the article written by

Osaili, T.M published in 2011 entitled "Food safety knowledge and practices among college female students in north of Jordan" obtained 66 citations. The article investigation indicated that female college students were the most aware of cross-contamination prevention and disinfection processes and had the most difficulty with culinary responsibilities and food sources of foodborne pathogens (Osaili et al., 2011).

The second proactive author is Jevšnik, M. Jevšnik, M. had published six articles pertinent to safety knowledge, and the most cited paper was issued in 2008, with 117 citations. His most cited paper is entitled "Food safety knowledge and practises among food handlers in Slovenia". Based on the article, Jevšnik, M. and his colleagues determined that rigorous adherence to Hazard analysis and critical control points (HACCP) system principles and food hygiene is vital for the prevention of food-related diseases and the efficient assurance of safe food (Jevšnik et al., 2008).

A proactive evaluation of authors and their frequently cited publications by previous researchers demonstrates that studies on safety knowledge include a wide range of topics involving food safety and food hygiene. Indirectly, this topic can tell readers and other researchers that safety knowledge and food safety are closely associated and have frequently attracted the interest of previous researchers. Consequently, there is an ever-increasing demand for a thorough examination of safety expertise in food safety.

Figure3. Word cloud graph of proactive authors

Energetic Research Institutions

Each author featured in the publications is affiliated with an institution. ScientoPy also utilises this information in its processing. Researchers are aided in selecting research stays or enrolling in one of their academic programmes or research projects when they can find the most representative institutions in the field. This study confers prestige on the institutions and encourages others to continue writing to acquire an exceptional standing. Figure 4 is a word cloud depicting the ten most prolific safety knowledge publishing institutions. Considering Figure 4, the greater the institution's size, the greater its number

of publications. The current study revealed that Jordan University of Science and Technology in Irbid, Jordan led the top 10 institutions with nine publications. Next on the list were Gazi University in Turkey and the University of Ljubljana in Slovenia, each with six publications.

Figure 4. Word cloud graph of energetic research institutions

The Primary Authors' Keywords

"Author keywords" refers to a document's authors' chosen keywords. The authors' keywords facilitated readers and academics to find significant passages. Author keywords are used by many search engines, databases, and journal websites. ScientoPy may use authors' keywords to track the evolution of a study topic or search argument. This section analyses past authors' keywords. To finish the workflow, keyword-based research trends were discovered. Similar American and British spellings and singular and plural keywords may be merged, including the abbreviations. These manual operations organise data and remove term duplication, resulting in more substantial outcomes.

Figure 5 displays ten keywords from prior studies. As seen in Figure 5, the larger a keyword's magnitude suggested a more significant number of articles. In 124 documents, the keyword "Food safety" appears most frequently in this analysis. The second most prevalent term is "Knowledge", which appears in 72 publications. In third place is the keyword "Food safety knowledge", which has been utilised in 35 articles. Based on the results, it is crucial to recognise that knowledge, food safety, and food safety knowledge are fundamental to studying the context of safety knowledge. These factors may explain why epidemiological data indicate that households are the most common reported sites for foodborne outbreaks worldwide (Jovanovic et al., 2022). Moreover, according to Wan Nawawi et al. (2022), foodborne illness is one of the greatest threats to public health, but it can be circumvented by upholding food safety practices. Thus, to maintain food safety, it is essential to have safety knowledge regarding the proper handling, preparation, and storage of food.

Figure 5. Word cloud graph of the top ten authors' keywords

This study also analysed the co-occurrence of authors' keywords that were generated using VOSviewer. Based on phrases extracted from the title and abstract field of previously collected articles, VOSViewer developed a content analysis graphic (Alkhaleefah et al., 2021). Alkhaleefah et al. (2021) stated that a minimum number of occurrences indicating how many vital terms were included in the analysis was determined to establish the content analysis diagram. Before analysing the results, the thesaurus file with a combination of singular and plural, different spellings, and the abbreviation is recorded. Following that, the thesaurus file was analysed in conjunction with the retrieval metadata, with a minimum number of occurrences is ten. As a result, out of 983 keywords, only 14 met this threshold.

Figure 6 depicts the co-occurrence of authors' keywords. Five clusters are represented by various colours (red, blue, green, yellow, and purple). The list of keywords grouped in each cluster is shown in Table 2. Based on Figure 6, the rectangular size is denoted by the number of occurrences of keywords; the larger the size, the higher frequency ensued. In this study, the keyword "food safety" is most frequently used by previous researchers, followed by "knowledge", "food safety knowledge", "attitudes", and "practices". It also addressed that the keyword "knowledge" is firmly nexus to "food safety", "practices", and "attitudes". Based on the results, food safety, attitudes, and practices are close and provide a meaningful relationship. Thus, it supports the interpretation by Akabanda et al. (2017) that numerous individuals handle food in cooking on a large scale, which increases the likelihood of food contamination due to improper handling. Akabanda et al. (2017) added that intentional or unintentional food contamination during mass production could endanger consumers' health and have extremely costly repercussions for a nation. Consequently, the elements of food safety, attitudes, and practices are crucial to comprehending food safety and have a close relationship with the safety knowledge possessed by an individual.

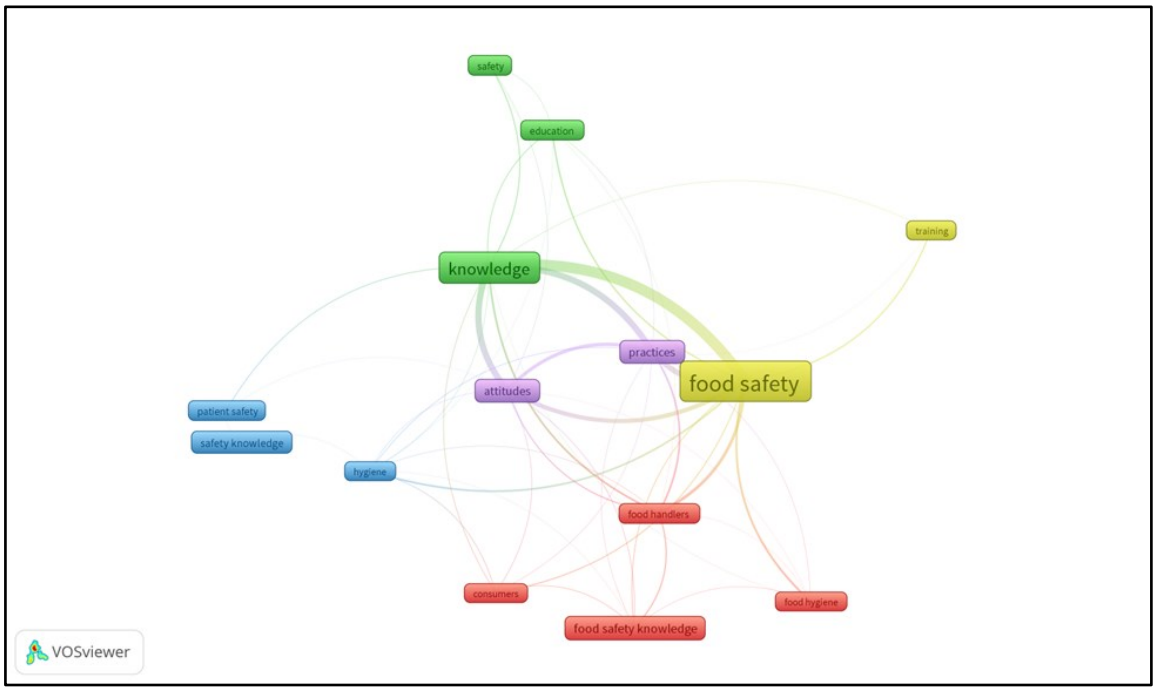

Figure 6. The co-occurrence of authors' keywords

Table 2. The Group of Clusters and Keywords

Clusters	Keywords
Red	"food handlers", "consumers", "food hygiene", and "food safety knowledge"
Blue	"hygiene", "safety knowledge", and "patients safety"
Green	"knowledge", "education", and "safety"
Yellow	"food safety" and "training"
Purple	"attitudes" and "practices"

CONCLUSION

This study found that safety knowledge has generated a significant research impact in recent years, particularly in food safety. It is similar to a bibliometric study conducted by Abdullah and Azizi in 2020 based on the Scopus database. This study could reach its goal by completing a bibliometric analysis using the Scopus and WoS databases and analysing the metadata using ScientoPy and VOSviewer. This study aims to examine the evolution of safety knowledge publication based on publications productivity, subject areas, proactive authors, energetic research institutions, and the primary authors' keywords.

There is a significant increase in safety knowledge publications, with WoS publications outpacing Scopus in growth explicitly after 2012. It has been established that WoS is a leading data source based on its prominence in scientific journals for a vast array of academic disciplines. Moreover, WoS is frequently updated and favoured by researchers in various academic fields. The increasing research interest in safety knowledge demonstrated the significance of this topic for advancing safety and health issues research in both databases.

Based on a review of subject areas, "Food Science and Technology" has been designated the most thoroughly researched field. This outcome revealed that "Food Science and Technology" became the primary focus of safety knowledge research. A likely reason is that food service establishments have been identified as critical contributors to

foodborne outbreaks. Besides, "Public, Environmental, and Occupational Health" had become the second most significant subject. This result could portray that safety knowledge is essential for this subject area because workers' lack of safety information is the leading cause of increased workplace accidents. And to identify the issues, thus, critical observation concerning the scope of "Public, Environmental, and Occupational Health" is vital.

Osaili, T.M., and Jevnik, M., are acknowledged as proactive contributors to safety knowledge research. A proactive review of authors and their frequently cited publications by earlier researchers reveals that studies on safety knowledge include a vast array of topics on food safety and food hygiene. Indirectly, this topic can inform readers and other researchers that safety knowledge and food safety are closely related and have drawn the attention of many researchers in the past. Consequently, there is an increasing necessity for a comprehensive review of food safety experts' safety knowledge. Also, this study provides prestige to the institutions and motivates others to keep writing to achieve a distinguished reputation. According to this current report, Jordan University of Science and Technology in Irbid, Jordan, dominated the top 10 institutions with nine publications. Gazi University in Turkey and the University of Ljubljana in Slovenia followed the second and third-ranked.

Based on the findings of a keyword analysis of the authors' publications. This study discovered that content analysis is predominately geared towards "food safety", "attitudes", and "practices", which are closely associated and give a meaningful relationship. Increased food contamination is attributed to attitudes and practices involving inappropriate food handling. Intentional or unintentional food contamination during mass production could harm customers' health and have enormously costly consequences for a country. Therefore, the factors of food safety, attitudes, and behaviours are essential to understanding food safety and have a close relationship with an individual's safety knowledge.

Limitations and Future Research Direction

This study mapped Scopus and WoS publications pertinent to safety knowledge research. This study's conclusions were limited to identifying the databases' main themes or keywords associated with safety knowledge research in general and not specific to any setting. Systematic literature reviews or meta-analyses are recommended if future research desires to build on the background or address broad subjects. Future researchers should also analyse the pattern of safety knowledge publication in industrial, construction, and health settings if they wish to discover the fundamental concepts or themes about safety knowledge in those settings.

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