

Bibliometric Analysis of Safety Behaviour Research

Khairul Hafezad Abdullah

Universiti Teknologi MARA, Perlis Branch, Arau Campus, Malaysia

*Corresponding Author: khairul085@uitm.edu.my

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Abstract: *Individuals may be able to deal with their apprehension, but it was revealed that positive emotional states about safe acts are interrelated to how they act. Accordingly, it is necessary to understand how individuals behave to be safe and evolve their behaviour. This study examines publication trends and delves into information on authors' keywords pertinent to safety behaviour in the Scopus and Web of Science databases. The metadata collected in this study is processed using the ScientoPy and VOSviewer software. The results designated that since 2008, the literature on safety behaviour has risen at a favourable rate in both databases. The top three research areas were acknowledged as (i) Psychology, (ii) Environmental Science and Ecology, and (iii) Public, Environmental, and Occupational Health. The United States contributed the most publications, followed by China and the United Kingdom. Safety behaviour has been investigated extensively and has been found to be knottily linked to the keywords of "COVID-19", "Social anxiety", "Assessment", and "Mental health". The keywords "COVID-19" and "Patient safety" have been used most frequently by prior studies in the last five years (2017 to 2021). This study highlighted the scholarly communication practices prevalent in safety behaviour research. These trends will aid researchers from various fields to identify the core areas, proactive institutions, and core source titles published in this knowledge. Moreover, the result of this study encourages researchers to work together and develop new ways to study safety behaviour by glancing at the most popular keywords.*

Keywords: Safety behaviour, bibliometric, Scopus, Web of Science

1. Introduction

Human behaviours are critical issues that have frequently been scrutinised, whether in political, social, or economic circumstances. Civilisations could progress and attain the highest level of social stratification by reasoning human behaviour, as humans are instrumental in forming civilisations and nation-states. Behaviour could be depicted by how an individual reacts to positive or negative stimuli or incentives or penalties. Internal influences such as ideas and feelings inspire an individual's behaviour, as do exterior effects such as the environment, objects, and other people (Young, 2016). Understanding an individual's behaviour is notoriously cumbersome. A solid reason is that individuals behave according to their desires, for instance, in the context of safety behaviour. Some people are caught in a quandary, unable to balance feelings of safety and comfort with the ability to do tasks swiftly. In this scenario, they would prefer not to wear personal protective equipment because adopting this action is harassing. Heinrich (1931) observed safety behaviour by developing an accident causation model that argued unsafe behaviours are the direct cause of accidents. To that end, it is

indicated that the accident causation model is appealing to comprehending complex individual behaviours pertinent to safety at work.

In a nutshell, safety behaviour can be elucidated by an individual's attempt to prevent a feared consequence in a specific setting. Neal and Griffin (2006) suggested a two-factor model of safety behaviour that encompasses compliance and participation in safety to discuss this terminology. This two-factor model of safety behaviour was derived from the safety performance model, which was coined by Neal and Griffin in 1997. The model was inspired by Borman and Motowidlo (1993) and Campbell et al. (1993), who proposed a model on current theories of job performance. The subject of job performance has been extensively discussed and conceptualised in numerous ways. López-Cabarcos et al. (2022) discovered that in a task-oriented sector such as the industrial subdivision, engaging in people-oriented management practices via transformational leadership is ideal for conquering optimal employee job performance. Subsequently, managers must support leadership development programmes that teach leaders how to embrace transformational leadership principles and serve as role models for their subordinates in achieving complex performance objectives (López-Cabarcos et al., 2022). A likely reason is that agents' decisions about working time to dedicate to individual tasks, cooperative activities, and shirking activities are determined by their values (Roos et al., 2022). Conversely, safety performance is re-counting as an organisation's capacity to avoid work-related accidents or injuries. It has been prominent in recent decades due to its impact on organisational safety performance (Arzahan et al., 2022).

Most safety and health scholars have deliberated on safety behaviour regarding safety compliance and participation (Abdullah & Abd Aziz, 2020a; Alroomi & Mohamed, 2022; He et al., 2019; Lyu et al., 2018; Su, 2021). Zhang et al. (2020) signified that safety compliance entails acting per institutional standards, job responsibilities, and specific work needs; safety participation is an affirmative action that helps develop a safe environment. Compliance with safety regulations is critical; personnel must follow safety procedures to perform work safely. Integrating employees into organisational operations aids in ensuring compliance with safety standards and procedures for each project or activity (Bensonch et al., 2022). The extent to which workers participate in the organisation from the standpoint of plan design necessitates the involvement of an increasing number of people who are aware of their performance, which results in improvements in risk management systems (Walter, 2017). Thus, safety compliance and participation are the most appropriate terms to characterise workplace safety behaviour.

Safety at work is a top priority for researchers in safety management undertaking in-depth studies. It is exacerbated when dealing with this circumstance regarding safety behaviour (Ab Aziz et al., 2021). Albeit the severity of anxiety can be managed, good impressions of safe actions are associated with how an individual practises safe behaviour in everyday life were deemed essential to explore (Meyer et al., 2019). Hence, to investigate safety behaviour, it is necessary to understand how individuals act safely (Knoll et al., 2019) and grapple with individuals' behaviour vicissitudes (Abdullah & Abd Aziz, 2020b). This is because an individual effort made safely successfully lowered the accident rate. Accordingly, safety behaviour study has piqued the interest of researchers from a variety of fields of work, including industrial and academic settings. Attention should be made to the fact that adequate and relevant procedures for assuring and developing safety management and behaviour are required in many organisations, especially in hazardous industries.

Previously published research has emphasised the critical role of safety behaviour in maintaining workplace safety. Sugumaran et al. (2017) discovered that a safety mindset,

management support, and safety regulations and procedures have a significant positive association with compliance and safety behaviour in the manufacturing industry in Malaysia. According to Padmaraj and Sujatha (2022), while employee behaviour in the manufacturing industry and work participation are slightly positive, it is also the indicator with the highest proportion of negative evaluations for employees who are routinely questioned about their safety concerns. Liu et al. (2015) revealed a significant association between diverse safety climates, safety behaviour, and unintentional injuries among Chinese manufacturing workers. Their research findings support the observed association between workplace safety atmosphere and injuries and suggest viable strategies for reducing work-related injuries in China.

Another research conducted by Hu et al. (2021) revealed that safety behaviour had become a positive mediating factor between practised safety values and safety performance in the healthcare setting. The results imply that Chinese nursing managers should establish a patient safety culture guided and driven by appropriate values, which will eventually be externalised as nurses' daily behaviour. According to Olsen (2018), the social interactions within the hospital context are exemplified by how organisational elements influence both safety behaviour and perceptions of patient safety levels. Al Faqeeh et al. (2019) discovered that safety attitudes partly mediate the link between safety climate and safety behaviour in Abu Dhabi. Furthermore, safety stressors did not affect the relationship between safety climates, safety attitudes, and safety behaviours, intriguing implications for healthcare practitioners.

Safety behaviour in the laboratory became an emphasis in the academic context. According to a study conducted by Abdullah and Abd Aziz (2020a), safety commitment is essential in improving safety motivation and safety behaviour among students. Consequently, the university administration should reassure the participation of the Student Representative Council in representing the voice of students to improve laboratory safety behaviour. This is because engineering control systems alone cannot avoid laboratory mishaps at universities, even if they can enhance laboratory testing performance (Steward et al., 2016). Despite implementing engineering control systems, Gibson et al. (2014) observed that accidents in university laboratories were still on the rise. Purohit (2018) claimed that the necessity to build, consolidate, and improve a safety culture is highly anticipated, particularly in terms of safety behaviour. Instead, safety behaviour has been identified as necessary for establishing safety cultures, compliance with safety standards, and safety engagement that must be prompted by exemplary safety leadership (Abdullah et al., 2020).

The abundance of information and the everlasting publication of research on any research topic makes it challenging for scholars and researchers to assess its contemporary comprehension, utility, and future direction. 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 flowing status (Gazali et al., 2021). Indirectly, information retrieval is a critical component of both the interdisciplinary subject of information science and the discipline of computer science (Rahman & Sofik, 2022). A bibliometric analysis provides a visible picture of vast amounts of scientific literature and is crucial for scholars to make appropriate conclusions (de Oliveira et al., 2019). Nowadays, bibliometric analysis is frequently used to assess the progression of publications, publishing countries and institutions and identifies attractive parameters for researchers, such as the evolution trend of publications, research fields, and prominent authors (Sofyan & Abdullah, 2022).

Bibliometrics is a valuable study tool that enables researchers to present summaries of significant trending knowledge to assist future researchers in delving further into a topic. In addition, this technique will facilitate the identification of research gaps and the exploration of novel issues and research possibilities (Abdullah & Othman, 2022). Nonetheless, there is a depleted bibliometric analysis concerning safety behaviour. In terms of behaviour, bibliometric studies have been conducted on pro-environmental behaviour (Farrukh et al., 2022), consumer behaviour (Muñoz-Leiva et al., 2012), recycling behaviour (Phulwani et al., 2020), consumer credit behaviour (Carlsson et al., 2017), behaviour-based safety (Abd Aziz et al., 2021), and unsafe behaviour (Malakoutikhah et al., 2021). The current study’s primary goal was to identify patterns in safety behaviour-focused publications. Its current state, relationship to other related study constructs, and future directions will also be determined. Through bibliometric analysis, the readers will be provided with an overview of the critical dissections of safety behaviour research to give a clear picture of the research undertaken thus far. Readers and researchers will benefit from sleuthing publication trends and potential research areas to investigate further.

2. Data and Methods

As represented in Figure 1, the methodological approach is separated into three major stages. The first stage is developing the idea and preparing data for bibliometric analysis of safety behaviour. The second stage focuses on combining the databases and extracting the parameters to be analysed with ScientoPy. Finally, the final stage analyses the results and assesses the most representative literature using ScientoPy and VOSviewer parameters.

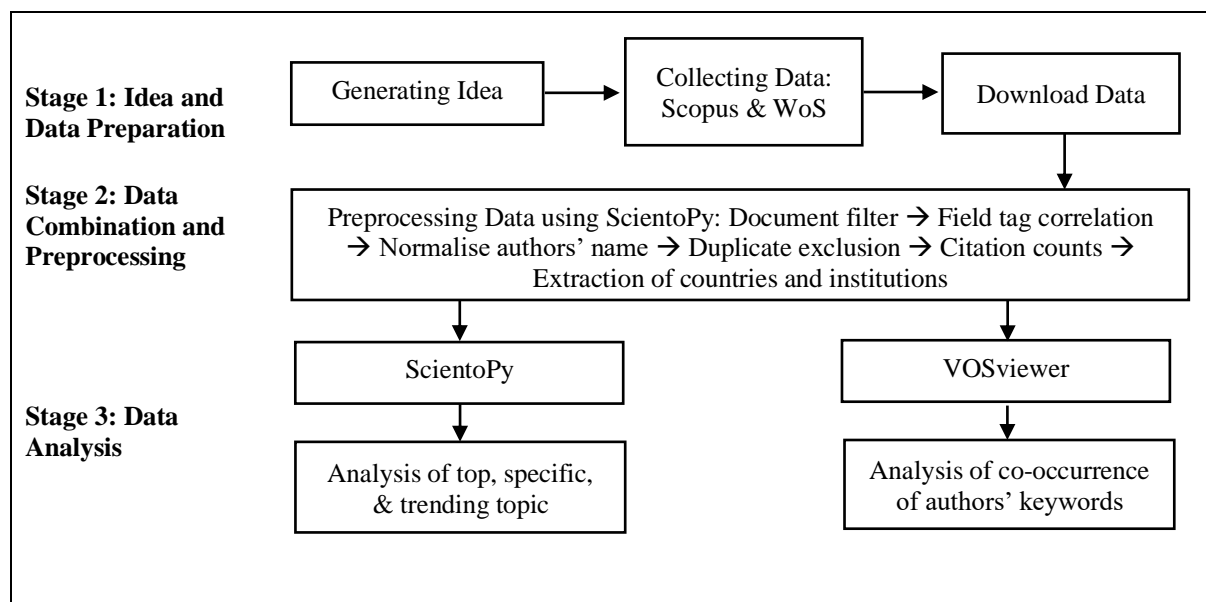


Figure 1: Bibliometric Workflow

Due to the interdisciplinary character of the research area under investigation, the literature on safety behaviour was scattered over numerous disciplines. As a result, it was necessary to search and identify relevant material on this subject using available and multiple bibliographic databases. For that reason, data for this study were gathered from two primary databases: Scopus and Web of Science (WoS). These databases span multiple fields (Martín-Martín et al., 2021), and searching them would aid researchers in locating the most significant number of citations on safety behaviour primary sources for bibliometric studies (Pranckutė, 2021). After defining the databases, the search queries “safe* behav*” OR “safe*-seek* behav*” OR “safe* seek* behav*” OR “behav* safe*” OR “behav* bas* safe*” OR “behav*-bas* safe*” were

chosen. The following fields were scanned for topic-related terms: title, abstract, and keywords. Truncation or stemming with the asterisk (*) was employed to extend the search. It included alternative word ends and spellings and identified any paper containing all the fundamental concepts' derivations in the title, abstract, or keywords. This inquiry was accomplished on May 1, 2022. There is no specified span for accessing the complete information of published works in both databases. Additionally, the sorts of documents are not limited. Nevertheless, an institutional subscription was necessary for both databases to retrieve the raw source datasets.

Data were pre-processed during the second stage using ScientoPy. 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) removes duplicated samples with the same title and authors (Ruiz-Rosero et al., 2019). The pre-processing information is recorded in Table 1. Based on Table 1, the ScientoPy pre-processing script prioritises WoS documents over Scopus documents; after duplicate removal, there are more papers from WoS databases than Scopus. This study used a raw source dataset of 8876 papers from the WoS and Scopus databases. In this study, there are 347 of the 8876 loaded papers eliminated due to ScientoPy's analysis focusing exclusively on five types of publications which are (i) conference papers, (ii) articles, (iii) reviews, (iv) proceeding papers, and (v) articles in press (Ruiz-Rosero et al., 2019). Thus, other publications such as books, letters, and errata were omitted. Following data reconciliation, this study examined 5334 papers from both databases, containing 3760 papers from WoS and 1574 papers from Scopus, removing 3174 from Scopus and 21 duplicated papers from WoS.

Table 1: Information on Initial Data Analysis

Information	Number	Percentage (%)
Loaded papers	8876	
Omitted papers by document type	347	3.90
Total papers after omitted papers removed	8529	
Loaded papers from WoS	3781	44.30
Loaded papers from Scopus	4748	55.70
Duplicated removal results:		
Duplicated papers found	3195	37.50
Removed duplicated papers from WoS	21	0.60
Removed duplicated papers from Scopus	3174	66.80
Duplicated documents with different cited by	2138	66.90
Total papers after duplicate removal	5334	
Papers from WoS	3760	70.50
Papers from Scopus	1574	29.50

ScientoPy is a free, open-source Python-based scientometric analysis application to analyse data for classifying the most popular, specific, and trending subjects. In this study, VOSviewer is another 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). Finally, the data set of 5334 was analysed, and the necessary statistical reports, graphs, and tables were generated using bibliometric data visualisation tools, namely, ScientoPy and VOSviewer.

3. Results and Discussion

Publication Growth

The number of peer-reviewed publications is an excellent indicator of the growth of a scientific topic or subject. Since 2008, Figure 2 demonstrates a significant increase in articles on safety behaviour. Notably, WoS publications have grown steadily compared to Scopus, with a sharp surge following 2016. It has been discovered that WoS is a leading data source based on its recognition in scientific publications for countless study fields. Also, WoS is constantly updated and favoured by many researchers in various research domains. The increased research interest in safety behaviour research in both databases depicted that this topic is crucial in advancing safety and health issues research. Bayram et al. (2021) noted that employee participation in safety and health issues and safe workplace behaviour is contingent upon management prioritising those issues on par with production, developing safe working rules, procedures, and practices implementing comprehensive and ongoing training programmes. Indirectly, research on safety behaviour has gained more attention in recent years to discover the best argument to boost employee safety and awareness about enhancing safe performances.

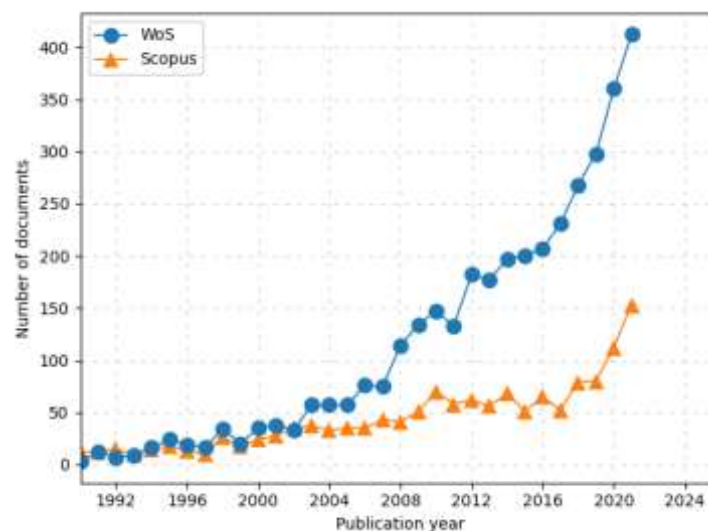


Figure 2: Timeline Graph of Publication Trends of Safety Behaviour Research

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 behaviour has been undertaken to be identified. Figure 3 depicts an evolution graph of the top ten subject areas that can be used to categorise safety behaviour research from the Scopus and WoS databases. Psychology has been identified as the most extensively investigated field, with over 800 publications. This outcome was prophesied, given the subject under examination is significant from a psychological standpoint, focusing on how humans approach safety issues in everyday work to gain a competitive edge and enhance the quality of work through improved decision-making and behaviour-based safety. Also, psychology benefits humans significantly because it can explain why people behave in specific ways (Lobanova & Evtiukov, 2020). Another fascinating subject is Environmental Sciences and Ecology; this subject is connected to safety behaviour since it investigates the interactions between people and their environment. This subject is vital because the ecosystem becomes a constraint on the country's overall development and the development of specific regions. The question of determining a territory's level of ecological safety arises. The composite index of the environmental safety approach, which is based on the aggregation of indicators reflecting the region's social and economic development, ecological

circumstances, and human capability, provides acceptable estimations for the region’s primary territorial levels of management (Glinskiy et al., 2015). As a result, understanding human behaviour related to environmental safety is also indispensable to be well-thought-out in developing a country. As shown in Figure 3, the third-ranked subject area is Public, Environmental, and Occupational Health. This subject is connected to chemical pollution, air pollution, climate change, pathogenic bacteria, a lack of access to health care, inadequate infrastructure, and poor water quality (Pronczuk et al., 2008). And to comprehend the underlying components, we can divide them into four categories: physical, chemical, biological, and cultural. Physical hazards are natural physical processes that occur in the environment and are also associated with unsafe behaviour.

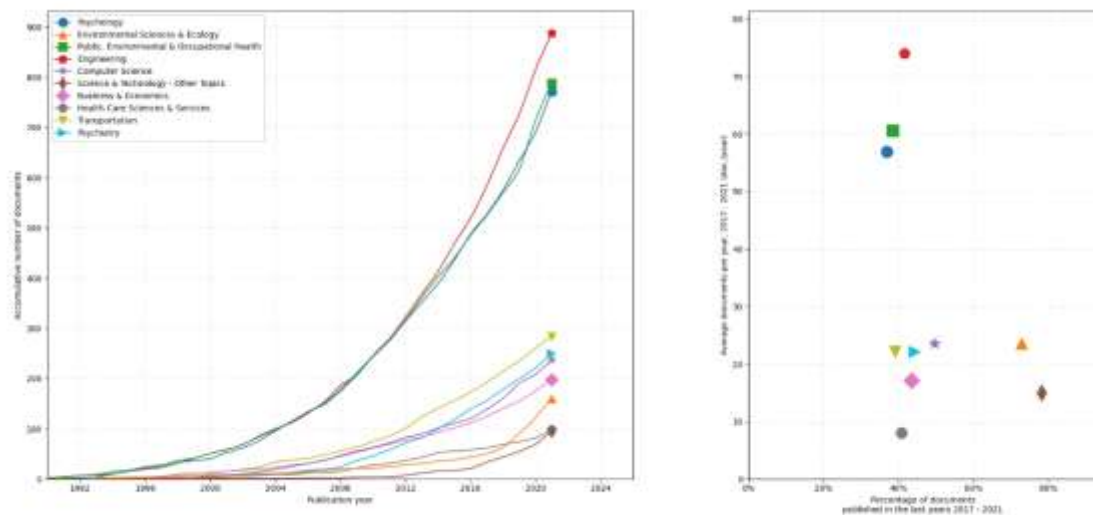


Figure 3. Subject Evolution Graph of Safety Behaviour Research

Publishing Countries

Since 1968, safety behaviour research has been conducted in 90 various countries. Compared to other countries, the United States is the only country that has produced more than 1,000 pieces of study and an average of 100 publications within the last five years (2017-2021). Figure 4 represents the country evolution graph of safety behaviour research in this study. Based on the figure, the United States, China, and the United Kingdom were identified as the top three publishing countries in safety behaviour research. In the United States, a series of case studies indicated that failing to address safety and productivity holistically might result in unforeseen repercussions in some circumstances, and this factor is the primary motivation for safety behaviour studies (Ghodrati et al., 2022). In China, safety behaviour research has attracted to solving problems concerning fatality at construction sites. According to Gu and Guo (2022), the death rate in China’s construction sector is not adequately controlled. The number of fatal occurrences has explicitly increased in the construction industry after hitting a low point in 2015 (Gu & Guo, 2022). Thus, it is critical to contribute crucial information to the study to understand the goal behind safety behaviour. The situation at work in the United Kingdom, which is often thought of as having good occupational health and safety management, still has a lot of construction workers getting injured and sick (Oswald et al., 2018). Apparently, supervision is crucial for managing safety behaviour and performance. This is because supervisory behaviour has the most significant influence on safety behaviour, but it is unclear which organisational characteristics may be employed most successfully to adjust

supervisory behaviour to improve safety performance (Prinsloo & Hofmeyr, 2022). Thus, the study of safety behaviour should be explored deeper and further in many organisations.

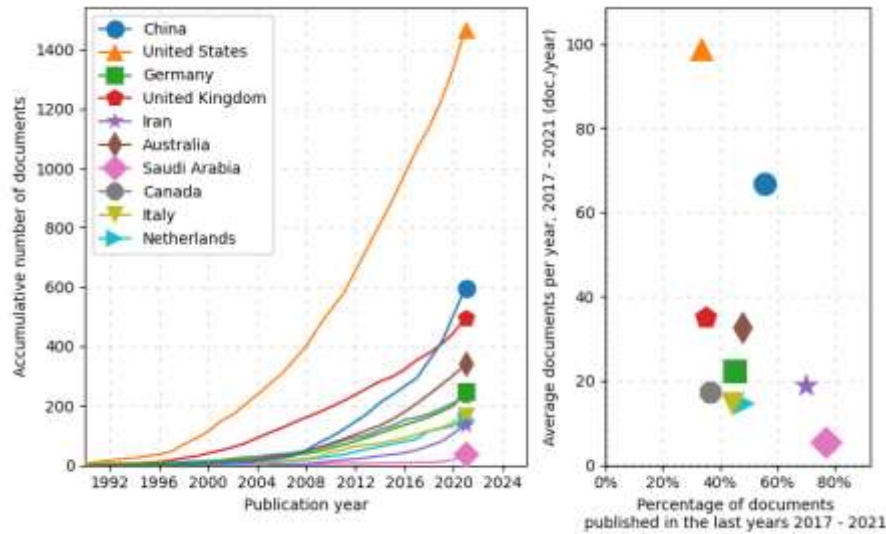


Figure 4. Country Evolution Graph of Safety Behaviour Research

Sources Titles

The information in Figure 5 pertains to the most influential source titles in safety behaviour research, which are ranked according to the number of publications. Additionally, a list of ten sources is included, along with the last five years' trending percentages.

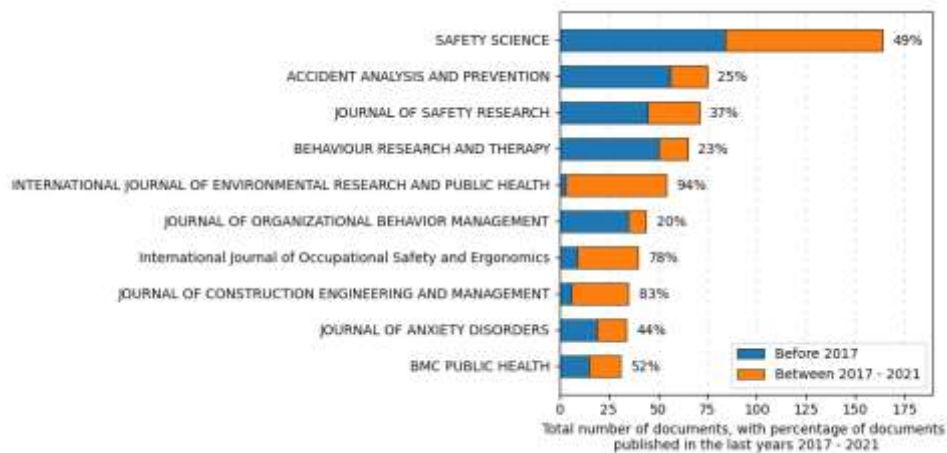


Figure 5: Source Title Bar Trends Graph of Safety Behaviour Research

According to Figure 5, Safety Science was ranked first in safety behaviour research publications with 164 publications, followed by Accident Analysis and Prevention (75 publications) and Journal of Safety Research (71 publications). Safety Science was the most critical journal and remained the most influential in safety behaviour research, with plans to publish additional publications. Safety Science was headquartered in the Netherlands and was classified by Scopus as a high-impact publisher in the First Quartile (Q1) (Abd Aziz et al., 2021). This information will assist readers, and other researchers locate a reliable source of papers on safety behaviour. Notably, the International Journal of Environmental Research and Public Health has been the proactive source title in the last five years, with 94% of publications released from 2017 to 2021. Also, the compelling source title in the previous five years is the

Journal of Construction Engineering and Management, with 83% 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 behaviour.

Institutional Analysis

Figure 6 pertains to the top ten institutions that publish academic works on safety behaviour. The scholars from King’s College London in the United Kingdom were credited with the most publications, with more than 35. The second institution is Tsinghua University in China. In this study, the Queensland University of Technology in Australia is ranked third. An intriguing feature of the top ten institutions is that four are from the Australian institutions. Consultation on workplace safety and health is a critical component of promoting worker morale, enhancing workplace safety and health, and enhancing overall organisational performance. Although it is a formal obligation under Australian occupational safety and health legislation, little information regarding the consultation processes and techniques is publicly available, making it critical to perform several studies (Simao et al., 2021).

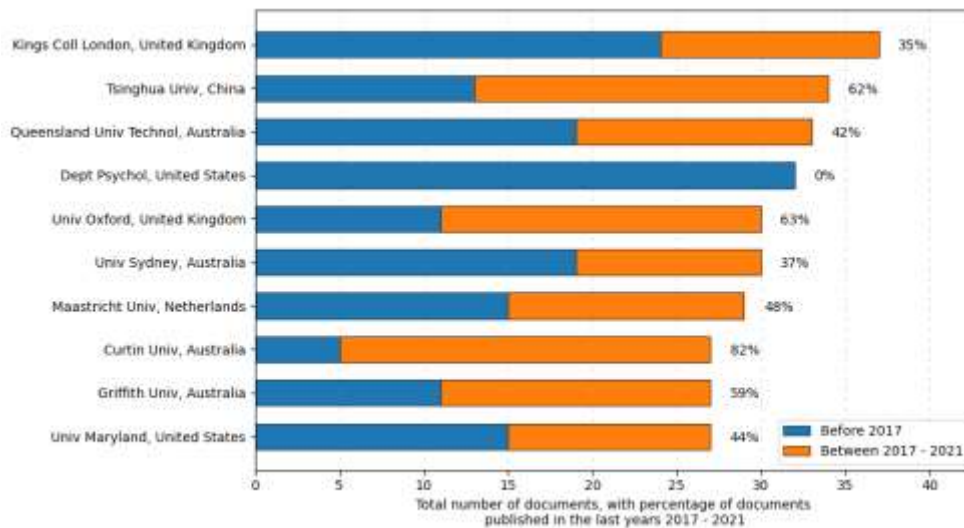


Figure 6. Institutional Bar Trends Graph of Safety Behaviour Research

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 identify the publications’ significant ideas and arguments. 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. 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 behaviour. In order to complete the procedure, the authors’ keywords were used to find research trends. It has been proposed to combine comparable terminology such as “safety behavior” (American spelling) and “safety behaviour” (British spelling), as well as pairings such as “behaviour-based safety” and “behaviour based safety.” These manual tasks assist in organising data and eliminating term duplication, resulting in more robust results.

Figure 7 exhibits 15 previously researched keywords. As illustrated in Figure 7, the top three used term is “Safety behaviour,” followed by “Safety” and “Social anxiety”. 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 determine which ones to employ while conducting document analysis. While Figure 7 illustrates the first 15 keywords, ScientoPy enables us to view an infinite number of keywords (Ruiz-Rosero et al., 2019). Also, Figure 7 displays the percentage of documents published in the preceding five years (2017–2021) to illustrate a relative increase. We can observe from this indicator that “COVID-19” has the highest proportion (100%). It is self-evident that the issue has increased the greatest in popularity over the last five years compared to other keywords. Additionally, patient safety has been a hot topic, with 60% of publications published from 2017 to 2021. Thus, this study depicted that COVID-19 and patient safety has sparked scholars’ curiosity.

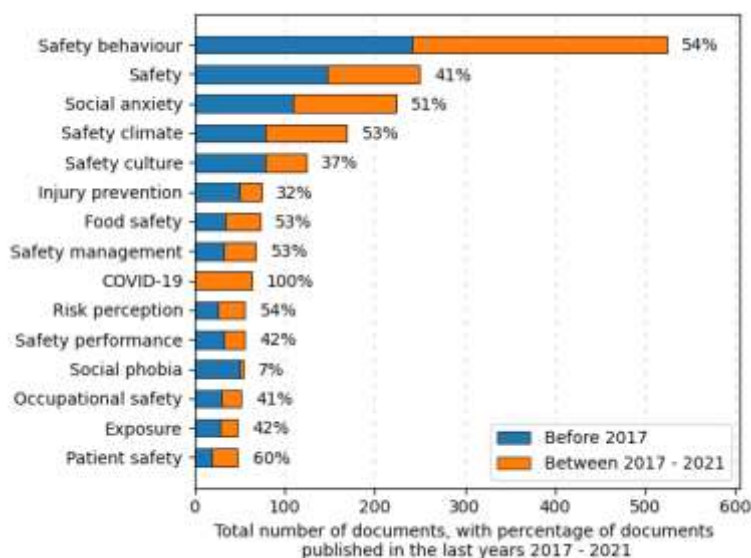


Figure 7: Author Keywords Bar Trends Graph of Safety Behaviour Research

Furthermore, this study used cluster mapping to ascertain the co-occurrence of the authors’ keywords to denote themes or issues relevant to safety behaviour (see Figure 8). 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 Figure 8, it can be deduced that the most frequently used keywords were “Safety behaviour”, “Social anxiety disorder”, “COVID-19”, “Assessment”, and “Patient safety”. These keywords are inextricably linked. The keyword “Safety behaviour” was grouped in the same clusters (blue colours) as “Social anxiety disorder”, “COVID-19”, “Mental health”, and “Assessment”. “Safety behaviour” is also closely linked to “Patient safety”. Based on this map, safety behaviour research also focused on patients and their safety, which should be a priority across all levels of medical education. Thus, graduate medical education should prioritise strengthening residents’ patient safety behaviours to protect the safety of present and future patients (Silkens et al., 2018). Moreover, conditions conducive to learning and patient safety may encourage this behaviour. Importantly, this study demonstrated that research on safety behaviour is not limited to industrial workplaces but has attracted scholars in the public health research sector.

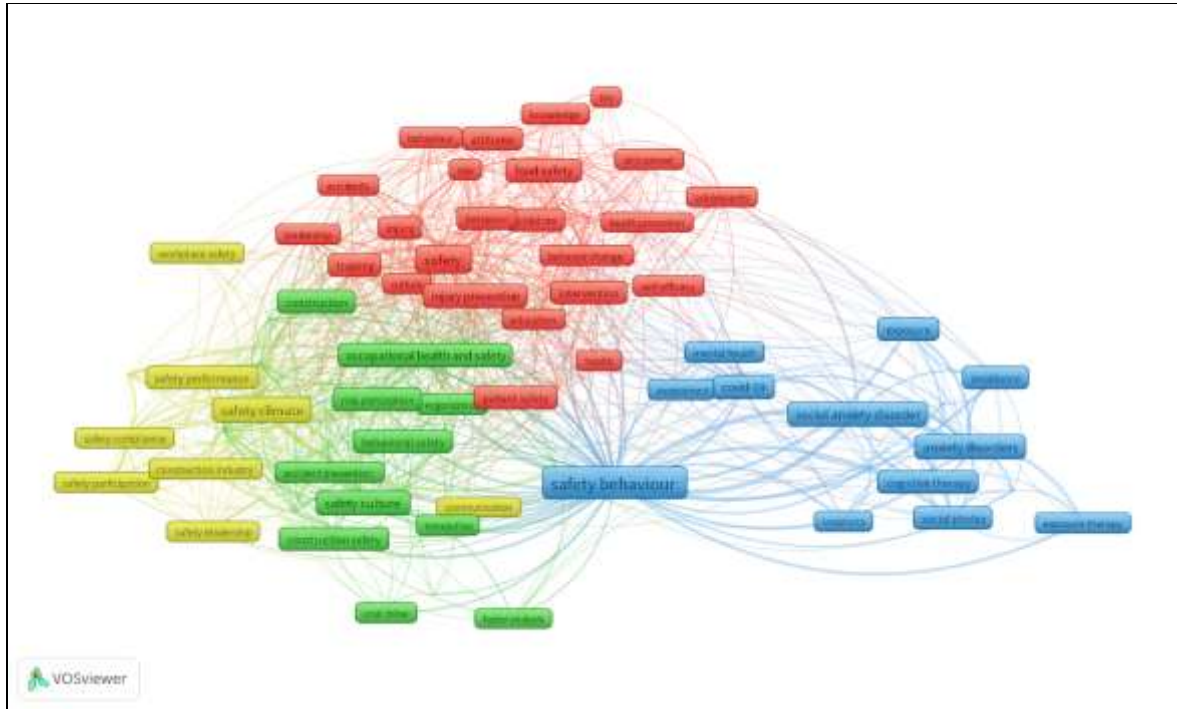


Figure 8: Network Visualisation of the Co-occurrence of Authors' Keywords

4. Conclusion

While individuals may be able to overcome their apprehension, it was discovered that positive emotional states about safety behaviours are associated with how they are performing. Therefore, it is critical to comprehend how individuals behave to stay safe and evolve their behaviour. This study examines publication trends and delves into the Scopus and WoS databases for information on publication trends and authors' keywords related to safety behaviour research.

The results indicated that publications on safety behaviour had increased significantly since 2008. Notably, WoS publications have expanded consistently compared to Scopus, with a sharp increase following 2016. With over 800 publications, Psychology has been identified as the most thoroughly explored research area. The United States, China, and the 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 behaviour, followed by Accident Analysis and Prevention and Journal of Safety Research. With almost 35 publications, scholars from King's College London in the United Kingdom were credited with the most active institution. The keyword "Safety behaviour" is the most frequently used by previous researchers, followed by "Safety" and "Social anxiety." Safety behaviour was clustered in the same group with "Social anxiety disorder," "COVID-19," and "Assessment". Remarkably, "safety behaviour" and "patient safety" are inextricably intertwined.

This study includes certain limitations that may serve as a guide for future research. The current study investigated and mapped publications in the Scopus and WoS databases. Accordingly, this study's conclusions were confined to identifying the primary themes or crucial keywords linked with studies on safety behaviour based on those databases. Thus, systematic literature reviews or meta-analyses are recommended if future research desires to build on the background or address broad topics to give the most pertinent evidence synthesis. Nonetheless, this study sheds light on the scholarly communication procedures in safety behaviour research.

This study established that research on safety behaviour is not limited to industrial workplaces but has attracted researchers to study safety behaviour in healthcare settings. This study will assist academics from various disciplines in identifying crucial publication trends parameters for the systematic dissemination of research on safety behaviour. Additionally, the findings of this study encourage academics to collaborate and develop novel approaches for studying safety behaviour by examining the most often used keywords.

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