A 39 Years (1980-2019) Bibliometric Analysis of Safety Leadership Research

[1]Khairul Hafezad Abdullah,[2]Mohd Nazri Hashim,[3]Fadzli Shah Abd Aziz

[1]Senior Science Officer, Universiti Teknologi MARA cawangan Perlis
[2]Senior Lecturer, Institut Pendidikan Guru Kampus Darul Aman
[3]Associate Professor, School of Business Management, Universiti Utara Malaysia
*Corresponding author E-mail: khairul085@uitm.edu.my

Abstract

Safety leadership is a crucial element in managing workplace safety and health management efficiently. This study aims to examine the bibliometric analysis of safety leadership publication patterns, research growth, and related publication information. A total of 445 safety research publications from the Scopus database were analysed from 1980 to 2019. Data were exported to Microsoft Excel, Publish or Perish (PoP), and VOS viewer. This study evaluated the data on the global trend of publication, the contribution of countries, the contribution of journals, distribution of institutions, the contribution of authors, reference analysis, and keywords analysis. By using bibliometric parameters, this study found contradictory publication trends. The results showed that safety leadership research focused mainly on engineering and medicine, while the most influential publication countries were the United States of America and the United Kingdom. Safety Science was the most potent and compelling resource. Academicians and professional authors actively engaged in writing safety leadership research articles over 39 years. Authors' keywords of safety leadership, safety culture, safety climate, and safety performance were written simultaneously in the articles. Therefore, this study is capable of establishing a new safety leadership research dimension to be considered in the future.

Keywords: Bibliometric analysis, safety leadership, occupational safety and health management, Scopus database.

I.   Introduction

Leaders play a crucial role in fostering safety and health in the workplace. Safety leadership's principal duty revolves around inspiring subordinates to create a safe work environment (Alidrisi & Mohamed, 2017). There has been growth in safety leadership research, with a significant surge starting from the year 2000 (Figure 2B). Research on safety leadership is a special investigation that encompasses issues of openness, transparency, well-being, and safety promotion (Daniel, 2015). Honesty and openness

+6 were imperative for the organisation to lead occupational safety and health successfully (Davis & Gardner, 2012; Gardner, Cogliser, Davis, & Dickens, 2011). Donovan, Salmon, and Lenne (2016) also supported that the effectiveness of safety leadership had influenced proper occupational safety and health management in the organisation. Also, the level of well-being was related to the leaders' characteristics and the way how the leaders promote safety in their workplace (Daniel, 2015). Besides, leaders can influence the organisations' behaviours and vision. Therefore, a lack of a clear vision, or when the leadership team

disengages, results can be catastrophic (Daniel, 2018).

Unlike other organisational frameworks, safety leadership may be one that has successfully put together scholarly attention from different organisations such as terminal operations (Lu & Yang, 2010), construction (Wu, Fang, & Li, 2015), hospital (Clay-Williams, Taylor, Ting, Winata, Arnolda, & Braithwaite, 2020), offshore oil and gas (O'Dea & Flin, 2001), nuclear power plant (Gracia, Tomás, Martínez-Córcoles, & Peiró, 2020) and others. The development of the construct across disciplines can be due to the universal emphasis on safety in all workplace activities; its impact on safety performance (Gracia et al., 2020), human and organisational factors (Mearns, 2020), safety behaviour (Andersen, Nørdam, Joensson, Kines, & Nielsen, 2018; Lu & Yang, 2010) and safety outcomes (Mullen & Kelloway, 2009).

In the past, an extensive bibliometric analysis had been performed in various subdomains of occupational safety and health. The subdomains were; safety climate (Bamel, Pandey, & Gupta, 2020), safety culture (Van Nunen, Li, Reniers, &Ponnet, 2018), patient safety (Rodrigues, Van Eck, Waltman, & Jansen, 2014), injury prevention (Borse & Hyder, 2009), construction safety (Liang, Zhang, & Su, 2018), process safety and risk analysis (Amin, Khan, & Amyotte, 2019), and laboratory safety in the university (Yang, Reniers, Chen, & Goerlandt, 2019). Since accidents at workplaces have increasingly become a global concern related to safety leadership (Monteiro, Hopkins, & e Melo, 2020); thus, refining the evolution of safety leadership research trends is imperative.

For that reason, this study performed a bibliometric analysis of safety leadership research to provide a macroscopic overview of research developments. Bibliometrics is a valuable measurement tool for deconstruction and assesses research patterns (Bucher, 2018; Zou, Luo, Zhang, Xia, Tan, & Huang, 2019). Sanni and Zainab (2010) stated that one way to evaluate transmitted information of crucial research is through a bibliometric analysis of published articles in that field of studies.

The strategy for discovering safety leadership research effectiveness in this study is through publications in high-quality journals, i.e., Scopus database. According to Weale, Bailey, and Lear (2004), the articles commonly cited would most likely have some influence and significance in the field of research relative to those less cited. The bibliometric analysis, therefore, reflected the nature of the work and considered appropriate for the analysis of research trends and developments (Ellegaard & Wallin, 2015).

This study intends to inspect the bibliometric analysis of publishing patterns, research growth, and analyses information on safety leadership research publications. The information presented in this study has been intended to provide a consistent explanation of the pattern in safety leadership research that could help readers, occupational safety and health professionals and researchers scrutinise the information for future studies. We fervently believe that the approach to bibliometric analysis has the potential to make significant contributions to existing safety leadership research.

In the following sections, the safety leadership literature briefs are reviewed, followed by research methodology and analysis. The results and discussion sections are followed by the conclusion and future direction of this research.

Safety Leadership: A Brief Note

For many organisations, safety is of utmost importance, particularly for high-risk industries such as nuclear power plants, commercial aviation, and other sectors that cause disastrous consequences (Gracia et al., 2020). Thus, the leadership dimension has had gained much attention and has been considered a critical factor in enhancing workplace environment safety. Leadership is commonly characterised as a process of social control between a leader and a group of individuals (subordinates) to support a common goal (Northouse, 2018). According to Raelin (2011)

and Denis, Langley, & Sergi (2012), leadership is an activity that varies and depends on context, although this is often overlooked (Osborn, Hunt, & Jauch, 2002). Therefore, with regards to the safety dimension, leadership activities aim to create a safe workplace atmosphere in the respective organisations.

The idea of safety leadership originated from the foundations of organisational leadership and revealed substantial positive effects of employee safety behaviour (Dartey-Baah & Addo, 2018) and positively linked to safety climate and safety culture (Alidrisi & Mohamed, 2017). In recent years, research has centred on leadership quality, i.e. characteristics and behaviours that help individuals improve, promote healthy interactions, maintain ethical and moral principles, and cultivate positive organisational social dynamics (Marques, Reis & Gomes, 2018).

The previous literature review found that widely accepted leadership models are the transformation and transaction models; that added substantial value to improve safety effectiveness (Hoffmeister, Gibbons, Johnson, Cigularov, Chen, & Rosecrance, 2014). Both models concentrate on leader-follower relationships and how a leader can encourage followers or subordinates to engage in safety-related activities (Griffin & Hu, 2013).

Transformational leadership is described as prominent behaviours that transform and promote followers to act beyond expectations while elevating organisational self-interest (Avolio, Walumbwa, & Weber, 2009). Transformational leadership involves four leading behaviours (Bass, 1985), i.e. idealised power, constructive motivation, intellectual stimulation, and individual concern, and is characterised by quality-based and individualised participation, resulting in more substantial-quality exchange and welfare concern (Clarke, 2013). Transformational leadership believes that subordinates develop as professionals and individuals through leaders' influence in shaping their vision, moral principles, coherence, motivation, and ethics (Burns, 1978).

By contrast, Zohar (2002) noted that transactional leadership is based on non-individualised hierarchical relationships, involving three dimensions: constructive leadership, corrective leadership, and laissez-faire leadership. Pillbeam et al. (2016) claimed that successful leadership requires good results and incentives, such as better pay, promotion, and job protection. Such interaction needs direct leader-follower communiqué. For this reason, the understanding of individual needs is required to motivate the subordinates. Corrective leadership tracks and corrects individual performance against expectations (Pillbeam et al., 2016).

Based on the social exchange theory, Hofmann and Morgeson (1999) observed that workers who considered a high-quality relationship with their subordinates were more likely to pose safety issues and were more committed to promoting by ensuring or insisting on safety at work. Kelloway and Barling (2010) propose three fundamental ways in which a leader advises safety outcomes at work; by acting as a guide for others, such as modelling healthy work practices; by praising or promoting other people's desirable behaviours or mitigating undesirable behaviours; and by taking decisions that can minimise worker stressors, such as reducing job demands. Such factors have been at the centre of transformation leadership tenet, with leaders and subordinates engaged in interaction-based relationships, sharing beliefs, and other personal and professional stimulation (Tal & Gordon, 2016).

Factors influencing safety leadership were also addressed in previous studies. Conchie (2013) examined contextual factors influencing supervisory safety leadership behaviour, describing task pressure, demand for production, characteristics of subordinates, and coordinated actions for hindrance tasks in leadership performance. Social encouragement and perceived autonomy were recognised as supporting factors. Newnam, Lewis, and Watson (2012) analysed the effectiveness of the safety effects of leader-follower

relationships and explored role overload to moderate the effect. However, several safety-related factors can be affected by safety leadership. Safety leadership style strength has been found to affect safety knowledge and information-related work safely in the workplace (Jiang & Probst, 2016).

In previous studies, safety leadership research was also focused on the leader's personality or actions rather than behaviours and practices. Nevertheless, these factors fail to consider the impact of these factors due to the trend of broader leadership literature (Pilbeam, Doherty, Davidson, & Denyer, 2016). For example, a prior meta-analysis of safety leadership styles as a background of safety behaviours did not consider how it could influence the style to choose the appropriate behaviours (Clarke, 2013). Conchie et al. (2013) acknowledged this lack of work on the effect of background on leadership, using it to clarify supervisors' commitment to safety leadership. This paper is an attempt to integrate and elucidate the safety leadership research based on the research pattern and evolution approach via bibliometric analysis.

II. Methodology

Data Sources and Data Retrieval Strategy

The number of articles published in any field of study has led to a more persuasive argument for researchers to obtain the most relevant information (Rodrigues et al., 2014). Therefore, bibliometric analysis grew into a popular research trend to deal with the matter. In the past, a bibliometric analysis was a useful statistical and mathematical technique to analyse books and other communication media (Pritchard, 1969). Currently, bibliometric analysis is used to obtain information about publication trends (Hall, 2011), evaluate the quantity and quality of publications (Sweileh, Al-Jabi, Abu Taha, Sa'ed, Anayah, & Sawalha, 2017), and is capable of exploring author details, keyword

frequencies, and citations (Rusly, Ahmi, Yakimin, & Rosly, 2019).

Bibliometric analysis in this study was conducted using the VOSviewer software (www.vosviewer.com) developed by Van Eck and Waltman (2010). According to Van Eck and Waltman (2019) and Van Eck, Waltman, Dekker, and Berg (2010), VOSviewer applied visual elements based on mapping techniques. Mapping techniques help researchers convert publication information in CSV format into diagrams or clusters to provide new information (Ahmi & Mohamad, 2019). Furthermore, mapping techniques assist researchers in analysingdata from articles such as authors, locations and institutions, analysis of citations and co-citations, and other aspects to be refined (Khalil & Crawford, 2015; Rizzi, Van Eck, & Frey, 2014).

Data Collection

Data sources in this study were collected and analysed according to the nature of the study conducted by Zare, Elsawah, Iwanaga, Jakeman, and Pierce (2017), as shown in Figure 1. The data in this study were accessed through the Scopus search engine on December 12, 2019. If the same keywords were accessed at different dates, the search results might be different. The difference is due to the ongoing process of updating articles in the Scopus database (Elsevier, 2017).

In this analysis, we selected the Scopus database because many researchers obtained articles in the Scopus database and had frequently cited as previous studies (Khiste & Paithankar, 2017; Martín-Martín, Orduna-Malea, Thelwall, & López-Cózar, 2018). The Scopus database also has extensive documents compared to the Web of Science and Pubmed (Sweileh et al., 2017).

The bibliometric analysis of this study was initiated with the identification of precise keywords. According to Sharma, Bairwa, Gowthamghosh, Gupta, & Mangal (2018), the selected keywords should be able to provide accurate information that

parallels the specific goal of the analysis. In this study, the keyword "safety leadership" was used to obtain safety leadership research publications from the Scopus database. The term "safety leadership" was explored based on TITLE-ABS-KEY ("Safety Leadership"). Quotation marks were used to generate accurate search results (Liu, Zhang, Hong, Niu, & Liu, 2013).

The keyword "safety leadership" was searched from 1980 to 2019 and yielded 445 publications. Out of the 445 publications, 199 were conference papers, and 191 were articles from various journal sources. However, other publications, such as chapters of books, and abstracts, were limited to less than 20 copies. Also, a total of 441 publications were written in English, four in Russian, two in Persian and one in French, Spanish, and Danish, respectively.

Data in CSV and RIS format such as years, authors, the field of study, article sources, countries, and languages were exported to Microsoft Excel, Publish or Perish (PoP), and VOSviewer software for further analysis. The data was evaluated based on (i) global trend of publication, (ii) contributions of countries, (iii) contribution of journals, (iv) distribution of institutions, (v) contributions of authors, (vi) reference analysis and (vii) analysis of keywords.

Figure 1: Research Design
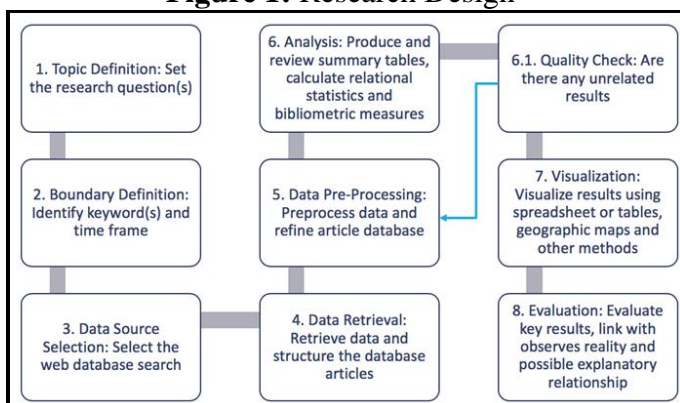
Source: Zare et al. (2017).

III. Results

Global Trend of Publications

The number of publications is an essential determinant for the development of any research field. Figure 2A shows the number of publications on safety leadership research retrieved from Scopus database from 1980 to 2019. The number of publications on safety leadership research was static from 1980 to 1998. There were only four articles published within 18 years and this indicated that safety leadership research has been sluggish.

Nevertheless, between 1999 and 2019, the trend was noticed as an erratic cycle. The number of articles published between 1980 and 2004 was less than ten copies a year. However, the number of articles rose from 2005 to 2019, with more than ten copies produced per year. In 2012, the number of articles published rose to 39 copies. However, in 2013, the number of articles published decreased to 22 copies.

The trend of publications saw a spike from 2014 to 2016 and it remained constant in 2017. In 2016 and 2017, 41 research articles on safety leadership were successfully published and this was recorded as the highest over the three decades. Then, again the trend experienced an up and down pattern; with a sharp drop to 30 copies in 2018 and then it increased marginally to 33 copies in 2019. The information in Figure 2B designates the cumulative frequency percentage of safety research articles with an exponential increase over the 39 years.
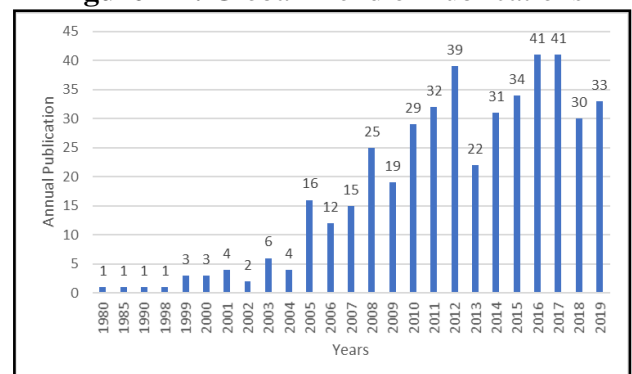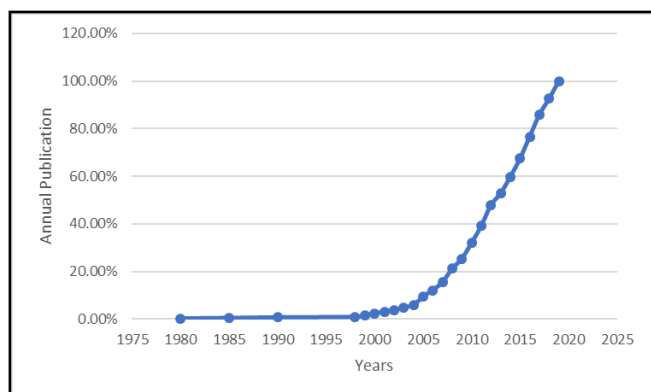
Figure 2A: Global Trend of Publications

Figure 2B: Cumulative Percentage of Safety Leadership Research Articles

Country	Number of Publications	Per cent (%)
China	8	1.61
Sweden	7	1.41
Brazil	6	1.21
Netherlands	6	1.21
United Arab Emirates	6	1.21
Malaysia	5	1.01
Norway	5	1.01

Figure 3: Network Visualization Map of Countries

Contributions of Countries

Scholars from 14 different countries have contributed to the dissemination of safety leadership research with at least five publications. Table 1 listed all the countries that contributed to the publications of safety leadership research. Top five on the list are the United States of America with a total of 158 publications (31.79 %), followed by the United Kingdom (73 publications, 14.69 %), Australia (23 publications, 4.63 %), Canada (14 publications, 2.82 %) and Taiwan (12 publications, 2.82 %). Results indicate that developed countries have dominated the publishing of safety leadership research over the 39 years.
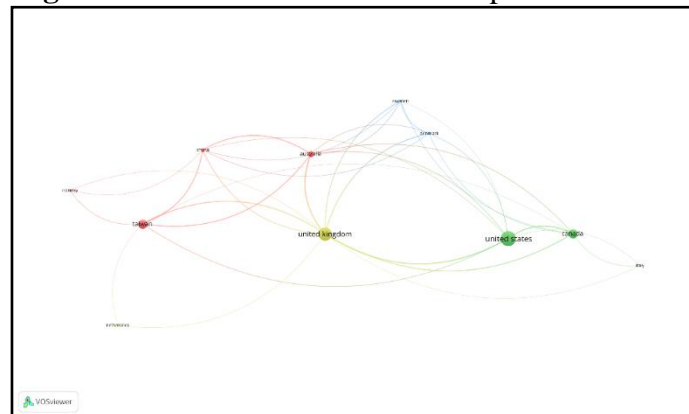
A network map using VOSviewer was used to view the distribution of countries that contributed to the field of safety leadership research, as shown in Figure 3. Based on Figure 3, the United States of America ranked the highest number, with 717 citations followed by the United Kingdom (573 citations), Taiwan (311 citations), and Canada (307 citations). Although Australia was ranked third in the number of publications, the overall number of citations was lower than in Taiwan and Canada.

Contribution of Journals

As shown in Figure 4A, the top 13 academic journals from 160 active sources account for more than one-third of the total 354 publications on safety leadership research (117, 33 %). Based on Figure 3, Safety Science was ranked first in the safety leadership research publications (26 publications, 7.34 %) followed by the Institution of Chemical Engineers Symposium Series (24 publications, 6.78 %).

Figure 4B shows the 21 research hotspots that were the subjects of the study. It showed that engineering ranked first in the field of safety leadership research with 201 publications (26.41 %), followed by medicine (114 publications, 14.98 %). Over the 39 years, both research hotspots have produced more than 100 publications of safety leadership research. Other significant contributors to the research of safety leadership included chemical engineering, social sciences, energy, earth, and planetary sciences, and environmental science.

Co-citation analysis of journal contributions was conducted to identify the source of the most prominent safety leadership research. Figure 4C illustrates the relationship of co-citation of safety

Table 1: Contribution of Countries

Country	Number of Publications	Per cent (%)
United States of America	158	31.79
United Kingdom	73	14.69
Australia	23	4.63
Canada	14	2.82
Taiwan	12	2.41
Denmark	11	2.21
Italy	9	1.81

leadership research with at least 20 references. As shown in Figure 4C, the larger the node, the more frequent is the source of articles cited by other researchers. In this regard, Safety Science was the most widely cited source of articles (387 citations), followed by the Journal of Applied Psychology (353 citations), the Journal of Safety Research (167 citations), and the Journal of Occupational Health (111 citations).

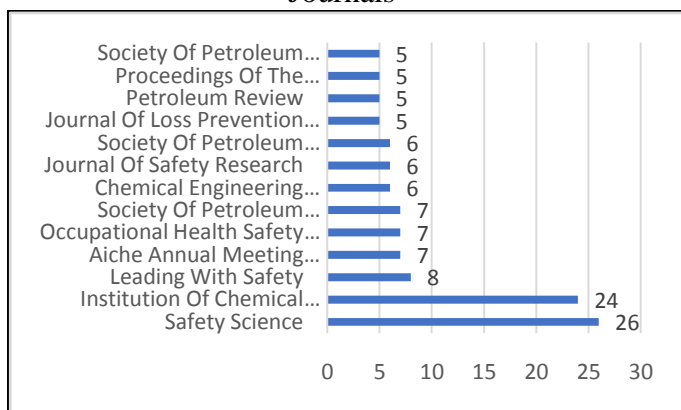**Figure 4A:** Distribution of top 13 Academic Journals

Figure 4B: Research Publication Areas on Safety Leadership Research
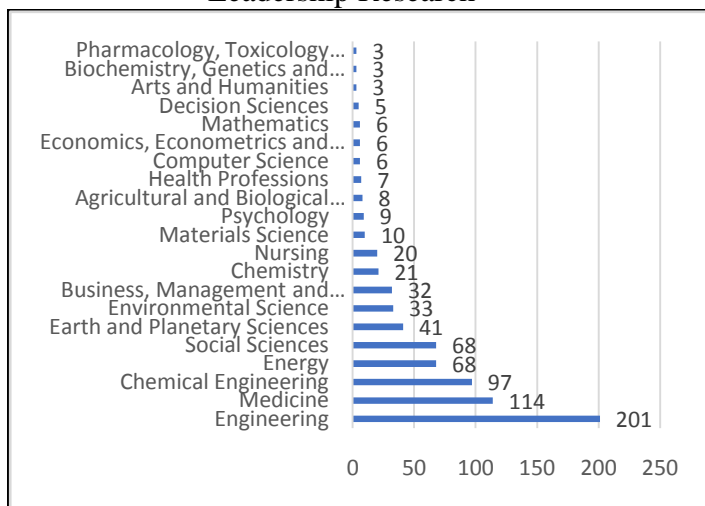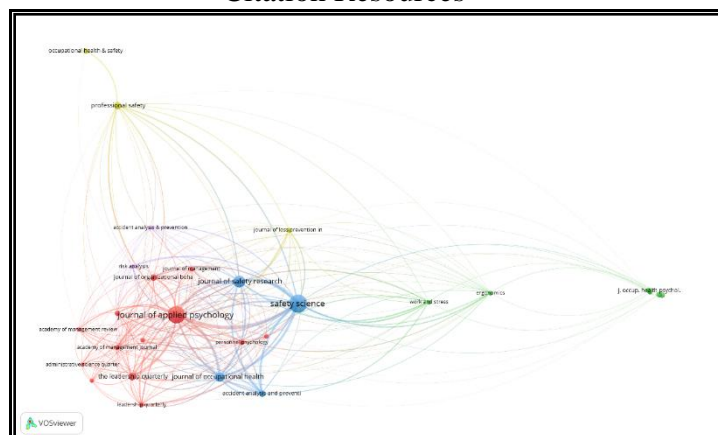

Figure 4C: Network Visualization Map of Co-Citation Resources

Distribution of Institutions

The involvement of the institutions in safety leadership research was also considered in this review based on at least five publications. Table 2 displayed that the University of Aberdeen had the highest number of publications on safety leadership research (8 publications, 2.42 %). Hungkuang University and Monash University were the second-highest (7 publications, 2.12 %) led by ExxonMobil Development Company, Petrobras, and Health and Safety Executive (6 publications, 1.82 %). In terms of regional analysis, the University of Aberdeen in the United Kingdom was the leading institution for safety leadership research publications, followed by the University of Hungkuang in Taiwan and the University of Monash in Australia. Such institutions, therefore, have the most powerful impact on productivity and participation in the field of safety leadership research.

Table 2 also indicated that researchers from academic and professional institutions had been actively engaged in safety leadership research for the 39 years and played a considerable role in the publications.

Table 2: Institutions Contributing to Publications

Institutions	Number of Publications	Percentage (%)
University of Aberdeen	8	2.42
Hungkuang University	7	2.12

Monash University	7	2.12
ExxonMobil Development Company	6	1.82
Petrobras	6	1.82
Health and Safety Executive	6	1.82
HFL Risk Services	5	1.52
University of Colorado Health Sciences	5	1.52
Royal Dutch Shell	5	1.52

Contributions of Authors

Since 1980, a total of 445 safety leadership research articles were written by 1,084 authors. Table 3 recorded the author's information who had produced more than five publications. Pater, R. was the most successful author in writing a total of 11 publications. In the meantime, Table 4 provided details of the number of authors in each publication. In this review, 33.90 per cent of the safety leadership research publications had been composed by single authors, and which was also the highest ranking.

Table 3: Most Active Authors on Safety Leadership Research

Author's name	Number of Publications	Percentage (%)
Pater, R.	11	2.82
Flin, R.	7	1.79
Wu, TC	7	1.79
Fowler, A.	5	1.28
Mearns, K.	5	1.28
Silva, LP	5	1.28

Table 4: Number of Authors per Document

No. of Authors	Number of Publications	Percentage (%)
1	151	33.90
2	102	22.90
3	72	16.20
4	27	6.10
5	32	7.20
6	12	2.70
7	8	1.80
8	3	0.70
9	1	12.20
10	5	1.10
11	2	12.40
12	1	12.20
Total	445	100.00

This study further analysed the cooperation of the authors by performing a co-authorship review using VOSviewer. The bibliometric mapping of co-authorship relationships between authors allows for the representation of information in ways that make relations between authors easier to understand (Mesdaghinia et al., 2015).

The review is based on prominent authors with more than five citations and is measured using the fractional counting method. Figure 5A illustrates that the colour, the size of the node, the font size, and the width of the linking lines reflect the intensity of the relationship between the authors. Connected authors, shown in the same colour, are usually grouped. For instance, Figure 6A shows that Mearns, K. and Flin, R. works were performed with close collaboration (red cluster).

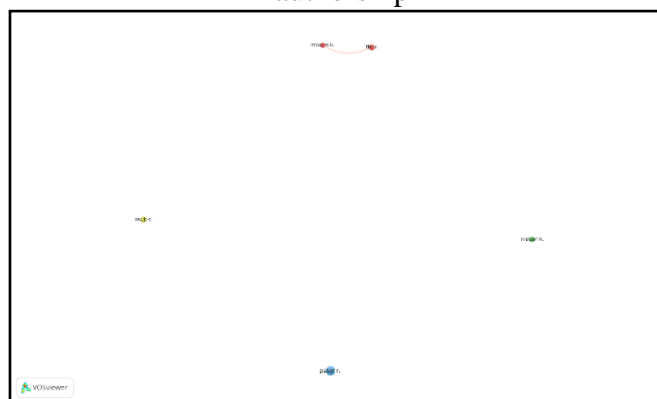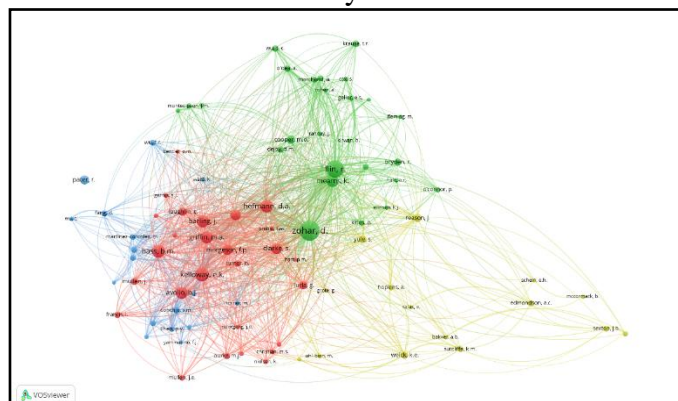**Figure 5A:** Network Visualization Map of the Co-authorship

Figure 5B: Network Visualization Map of the Co-citation by Author

In this study, we also carried out a co-citation analysis to map the intellectual link of the research

field. This method consists of measuring pairs of co-cited sources from a specific field of study (Ma, 2009). The VOSviewer-generated a co-citation map (Figure 5B) that showed the degree of the author's teamwork. The co-citation analysis in Figure 5B generated at least 20 references in 445 articles. The co-citation map allows for two fundamental analyses (Ferreira et al., 2014). First, the lines refer to the conceptual ties between the works, thereby reflecting the connections of co-citation; thicker lines represent related works. Second, the position of nodes in the network illustrates the notion of the centrality of each work; nodes in the central position were more important, prominent, and influential. Based on Figure 5B, Zohar, D (256 citations) became the most active author, followed by Flin, R (202 citations). Those two articles were the most co-cited and the most important in safety leadership research.

Reference Analysis

Reference analysis is one of the primary bibliometric analysis identification process (De Oliveira, Da Silva, Juliani, Barbosa, & Nunhes, 2019). Table 6 summarised the citation metrics for the retrieved document. As noted, there were 2548 citations published in the 39 years of safety leadership research. Citation metric was obtained by Publish or Perish (PoP) software by importing files in RIS format from the Scopus database. Table 7 summarised the top ten most cited articles (based on the citation number of the text) as per the Scopus database. O'Dea and Flin (2001) authored the article entitled "Site managers and safety leadership in the offshore oil and gas industry" issued by the Safety Science got the highest number of citations, that is a total of 147 citations, equivalent to 8.17 citations per year. Two articles on safety leadership research had been published as indicated from the list of the top ten cited articles (see Table 7), the Safety Sciences, and the Journal of Occupational and Organisational Psychology. These publication

sources were the most prominent publishers of safety leadership research articles.

Table 6: Metrics Citation

Metrics	Data
Publication years	1980 - 2019
Citation years	39 (1980 -2019)
Papers	445
Citations	2548
Citation / year	65.33
Citation / paper	5.73
Author / paper	2.43
Hirsch h-index	24
Egghe g-index	42
PoP hI, the norm	15
PoP hI, annual	0.38

Analysis of Keywords

Keywords aid to imitate research hotspots and help researchers to identify new frontier issues. By analysing articles' common keywords, we were able to realise the essence of the research focus comprehensively (Zou et al., 2019). In this analysis, VOSviewer had mapped the keywords of the authors. Figure 6A provided a network diagram of the author's keywords in which colour, node size, font size, and thickness of the connecting lines to illustrate the relationship with other keywords (Sweileh et al. 2017).

In Figure 6A, the keyword "safety leadership" in red nodes and "leadership" in yellow nodes were two keywords widely used by previous researchers. The closeness in the distance between keywords indicates the higher the relationship between keywords. The distance between the keywords "safety leadership," "safety culture," "safe climate" and "safety performance" is close. It is thus evident that "safety leadership," "safety culture," "safety climate and "safety performance" have a substantial impact.

This analysis also inspected the titles and abstracts of the retrieved documents based on the number of co-occurrences - the binary counting method was used to create a co-occurrence network by authors. Van Eck and Waltman (2019) claimed that using binary counting means the number of noun phrases

appears in the title, and the abstract does not play a significant role and is equally concerned.

Figure 6B demonstrated the co-occurrence network based on the title and abstract fields. The overall strength of the relationship between the terms was 20032. The term "safety climate", "safety behaviour", "leadership style" and "employee" were grouped into a cluster with the same colour (green), which means these terms appeared simultaneously in the titles and abstracts. The study also described that 135 terms from titles and abstracts grouped into four clusters in different colours.

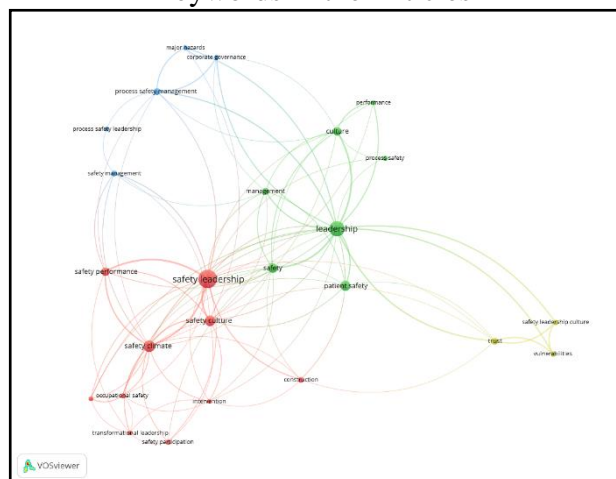**Figure 6A:** Network Visualisation Map of Author Keywords in the Articles

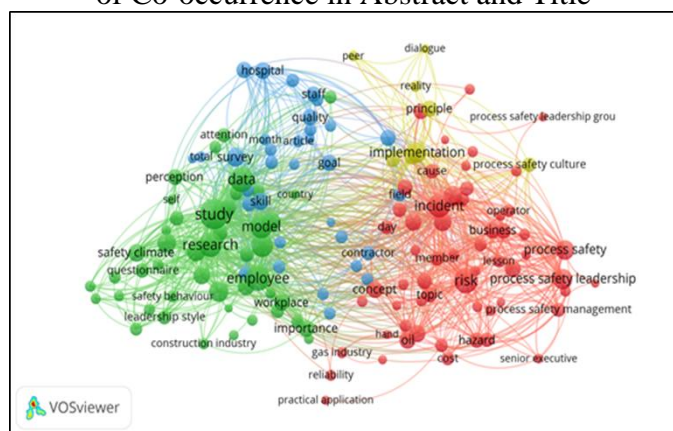**Figure 6B:** Network Visualisation Map of a Term of Co-occurrence in Abstract and Title

Table 7: Top Ten Cited Articles

Author	Title	Source	Citation	Citation / Year
O'Dea & Flin (2001)	Site managers and safety leadership in the offshore oil and gas industry	Safety Science	147	8.17
Clarke (2013)	Safety leadership: A meta-analytic review of transformational and transactional leadership styles as the antecedents of safety behaviours	Journal of Occupational and Organizational Psychology	145	24.17
Mullen & Kelloway (2009)	Safety leadership: A longitudinal study of the effects of transformational leadership on safety outcomes	Journal of Occupational and Organizational Psychology	123	12.30
Frankel et al. (2003)	Patient Safety Leadership WalkRounds.	Joint Commission Journal on Quality and Safety	112	7.00
Wu et al. (2008)	A correlation among safety leadership, safety climate and safety performance	Journal of Loss Prevention in the Process Industries	105	9.55
Lu and Yang (2010)	Safety leadership and safety behaviour in container terminal operations	Safety Science	74	8.22
El-Jardali et al. (2011)	Predictors and outcomes of patient safety culture in	BMC Health Services Research	73	9.13

	hospitals			
Griffith et al. (2010)	The assessment of food safety culture	British Food Journal	65	7.22
Krause (2005)	Leading with Safety	John Wiley & Sons	63	4.50
Mullen et al. (2011)	Inconsistent style of leadership as a predictor of safety behaviour	Work and Stress	58	7.25

IV.   Discussion

Bibliometric analysis is essential because it can determine the efficacy of the research carried out (Cox, Gadd, Peterson, & Shaffi, 2019). Bibliometric analysis in this study was conducted to explore the growing trend of safety leadership research publications. Also, this analysis was conducted to review the information in safety leadership research articles that concentrated on (i) publications trend, (ii) contributions of countries, (iii) contributions of journals, (iv) distribution of institutions, (v) contributions of authors, (vi) reference analysis and, (vii) keywords analysis. Knowledge derived from the bibliometric review can act as a guide to determine the benefits of research and to assist research agencies in monitoring the allocation of funding (Gu, 2004). The results of this bibliometric analysis will clarify contributing factors to the field of study (safety leadership research) and help future researchers to produce high-impact publications (Akhavan, Ebrahim, Fetrati, & Pezeshkan, 2016).

The bibliometric analysis focused on safety leadership research in the Scopus database. From the analysis, we found that a total of 445 research articles published between 1980 and 2019. Safety leadership research publication was initiated by Rosenfield (1980) with the title "Safety leadership - Use it or lose it". Nevertheless, the article failed to get any citations from previous researchers due to the slow progress of safety leadership research in

the 1980s. This fact was illustrated in Figure 2A and 2B, that the number of safety leadership research articles had been published consistently with one manuscript from 1980 to 1998.

Safety leadership research started to increase in 2008, with more than 20 publications. The successful publication of safety leadership research articles indicated that the importance of safety leadership awareness started after two decades and has been increasingly considered a vital tool to manage occupational safety and health in the organisations concerned.

In the context of the author's information, Patel R. was the most active author. In this analysis, we also found that safety leadership research publications were authored mostly by a single author. For future studies, safety leadership research publications need to collaborate with other authors for truthfulness, credibility and consistency of articles. This is because a single author may suffer personal discrimination, irrelevant or over-criticism and raise doubts or issues of inevitability. Moreover, in this era of speedy growth and advancements in information, communication and technology (ICT) that enables fast, cheap and borderless communication, authors, nowadays, can collaborate easily and comfortably to publish more articles.

Based on cooperation between countries, the United States and the United Kingdom indicated close research network with Canada, the Netherlands, and Italy. This information exposed that developed countries dominated in publishing safety leadership research articles compared to other countries. It is also mainly because developed countries have commemorated the active participation of researchers or scholars of safety leadership to join related research activities. As such, safety leadership conferences have been often held in the United States and the United Kingdom, conducted by the American Society of Safety Professionals and the Institute for Occupational Safety and Health in the United Kingdom. These two professional bodies of research also play active roles to enhance and encourage research activities in both countries.

Safety science was the most influential source of safety leadership research over the 39 years. Safety Science was based in the Netherlands and was categorised as a high-impact publisher by Scopus with First Quarter (Q1). This information will help readers and other researchers to get a good source of safety leadership publications. Medical and engineering were the most focused areas of safety leadership research publications due to a vast number of engineering and medical organisations, including construction and hospitals, that have been actively pursuing studies on occupational safety and health issues. Science, mathematics, computer science, and psychology were less focused areas. Therefore, only very few focused areas contribute substantially to safety leadership research publications. As such, researchers should formulate significant future research which includes forecasting the probability of injuries and working through mathematical and computational simulation.

As far as countries and institutions are concerned, the United States is the country with the most published safety leadership research documents followed by the United Kingdom and Australia. This factor is due to researchers in developed countries actively assessing the effectiveness of safety leadership in addressing the challenges of the current progress they are making in terms of job safety.

This study also found that authors from universities have published more articles related to safety leadership. Authors from the University of Aberdeen were found to have been the highest producers of safety leadership articles, followed by authors from Hungkuang University and Monash University. Also, the professional author from ExxonMobil Development Company, Petrobras, and the Health and Safety Executive writes safety leadership research articles. Accordingly, this case concerns an investigation that has revealed that safety leadership research has not only attracted attention among academics in the universities, but it was also studied by professional researchers.

Based on the last 39 years of publication, a total of 445 articles were published with a total number of 2548 of citations, with a total of 65,33 citations per year, 5,73 citations per article, and 2,43 citations per author. Also, we have compiled a list of 10 authors with the quotation through the Hirsch h-Index to identify the author of an influential research paper published in the field of safety leadership. O'Dea and Flin (2001) are the most influential authors with Hirsh's h-Index of 147 for the article entitled "Site Managers and Safety Leaders in the Offshore Petroleum and Gas Industry" and followed by Clarke (2013), Hirsch's h-Index of 145 for the article entitled "A Meta- analytic Review of Transformational and Transactional Leadership Styles as Antecedents of Safety behaviours."

Meanwhile, the co-citation results showed that Safety Science and the Journal of Applied Psychology were the most influential sources. As such, the information obtained may help readers and researchers to identify the leading author in the field of study. Also, information on article sources couldenable readers or researchers to cite quality articles in their publications.

Based on the analysis of authors' keywords (see Figure 6A), we found that there were various safety dimension links with safety leadership such as safety climate, safety management and safety behaviour. For future research studies, the other dimensions such as safety habits, safety psychology and safety commitment can be focused or prioritised as possible gaps to complement safety leadership research. As a result, the new proposed dimensions would be able to shape a stronger foundation to improve organisations' levels of workplace safety and health, besides enhancing the efficacy of the practice and culture of safety leadership.

Information related to the authors' keywords used in the articles also reveals that safety leadership had a close relationship with safety culture, safety climate and safety performance. This work demonstrated that safety leadership was concerned

with safety culture, safety climate and safety performance. Thus, the leadership of the workplace is crucial in forming a good quality of safety culture and safety performance. Also, in the title and abstract, the four terms, namely, "safety climate", "safety behaviour", "leadership style", and the "employee", were written simultaneously. These terms recapped readers and researchers that safety leadership requires strong relationships between safety climate, safety behaviour, leadership style and employee to achieve the desired goals of occupational safety and health in any organisation. Additionally, safety leadership research is as crucial as ever in any organisation even though organisations have become increasingly digital and personnel at different levels evolve more in "virtual" engagements than ever before.

V. Conclusion

Based on a bibliometric analysis of safety leadership research published from 1980 to 2019, we found that the information will able to provide readers, especially organisational leaders, occupational safety and health practitioners and researchers as follows:

1)   The number of articles on safety leadership research publications fluctuated, and the highest number of publications was 41 copies (2016 and 2017). The articles mainly focused on engineering and medicine.

2)   In terms of countries and institutions, the United States of America and the United Kingdom were active publishing countries. Meanwhile, academicians at the universities and professional authors from occupational safety and health agencies actively participate in publishing articles regarding safety leadership research.

3)   The most active author for safety leadership research publications was Pater, R. Meanwhile, O'Dea and Flin (2001) and Clarke (2013) were the most influential authors in safety leadership research.

4)   The authors' keywords, namely; safety leadership, safety climate, safety culture, and safety performance, had a strong relationship; and this means safety leadership research was related to the safety culture, safety climate and safety performance dimensions. In addition, the analysis of authors' key words also resulted in four clusters, first cluster "leadership", "safety", "patient safety", "management", "culture", "performance", and "process safety"), second cluster ("safety leadership", "safety culture", "safety climate", "safety performance", "occupational safety", "transformational leadership", "safety participation", and "intervention", the third cluster ("trust", "vulnerabilities", and "safety leadership culture") and the fourth cluster ("process safety management", "major hazards", "corporate governance", "process safety leadership", and "safety management").

Safety leadership is thus, evidently a vital element in managing workplace safety and health management efficiently. Therefore, safety leadership, safety culture, safety climate and safety performance are elements that should never be compromised in any workplace context.

REFERENCES

[1]   Ahmi, A., & Mohamad, R. (2019). Bibliometric analysis of global scientific literature on web accessibility. *International Journal of Recent Technology and Engineering*, *7*(6), 250–258.

[2]   Akhavan, P., Ebrahim, N. A., Fetrati, M. A., & Pezeshkan, A. (2016). Major trends in knowledge management research: A bibliometric study. *Scientometrics*, *107*(3), 1249-1264.

[3]   Alidrisi, H. M., & Mohamed, S. (2017, September). Systematic Review of Safety Leadership: A Fresh Perspective. In *International Conference on Engineering, Project, and Product Management* (pp. 215-223). Springer, Cham.

[4]   Amin, M. T., Khan, F., & Amyotte, P. (2019). A bibliometric review of process

safety and risk analysis. *Process Safety and Environmental Protection*, *126*, 366-381.

[5] Andersen, L. P., Nørdam, L., Joensson, T., Kines, P., & Nielsen, K. J. (2018). Social identity, safety climate and self-reported accidents among construction workers. *Construction Management and Economics*, *36*(1), 22-31.

[6] Avolio, B. J., Walumbwa, F. O., & Weber, T. J. (2009). Leadership: Current theories, research, and future directions. *Annual Review of Psychology*, *60*, 421-449.

[7] Bamel, U. K., Pandey, R., & Gupta, A. (2020). Safety climate: Systematic literature network analysis of 38 years (1980-2018) of research. *Accident Analysis and Prevention*, *135*, 1-16.

[8] Bass, B.M. (1985). *Leadership and performance beyond expectations*. Free Press: New York.

[9] Borse, N. N., & Hyder, A. A. (2009). Call for more research on the injury from the developing world: Results of a bibliometric analysis. *Indian Journal of Medical Research*, *129*(3), 321-326.

[10] Bucher, S. (2018). Bibliometric analysis of Central European journals in the Web of Science and JCR Social Science Edition. *Malaysian Journal of Library and Information Science*, *23*(2), 95-110.

[11] Clarke, S. (2013). Safety leadership: A meta- analytic review of transformational and transactional leadership styles as antecedents of safety behaviours. *Journal of Occupational and Organisational Psychology*, *86*(1), 22-49.

[12] Clay-Williams, R., Taylor, N., Ting, H. P., Winata, T., Arnolda, G., & Braithwaite, J. (2020). The clinician safety culture and leadership questionnaire: Refinement and validation in Australian public hospitals. *International Journal for Quality in Health Care*, *32*(Supplement 1), 52-59.

[13] Conchie, S. M. (2013). Transformational leadership, intrinsic motivation, and trust: A moderated-mediated model of workplace safety. *Journal of Occupational Health Psychology*, *18*(2), 198.

[14] Cox, A., Gadd, E., Peterson, S., & Shaffi, L. (2019). Competencies for bibliometrics. *Journal of Librarianship and Information Science*, *51*(3), 746-762.

[15] Daniel, L. (2015). Safety leadership defined within the Australian construction industry, *Construction Economics and Building*, *15*(4), 1-15.

[16] Daniel, L. (2018). *Practical guide to safety leadership: An evidence-based approach*. New York: Routledge.

[17] Dartey-Baah, K., & Addo, S. A. (2018). Charismatic and corrective leadership dimensions as antecedents of employee safety behaviours. *Leadership and Organization Development Journal*, *39*(2), 186-201.

[18] Davis, K. M., & Gardner, W. L. (2012). Charisma under crisis revisited: Presidential leadership, perceived leader effectiveness, and contextual influences. *The Leadership Quarterly*, *23*(5), 918-33.

[19] De Oliveira, O. J., Da Silva, F. F., Juliani, F., Barbosa, L. C. F. M., & Nunhes, T. V. (2019). Bibliometric Method for Mapping the State-of-the-Art and Identifying Research Gaps and Trends in Literature: An Essential Instrument to Support the Development of Scientific Projects. In *Scientometrics Recent Advances*. IntechOpen.

[20] Denis, J. L., Langley, A., & Sergi, V. (2012). Leadership in the plural. *The Academy of Management Annals*, *6*(1), 211-283.

[21] Donovan, S. L., Salmon, P. M., & Lenne, M. G. (2016). Leading with style: A literature review of the influence of safety leadership on performance and outcomes. *Theoretical Issues in Ergonomics Science*,*17*(4), 423-442.

[22] El-Jardali, F., Dimassi, H., Jamal, D., Jaafar, M., & Hemadeh, N. (2011). Predictors and outcomes of patient safety culture in hospitals. *BMC Health Services Research*, *11*(1), 1-12.

[23] Ellegaard, O., & Wallin, J. A. (2015). The bibliometric analysis of scholarly production: How great is the impact? *Scientometrics*, *105*(3), 1809-1831.

[24] Elsevier. (2017). Scopus: Content coverage guide. Retrieved February 18, 2020. from www.elsevier.com

[25] Ferreira, M. P., Li, D., Reis, N. R., & Serra, F. R. (2014). Culture in international business research: A bibliometric study in four top IB journals. *Management Research*: *The Journal of the Iberoamerican Academy of Management*, *12*(1), 68-91.

[26] Frankel, A., Graydon-Baker, E., Neppl, C., Simmonds, T., Gustafson, M., & Gandhi, T. K. (2003). Patient safety leadership WalkRounds™. *The Joint Commission Journal on Quality and Safety*, *29*(1), 16-26.

[27] Gardner, W. L., Cogliser, C. C., Davis, K. M., & Dickens, M. P. (2011). Authentic leadership: A review of the literature and research agenda. *The Leadership Quarterly*, *22*(6), 1120-1145.

[28] Gracia, F. J., Tomás, I., Martínez-Córcoles, M., & Peiró, J. M. (2020). Empowering leadership, mindful organising and safety performance in a nuclear power plant: A multilevel structural equation model. *Safety Science*, *123*, 1-9.

[29] Griffin, M. A., & Hu, X. (2013). How leaders differentially motivate safety compliance and safety participation: The role of monitoring, inspiring, and learning. *Safety Science*, *60*, 196-202.

[30] Griffith, C. J., Livesey, K. M., & Clayton, D. (2010). The assessment of food safety culture. *British Food Journal*, *112*(4), 439-456.

[31] Gu, Y. (2004). Global knowledge management research: A bibliometric analysis. *Scientometrics*, *61*(2), 171-190.

[32] Hall, C. M. (201). Publish and perish? Bibliometric analysis, journal ranking and the assessment of research quality in tourism. *Tourism Management*, *32*(1), 16-27.

[33] Hoffmeister, K., Gibbons, A. M., Johnson, S. K., Cigularov, K. P., Chen, P. Y., & Rosecrance, J. C. (2014). The differential effects of transformational leadership facets on employee safety. *Safety Science*, *62*, 68-78.

[34] Hofmann, D. A., & Morgeson, F. P. (1999). Safety-related behavior as a social exchange: The role of perceived organisational support and leader–member exchange. *Journal of Applied Psychology*, *84*(2), 286.

[35] Jiang, L., & Probst, T. M. (2016). Transformational and passive leadership as cross-level moderators of the relationships between safety knowledge, safety motivation, and safety participation. *Journal of Safety Research*, *57*, 27-32.

[36] Kelloway, E. K., & Barling, J. (2010). Leadership development as an intervention in occupational health psychology. *Work and Stress*, *24*(3), 260-279.

[37] Khalil, G. M., & Crawford, C. A. G. (2015). A bibliometric analysis of US-based research on the behavioral risk factor surveillance system. *American Journal of Preventive Medicine*, *48*(1), 50-57.

[38] Khiste, G. P., & Paithankar, R. R. (2017). Analysis of Bibliometric term in Scopus. *International Journal of Library Science and Information Management (IJLSIM)*, *3*(3), 81-88.

[39] Krause, T. R. (2005). *Leading with safety*. New Jersey: John Wiley & Sons.

[40] Liang, H., Zhang, S., & Su, Y. (2018). The structure and emerging trends of construction safety management research: A bibliometric review. *International Journal of Occupational Safety and Ergonomics*, 1-20.

[41] Liu, X., Zhan, F. B., Hong, S., Niu, B., & Liu, Y. (2013). Replies to comments on "a bibliometric study of earthquake research: 1900–2010". *Scientometrics*, *96*(3), 933-936.

[42] Lu, C.S. & Yang, C.S. (2010). Safety leadership and safety behavior in container

terminal operations. *Safety Science*, *48*(2), 123-134.

[43] Ma, Z. (2009). The status of contemporary business ethics research: Present and future. *Journal of Business Ethics*, *90*(3), 255-265.

[44] Marques, T., Reis, N., & Gomes, J. F. (2018). Responsible leadership research: a bibliometric review. *BAR-Brazilian Administration Review*, *15*(1), 1-25.

[45] Martín-Martín, A., Orduna-Malea, E., Thelwall, M., & López-Cózar, E.D. (2018). Google Scholar, Web of Science, and Scopus: A systematic comparison of citations in 252 subject categories. *Journal of Informetrics*,*12*(4), 1160-1177.

[46] Mearns, K. J. (2020). Safety Leadership and Human and Organisational Factors (HOF)—Where Do We Go from Here?. In *Human and Organisational Factors* (pp. 15-23). Springer, Cham.

[47] Mesdaghinia, A., Mahvi, A. H., Nasseri, S., Nodehi, R. N., & Hadi, M. (2015). A bibliometric analysis on the solid waste-related research from 1982 to 2013 in Iran. *International Journal of Recycling of Organic Waste in Agriculture*, *4*(3), 185-195.

[48] Monteiro, G. P., Hopkins, A., & e Melo, P. F. F. (2020). How do organisational structures impact operational safety? Part 2–Designing structures that strengthen safety. *Safety Science*, *123*, 1-6.

[49] Mullen, J. E., Kelloway, E. K., & Teed, M. (2011). Inconsistent style of leadership as a predictor of safety behaviour. *Work and Stress*, *25*(1), 41-54.

[50] Mullen, J. E., & Kelloway, E. K. (2009). Safety leadership: A longitudinal study of the effects of transformational leadership on safety outcomes. *Journal of Occupational and Organizational Psychology*, *82*(2), 253-272.

[51] Newnam, S., Lewis, I., & Watson, B. (2012). Occupational driver safety: Conceptualising a leadership-based intervention to improve safe

driving performance. *Accident Analysis and Prevention*, *45*, 29-38.

[52] Northouse, P. G. (2018). *Leadership: Theory and practice*. Sage publications.

[53] O'Dea, A., & Flin, R. (2001). Site managers and safety leadership in the offshore oil and gas industry. *Safety Science*, *37*(1), 39-57.

[54] Osborn, R. N., Hunt, J. G., & Jauch, L. R. (2002). Toward a contextual theory of leadership. *The Leadership Quarterly*, *13*(6), 797-837.

[55] Pater, R. (2019). Becoming safety rock star. *Professional Safety*, 64(3), 22-25.

[56] Pilbeam, C., Doherty, N., Davidson, R., & Denyer, D. (2016). Safety leadership practices for organisational safety compliance: Developing a research agenda from a review of the literature. *Safety Science*, *86*, 110-121.

[57] Pritchard, A. (1969). Statistical bibliography or bibliometrics. *Journal of Documentation*, *25*(4), 348-349.

[58] Raelin, J. (2011). From leadership-as-practice to leaderful practice. *Leadership*, *7*(2), 195-211.

[59] Rizzi, F., Van Eck, N. J., & Frey, M. (2014). The production of scientific knowledge on renewable energies: Worldwide trends, dynamics and challenges and implications for management. *Renewable Energy*, *62*, 657-671.

[60] Rodrigues, S. P., Van Eck, N. J., Waltman, L., & Jansen, F. W. (2014). Mapping patient safety: a large-scale literature review using bibliometric visualisation techniques. *BMJ Open*, *4*(3), 1-9.

[61] Rosenfield, H. N. (1980). Safety leadership - use it or loss it. Paper presented at the ASAE Publication, 2-3. Retrieved December 30, 2019, from www.scopus.com

[62] Rusly, F. H., Ahmi, A., Yakimin, Y., Talib, A., & Rosli, K. (2019). Global perspective on payroll system patent and research: A bibliometric performance. *International*

Journal of Recent Technology and Engineering, *8*(2S2), 148–157.

[63] Sanni, S. A., & Zainab, A. N. (2017). Google Scholar as a source for citation and impact analysis for a non-ISI indexed medical journal. *Malaysian Journal of Library and Information Science*, *15*(3), 35-51.

[64] Sharma, N., Bairwa, M., Gowthamghosh, B., Gupta, S. D., & Mangal, D. K. (2018). A bibliometric analysis of the published road traffic injuries research in India, post-1990. *Health Research Policy and Systems*, *16*(1), 1-11.

[65] Sweileh, W. M., Al-Jabi, S. W., Abu Taha, A. S., Sa'ed, H. Z., Anayah, F. M., & Sawalha, A. F. (2017). Bibliometric analysis of worldwide scientific literature in mobile-health: 2006–2016. *BMC Medical Informatics and Decision Making*, *7*(1), 1-12.

[66] Tal, D., & Gordon, A. (2016). Leadership of the present, current theories of multiple involvements: A bibliometric analysis. *Scientometrics*, *107*(1), 259-269.

[67] Van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, *84*(2), 523-538.

[68] Van Eck, N. J., & Waltman, L. (2019). *VOSviewer Manual version 1.6.10*. Leiden: Univeristeit Leiden.

[69] Van Eck, N. J., Waltman, L., Dekker, R., & Berg, J.V. (2010). A comparison of two techniques for bibliometric mapping: Multidimensional scaling and VOS. *JASIST 61*, 2405-2416.

[70] Van Nunen, K., Li, J., Reniers, G., & Ponnet, K. (2018). Bibliometric analysis of safety culture research. *Safety Science*, *108*, 248-258.

[71] Weale, A. R., Bailey, M., & Lear, P. A. (2004). The level of non-citation of articles within a journal as a measure of quality: a comparison to the impact factor. *BMC Medical Research Methodology*, *4*(1), 1-8.

[72] Wu, C., Fang, D., & Li, N. (2015). Roles of owners' leadership in construction safety: The case of high-speed railway construction projects in China. *International Journal of Project Management*, *33*(8), 1665-1679.

[73] Wu, T. C., Chen, C. H., & Li, C. C. (2008). A correlation among safety leadership, safety climate and safety performance. *Journal of Loss Prevention in the Process Industries*, *21*(3), 307-318.

[74] Yang, Y., Reniers, G., Chen, G., & Goerlandt, F. (2019). A bibliometric review of laboratory safety in universities. *Safety Science*, *120*, 14-24.

[75] Zare, F., Elsawah, S., Iwanaga, T., Jakeman, A.J., & Pierce, S.A. (2017). Integrated water assessment and modelling: A bibliometric analysis of trends in the water resource sector. *Journal of Hydrology*, *552*, 765-778.

[76] Zohar, D. (2002). The effects of leadership dimensions, safety climate, and assigned priorities on minor injuries in work groups. *Journal of Organizational Behavior*, *23*(1), 75-92.

[77] Zou, Y., Luo, Y., Zhang, J., Xia, N., Tan, G., & Huang, C. (2019). Bibliometric analysis of oncolytic virus research, 2000 to 2018. *Medicine*, *98*(35), 1-10.