Safety Science xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/safety

Review

Bibliometric analysis of safety culture research

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ARTICLE INFO

Keywords:
Bibliometric analysis
Safety culture
Organisational safety
Patient safety
Health-care safety
Scientific knowledge

ABSTRACT

The concept of safety culture is characterised by complexity. On the one hand, the concept is challenging content-wise, and on the other hand, is it a multi-dimensional and cross-disciplinary research domain. In this paper, bibliometric analysis has been applied to the field of safety culture to identify fundamental influences and to obtain a structured overview of the characteristics and the developments in this research domain. In total, 1789 publications published between 1900 and 2015 related to safety culture were identified in Web of Science. The 1789 publications cover 4591 authors, 775 journals, 76 countries or territories, and 1866 institutions. Two main research areas can be distinguished in the domain of safety culture: (1) organisational safety culture and (2) health-care and patient safety culture. The latter research area stands in a dominant position in safety culture research nowadays. Key publications are from Guldenmund (2000) and Sexton et al. (2006). Furthermore, 'Safety Science' is the key journal publishing on safety culture research, and the USA, England and China are the countries that dominate the publication production. It can be concluded that there is much collaborative research in the safety culture domain as multi-authored publications make up about three quarters of all publications. Also, safety culture research is characterised by a wide variety of research themes and multi-disciplinarity. Geographical inequality in the publication output is identified as a point of concern. A movement away from technical aspects towards more human aspects could be detected as a noteworthy change in research focus.

1. Introduction

The amount of scientific literature available on a specific research discipline or research topic is often overwhelming, which makes it challenging for researchers and practitioners to have a structured overview of relevant information (Rodrigues et al., 2014; Zhou et al., 2015). Bibliometric analysis is a technique which makes it possible to provide a macroscopic overview of large amounts of academic literature. Through a quantitative analysis of information on the publication history, the characteristics and the development of scientific output within a specific field of research can be mapped (Jia et al., 2014; Li and Hale, 2016). Bibliometric methods can be used to assess the performance and research patterns of authors, journals, countries and institutes, and can be used to identify and quantify cooperation patterns between them (Li and Zhao, 2015). Influential authors and publications, and core journals, countries and institutions publishing on a specific topic can be identified. The number of different journals publishing on a specific topic and the subject categories allocated to publications can give an indication on the variety of research themes, and the multidisciplinary character of a research domain. Bibliometrics can reveal the latest advances, research directions and leading topics in a particular field of research (Wang et al., 2014). Bibliometric analysis also allows identification of current gaps in a certain research discipline, both content-wise as well as geographically (Gall et al., 2015). Furthermore, bibliometrics can play a crucial role in the decision-making process related to science. It is widely used to rank applications for academic positions, and to evaluate the performance of journals, countries and institutions. Bibliometric results can also be considered to support policy makers and funding agencies to allocate research funding (Ugolini et al., 2015).

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http://dx.doi.org/10.1016/j.ssci.2017.08.011
Received 22 November 2016; Received in revised form 28 June 2017; Accepted 13 August 2017
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In this paper, bibliometric analysis has been applied to the field of safety culture research. The research topic of safety culture is a relative new one in terms of academic research. The concept was first used in 1986 in response to the Chernobyl disaster (EU-OSHA, 2011). From then on, an increased attention in the research area of safety culture can be observed. This increase is driven by the fact that, despite improvements over the years, disasters, accidents and incidents continue to persist in organisations, at home, and at all other levels of society. This has led to a continuously growing publication rate regarding safety culture, which makes it difficult to obtain a comprehensive overview on the topic.

This difficulty is enhanced by the complexity of the concept of safety culture. First of all, safety culture is a complicated topic based on its content. Many efforts have been devoted to develop and test models and theories to frame the concept. However, until today, little consensus has been reached on the definition, the cause and the consequences of safety culture (Guldenmund, 2000). Secondly, safety culture is a multidimensional research topic. As previously mentioned, the concept was first used in the nuclear organisational sector. However, the concept of safety culture is not only explored in the context of organisational safety, but is adopted for a wide variety of purposes. In health-care, for instance, safety culture is associated with patient safety, the quality of care and the occurrence of adverse events (Sammer et al., 2010; Weaver et al., 2013). Other contexts in which the concept of safety culture is used are, for example, railway traffic, aviation, road traffic, transportation, food industry, education, and home injuries. Thirdly, the complexity of safety culture is strengthened by the large variety of research disciplines engaging in safety culture research. The concept of safety culture has been studied by, amongst others, engineers, psychologists, sociologists, and anthropologists (Guldenmund, 2000; EU-OSHA, 2011). This cross-disciplinary focus has resulted in very different approaches for exploring and assessing safety culture (EU-OSHA, 2011). The complexity of safety culture and the continuously growing publication rate makes it an optimal topic for bibliometric analysis.

The goal of this descriptive paper is to provide a macroscopic overview on the main characteristics of safety culture publications based on a bibliometric analysis. The information presented in this paper provides a clear picture on the research progress achieved in the domain of safety culture research, and it can assist researchers and practitioners in identifying fundamental influences from authors, journals, countries, institutions, references and research topics.

2. Data and methods

The data for this study were retrieved from Web of Science on December 30, 2015. Web of Science was chosen as search engine because it is the most widely accepted and frequently used database for analysis of scientific publications (Yang et al., 2013). The term “safety culture” was used as search topic. This topic search means that the term “safety culture” is identified in the title, the abstract and/or in the keywords of the publications. Quotation marks have been included in the search term. This tighter condition ensures the robustness of the search results (Liu et al., 2013). The time span was set from 1900 to 2015 included. In Fig. 1, the search method can be found. As can be seen at the bottom of Fig. 1, the date on which the Web of Science database was last updated on the date of the search (i.e. December 30, 2015) was December 28, 2015. If the exact same search strategy is performed on a different date, it can be possible that the results slightly differ. These differences are due to the fact that Web of Science is continuously updated – also retrospective – which can lead to minor changes over time (Liu et al., 2013).

In total, 1789 publications related to safety culture were identified.

All types of publications were included in the search. Looking at the document types, the majority is article (n = 1128) and proceedings paper (n = 344). The other document types, such as meeting abstracts and editorial material, are limited in numbers (all less than hundred).

Every publication in Web of Science contains many details, including publication year, authors, addresses of the authors, title, abstract, source journal, subject categories and references. These data of the 1789 publications stored in Web of Science were exported to Excel. Both Excel and IBM SPSS Statistics 23 were used to analyse the following topics: (1) publication output and growth trend, (2) authors and their cooperation, (3) journals publishing on safety culture, (4) geographical and institutional distribution and cooperation, (5) cited analysis, (6) citing and co-citation analysis, (7) subject categories, and (8) terms.

The freely available software program VOSviewer (www.vosviewer.com) (van Eck and Waltman, 2010) was used to analyse and visualise relationships between authors, countries, co-citations and terms. The VOS (Visualization Of Similarities) mapping method was used to calculate and locate each topic in a two-dimensional map in such a way that the distance between two items reflects the similarity or relatedness of the items as accurately as possible. The VOS clustering method was applied to cluster topics into different groups, where each cluster is marked with a different colour (van Eck et al., 2010; Waltman et al., 2010). The interpretation of the visualisations is explained in detail in the results section. In general, the interpretation is as follows: the size of the circles and the font of the label represents the number of occurrence, the colours represent clusters, and the distance between two circles reveals the relatedness and similarity between them (Rizzi et al., 2014; Khalil and Gotway Crawford, 2015). The x-axis and y-axis have no special meaning; the maps may be freely rotated and flipped (Khalil and Gotway Crawford, 2015).

3. Results and discussion

3.1. Publication output and growth trend

The number of peer-reviewed publications is an important indicator to measure the development trend of a scientific research discipline or subject. As displayed in Fig. 2, the number of safety culture publications increased since 1990. There were only eight publications on safety culture in 1991. Until 2005, the publications on the topic remained limited (less than fifty publications each year). From 2006, an increasing number of publications could be observed every year, with exceptions in 2008 and 2010, where a decline could be observed. A peak of publications is reached in 2013 (n = 225), after which a declining trend occurs (n = 191 in 2014 and n = 173 in 2015). The question remains if this declining trend will continue during the following years. A possible explanation for the decline in the number of publications is not straightforward. An explanation can be found in Price’s law which evaluates the overall growth of scientific publications in a specific research domain (Price, 1963). According to this law, the growth of a research domain goes through four phases: (1) a precursors’ phase, where a small body of scientists begins to publish on a new field, (2) the proper exponential growth, where an increasing number of scientists is attracted by the many aspects of the subject that still have to be explored, (3) a consolidation of the body of knowledge and (4) a decrease in the number of publications (Dabi et al., 2016). This last phase reflects the inflection point of maturity where the research domains is saturated, resulting in a significant reduction of publications (Dabi et al., 2016). It is however questionable that this maturity point has already been reached in the domain of safety culture research. After all, this domain is, up to now, characterised by a lack of consensus on the definition, content and consequences of the concept of safety culture.

Looking at the cumulative number of publications in Fig. 2, it can be stated that the importance of safety culture research has increased. It took approximately twenty years (from 1991 until 2011 inclusive) to reach a total of 1000 publications on the topic of safety culture. The following four years (from 2012 until 2015 inclusive), this number

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