

SAFETY CULTURE IN GLOBAL RESEARCH: A SYSTEMATIC LITERATURE REVIEW

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Purpose: The article presents the results of research related to the development of safety culture (SC) around the world. In particular, attention was focused on the search for trends that set the direction of SC development. Research gaps were identified as the basis for addressing new cognitive challenges, particularly in the area of SC modeling in manufacturing companies, to improve workplace health and worker productivity.

Design/methodology/approach: A systematic literature review (SLR) of a total of 22,199 scientific articles on SC culture available in three databases was adopted as the research method: Elsevier Science Direct, Springer Link, and Wiley Online Library, published between 2013 and 2023 based on defined keywords.

Originality/value: A new research task has been formulated, the implementation of which would be an important addition to the existing body of work on the formation of safe working conditions based on a human-centered approach.

Keywords: safety culture, Systematic Review, safety culture implementation, safety culture model.

Category of the paper: Literature review.

1. Introduction

The most compelling argument for developing a safety culture (SC) in companies is its impact on reducing accidents and disasters. Barry Turner's pioneering safety book, "Man-Made Disasters," described three disasters in the late 1970s and their causes. The purpose of the book was to present ways to formulate general rules and principles for the occurrence of disasters, derived from an analysis of available evidence from previous disasters and serious accidents (Turner, 1978). The term "safety culture" first appeared in 1987 in a report by the OECD Nuclear Agency (IAEA, 1991) on the 1986 Chernobyl disaster. Since then, a large community

of safety scientists has started to frequently use the word (Reason, 1998; Borys et al., 2009; Waterson, 2017; Nunen et al., 2018).

The progressive humanization of work, which became especially apparent after World War II, has been a major factor in the significant rise in interest in "safety culture" around the world. This interest is linked to company management's conscious focus on managing employee safety and maintaining employee health (Cooper, 2000; Cox et al., 2000), as well as managing the company through the lens of risk and safety (Ramos et al., 2020; Dahler-Larsena et al., 2020). We have created a statistical compilation that reflects the true level of interest in safety culture among scientists because safety culture is developing as a research topic among scientists around the world and is currently enjoying a great deal of interest and a multitude of scientific reports. Based on the results obtained (Figure 1), it can be said with certainty that interest in safety culture is growing significantly from year to year. The trend line of the graph is a linear function and explains 97% of the data ($R^2 = 0.9726$), which indicates a very good fit of the values and regularity of the trend. This carries a high probability that companies will develop increasingly effective occupational health and safety management systems, improving the safety of their employees (Reason, 2016; Li et al., 2018; Kim et al., 2019).

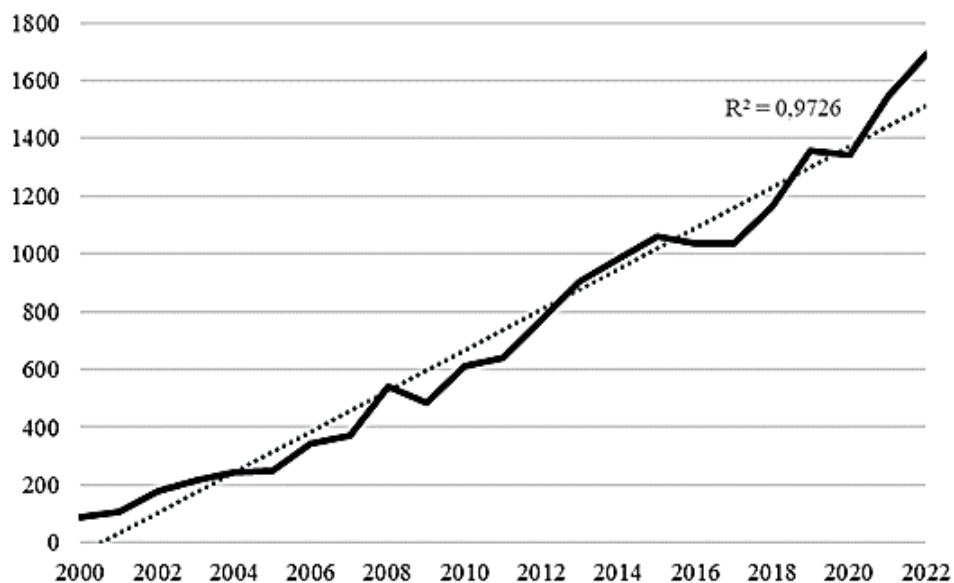


Figure 1. Number of papers on "safety culture" in particular years.

Source: own study based on Elsevier (Science Direct).

Overall, the findings suggest that there have been numerous studies on safety culture conducted in the 21st century, and that number is increasing rapidly. The safety culture construct has received a number of criticisms from researchers in the interim. For instance, Antonsen (2009) used qualitative and quantitative comparisons to compare the degree of safety culture in one organization. Based on his research, he discovered that the results were inconsistent, which made him doubt the validity of measuring safety culture. In addition, Henriqson et al. (2014) thought that the proliferation of safety-related systems and standards in

businesses largely overshadows disagreements between employees and managers that have a direct bearing on safety.

Taking the above considerations as the background of the study, the goal was to diagnose the current directions of safety culture development and also identify research gaps in this area. Consequently, the result of this study is an attempt to formulate a new research task, whose implementation would significantly complement the current achievements in the formation of safe working conditions.

2. Material and method

A systematic literature review (SLR) was adopted as a research method. The procedure for SLR was mainly consistent with Mengist et al. (2020). Particularly, five main stages were implemented during the study: (s_i) definition of the research question that the study would answer; (s_ii) definition of clearly stated objectives; (s_iii) a searching strategy including all related papers that would meet the eligibility criteria; (s_iv) presentation and synthesis of the data; (s_v) formulation of the study findings.

The research question concerns the dominant examination streams of SC within the last 10 years, i.e., from 2013 to 2023 (s_i). Finding an answer to such a question would support obtaining the study objective, which is the recognition of the research gaps intended for future explorations aimed at consolidating SC into any occupational activities (s_ii).

The searching strategy (s_iii) includes sixteen keywords associated with SC: model, implementation, factors, measurements, education, training, work effectiveness, productivity, ergonomics; cognitive ergonomics; Occupational Health and Safety (OSH); green management; sustainability; artificial intelligence; work behavior; innovation. The keywords have been aggregated into the following homogenous groups of study problems:

- 1) SC in formal description with keywords: model, factors, measurement, implementation.
- 2) SC in education with keywords: education, training.
- 3) SC in working processes with keywords: work effectiveness, productivity, work behavior.
- 4) SC in safety and health with keywords: ergonomics, cognitive ergonomics, OSH.
- 5) SC in sustainability with keywords: sustainability, green management.
- 6) SC in innovations with keywords: innovation, artificial intelligence.

Table 1 contains boolean operators and various combinations of phrase searches in order to obtain as many appropriate papers to explore as possible. The obligation was to find a particular phrase within the title or abstract of a paper.

Table 1.*A way of defining keywords*

| Key words | Boolean operators and phrase search |
|-------------------------|---|
| SC+model | "safety culture model" |
| | "model of safety culture" |
| SC+implementation | "safety culture implementation" |
| | "implementation of safety culture " |
| SC+factors | "safety culture factors" |
| | "factors of safety culture" |
| SC+education | "safety culture" AND "education" |
| SC+trainings | "safety culture" AND "training" |
| SC+measurement | "safety culture measurement" |
| | "measurement of safety culture" |
| | "safety culture" AND "measurement" |
| SC+work effectiveness | "safety culture" and "work effectiveness" |
| | "safety culture" and "work efficiency" |
| SC+productivity | "safety culture" and "productivity" |
| SC+ergonomics | "safety culture" and "ergonomics" |
| SC+cognitive ergonomics | "safety culture" AND "cognitive ergonomics" |
| SC+OHS | "safety culture" AND "Occupational Health and Safety" |
| SC+green management | "safety culture" AND "green management" |
| | "safety culture" AND "green economy" |
| SC+Sustainability | "safety culture" AND "sustainability" |
| SC+AI | "safety culture" AND "artificial intelligence" |
| SC+work behaviour | "safety culture" AND "work behavior" |
| | "safety culture" AND "work behaviour" |
| SC+innovations | "safety culture" AND "innovations" |

Source: own study.

Three online library databases from Elsevier—Science Direct, Wiley Online Library, and Springer Link (3LD)—have been incorporated into this study. The criteria for the inclusion of a particular paper in the analysis was the paper type, such as a research paper or review paper. At the same time, a simplification has been adopted by taking all records returned to the study without examining their possible repetition.

The descriptive statistics methods were used (s_{iv}) to summarize a set of papers and extract the conclusions or generalizations in accordance with the research questions and objectives (s_v).

3. Results and discussion

Based on the SLR methodology, a quantitative summary was compiled. Table 2 presents the safety culture dataset spanning from 2013 to 2023, available in 3LD. The dataset includes a number of papers that covered the research criteria for searching, safety culture, and all defined keywords.

Table 2.*Numbers of papers with the division on library databases*

| Key Words | Springer Link | Wiley Online Library | Elsevier - Science Direct |
|-------------------------|---------------|----------------------|---------------------------|
| SC+model | 33 | 24 | 173 |
| SC+implementation | 2 | 5 | 82 |
| SC+factors | 19 | 13 | 167 |
| SC+education | 0 | 759 | 2372 |
| SC+trainings | 11 | 1424 | 3190 |
| SC+measurement | 7 | 1805 | 4513 |
| SC+work effectiveness | 0 | 0 | 51 |
| SC+productivity | 0 | 105 | 1040 |
| SC+ergonomics | 1 | 55 | 616 |
| SC+cognitive ergonomics | 0 | 8 | 28 |
| SC+OHS | 0 | 138 | 644 |
| SC+green management | 0 | 0 | 10 |
| SC+Sustainability | 0 | 315 | 2404 |
| SC+AI | 0 | 83 | 279 |
| SC+work behaviour | 0 | 44 | 150 |
| SC+innovations | 0 | 244 | 1385 |
| Total | 73 | 5022 | 17104 |

Source: own study.

The findings indicate the high number of papers that take into consideration the studies on SC. Two library databases from Elsevier, Science Direct and Wiley Online Library, dominate with 17104 and 5022 papers reported, respectively. The Springer Link database reported only 73 papers in total. The above-mentioned dominance concerns all keywords apart from the combination of SC and model, where the Springer Link returned 33 records, which is higher than the Wiley Online Library. Elsevier Science Direct returned the highest number of studies on SC, regardless of a particular keyword. The following analyses included in this study concern the summative results of the 3LD.

However, there are some interesting conclusions regarding topics associated with SC that are presented in Figure 2.

The percent of papers available in Figure 2 demonstrates that the highest number of them were published on topics connected to training and education in SC: 28,49% and 20,83%, respectively. The rest of the results do not exceed 20%. In this group of papers, *measurement* in the context of SC was the subject matter of a relatively high number of reports.

Surprisingly, *ergonomics* and *cognitive ergonomics* are not at the forefront of SC studies, even if these are obviously related to SC.

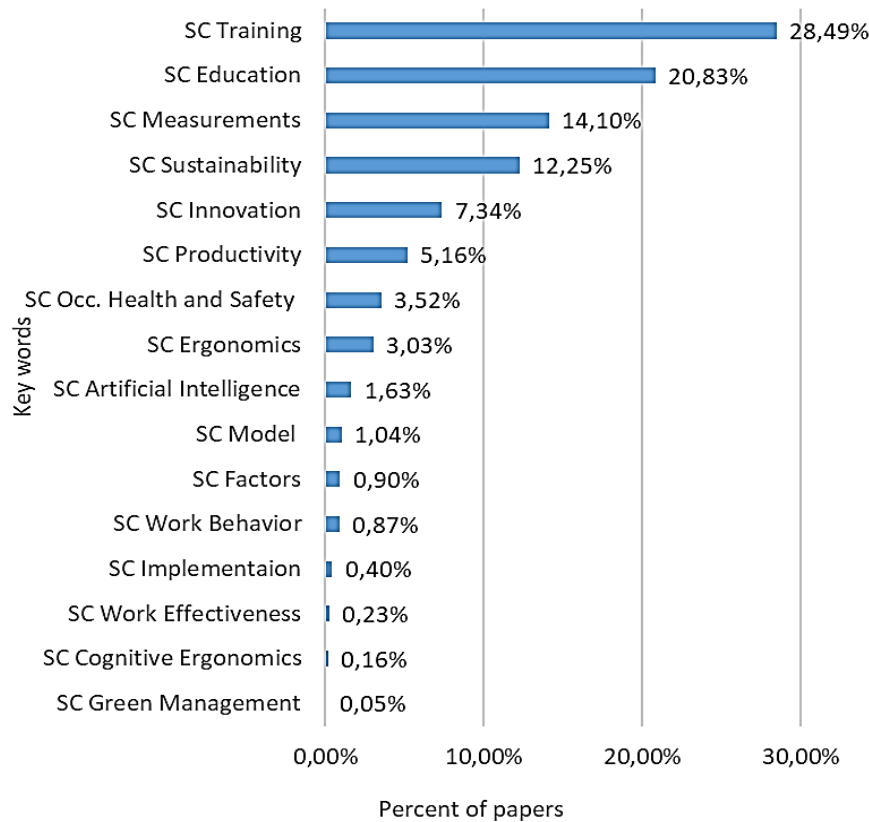


Figure 2. The percent of papers on SC taking into consideration keywords.

Source: own study.

Similarly, a topic not taken up widely was the *SC model* (only slightly more than 1% of the total dataset). This important result indicates a large research gap in the study of the relationships and interdependences between such important elements affecting the formation and maintenance of SC as methods, conditions and limitations, constraints, consequences for employees and the organization, etc. A lack of verified and validated SC models makes it difficult to find possible ways or simplified representations of conduct patterns for enterprises intending to implement SC successfully.

Moreover, *green management*, which is also a trendy and important aspect, was not focused on much, and the lowest number of articles were published in all 3LD.

Topics on global trends, including long-term ONZ policies related to *sustainable development*, proved more attractive. Sustainability is promoted by sustainable business that takes into account its impact on the worker and respects workers' rights, among other things. Therefore, the social cost of business activity, which is not considered in traditional business analysis, becomes an important element. On the other hand, conducting sustainable business is supported by adequate financing that has been provided by the European Commission.

After aggregating the keywords into the homogenous groups of study problems, the chart of it is available in Figure 3, several new findings to discussion can be added.

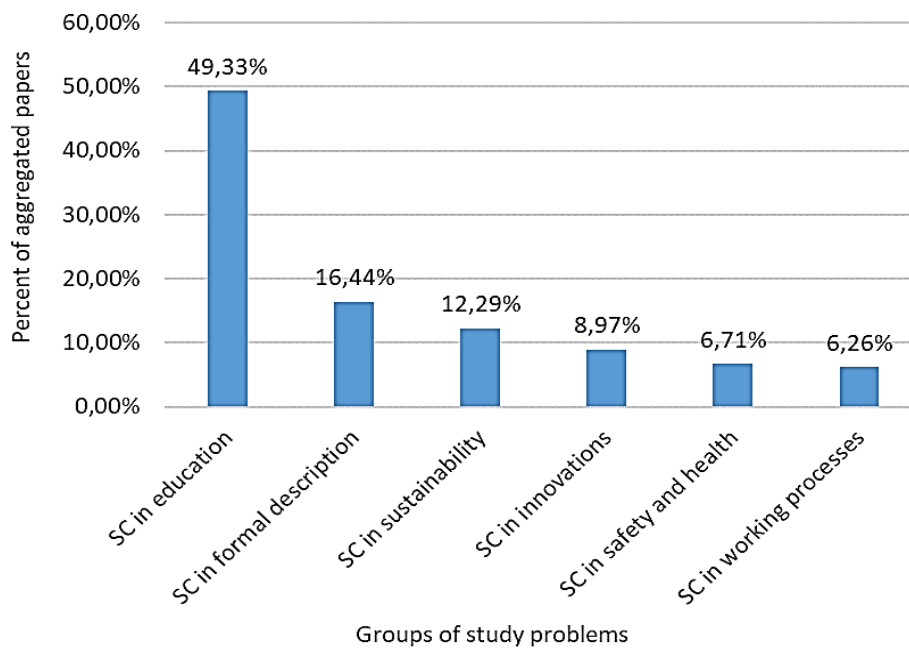


Figure 3. The percent of papers on SC taking into consideration the homogenous groups of study problems.

Source: own study.

Considering the homogenous groups, almost half of all studies touch on the educational aspects of SC.

In turn, the smallest set of papers was devoted to such problems as SC in working processes.

Taking into account these two homogenous groups, it is worth highlighting the high disproportion between the number of studies in both. When discussing the reasons, two interrelated aspects could be analyzed: (i) the nature of studies that are understood as theoretical or practical; and (ii) the location of studies that are understood as the incorporation of researchers into work activities inside an entity (the research subject) or without such incorporation.

It can be observed that the lack of skills in cooperation between the scientific sector and business influences both the nature and location of studies. The papers on SC in work processes contain the results of research conducted in enterprises. Unfortunately, conducting research in such an environment brings with it a number of inconveniences related to gaining permission from the enterprise to conduct certain research, devoting time by the enterprise's employees, and meeting the enterprise's requirements for researchers related to occupational health and safety. All this can discourage scientists from conducting research of a practical nature. The articles on SC in education are more theoretical in nature so they are easier and faster to produce and mainly deal with methods of conducting training and curricula.

In order for there to be a possibility of changing the proportion of articles and for the process related to the implementation of research results to proceed properly, both the scientists conducting the research and the companies that could translate the results into success should actively participate in it. Researchers should not just stop at theoretical research but also take on the challenges of furthering their achievements on the road to the success of the enterprise, especially related to improving safety in the enterprise and minimizing accidents at work (Furman, Małysa, 2023; Nedeliaková et al., 2022, Bartnicka et al., 2020). Therefore, in order for there to be an opportunity to implement the results of the researchers' research, their knowledge of work processes in enterprises is essential (Anvari et al., 2011; Cordeiro et al., 2020).

It is worth mentioning that the second group of interest to researchers was *SC in the formal description*. However, the study efforts are mostly directed at particular problems, especially those connected to measurements of SC. Therefore, they are focused on the evaluation of SC effects rather than on a formal holistic view of SC-based emergence and management issues.

In Figure 4, the chart compares the datasets among Elsevier—Science Direct, Wiley Online Library, and Springer Link from 2013 to 2023 for different safety culture keywords. These include the safety culture model, safety culture implementation, safety culture factors, safety culture measurements, safety culture and education, safety culture and training, safety culture's impact on work effectiveness, safety culture and productivity, safety culture and ergonomics, safety culture and cognitive ergonomics, safety culture and occupational health and safety, safety culture and green management, safety culture sustainability, safety culture and artificial intelligence, safety culture and work behavior, and safety culture and innovation. Based on the chart, Elsevier has published 173, 82, 167, 2372, 3190, 4513, 51, 1040, 616, 28, 644, 10, 2404, 279, 150, and 1385, respectively, on the above-mentioned parameters, whereas Springer has published 33, 2, 19, 0, 11, 7, 0, 0, 0, 0, 0, 0, 0, 0, and 0 articles on these respective keywords, while Wiley Online Library has only published 24, 5, 13, 759, 1424, 1805, 0, 105, 55, 8, 138, 0, 315, 83, 44, and 244 articles. The percentage breakdown of published data in Elsevier is 1%, 0.5%, 1%, 13.9%, 18.6%, 26.4%, 0.3%, 6.1%, 3.6%, 0.2%, 3.8%, 0.1%, 14%, 1.6%, 0.9%, and 8.1%, respectively, whereas the percentage of published articles in the Springer database is 45.2%, 2.7%, 26%, 0%, 15.1%, 9.6%, 0%, 0%, 1.4%, 0%, 0%, 0%, 0%, 0%, 0%, 0%, 0%, 0%, 0%, 0%, 0%, and 0%, while the percentage in the Wiley Online Library database is 0.5%, 0.1%, 0.3%, 28.4%, 36%, 0%, 0%, 0%, 2.1%, 1.1%, 0.2%, 2.7%, 0%, 0%, 0%, 0%, 0%, 0%, 0%, 0%, 0%, 0%, 0%. Based on the findings, it can be concluded that Springer has published the most articles related to the safety culture model. On the other hand, Elsevier and Wiley Online Library have published the highest number of articles on safety culture training. Comparing the publications of Elsevier, Springer, and Wiley Online Library, it appears that Elsevier has published the fewest articles on Safety Culture and Green Management, while Springer has not published any or has the lowest number of articles on several topics such as Safety Culture Measurement, Safety Culture and Work Effectiveness, Safety Culture and

Productivity, Safety Culture and Cognitive Ergonomics, Safety Culture and Occupational Health and Safety, Safety Culture and Green Management, Safety Culture and Sustainability, Safety Culture and Artificial Intelligence, Safety Culture and Work Behavior, and Innovation. Similarly, Wiley Online Library has not published any or has the lowest number of articles on safety culture and work effectiveness, as well as safety culture and green management, over the past few decades.

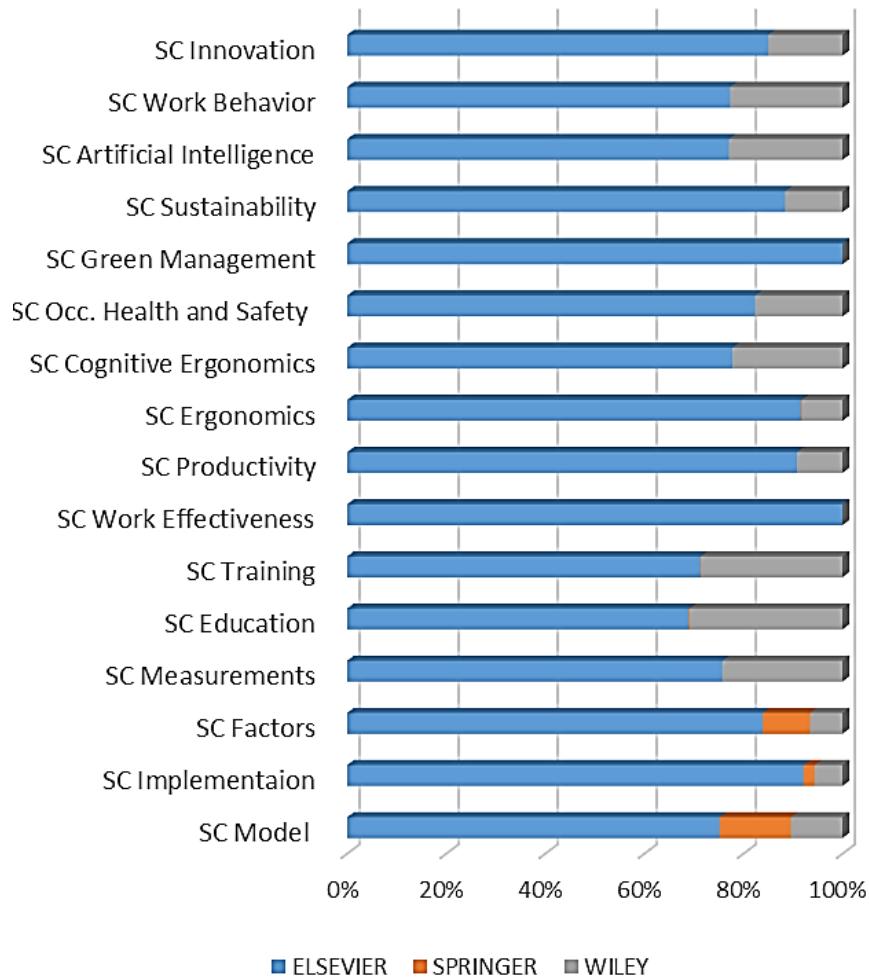


Figure 4. Comparative Analysis of SC among three databases i.e. Elsevier, Springer, and Wiley Online Library.

Source: own study.

4. Summary and conclusion

A systematic literature review was used to find the dominant examination streams of SC within the last 10 years, i.e., from 2013 to 2023. Training and education were the vast majority of topics within the explored literature, almost half of them.

A clear difference in research was recognized between theoretical aspects (which were the vast majority of them) and practical ones, including those related to such important elements as ergonomics, human behavior at work, or working processes. Also, the important literature research outcome is that studies were focused rather on particular aspects of SC, like measurement, implementation, and factors, than on a holistic approach that, among other things, is the SC model.

Taking into account all the findings, it can be concluded that the study objective, which was the recognition of the research gaps, was achieved, and future explorations should be oriented toward developing a comprehensive SC model. Such a model should include both practical and theoretical aspects of SC and be flexible enough to be used in any occupational activity.

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