



CHARACTERIZATION OF INDICATORS FOR ASSESSING THE PERFORMANCE OF MANAGEMENT SYSTEMS

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SUMMARY: Ergonomics is related to protecting workers' health, involving the physical, cognitive and organizational domains, achieving a systemic approach to all aspects of human activity. In the same sense as the activities of the Occupational Health and Safety Management System (SGSST). These prevention activities need to be evaluated to verify their effectiveness and consequently establish reliable improvement strategies. Consequently, performance assessment is considered essential in the advancement of the system and its indicators must measure the particularities of risks in the context of the company, allowing action plans to be defined. Therefore, characterizing the type of evaluation and performance indicators was the objective of this article. In the research, ProKnow-C was used, carrying out a systemic analysis that identified and explored the characteristics of the methods applied. It was found that 11 articles used individual or isolated indicators to measure performance, 14 applied a set of indicators. The evaluation systems applied are considered generic, as they do not adjust to the particularities of the organization. A research gap was identified in relation to the indicators used to evaluate the SGSST. As they are generic, they may not offer accurate information on the SGSST situation, which can lead to errors in defining improvement strategies. Likewise, there is a lack of structures to define performance indicators adjusted to the characteristics of the organization. Furthermore, it is necessary to define monitoring procedures for the indicators, allowing to respond effectively to the control of occupational risks and contribute to the continuous improvement of the organization.

KEYWORDS: Ergonomics; Occupational Health and Safety Management System; Performance evaluation; Performance indicators; Proknow-C.

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INTRODUCTION

Ergonomics seeks to adapt work to human beings, covering not only activities carried out with machines and equipment used to transform materials. Furthermore, the entire relationship between the person and the productive activity. This involves, in addition to the physical environment, cognitive and organizational aspects. Therefore, to achieve the desired work results, both planning and design activities and control and evaluation activities must include ergonomics with its physical, cognitive and organizational domains in order to obtain a complete management system (Iida & Buarque, 2016).

Obtaining safe work areas and providing the physical, psychological and social health of their workers is a constant concern for organizations. To achieve these objectives, the Occupational Health and Safety Management System (SGSST) was developed. Between 1970 and 1980, three developments made the safety management system a topic of general interest: the increased demand for safety regulations in European countries; official reports on the consequences of major industrial catastrophes; and the introduction of international standards for quality management systems (Hale et al., 1997).

It should be noted that the management system is a set of interrelated elements that allows the establishment of policies and objectives to define actions. The Occupational Health and Safety Management System is considered a management system or part of a management system used to achieve occupational safety and health policy. Actions and results are aimed at preventing workers' health problems and injuries, providing healthy workplaces (ISO, 2018).

The SGSST seeks to identify and evaluate work risks and legal requirements according to the organization's economic activity. Furthermore, it defines the policy, organizational structure, responsibilities and functions to execute the planning of activities, processes, procedures, resources, etc. (ILO, 2001) same aspects that analyze the domains of ergonomics. Among the elements that make up prevention procedures, performance evaluation and monitoring are particularly important (Ai Lin Teo & Yean Yng Ling, 2006). The methods to evaluate them are generally oriented to verify the number of activities and the people participating, that is, the presence of the SGSST. However, it is necessary to analyze the degree of protection and well-being of workers in the workplace. Furthermore, identify the level of efficiency and effectiveness of the activities and strategies implemented (Ai Lin Teo & Yean Yng Ling, 2006). The current focus of the SGSST assessment aims to identify the presence of protective activities and the well-being of workers resulting from prevention activities. This approach makes it difficult to identify the efficiency and effectiveness of implemented strategies and to define prevention activities and processes (Neely et al., 1995). Precisely, performance evaluation is defined as the process of quantifying the efficiency and effectiveness of actions (Neely, 1999).

In occupational activities it is necessary to adopt an approach that involves physical and cognitive, organizational, environmental, social aspects, etc. (IEA, 2019; Iida & Buarque, 2016). Resulting in better adaptation to technological and work environments (Iida & Buarque, 2016).

Given the importance of evaluating SGSST performance, this article aims to analyze the characteristics of the type of evaluation used in scientific publications and the SGSST performance indicators used. For this, a basic and advanced bibliometric analysis was carried out. These analyzes allowed us to generate knowledge, identify gaps and opportunities for future research. When carrying out the research, the Knowledge Development Process-Constructivist (ProKnow-C) (Dutra et al., 2015; L Ensslin et al., 2017; S. R. Ensslin et al., 2014) was applied as a tool.

From the identification and analysis of the characteristics of the articles, in this fragment of literature, and the knowledge generated, guidelines for new research are identified, producing relevant information for the scientific community. It is considered original because an article

that analyzes the characteristics of the construction of the SGSST performance evaluation method was not found in this fragment of literature.

METHOD

An exploratory and descriptive bibliographical research was carried out to build the theoretical framework and expand the understanding of SGSST performance assessment. In this case, the intervention methodology adopted was the Knowledge Development Process - Constructivist (ProKnow-C), as an intervention instrument.

The research is based on a constructivist approach that develops: compilation, analysis and study of scientific knowledge, acquisition of main postulates and construction of the theoretical framework (Dutra et al., 2015; L Ensslin et al., 2017; S. R. Ensslin et al., 2014; Valmorbida et al., 2016).

ProKnow-C

This process is divided into steps that help build researchers' knowledge in the selection, organization and subsequent use, according to the interests established in the research (Dutra et al., 2015; L Ensslin et al., 2017). In this process, the researchers worked on defining the database selection criteria, keywords, time limits, especially the inclusion and exclusion criteria for articles to establish the Bibliographic Portfolio (BP) (De Oliveira Lacerda et al., 2014; L Ensslin et al., 2017).

The systematic search is structured in four stages, shown in Fig. 1: (i) bibliographic selection of the portfolio; (ii) bibliometric analyses; (iii) systemic analyses; and (iv) formulating questions, identifying gaps and research objectives (Cardoso et al., 2015; Dutra et al., 2015; L Ensslin et al., 2017; S. R. Ensslin et al., 2014; Valmorbida et al., 2016; Valmorbida & Ensslin, 2015).

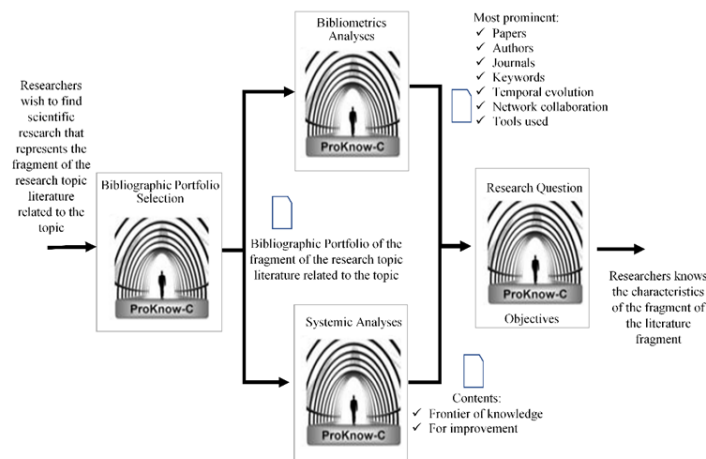


Figure 1. Steps of adapted ProKnow-C (L. Ensslin et al., 2012)

Phase 1 was applied, identifying, according to the researchers' perceptions, a limited set of relevant scientific articles that are aligned with the research topic; Phase 2, which offered the opportunity to identify the most relevant articles, authors, journals, and keywords in the selected bibliographic portfolio; and Phase 4, defining research gaps and objectives.

Procedures for selecting the Bibliographic Portfolio

The selection of the Bibliographic Portfolio involves: (i) definition of keywords; (ii) definition of databases; (iii) search for articles in selected databases based on defined keywords; and (iv) keyword adherence test (Dutra et al., 2015; L Ensslin et al., 2017; S. R. Ensslin et al., 2014; Valmorbida et al., 2016).

The definition of keywords is made based on the identification of the research axes, the first being Performance Assessment, the second Occupational Health and Safety Management Systems. Establishing as a search command ("performance measure*" OR "performance evaluation" OR "performance assessment*" OR "performance appraisal" OR "management" OR "indicator*") AND ("health and safety" OR "ergonomics" OR " safety incidents" OR "occupational safety" OR "workplace risk"). Using a combination of search expressions that included singular and plural options for keywords.

The definition of databases consists of identifying scientific bases whose contents are aligned with the research theme. The databases, chosen from the CAPES journal portal, were: Scopus; Web of Knowledge; Science Direct; Compendex; ProQuest; EBSCO Academic Search Premier.

For the research, the delimitations of the process were: (i) articles published in scientific journals; (ii) articles published from 2000 to 2021; (iii) search on keywords, title and abstract; and, (iv) articles in English and Portuguese.

Access to the databases was carried out through the Federal University of Santa Catarina (UFSC) network. EndNote® X9 software (Thomson Corporation, 2018) is used to manage the information collected in the databases used in the research process.

With these documents imported from the databases, initial filtering is done. First delete all documents that are not articles and duplicates. To complete the first step, the keyword adherence test was performed to validate the raw database of articles.

The next step is to select, by title, articles aligned with the theme. The summary was then analyzed. Finally, a complete review of the content of the articles is carried out. They are called initial Bibliographic Portfolio (BP) articles.

The final stage corresponds to the analysis of references from the initial PB articles, following the same delimitation criteria. Selecting a new group of articles aligned to the research topic. Figure 2 illustrates the sequence of the PB selection process and the Representativeness Test.

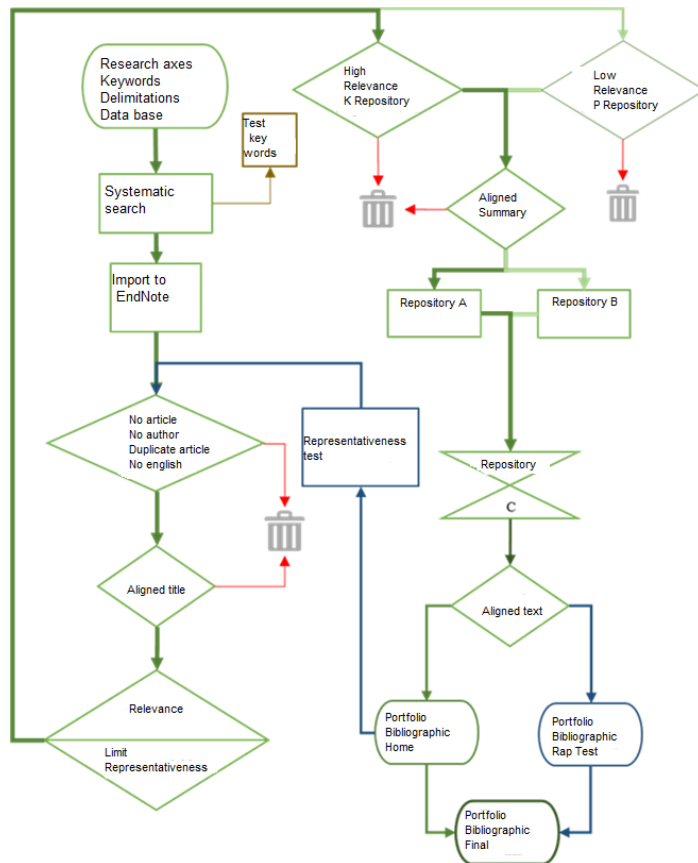


Figure 2. Composition of the bibliographic portfolio: BP filtering and Representativeness test

Thus, the stage of selecting the fragment of literature on performance evaluation of Occupational Health and Safety Management Systems was concluded, according to the perception, delimitations and emphasis of the researchers' interests. To finally carry out bibliometric and systemic analyzes of the selected articles.

RESULTS

Bibliometric Analysis: Basic Characteristics

The basic bibliometric analysis characterizes the following variables: (i) prominent authors; (ii) relevant articles; (iii) keywords that represent the subject or were the most used; (iv) prominent scientific journals; and (v) impact factor of scientific journals (De Oliveira Lacerda et al., 2014; L Ensslin et al., 2017); (vi) temporal evolution of publications; and (vii) tools used in empirical studies (Cardoso et al., 2015; Valmorbida & Ensslin, 2015).

The first variable, prominent authors, of the 54 articles selected to address the topic of SGSST evaluation, aims to identify researchers with an established career in the area. Figure 3 shows the authors of the PB and the representativeness test, taking into account the number of articles published. This information can contribute to obtaining a better understanding and updating knowledge. Likewise, it can be a guide in research lines.

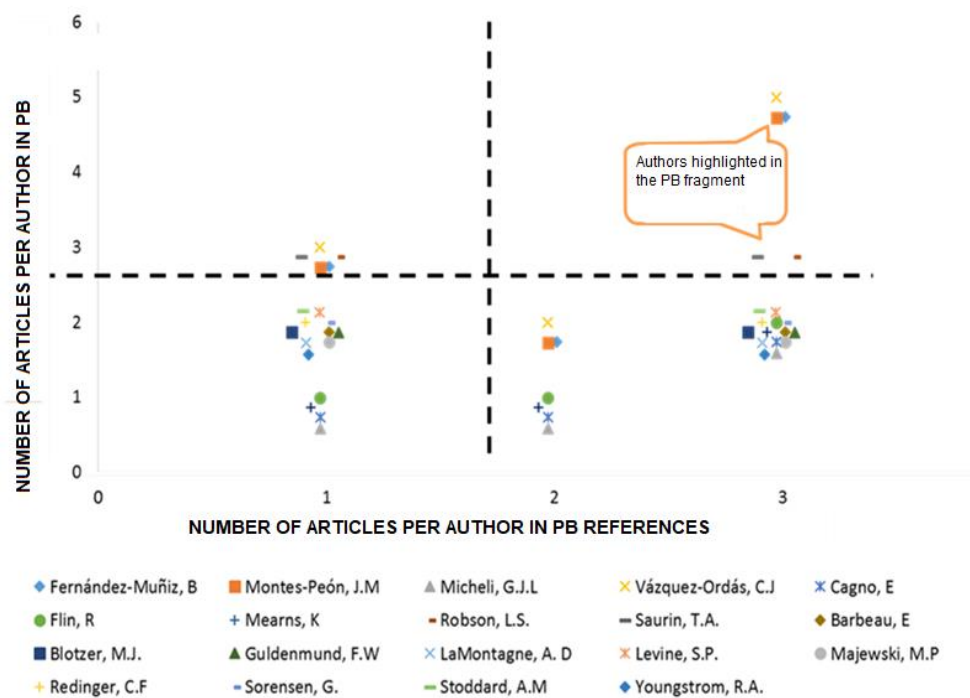


Figure 3. Prominent authors

The authors who led the articles with the highest number of citations were Lynda S. Robson, Tarcisio Abreu Saurin, the team of researchers Beatriz Fernández-Muñiz, José Manuel Montes-Peón and Camilo José Vázquez-Ordás. Lynda S. Robson has been a researcher at the Institute for Work & Health (IWH) since 1997. Her research projects are focused on two areas (i) advancing organizational change in OSH and evaluating prevention programs; and (ii) development of key SST audit data management indicators. In turn, Tarcisio Abreu Saurin has a postdoctoral degree at the University of Salford, in England, in 2012. His research focuses on safety and production management in complex systems; lean production systems and resilience engineering.

Beatriz Fernández-Muñiz has a PhD in Business Management from the University of Oviedo. His research activity focuses on the study of human resource management, corporate strategy, competitive advantage, organizational culture and safety management and culture. José Manuel Montes-Peón has a PhD in Business Economics from the University of Oviedo. His main interests include human resources management, strategy and organization, knowledge management and safety management and culture. Finally, Camilo José Vázquez-Ordás has a PhD in Economic and Business Accounting from the University of Oviedo. His research activity focuses on the study of business operations management, production strategy and safety management and culture.

Likewise, a graph was prepared that illustrates how many authors participated in each article in this fragment of literature, Fig. 4. When analyzing the number of authors, it was identified that articles written by 3 authors predominate, a total of 16, observing that the team of Fernández-Muñiz, Beatriz; Vázquez-Ordás, Camilo José and Montes-Peón, José Manuel, participated in 5 articles. Pairs of authors wrote 14 of the articles; and finally, teams of 4 authors write 9 different articles

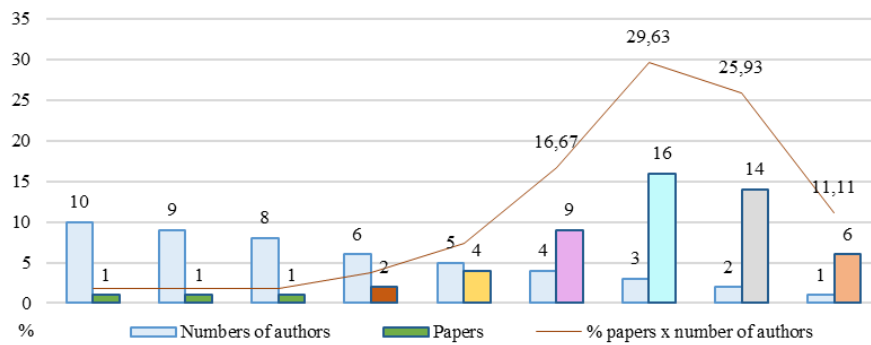


Figure 4. Number of authors in each article

The highlighted articles are now presented in this fraction of the literature. Figure 5 illustrates how many citations each selected article has. This information was consulted on Google Scholar in 2021. The three articles with the highest number of citations are those led by authors Bourne, Mike, Flin, R., and Guldenmund, F.W., published in 2000.

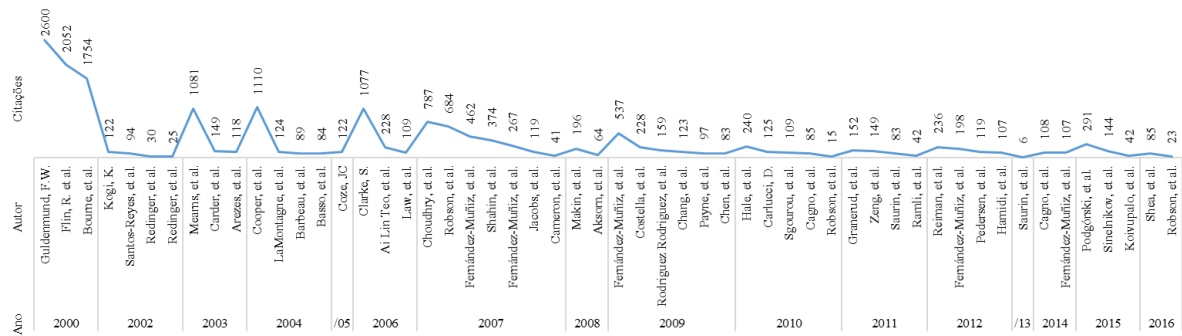


Figure 5. Featured articles

The first article is “The nature of safety culture: a review of theory and research”, written by Frank Guldenmund and published in *Safety Science* in February 2000. The article analyzes safety culture and the safety climate, discussing the content and consequences of these topics in the last two decades of the 20th century. The author indicates that the safety climate can be considered an indicator of safety performance (Guldenmund, 2000).

Secondly, the article "Measuring safety climate: identifying the common characteristics" is the result of research by the authors Flin, R.; Mearns, K.; O’ Connor, P. and Bryden, R. It is an article published in *Safety Science* in February 2000. The article deals with the measurement of safety climate and how it has given rise to a proliferation of assessment tools. The authors analyzed 18 scales used to assess the safety climate. They reviewed the categories covered by the questionnaires of these 18 scales (Flin et al., 2000).

Finally, "Designing, implementing and updating performance measurement systems", written by Mike Bourne, John Mills, Mark Wilcox, Andy Neely, and Ken Platts, published in the *International Journal of Operations & Production Management*, in July 2000. The article addresses the problems when designing, implementing, using and continually updating performance measurement systems in manufacturing companies. The authors developed, based on theoretical research, a framework to analyze the implementation of a performance measurement system. The article concludes that specific procedures are necessary to continually align the performance measurement system with the company's strategy. The authors indicate that when these processes are combined with a well-defined model of strategic

success, the measurement system can improve case management by challenging assumptions and the strategy itself (Bourne et al., 2000).

Next, keywords that best represent the subject or that most authors used were analyzed. Figure 6 shows the keywords used two or more times in the group of selected articles. The most used keywords were Occupational health and safety, and Safety climate, present in 7 articles. Next, we identified Safety management system and Health & Safety management, used in 6 articles. In addition to the keywords: Accident(s), Safety culture and Structural equation modeling, present in 5 articles. Another 189 keywords, different and not repeated, were used by the authors to identify the research topic.

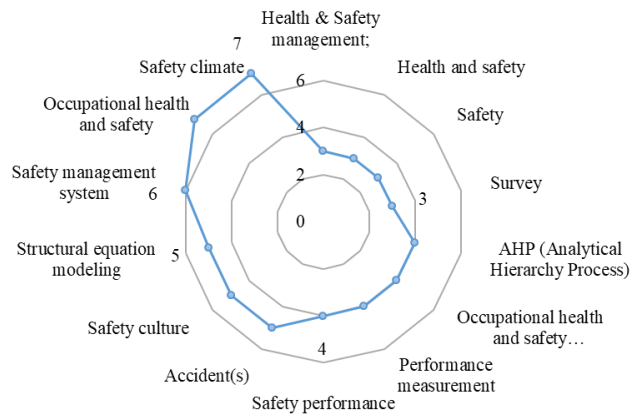


Figure 6. Keywords

Then, prominent scientific journals and their impact factor were analyzed. It was possible to identify that the journals Safety Science, Journal of Loss Prevention in the Process Industries, and Journal of Safety Research had the largest number of publications, Fig. 7. Another 14 journals participated with an article, among those selected in this fragment of literature scientific, which addresses the topic of Performance Assessment of the Occupational Health and Safety Management System, with the delimitations established by the researchers.

The most prominent magazine was Safety Science, a multidisciplinary magazine created in 1989. It publishes topics ranging from human safety at work to various areas such as transport, energy or infrastructure, as well as fields of human activities considered dangerous or high risk. This magazine allows academic researchers, engineers and decision makers in companies, government agencies and international organizations to increase their level of information about the latest trends in the field.

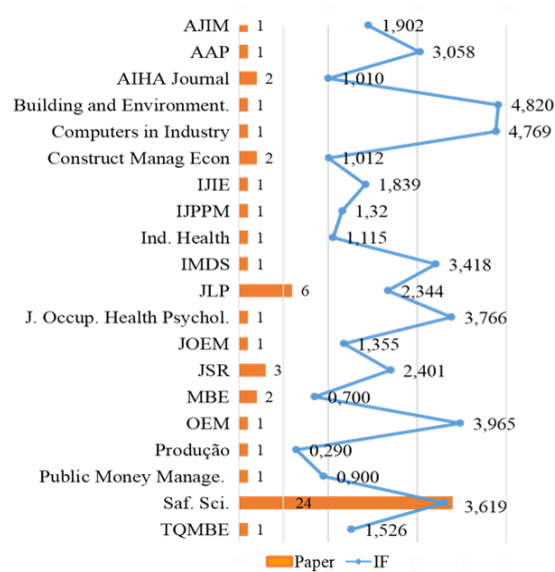


Figure 7. Prominent journals and impact factor

In turn, the Journal of Loss Prevention in the Process Industries (JLP) with an impact factor of 2.344. Publishes articles in the areas of process and plant design, plant layout, risk assessment, accidents and losses, factory inspection, plant operation, process control and monitoring, protection systems design, equipment design and reliability, utilization of computer systems in loss prevention, accident analysis, emergency planning, transport and offshore, risk assessment, aspects of management and operational training, as well as risk assessment in work activities.

On the other hand, the following basic characteristic analyzed was the temporal evolution of publications on Performance Assessment of the Occupational Health and Safety Management System. It was possible to identify that in 2006 and 2010 the largest number of works were written, seven, compared to other years, from the segment selected in this research.

In 2007, a management safety performance measurement was developed. The authors proposed to validly and reliably measure the safety performance of construction managers. Likewise, the article sought to motivate managers to improve their safety performance (Cameron & Duff, 2007).

Shahin and Mahbod conduct research using the Analytical Hierarchy Process (AHP) technique as a basis for comparisons of SMART (specific, measurable, attainable, realistic, time-sensitive) criteria, considering each organizational performance indicator (KPIs) in terms of SMART (Shahin & Mahbod, 2007).

Furthermore, researchers used the structural equation statistical technique with which they analyzed the most important works on security management. They developed a measurement scale operationalizing the concept of a safety management system. Using the scale, they calculated the reliability and validity of the system (Fernández-Muñiz et al., 2007b).

In the same year, Robson led a team that carried out a systematic search across eight databases to describe the effectiveness of the SGSST. The analysis presents the characteristics, but concluded that the evidence was scarce to make recommendations for or against SGSST due to the heterogeneity of the articles analyzed (Robson et al., 2007).

Additionally, Choudhry, Wu, Chuang, and Ma conducted a safety culture review. They made special emphasis on a 1998 survey and presented some clarifications in terms of positive safety culture and safety culture models. Aggregation levels and safety performance were provided after presenting appropriate empirical evidence and theoretical developments (Choudhry et al., 2007).

In 2010, theoretical research was published whose objective was to examine the content validity of management audit methods in occupational health and safety (OSH) (Robson et al., 2010). Furthermore, Cagno, Micheli and Perotti also carried out theoretical research to identify which are the most impactful factors when the company wants to improve the SGSST. In the article they analyzed the interaction of key SGSST factors. They identified the training factor interacting with 'correct operational procedures' and 'use and status of PPE' as interesting aspects. The magnitude of working time and the frequency of use and status of PPE were evaluated as factors in which it is easier to intervene in the context of small and medium-sized companies (Cagno et al., 2011).

And, Carlucci proposes a model, based on the Analytic Network Process (ANP) to guide managers in the selection of organizational performance indicators (KIPs). The use of ANP makes it possible to extract weights to establish priorities between indicators, taking into account the mutual dependencies between indicators and criteria (Carlucci, 2010).

Ramli, Watada and Pedrycz develop an Intelligent Data Analysis (IDA) with possibilistic regression. They present an approach to support the analysis of key factors that influence SGSST (Ramli et al., 2011). In turn, Saurin and Carim Junior evaluate and make a proposal to improve a method for evaluating health and safety management systems using Resilience Engineering (RE) (Saurin & Carim Júnior, 2011). In the same year, Granerud and Roch presented a model with which it is possible to identify and analyze improvement processes in the management system. They presented the results of the application in five case studies (Granerud & Rocha, 2011). Finally, Zeng, Xie, Tam and Shen perform an analysis of the management system of offshore facilities to identify best practices in safety management (Zeng et al., 2011).

The last basic characteristic of the analysis corresponds to the tools used in the articles selected in the bibliographic portfolio. First, the type of article is classified: (i) theoretical, (ii) case study or (iii) survey. The total number of articles in each type is presented in Fig. 8, 8 articles present the results of case studies, 20 articles carry out theoretical analysis to present the findings and 26 were survey type (data collection with workers from one or several companies).

Finally, with survey articles, the tool used to analyze the collected data was identified. Figure 9 shows the list of tools used. The Analytic Hierarchy Process (AHP) was used in 5 studies (Ai Lin Teo & Yean Yng Ling, 2006; Chang & Liang, 2009; Law et al., 2006; Podgórski, 2015; Shahin & Mahbod, 2007). And the Structural equation modeling used in 4 (Fernández-Muñoz et al., 2007b, 2007a, 2014; Zeng et al., 2011). Being the most used tools.

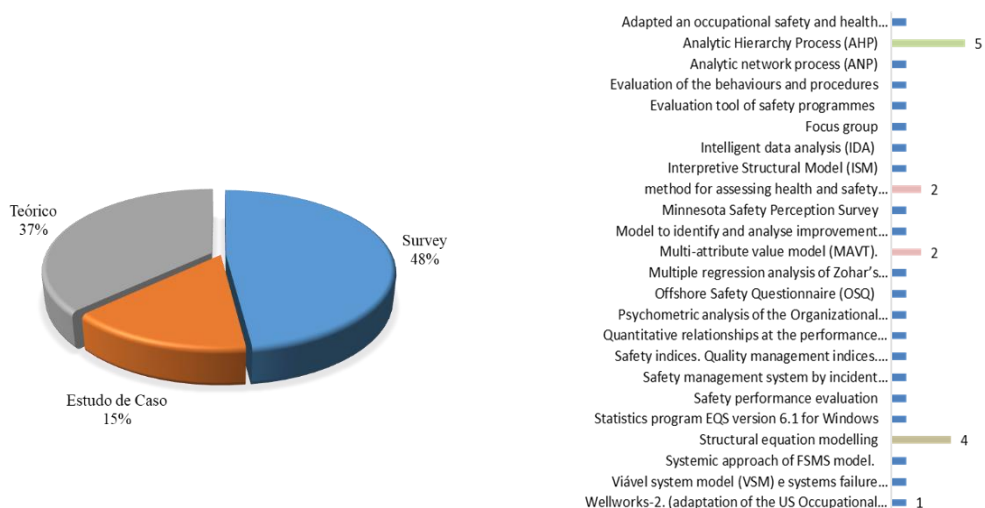


Figure 8. Search type

Figure 9. Tool used

Bibliometric analyses: advanced features

The advanced analyzes applied with the ProKnow-C tool were structured according to the concepts defined by Neely et al., (1995): (i) system analysis or performance assessment tool developed/applied; (ii) alignment of indicators or objectives with the company’s strategy; (iii) use of a tool or system; and (iv) interactions of the assessment performance system with the environment. Likewise, the characteristics of the life cycle or phases of performance assessment systems are analyzed (v) type of design; (vi) implementation characteristics; and (vii) use or review of the system. The latter are based on information presented by authors Bourne et al., (2000) and Nudurupati et al., (2011).

When analyzing the 28 articles that use systems or tools in the development of research, the first advanced characteristic, presented in Fig. 10. It was identified that 11 use individual measures to measure performance. In 14 articles the authors applied a set of measures, the other articles did not apply measures in their analyses.

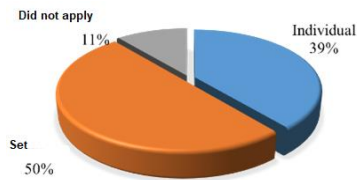


Figure 10. Assessment system or tool

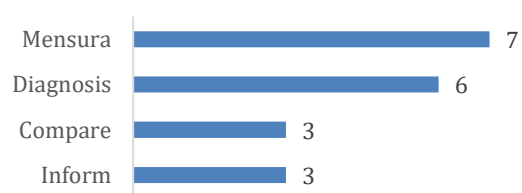


Figure 11. Use of tool or system

The second characteristic, alignment of indicators and/or objectives, identified that in seven cases the indicators make the relationship between the performance evaluation system and the environment. Furthermore, 16 surveys show that there is an alignment of indicators with the company's strategy or goals. In the other articles, no evidence was found to classify the indicators.

Regarding the use of the tool or system, third advanced analysis, Fig. 11, it was possible to identify how the indicators are used. Checking how many articles: measure performance; presents a performance diagnosis; compare with other performance; or provides information to management. In most articles, performance measurements were carried out. In six cases, the authors presented a diagnosis of the assessments made, 3 articles compared the results between several companies and another 3 provided information for the management of the SGSST.

Regarding the type of interaction between the performance evaluation system and the environment, the fourth advanced characteristic. It was found that the indicators analyzed the internal environment in 10 articles. In other surveys, both the internal and external environment are measured, in 18 of them.

Regarding the type of project, it was identified when the research used: (i) 5 used an existing system, created by other authors and not modified; (ii) 13 studies used indicators adapted from another system or tool; or (iii) the authors built a new system or tool in 7 searches.

While, to the research that implemented the system, characterizing the type of data collection used, Fig.12. It was identified in how many cases the research used interviews, observations, questions, focus groups, document review or audit in the collection process.

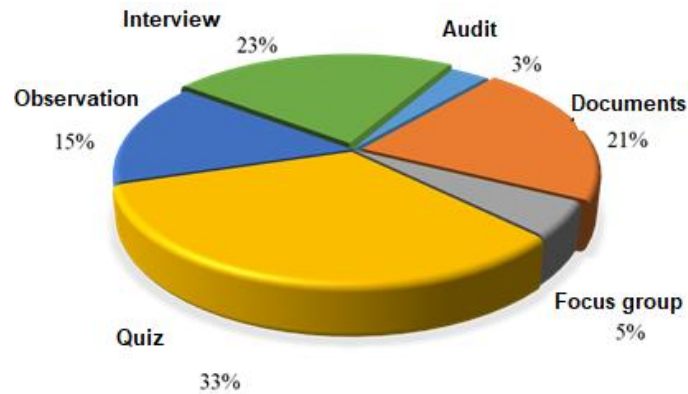


Figure 12. Type of data collection used

In some cases, the collection was carried out with various types of data collection, such as “Measuring effectiveness of safety programs in the Thai construction industry”. In it, the authors used interviews and observations (Aksorn & Hadikusumo, 2008). In the case of the article “Evaluating and selecting key performance indicators: an ANP based model”, the author used interviews, focus groups and document reviews (Carlucci, 2010). To analyze the theme of the article “Developing a model to measure the effectiveness of safety management systems of construction sites”, the authors used interviews and audit reports (Ai Lin Teo & Yean Yng Ling, 2006). And in the research carried out for the article “Exploratory analysis of the safety climate and safety behavior relationships”, the authors used questions and observations (Cooper & Phillips, 2004).

While using the system review, 13 studies were identified that presented a diagnosis, 12 analyzed performance, and 9 communicated the results obtained with the system or tool applied in the study.

DISCUSSION

Bibliometric analysis, applying ProKnow-C, allowed the generation of knowledge to identify gaps and opportunities for future contributions. Likewise, it shows its constructivist dynamics to identify "where" and "how" to intervene scientifically. The definition of the characteristics studied allows a complete analysis of the information covered in the scientific literature. In other words, how the themes were approached, to validate new choices or support its application in a new article.

It also makes it possible to identify advances in SGSST performance assessment and the perspectives addressed by researchers. As well as what has been done so far, the gaps and alignments to continue improving this subject. In fact, with bibliometric analysis it was possible to identify the characteristics of the publications. This analysis focuses on the qualitative evidence of the information in the articles.

Some aspects, such as who are the prominent authors, identified the level of impact of the research; which journals published the research indicates their level of scientific relevance. In turn, advanced analysis made it possible to understand the alignment of worker health and safety from the point of view of the tool used to carry out the analysis and evaluation of the system's performance. Likewise, the alignment of the indicators used and the characteristics of the life cycle or phases of performance management systems.

The indicators proposed in the articles analyzed require additional studies and validation for use in various industry sectors. The indicators used were generic, taken from scientific literature without adjusting the characteristics of the organization in which they were applied. It is

considered necessary to establish structures to define performance indicators adjusted to the characteristics of the organization that will be evaluated. Furthermore, it is necessary to define monitoring procedures for indicators as part of the SGSST so that managers respond more effectively to operational irregularities.

To solve problems related to health, safety, comfort and efficiency, it is necessary to use the fields of ergonomics. The ergonomic approach is based on systems theory, analyzing the relationship between the worker and his tasks. Thus, risks can be controlled or reduced, considering human capabilities and limitations during project work and its environment. This approach can also help prevent errors and improve employee performance. It brings numerous benefits, both from a financial point of view for cost reduction and increased productivity, from a motivational point of view.

CONCLUSION

The research used ProKnow-C to perform systemic analyzes to identify and explore the characteristics of the methods applied in the selected articles. Allowing to characterize the type of evaluation and performance indicators of the SGSST.

The various advanced analyzes applied allowed us to understand the characteristics of the models applied by the authors of the articles analyzed. This information allows you to delve deeper into the details of the type of analysis applied during the collection process, as well as in the analysis. Providing tools for researchers to use in new research in this area.

Regarding the indicators used to evaluate the SGSST, a research gap was identified. They are generic and may not offer accurate information on the SGSST situation in the organization evaluated, this can lead to errors in defining continuous improvement strategies. Likewise, there is a lack of structures to define performance indicators adjusted to the characteristics of the organization.

It is considered necessary to develop research to define monitoring procedures for indicators, allowing an effective response to the control of occupational risks, taking into account aspects of physical, cognitive and organizational ergonomics to contribute to the continuous improvement of the organization. Research that allows the definition of systematic evaluation methods that measure and establish classification scales to eliminate subjectivity in the results. In addition to establishing objective criteria or standards to evaluate performance.

This study was delimited by searching for articles on the CAPES journal portal. The selection of works depends not only on the professional knowledge of each researcher, but also on some personal judgments, therefore, subjectivity is unavoidable in this process. Other criteria in the selection of articles can be studied in future research.

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