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Where is occupational health and safety management research in small and medium-sized enterprises headed? A thematic evolution and bibliometric analysis

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ABSTRACT

Without a doubt, small and medium-sized enterprises (SMEs) are one of the European economy's great strengths as they employ over half of the total workforce. As a result, the current EU-OSHA strategy for 2022–2027 emphasizes the need to pay special attention to the specific problems of SMEs in order to improve health and safety management in these organizations. The objective of this study is to analyze the existing research gaps and from this point to trace future research lines in terms of the thematic evolution in the field of research on health and safety management specifically in SMEs through an exhaustive bibliometric analysis, in terms of both structure and concept. We used the Science Mapping Analysis Software Tool (SciMAT) program, an open-source software tool that builds scientific maps in a longitudinal framework, to identify the main topics covered within this thematic area over time. This bibliometric analysis concludes that it is essential to broaden knowledge about conceptual models for workplace risk analysis and assessment in order to boost occupational health and safety management performance with a special interest among SMEs. The emphasis is on integrating the *Resilience Engineering* paradigm and the emerging Safety II approach to address these challenges effectively.

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1. Introduction

Occupational health and safety (known by its acronym as OHS), which refers to a series of measures aimed at reducing the possibility of workers suffering from harm or injury while at work, has a significant impact on the daily operations of companies and the well-being of their workers (Walters & Wadsworth, 2016). Taking this one step further, the concept of occupational health and safety management can be defined as a combination of management planning and review, consulting and other specific elements that are part of a company's organization program. All of these elements must be integrated in order to work together, establishing OHS policies and objectives while also improving performance (Li & Guldenmund, 2018; Mohammadfam et al., 2016).

The literature shows that small and medium-sized enterprises (known by its acronym as SMEs) face more problems than other companies in this area due to their limited resources and lack of knowledge about the risk management process (Boustras & Guldenmund, 2017; Rodrigues et al., 2020). Consequently, the EU-OSHA Strategy for 2022–2027 emphasizes the need to pay special attention to the specific problems of SMEs to improve health and safety management in these companies (European Agency for Safety and Health at Work (EU-OSHA), 2022).

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SME management should therefore include the design of an OHS strategy as human capital is one of the greatest assets a company can have and must be taken care of and protected accordingly in order to ensure the company's proper operations. Consequently, it is important for SMEs to see that actions aimed at ensuring this goal will increase and maintain productivity, improve their image with suppliers, customers and their own staff, as well as other additional benefits (Makin & Winder, 2008).

According to the European Union Commission's definition (2003), small and medium-sized enterprises are companies with fewer than 250 employees, which encompasses micro, small and medium-sized companies. According to statistical data from the European Agency for Safety and Health at Work (EU-OSHA) (Elsler, 2009), SMEs are unquestionably one of the biggest strengths of the European economy, providing employment for over half of the total workforce in addition to key resources for innovation and growth (Eurostat, 2018).

However, these SMEs also account for approximately 82% of all work-related injuries and up to 90% of fatal accidents (European Agency for Safety and Health at Work (EU-OSHA), 2024). Consequently, the primary objective of the European Union's safety policy is to improve the implementation of OHS management systems in order to better control the risks of accidents, especially for SMEs (Wadsworth & Walters, 2018). It is also sparking increased interest in the scientific community and among the public authorities in charge of formulating policies to address OHS in SMEs (da Silva & Amaral, 2019; Legg et al., 2015; Masi & Cagno, 2015).

Nevertheless and despite the unquestionable importance of this issue, SMEs tend towards the perception that investment in safety is not very profitable (Bonafede et al., 2016), which is usually due to the difficulties these companies have in effectively managing OHS due to the limited resources available to them (Bianchini et al., 2017). This makes it important for OHS management to not be merely considered as an obligation or an expense that increases business costs.

1.1. Background on occupational health and safety management research in small and medium-sized enterprises

Despite the importance of this theme in terms of OHS management, the information found in the literature is dispersed and often not expressly addressed to SMEs and their thematic evolution in the scientific literature. Following are some of the most important bibliographic review studies from the last two decades.

Champoux and Brun (2003) provide an overview of OHS practices in small businesses in addition to avenues for intervention and research in small businesses. They also argue that OHS in small businesses has received very little attention, both in terms of research and support for prevention initiatives. Furthermore, Champoux and Brun (2003) state that up until their publication, researchers had paid very little attention to work organization and OHS practices in small businesses.

Cagno et al. (2011) conducted a comprehensive literature review to identify the factors that impact OHS performance in 396 SMEs. This study provided some evidence of low risk perception in SMEs, the difficulties faced by SME managers who are owners and workers at the same time, and the difficulty of ensuring that institutions' prevention efforts reach all SMEs. This evidence allows entrepreneurs and managers to plan effective interventions to improve OHS performance.

In another line of research, Cagno et al. (2013) carried out a systematic review on scientific work modeling approaches, practical tools and work methods used to make economic assessments of OHS management systems, with a clear emphasis on SMEs.

Walters and Wadsworth (2016) offer a critical overview of OHS focusing on micro and small businesses in the EU. This systematic review provides evidence that indicates a higher risk of serious and fatal injuries in micro and small businesses than in larger organizations and discusses the main reasons, including the limited resources of micro and small businesses and their position in the economy. This report also highlights that effective health and safety management in these companies is crucial for the employees' well-being and the company's survival.

Work with great impact on research is that of Li and Hale (2016). This study conducted an analysis of the distribution of thematic maps in safety-related journals using the VOSviewer bibliographic mapping software. The topics evidenced by this study are focused on major hazard, transportation, work safety and traffic safety always in large companies, but leaving SMEs out of its consideration of OHS management.

Boustras and Guldenmund (2017) conducted a noteworthy study in which they compiled the information existing up until that point on safety management in SMEs. This study has become a reference for designing and adopting appropriate safety strategies for SMEs, exhaustively reviewing methodologies for the assessment of qualitative, quantitative and semi-quantitative risks that are applicable to SMEs.

Tremblay and Badri (2018a) subsequently conducted a thorough analysis of the literature, providing a summary of the tools currently employed to measure OHS (Occupational Health and Safety) performance and assessing their relevance for use within SMEs (Small and Medium-sized Enterprises). Their research recommends the creation of simple tools designed to function as performance indicators for OHS professionals operating in SME settings, with the goal of significantly enhancing workplace accident prevention. The six tools identified are: Corporate Health and Safety Performance Index; OHS Self-diagnostic Tool; Project Safety Index; Organizational Performance Metric; Total Safety Performance; and Fuzzy Comprehensive Performance Evaluation of Health, Safety, and Environment (HSE).

Next, Barbosa et al. (2019) conducted a bibliographic review of different OHS studies published in scientific journals between 2008 and 2018, to identify OHS performance indicators for OHS in the context of SMEs. This study identified 14 OHS management indicators applied to SMEs and discussed their applicability for evaluating OHS performance and reliability.

Salguero-Caparrós et al. (2020) carried out a systematic review of studies that explored the connection between OHS management and compliance with legislation, regulations and standards. Their findings revealed that ensuring legal compliance, particularly in SMEs, has increasingly become a challenging endeavor.

A notable systematic review conducted by Provan et al. (2020) offers the first practical explanation of the duties and responsibilities of safety professionals from the theoretical frameworks of Resilience Engineering and Safety II. The literature outlines two distinct approaches to managing safety that can be employed to meet safety objectives: a centralized control model and a guided adaptability model. Hollnagel referred to the first as Safety I (Hollnagel et al., 2015), where the aim is to exert control over the organization and its personnel through centralized decision-making. The second approach, known as Safety II (Hollnagel, 2018), focuses on enabling the organization and its employees to adapt safely to evolving circumstances and challenges. This review highlights the evolving role of safety professionals as they work to support the implementation of the Safety II approach.

Concluding with this background on occupational health and safety management among SMEs, it is worth noting, as recently highlighted by Martínez-Aires et al. (2024), that managing health and safety remains a persistent challenge for companies. Therefore, it is essential to address the adaptation of businesses to the new work methods required for the transition to Industry 5.0. This discussion can serve as a valuable tool for future decision-making aimed at improving the regulatory framework.

1.2. Scope and contribution of this study

Drawing on published scientific studies within this reference framework, the aim of this research has been to identify gaps in the existing literature and, from there, highlight the key topics related to occupational health and safety management in small and medium-sized enterprises (SMEs). Hence the importance of knowing the driving and facilitating themes of this topic in order to see what the future lines of research are to illuminate the nuances of health and safety management in SMEs and pointing out the existing research gaps.

To this end, we would like to answer the following research questions:

- Question 1: What has been the conceptual and thematic evolution of health and safety management in small and medium-sized enterprises over time?
- Question 2: What will be the driving thematic areas of this field of study in the future?

To achieve this goal and guide future research, a roadmap for the thematic evolution of research in health and safety management for SMEs, both conceptually and structurally, would be developed. A longitudinal bibliometric analysis was conducted using SciMAT (Science Mapping Analysis Software Tool). SciMAT, created by Cobo et al. (2012), is a freely available software that facilitates the complete

bibliometric process, including methods, algorithms, and metrics for all phases of science mapping, from pre-processing to result visualization. The approach introduced by Cobo et al. (2011) has been validated in various studies, including works by Cobo et al. (2014), Kipper et al. (2020), Casado-Aranda et al. (2021), and Molina-Collado et al. (2022).

The first step of this study was to determine the most frequently cited articles on OHS management in SMEs in the scientific databases consulted between 1992 and 2022. Secondly, it aimed to identify the key concepts (Key themes) discussed in this period in relation to the theme in question. The third proposal was to design a strategic diagram identifying the driving, fundamental and emerging themes that evolved over this period.

As a result, the implication of this work to OHS standards is not only original, but also important for formulating strategies that enable government agencies and social and economic agents to plan interventions to improve OHS management performance in SMEs.

After providing the context for the theme and objectives in the introduction, the rest of the document is organized according to the following structure: [Section 2](#) describes the approach based on the methodology; [Section 3](#) presents the results; [Section 4](#) includes a discussion and critique derived from the main results of this research; and the article ends with the conclusions and guidelines for future research in [Section 5](#).

2. Methodology

This research offers a bibliometric analysis of the thematic development in the area of health and safety management research within small and medium-sized enterprises, focusing on both conceptual and structural aspects. To achieve this, the study utilized the open-source Science Mapping Analysis Software Tool (SciMAT), which generates scientific maps in a longitudinal format, enabling the identification of key topics in this field over time. Following the approach suggested by Cobo et al. (2011) for defining a research field in terms of structure and concept, a five-step process was implemented:

1. Raw data collection: To carry out this study, we searched the Scopus database for useful documents on this topic. The search run on March 22, 2023, was: TITLE-ABS-KEY (('OCCUPATIONAL HEALTH AND SAFETY' OR 'OHS') AND ('SME' OR 'SMALL BUSINESS' OR 'MEDIUM BUSINESS' OR 'SMALL AND MEDIUM BUSINESS' OR 'SMALL AND MEDIUM SIZED ENTERPRISE')) We only included author keywords and discarded the plus keywords since many of them diverge from the topic covered in the research. All types of documents were considered with no specific time interval. The search language was English for all document types. The goal was to analyze the results on this theme to identify publication trends and patterns.
2. Selection of the type of item to be analyzed: The author keywords were used as the units of analysis. Using the PRISMA flowchart (Moher et al., 2009), 17 records of the 314 documents were eliminated prior to screening, mainly due to duplications, and another 45 documents were eliminated during the screening process as health and safety management in SMEs was not the main objective of the study, for example articles on major accidents or food safety ([Figure 1](#)). Consequently, the final number of documents considered in this study was 252 from 878 authors.
3. Extracting relevant information from the dataset: we examined the frequency of keyword co-occurrence, identifying instances where two terms appeared together in the same document.
4. Normalization: The relationships between the elements identified in step three were calculated using the equivalence index, as outlined by Cobo et al. (2011).
5. Clustering: This step involved identifying subgroups of closely related keywords. These clusters represent the core areas of focus or the primary topics of interest for researchers studying health and safety management in SMEs. To achieve this, we applied the simple centers algorithm (Coulter et al., 1998), which has been widely used in co-word analysis (Bailón-Moreno et al., 2005; 2006; Coulter et al., 1998; Courtial & Michelet, 1994). These clusters are referred to as themes (Cobo et al., 2011).

According to Coulter et al. (1998), the simple centers algorithm processes the data in two stages to build the intended networks. In the first stage, known as Pass-1, it creates networks that display the

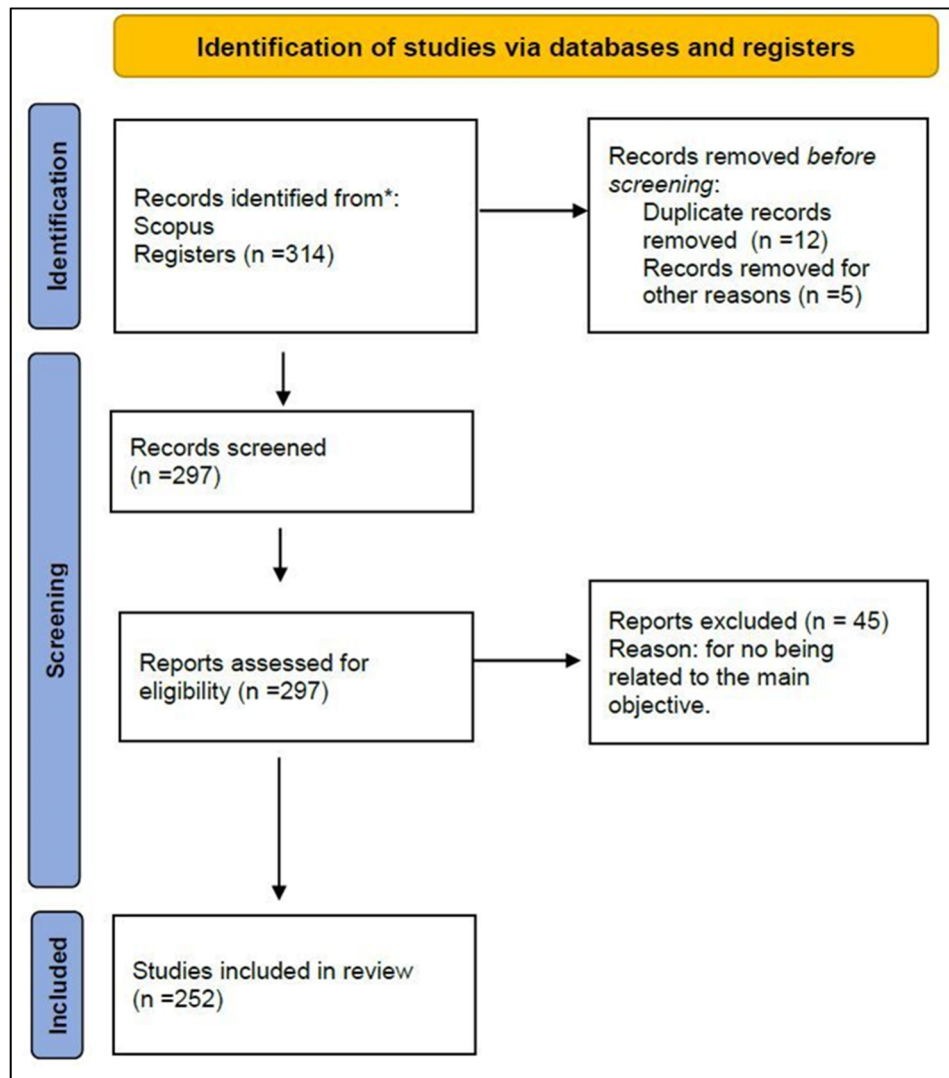


Figure 1. PRISMA flow diagram (Source: Prepared by the authors based on Moher et al., 2009).

strongest associations, where the connections established are termed internal links. In the second stage, Pass-2, the algorithm adds links of lesser strength to these networks, which serve to connect different networks. These added connections are referred to as external links (Cobo et al., 2011).

As Coulter et al. (1998) also observed, keywords that appear rarely in the corpus but consistently together are assigned higher strength values than keywords that appear frequently but almost always together. As a result, weaker or less relevant associations may become prominent in the network. The simple centers algorithm addresses this by implementing parameters that set minimum frequency and co-occurrence thresholds. Only keyword pairs that meet or exceed these thresholds are regarded as potential links in the first pass of network construction. Additionally, the algorithm uses two parameters to control the network sizes for detected themes: the minimum and maximum network sizes (Cobo et al., 2011).

Regarding the visualization of themes and thematic networks, bibliometric analysis using the SciMAT program provides three types of figures that help interpret the results: a longitudinal map, a strategic map, and a thematic network (Cobo et al., 2012).

The longitudinal map (Figure 2a) is structured with a column for each study period, displaying the most prominent themes during each timeframe, which are linked according to their progression. Within each column, the themes for each sample period are listed, with lines connecting related themes across periods. Solid lines indicate that the connected themes share the same name, or one theme is part of the other, signifying a close relationship. The line thickness corresponds to the inclusion index, so thicker

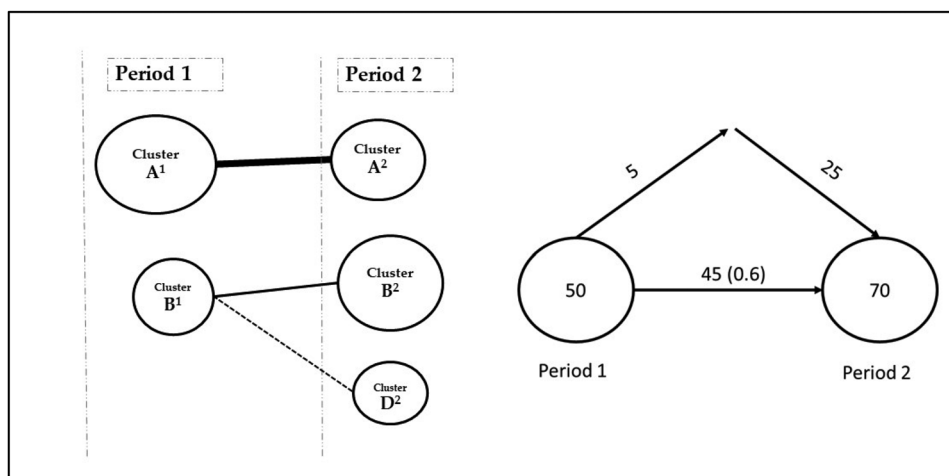


Figure 2. Longitudinal map and overlapping map (Source: Cobo et al., 2012).

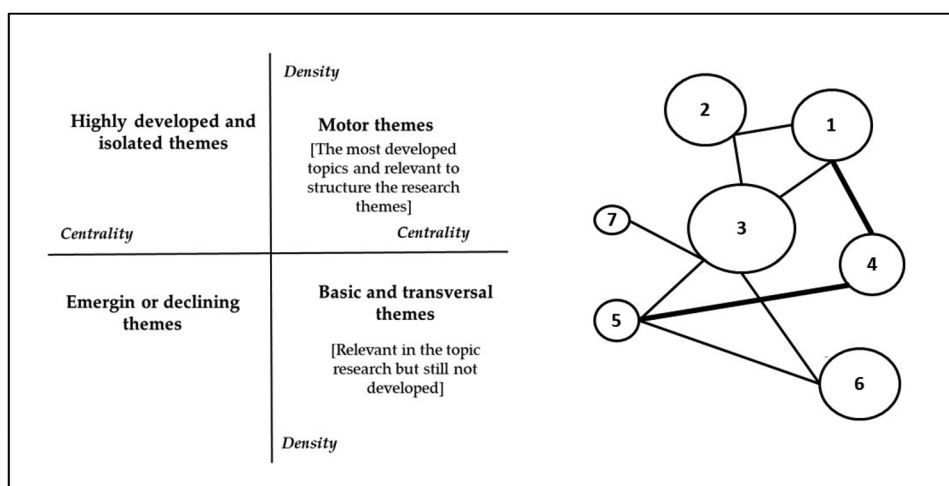


Figure 3. Example of a strategic map and thematic network (Source: Cobo et al., 2012).

lines reflect a stronger connection. Some themes may appear without any connections, indicating that they are emerging or isolated themes with no current links to others. The development of these themes should be tracked across different periods. The size of each cluster reflects the chosen performance metrics.

Figure 2b illustrates the overlapping map, which highlights the addition, removal, or continuation of keywords between consecutive periods throughout the entire analysis. In this overlapping map, each period is represented by a circle, with the number inside indicating the associated keywords for that timeframe. The arrows pointing outward from the circle represent keywords that disappeared from one period to the next, while inward-pointing arrows indicate newly added keywords. Arrows connecting the periods display the number of shared keywords between them, along with their equivalence index, which quantifies the relationship between two words, i and j . This index ranges from 0 to 1, with 0 indicating no co-occurrence of the words.

To understand the arrangement of the most discussed themes in the scientific literature in each period, the strategic map (Figure 3a) is divided into four areas (double entry table) depending on whether the concepts of density and centrality are considered high or low. Density measures the internal cohesion or strength of the internal relationship between the keywords included in the period. Centrality measures the external cohesion or strength of external links with other themes (Cobo et al., 2011).

The upper right quadrant (high density and centrality), also known as driving themes, includes the most well-developed, significant themes during that period. The lower right quadrant (high density and

low centrality) contains the transversal, fundamental themes that contain underdeveloped keywords, but that made important contributions to the studies analyzed.

The lower left quadrant (low density and centrality) includes themes that have not yet been developed and are marginal. They represent emerging or disappearing themes.

Lastly, the upper left quadrant (low density and high centrality) includes themes that are very specific and are isolated from other thematic lines. (Cobo et al., 2012).

The thematic network (Figure 3b) shows the connections between each driving theme that appears in the center and each of the related keywords according to the analyzed documents.

3. Results

We worked with 252 documents from 878 authors for the time period from 1992 to 2022. Figure 4 shows the number of documents published per year in this period.

The documents are divided into two consecutive time sub-periods (1992–2014) and (2015–2022). In our case, the periods under analysis were selected for two reasons. The first is quantitative. We selected an initial period of 22 years (1992–2014) with the idea of giving good input to the co-word analysis to locate the main themes. At the beginning of the period taken for this research on occupational health and safety management in SMEs, we found only a small number of researchers and research papers, so we had to combine a greater number of years to obtain an adequate number of documents to work with. In the following 8-year sub-period (2015–2022), the field of research began to advance in its development and we obtained up to 134 documents.

The second reason is qualitative. In 2014, researchers from the Politécnico di Milano in Italy and the Universidade Nova de Lisboa in Portugal published a study entitled: 'An interpretive model of occupational safety performance for small- and medium-sized enterprises' (Cagno et al., 2014). This study presents a total of 69 citations in Scopus up through 2022, with the largest number of citations coming from the 2014–2022 period. Furthermore, up to 48% of citations have been received in the last three years. Also, as extracted from the PlumX metrics, 243 users have read/shared the article, which suggests that this article is receiving a lot of interest. This study identified 32 factors that affect occupational health and safety (OHS) in small and medium-sized enterprises (SMEs), distributed into 8 areas of similarity, but did not go into how these factors are related. The authors also stated that the existing conceptual models at that time could not be fully used by managers and business owners because they could not offer a complete picture covering all the factors related to safety performance. Consequently, this study proposes the creation of conceptual models that would facilitate the interpretation of OHS performance designed specifically for SMEs. To do this, the authors argue that the effect of the specific nature of SMEs on OHS performance must be taken into account. This study therefore signals an important turning point in the study of OHS management in SMEs.

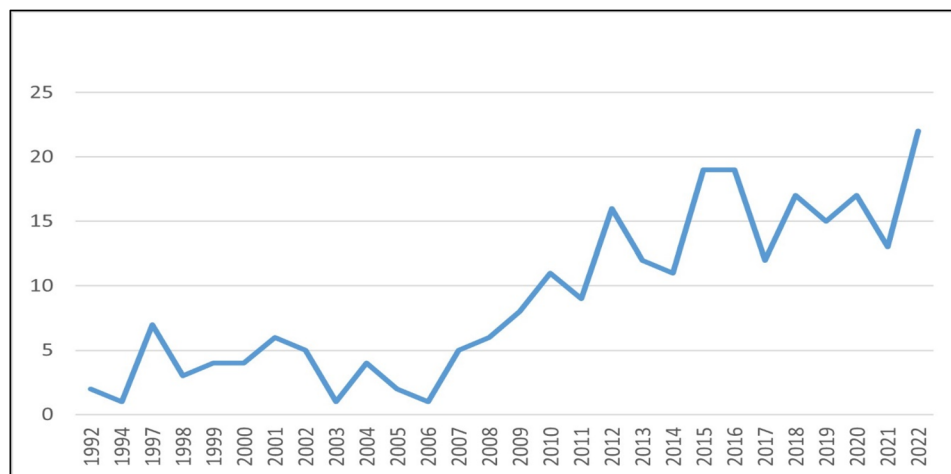


Figure 4. Number of documents trend overtime, 1992–2022.

Table 1. List of journals that published at least four papers on health and safety management in SMEs, 1992–2022.

Source	Number of documents
Safety Science	30
Journal of Occupational Health and Safety	13
International Journal of Environmental Research and Public Health	8
Work	8
International Journal of Occupational Safety and Ergonomics	5
Journal of Safety Research	4
American Journal of Industrial Medicine	4
Annals of Work Exposures and Health	4
Small Enterprise Research	4
Construction Management and Economics	4

Table 2. Main documents based on the frequently cited Scopus records, 1992–2022.

References	Journal	Title	Number of citations
Cooper (2000)	Safety Science	Towards a model of safety culture	2287
Zohar (2010)	Accident Analysis and Prevention	Thirty years of safety climate research: Reflections and future directions	1350
Hollnagel et al. (2015)	University of Southern Denmark, University of Florida, USA, and Macquarie University, Australia.	From Safety-I to Safety-II: A White Paper	724
Quinlan et al. (2001)	International Journal of Health Services	The global expansion of precarious employment, work disorganization, and consequences for occupational health: A review of recent research	483
Hofmann et al. (2017)	Journal of Applied Psychology	100 Years of Occupational Safety Research: From Basic Protections and Work Analysis to a Multilevel View of Workplace Safety and Risk	316
Patriarca et al. (2018)	Safety Science	Resilience engineering: Current status of the research and future challenges	264
Champoux and Brun (2003)	Safety Science	Occupational health and safety management in small size enterprises: An overview of the situation and avenues for intervention and research	213
Labodová (2004)	Journal of Cleaner Production	Implementing integrated management systems using a risk analysis based approach	169
Le Coze (2015)	Safety Science	Reflecting on Jens Rasmussen's legacy. A strong program for a hard problem	112
Duan et al. (2011)	Journal of Hazardous Materials	The situation of hazardous chemical accidents in China between 2000 and 2006	111
Eakin (1992)	International Journal of Health Services	Leaving it up to the workers: Sociological perspective on the management of health and safety in small workplaces	108
Zalk and Nelson (2008)	Journal of Occupational and Environmental Hygiene	History and evolution of control banding: A review	100
Arocena and Núñez (2010)	International Small Business Journal	An empirical analysis of the effectiveness of occupational health and safety management systems in SMEs	94

Table 1 shows the journals with more than four documents included in this study. The other journals not included in the table were distributed as follows: eight journals (7.6%) had published three documents on this topic, fourteen journals (13.4%) has published two documents, and 71 journals (68%) published only one document.

Table 2 shows the number of citations of the main articles and the journal in which they were published. The most cited article was: 'Towards a model of safety culture' (Cooper, 2000), published in *Safety Science*.

3.1. Keyword evolution

To examine the progression of research in occupational health and safety (OHS) management within small and medium-sized enterprises (SMEs), it is useful to observe how keywords have been utilized in the literature over time.

Figure 5 illustrates that, in the initial period, 242 keywords were used, but 189 of them were no longer employed in the subsequent period. Only 53 keywords from the first period remained in use during the second. In this second period, 314 new keywords were added, bringing the total to 367. The similarity index between the two periods was 0.1, indicating significant changes in the themes, with little overlap between them as new ideas and concepts emerged. This shift is evident in the large number of

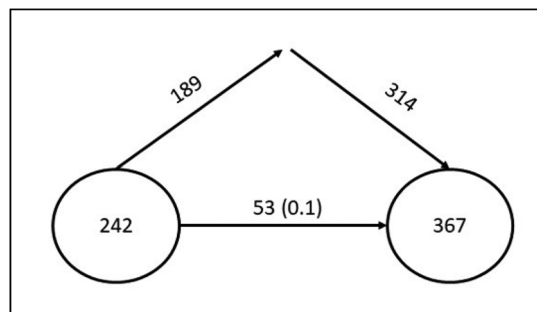


Figure 5. Overlapping graph of keywords from 1992 to 2022.

keywords that disappeared from the first to the second period, alongside the substantial introduction of new terms in the latter period, suggesting that the field was undergoing considerable growth and evolution between these intervals.

3.2. Map of thematic evolution

After analyzing how the keywords evolved, we examined the evolution of the thematic areas on OHS management in SMEs. In the evolution map (Figure 6), the different shades of color group the themes that are part of the same thematic area together. All of the themes are shaded in a color, which means that they all belong to a specific thematic area.

In this study, there are different thematic areas present in both periods, such as *Safety Management*, *Construction Industry* and *Small Business*, as they are pillars of knowledge in this area. *Work Environment* is also present in both periods, with notable growth in the second period as the area of the circle indicates the increase in the number of citations. *Small Business* stands out in the first period and evolves in the second period towards *Performance and Process*, *Risk Assessment*, and *Legislation*, in addition to consolidating the *Small Business* thematic area. Another interesting theme is *SMEs* as it evolves with a significant relationship towards *Barriers*, *Implementation* and *Safety Management System*. The latter is one of the most important in terms of its impact in the second period, which is in turn related to *Safety Management*, forming an important thematic area. The *Construction Industry* theme not only continues in the second period, but also develops from *Health and Safety Training*. Another important finding is that *Safety Culture* moves towards *Safety Climate* and *Knowledge Management*, as a way of generalizing safety in the organization. The concept of *Resilience* also experienced a notable evolution towards *Resilience Engineering*, consolidating this study perspective, as well as the evolution of both *Tool* and *Injury* towards *OHSMS*.

Observing the development of the research field of health and safety in SMEs, the thematic areas are continuously evolving with no gaps in their development.

Table 3 shows the most significant themes in terms of quantitative measurements and impact.

The most intense relationships (solid lines) between the different thematic areas are the Key themes that evolved most solidly from the first study period to the second. Table 4 shows these Key themes with the reference to the studies where they were cited, highlighting each of the most interesting findings.

3.3. Analysis of the strategic map for each period

The strategic map for each period will be used to study these themes, where the highlighted themes are distributed into the four quadrants according to their density and centrality and the thematic network that each one of these themes forms with other basic units or keywords (Cobo et al., 2012).

3.3.1. Period from 1992 to 2014

Figure 7 shows that the main driving themes are the themes that are well developed and significant. For this period, these themes are *Safety*, *Health and Safety Training*, *Safety Performance*, and *Prevention*. These

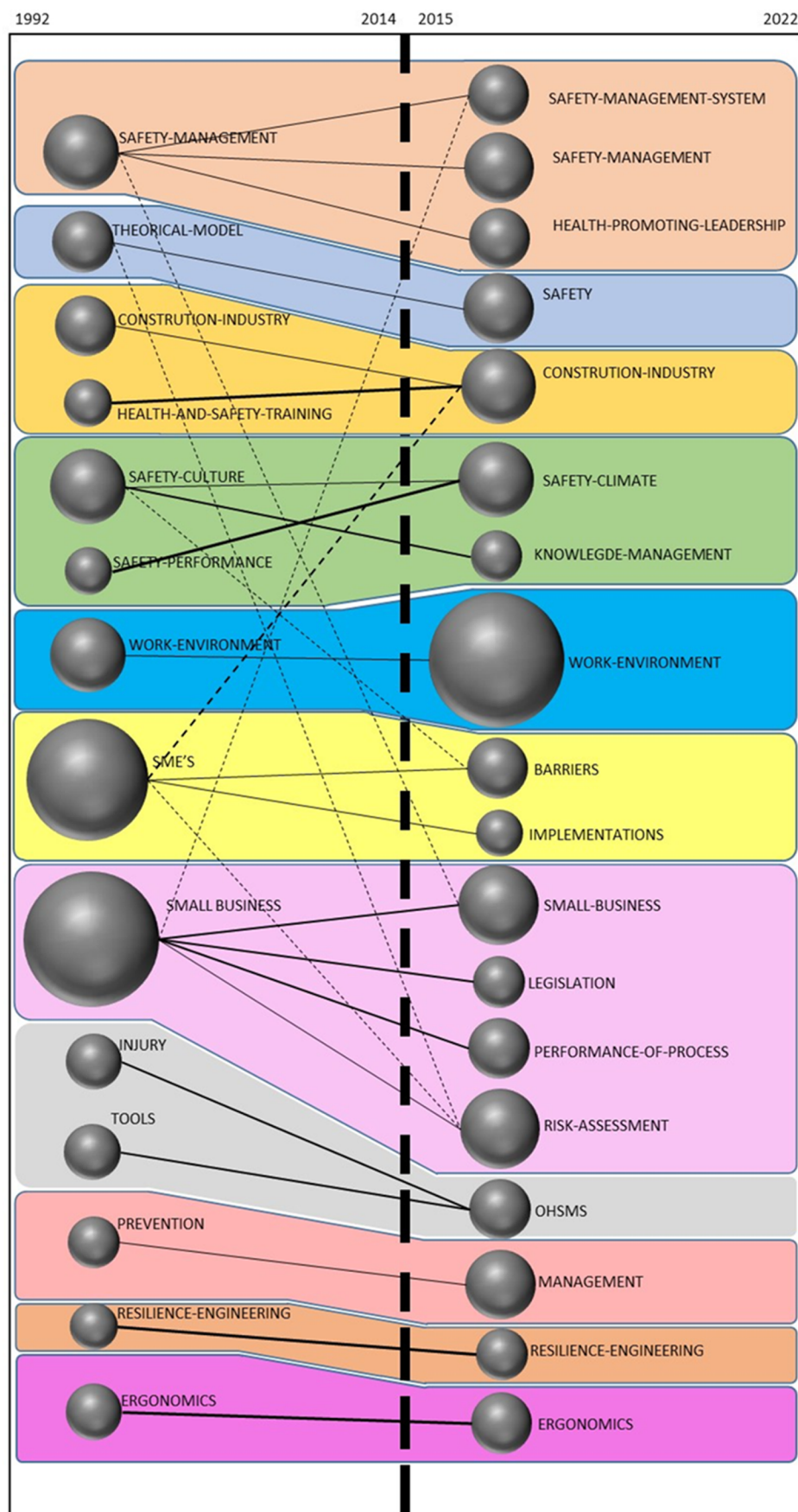


Figure 6. Thematic evolution of the periods analyzed.

Table 3. Impact data for the established thematic areas.

Thematic area	Documents	Citations	h-index
Work Environment	70	1012	21
Small Business	56	1182	21
Safety Management System	52	606	15
SMEs	33	1000	18
Construction Industry	20	422	13
Risk Assessment	15	151	7
Resilience Engineering	12	988	2
Safety Culture	11	3819	8
Theoretical Model	7	103	2

Table 4. Key themes in OHS management in SMEs.

Topics	Findings	Key references
SMEs and Occupational Health and Safety Management Systems (OHSMS)	Safety is an important aspect of everyday business operations. SMEs face extra problems in this area due to limited resources and lack of knowledge. OHS in small firms has received very little attention, in terms of either research or support for preventive initiatives. OHS is poorer in SMEs than in large corporations.	Boustras and Guldenmund (2017); Rodrigues et al. (2020) Champoux and Brun (2003)
Barriers in SMEs	SMEs face a combination of barriers that make it difficult to integrate occupational health and safety into them	Tremblay and Badri (2018a) Eakin et al. (2010); Taylor and Taylor (2004)
Construction industry	SMEs in the construction industry focus more on short-term safety issues than on the implementation of safety management systems.	Chan et al. (2004); Kheni et al. (2010); Canamares et al. (2017)
Tools	A novel OHS performance evaluation tool better adapted to SMEs. is proposed. The certification of OHSMS can be an important tool to measure the degree of implementation in SMEs.	Tremblay and Badri (2018a) Santos et al. (2011); Santos et al. (2013)
Safety Management Systems	The overarching intention is to simplify the implementation process and make the benefits of OHSMS in SMEs more obvious.	Makin and Winder (2008)
Theoretical model	The evolution of theoretical models goes from a simple sequence of events to non-linear systemic models The theoretical model offers a stereotypical way of thinking about how events that affect the health and safety of workers occur.	Heinrich (1931); Perrow (1984); Reason (1990); Hollnagel et al. (2006) Le Coze (2013)
Resilience Engineering	The conceptual model developed under Resilience Engineering breaks from the traditional concept of reactive safety focused on the study of things that go wrong by analyzing simple causal relationships (Safety I) and goes further by studying the things that go well and daily successes (Safety II).	Hollnagel et al.,(2006); Dekker et al. (2008); Hollnagel (2018)
Safety Culture vs Safety Climate	An integrative approach to managing safety has been proposed which is based on a combination of the behavior change and culture change attitude to safety.	Cooper (2000); Zohar (2010); Hofmann et al. (2017)
Occupational injuries	Efforts to prevent work-related injuries have had tangible success in industrialized countries but have had very poor results in developing countries.	Tremblay and Badri (2018b); Kheni et al. (2008)
Risk-assessment Vs SMEs	Risk assessment has evolved from a tool for safety management of risks of serious accidents related to hazardous substances into the basic assessment tool in all EU Member States. The European Commission, through EU-OSHA, recognizes the importance of conducting an occupational risk assessment. However, differences have been detected in the perceived value of these risk assessments between the countries in northern and southern Europe, and those differences are more marked in companies with fewer than five employees.	Labodová (2004); Anyfantis et al. (2021) Walters and Wadsworth (2016); Wadsworth and Walters (2018); Anyfantis et al. (2021)
Work environment	The implementation and improvement of OHS management has direct effects on the improvement of the work environment in SMEs.	Torp and Moen (2006)

are the themes that structure the research field for these years as it is implied that they are externally related to other conceptually similar themes.

The fundamental themes that still require development due to their transversal or generic nature but that are at the foundations of the field of study of Health and Safety in SMEs are *SMEs*, *Small Business*, *Work Environment*, *Safety Culture*, *Theoretical Model*, and *Construction*. The *Safety Management* theme falls in between the fundamental themes and the driving themes.

Peripheral or isolated themes include *Cooperatives*, which are only marginally important in this field.

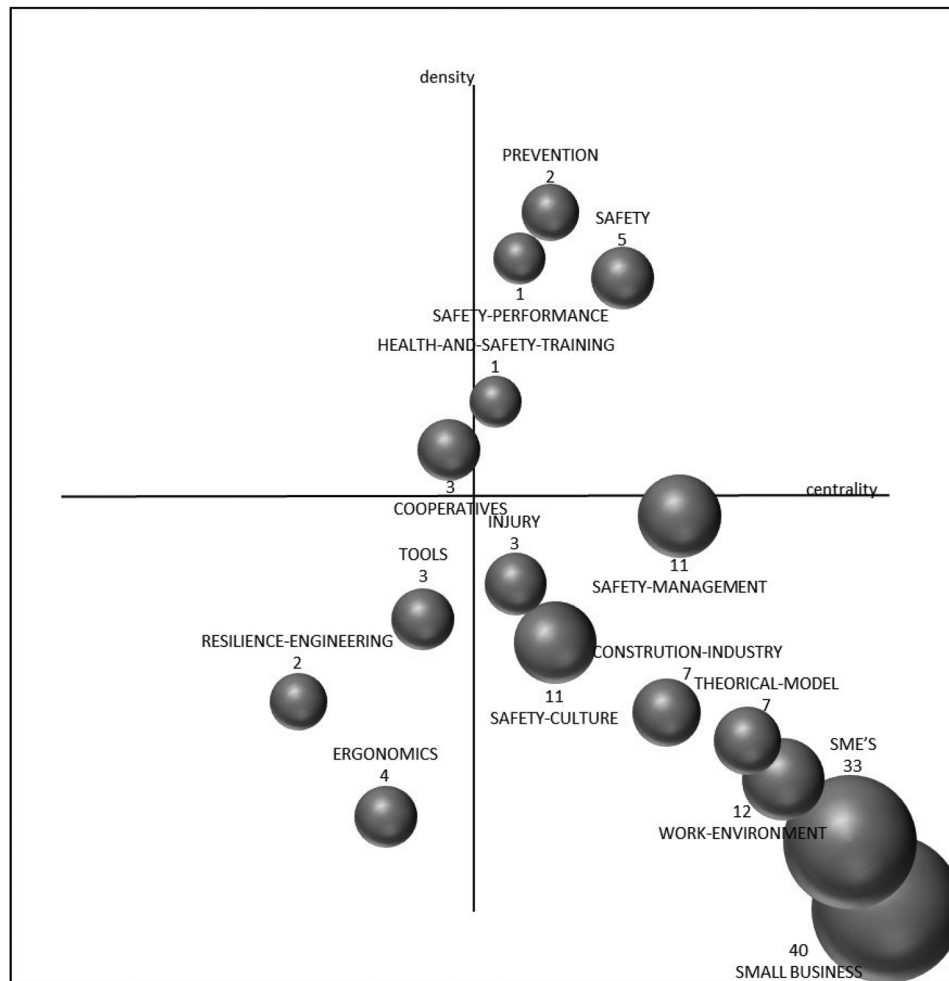


Figure 7. Strategic diagram for 1992–2014.

Emerging themes include *Tool*, *Resilience Engineering*, and *Ergonomics*. The latter two evolve into driving themes in the second period.

3.3.2. Period from 2015 to 2022

Figure 8 shows how the driving themes in this area of knowledge are *Personal Protective Equipment*, *Work Accident*, *Key Messages*, *Ergonomics*, and *Resilience Engineering*. The latter two evolved from emerging themes in the first period into driving themes in the second period.

The fundamental themes are *Safety Management System*, *Work Environment*, *Safety Management*, *Construction Industry*, and *Safety Climate*, among others. These results are very much in line with the obtained in the thematic evolution map and represent the themes on which the evolution of the knowledge area is based.

The peripheral or isolated themes include *Safety Science*, *Driver Factors and Legislation Safety Management System*, *Theoretical Model*, and *Behavior-based Safety*, as the main themes in this quadrant.

Emerging themes include *Government Regulation*, *Barriers*, *Knowledge Management* and *Risk Level*, which is among the emerging and fundamental themes.

4. Discussion

As stated earlier, previous literature review studies relating OHS to SMEs primarily focus on: identifying factors that impact the performance of SMEs (Cagno et al., 2011; Tremblay & Badri, 2018a); the practical tools used in economic evaluations of OHS systems (Cagno et al., 2013); safety management in SMEs (Boustras & Guldenmund, 2017); the identification of performance indicators (Barbosa et al., 2019); and

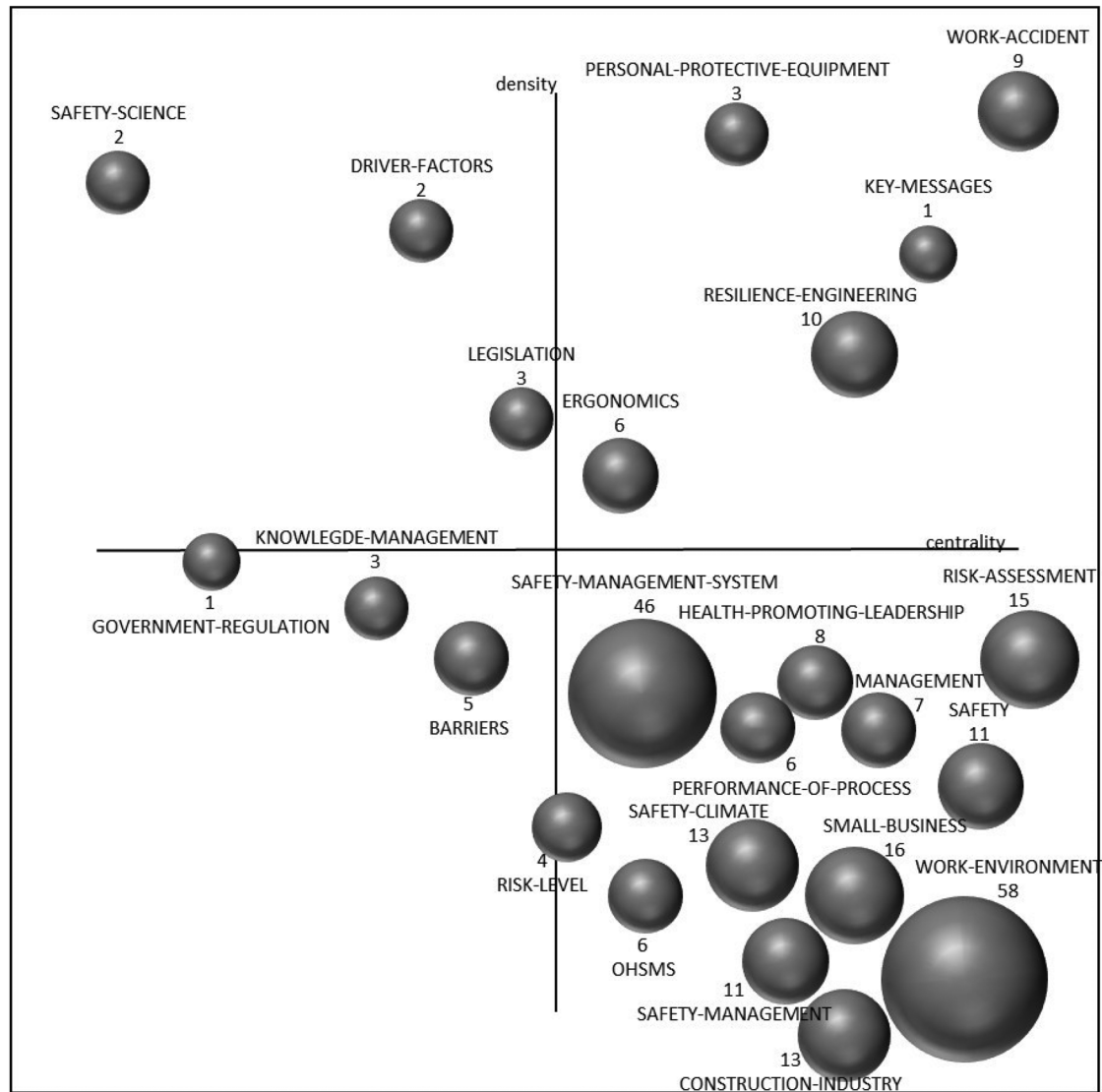


Figure 8. Strategic diagram for 2015–2022.

compliance with legislation, regulations and standards (Salguero-Caparrós et al., 2020). This study contributes a perspective of the thematic evolution of the field of OHS research in SMEs, thereby allowing us to quantify and visualize the impact of both the identified themes and general thematic areas.

The longitudinal bibliometric analysis of OHS management in SMEs shows that sixteen of the twenty-five most cited articles in Scopus pertaining to the area of interest were published before 2014. This makes clear sense since the articles with the greatest impact in the area in question accumulate more citations over time. Also for the period of time analyzed from 1992 to 2022, the most cited papers have a direct relationship with the study of OHS in SMEs, indicating the importance that organizations place on management.

Outlined below is the progression of the key thematic areas identified across the two periods analyzed in relation to occupational health and safety management in SMEs.

4.1. Small business and SMEs

The results of this study show that the two essential themes that are discussed the most are those related to Small Businesses and SMEs, showing a strong centrality and high density during the period from 1992 to 2014. Analyzing the evolution of these concepts in the following period from 2015 to 2022, we see that the research focuses on the management of safety systems in SMEs and their work

environment. This study shows the evolution of this term throughout the second period. The natural evolution of this field of study includes safety management, risk assessment and resolving various barriers inherent to SME management, as shown in the thematic evolution map in [Figure 6](#). In this regard, Boustras and Guldenmund (2017) argue that safety is an important aspect of day-to-day business operations and SMEs face additional problems in this area due to limited resources and a lack of knowledge.

4.2. Work environment

A fundamental, transversal driving theme addressed in the first study period (1992–2014), which evolved in the second period (2015–2022) to become the most cited theme, is the concept of *Work Environment*. The implementation and improvement of OHS management has a direct impact on improving the work environment in SMEs (Torp & Moen, 2006). However, leadership is required on the part of management in order to achieve this result, hence *Work Environment* has become the most central, dense concept during the second period under study (2015–2022).

4.3. SMEs vs barriers

Research on the theme of *SMEs* is also a driving theme in the 2015–2022 period related to the barriers these organizations face in implementing health and safety management. In this case, studies by Taylor and Taylor (2004) and Eakin et al. (2010) received the most citations with 52 and 55 citations respectively, in addition to a high social impact as can be seen from the PlumX metrics values. The use of OHS management systems in SMEs has been fraught with difficulties, as the mechanics and bureaucracy of the system itself sometimes become overwhelming (Makin & Winder, 2008). In regard to these difficulties, SMEs face a set of barriers that hinder the integration of OHS into their companies.

A study by Taylor and Taylor (2004) revealed five key factors the authors consider to be ‘barriers’ in the successful implementation of safety systems management. These systems are not only complicated, costly, and unnecessary when dealing with systems that comply with established standards, they also face obstacles caused by external and personnel problems. Eakin et al. (2010) added excessive regulation, outsourcing, levels of unionization, the changing nature of small businesses, restrictions enforced by management bodies, and the orientation of institutional policies towards large companies, to this classification.

Specifically, compliance with laws and regulations is becoming increasingly difficult for SMEs as a whole to understand and manage, thereby becoming a major obstacle both for these companies to manage OHS (Swuste et al., 2020) and for professionals acting as occupational safety and health consultants (Provan et al., 2018). This reasoning justifies the appearance of the theme *Legislation* in the second study period (2015–2022), which is directly related to small businesses.

4.4. Construction industry

A key, cross-cutting theme explored during the initial period from 1992 to 2014 was the Construction Industry, which remained a significant focus in the subsequent period under review. Chan et al. (2004) highlighted the challenges faced by construction companies, particularly small and medium-sized enterprises, in implementing essential processes for an effective health and safety management system. Research by Kheni et al. (2010) suggests that SMEs in the construction sector require a robust legal and economic framework and a supportive socioeconomic environment to enhance their health and safety performance. They advocate for a more proactive management approach that acknowledges the unique working cultures within these companies. Additionally, Kheni et al. (2008) emphasize the need for a shift in the attitudes of owners and managers, considering size-related limitations, to improve health and safety outcomes for SMEs. These challenges regarding OHS management in the construction industry have continued to be relevant in the second period of study (2015–2022), as confirmed by research such as that by Canamares et al. (2017).

4.5. Safety culture vs safety climate

A new fundamental theme addressed during the 1992–2014 period is *Safety Culture*, which evolved into the concept of *Safety Climate* during the 2015–2022 period. The studies with the most citations regarding this fundamental, transversal theme were by Cooper (2000), Zohar (2010) and Hofmann et al. (2017). These studies also have a very high social impact as can be seen from the PlumX metrics values, as well as a high scientific impact as can be seen from the Field-Weighted citation impact (FWCI) above 15 points in all three articles.

The authors noted that small and medium-sized enterprises frequently struggle with inadequate resources to equip their supervisors with the necessary safety leadership skills to foster and sustain a robust safety culture at work. Consequently, they recommend adopting a comprehensive safety management strategy that integrates both behavioral and cultural changes to enhance health and safety within organizations.

4.6. Small business vs risk-assessment

A recurring and crucial theme in the thematic analysis is Risk Assessment, which closely relates to three key central concepts from the first period: Small Business, SMEs, and Theoretical Model. The EU Framework Directive on OHS introduced in 1989 underscored the necessity of conducting a thorough, systematic, and documented risk assessment for all workplaces within the EU (COUNCIL DIRECTIVE 89/391/EEC, 1989). The European Commission, through EU-OSHA, acknowledges the unique challenges and constraints faced by micro, small, and medium-sized enterprises, emphasizing the critical role of occupational risk assessment (Wadsworth & Walters, 2018). However, significant disparities were observed in OHS management and the perceived importance of workplace risk assessment between Northern and Southern European countries, as well as in companies with fewer than five employees. Many Southern European firms, operating with limited resources and often as subcontractors or in dependent roles relative to larger companies, adopt a 'survival' strategy, which restricts their decision-making capabilities (Anyfantis et al., 2021).

4.7. Tools vs occupational health and safety management systems (OHSMS)

Of the emerging themes in the first study period (1992–2014), the generic theme *Tools* stands out, showing a close relationship with the fundamental, transversal theme *Occupational Health and Safety Management Systems (OHSMS)* in the 2015–2022 period.

Research, including the study by Tremblay and Badri (2018a), indicates that occupational health and safety (OHS) conditions are generally less favorable in small and medium-sized enterprises (SMEs) compared to larger corporations. Specifically, fatal accidents are up to eight times more frequent in SMEs, and non-fatal injuries are up to 50% more likely. To enhance the health and safety standards in SMEs, it is crucial to consider the operational constraints these businesses face (Barbosa et al., 2019). Currently, there are limited tools designed to assess OHS performance specifically for SMEs, largely because most research focuses on the needs of larger organizations. This gap is addressed in the EU-OSHA strategy for 2022–2027, which includes 'providing relevant tools for smaller workplaces to manage health and safety and involving intermediaries in the development and dissemination of these tools' (European Agency for Safety and Health at Work (EU-OSHA), 2022).

Accordingly, the review study by Tremblay and Badri (2018a) indicates that a very positive development would be to create tools for evaluating OHS performance including a selection of indicators that are more appropriate for SMEs and offer a higher degree of reliability. That way, in addition to using the classic reactive approach associated with retrospective indicators, also called 'lagging indicators' (Manuele, 2009; Sheehan et al., 2016; Toellner, 2001), which are so widespread given their simplicity and ease of interpretation, 'leading indicators', as they are known in the literature, can also be used (Podgórski, 2015; Sinelnikov et al., 2015) in order to provide a forecast of future performance as well as a forward-looking perspective of risk (Hallowell et al., 2013; Hinze et al., 2013; Lingard et al., 2017).

Regarding the available tools, a 1998 study by Vassie and Cox demonstrated that SMEs were already showing interest in the process of voluntary certification for health and safety management.

Certification of OHS management systems can be an important tool to measure the degree of implementation in SMEs (Santos et al., 2013). Regardless of a company's size or business activities, the use of international standards such as ISO 45001 occupational health and safety management systems have proven to be an important working tool to implement, manage and update OHS management systems (Darabont et al., 2017).

SMEs pursue certification to reduce or eliminate workplace risks and enhance their reputation by decreasing the incidence of occupational accidents (Santos et al., 2011). However, many small and micro enterprises struggle to meet the certification requirements due to limited resources, which are more easily managed by larger firms (Salguero-Caparrós et al., 2020). Owners and managers of these smaller companies often lack robust practices for legal compliance in OHS (Walters & Wadsworth, 2016).

4.8. Theoretical model

Finally, the longitudinal analysis allowed us to see the strong evolution of the *Theoretical Model* concept between the two study periods. The theoretical conceptual model is particularly important when conducting workplace risk analysis and assessment as it provides a stereotypical way of envisioning how events occur that affect the workers' health and safety. The evolution of theoretical models for risk and accident management shows that there has been a shift over time from the simple sequence of events to the representation of the system as a whole (Le Coze, 2013).

The initial theoretical framework developed was a straightforward linear or sequential model, prominently exemplified by Heinrich's 'Domino Theory' (1931). This model characterized an 'accident' as the outcome of a series of events occurring in a specific sequence. The second theoretical framework introduced was a more intricate linear or epidemiological model, which likened accidents to diseases. This perspective views accidents as a result of various agents and factors interacting to create adverse conditions. This model is represented by the 'Swiss cheese theory' from J. Reason's book *Human Error* (1990). The third theoretical framework is a systemic or complex non-linear model, which treats accidents as deviations from the norm within a complex organizational system. According to this model, accidents are seen as 'emergent' phenomena arising from the usual state of affairs (Perrow, 1984). Within this systemic approach, notable models include Rasmussen's socio-technical model (Accimap) (Rasmussen, 1997), Levenson's Systems-Theoretical Accident Model and Processes (STAMP) (2004), and Wiegmann and Shappell's Human Factors Analysis and Classification System (HFACS) (2001). The development of these systemic models has led to the contemporary concept of Resilience Engineering (Hollnagel et al., 2006), which views accidents as non-linear events emerging from complex systems and contributes to the evolution of systemic or non-linear models of accident causation.

Specifically, OHS management in SMEs involves dealing with complex issues resulting from their peculiarities and limitations. Researchers such as Labodová (2004) came up with conceptual theoretical models of occupational health and safety and OHS performance that could be used by SMEs. However, these models may not be as useful for managers and entrepreneurs of SMEs as they do not take into account the particular and relevant factors of OHS and safety performance in an SME (Cagno et al., 2011).

According to Cagno et al. (2014), a systemic conceptual model for managing risk and accidents proves to be a valuable method for grasping and handling the complexities inherent in such organizations. Similarly, Guo et al. (2015) emphasize the need to delve deeper into the dynamic intricacies of safety management within SMEs by pinpointing and categorizing recurring behavioral patterns in health and safety practices.

4.9. Resilience engineering

In an attempt to address the challenges described above, the new paradigm in health and safety management is *Resilience Engineering* (Dekker et al., 2008). While traditional safety conceptual models focused on error and accident prevention by, for example, evaluating a system's performance in terms of its error rate, the concept of *Resilience Engineering* focuses on success; in other words, studying normal operations is considered to be more relevant than studying incidents or accidents.

The conceptual model introduced by Resilience Engineering challenges the conventional reactive safety paradigm, which centers on examining failures by analyzing straightforward causal links, a concept referred to as Safety I (Hollnagel et al., 2015). Instead, this new framework embraces a proactive stance known as Safety II (Hollnagel, 2018), which focuses on understanding instances of success and normal operational achievements through intricate, non-linear interactions. Resilience Engineering and Safety II provide a novel approach to safety management, addressing the limitations of traditional methods used for managing safety in complex systems. This approach is therefore one of the main innovations presented in this article, making a significant contribution to the existing literature on occupational safety and health management in the context of SMEs.

5. Conclusions

Based on an exhaustive bibliometric analysis, the objective of this study was to identify the Key themes related to occupational health and safety (OHS) management among small and medium-sized enterprises (SMEs) and how these themes have evolved since the publication of the first study on this subject, which focused exclusively on SMEs. The Key themes with the greatest potential and influence identified in the study period from 1992 to 2022 are: *SMEs, Small Business, Work Environment, Safety Management Systems, Safety Climate, Risk Assessment, Construction Industry, and Theoretical Model*.

After more than thirty years of research, it is pertinent to ask: What is the future direction of OHS management research for SMEs? An analysis of the thematic evolution in the area of health and safety research for SMEs offers insight by painting a broader picture of the driving themes that have been well developed over time and the fundamental, transversal themes that form our current knowledge base, as well as very specific, isolated themes and even marginal themes or those that are falling by the wayside, but should still be taken into account.

Limited resources, poor knowledge of health and safety management processes, as well as deficiencies in organizational processes are often identified in the literature as the main obstacles to achieving OHS management in SMEs. In the face of these challenges, the conceptual model based on Resilience Engineering together with the Safety II approach presents an effective alternative for safety and health management in SMEs.

Similarly, this review study reveals that OHS management in SMEs still receives very little attention in the scientific field compared to large companies and major accidents. Advanced health and safety management systems are significantly less developed in SMEs.

5.1. Future lines of research

Considering all of the above, and paying particular attention to the specific problems of small and medium-sized enterprises, the following future lines of research of this bibliometric analysis are presented: On the one hand, it allows the roadmap to be drawn up as to what kind of interventions are really effective in order to combat the barriers that hinder the integration of occupational safety and health management in small and medium-sized enterprises. On the other hand, this study makes it possible to formulate strategies and public policies that make it easier for government agencies, social and economic actors to plan interventions to improve the performance of occupational safety and health management in SMEs so that they are on a par with large enterprises. Seeking answer to these challenges presents an opportunity for future research in this field, which we understand still needs a lot of improvement. Knowledge management is also an essential tool for improving competitiveness and stakeholder satisfaction in SMEs as argued by Agrawal and Mukti (2020) and Animesh and Mukti (2019).

As a final conclusion, this study provides significant practical and policy contributions to strengthen the organizational resilience of small and medium-sized enterprises (SMEs) through innovative approaches to occupational health and safety (OHS) management. The identification of key themes, such as Resilience Engineering and the Safety II approach, highlights how these paradigms can help SMEs build more robust and adaptable safety systems. These strategies not only reduce workplace risks but also enhance the capacity of organizations to anticipate, respond to, and recover from disruptions, thereby

strengthening their overall resilience. Furthermore, the findings underscore the need for policymakers to develop simplified and targeted programs and tools for SMEs, fostering the integration of knowledge-based systems and training. This collaborative approach, involving government agencies, industry associations, and SMEs, is essential for co-creating solutions that balance regulatory compliance with the need for organizational resilience, ensuring that SMEs remain competitive in an ever-changing and dynamic environment.

5.2. Limitations

The study has taken into account only the articles collected in the Scopus database. Although it is one of the main indexed lists, there are other complementary databases.

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The authors agree to share the data upon reasonable request.

References

- Agrawal, A., & Mukti, S. K. (2020). Knowledge management & its origin, success factors, plannings, tools, applications, barriers and enablers: A review. *International Journal of Knowledge Management*, 16(1), 43–82. <https://doi.org/10.4018/IJKM.2020010103>
- Animesh, A., & Mukti, S. K. (2019). Case study of critical success factors affecting knowledge management in small-and medium-sized enterprises in developing state: Steel sector. In *Advances in Industrial and Production Engineering: Select Proceedings of FLAME 2018* (pp. 825–831). Springer Singapore.
- Anyfantis, I. D., Leka, S., Reniers, G., & Boustras, G. (2021). Employers’ perceived importance and the use (or non-use) of workplace risk assessment in micro-sized and small enterprises in Europe with focus on Cyprus. *Safety Science*, 139, 105256. <https://doi.org/10.1016/j.ssci.2021.105256>
- Arocena, P., & Núñez, I. (2010). An empirical analysis of the effectiveness of occupational health and safety management systems in SMEs. *International Small Business Journal: Researching Entrepreneurship*, 28(4), 398–419. <https://doi.org/10.1177/0266242610363521>
- Bailón-Moreno, R., Jurado-Alameda, E., & Ruiz-Baños, R. (2006). The scientific network of surfactants: Structural analysis. *Journal of the American Society for Information Science and Technology*, 57(7), 949–960. <https://doi.org/10.1002/asi.20362>
- Bailón-Moreno, R., Jurado-Alameda, E., Ruiz-Baños, R., & Courtial, J. P. (2005). Analysis of the field of physical chemistry of surfactants with the Unified Scientometric Model. Fit of relational and activity indicators. *Scientometrics*, 63(2), 259–276. <https://doi.org/10.1007/s11192-005-0212-4>
- Barbosa, C., Azevedo, R., & Rodrigues, M. A. (2019). Occupational safety and health performance indicators in SMEs: A literature review. *Work*, 64(2), 217–227. <https://doi.org/10.3233/WOR-192988>
- Bianchini, A., Donini, F., Pellegrini, M., & Sacconi, C. (2017). An innovative methodology for measuring the effective implementation of an Occupational Health and Safety Management System in the European Union. *Safety Science*, 92, 26–33. <https://doi.org/10.1016/j.ssci.2016.09.012>
- Bonafede, M., Corfiati, M., Gagliardi, D., Boccuni, F., Ronchetti, M., Valenti, A., Marinaccio, A., & Iavicoli, S. (2016). OHS management and employers’ perception: Differences by firm size in a large Italian company survey. *Safety Science*, 89, 11–18. <https://doi.org/10.1016/j.ssci.2016.05.012>
- Boustras, G., & Guldenmund, F. W. (Eds.) (2017). *Safety management in small and medium sized enterprises (SMEs)*. CRC Press.
- Cagno, E., Micheli, G. J. L., Jacinto, C., & Masi, D. (2014). An interpretive model of occupational safety performance for small-and medium-sized enterprises. *International Journal of Industrial Ergonomics*, 44(1), 60–74. <https://doi.org/10.1016/j.ergon.2013.08.005>
- Cagno, E., Micheli, G. J., & Perotti, S. (2011). Identification of OHS-related factors and interactions among those and OHS performance in SMEs. *Safety Science*, 49(2), 216–225. <https://doi.org/10.1016/j.ssci.2010.08.002>

- Cagno, E., Micheli, G. J., Masi, D., & Jacinto, C. (2013). Economic evaluation of OSH and its way to SMEs: A constructive review. *Safety Science*, 53, 134–152. <https://doi.org/10.1016/j.ssci.2012.08.016>
- Canamares, M. S., Escribano, B. V., García, M. G., Barriuso, A. R., & Sáiz, A. R. (2017). Occupational risk-prevention diagnosis: A study of construction SMEs in Spain. *Safety Science*, 92, 104–115. <https://doi.org/10.1016/j.ssci.2016.09.016>
- Casado-Aranda, L. A., Sánchez-Fernández, J., & Bastidas-Manzano, A. B. (2021). Tourism research after the COVID-19 outbreak: Insights for more sustainable, local and smart cities. *Sustainable Cities and Society*, 73, 103126. <https://doi.org/10.1016/j.scs.2021.103126>
- Champoux, D., & Brun, J. P. (2003). Occupational health and safety management in small size enterprises: An overview of the situation and avenues for intervention and research. *Safety Science*, 41(4), 301–318. [https://doi.org/10.1016/S0925-7535\(02\)00043-7](https://doi.org/10.1016/S0925-7535(02)00043-7)
- Chan, A. H., Kwok, W. Y., & Duffy, V. G. (2004). Using AHP for determining priority in a safety management system. *Industrial Management & Data Systems*, 104(5), 430–445. <https://doi.org/10.1108/02635570410537516>
- Cobo, M. J., Chiclana, F., Collop, A., de Ona, J., & Herrera-Viedma, E. (2014). A bibliometric analysis of the intelligent transportation systems research based on science mapping. *IEEE Transactions on Intelligent Transportation Systems*, 15(2), 901–908. <https://doi.org/10.1109/TITS.2013.2284756>
- Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011). An approach for detecting, quantifying, and visualizing the evolution of a research field: A practical application to the Fuzzy Sets Theory field. *Journal of Informetrics*, 5(1), 146–166. <https://doi.org/10.1016/j.joi.2010.10.002>
- Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2012). SciMAT: A new science mapping analysis software tool. *Journal of the American Society for Information Science and Technology*, 63(8), 1609–1630. <https://doi.org/10.1002/asi.22688>
- Cooper, M. D. (2000). Towards a model of safety culture. *Safety Science*, 36(2), 111–136. [https://doi.org/10.1016/S0925-7535\(00\)00035-7](https://doi.org/10.1016/S0925-7535(00)00035-7)
- Coulter, N., Monarch, I., & Konda, S. (1998). Software engineering as seen through its research literature: A study in co-word analysis. *Journal of the American Society for Information Science*, 49(13), 1206–1223. [https://doi.org/10.1002/\(SICI\)1097-4571\(1998\)49:13<1206::AID-ASI7>3.0.CO;2-F](https://doi.org/10.1002/(SICI)1097-4571(1998)49:13<1206::AID-ASI7>3.0.CO;2-F)
- Courtial, J. P., & Michelet, B. (1994). A cword analysis of scientometrics. *Scientometrics*, 31(3), 251–260. <https://doi.org/10.1007/BF02016875>
- da Silva, S. L. C., & Amaral, F. G. (2019). Critical factors of success and barriers to the implementation of occupational health and safety management systems: A systematic review of literature. *Safety Science*, 117, 123–132. <https://doi.org/10.1016/j.ssci.2019.03.026>
- Darabont, D. C., Antonov, A. E., & Bejinariu, C. (2017). Key elements on implementing an occupational health and safety management system using ISO 45001 standard. *MATEC Web of Conferences*, 121, 11007.
- Dekker, S., Hollnagel, E., Woods, D., & Cook, R. (2008). Resilience engineering: New directions for measuring and maintaining safety in complex systems. *Lund University School of Aviation*, 1, 1–6.
- Duan, W., Chen, G., Ye, Q., & Chen, Q. (2011). The situation of hazardous chemical accidents in China between 2000 and 2006. *Journal of Hazardous Materials*, 186(2–3), 1489–1494. <https://doi.org/10.1016/j.jhazmat.2010.12.029>
- Eakin, J. M. (1992). Leaving it up to the workers: Sociological perspective on the management of health and safety in small workplaces. *International Journal of Health Services*, 22(4), 689–704. <https://doi.org/10.2190/DNV0-57VV-FJ7K-8KU>
- Eakin, J. M., Champoux, D., & MacEachen, E. (2010). Health and safety in small workplaces: Refocusing upstream. *Canadian Journal of Public Health*, 101 Suppl 1(Suppl 1), S29–S33. <https://doi.org/10.1007/BF03403843>
- Elsler, D. (Ed.). (2009). *Occupational safety and health and economic performance in small and medium-sized enterprises: A review*. Publications Office.
- European Agency for Safety and Health at Work (EU-OSHA). (2022). EU-OSHA Multi-annual Strategic Programme 2022–2027.
- European Agency for Safety and Health at Work (EU-OSHA). (2024). *European Safety and Health Agency*. Retrieved January 29, 2024, from <http://www.osha.europa.eu/en/statistics/index.stm>
- European Union Commission. (2003). Commission recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises. *Official Journal of the European Union*, 46(L124), 36–41.
- Eurostat. (2018). *Statistics on small and medium-sized enterprises* [WWW Document]. Retrieved January 29, 2024, from https://ec.europa.eu/eurostat/statisticsexplained/index.php?title=Archive:Statistics_on_small_and_medium-sized_enterprises
- Guo, B. H., Yiu, T. W., & González, V. A. (2015). Identifying behaviour patterns of construction safety using system archetypes. *Accident Analysis & Prevention*, 80, 125–141. <https://doi.org/10.1016/j.aap.2015.04.008>
- Hallowell, M. R., Hinze, J. W., Baud, K. C., & Wehle, A. (2013). Proactive construction safety control: Measuring, monitoring, and responding to safety leading indicators. *Journal of Construction Engineering and Management*, 139(10), 04013010. [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0000730](https://doi.org/10.1061/(ASCE)CO.1943-7862.0000730)
- Heinrich, H. W. (1931). *Industrial accident prevention*. McGraw Hill.
- Hinze, J., Thurman, S., & Wehle, A. (2013). Leading indicators of construction safety performance. *Safety Science*, 51(1), 23–28. <https://doi.org/10.1016/j.ssci.2012.05.016>
- Hofmann, D. A., Burke, M. J., & Zohar, D. (2017). 100 years of occupational safety research: From basic protections and work analysis to a multilevel view of workplace safety and risk. *The Journal of Applied Psychology*, 102(3), 375–388. <https://doi.org/10.1037/apl0000114>

- Hollnagel, E. (2018). *Safety-I and safety-II: The past and future of safety management*. CRC Press.
- Hollnagel, E., Wears, R. L., & Braithwaite, J. (2015). *From Safety-I to Safety-II: A white paper*. The resilient health care net: Published simultaneously by the University of Southern Denmark, University of Florida, USA, and Macquarie University, Australia.
- Hollnagel, E., Wodds, D., & Leveson, N. (2006). *Resilience engineering: Concepts and precepts*. Ashgate Publishing, Ltd.
- Kheni, N. A., Dainty, A. R., & Gibb, A. (2008). Health and safety management in developing countries: A study of construction SMEs in Ghana. *Construction Management and Economics*, 26(11), 1159–1169. <https://doi.org/10.1080/01446190802459916>
- Kheni, N. A., Gibb, A. G., & Dainty, A. R. (2010). Health and safety management within small-and medium-sized enterprises (SMEs) in developing countries: Study of contextual influences. *Journal of Construction Engineering and Management*, 136(10), 1104–1115. [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0000218](https://doi.org/10.1061/(ASCE)CO.1943-7862.0000218)
- Kipper, L. M., Furstenuau, L. B., Hoppe, D., Frozza, R., & Iepsen, S. (2020). Scopus scientific mapping production in industry 4.0 (2011–2018): A bibliometric analysis. *International Journal of Production Research*, 58(6), 1605–1627. <https://doi.org/10.1080/00207543.2019.1671625>
- Labodová, A. (2004). Implementing integrated management systems using a risk analysis based approach. *Journal of Cleaner Production*, 12(6), 571–580. <https://doi.org/10.1016/j.jclepro.2003.08.008>
- Le Coze, J. C. (2013). New models for new times. An anti-dualist move. *Safety Science*, 59, 200–218. <https://doi.org/10.1016/j.ssci.2013.05.010>
- Le Coze, J. C. (2015). Reflecting on Jens Rasmussen's legacy. A strong program for a hard problem. *Safety Science*, 71, 123–141. <https://doi.org/10.1016/j.ssci.2014.03.015>
- Legg, S. J., Olsen, K. B., Laird, I. S., & Hasle, P. (2015). Managing safety in small and medium enterprises. *Safety Science*, 71, 189–196. <https://doi.org/10.1016/j.ssci.2014.11.007>
- Leveson, N. (2004). A new accident model for engineering safer systems. *Safety Science*, 42(4), 237–270. [https://doi.org/10.1016/S0925-7535\(03\)00047-X](https://doi.org/10.1016/S0925-7535(03)00047-X)
- Li, J., & Hale, A. (2016). Output distributions and topic maps of safety related journals. *Safety Science*, 82, 236–244. <https://doi.org/10.1016/j.ssci.2015.09.004>
- Li, Y., & Guldenmund, F. W. (2018). Safety management systems: A broad overview of the literature. *Safety Science*, 103, 94–123. <https://doi.org/10.1016/j.ssci.2017.11.016>
- Lingard, H., Hallowell, M., Salas, R., & Pirzadeh, P. (2017). Leading or lagging? Temporal analysis of safety indicators on a large infrastructure construction project. *Safety Science*, 91, 206–220. <https://doi.org/10.1016/j.ssci.2016.08.020>
- Makin, A. M., & Winder, C. (2008). A new conceptual framework to improve the application of occupational health and safety management systems. *Safety Science*, 46(6), 935–948. <https://doi.org/10.1016/j.ssci.2007.11.011>
- Manuele, F. A. (2009). Leading & lagging indicators. *Professional Safety*, 54(12), 28.
- Martínez-Aires, M. D., López-Alonso, M., de la Hoz-Torres, M. L., Aguilar-Aguilera, A., & Arezes, P. (2024). Occupational risk prevention in the European Union construction sector: 30 years since the publication of the Directive. *Safety Science*, 177, 106593. <https://doi.org/10.1016/j.ssci.2024.106593>
- Masi, D., & Cagno, E. (2015). Barriers to OHS interventions in small and medium-sized enterprises. *Safety Science*, 71, 226–241. <https://doi.org/10.1016/j.ssci.2014.05.020>
- Mohammadfam, I., Kamalinia, M., Momeni, M., Golmohammadi, R., Hamidi, Y., & Soltanian, A. (2016). Developing an integrated decision making approach to assess and promote the effectiveness of occupational health and safety management systems. *Journal of Cleaner Production*, 127, 119–133. <https://doi.org/10.1016/j.jclepro.2016.03.123>
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & PRISMA Group*. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Annals of Internal Medicine*, 151(4), 264–269, W64. <https://doi.org/10.1016/j.ijisu.2010.02.007>
- Molina-Collado, A., Santos-Vijande, M. L., Gómez-Rico, M., & Madera, J. M. (2022). Sustainability in hospitality and tourism: A review of key research topics from 1994 to 2020. *International Journal of Contemporary Hospitality Management*, 34(8), 3029–3064. <https://doi.org/10.1108/IJCHM-10-2021-1305>
- Official Journal. (1989). Council Directive of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work (89/391/EEC). OJ.
- Patriarca, R., Bergström, J., Di Gravio, G., & Costantino, F. (2018). Resilience engineering: Current status of the research and future challenges. *Safety Science*, 102, 79–100. <https://doi.org/10.1016/j.ssci.2017.10.005>
- Perrow, C. (1984). *Normal accidents. Living with high risk technologies*. Basic Books.
- Podgórski, D. (2015). Measuring operational performance of OSH management system – A demonstration of AHP-based selection of leading key performance indicators. *Safety Science*, 73, 146–166. <https://doi.org/10.1016/j.ssci.2014.11.018>
- Provan, D. J., Dekker, S. W., & Rae, A. J. (2018). Benefactor or burden: Exploring the professional identity of safety professionals. *Journal of Safety Research*, 66, 21–32. <https://doi.org/10.1016/j.jsr.2018.05.005>
- Provan, D. J., Woods, D. D., Dekker, S. W., & Rae, A. J. (2020). Safety II professionals: How resilience engineering can transform safety practice. *Reliability Engineering & System Safety*, 195, 106740. <https://doi.org/10.1016/j.ress.2019.106740>
- Quinlan, M., Mayhew, C., & Bohle, P. (2001). The global expansion of precarious employment, work disorganization, and consequences for occupational health: A review of recent research. *International Journal of Health Services*, 31(2), 335–414. <https://doi.org/10.2190/607H-TTV0-QCN6-YLT4>

- Rasmussen, J. (1997). Risk management in a dynamic society: A modelling problem. *Safety Science*, 27(2-3), 183–213. [https://doi.org/10.1016/S0925-7535\(97\)00052-0](https://doi.org/10.1016/S0925-7535(97)00052-0)
- Reason, J. (1990). *Human error*. Cambridge University Press.
- Rodrigues, M. A., Sá, A., Masi, D., Oliveira, A., Boustras, G., Leka, S., & Guldenmund, F. (2020). Occupational Health & Safety (OHS) management practices in micro-and small-sized enterprises: The case of the Portuguese waste management sector. *Safety Science*, 129, 104794. <https://doi.org/10.1016/j.ssci.2020.104794>
- Salguero-Caparrós, F., Pardo-Ferreira, M. D. C., Martínez-Rojas, M., & Rubio-Romero, J. C. (2020). Management of legal compliance in occupational health and safety. A literature review. *Safety Science*, 121, 111–118. <https://doi.org/10.1016/j.ssci.2019.08.033>
- Santos, G., Barros, S., Mendes, F., & Lopes, N. (2013). The main benefits associated with health and safety management systems certification in Portuguese small and medium enterprises post quality management system certification. *Safety Science*, 51(1), 29–36. <https://doi.org/10.1016/j.ssci.2012.06.014>
- Santos, G., Mendes, F., & Barbosa, J. (2011). Certification and integration of management systems: The experience of Portuguese small and medium enterprises. *Journal of Cleaner Production*, 19(17-18), 1965–1974. <https://doi.org/10.1016/j.jclepro.2011.06.017>
- Sheehan, C., Donohue, R., Shea, T., Cooper, B., & De Cieri, H. (2016). Leading and lagging indicators of occupational health and safety: The moderating role of safety leadership. *Accident Analysis & Prevention*, 92, 130–138. <https://doi.org/10.1016/j.aap.2016.03.018>
- Sinelnikov, S., Inouye, J., & Kerper, S. (2015). Using leading indicators to measure occupational health and safety performance. *Safety Science*, 72, 240–248. <https://doi.org/10.1016/j.ssci.2014.09.010>
- Swuste, P., Groeneweg, J., Van Gulijk, C., Zwaard, W., Lemkowitz, S., & Oostendorp, Y. (2020). The future of safety science. *Safety Science*, 125, 104593. <https://doi.org/10.1016/j.ssci.2019.104593>
- Taylor, E. A., & Taylor, J. Z. (2004). Using qualitative psychology to investigate HACCP implementation barriers. *International Journal of Environmental Health Research*, 14(1), 53–63. <https://doi.org/10.1080/09603120310001633877>
- Toellner, J. (2001). Improving safety & health performance: Identifying & measuring leading indicators. *Professional Safety*, 46(9), 42.
- Torp, S., & Moen, B. E. (2006). The effects of occupational health and safety management on work environment and health: A prospective study. *Applied Ergonomics*, 37(6), 775–783. <https://doi.org/10.1016/j.apergo.2005.11.005>
- Tremblay, A., & Badri, A. (2018a). Assessment of occupational health and safety performance evaluation tools: State of the art and challenges for small and medium-sized enterprises. *Safety Science*, 101, 260–267. <https://doi.org/10.1016/j.ssci.2017.09.016>
- Tremblay, A., & Badri, A. (2018b). A novel tool for evaluating occupational health and safety performance in small and medium-sized enterprises: The case of the Quebec forestry/pulp and paper industry. *Safety Science*, 101, 282–294. <https://doi.org/10.1016/j.ssci.2017.09.017>
- Vassie, L., & Cox, S. (1998). Small and Medium Size Enterprises (SME) interest in voluntary certification schemes for health and safety management: Preliminary results. *Safety Science*, 29(1), 67–73. [https://doi.org/10.1016/S0925-7535\(98\)00017-4](https://doi.org/10.1016/S0925-7535(98)00017-4)
- Wadsworth, E., & Walters, D. (2018). *From policy to practice: Safety and health in micro and small enterprises in the EU, European Risk Observatory*. European Agency for Safety and Health at Work.
- Walters, D., & Wadsworth, E. J. (2016). *Contexts and arrangements for occupational safety and health in micro and small enterprises in the EU-SESAME projects*. Publications Office of the European Union.
- Wiegmann, A., & Shappell, S. A. (2001). Applying reason: The human factors analysis and classification system (HFACS). *Human Factors and Aerospace Safety*, 1, 59–86.
- Zalk, D. M., & Nelson, D. I. (2008). History and evolution of control banding: A review. *Journal of Occupational and Environmental Hygiene*, 5(5), 330–346. <https://doi.org/10.1080/15459620801997916>
- Zohar, D. (2010). Thirty years of safety climate research: Reflections and future directions. *Accident Analysis & Prevention*, 42(5), 1517–1522. <https://doi.org/10.1016/j.aap.2009.12.019>