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-RESEARCH ARTICLE-

A BIBLIOMETRIC ANALYSIS ON OCCUPATIONAL HEALTH AND SAFETY PERFORMANCE: GLOBAL TRENDS AND THEMATIC APPROACHES

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Abstract

This study aims to map the intellectual structure, developmental process, and current research trends of the "safety performance" concept, which holds critical importance in occupational health and safety literature, from a holistic perspective. Within the scope of the research, 752 academic publications covering the years 2000-2025 were retrieved from the Web of Science database and examined. A multi-faceted methodology comprising descriptive statistics, bibliometric network mapping, and conceptual structure analyses was followed for data analysis, utilizing BibExcel, VOSviewer, CiteSpace, and Biblioshiny software. The analysis findings indicate that safety performance research has chronologically evolved through three fundamental phases. These are the "safety culture and climate" focused initiation period (2000-2010), the "system and behavior" focused maturation period (2010-2018), and the "leadership, technology, and analytical decision making" focused current period (2019-2025). The study reveals that the field has shifted towards "implementation" and "safety leadership" rather than theoretical modeling, and that safety has gained a psychosocial depth with the rise of "burnout" and "stress" concepts. Furthermore, it has been determined that reactive approaches based on post-accident data have been replaced by data-driven prediction and leading indicators. Consequently, this study demonstrates the need for mixed management models where technical measures are integrated with employee well-being and digitalization, emphasizing that managers must transition from a "transactional" role to a "transformational leader" role for sustainable safety performance. It further demonstrates the need for a digital transformation process where technical measures are integrated with human-centric Industry 5.0 frameworks and artificial intelligence supported hybrid management models.

Keywords: *Safety Performance, Occupational Health and Safety, Bibliometric Analysis, Science Mapping.*

JEL Codes: *J28, M54.*

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İŞ SAĞLIĞI VE GÜVENLİĞİ PERFORMANSI ÜZERİNE BİBLİYOMETRİK BİR ANALİZ: KÜRESEL EĞİLİMLER VE TEMATİK YAKLAŞIMLAR[3]

Öz

Bu çalışma, iş sağlığı ve güvenliği literatüründe kritik bir öneme sahip olan "güvenlik performansı" kavramının entelektüel yapısını, gelişim sürecini ve güncel araştırma eğilimlerini bütüncül bir perspektifle haritalandırmayı amaçlamaktadır. Araştırma kapsamında, Web of Science veri tabanından elde edilen ve 2000-2025 yılları arasını kapsayan 752 akademik yayın incelenmiştir. Verilerin analizinde; betimsel istatistikler, bibliyometrik ağ haritalamaları ve kavramsal yapı analizlerini içeren çok yönlü bir metodoloji izlenmiş; BibExcel, VOSviewer, CiteSpace ve Biblioshiny yazılımları kullanılmıştır. Analiz bulguları, güvenlik performansı araştırmalarının kronolojik olarak üç temel evreden geçtiğini göstermektedir. Bunlar; "güvenlik kültürü ve iklimi" odaklı başlangıç dönemi (2000-2010), "sistem ve davranış" odaklı olgunlaşma dönemi (2010-2018) ve "liderlik, teknoloji ve analitik karar verme" odaklı güncel dönem (2019-2025) evreleridir. Çalışma, alanın teorik modellemeden ziyade "uygulama" ve "güvenlik liderliği" konularına yöneldiğini; "tükenmişlik" ve "stres" kavramlarının yükselişiyle güvenliğin psikososyal bir derinlik kazandığını ortaya koymaktadır. Ayrıca, kaza sonrası verilere dayalı reaktif yaklaşımların yerini, veriye dayalı öngörü ve öncü göstergelere bıraktığı tespit edilmiştir. Sonuç olarak bu çalışma; sürdürülebilir güvenlik performansı için yöneticilerin "geleneksel işlemci" rolünden "dönüştürücü lider" rolüne geçmesi gerektiğini vurgulamaktadır. Ayrıca teknik önlemlerin Endüstri 5.0 prensipleriyle uyumlu insan merkezli yapılar ve yapay zeka destekli hibrit yönetim modelleriyle bütünleştirildiği bir dijital dönüşüm sürecine ihtiyaç duyulduğunu göstermektedir.

Anahtar Kelimeler: *Güvenlik Performansı, İş Sağlığı ve Güvenliği, Bibliyometrik Analiz, Bilimsel Haritalama.*
JEL Kodları: *J28, M54.*

"Bu çalışma Araştırma ve Yayın Etiğine uygun olarak hazırlanmıştır."

[3] Genişletilmiş Türkçe Özet, makalenin sonunda yer almaktadır.

1. INTRODUCTION

Occupational Health and Safety (OHS) is a critical management area for business sustainability, aiming to protect the physical, mental, and social well-being of employees. As industrialization, technological diversity, and global competition increase, the social and economic burden of occupational accidents and diseases is becoming more evident. According to International Labour Organization (ILO) estimates, approximately 3 million people died due to work-related accidents and illnesses in 2019. Most of these deaths (89%) were caused by occupational diseases, while about 11% resulted from work accidents. Additionally, 395 million workers suffered from non-fatal occupational accidents (ILO, 2024). This data shows that occupational accidents and diseases lead to significant economic costs, further highlighting the importance of occupational health and safety management. Consequently, measuring, monitoring, and improving safety performance is no longer just a legal obligation. It has become a strategic necessity for corporate productivity, employee satisfaction, and corporate reputation (Fernández-Muñiz et al., 2009: 8; Bayram et al., 2017: 285,286).

OHS performance refers to the behaviors and practices individuals demonstrate during work to protect their health and safety. Understanding the factors that influence safety performance helps managers encourage safe working behaviors and reduce the negative impacts of unsafe actions (Burke et al., 2002: 431). Measuring OHS performance allows organizations to evaluate how well they are meeting their established OHS policies and objectives. Performance measurement helps identify strengths and weaknesses in OHS practices across the organization or its sub-units. This makes it possible to pinpoint areas needing improvement and take timely corrective and preventive measures. Such an approach contributes to detecting risks early and enhancing the overall effectiveness of OHS processes (Lingard et al., 2011: 31; Üngören and Koç, 2015: 128).

Performance measurement is also an essential tool for evaluating the effectiveness of OHS interventions. The resulting data shows which practices are effective and where improvements are needed. Furthermore, performance measurement supports the systematic review of OHS practices and organizational processes. It also allows for benchmarking, enabling comparisons both between internal sub-units and with other organizations in the same sector (Saunders et al., 2016: 918).

Research shows that the quality of job design directly affects OHS performance (Zacharatos et al., 2005). In particular, factors such as role ambiguity, excessive workload, and role conflict negatively impact safe behaviors, leading to a decline in OHS performance. In workplaces where these issues exist, the perception that production targets are prioritized over safety grows stronger. This results in a negative safety climate and, ultimately, weakened safety performance (Clarke, 2010: 555).

OHS performance is a multidimensional concept that reflects how effectively organizations provide a safe working environment. While traditional evaluation

methods focus on reactive indicators like accident frequency and severity rates, modern OHS principles prioritize proactive measurement systems. These include behavioral elements such as safety culture and climate, the effectiveness of management systems, and risk-based approaches. Consequently, the literature on OHS performance offers a vast field of study, encompassing both theoretical and practical perspectives.

Implementing an OHS management system at the corporate level does more than just enhance employee safety; it creates multidimensional positive effects on overall business performance. An advanced OHS system improves product and service quality by ensuring that work procedures, instructions, and control mechanisms are systematically defined. Beyond improving quality, this significantly boosts productivity by reducing production disruptions and cost losses associated with occupational accidents. Furthermore, reducing accidents and providing a safe work environment increases customer satisfaction while strengthening the company's social reputation and corporate image. Improvements in OHS practices also foster innovation within technology and organizational structures, thereby increasing the company's innovation capacity (Fernández-Muñiz et al., 2009: 989).

Consequently, a high level of OHS performance plays a critical role in protecting intangible assets—such as intellectual capital, corporate reputation, expert knowledge, and employee commitment—that provide a sustainable competitive advantage beyond mere legal compliance. In this sense, the effective management of occupational risks transforms OHS performance into a strategic value driver (Fernández-Muñiz et al., 2009: 989).

Numerous studies have demonstrated that implementing an Occupational Health and Safety Management System (OHSMS) positively impacts OHS performance. Some researchers suggest that the primary goal of OHSMS certification is to ensure the auditability of OHS performance, which allows organizations to systematically monitor and improve their safety practices (Wang et al., 2020: 12). Additionally, research indicates that companies with OHS management systems and employee training programs experience improved safety performance, which in turn positively impacts financial performance (Bautista-Bernal et al., 2024). However, despite these positive evaluations in the literature, there is no clear consensus regarding the actual impact of OHSMS implementation on the ground. This stems not so much from the theoretical structure of OHSMS, but from the ineffectiveness of practical application methods. Instead of using OHSMS as an effective management tool, many businesses, certification bodies, and audit teams treat the system as a formal, document-oriented, and bureaucratic process. Such practices overlook the system's real impact on OHS performance, thereby preventing the potential benefits of OHSMS from being fully realized (Podgorski, 2015: 147).

Recent years have seen a significant increase in the number of academic studies in the field of OHS performance (Wang et al., 2020: 8). This growth in publications has brought about interdisciplinary collaborations, new methodological approaches, and

thematic diversity. For instance, areas such as AI-based risk analysis, behavioral safety practices, ergonomic design, safety leadership, and management system integrations are gaining increasing attention. However, this rapid expansion of the literature necessitates a systematic mapping of research trends, development trajectories, leading authors and institutions, thematic focuses, and emerging research gaps.

At this point, bibliometric analysis serves as an essential tool that enables a holistic evaluation of the current state of literature by examining scientific production through quantitative methods. Bibliometric techniques allow for the scientific mapping of publication performance, citation dynamics, collaborations, and research themes. Such analyses do more than just identify general trends; they also provide strategic guidance for future research. While several bibliometric studies have been conducted in the OHS field, most have focused on specific sub-topics such as OHS management systems, safety culture, the construction industry, leadership, the work environment, and employee well-being (Otitolaiye and Aziz, 2024; Nunen et al., 2018; Yamaner Kuzeyli and Özbakır, 2024; Prihatsanti et al., 2025). However, no bibliometric analysis has been identified that addresses the concept of OHS performance holistically. To fill this gap in the literature, this study examines OHS performance-related articles in the Web of Science (WoS) database to answer the following research questions:

RQ1: What are the publication trends, geographical distributions, and most influential actors (authors, institutions, and countries) in the OHS performance literature between 2000 and 2025?

RQ2: What are the core research clusters that shape the intellectual structure and conceptual development of the field, and what are the structural relationships between these clusters?

RQ3: How has the historical evolution of OHS performance research unfolded, and what future directions do current research trends suggest?

2. METHODOLOGY

2.1. Data Source and Collection Process

The dataset for this study was obtained from the Web of Science Core Collection database, chosen for its inclusion of journals with the highest impact factors and its consistent data quality. WoS is considered one of the most reliable and prestigious sources for bibliometric analysis, thanks to its interdisciplinary diversity and comprehensive citation networks (Birkle et al., 2020). Compared to other databases such as Scopus, WoS yields more consistent results in mapping analyses conducted with software like CiteSpace and VOSviewer, particularly because it provides historical citation data in a more standardized format (Mongeon and Paul-Hus, 2016). Since this study aims to focus on the most qualified and high-impact research in the

field of OHS performance, the WoS database was preferred for the data mining process.

This study focuses exclusively on English-language publications indexed in the WoS database to maintain data quality and ensure the consistency of citation analyses. Data retrieval from the Web of Science Core Collection database was performed on December 1, 2025. Therefore, the data for 2025 are limited to the publications indexed in the database up to this retrieval date and should not be interpreted as representing the full year. Consequently, studies available in other databases, such as Scopus, or those published in different languages are excluded from the scope of this analysis. Furthermore, due to the nature of bibliometric methods, the scientific impact of the most recent publications in the dataset may not be fully observable, as their citation counts have not yet reached maturity.

This study employs bibliometric analysis to address the specified research questions. The research process was conducted in accordance with the PRISMA protocol, ensuring a transparent and reliable selection of data, with the flow diagram presented in Figure 1. To reach a comprehensive literature pool, the following search query was used in the Web of Science database: TS=((“Occupational health and safety” OR “Occupational health” OR “Occupational safety” OR “Workplace health and safety” OR “Industrial safety” OR “Workplace safety” OR “Employee safety” OR “Safety and Health”) AND (“Key Performance Indicators” OR “KPI” OR “Safety performance” OR “Performance measurement” OR “Safety performance evaluation” OR “Workplace performance” OR “Occupational health and safety performance”)). The research process primarily consists of creating the dataset through this query, applying necessary filters, and analyzing the data. Technical details regarding the data collection process and the visualization tools used in the analysis are provided in the following sections.

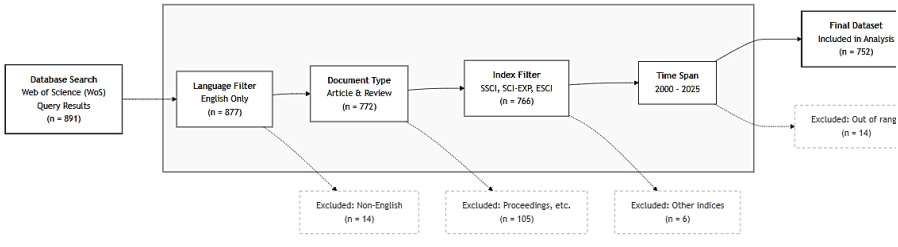

Figure 1: PRISMA Flow Diagram of the Web of Science Dataset Regarding OHS Performance Studies

This study aims to systematically examine the academic literature on OHS performance through bibliometric methods, highlighting research trends, influential actors, thematic clusters, and emerging research gaps. Within this framework, the study analyzes the historical development of the literature, evaluates geographical and institutional distributions, and visualizes the relationships between key concepts through scientific networks. The findings are expected to contribute to the

development of research and practical strategies for OHS performance, benefiting both academics and practitioners.

2.2. Data Analysis and Visualization Tools

This study adopts a multifaceted analysis approach, integrating four complementary software tools to examine the bibliometric characteristics, relational networks, and conceptual structure of the data from a holistic perspective. The methodological workflow regarding the analysis process and the software tools utilized is presented in Figure 2.

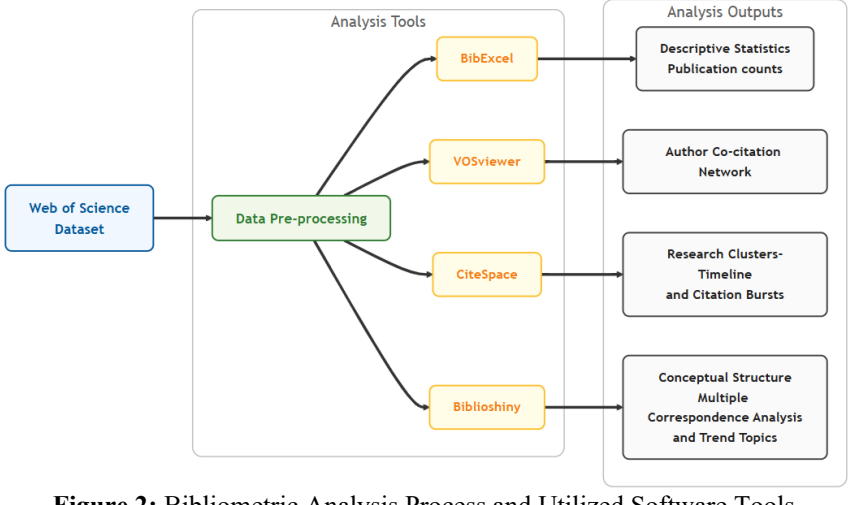

Figure 2: Bibliometric Analysis Process and Utilized Software Tools

BibExcel: This tool was utilized for data preprocessing, preparing research data for analysis, and calculating basic descriptive statistics (Persson et al., 2009). Initially, raw data downloaded from the Web of Science database underwent extensive cleaning and standardization to resolve inconsistencies in keywords, countries, and author names. Performance analyses, such as annual publication distributions and the productivity of authors, journals, and countries, were conducted using this cleaned dataset. In the final stage, the data was exported in the appropriate formats for use in VOSviewer and CiteSpace analyses.

VOSviewer: This software was utilized to map the intellectual structure and relational networks of the literature. In the Author Co-Citation Analysis (ACA) process, the "association strength" normalization method was used to visualize citation links between authors. By applying the VOS mapping technique for node positioning and a modularity-based clustering algorithm for cluster identification, the core scientific schools of thought and their interaction networks were visualized (Van Eck and Waltman, 2010). To define the thematic content and determine the specific research

topics around which these author clusters (color groups) were formed, CiteSpace software was subsequently employed.

CiteSpace: This tool was used to analyze the temporal evolution, research clusters, and citation bursts of the study (Chen, 2006). During the network construction process, the time slice was set to 5 years. The g-index (k=15) was selected as the node selection criterion, and the "Pathfinder" algorithm was preferred for network pruning. The reliability of the resulting network structure was validated by a Modularity Q value of 0.4357 and a Weighted Mean Silhouette S value of 0.7342. These values indicate that the network has significant modularity (Q>0.3) and high clustering consistency (S>0.7) (Chen et al., 2010: 1391).

Bibliometrix R-Package (Biblioshiny Interface): To reveal the conceptual structure and temporal trends of the study, Biblioshiny—the web-based interface of the RStudio-based Bibliometrix library—was employed (Aria and Cuccurullo, 2017). During the analysis, Multiple Correspondence Analysis (MCA) was first applied to determine the semantic relationships between words. Concepts were mapped on a two-dimensional plane, with explained variance ratios (Dim 1: 52.53%, Dim 2: 17.91%) reported. Additionally, a trend topics analysis was conducted to identify the evolution of research themes over the years, their periods of popularity, and current areas of study.

The data obtained through the analysis tools detailed above are presented systematically in the following section. The findings begin with general publication performance and descriptive statistics, followed by a detailed discussion focused on the intellectual structure, temporal evolution, and current conceptual trends of the literature.

3. FINDINGS AND DISCUSSION

3.1. General Overview of the Research Field and Descriptive Statistics

Within the scope of this analysis, a total of 752 original and review articles on OHS performance were identified. Although the earliest studies in this field date back to the 1980s, the analysis begins with publications from 2000, as earlier works were limited in number and a more focused examination was intended.



Figure 3: Number of Publications and Citation Data by Year in the Field of OHS Performance*

* 2025 data are partial and cover records indexed up to December 1, 2025.

Figure 3 demonstrates a clear upward trend in the number of publications on OHS performance between 2000 and 2025. The sharp rise in 2008 can be attributed to the increased academic interest in OHS management systems following the publication of the OHSAS 18001:2007 standard. Similarly, the rapid growth observed during the 2018–2022 period may be associated with the global awareness and standard transition process following the adoption of ISO 45001:2018. Reaching a peak with 80 publications in 2022, this trend indicates that OHS performance research gains significant momentum during periods when international OHSMS standards are released.

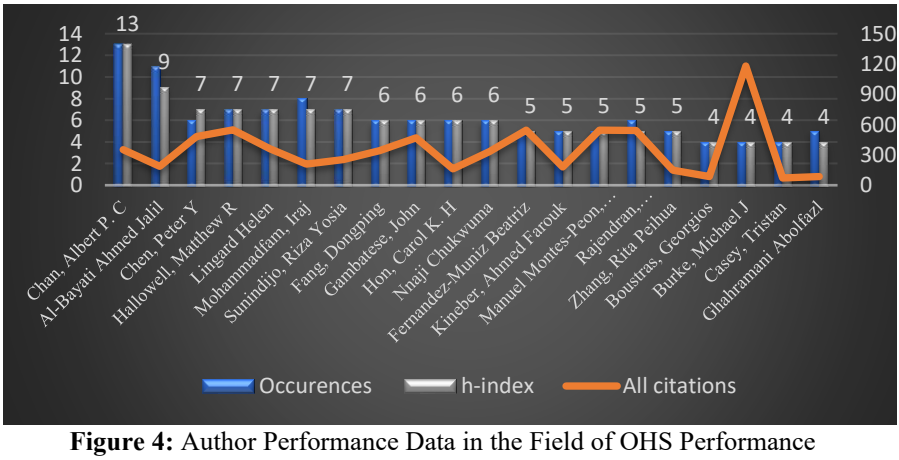

Figure 4: Author Performance Data in the Field of OHS Performance

Figure 4 compares the number of publications (occurrences), h-index, and all citations for the top 20 authors ranked by h-index among 2256 researchers. While Chan Albert P. C. (13 publications) and Al-Bayati Ahmed Jalil (11 publications) stand out for their high publication counts, their high h-index values also demonstrate both productivity

and significant influence in the field. Notably, Burke Michael J. attracts attention with 1180 citations despite having only 4 publications. This suggests that a limited number of high-impact publications can significantly enhance academic visibility. Furthermore, authors such as Chen Peter Y., Hallowell Matthew R., Lingard Helen, Mohammadfam Iraj, and Sunindijo Riza Yosia provide consistent academic contributions with balanced publication and citation profiles, all maintaining an h-index of 7.

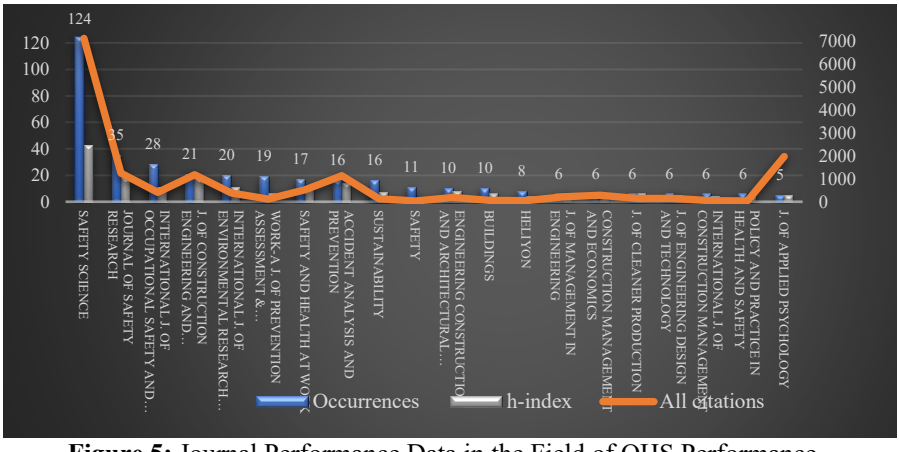

Figure 5: Journal Performance Data in the Field of OHS Performance

Based on the data presented in Figure 5, Safety Science emerges as the leading journal among the 271 journals publishing in the field of safety performance, standing out by a wide margin with 124 publications and 7122 citations, and demonstrating the highest academic impact with an h-index of 43. It is followed by Journal of Safety Research and International Journal of Occupational Safety and Ergonomics in terms of publication count. Despite its relatively low publication volume, Journal of Applied Psychology attracts considerable attention, receiving 1979 citations from only five publications. This finding reinforces the earlier observation regarding authors—that a limited number of highly influential publications can generate substantial academic visibility. Although publication count, citation numbers, and the h-index generally exhibit a parallel relationship, certain journals constitute notable exceptions due to the high impact of their published studies.

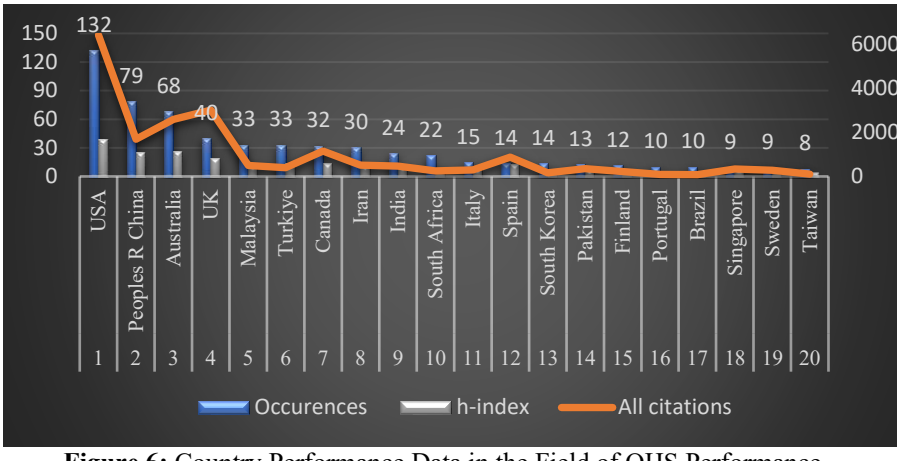

Figure 6: Country Performance Data in the Field of OHS Performance

According to Figure 6, among the 72 publishing countries, the United States emerges as by far the most productive and influential nation in safety performance research, with 132 publications, 6426 citations, and an h-index of 39. It is followed by China (79 publications, 1688 citations, h=25), Australia (68 publications, 2600 citations, h=26), and the United Kingdom (40 publications, 3012 citations, h=19). Notably, the United Kingdom (75.3), Spain (63.0), the United States (48.6), and Australia (38.2) stand out for their high average citations per publication. Turkiye demonstrates significant productivity with 33 publications, showing a moderate impact with 403 citations, an h-index of 14, and an average of 12.2 citations per publication. Generally, while a strong correlation exists between publication count and total citations across countries, certain nations distinguish themselves through a lower volume of highly influential work.

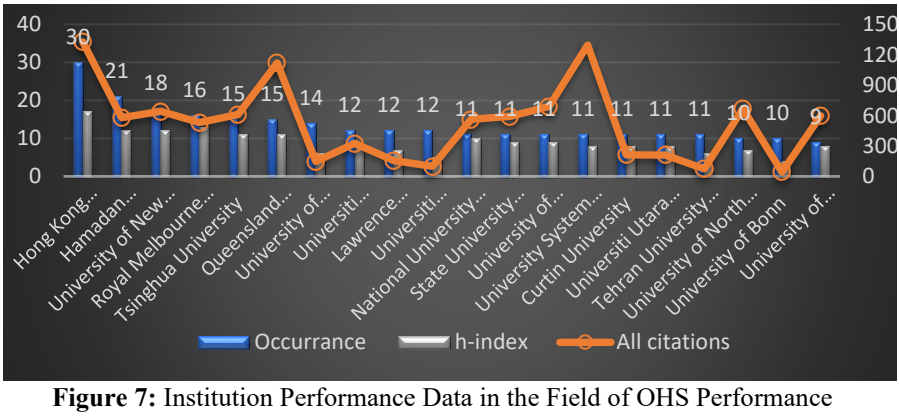

Figure 7: Institution Performance Data in the Field of OHS Performance

Based on the institutional performance data in Figure 7, the Hong Kong Polytechnic University emerges as the most productive institution in the field, leading in both

publication count (30) and citation impact (1326). The analysis reveals that a high volume of publications does not always equate to high impact; for instance, the University System of Georgia demonstrates "quality over quantity" by achieving a remarkably high citation count (1295) with fewer publications (11). In a list dominated geographically by US and Australian universities, the presence of institutions from countries such as Iran and Malaysia indicates that the subject possesses a broad research network on a global scale.

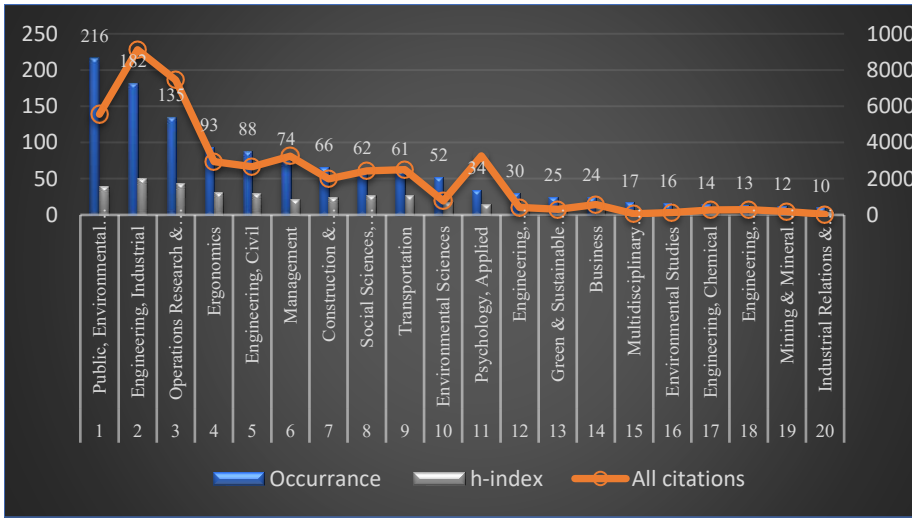

Figure 8: Publication Performance Data by WoS Categories in the Field of OHS Performance

Based on the Web of Science category data in Figure 8, research on OHS performance demonstrates a clearly multidisciplinary structure. While the category of "Public, Environmental & Occupational Health" (n=216) ranks first in terms of publication count, an analysis of academic impact reveals that "Industrial Engineering" emerges as the most influential field, reaching 9120 citations and an h-index of 50 with 182 publications. Similarly, "Operations Research & Management Science" (n=135, 7448 citations, h=44) stands out as a core area of high impact. The most striking finding, however, is observed in the "Applied Psychology" category; despite having only 34 publications, it received 3255 citations—achieving a remarkably high average of 95.7 citations per publication—thereby demonstrating that qualitative impact can develop independently of quantity. Overall, the data indicate that OHS performance studies generate a higher academic impact within the framework of industrial engineering and management sciences rather than occupational health sciences alone.

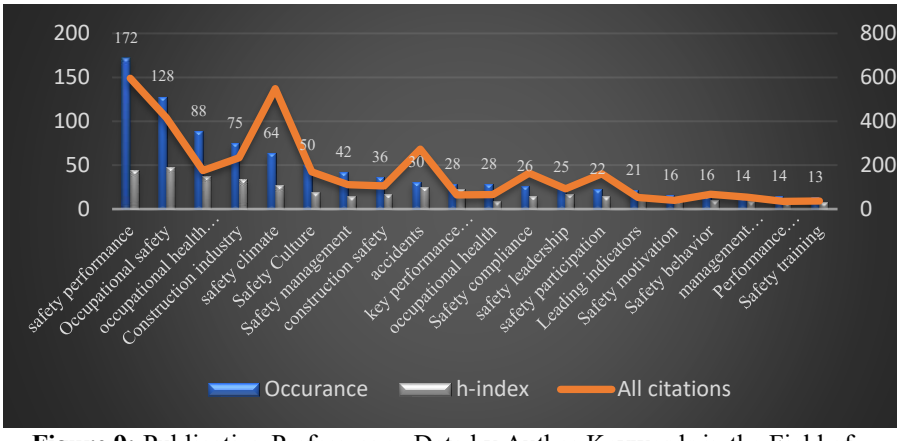

Figure 9: Publication Performance Data by Author Keywords in the Field of OHS Performance

An examination of the author keywords in Figure 9 reveals that the literature is primarily clustered around the concept of "safety performance" (n=172), as expected. On a sectoral basis, the highest concentration occurs within the "construction industry" with 75 occurrences. Furthermore, the prominent ranking of concepts such as "safety climate" (64), "safety culture" (50), and "safety leadership" (25) indicates that research has shifted toward human- and management-oriented topics—such as safety climate, culture, and leadership—rather than focusing solely on technical measures. Additionally, key performance indicators (KPIs) stand out as a fundamental element used in the measurement of OHS performance.

3.2. Conceptual and Intellectual Structure of the Research Field

Beyond the quantitative growth of the OHS performance literature, understanding the semantic relationships, theoretical foundations, and disciplinary boundaries behind this expansion is essential for a holistic assessment of the field's current state. Moving beyond descriptive statistics, this section examines the cognitive architecture of the research landscape through bibliometric mapping techniques. The analysis is structured across three fundamental dimensions: first, the dominant thematic clusters are identified through keyword networks; second, the structural positioning of concepts specifically their technical and social dimensions is mapped using Multiple Correspondence Analysis; and finally, the influential schools of thought shaping the literature are revealed through author co-citation analyses.

3.2.1. Thematic Clusters and Keyword Network



Figure 10: Keyword Cloud in the Field of OHS Performance*

* During the data preprocessing stage, synonyms were merged, and sub-components were made visible by excluding the term "Safety Performance".

Figure 10 presents the keyword cloud in the field of OHS performance. The visualization reveals that the concept of "Climate" is positioned at the center of the literature. This indicates that researchers accept organizational climate as the primary reference point and a leading indicator when evaluating safety performance. Following the concept of climate, the dominance of "Management" and "Occupational Health" terms suggests that performance is attributed to the effectiveness of management systems rather than solely to individual worker behaviors. Furthermore, the disproportionate size of the term "Construction" compared to other sectors confirms as previously noted that the safety performance literature is largely shaped by the dynamics of the construction industry, where high-risk factors trigger substantial academic output.

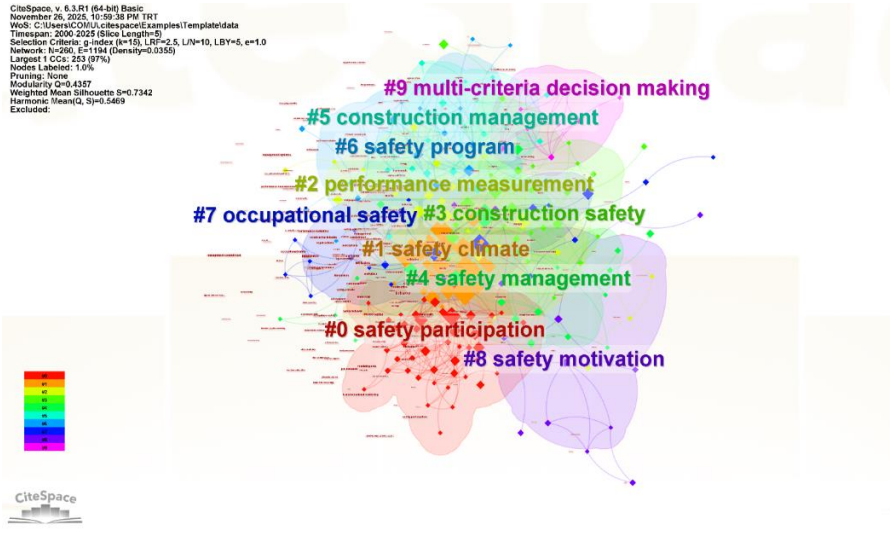

Figure 11: Keyword Cluster Map*

* Each color block represents a cluster, and all nodes within a color block belong to that specific cluster. The larger the cluster number, the smaller the cluster size.

The CiteSpace keyword co-occurrence network analysis presented in Figure 11 reveals the evolution, major trends, and intellectual structure of the safety performance literature over the past 25 years. Within this structure, keywords are grouped into 10 fundamental clusters: safety participation (Cluster #0), safety climate (Cluster #1), performance measurement (Cluster #2), construction safety (Cluster #3), safety management (Cluster #4), construction management (Cluster #5), safety program (Cluster #6), occupational safety (Cluster #7), safety motivation (Cluster #8), and multi-criteria decision making (Cluster #9). The silhouette values, average publication years, and dominant keywords for these clusters are detailed in Table 1.

Table 1: Details Regarding Keyword Clusters

Cluster	Size	Silhouette	Mean year	Keywords (Sorted from highest to lowest frequency)
Cluster #0	45	0.612	2016	workplace safety, transformational leadership, mediating role, motivation, meta-analysis, safety compliance, risk perception, safety participation, antecedents, safety behavior, job demands, perceived organizational support, engagement, safety leadership, communication, structural equation modeling, leader member exchange, moderating role, behaviors
Cluster #1	35	0.816	2007	climate, safety performance, performance, management, model, behavior, culture, accidents, safety climate, impact, leadership, work, safety culture, occupational health and safety, workers, perceptions, validation, construction, attitudes, workplace, management commitment, outcome, dimensions, organizations, commitment, transactional leadership
Cluster #2	31	0.582	2014	risk, leading indicators, system, risk management, occupational health, quality, performance measurement, environment, organizational safety, key performance indicators, lagging indicators, strategy, productivity, labor and personnel issues
Cluster #3	29	0.738	2014	industry, construction industry, construction safety, prevention, design, risk assessment, indicators, occupational accidents, work environment, health and safety performance, interventions, fatality, construction project, management system, BIM, supervisory practices, job satisfaction, barriers, sector

Cluster #4	24	0.737	2010	occupational health, injury, safety management, safety, management system, construction workers, stress, identification, technology, knowledge, occupational injury, models, resilience, fatigue, challenges, delphi method
Cluster #5	23	0.782	2018	OHSAS 18001, implementation, consequences, occupational safety and health, hazard identification, certification, performance indicators, employee, integration, company, oil, self-efficacy, sustainable development, information modeling BIM, construction management, sites, social identity, psychological safety, construction projects, augmented reality, ISO 45001
Cluster #6	21	0.833	2016	framework, management systems, improvement, information, developing country, benefits, efficiency, mental health, safety management system, safety program, employees, care, issue, maturity, developing countries, DEA, firm performance, decision making units, psychosocial factors, corporate social responsibility
Cluster #7	21	0.775	2010	occupational safety, health, systems, intervention, safety training, behavior-based safety, contractors, feedback, simulation, knowledge management, risk based management
Cluster #8	15	0.81	2018	safety motivation, management practices, roles, occupational safety, patient safety, organization, corporate social responsibility, safety knowledge, validity, fit index, trust, injury rates, acute care, healthcare professionals
Cluster #9	9	0.954	2020	selection, decision making, fuzzy AHP, multi-criteria decision making, age, innovation, FMEA, employment, analytic hierarchy process

An examination of the clustering indicators presented in Table 1 reveals that the silhouette values for all clusters exceed 0.5, indicating that the network structure possesses a high degree of homogeneity (Chen et al., 2010: 1391). These ten fundamental clusters demonstrate that safety performance research is not a one-dimensional structure but is instead organized around three main axes: “managerial systems” (Clusters #2, #4, #6), “behavioral dynamics”(Clusters #0, #1, #8), and “sectoral/methodological applications” (Clusters #3, #5, #9). In particular, the size of the “Safety Participation” (Cluster #0) and “Safety Climate” (Cluster #1) clusters serves as an indicator of the field’s expansion from technical measurements toward human-oriented approaches. The historical development of these clusters and their interactions will be detailed in the following sections through a timeline analysis (See Section 3.3.1).

3.2.2. Conceptual Architecture of the Literature: Technical and Social Dimensions

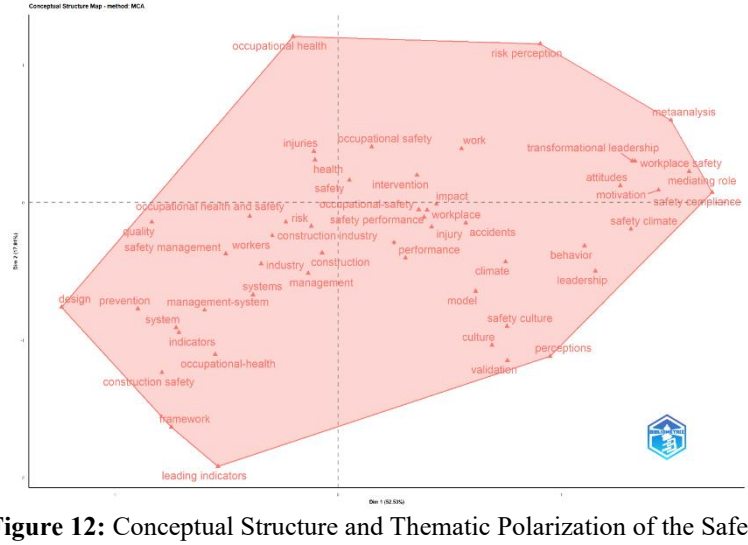

Figure 12: Conceptual Structure and Thematic Polarization of the Safety Performance Literature

The Multiple Correspondence Analysis (MCA) map presented in Figure 12 provides a high representative power for the conceptual architecture of the research field, explaining 70.44% of the total variance in the dataset (Dim 1: 52.53% and Dim 2: 17.91%). While this high explanatory power reliably reflects the general structure of the literature, an examination of the distribution reveals that the first dimension—explaining 52.53% of the variance on its own—constitutes the primary differentiating factor in the field. The distinct polarization along this axis clearly demonstrates that OHS performance research is shaped across two major theoretical planes.

An examination of this axis reveals a clear thematic divergence in safety performance research. The concepts positioned on the right plane of the map—including transformational leadership, mediating role, safety climate, motivation, safety compliance, safety culture, attitudes, and behavior—represent the social and behavioral dimensions of the field. In contrast, the concepts concentrated on the left plane, such as prevention, design, management-system, and leading indicators, constitute the technical and structural dimensions of the research landscape.

This finding aligns perfectly with Socio-Technical Systems Theory, which emphasizes that safety performance is not a one-dimensional output but rather emerges from a combination of the organization's technical and social subsystems. As noted by Appelbaum (1997: 453), while traditional approaches often attempt to design the technical component first and then adapt the human element to it, this typically results in mediocre performance. Successful organizational development is only possible when neither the technical nor the social system operates at the expense of the other; instead, it requires the "joint optimization" of both systems. These analysis results empirically demonstrate that researchers, rather than focusing solely on technical infrastructure or the human factor, are moving toward an integration of these two dimensions in a mutually supporting structure.

3.2.3. Intellectual Foundations and Scientific Schools

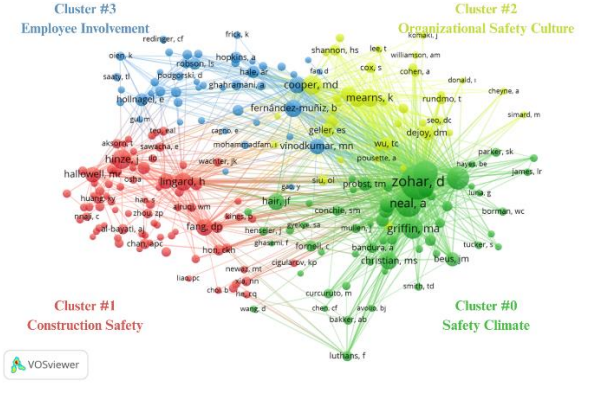

Figure 13: Author Co-citation Network Visualization Map*
* Generated using VOSviewer; node size indicates citation weight, and colors represent clusters.

An author co-citation analysis was conducted to identify the pioneering authors who define the theoretical boundaries of the research field and the intellectual links between these actors. Figure 13 presents the author co-citation network visualization map created using VOSviewer software based on data obtained from the Web of Science database. Aiming to uncover the "invisible colleges" in scientific communication, co-citation analysis is a method that detects intellectual similarities between scientific studies, publications, or authors. When pairs of authors are cited together across multiple works, specific clusters of research tend to form within the literature (Van Eck and Waltman, 2010). In this analysis, the size of the nodes represents the most frequently cited authors, while the colors indicate the research clusters to which the authors belong. The results reveal that authors are grouped into four fundamental clusters—represented by red, green, blue, and yellow—based on their thematic focus within the literature.

While VOSviewer successfully reveals the relational networks and collaboration patterns among authors, it remains limited in defining the conceptual content and thematic labels of the resulting clusters. Consequently, to delve deeper into the semantic content and thematic focuses of these author clusters, the advanced cluster labeling algorithms of CiteSpace software were utilized. According to the findings detailed in Table 2 and the temporal evolution shown in Figure 14, the intellectual structure of the OHS performance literature is shaped along four main axes: (1) "Safety Climate," led by Zohar and Neal, which constitutes the largest cluster; (2) the sector-specific "Construction Safety," represented by Hinze and Lingard; (3) "Organizational Safety Culture," pioneered by figures such as Reason and Mearns; and (4) "Employee Participation," identified with Fernández-Muñiz. This thematic classification provides concrete data on how the field has followed a theoretical progression in both technical (construction/engineering) and behavioral (climate/culture) dimensions.

Table 2: Research Clusters, Representative Authors, and Thematic Focus Points Identified via Author Co-citation Analysis

Cluster No	Cluster Label	Size	Silhouette	Avg. Year	Representative Authors	Main Focus
0	Safety Climate	58	0.866	2012	Zohar, D Neal, A Griffin, Ma Clarke, S Hoffman, Da Christian, Ms	Leadership Safety Behavior Safety Compliance Safety Leadership Safety Management Practices Safety Participation Transformational leadership
1	Construction Safety	55	0.872	2015	Hinze, J Lingard, H Hallowell, Mr Fang, Dp	Barriers Behavior-Based Safety Construction Management Health and Safety Machine Learning Management Commitment
2	Organizational Safety Culture	47	0.746	2006	Reason, J Mearns, K Cooper, Md Dejoy, Dm	Ergonomics Management Manufacturing Occupational Injury Safety Management Training
3	Employee Involvement	31	0.824	2017	Fernández-Muñiz Vinodkumar, Mn	Safety Culture Managers' Commitment Employees' Involvement

Organizational Safety Culture (Cluster #2, Yellow): With an average publication year of 2006, this cluster forms the historical and theoretical foundation of the literature. At the center of this group are James Reason (1990), who is widely regarded as the leading authority on human error management for explaining organizational accidents through the "Swiss Cheese Model", alongside Mearns and Cooper. This school of thought approaches safety not merely through individual errors but from a broad organizational culture perspective that encompasses managerial, ergonomic, and educational processes.

Safety Climate (Cluster #0, Green): Representing the largest and most central structure of the network with an average publication year of 2012, this cluster constitutes the backbone of the literature. This group brings together Zohar (1980), who is considered the pioneer of the field for defining safety climate as an influence that shapes people's risk perception, with Neal and Griffin, who established the concept within a formal model. This school of thought shifted the focus of the literature from abstract cultural discussions toward safety climate, which is a more specific and measurable phenomenon. In this context, Neal and Griffin (2000) empirically demonstrated that safety climate has a direct and positive impact on employees' safety compliance and safety participation behaviors, thereby establishing the behavioral foundations of safety performance.

Construction Safety (Cluster #1, Red): With an average publication year of 2015, this cluster represents the adaptation of theoretical models to the specific dynamics of the construction industry. Within this school of thought, Hinze (2013a; 2013b) investigated construction management and the use of leading indicators in projects, while Hallowell (2016) developed data-driven predictive models through machine learning, and Lingard (2025) contributed studies that outline collaborative management strategies among stakeholders.

Employee Involvement (Cluster #3, Blue): Led by Fernández-Muñiz and Vinodkumar, this cluster represents the most recent school of thought with an average publication year of 2017. Fernández-Muñiz (2007) positioned managers' commitment as the driving force of the system and demonstrated that management systems established with executive support encourage the active employees' involvement in decision-making processes, which in turn directly improves safety performance. Consequently, this school represents an approach that views the employee as the ultimate barrier against risks and treats human error not as a primary cause but as a consequence of managerial processes.

The results of the author co-citation analysis clearly illustrate the trajectory of safety performance research over time. The general approach, which initially focused on the causes of accidents under the leadership of Reason (Cluster #2), has since given way to a more concrete understanding that measures employee behavior and safety climate through the work of Zohar and Neal (Cluster #0). In the subsequent period, Hinze (Cluster #1) applied this theoretical knowledge to the construction sector by integrating it with data and technology. Today, with Fernández-Muñiz (Cluster #3),

the focus has shifted toward an integrated model where management systems and employee involvement are intertwined. This evolution demonstrates that safety performance is no longer achieved solely through technical measures but through the harmonious operation of the human factor and technology.

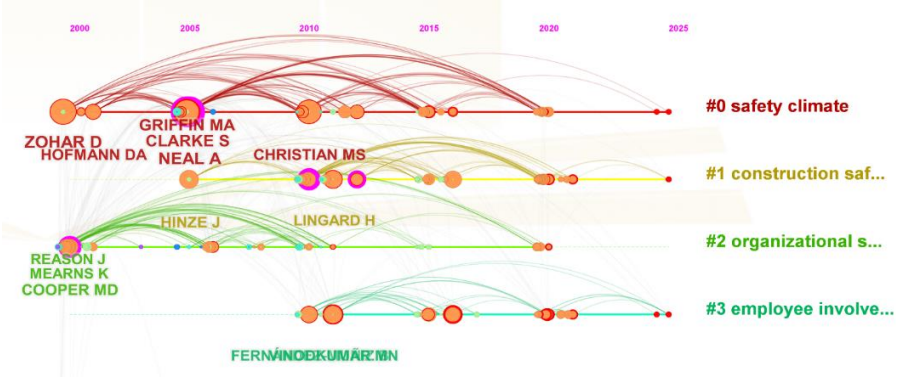

Figure 14: Temporal Evolution of Research Clusters Identified via Author Co-citation Analysis*

* Generated using CiteSpace; time slice = 5 years, g-index k = 15, pruning = Pathfinder.

A timeline analysis was also conducted via CiteSpace to track the temporal dynamics and historical continuity of the research clusters within the author co-citation network. The visualization presented in Figure 14 illustrates the periods during which the schools of thought in the safety performance literature were active and how they have evolved. Accordingly, while Cluster #2 (Organizational Safety Culture) and Cluster #0 (Safety Climate) constitute the deep-rooted and long-standing theoretical foundations of the literature, Cluster #3 (Employee Involvement) stands out as a research area that has become prominent more recently. Furthermore, the citation flows in the timeline indicate that after 2010, the research focus shifted from static models that merely measure the system toward dynamic processes that center on employee involvement and the human factor.

3.3. Temporal Evolution and Research Trends

In this section, the evolution of the OHS performance literature from the past to the present and the direction in which it has transformed are examined. To illustrate the historical journey of research topics in the field of safety performance, a timeline analysis is provided below, followed by detailed trend and citation burst analyses aimed at identifying current focal points and emerging trends.

3.3.1. Temporal Evolution of Research Themes

A CiteSpace timeline analysis, shown in Figure 15, was conducted to track the temporal evolution and life cycles of the research clusters whose static frameworks were outlined in Figure 11 and Table 1. On the map, the length of the horizontal lines

represents the currency of the topics, while the size and color temperature of the nodes indicate the citation intensity during the respective periods. When the visual data and cluster contents are evaluated holistically, the evolution of the OHS performance literature can be characterized in four fundamental periods:

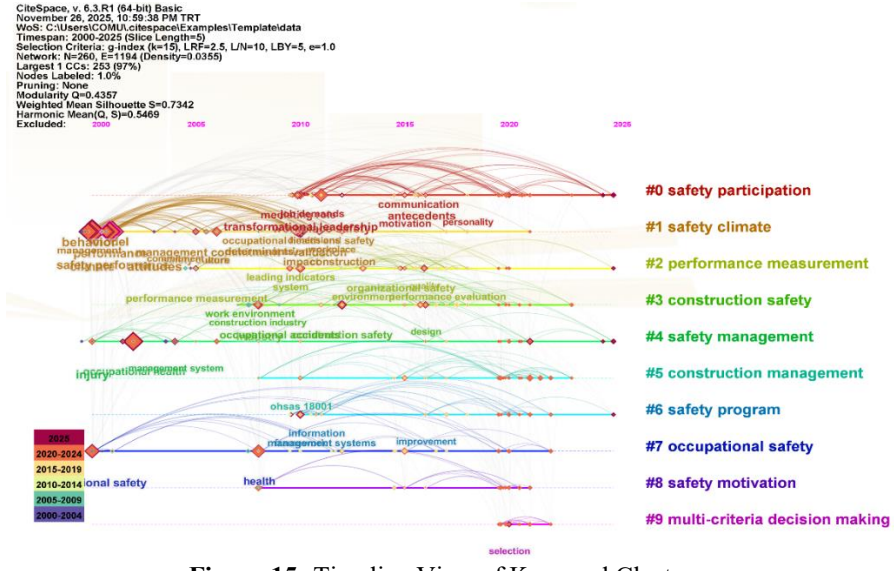

Figure 15: Timeline View of Keyword Clusters

Fundamental Structure and Historical Origins (2007-2010): When the foundations of the safety performance literature are examined, it is evident that research in the initial period focused on cultural and managerial infrastructure rather than physical measures. Cluster #1 (Safety Climate), which has an average publication year of 2007, forms the most deep-rooted structure of the field by centering on concepts such as "safety culture" and "management commitment." Studies conducted during this time demonstrated that measuring safety climate provides opportunities for enterprises to improve their safety performance (Clarke, 2006: 315). Following this period, Cluster #4 (Safety Management) and Cluster #7 (Occupational Safety), both centered around 2010, represent the establishment of the safety phenomenon within a systemic framework. Topics emerging in these clusters, such as occupational health management and behavior-based safety training, indicate that researchers approached safety performance as a corporate management system and an organizational whole.

Measurement Orientation and Sectoral Deepening (2014): Around 2014, the trajectory of the literature evolved from the establishment of management systems toward the concrete measurement of performance. Cluster #2 (Performance Measurement) serves as the clearest indicator of this transition. During this period, researchers shifted their focus from the question of "how do we manage?" toward "how do we measure?" as key performance indicators, leading indicators, and risk management strategies gained prominence. Simultaneously, the emergence of Cluster

#3 (Construction Safety) indicates that safety research became concentrated in the construction sector, which is recognized as one of the most high-risk industries.

Human Factor, Leadership, and Psychological Dimension (2016-2018): The most significant divergence and concentration in the literature occurred during the 2016-2018 period, when the human factor was placed at the center of research. Cluster #0 (Safety Participation), which is the largest group in the analysis with an average publication year of 2016, reinforced the view that safety is ensured not only through rules but through active employee involvement. Within this cluster, concepts such as transformational leadership, engagement, and organizational support are predominant. There is a growing body of evidence indicating a positive relationship between transformational leadership and employees' safety performance behaviors. Studies have shown that behaviors specific to transformational leadership are associated with both safety participation and compliance with safety rules among employees (Mullen et al., 2017: 406). In parallel, Cluster #6 (Safety Program) and Cluster #8 (Safety Motivation) explored corporate social responsibility, employee mental health, and motivational factors. During this period, safety began to be viewed as a component of corporate culture through corporate social responsibility rather than merely a legal obligation (Granerud, 2011: 119). Furthermore, the emphasis on patient safety in Cluster #8 indicates that the concept of safety performance has expanded beyond industrial boundaries into diverse fields such as healthcare.

Technology Integration and Advanced Decision-Making Methods (2018-2020): Recent studies are characterized by the integration of digitalization and analytical decision-making processes into the field. Cluster #5 (Construction Management) emphasizes the role of Industry 4.0 technologies, such as Building Information Modeling (BIM) and Augmented Reality (AR), alongside ISO 45001 standards in safety management. Cluster #9 (Multi-criteria Decision Making), which is the most current cluster in the analysis with an average year of 2020, indicates that the field has reached methodological maturity. Researchers now aim to produce more precise and data-driven results by employing complex mathematical models such as Failure Mode and Effects Analysis (FMEA), which addresses potential errors and risks through a proactive approach, in addition to multi-criteria decision-making techniques like the Analytic Hierarchy Process when evaluating safety performance.

The developmental trajectory revealed by the current bibliometric map demonstrates that the field has progressed from cultural foundations toward analytical modeling. This trend indicates that safety performance research is poised to shift toward the axis of Predictive and Proactive Safety Management in the future. In particular, the recent concentration on multi-criteria decision-making (Cluster #9) and technology-driven management systems (Cluster #5) suggests that the field is evolving toward the concepts of Safety 4.0 and Safety 5.0. In future studies, it is expected that static performance indicators will be replaced by real-time data collected through the Internet of Things (IoT) and wearable sensors. Furthermore, existing mathematical models are anticipated to transform into hybrid systems that predict accidents before they occur, supported by Artificial Intelligence and Machine Learning algorithms.

Additionally, the interaction between the human factor, which holds a strong position in the literature, and digitalization stands out as an unexplored and high-potential research area for scholars, especially when redefined in line with sustainability goals.

3.3.2. Emerging Trends and Citation Bursts

In this study, CiteSpace (citation burst) and Biblioshiny (trend topics) analyses were evaluated together to reveal the historical development and current orientations of the safety performance literature. When the findings obtained from Figure 16 and Figure 17 are synthesized, the evolutionary process of the field can be clearly tracked.

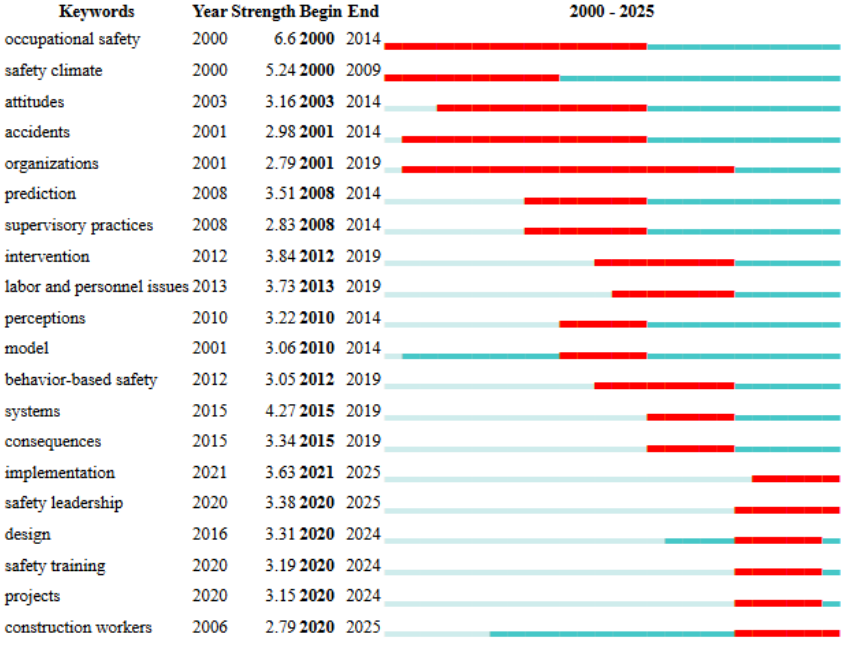

Figure 16: Temporal Citation Burst Analysis of Keywords (Top 20 Keywords)

The citation burst analysis presented in Figure 16 summarizes the evolution of the safety performance literature over the last 25 years in three distinct periods. The first period, spanning from 2000 to 2014, is when the conceptual framework of the field was established. During this time, the concepts of "occupational safety" and "safety climate," which possessed the highest burst strength, dominated the literature, and research focused primarily on basic safety perception and the phenomenon of accidents. The second period, from 2012 to 2019, is the stage where the focus shifted from definition toward prevention. The concentration of keywords such as "prediction," "intervention," and "systems" indicates that researchers moved from reactive approaches toward proactive and systemic models. The third and current period, covering 2020 to 2025, is characterized as the era of leadership and

implementation. The concepts of "safety leadership," "implementation," and "safety training," where the red bars extend to the present day, reveal that the effective field application of existing theoretical models and their support through leadership mechanisms constitute the most prominent research topics today.

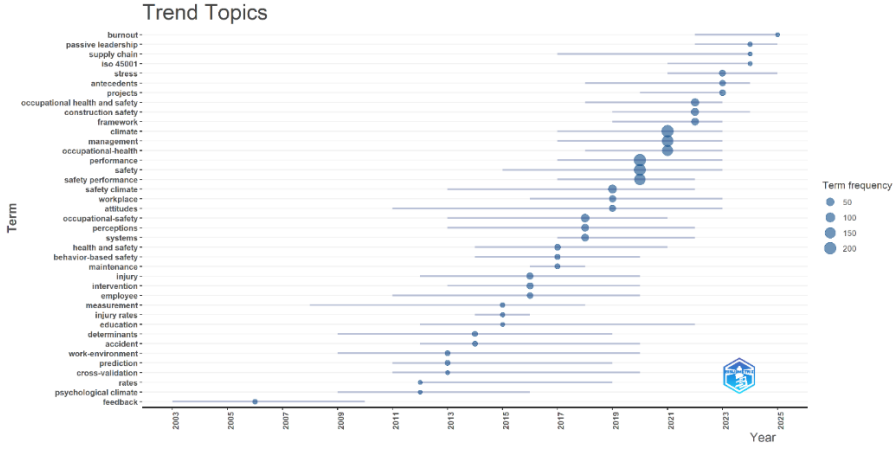

Figure 17: Trend Topics Regarding OHS Performance

The Biblioshiny analysis presented in Figure 17, which details the historical flow, reveals the psychosocial depth the literature has gained in recent years. In particular, the significant increase in the concepts of burnout and stress is noteworthy. This situation confirms Appelbaum's (1997, s. 458) emphasis on the social subsystem. The results indicate that employee well-being has now become an integral part of safety performance.

In addition to these points, the analyses provide evidence that the operational boundaries of the field have expanded. In particular, the rise of "ISO 45001" standards and the concept of the "supply chain" serve as significant indicators of this trend. Indeed, ISO 45001 certifications are recognized by workplaces and international supply chains across different countries, enabling enterprises to document their OHS performance in global markets. These findings reveal that safety performance is no longer limited to internal organizational dynamics; instead, it is now approached through a global and integrated perspective that encompasses supplier networks.

CONCLUSION AND FUTURE DIRECTIONS

When the literature between 2000 and 2025 is examined within the scope of this study, it is observed that safety performance research has undergone a dynamic transformation process consisting of three fundamental stages. While studies in the first stage of the literature were predominantly built upon the concepts of culture and climate, the focus shifted toward system and behavior topics in the subsequent period. Today, the field has assumed a more integrated structure dominated by leadership, technology, and analytical decision-making. In particular, the momentum gained by

the concepts of implementation and safety leadership in recent years clearly demonstrates that academic interest has moved away from theoretical discussions toward concrete field applications and sustainability.

The findings obtained provide evidence that the operational boundaries of safety management have expanded. The rise of topics such as the supply chain and ISO 45001 indicates that safety has moved beyond being a closed process managed only within factory walls or construction sites. Instead, it has transformed into a global ecosystem that encompasses supplier networks and international standards. In this context, technical measures alone are insufficient for improving occupational health and safety performance; management approaches must also keep pace with this transformation. The analysis results emphasize that it is of critical importance for managers to move beyond their traditional roles of merely supervising rules and instead adopt a transformational leadership style that listens to, motivates, and encourages employees toward safe behaviors.

On the other hand, the increasing prevalence of the concepts of stress and burnout in the literature demonstrates that employee mental health cannot be considered separately from occupational safety. Enterprises and policymakers must not limit risk assessment processes to physical hazards alone; instead, they must incorporate excessive workload and psychosocial risk factors into these processes. Furthermore, it has become a necessity for sustainable safety performance that traditional reactive approaches focusing on post-accident data (lagging indicators) be replaced by proactive early warning systems (leading indicators) that monitor employee behaviors, near-miss events, and risk tendencies.

Current literature appears to be heavily concentrated on the construction sector. Therefore, exploring safety performance dynamics in diverse fields such as the service sector, logistics, and especially the gig economy, where flexible working models are becoming increasingly prevalent, will significantly contribute to filling this critical gap. Furthermore, it is recommended that businesses and policymakers expand their risk assessment frameworks beyond purely physical hazards to incorporate a broader perspective that encompasses excessive workload and psychosocial risk factors.

While bibliometric analyses strongly point toward the rise of digitalization and the Safety 4.0 paradigm, future research must now pivot toward Industry 5.0 principles, which prioritize human-centric, sustainable, and resilient systems. In this context, Multi-Criteria Decision Making and fuzzy logic models should be integrated with deep learning and Artificial Intelligence algorithms to yield more dynamic and objective results. Specifically, the development of AI-based hybrid models for accident prediction and proactive risk management will enhance the methodological maturity of the field. Karatas (2025: 12-13) demonstrated that accelerometer, gyroscope, and pressure data collected from construction workers can be analyzed through deep learning models to identify work-at-height conditions and support real-time safety alerts. This example illustrates how AI-supported hybrid models can transform sensor-based monitoring into proactive safety interventions. This shift will

enable researchers to analyze not only technical efficiency but also the cognitive load and psychosocial impacts of technology on employees, aligning with the core tenets of the emerging industrial landscape.

İŞ SAĞLIĞI VE GÜVENLİĞİ PERFORMANSI ÜZERİNE BİBLİYOMETRİK BİR ANALİZ: KÜRESEL EĞİLİMLER VE TEMATİK YAKLAŞIMLAR

1. GİRİŞ

İş sağlığı ve güvenliği, günümüz küresel rekabet ortamında işletmelerin sürdürülebilirliği, çalışan esenliği ve kurumsal itibar yönetimi açısından stratejik bir zorunluluk haline gelmiştir. Uluslararası Çalışma Örgütü verileri, her yıl yaklaşık 3 milyon kişinin işle ilgili nedenlerle hayatını kaybettiğini ortaya koyarak İSG yönetiminin yaşamsal önemini vurgulamaktadır. Bu bağlamda, İSG performansının ölçülmesi ve iyileştirilmesi yalnızca yasal bir uyum süreci değil, aynı zamanda verimlilik ve inovasyon kapasitesini artıran bir değer unsuru olarak değerlendirilmektedir.

Literatürde İSG yönetim sistemleri ve güvenlik kültürü gibi alt başlıklarda bibliyometrik çalışmalar bulunsa da, "İSG performansı" kavramını bütüncül bir perspektifle ele alan kapsamlı bir analize duyulan ihtiyaç bu çalışmanın temel motivasyonunu oluşturmaktadır. Bu araştırmanın amacı, 2000-2025 yılları arasındaki İSG performansı literatürünü sistematik olarak inceleyerek entelektüel yapıyı, tarihsel evrimi ve gelecekteki araştırma eğilimlerini haritalandırmaktır.

2. YÖNTEM

Araştırma, nitelikli ve yüksek etkili yayınlara odaklanmak amacıyla Web of Science Core Collection veri tabanından elde edilen 752 akademik yayın üzerinden yürütülmüştür. Veri toplama süreci PRISMA protokolüne uygun olarak şeffaf bir şekilde gerçekleştirilmiştir.

Çalışmada betimsel istatistikler, ağ haritalamaları ve kavramsal yapı analizlerini içeren çok boyutlu bir metodoloji benimsenmiş ve birbirini tamamlayan dört farklı yazılım aracı kullanılmıştır. Verilerin ön işlenmesi ve performans analizleri için BibExcel; entelektüel yapının ve yazar ortak atıf ağlarının görselleştirilmesi için VOSviewer; zamansal evrim, araştırma kümeleri ve atıf patlamalarının tespiti için CiteSpace; çoklu uyum analizi ve trend konuların belirlenmesi için ise Biblioshiny yazılımları kullanılmıştır.

3. BULGULAR VE TARTIŞMA

Analiz sonuçları, İSG performansı literatürünün özellikle ISO 45001 gibi uluslararası standartların yayımlandığı dönemlerde ivme kazandığını ve 2022 yılında zirve noktasına ulaştığını göstermektedir. ABD, yayın sayısı ve atıf etkisi bakımından alanın en baskın ülkesi olarak öne çıkarken; "Safety Science" dergisi en yüksek akademik etkiye sahip mecra olarak tespit edilmiştir.

Anahtar kelime küme haritasında tespit edilen on temel küme, güvenlik performansı araştırmalarının tek boyutlu bir yapıdan ziyade; yönetimsel sistemler (Küme #2, #4,

#6), davranışsal dinamikler (Küme #0, #1, #8) ve sektörel/metodolojik uygulamalar (Küme #3, #5, #9) olmak üzere üç ana eksen etrafında kesiştiğini göstermektedir. Özellikle "Güvenlik Katılımı" (Küme #0) ve "Güvenlik İklimi" (Küme #1) kümelerinin büyüklüğü, alanın teknik ölçümlerden insan odaklı yaklaşımlara doğru genişlediğinin bir göstergesidir.

Yazar ortak atıf analizi, literatürün dört temel entelektüel ekol etrafında şekillendiğini göstermektedir. Bu ekoller; (1) Zohar ve Neal öncülüğünde gelişen ve boyutu en yüksek kümeyi oluşturan "Güvenlik İklimi" , (2) Hinze ve Lingard'ın temsil ettiği sektörel odaklı "İnşaat Güvenliği", (3) Reason ve Mearns gibi öncülerin temellerini attığı "Örgütsel Güvenlik Kültürü" ve (4) Fernández-Muñiz ile özdeşleşen "Çalışan Katılımı" olarak tespit edilmiştir. Bu tematik sınıflandırma, alanın hem teknik (inşaat/mühendislik) hem de davranışsal (iklim/kültür) boyutlarda nasıl bir teorik gelişim izlediğini somut verilerle ortaya koymaktadır.

Çoklu Uyum Analizi sonuçları, literatürdeki teknik ve sosyal boyut ayrışmasının modern çalışmalarda bütünleşik bir yapıya evrildiğini göstermektedir. Bu durum, organizasyonları teknik ve sosyal alt sistemlerin birleşimi olarak gören Sosyoteknik Sistemler Teorisi ile tam bir uyum içindedir. Appelbaum'un (1997) belirttiği üzere, başarının anahtarı bu iki sistemin ortak optimizasyonu olup, sistemlerden birinin diğeri pahasına önceliklendirilmesi performansı zayıflatmaktadır. Analiz bulguları, araştırmacıların artık teknik altyapı ile insan faktörünü birbirini destekleyen bir bütün olarak ele aldıklarını göstermektedir.

İSG performansı alanındaki trend konularda "stres" ve "tükenmişlik" kavramlarının giderek daha fazla ön plana çıktığının görülmesi, çalışan ruh sağlığının iş güvenliğinden ayrı düşünülemeyeceğini göstermektedir. İşletmelerin ve politika yapıcıların, risk değerlendirme süreçlerini sadece fiziksel tehlikelerle sınırlı tutmayıp; aşırı iş yükü ve psikososyal risk faktörlerini de sürece dahil etmeleri gerekmektedir. Ayrıca, kaza sonrası verilere odaklanan geleneksel reaktif yaklaşımların yerini; çalışan davranışlarını, ramak kala olaylarını ve risk eğilimlerini izleyen proaktif erken uyarı sistemlerine bırakması, sürdürülebilir bir güvenlik performansı için zorunluluk haline gelmiştir.

SONUÇ

Bu çalışma kapsamında 2000-2025 yılları arasındaki literatür incelendiğinde, güvenlik performansı araştırmalarının kültürel temellerden başlayarak sistemsel yaklaşımlara, günümüzde ise teknoloji ve liderlik odaklı bütünleşik bir yapıya evrildiği görülmektedir. Özellikle son yıllarda uygulama ve güvenlik liderliği kavramlarının kazandığı ivme, akademik ilginin artık teorik tartışmalardan ziyade sahadaki somut uygulamalara ve sürdürülebilirliğe yöneldiğini ortaya koymaktadır. Elde edilen bulgular, İSG yönetiminin operasyonel sınırlarının fabrika duvarlarını aşarak tedarik zincirlerini ve uluslararası standartları kapsayan küresel bir ekosisteme dönüştüğünü göstermektedir. Bu bağlamda, teknik önlemlerin tek başına yeterli olmadığı, yöneticilerin geleneksel denetleyici rollerinden sıyrılarak çalışanları motive

eden dönüştürücü liderlik tarzını benimsemelerinin kritik bir zorunluluk haline geldiği görülmektedir.

Mevcut literatürün büyük ölçüde inşaat sektörü odaklı olması bir kısıtlılık olarak değerlendirilmekte; gelecek çalışmaların gig ekonomisi, lojistik ve hizmet sektörü gibi esnek çalışma alanlarına yönelmesi önerilmektedir. Ayrıca araştırmacıların, dijitalleşme ve Endüstri 4.0 kavramlarının ötesine geçerek; insan merkezli, dayanıklı ve sürdürülebilir sistemleri esas alan Endüstri 5.0 prensiplerine odaklanmaları gerekmektedir. Bu yeni dönemde, çok kriterli karar verme modellerinin yapay zeka ve makine öğrenmesi algoritmalarıyla desteklenen hibrit sistemlere dönüştürülmesi, proaktif risk yönetimi ve kaza tahmini süreçlerinde yöntemsel bir devrim yaratarak alanın gelişimini hızlandıracaktır.

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