Uncovering Global Research Patterns in Safety Risk Assessment: Insights from a Bibliometric Approach

Sofian Bastuti[1], Roslina Mohammad[2], Abdul Yasser Abd Fatah[3], Rini Alfatiyah[4]

Abstract

Safety Risk Assessment (SRA) has attracted considerable attention from both practitioners and scholars over the past decade, driven primarily by the increasing frequency of workplace accidents and occupational diseases, particularly in developing countries. This recognition has led many organizations to prioritize SRA as a fundamental practice for mitigating workplace hazards and enhancing occupational safety. This study aims to elucidate global research patterns in SRA by analyzing the distribution of related publications from the perspectives of authorship, countries, institutions, and research trends. Utilizing a bibliometric analysis approach, data were retrieved from the Scopus database and analyzed using VOSviewer software. A comprehensive analysis of 1888 research articles published between 1970 and 2023 was conducted, focusing on international collaboration, keyword co-occurrence, and thematic trends to identify prevailing topics and emerging areas in SRA research. The results reveal a notable increase in SRA-related publications since 2006, with an accelerated growth observed post-2018. China and the United States are highlighted as leading contributors, with China demonstrating significant intra-country research dominance. The analysis also indicates that keywords such as 'Safety Risk Assessment' and 'Food Safety' are frequently emphasized, underscoring core research interests in the identification and management of safety risks. Furthermore, the integration of advanced technologies, including the Internet of Things (IoT) and big data, represents a growing trend in the field. This study provides valuable insights into the current state and evolution of SRA research, serving as a foundational reference for future scholarly exploration and practical implementation.

Keywords: *Bibliometric Analysis, Scopus Database, Safety Risk Assessment (SRA), Countries Co-Authorship, Keywords Co-Occurrence, Indonesia.*

Introduction

Over the past decade, Safety Risk Assessment (SRA) has emerged as a critical area of focus for both practitioners and academics, driven by increasing workplace accidents and occupational illnesses, particularly in developing countries (Chen et al., 2022; Ünal et al., 2021). As industries across various sectors undergo rapid technological advancements and adopt increasingly complex operations, the risks associated with human involvement in production processes have intensified. These risks range from minor injuries to severe accidents, which can result in subtantial financial losses, production disruptions, and long-term reputational damage for companies (Bhattacharjee et al., 2022; Chen et al., 2022). Consequently, an increasing number of organizations are adopting SRA frameworks to proactively identify, evaluate, and mitigate workplace hazards, ultimately fostering safer work environments (Jaganathan & Mathesan, 2022). The importance of SRA is rooted in its ability to assess and address potential risks before they manifest into incidents. By systematically identifying hazards and evaluating their likelihood and impact, organizations can implement targeted measures that enhance the safety and well-being of employees while also reducing operational risks (Ak et al., 2022; Marhavilas et al., 2022). In this context, risk assessment serves as a foundation for safety management, offering a structured approach to minimize occupational hazards and prevent accidents.

Despite the significant body of research on **SRA**, the rapidly evolving industrial landscape calls for continuous updates and reflections on current research trends. The volume of research on SRA, found across databases such as Scopus, Web of Science (WoS), and PubMed, highlights its multidisciplinary nature and broad relevance (Dehdashti et al., 2020; Ji et al., 2022). However, the extensive number of publications

---

[1] Razak Faculty of Technology and Informatics, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia, Industrial Engineering, Pamulang University, Banten, Indonesia, Email: bastuti@graduate.utm.my, (Corrsesponding Author)
[2] aRazak Faculty of Technology and Informatics, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia
[3] aRazak Faculty of Technology and Informatics, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia.

[4] Industrial Engineering, Pamulang University, Banten, Indonesia

makes it challenging to identify key research themes, gaps, and future directions, underscoring the need for comprehensive bibliometric analyses. Such analyses not only consolidate existing knowledge but also shed light on emerging trends and research priorities, guiding scholars and practitioners in their pursuit of more effective risk assessment methodologies (Donthu et al., 2021; Ibrahim et al., 2023).

Although prior bibliometric studies have explored risk assessment in construction and other industries (Aliu et al., 2023; Tezel & Giritli, 2022), few have focused specifically on SRA using data from the Scopus database. Given the distinct scope of Scopus compared to WoS, a more targeted bibliometric analysis of SRA publications within Scopus is warranted. Scopus, recognized as the largest abstract and citation database of peer-reviewed literature, encompasses a broad range of disciplines and offers a more comprehensive view of global research trends in safety risk assessment (Aghaei Chadegani et al., 2013; Vendemiatti et al., 2021). Scopus is widely recognized as the largest abstract and citation database for peer-reviewed literature, covering a broad range of subjects (Abalkina, 2024; Renjith et al., 2021). This study leverages the vast repository of Scopus to address gaps in the existing bibliometric analyses, providing a detailed overview of global SRA research trends from a variety of perspectives, including authorship, institutional contributions, and international collaboration.

Thus, the primary objective of this study is to present a comprehensive bibliometric analysis of SRA-related research articles, drawing from a robust dataset within the Scopus database. By analyzing trends in publications, co-authorship patterns, and keyword co-occurrences, this study aims to map the current state of SRA research and highlight emerging themes. Furthermore, the study explores technological advancements such as the integration of the Internet of Things (IoT) and big data analytics in SRA, which represent promising areas for future research. Ultimately, this analysis provides insights that can serve as a reference point for both academic and industrial stakeholders, paving the way for more innovative and effective safety risk management practices. This study is expected to make a significant contribution to the development of safety risk assessment in the future by addressing two main research questions:

- What is the overall landscape and publication trend related to Safety Risk Assessment (SRA)?

- What opportunities exist for future investigations into Safety Risk Assessment (SRA)?

Method

A bibliometric analysis study is a mechanistic approach to understanding global research trends within a specific area based on results from academic literature databases (Greener, 2022). This approach differentiates a bibliometric analysis paper from a review paper, which focuses primarily on discussing recent advancements, challenges, and future directions within a particular topic (Lazarides et al., 2023).

Data Sources And Search Strategy

This study employs a bibliometric analysis approach to investigate global research trends in Safety Risk Assessment (SRA). Bibliometric analysis allows for a quantitative evaluation of academic publications and their interrelationships, offering insights into research dynamics within a specific domain (Donthu et al., 2021). The Scopus database was chosen as the data source due to its extensive coverage of peer-reviewed literature and its recognition as a leading citation database (Aghaei Chadegani et al., 2013).

Data collection was conducted on April 25, 2024, with the search covering publications from 1970 to 2023. The year 2024 was excluded to avoid incomplete data for the ongoing year. To ensure relevance, only research articles were included, while review articles, conference papers, and book chapters were excluded to focus solely on empirical studies. The search query used was: TITLE-ABS ("safety risk" assessment) AND (EXCLUDE (PUBYEAR, 2024)) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (SRCTYPE, "j")).

This query yielded 1,921 documents, which were further refined by eliminating review articles and documents lacking primary research. The final dataset consisted of 1,888 research articles. The data, including citation details, author information, and keywords, was exported in CSV format for further analysis. This data was subsequently processed using VOSviewer (version 1.6.19), a widely recognized tool for creating and visualizing bibliometric maps based on co-authorship, keyword co-occurrence, and citation networks.The data mining and report elimination process is summarized in Figure 1.
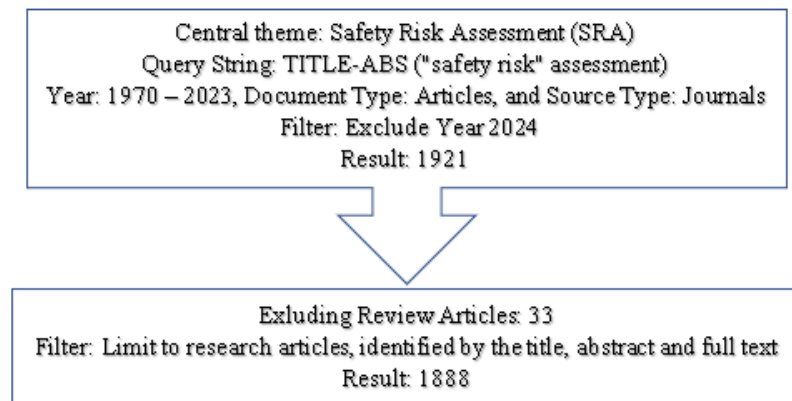

Figure 1. Illustrates The Flowchart Of Data Collection For Research Articles In SRA

Bibliometric Analysis Tools and Techniques

The analysis was carried out using VOSviewer (version 1.6.19), a tool widely recognized for visualizing bibliometric networks, and Microsoft Excel for supplementary data processing. The study comprised the following steps:

- Descriptive Analysis: The distribution of publications was assessed by year, subject area, and leading authors and institutions. Scopus' built-in analysis functions aided in summarizing publication metrics, such as subject categorizations and country-level contributions.

- Co-Authorship Analysis: Collaboration networks were visualized using VOSviewer to illustrate co-authorship patterns at both author and country levels. This analysis highlighted the degree of international collaboration and dominant research hubs.

- Keyword Co-Occurrence Analysis: To understand thematic trends and identify emerging research areas, a keyword analysis was conducted. Keywords from article metadata were cleaned and standardized to merge similar terms. VOSviewer's overlay visualization mode was used to map keyword occurrences and their average publication years, revealing thematic shifts and emerging topics within SRA research.

Data Interpretation and Visualization

The resulting bibliometric maps and networks provided insights into the extent of collaboration, the prominence of specific keywords, and the historical and emerging research focus. Trends in the use of new technologies, such as big data and IoT, were particularly noted to show their integration into modern SRA practices. This approach allowed for the identification of established and growing subfields, guiding future research efforts in the domain.

Limitations

 While this method offers a comprehensive quantitative overview, it does not capture the qualitative impact of studies. The reliance on Scopus may also limit the inclusion of relevant research from other databases,

such as Web of Science and PubMed. Future studies may consider incorporating multiple databases and qualitative content analyses to provide a more holistic understanding.

Results and Discussion

This section explores the prevailing research themes and significant findings related to Safety Risk Assessment (SRA). The reported results and analysis include a detailed examination of publication trends, co-authorship networks using bibliometric mapping, and keyword co-occurrence analysis. These insights are derived from the comprehensive analysis of publication metadata and visualized using bibliometric tools to illustrate research collaboration and thematic developments within the field

Publication Outputs

The bibliometric analysis identified 1,888 research articles on Safety Risk Assessment (SRA) published between 1970 and 2023. As shown in Figure 2, the number of publications has grown steadily over time, with significant growth occurring after 2006. Between 2007 and 2017, an average of 52 articles were published annually. However, a sharp increase occurred from 2018 to 2023, with the highest number of publications, 275, recorded in 2023. This surge indicates a rising global interest in addressing safety risks, possibly driven by advancements in industrial safety practices, regulatory changes, and technological integration, such as IoT and big data.
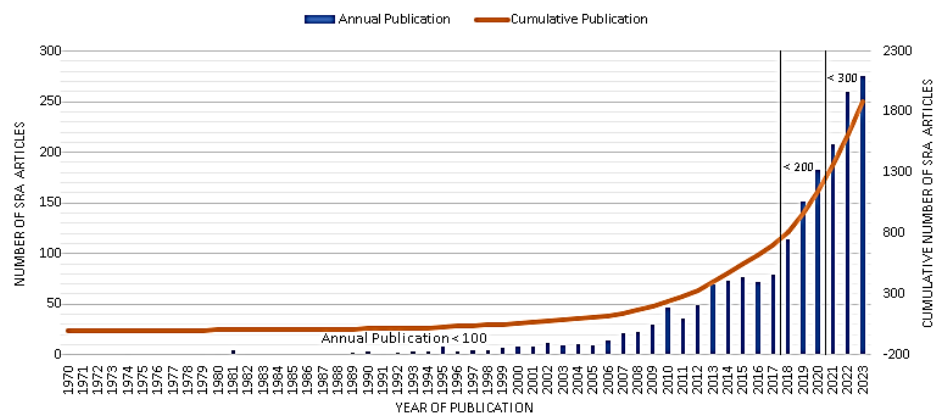

Figure 2. Illustrates The Analysis of Annual And Cumulative Number Of Research Articles on SRA From 1970 to 2023

The primary language for publications is English, accounting for 83% of the total articles, followed by Chinese (15%). Other languages, such as German, Italian, and Spanish, have minimal representation. The most cited article, titled "A New Accident Model for Engineering Safer Systems" (Leveson, 2004), has accumulated 1,690 citations, highlighting its significant influence in the field. This is followed by an open-access article published in 2002 in the Journal of Experimental Psychology, titled "Evaluation of a behavioral measure of risk-taking: The Balloon Analogue Risk Task (BART)" (Lejuez et al., 2002) with 1638 citations. The earliest publication from 1970, "Human safety risk assessment of lymph node angiomas observed in 2-year carcinogenicity studies in rats" (Radi & Morton, 1970) has received 9 citations. Out of all published articles, only 714 articles (38%) were published in open access journals. (Young & Brandes, 2020) suggest that open-access journal publications may receive more citations as these articles are freely available to readers.

Subject Areas and Preferred Journals

SRA research spans 27 subject areas, with Engineering dominating the field, contributing 36% of the total publications (675 articles). Medicine follows with 27%, and Agricultural and Biological Sciences accounts for 15% (Figure 3). The dominance of engineering reflects the importance of developing technical solutions

to manage industrial safety risks. The field of medicine's large contribution highlights the growing recognition of occupational health as a key component of risk assessment.
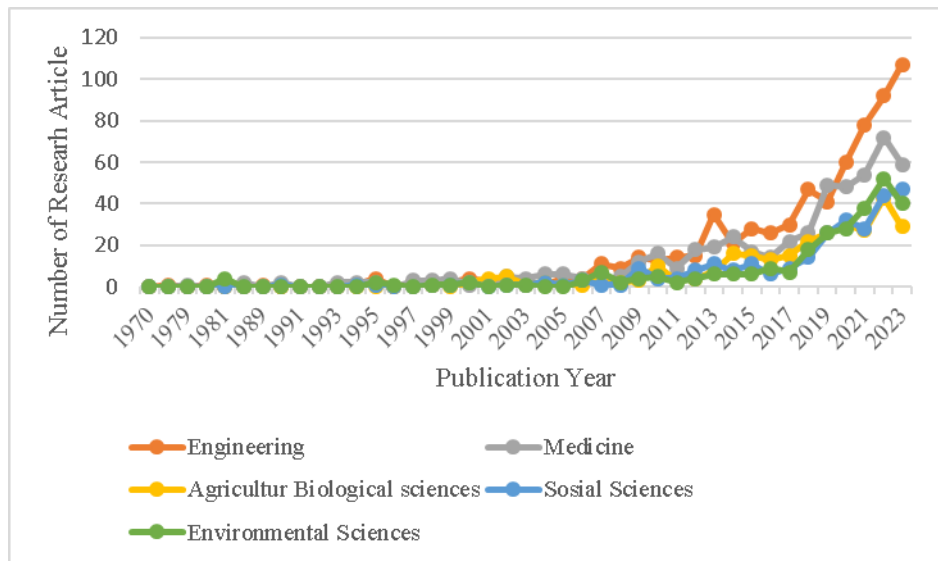

Figure 3. Illustrates the Analysis of the Number of Published Research Articles Associated With the Top 5 Subject Areas in SRA Over the Years

The dominance of the 'Engineering' field and the distribution of research articles across other areas reflect current research priorities and their impact on scientific and technological development. However, the relatively even distribution among fields such as 'Medicine', 'Agricultural and Biological Sciences', 'Social Sciences', and 'Environmental Science' underscores the importance of multidisciplinary research in addressing complex global challenges. This necessitates closer collaboration among scientific disciplines to maximize the impact of research towards achieving sustainable and inclusive solutions. The high citation count in 'Engineering' also indicates a phenomenon that warrants further exploration to understand cross-field research dynamics and how innovations in one area can influence or be applied in other contexts.

Display quotations of over 40 words or as needed.

Articles on SRA have been published in 160 different journals, and the top 10 journals producing these articles are presented in Table 1.

Table 1. The List of 10 Most Productive Journals in Publishing Research Articles on SRA

No	Journal name	Total Publication	Percentage publication	Total citations	CiteScore 2022	Most cited article	Citation number	Publisher
1	Safety Science	43	2.3	4100	12.4	A new accident model for engineering safer systems (Leveson, 2004)	1,690	Elsevier
2	Chinese Journal Of Food Hygiene	33	1.7	27	0.5	Assessment of sugar-sweetened beverages consumption and free sugar intake among urban	9	Editorial Office of Chinese Journal of Food Hygiene

No	Journal name	Total Publication	Percentage publication	Total citations	CiteScore 2022	Most cited article	Citation number	Publisher
						residents aged 3 and above in China (Nuzulia, 1967)		
3	China Safety Science Journal	28	1.5	54	0.2	Safety evaluation of continuous multi-span aqueduct's demolition blasting based on FAHP method (ZHANG Zhixiong, 2020)	7	Editorial Department of China Safety Science Journal
4	Efsa Journal	27	1.4	1250	5.1	Scientific Opinion on the maintenance of the list of QPS biological agents intentionally added to food and feed (2013 update) (Andreoletti et al., 2013)	209	Wiley-Blackwell
5	Sustainability Switzerland	25	1.3	264	5.8	Road safety risk assessment: An analysis of transport policy and management for low-, middle-, and high-income Asian countries (Shah et al., 2018)	39	Multidisciplinary Digital Publishing Institute (MDPI)
6	Food Control	22	1.2	486	10.6	Occurrence of four mycotoxins in cereal and oil products in Yangtze Delta region of China and their food safety risks (R. Li et al., 2014)	95	Elsevier
7	Journal Of Food Protection	22	1.2	418	4.2	Assessment of food safety practices of food service food handlers (risk assessment data): Testing a communication intervention (evaluation of	109	Elsevier

No	Journal name	Total Publication	Percentage publication	Total citations	CiteScore 2022	Most cited article	Citation number	Publisher
						tools) (Chapman et al., 2010)		
8	Journal Of Construction Engineering And Management	21	1.1	690	8.0	Image-based safety assessment: Automated spatial safety risk identification of earthmoving and surface mining activities (Chi & Caldas, 2012)	111	American Society of Civil Engineers
9	International Journal Of Food Microbiology	16	0.8	881	10.3	Future challenges to microbial food safety (Havelaar et al., 2010)	193	Elsevier
10	International Journal Of Environmental Research And Public Health	15	0.8	289	5.4	Health risk-based assessment and management of heavy metals-contaminated soil sites in Taiwan (Lai et al., 2010)	71	Multidisciplinary Digital Publishing Institute (MDPI)

Safety Science emerges as the leading journal in the field, publishing 43 articles (2.3% of the total), with a CiteScore of 12.4. The journal's prominence in disseminating SRA research is underscored by the high citation count of its published articles. China Safety Science Journal and EFSA Journal are also noteworthy contributors, particularly in the areas of food safety and sustainability, respectively.

Author Performances

The most prolific authors in SRA research are dominated by experts from Europe and Asia, with Bolton D., Davies R., and Koutsoumanis K. leading the list with 11 publications each and an h-index of 11. Their first publications, released in 2013, have set the foundation for much of the current research, especially in food safety and hazard prevention.

Table 2. The Top 10 Prolific Authors in SRA

No	Name	Scopus author ID	1st publication	Total publication	h-index	Total citation	Current affiliation	Country
1	Bolton, D.	24578608300	2013	11	11	833	Ashtown Food Research Centre, Dublin	Ireland
2	Davies, R.	7404392598	2013	11	11	833	Animal and Plant Health Agency, Addlestone	United Kingdom
3	Koutsoumanis, K.	8569036600	2013	11	11	833	Aristotle University of Thessaloniki, Thessaloniki	Greece

No	Name	Scopus author ID	1st publication	Total publication	h-index	Total citation	Current affiliation	Country
4	Lindqvist, R.	7004269964	2013	11	11	833	Swedish Food Agency, Uppsala	Sweden
5	Ru, G.	57201422206	2013	11	11	833	Istituto Zooprofilattico Sperimentale del Piemonte, Liguria e Valle d'Aosta, Turin	Italy
6	Simmons, M.	7201976314	2013	11	11	833	Animal and Plant Health Agency, Addlestone	United Kingdom
7	Wu, X.	55781337300	2014	11	9	486	Huazhong University of Science and Technology, Wuhan	China
8	Sanaa, M.	55907687000	2013	10	10	760	Organisation Mondiale de la Santé, Geneva	Switzerland
9	Cocconcelli, P.S.	35606221300	2014	9	9	579	Università Cattolica del Sacro Cuore, Milan	Italy
10	Correia, S.	56725898600	2014	9	9	579	Autorità Europea per la Sicurezza Alimentare, Parma	Italy

At the country level, China leads global contributions to SRA research with 694 publications, of which 87.8% are single-country publications (SCP), indicating a strong domestic research focus (Table 3). The USA follows with 441 publications, demonstrating higher levels of international collaboration compared to China, as evidenced by its lower SCP percentage (68.5%). Other countries with significant contributions include the United Kingdom, Canada, and Germany. The extensive contribution from China highlights the country's focus on industrial safety, while the USA's collaboration rates suggest a broader, more globalized research network.

Performance of Countries on Co-Authorship

Data regarding the leading countries and institutions in the field of SRA are displayed in Figure 4 and Table 3.

Figure 4. The Top 10 Most Productive Countries Producing Research Articles in SRA

Table 3. The Top 10 Most Productive Countries and Academic Institutions in SRA Publications

No	Countries	Total publication	Single country publication (SCP)	Percentage SCP	Most productive academic institution	Total institution publication
1	China	694	609	87.8	Beijing Jiaotong University	21
2	USA	441	302	68.5	University of Colorado Boulder	9
3	United Kingdom	141	64	45.4	University of Cambridge	4
4	Canada	93	47	50.5	University of Montreal	9
5	Australia	78	34	43.6	UNSW Sydney	5
6	Italy	69	34	49.3	Università degli studi di Bari Aldo Moro	3
7	Netherlands	66	31	47	Delft University of Technology	9
8	Germany	66	25	37.9	Technische Universität München	4
9	Iran	48	34	70.8	Islamic Azad University	8
10	Turkey	38	35	92.1	Yıldız Teknik Üniversitesi	8

The performance of countries in terms of co-authorship provides insight into the degree of international collaboration in Safety Risk Assessment (SRA) research. Data from the analysis reveal that China, the United States, and the United Kingdom are the most productive countries in SRA publications. As shown

in Figure 4 and Table 3, China leads with a total of 694 publications, of which 609 are single-country publications (SCP), representing an 87.8% dominance of domestic collaborations. This high percentage indicates a strong focus on internal research efforts, with relatively limited international cooperation compared to other leading nations.

Following China, the United States is the second most prolific contributor, with 441 publications, and exhibits a lower SCP percentage (68.5%), suggesting a higher level of international collaboration. The University of Colorado Boulder stands out as the most productive institution in the United States, contributing to the country's strong output in SRA research.

The United Kingdom ranks third with 141 publications, of which 64 are SCPs, indicating a balance between domestic and international collaboration. Major institutions, such as the University of Cambridge, play a significant role in SRA research in the UK, fostering both national and international partnerships.

Other notable contributors include Canada, Australia, and Germany, each showing significant research output and moderate levels of international collaboration. For example, Canada has 93 publications, with 50.5% SCP, reflecting a well-balanced approach between domestic research and global partnerships.

Interestingly, countries such as Iran and Turkey have relatively high SCP percentages, at 70.8% and 92.1%, respectively. This suggests a more localized research ecosystem with limited international collaboration. However, institutions like Islamic Azad University in Iran and Yıldız Technical University in Turkey are emerging as key players in their respective regions.

The co-authorship network, visualized using VOSviewer, highlights the global collaboration patterns in SRA research as shown in Figure 5
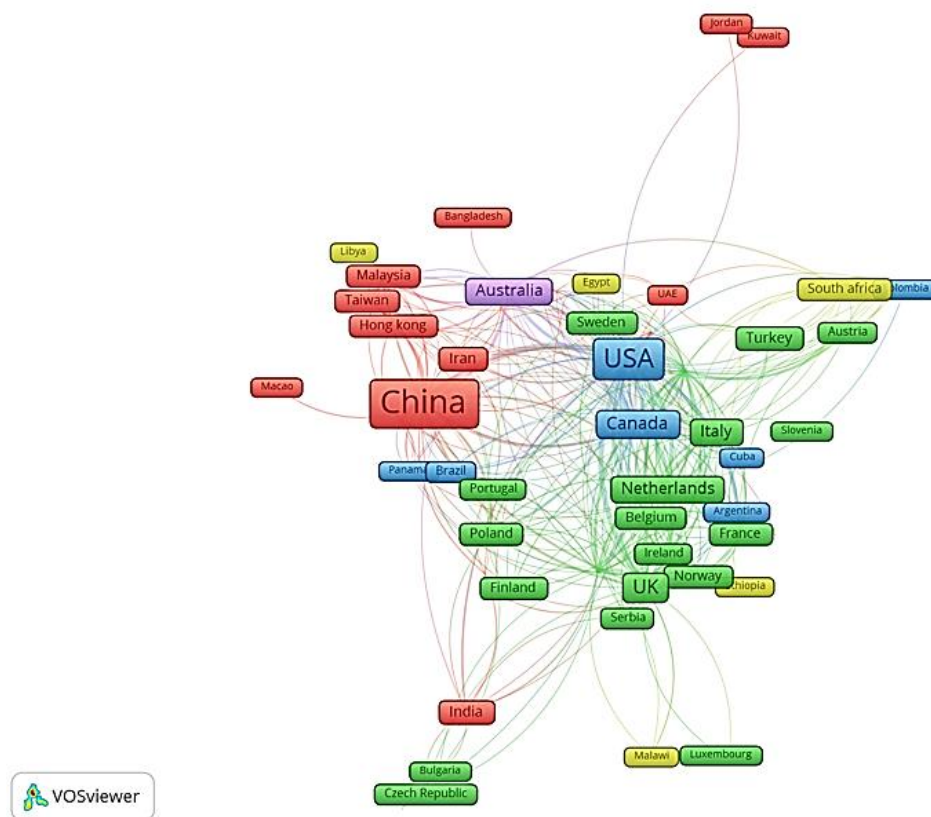

Figure 5. Network Visualization of Co-Authorship.

Figure 5 shows that the United States has the strongest international presence, with co-authorship links to 56 countries and 277 instances of collaboration. This is followed by the United Kingdom (38 links, 154 co-authorships) and Germany (30 links, 121 co-authorships). The extensive collaboration of these countries underscores their central role in facilitating global knowledge exchange in SRA research.

In contrast, some countries, including Brunei Darussalam, Sri Lanka, and North Macedonia, show limited or no international collaboration. These countries may benefit from more active engagement in global research networks to enhance their contributions to SRA. Several factors influence the dynamics of international collaboration, such as the diversity of research partners, the involvement of international postgraduate students and visiting scholars, and strong research funding. In addition, flexible and consistent research policies are crucial to maintaining the long-term sustainability of these collaborations.

Author keywords

A total of 5,632 author keywords were extracted from the Scopus database and analyzed using VOSviewer to visualize the trends in Safety Risk Assessment (SRA) research. However, many keywords were found to be redundant or similar in nature. For example, some publications used the term "accident," while others used "accidents." To address this, a data-cleaning process was conducted to consolidate similar keywords into a single representative term. After cleaning, the final list comprised 311 unique keywords. A minimum occurrence of three times was set for keywords to be included in the analysis, ensuring that only relevant and frequently used terms were visualized.

The co-occurrence relationships between the keywords were illustrated using VOSviewer. Figure 6 presents the visualized keyword map, where keywords are displayed according to their average publication year and their co-occurrence strength with other terms.

Figure 6. Network Visualization of Co-Occurrences of the Author Keywords

Source: Authors' Own Elaboration, Using Vosviewer 1.6.19

The analysis reveals that "Safety Risk Assessment (SRA)" is the most frequently used keyword, appearing in 379 publications and linking to 187 other keywords. This strong presence reflects the central focus of the field on identifying and managing risks in various contexts, particularly in industries such as construction, manufacturing, and food safety. Commonly associated terms include "Risk Identification," "Risk Factors," "Risk Evaluation," and "Risk Management," emphasizing the comprehensive approach taken by researchers to assess potential hazards and implement mitigation strategies.

Other frequently occurring keywords include "Safety" (119 occurrences, 78 links), "Food Safety" (99 occurrences, 79 links), and "Risk" (44 occurrences, 43 links). The term "Food Safety" highlights the increasing attention given to ensuring safe food production and distribution, particularly in the context of public health and regulatory compliance.

Notably, emerging research trends were identified through keywords such as "Internet of Things (IoT)" and "big data," which are becoming more prominent in the SRA landscape. These technologies enable real-time risk monitoring and data-driven decision-making, allowing for more adaptive and responsive safety management systems. The integration of IoT and big data is indicative of a broader shift towards using advanced digital tools to enhance safety protocols and risk assessments in complex environments.

Furthermore, tools and methodologies for conducting SRA are also evolving. Keywords related to fuzzy logic, Bayesian networks, and Fuzzy TOPSIS are increasingly prevalent, indicating a growing interest in applying artificial intelligence (AI) and machine learning models to improve risk prediction and analysis. These approaches offer enhanced precision and flexibility in managing dynamic and uncertain risk factors.

Overall, the analysis of author keywords provides a clear overview of the thematic areas that have shaped SRA research over the years. The strong focus on risk identification and safety management remains consistent, while newer technological advancements signal the future direction of the field. Researchers are increasingly exploring how digital technologies, such as IoT and AI, can be leveraged to refine traditional risk assessment methods and address emerging safety challenges in various industries.

Research Topics and Pattern

The field of **Safety Risk Assessment (SRA)** is continually evolving as new research areas emerge, driven by advancements in technology, methodologies, and regulatory demands. Both historical and current research trends have been outlined in this study, but a more detailed analysis of keyword co-occurrences offers valuable insights into future research directions. By identifying the most recently published keywords and their average publication year, we can predict emerging themes and areas of growing interest within the SRA field. The analysis of keyword co-occurrences categorizes the research trends in SRA into several key areas that frequently appear across studies:

Risk Assessment Methodologies: This includes the development and improvement of methods to identify, analyze, and assess risks (Yeo et al., 2023). Objective: This area focuses on the development and refinement of methods for identifying, analyzing, and assessing risks in various environments. Research Directions: Innovations in probabilistic models, the integration of artificial intelligence for predictive risk modeling, and the adaptation of traditional risk assessment frameworks to address modern challenges are gaining prominence. These include models that account for complex, dynamic systems. Current Focus: As noted by Yeo et al. (2023), recent efforts have centered on enhancing the accuracy and usability of risk assessment tools to accommodate increasingly complex industrial systems.

Technology and Innovation: Researching the application of new technologies in risk management and assessment, such as the Internet of Things (IoT), and big data for real-time risk detection and response (Abdulhamid et al., 2023; Nyman et al., 2021). Objective: The application of advanced technologies, such as the Internet of Things (IoT) and big data, for real-time risk detection and response, has become a critical focus.. Research Directions: IoT facilitates the collection and analysis of real-time data, allowing for immediate risk evaluations. Big data analytics further enhances this by processing vast datasets to identify patterns and predict potential hazards.. Current Focus: Recent studies, such as those by Abdulhamid et al. (2023) and Nyman et al. (2021), have examined how these technologies can be integrated into traditional risk management systems to create more responsive and adaptive safety frameworks..

Regulation: Analyzing existing safety regulations and standards and their development, including assessing the effectiveness of safety policies and ways to enhance them (Bondebjerg et al., 2023). Objective: This area explores the development and assessment of safety regulations and standards, evaluating their effectiveness and identifying areas for improvement. Research Directions: Comparative analyses of safety regulations

across different industries and countries, as well as assessments of how current policies address emerging risks, are key research priorities. This includes the formulation of new regulatory frameworks to address technological advancements.. Current Focus: Bondebjerg et al. (2023) emphasize the need to reassess existing regulations to better protect workers and adapt to new safety challenges, particularly in fast-evolving sectors..

Occupational Health and Safety: Focused on risk assessments related to worker health and safety, including preventing workplace accidents and occupational diseases (Bejinariu et al., 2023). Objective: This area focuses on assessing risks related to worker health and safety, aiming to prevent workplace accidents and occupational diseases. Research Directions: Studies are increasingly exploring ergonomic risk factors, interventions to prevent injuries, and the promotion of a safety culture within organizations. This includes both physical and psychological risks. Current Focus: As discussed by Bejinariu et al. (2023), recent research has prioritized proactive risk assessments and preventative measures to reduce the incidence of workplace accidents and illnesses.

These key areas illustrate how SRA research is broadening to encompass not only traditional risk management but also the integration of cutting-edge technologies and regulatory analysis. As the field continues to evolve, there is an increasing emphasis on developing holistic approaches that incorporate technological innovations and respond to new and emerging risks.

Conclusion

This bibliometric analysis highlights several fundamental findings regarding global research patterns in Safety Risk Assessment (SRA). The study examined 1,888 research articles published between 1970 and 2023, revealing a significant increase in SRA-related publications, especially after 2018. The analysis indicated that China and the United States are the most prolific contributors, with China showing a strong focus on domestic research while the United States demonstrated greater international collaboration. The keywords analysis underscored that core topics such as 'Risk Identification', 'Risk Evaluation', and the incorporation of technological tools like IoT and big data are central to ongoing research.

Further analysis delved into the dynamics of co-authorship, uncovering key institutions and networks that drive SRA research. The study highlighted strong inter-institutional collaborations, particularly between leading universities in the United States, the United Kingdom, and Germany. Emerging themes, such as the application of machine learning models and advanced risk assessment methodologies, pointed towards a shift in research focus, emphasizing data-driven solutions and adaptive safety frameworks. This trend suggests a growing interest in utilizing sophisticated tools to enhance real-time risk assessment and improve industrial safety.

Overall, the results align well with the study's aim of mapping global SRA research patterns and identifying emerging trends. The findings provide a comprehensive overview that supports the current understanding of the field while shedding light on future research directions. The analysis met the objective set by the title, confirming that the integration of new technologies and fostering international collaboration are pivotal for advancing SRA research. Future studies should focus on expanding interdisciplinary approaches, leveraging innovations in digital technology, and promoting global partnerships to address the complexities of modern safety risk management

References

Abalkina, A. (2024). Challenges posed by hijacked journals in Scopus. Journal of the Association for Information Science and Technology, 75(4), 395–422. https://doi.org/10.1002/asi.24855

Abdulhamid, A., Kabir, S., Ghafir, I., & Lei, C. (2023). An Overview of Safety and Security Analysis Frameworks for the Internet of Things. Electronics (Switzerland), 12(14). https://doi.org/10.3390/electronics12143086

Aghaei Chadegani, A., Salehi, H., Md Yunus, M. M., Farhadi, H., Fooladi, M., Farhadi, M., & Ale Ebrahim, N. (2013). A comparison between two main academic literature collections: Web of science and scopus databases. Asian Social Science, 9(5), 18–26. https://doi.org/10.5539/ass.v9n5p18

Ak, M. F., Yucesan, M., & Gul, M. (2022). Occupational health, safety and environmental risk assessment in textile production industry through a Bayesian BWM-VIKOR approach. Stochastic Environmental Research and Risk Assessment, 36(2), 629–642. https://doi.org/10.1007/s00477-021-02069-y

al-Sulbi, K., Chaurasia, P. K., Attaallah, A., Agrawal, A., Pandey, D., Verma, V. R., Kumar, V., & Ansari, M. T. J. (2023). A Fuzzy TOPSIS-Based Approach for Comprehensive Evaluation of Bio-Medical Waste Management: Advancing Sustainability and Decision-Making. Sustainability (Switzerland), 15(16). https://doi.org/10.3390/su151612565

Aliu, J., Oke, A. E., Kineber, A. F., Ebekozien, A., Aigbavboa, C. O., Alaboud, N. S., & Daoud, A. O. (2023). Towards a New Paradigm of Project Management: A Bibliometric Review. Sustainability (Switzerland), 15(13), 1–17. https://doi.org/10.3390/su15139967

Aminbakhsh, S., Gunduz, M., & Sonmez, R. (2013). Safety risk assessment using analytic hierarchy process (AHP) during planning and budgeting of construction projects. Journal of Safety Research, 46, 99–105. https://doi.org/10.1016/j.jsr.2013.05.003

Andreoletti, O., Lau Baggesen, D., Bolton, D., Butaye, P., Cook, P., Griffin, J., Davies, R., Fernández Escámez, P. S., Griffin, J., Hald, T., Havelaar, A., Koutsoumanis, K., Lindqvist, R., Nguyen-The, C., McLauchlin, J., Nesbakken, T., Prieto, M., Ricci, A., Ru, G., … Threlfall, J. (2013). Scientific Opinion on the maintenance of the list of QPS biological agents intentionally added to food and feed (2013 update). EFSA Journal, 11(11). https://doi.org/10.2903/j.efsa.2013.3449

Bejinariu, C., Darabont, D. C., Burduhos-Nergis, D. P., Cazac, A. M., & Chiriac-Moruzzi, C. (2023). Considerations Regarding the Application of the Occupational Injury and Illness Risk Assessment Method at Workplaces/Workstations, in Relation to the ISO 45001 Standard. Sustainability (Switzerland), 15(3). https://doi.org/10.3390/su15032121

Bhattacharjee, P., Dey, V., & Mandal, U. K. (2022). Failure Mode and Effects Analysis (FMEA) using interval number based BWM—MCDM approach: Risk Expected Value (REV) method. Soft Computing, 26(22), 12667–12688. https://doi.org/10.1007/s00500-022-07264-9

Bondebjerg, A., Filges, T., Pejtersen, J. H., Kildemoes, M. W., Burr, H., Hasle, P., Tompa, E., & Bengtsen, E. (2023). Occupational health and safety regulatory interventions to improve the work environment: An evidence and gap map of effectiveness studies. Campbell Systematic Reviews, 19(4). https://doi.org/10.1002/cl2.1371

Chapman, B., Eversley, T., Fillion, K., MacLaurin, T., & Powell, D. (2010). Assessment of food safety practices of food service food handlers (risk assessment data): Testing a communication intervention (evaluation of tools). Journal of Food Protection, 73(6), 1101–1107. https://doi.org/10.4315/0362-028X-73.6.1101

Chen, Q. Y., Liu, H. C., Wang, J. H., & Shi, H. (2022). New model for occupational health and safety risk assessment based on Fermatean fuzzy linguistic sets and CoCoSo approach. Applied Soft Computing, 126, 109262. https://doi.org/10.1016/j.asoc.2022.109262

Chi, S., & Caldas, C. H. (2012). Image-Based Safety Assessment: Automated Spatial Safety Risk Identification of Earthmoving and Surface Mining Activities. Journal of Construction Engineering and Management, 138(3), 341–351. https://doi.org/10.1061/(asce)co.1943-7862.0000438

Dehdashti, A., Fatemi, F., Jannati, M., Asadi, F., & Kangarloo, M. B. (2020). Applying health, safety, and environmental risk assessment at academic settings. BMC Public Health, 20(1), 1–7. https://doi.org/10.1186/s12889-020-09419-5

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. Journal of Business Research, 133(May), 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070

Gholamizadeh, K., Zarei, E., Kabir, S., Mamudu, A., Aala, Y., & Mohammadfam, I. (2023). A Knowledge-Driven Model to Assess Inherent Safety in Process Infrastructure. Safety, 9(2). https://doi.org/10.3390/safety9020037

Greener, S. (2022). Evaluating literature with bibliometrics. Interactive Learning Environments, 30(7), 1168–1169. https://doi.org/10.1080/10494820.2022.2118463

Havelaar, A. H., Brul, S., de Jong, A., de Jonge, R., Zwietering, M. H., & ter Kuile, B. H. (2010). Future challenges to microbial food safety. International Journal of Food Microbiology, 139(SUPPL. 1), S79–S94. https://doi.org/10.1016/j.ijfoodmicro.2009.10.015

Ibrahim, Z. S., Rifqiyah, F., Sultan, J., & Retnawati, H. (2023). A Visualized Bibliometric Analysis for Mapping Research Trends of Machine Learning in Academic Research. Vi, 271–279. https://doi.org/10.31643/2023.34

Jaganathan, A., & Mathesan, K. (2022). Risk prediction model and classification of various hazards in automobile industry using HAO based deep CNN. Sadhana - Academy Proceedings in Engineering Sciences, 47(3). https://doi.org/10.1007/s12046-022-01928-w

Ji, Z., Su, H., Wang, Y., Cao, Y., & Yang, S. (2022). Assessing the Risk of Hazards with Multidimensional Consequences for Industrial Processes. Processes, 10(6). https://doi.org/10.3390/pr10061145

Lai, H. Y., Hseu, Z. Y., Chen, T. C., Chen, B. C., Guo, H. Y., & Chen, Z. S. (2010). Health risk-based assessment and management of heavy metals-contaminated soil sites in Taiwan. International Journal of Environmental Research and Public Health, 7(10), 3595–3614. https://doi.org/10.3390/ijerph7103596

Lazarides, M. K., Lazaridou, I.-Z., & Papanas, N. (2023). Bibliometric Analysis: Bridging Informatics With Science. The International Journal of Lower Extremity Wounds, 153473462311535. https://doi.org/10.1177/15347346231153538

Lejuez, C. W., Richards, J. B., Read, J. P., Kahler, C. W., Ramsey, S. E., Stuart, G. L., Strong, D. R., & Brown, R. A. (2002). Evaluation of a behavioral measure of risk taking: The balloon analogue risk task (BART). Journal of Experimental Psychology: Applied, 8(2), 75–84. https://doi.org/10.1037/1076-898X.8.2.75

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

Li, J., Deng, C. C. C., Xu, J., Ma, Z., Shuai, P., & Zhang, L. (2023). Safety Risk Assessment and Management of Panzhihua Open Pit (OP)-Underground (UG) Iron Mine Based on AHP-FCE, Sichuan Province, China. Sustainability (Switzerland), 15(5). https://doi.org/10.3390/su15054497

Li, M., Wang, H., Wang, D., Shao, Z., & He, S. (2020). Risk assessment of gas explosion in coal mines based on fuzzy AHP and bayesian network. Process Safety and Environmental Protection, 135, 207–218. https://doi.org/10.1016/j.psep.2020.01.003

Li, R., Wang, X., Zhou, T., Yang, D., Wang, Q., & Zhou, Y. (2014). Occurrence of four mycotoxins in cereal and oil products in Yangtze Delta region of China and their food safety risks. Food Control, 35(1), 117–122. https://doi.org/10.1016/j.foodcont.2013.06.042

Marhavilas, P. K., Filippidis, M., Koulinas, G. K., & Koulouriotis, D. E. (2022). Safety-assessment by hybridizing the MCDM/AHP & HAZOP-DMRA techniques through safety's level colored maps: Implementation in a petrochemical industry. Alexandria Engineering Journal, 61(9), 6959–6977. https://doi.org/10.1016/j.aej.2021.12.040

Mazzi, A. (2023). Environmental and safety risk assessment for sustainable circular production: Case study in plastic processing for fashion products. Heliyon, 9(11), e21352. https://doi.org/10.1016/j.heliyon.2023.e21352

Nuzulia, A. (1967). Sugar Intake and Risk Assessment in Chinese Urban Residents (Overview). Angewandte Chemie International Edition, 6(11), 951–952., 1, 5–24.

Nyman, R., Kapadia, S., & Tuckett, D. (2021). News and narratives in financial systems: Exploiting big data for systemic risk assessment. Journal of Economic Dynamics and Control, 127, 104119. https://doi.org/10.1016/j.jedc.2021.104119

Permana, M. I., & Widyaningrum, D. (2023). Optimizing Workplace Safety: A Comprehensive Analysis Of Accident Risks Through FMEA And RCA Methods. Jurnal Sains Dan Teknologi Industri, 21(1), 158. https://doi.org/10.24014/sitekin.v21i1.26043

Radi, Z. A., & Morton, D. (1970). Human safety risk assessment of lymph node angiomas observed in 2-year carcinogenicity studies in rats. Regulatory Toxicology and Pharmacology, 64(3), 435–441. https://doi.org/10.1016/j.yrtph.2012.10.006

Raeihagh, H., Behbahaninia, A., & Macki Aleagha, M. (2020). Risk assessment of sour gas inter-phase onshore pipeline using ANN and fuzzy inference system – Case study: The south pars gas field. Journal of Loss Prevention in the Process Industries, 68, 104238. https://doi.org/10.1016/j.jlp.2020.104238

Rahimdel, M. J. (2023). Fuzzy Approach for the Safety Risk Assessment in Dimension Stone Mining. Earth Sciences Research Journal, 27(1), 37–45. https://doi.org/10.15446/esrj.v27n1.85482

Renjith, V. R., Vijayan, S. S., & Arunkumar, V. R. (2021). Web of Science (WoS) Indexed Library and Information Science (LIS) Journals in Scopus: An Analysis. Library Philosophy and Practice, 2021, 9–19. https://doi.org/10.2139/ssrn.3954318

SATICI, S. R., & METE, S. (2023). Fine-Kinney-Based Occupational Risk Assessment using Pythagorean Fuzzy AHP-COPRAS for the Lifting Equipment in the Energy Distribution and Investment Sector. Gazi University Journal of Science, 37(2), 854–873. https://doi.org/10.35378/gujs.1227756

Shah, S. A. R., Ahmad, N., Shen, Y., Pirdavani, A., Basheer, M. A., & Brijs, T. (2018). Road safety risk assessment: An analysis of transport policy and management for low-, middle-, and high-income Asian countries. Sustainability (Switzerland), 10(2). https://doi.org/10.3390/su10020389

Tezel, E., & Giritli, H. (2022). A scientometric analysis of studies in Turkey: Driving BIM into facilities management. Research Anthology on BIM and Digital Twins in Smart Cities, 533–549. https://doi.org/10.4018/978-1-6684-7548-5.ch024

Tian, C., Li, H., Tian, S., & Tian, F. (2020). Risk Assessment of Safety Management Audit Based on Fuzzy TOPSIS Method. Mathematical Problems in Engineering, 2020. https://doi.org/10.1155/2020/1612538

Ünal, Ö., Akbolat, M., Amarat, M., & Tilkilioğlu, S. (2021). The role of the human factor in occupational safety and health performance. International Journal of Occupational Safety and Ergonomics, 27(1), 179–184. https://doi.org/10.1080/10803548.2018.1554932

Vendemiatti, J. A. S., Camparotto, N. G., Vidal, C., Cristale, J., Agapito, E. V. de M., Oliveira, Á. C., Rodrigues, E. A., Montagner, C. C., Umbuzeiro, G. A., & Prediger, P. (2021). New benzotriazoles generated during textile dyeing process: Synthesis, hazard, water occurrence and aquatic risk assessment. Journal of Hazardous Materials, 403(August 2020). https://doi.org/10.1016/j.jhazmat.2020.123732

Xu, N., Di, K., Liu, F., Zhao, W., & Zhang, B. (2023). Risk Assessment of Lift-Jacking Accidents Using FFTA-FMEA. Applied Sciences (Switzerland), 13(12), 1–17. https://doi.org/10.3390/app13127312

Yang, S., Huang, R., Liu, H., Li, J., Zhang, X., & Ning, X. (2023). Gas Overrun Risk Assessment in Coal Mining Face Based on Fuzzy Bayesian Network. E3S Web of Conferences, 369(9), 1–8. https://doi.org/10.1051/e3sconf/202336902001

Yeo, S., Jeong, B., & Lee, W. J. (2023). Improved formal safety assessment methodology using fuzzy TOPSIS for LPG-fueled marine engine system. Ocean Engineering, 269(January), 113536. https://doi.org/10.1016/j.oceaneng.2022.113536

Young, J. S., & Brandes, P. M. (2020). Green and gold open access citation and interdisciplinary advantage: A bibliometric study of two science journals. Journal of Academic Librarianship, 46(2), 102105. https://doi.org/10.1016/j.acalib.2019.102105

ZHANG Zhixiong, Y. X. (2020). Safety evaluation of continuous multi-span aqueduct's demolition blasting based on FAHP method. 30(11).