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PREFACE

It is our great pleasure to present the *Proceedings of the 22nd International May Conference on Strategic Management*, a collection of contributions that reflect the dedication, creativity, and scholarly excellence of our academic and professional community.

We would like to express our sincere gratitude to all authors who have contributed their time, knowledge, and enthusiasm to this conference. This year, we are especially proud to highlight that the proceedings include contributions from authors representing more than 30 countries, underscoring the international character and growing impact of the conference. The diversity of topics and perspectives presented here highlights the importance of collaboration and continuous dialogue in addressing contemporary challenges.

We extend our deepest appreciation to our main sponsor, the Ministry of Science, Technological Development and Innovation, for its invaluable support and commitment to advancing research and innovation. We are also grateful to our gold sponsors, Zijin Mining and Zijin Copper, whose generous contributions have significantly supported the successful organization of this conference. In addition, we would like to thank our exhibition partner, MDPI, for their collaboration and engagement in promoting academic exchange.

We also extend our appreciation to the reviewers and members of the organizing committee, whose dedication and careful work ensured the quality and success of the conference. Their efforts have been essential in maintaining high academic standards and in bringing this publication to fruition.

Finally, we thank all attendees for their engagement and for fostering a stimulating and supportive environment. We hope that these Proceedings will serve as a valuable resource and inspiration for future research, collaboration, and innovation.

Thank you!!

Editors

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**ARTIFICIAL INTELLIGENCE ENABLED DECISION MAKING IN CONSTRUCTION
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FAILURE MODE AND EFFECTS ANALYSIS: LITERATURE REVIEW AND BIBLIOMETRIC ANALYSIS

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Abstract: Failure Mode and Effects Analysis (FMEA) is a methodology for identifying, evaluating, and managing risks in systems, processes, and products, to improve reliability and reduce potential failures. The main objective of the papers is to identify, select, and analyse relevant scientific articles to map the current research landscape, publication trends, keyword usage, and authorship patterns. A structured methodology was applied, including defining keywords, collecting articles, selecting relevant studies, and conducting bibliometric analysis. Data were obtained from the Web of Science database for the period 2019–2025. From an initial set of 4,201 articles, the selection was reduced to 347 articles focused on advanced approaches to the FMEA method, using Python scripts to minimise subjectivity. Bibliometric visualisation was conducted using VOSviewer, highlighting the most productive authors, country collaboration network, and co-occurrence of keywords. The bibliometric analysis identified the most influential authors and research clusters, with cooperation networks indicating pronounced international and interdisciplinary connections among researchers.

Keywords: FMEA, bibliometric analysis, VOSviewer, Python

1. INTRODUCTION

Failure Mode and Effects Analysis (FMEA) is one of the most widely used methods for identifying, analysing and managing risks in complex technical systems, production processes and industrial applications. The main objective of the FMEA method is to identify potential failure modes, assess their consequences and prioritise their elimination to improve the reliability and safety of the system.

The traditional FMEA method relies on calculating the Risk Priority Number (RPN), which is the product of the severity factor, probability of occurrence and likelihood of detection. However, several limitations of this approach have been highlighted in the literature, including subjectivity in estimating input parameters, insufficient model flexibility and the inability to adequately manage uncertainty (Bowles & Peláez, 1995; Franceschini & Galetto, 2001). To

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address these limitations, contemporary FMEA research increasingly focuses on developing advanced models that integrate multi-criteria decision-making methods (MCDM), fuzzy logic and artificial intelligence techniques. The application of fuzzy sets, originally introduced by Zadeh (1965), has enabled more effective modelling of imprecision and subjective assessments in risk analysis. Furthermore, methods such as AHP, TOPSIS, VIKOR and DEMATEL have become key tools for enhancing risk ranking and decision-making processes within FMEA.

In the past decade, the development of hybrid models that combine multiple approaches to increase the accuracy and robustness of analysis has been particularly noteworthy. These models facilitate the integration of expert knowledge, statistical methods, and soft computing techniques, which significantly enhances the quality of risk assessment in complex systems (Liu et al., 2018; Wang et al., 2020; Huang et al., 2020). Despite extensive research aimed at improving the FMEA method, there remains a need for a systematic review and mapping of contemporary trends in this field. It is especially important to identify dominant research directions, the most influential authors, patterns of collaboration, and the evolution of key topics over time. In this context, bibliometric analysis is a powerful tool for quantitative research of scientific literature, enabling the visualisation of research networks, identification of trends, and mapping of the development of scientific fields. This approach is increasingly used across various disciplines to analyse the structure and dynamics of scientific knowledge (Tranfield et al., 2003; Bota-Avram, 2022). This work aims to use bibliometric analysis of literature from the period 2019–2025 to identify key trends in the development of improved FMEA models.

2. LITERATURE REVIEW

In recent decades, the FMEA method has become one of the most widely used techniques for risk analysis and management in engineering and production systems. Alongside its development, the number of studies analysing the structure of the scientific field itself has increased, making bibliometric and systematic studies important tools for mapping scientific trends. One of the most influential works in this area is Huang et al. (2020), which provides a systematic overview of the development of the FMEA method and identifies key research directions. The authors demonstrate that research is increasingly focusing on fuzzy models, multi-criteria decision making (MCDM), and hybrid approaches, indicating the growing complexity and interdisciplinary nature of this field. Conversely, Liu et al. (2013) present one of the earlier reviews of the development of the FMEA method and highlight the limitations of the classic RPN approach. They emphasise the problem of subjectivity and insufficient precision in traditional models, which has prompted the development of new approaches for risk assessment. Bowles and Peláez (1995) made a significant contribution to the development of the fuzzy FMEA approach, being among the first to propose the use of fuzzy logic for ranking errors in FMEA analysis. Their work forms the basis for the subsequent development of fuzzy and hybrid models. Tranfield et al. (2003) define a systematic literature review as a structured and repeatable process for analysing scientific papers, enabling transparency and objectivity in research. This approach underpins modern bibliometric analyses. Donthu et al. (2021) provide guidelines for conducting bibliometric analysis, including the examination of co-authorships, co-citations, and keyword networks. Their work is widely used as a methodological framework for bibliometric research across various scientific fields. In the broader context of FMEA method development, the literature indicates a clear trend from classic deterministic models towards fuzzy, MCDM, and hybrid approaches, which facilitate improved management of uncertainty and complex systems. Despite the large number of existing studies, there is still a limited number of studies that cover the most recent period of FMEA literature development (2019–2025), as well as studies that combine detailed network analysis of authors, countries,

and keywords in a single framework. This research gap is the basis for conducting the bibliometric analysis in this paper.

3. METHODOLOGY

This research is based on bibliometric analysis, aiming to identify key trends, authors, countries, and research directions in the field of Failure Mode and Effects Analysis (FMEA). The focus is on the period 2019–2025, to observe the recent development of this method and enable comparison with previous studies.

3.1. Data collection

The data used in this paper were obtained from the Web of Science database, one of the most relevant academic databases for bibliometric analyses. The search was conducted on 26 December 2025. The search was performed within the title, abstract, and keywords fields to include all relevant publications. The search query was defined using a structured combination of keywords related to FMEA and risk analysis, including: (“FMEA” OR “FMECA”) AND (“risk priority number” OR “RPN”) AND (“risk evaluation” OR “risk assessment”) AND (“risk prioritization” OR “risk ranking”) AND (“risk factor weight” OR “weight of risk factor”) AND (“reliability analysis” OR “reliability management”) AND (“criticality analysis”) (Huang et al., 2020). The initial dataset contained 4,201 articles. After removing duplicates, the number of articles was reduced to 4,125. Further selection was carried out using the Python programming language to ensure greater objectivity and repeatability of the filtering process. Only scientific works published in English and in the form of journal articles were included in the analysis. Conference papers, books, book chapters, and other non-reviewed sources were excluded. Additionally, only articles addressing the improvement, modification, or development of the FMEA method were included. Articles referring exclusively to the classical application of FMEA without methodological improvements, as well as review articles without analytical contribution, were excluded from the final set. After this selection process, a final set of 347 articles was obtained that were used for bibliometric analysis. The research model is shown in Figure 1.

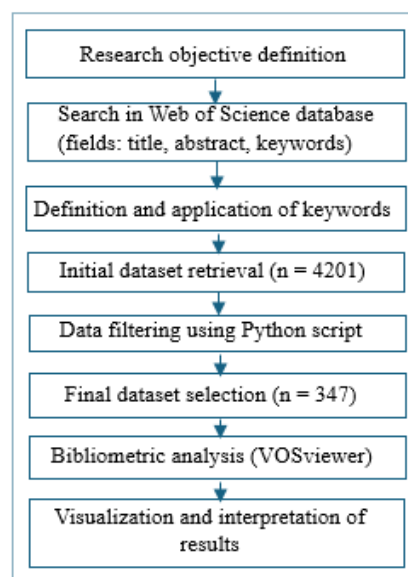


Figure 1. Research model (Authors)

3.2. Bibliometric analysis

Bibliometric analysis is a quantitative method for examining scientific literature, enabling the identification of research trends, influential authors, collaboration patterns, and dominant topics within a specific field. This methodology is increasingly used to map the structure of scientific disciplines and monitor their development (Donthu et al., 2021). In this paper, basic bibliometric techniques were applied, including the analysis of co-authorship, country collaboration network, and keyword occurrences. Co-authorship analysis provides insight into collaboration among researchers and institutions, while country collaboration network identifies the most productive and interconnected countries in the field. Keyword analysis is used to identify dominant research topics and their interrelationships.

VOSviewer software (version 1.6.20) was used for the visualisation and analysis of networks, enabling graphical display of bibliometric networks and identification of clusters based on the strength of connections between elements. VOSviewer uses a distance-based mapping approach, where the distance between nodes reflects the strength of their connectivity (Van Eck & Waltman, 2010).

4. RESULTS AND DISCUSSION

This section presents the results of the bibliometric analysis conducted on a dataset of 347 scientific articles related to improved FMEA methodologies. The analysis focuses on three main dimensions: co-authorship, country collaboration network, and keyword co-occurrence.

4.1. Co-authorship analysis

The co-authorship network in Figure 2 comprises eighteen authors grouped into four distinct clusters, revealing a structured collaboration pattern among researchers contributing to the development and enhancement of the FMEA method. The analysis covers the period from 2019 to 2025 and includes a number of significant joint publications in this field, primarily focusing on FMEA improvement, fuzzy logic applications, and multi-criteria decision-making (MCDM) methods. The largest and most centrally located cluster (Cluster 1, red) includes authors such as Zhou Ligang, Zhou Bin, Wu Qun, Chen Jing, and Pamučar Dragan. This cluster occupies a central position in the network and exhibits extensive connections both within the cluster and with other clusters, indicating its key role in the overall collaboration structure. The research activity within this group is highly productive and primarily focused on the enhancement of the classical FMEA method through fuzzy extensions and MCDM approaches for risk assessment and decision-support systems.

Cluster 2 (green), located on the right side of the network, includes authors such as Liu Yi, Yu Liying, Garg Harish, Rong Yuan, and Simić Vladimir. This cluster is characterized by strong internal cohesion and dense collaborative ties among its members, while showing limited connections with other clusters. The research within this group is mainly oriented toward optimization models and fuzzy MCDM approaches applied to complex engineering decision-making problems.

Cluster 3 (blue) includes authors such as Wang Weizhong, Liu Shuli, Pei Mengjiao, and Wen Haolan. This cluster plays a bridging role within the network, as Wang Weizhong is centrally positioned and connected to multiple clusters. As a result, this group acts as an important intermediary facilitating collaboration across different research communities. The main research focus includes methodological frameworks for decision-making under

uncertainty, particularly through fuzzy and hesitant fuzzy approaches, as well as the application of MCDM techniques.

Cluster 4 (yellow) consists of authors such as Deveci Muhammet, Mardani Abbas, Tang Jing, and Zheng Qiaohong. Positioned on the left side of the network, this cluster shows moderate internal connectivity and only limited links to the central part of the network. The research conducted within this group is primarily focused on the practical application of MCDM methods in real-world decision-making problems, including logistics and complex system analysis.

The network is characterized by strong intra-cluster collaboration and selective inter-cluster connections. Several centrally positioned authors act as bridging nodes, linking different clusters and ensuring knowledge diffusion across the network. This structure is consistent with established findings in co-authorship network analysis, where modular clustering and bridging authors are common features (Newman, 2001; Newman, 2004). The overall research landscape is strongly oriented toward the integration of fuzzy logic, soft computing, and multi-criteria decision-making techniques for the advancement of the FMEA method.

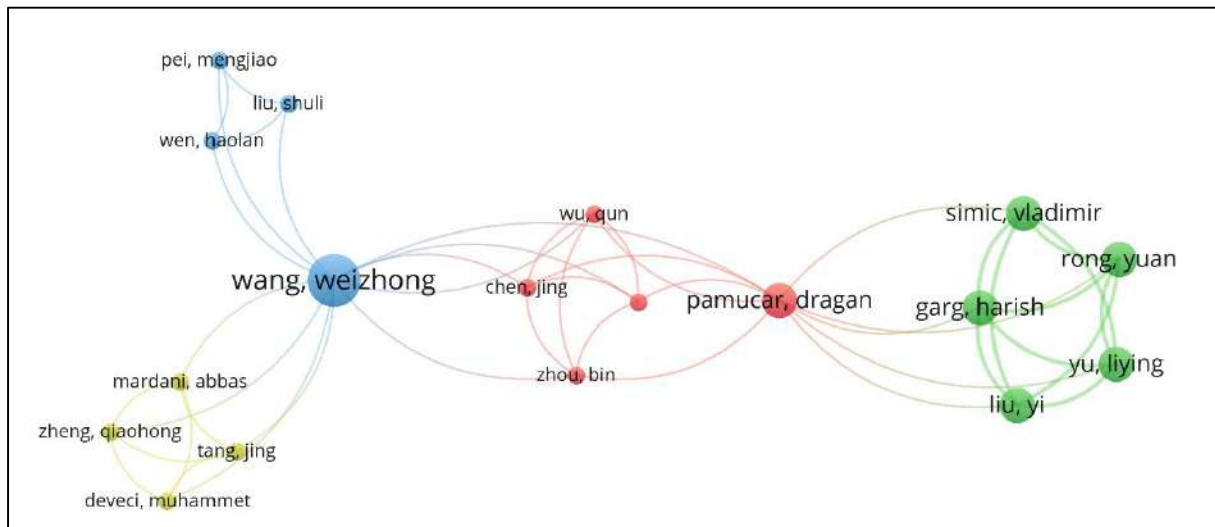


Figure 2. Author collaboration network in the field of FMEA (VOSviewer)

As presented in Table 1, Wang Weizhong has the highest total link strength (12) and the largest number of publications (3), followed by Pamučar Dragan with a total link strength of 10 and two publications. Similarly, Simić Vladimir, Liu Yu, and Rong Yuan each demonstrate a total link strength of 9. These authors can be considered the most productive and influential contributors within the analyzed co-authorship network, given their high publication output and strong collaborative ties.

Table 1 Top Authors in FMEA Research (2019 – 2025) (Authors)

No	Author	Document	Total link strength
1	Wang Weizhong	3	12
2	Pamucar Dragan	2	10
3	Simić Vladimir	2	9
4	Liu Yu	2	9
5	Rong Yuan	2	9

4.2. Country Collaboration Network

The Figure 3 illustrates the collaboration network between countries in the field of Failure Mode and Effects Analysis research, generated using the VOSviewer software. The network comprises 19 nodes organized into 5 clusters, with a total of 38 links and an overall link strength of 50. Node size reflects the intensity of scientific output, while the links represent collaborative relationships between countries. China occupies the central position in the network, exhibiting the highest number of connections, which highlights its dominant influence and pivotal role in advancing research in this field. In close proximity to China are countries such as India, Serbia, and Taiwan, which also demonstrate strong mutual collaboration and contribute significantly to the research landscape.

The network structure reveals clearly defined clusters, indicating the presence of distinct research groups. The central cluster is characterized by strong internal collaboration and represents the core of research activity, while the remaining clusters display somewhat weaker but still meaningful connections. Certain countries, such as the United States and Türkiye, act as bridging nodes, facilitating interactions between clusters and supporting the integration of different research streams. Conversely, some countries are positioned on the periphery, suggesting a lower level of engagement in international collaboration. Overall, the results point to a well-developed yet partially fragmented collaboration network, marked by the dominance of leading research hubs and the increasing importance of international cooperation in the advancement of FMEA methodologies.

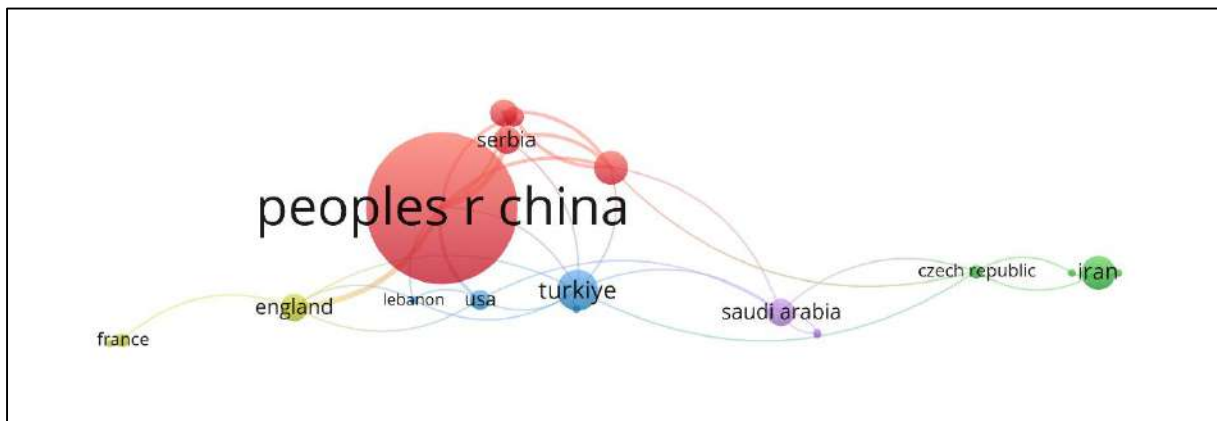


Figure 3. Country collaboration network in FMEA research (VOSviewer)

As presented in Table 2, China has the highest number of documents (22) and the strongest Total Link Strength (TLS) (16), confirming its central position in the collaboration network. India follows with 5 documents and a total link strength of 11, while Turkey (6 documents, TLS 9) and Taiwan (4 documents, TLS 7) also show significant participation in international collaboration. These results indicate that countries with higher publication output and stronger collaborative ties occupy more central positions within the FMEA research network.

Table 2 Top Countries in FMEA Research (2019 – 2025) (Authors)

No.	Countries	Document	Total link strength
1	China	22	16
2	India	5	11
3	Turkey	6	9
4	Taiwan	4	7

Table 3 presents the most frequent keywords in FMEA research based on their occurrences, highlighting the dominant concepts in the field such as failure mode, risk assessment, and prioritization.

Table 3 Top 5 Keywords in FMEA Research (2019 – 2025) (Authors)

No.	Keyword	Occurrences
1	Failure mode	18
2	Risk assessment	15
3	Prioritization	10
4	FMEA (Failure Mode and Effects Analysis)	8
5	Fuzzy	3

Overall, the results of the co-authorship, country collaboration, and keyword co-occurrence analyses presented in Figures 2–4 demonstrate a well-structured research landscape within the FMEA field, characterized by clearly defined thematic clusters and stable research directions. The co-authorship network reveals distinct collaboration groups of authors working on FMEA enhancement, particularly through fuzzy logic and multi-criteria decision-making (MCDM) approaches, while the country collaboration network highlights the dominant role of China and other key contributors in shaping international research cooperation. In addition, the keyword co-occurrence analysis confirms that contemporary FMEA research is strongly focused on risk assessment, prioritization, and the integration of fuzzy and hybrid decision-making models.

These findings are consistent with previous bibliometric and review studies, which emphasize the increasing interdisciplinarity and methodological complexity of FMEA research (Huang et al., 2020; Donthu et al., 2021; Aria & Cuccurullo, 2017). Notably, the transition from the classical FMEA methodology toward advanced models that combine analytical techniques with intelligent and data-driven approaches is clearly evident, further confirming the evolutionary development of this research field.

5. CONCLUSION

Failure Mode and Effects Analysis (FMEA) is one of the most important methods for identifying, assessing and managing risks in complex technical, industrial and organisational systems. Over the past decades, this method has developed significantly through integration with advanced approaches such as multi-criteria decision-making, fuzzy logic and intelligent systems, resulting in the formation of a broad and interdisciplinary research field.

The aim of this work was to identify, through bibliometric key research trends, the most influential authors, countries and thematic areas in the field of improving the FMEA method during the period 2019–2025. The analysis was based on 347 selected scientific articles from the Web of Science database, using Python tools for data processing and VOSviewer software for visualising bibliometric networks.

The research results show a clear increase in scientific production during the observed period, as well as the dominant role of authors and countries in the fields of engineering and computing. Key research clusters have been identified, indicating the development of FMEA towards hybrid models based on fuzzy logic and MCDM methods, as well as its increasing application in intelligent systems and the analysis of complex decision-making problems. Keyword analysis further confirms dominant themes related to risk assessment, prioritisation, and decision optimisation.

The scientific contribution of this work is reflected in the comprehensive mapping of the contemporary research landscape of the FMEA method and the integration of several

bibliometric analyses (co-authorship, country collaboration network and keyword analysis) into a single framework.

However, this work has certain limitations. The analysis is based exclusively on the Web of Science database, while other relevant databases (such as Scopus or Google Scholar) are not included, which may affect the completeness of the sample. In addition, only journal articles were considered, while other types of publications (such as conference papers and book chapters) were excluded. The research is also limited to the period 2019–2025 and to articles published in English, which may lead to the exclusion of relevant studies in other languages or from earlier periods.

Future research may focus on expanding the database to include more sources, as well as applying more advanced bibliometric and textual analyses, including machine learning and semantic network analysis.

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