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Emerging Trends and Research Insights in Fuzzy Multi-Criteria Decision-Making Applications for Logistics Location Selection: A Comprehensive Bibliometric Analysis (1982-2025)

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ABSTRACT

Selecting an appropriate location is a pivotal decision in logistics. Multi-Criteria Decision-Making (MCDM) methods have gained considerable attention for their effectiveness in identifying optimal logistics sites. This paper explores the evolution, applications, and prospects of Fuzzy MCDM methods in logistics location selection. Through an extensive bibliometric analysis of 35,566 relevant papers sourced from the Web of Science (WoS) database spanning 1982 to 2025, this study uncovers key trends, influential authors, major institutions, and the geographical distribution of research contributions, employing tools such as VOSviewer 1.6.20. The findings indicate that China has established itself as the leading country in terms of published papers. At the same time, Edmundas Kazimieras Zavadskas emerges as the most prolific author in this bibliometric review. The United Kingdom is highlighted for its robust international co-authorship networks. Additionally, King Abdulaziz University is recognized as a significant institution fostering global collaborations, with Zavadskas noted as a central figure in the author collaboration network. Moreover, the journal IEEE Access is the most frequently cited publication outlet for related work. Commonly used key terms among authors include decision making, machine learning, and fuzzy logic. The findings also indicate that the most frequently discussed topics related to the United Nations Sustainable Development Goals (SDGs) are Industry, Innovation and Infrastructure, followed by Sustainable Cities and Communities and Well-being and Health. This study offers a comprehensive overview of research on Fuzzy MCDM methods for logistics location selection, providing valuable insights for future research directions in this rapidly evolving field.

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1. Introduction

Fuzzy set theory, introduced by Zadeh in 1965 [1], has become widely recognized for its ability to represent the uncertainties inherent in human judgments objectively and to address ambiguities in multiple-criteria decision-making (MCDM) scenarios with defined criteria. Since Bellman and Zadeh introduced the theory of decision-making behavior in a fuzzy environment in 1970, numerous relevant models have been developed and implemented across various fields. The integration of fuzzy theory with multi-criteria decision-making is known as fuzzy MCDM [2]. Within this framework, a fuzzy MCDM model is employed to evaluate alternatives based on specific criteria established by a panel of decision-makers. This approach facilitates the assessment of how well various options align with the defined requirements and the significance weights assigned to the criteria, using linguistic terms represented as fuzzy numbers [3].

Linguistic terms such as "satisfied," "fair," and "dissatisfied" serve as clear indicators of individual preferences and judgments. These terms highlight the importance of fuzzy set theory in understanding decision-makers' preference structures. Fuzzy set theory plays a crucial role in assessing the ambiguity associated with concepts related to human subjective evaluations. Since these assessments arise from diverse perspectives on linguistic variables, they must be interpreted in a context of uncertainty and fuzziness [4]. In traditional set theory, an element's membership in a set is determined by a binary Boolean logic, signifying that a component is either a member or not. In contrast, fuzzy set theory utilizes multi-valued fuzzy logic, which recognizes varying degrees of membership. Within this framework, an element's membership is represented as a value in the real unit interval (0,1) [5]. Moreover, fuzzy MCDM methods have been extensively applied across numerous fields, including location selection, information project selection, material selection, management decisions, strategy selection, and various decision-making challenges [6-9].

The logistics sector is rapidly evolving alongside advancements in industrial and commercial activities. In today's competitive landscape, countries need to develop an effective logistics strategy that meets the demands of both industries and commerce. In this regard, logistics centers are recognized as essential facilities that address the challenges of urban logistics [10]. Location selection is a critical aspect of logistics, focusing on identifying the most advantageous sites for logistics facilities. This challenge entails determining the optimal placement of infrastructure components—such as land, sites, or facilities—within a defined area, while accounting for the decision maker's preferences and existing constraints [11]. Selecting a location for logistics operations is one of the most essential strategic decisions, as it dramatically affects long-term risk and profitability [12]. Furthermore, selecting an inappropriate location for logistics operations can significantly affect a company's performance and increase costs. Conversely, selecting an optimal location can enhance operational efficiency, improve competitiveness, and increase profitability while simultaneously reducing expenses [13].

1.1 Importance of Applying MCDM Methods in Location Selection Problem

Selecting a facility location is a complex and costly decision that can be challenging to modify once a business is operational, making it crucial for companies. This challenge is significant not only for startups but also for established businesses that are launching new sites. Additionally, determining the optimal solution for the facility location selection process is essential for the efficiency of a production system. The decision regarding a location selection involves a multifaceted process that considers various criteria [14, 15]. So far, various qualitative and quantitative methods have been used to address the location selection problem [16, 17]; however, the logistics location decision is an MCDM problem, as it depends on multiple factors [18]. In recent decades, Fuzzy MCDM

techniques have attracted considerable attention for their effectiveness in addressing challenges in logistics location selection. These methods are particularly valued for their ability to manage uncertainty, ambiguity, and the subjective evaluations often present in complex decision-making situations [19, 20].

1.2. Objective of the Current Study

The objective of this research is to conduct a comprehensive bibliometric analysis of studies focused on logistics location selection using Fuzzy MCDM techniques. Specifically, this research aims to:

i. Examine Trends: Identify and analyze trends over time in the application of Fuzzy MCDM methods for the location selection problem in logistics, including the evolution of methodologies and their adoption across various industries.
ii. Assess Research Impact: Evaluate the influence of significant publications, leading authors, and key journals in this field, highlighting essential contributions and highly cited works.
iii. Map Research Networks: Explore collaborative networks among researchers, institutions, and countries to gain insights into the global distribution and cooperative interactions within the related field.

1.3. Novelty of the Current Study

This study offers a comprehensive bibliometric analysis of the logistics location selection problem through the framework of Fuzzy MCDM methods. It provides valuable insights into research trends and methodologies in this field. The originality of this work stems from its systematic evaluation of the evolution of MCDM techniques related explicitly to logistics location selection, highlighting emerging trends, key studies, and significant research gaps. By employing advanced bibliometric tools, the study examines a substantial dataset of publications and uncovers notable patterns and shifts in research focus over time.

1.4. Organization of the Study

The structure of this article is as follows: The second section offers a comprehensive review of the current research landscape. The third section outlines the data and methodological approach employed in the study. In the fourth section, we present the findings obtained through bibliometric analysis. Finally, the fifth section concludes with a summary of our results, recommendations, and implications for future research.

2. Literature Review

In recent decades, researchers have conducted extensive bibliometric analyses to systematically analyze the patterns, trends, and impact of MCDM research across various fields. These analyses offer valuable insights into the development of the MCDM field by emphasizing key themes, influential authors, foundational publications, and emerging areas of interest. A brief overview of previous research in this field is presented in Table 1.

Table 1
Bibliometric research on MCDM

Author(s)	Research Title	Database(s)	Software	Key Findings / Results
[21]	Multi-criteria decision analysis (MCDA) in health care: A bibliometric analysis	Medline, PubMed, WoS, Biosis	Matheo Analyzer	The number of MCDA applications in the healthcare sector has increased significantly, with corresponding authors from the United States identified as the most prolific contributors.
[22]	Bibliometric Analysis of Multiple Criteria Decision Making in Agriculture	WoS	VOSviewer	Annual publication output has increased rapidly since 2005, accompanied by a continuous rise in citation counts, indicating growing academic interest in MCDM applications in agriculture.
[23]	Bibliometric analysis of the DEMATEL method	WoS	R-Biblioshiny	China emerged as the leading contributor (553 documents; 28.17%), while Taiwan recorded the highest h-index (62). *Journal of Cleaner Production* was identified as the most influential journal.
[24]	Bibliometric Studies on Multi-Criteria Decision Analysis (MCDA) Methods Applied in Military Problems	WoS, Scopus	VOSviewer, Bibliometrix	The Analytic Hierarchy Process was found to be the most frequently applied MCDM method in military-related decision-making studies.
[25]	Systematic review of MCDM approach applied to the medical case studies of COVID-19: trends, bibliographic analysis, challenges, motivations, recommendations, and future directions	ScienceDirect, IEEE Xplore, Scopus, WoS	PRISMA	MCDM approaches were shown to be effective tools for optimizing resources and supporting decision-making in medical contexts, particularly during pandemics and natural disasters.
[26]	Sustainable Supplier Selection through Multi-Criteria Decision Making (MCDM) Approach: A Bibliometric Analysis	Scopus	VOSviewer	Research on sustainable supplier selection using MCDM methods experienced its most significant growth in 2019.
[27]	A Bibliometric Analysis of Material Selection Using MCDM Methods: Trends and Insights	WoS	VOSviewer	Asia and Europe were identified as leading regions in advancing MCDM methodologies for material selection problems.
[28]	Sensitivity analysis in multi-criteria decision making: A state-of-the-art research perspective using bibliometric analysis	Scopus	RStudio, CiteSpace, VOSviewer	China led in publication output, while India showed strong international collaboration. The most cited authors included Pamučar, Kahraman, and Zavadskas.
[29]	Multi-criteria decision making (MCDM) in diverse domains of education: a comprehensive bibliometric analysis for research directions	Scopus	VOSviewer, R packages, Tableau	Fuzzy-based techniques were widely applied in educational MCDM studies, with China being both highly productive and highly cited in this domain.

Table 1
Continued

Author(s)	Research Title	Database(s)	Software	Key Findings / Results
[30]	Measurement of Alternatives and Ranking according to Compromise Solution (MARCOS) Method: A Comprehensive Bibliometric Analysis	Scopus	VOSviewer, R-Biblioshiny	*Sustainability*, *Mathematics*, and *Expert Systems with Applications* were identified as the most influential journals, while Stević Ž. emerged as the most cited and productive author.
[31]	Evaluation Based on Distance from Average Solution (EDAS) Method: A bibliometric analysis	Scopus	VOSviewer, CiteSpace, Biblioshiny	China was the leading contributor in publication volume, whereas India demonstrated strong international collaboration performance.
[32]	Multi-Criteria Decision-Making Methods for Robot Selection: A bibliometric analysis of research trend	Scopus	RStudio, VOSviewer, CiteSpace	India ranked first in publication output, while China played a central role in international research collaborations.
[33]	A Comprehensive Review of Multi-criteria Decision-making (MCDM) Toward Sustainable Renewable Energy Development	WoS, Scopus	VOSviewer	MCDM methods such as TOPSIS, DEMATEL, and BWM were widely employed in energy planning, site selection, and resource evaluation problems.
[34]	A Bibliometric Analysis of Multi-Criteria Decision-Making Techniques in Disaster Management and Transportation in Emergencies: Towards Sustainable Solutions	WoS, Scopus	R-Bibliometrix	Three major research clusters were identified: disaster planning and logistics, risk and resilience, and crisis response and decision support.
[35]	A Comprehensive and Systematic Review of Multi-Criteria Decision-Making (MCDM) Methods to Solve Decision-Making Problems: Two Decades from 2004 to 2024	Dimensions.ai	VOSviewer	Results revealed exponential growth in MCDM applications, particularly in sustainable energy, urban planning, and healthcare optimization.
[36]	Emerging Trends and Research Insights in Fuzzy Multi-Criteria Decision-Making Approaches for Logistics Location Selection: A Comprehensive Bibliometric Analysis	WoS	VOSviewer	This study explores the evolution, applications, and prospects of Fuzzy MCDM methods in logistics location selection.
[37]	Trends and Networks in the Application of MCDM Methods in Computer Science: Analysis of the Web of Science Database	WoS	RStudio, Biblioshiny	The results reveal a growing trend in publications, high activity by certain authors, and strong collaboration within research clusters.
[38]	A Comprehensive Review of Fuzzy Multiple Criteria Decision-Making (MCDM) Methods: Advancements, Applications, and Future Directions	Dimensions.ai	In-depth and systematic review	The paper offers a systematic classification of decision models, including outranking, value-based, pairwise comparison, and hybrid models.

2.1. Research Gap

Recent bibliometric research in the MCDM domain has primarily focused on various application areas, including healthcare [21, 25], agriculture [22], education [29], military decision-making [24], renewable energy [33], and disaster management and emergency transportation [34]. Furthermore, studies have examined specific methodologies such as DEMATEL, MARCOS, and EDAS [23, 30, 31]. While this research provides valuable insights into publication trends, notable authors, journals, and countries, it primarily addresses MCDM applications at a broad methodological level or in sector-specific contexts that do not directly relate to logistics. Additionally, while many bibliometric studies recognize the extensive application of fuzzy-based techniques across various fields [29, 35], there remains a significant lack of research on fuzzy MCDM applications specifically for logistics location selection. This is particularly critical given the numerous uncertainties, subjectivities, and conflicting criteria inherent in these decisions. Moreover, the existing bibliometric literature tends to examine either specific MCDM methods (such as DEMATEL, MARCOS, EDAS) or broader application areas, thereby highlighting a distinct gap in understanding the intellectual foundation, methodological advancements, and research trends of fuzzy MCDM techniques explicitly applied to logistics location selection. This gap is increasingly relevant given the growing complexity of logistics networks and the heightened need for decision frameworks that account for uncertainty. Therefore, this study seeks to address this gap by providing a comprehensive bibliometric analysis of fuzzy MCDM approaches in logistics location selection, thereby offering a focused and innovative contribution that integrates methodological, thematic, and temporal insights not previously explored in the existing bibliometric literature.

3. Data and Methodology

Bibliometrics is the application of mathematical and statistical methods to written communication and is currently considered one of the most reliable quantitative methods for determining the evolution and boundaries of a research field [39]. While traditional literature reviews generally cover a limited number of studies, bibliometric analyses identify studies using large datasets, offering a more objective and broader perspective [40]. This approach enables a more impartial examination of research trends, conceptual structures, and collaboration patterns by systematically analyzing large-scale datasets using science-mapping methods [41]. In this study, the bibliometric analysis method was adopted to systematically, transparently, and reproducibly examine large volumes of bibliographic data. The quality of the data used in bibliometric analyses is critical to the validity and reliability of the findings. In this research, the WoS database was chosen as the data source because it is considered the most consistent and reliable source for scientific mapping studies, thanks to its strict journal selection criteria and comprehensive citation data in the academic literature [42]. Additionally, the WoS database offers significant methodological advantages over other databases in terms of structural homogeneity and the interdisciplinary inclusiveness of bibliometric data, including author, institution, citation, and keyword data [43]. The VOSviewer software (version 1.6.20), developed by Van Eck and Waltman [44], was used to visualize and map the obtained bibliometric data. VOSviewer uses the Visualization of Similarities (VOS) technique to create bibliometric networks. The software is widely preferred for bibliometric analysis, particularly for its ability to efficiently process large-scale datasets and present complex citation relationships in understandable, clustered network maps. Furthermore, to align with the study's objectives, the bibliometric analysis was structured to address the following research questions:

i. What is the distribution of publications on fuzzy MCDM approaches for logistics location selection in the Web of Science database between 1982 and 2025?

ii. What are the most frequently used keywords in publications focusing on fuzzy MCDM-based logistics location selection in the Web of Science database?
iii. Which countries and researchers have the highest number of publications on fuzzy MCDM approaches applied to logistics location selection in the Web of Science database?
iv. Which countries, researchers, and institutions demonstrate the strongest collaboration patterns through co-authored publications in the fuzzy MCDM literature on logistics location selection?
v. Which countries and publications receive the highest number of citations in studies addressing fuzzy MCDM approaches for logistics location selection in the Web of Science database?
vi. How are publications on fuzzy MCDM-based logistics location selection distributed across academic journals?
vii. How are publications on fuzzy MCDM approaches for logistics location selection distributed among different publishers?
viii. How are publications on fuzzy MCDM-based logistics location selection classified in the Web of Science database in terms of their alignment with the SDGs?

Following the formulation of the research questions, Table 2 presents the thematic keyword groups used to implement the bibliometric search strategy, including terms related to fuzzy MCDM approaches in logistics location selection, to systematically capture the relevant literature.

Table 2
Keywords in the bibliometric search

Topics	Keywords
Fuzzy	Fuzzy Logic; Fuzzy Set Theory; Fuzzy Sets; Type-1 Fuzzy; Type-2 Fuzzy; Interval Type-2 Fuzzy; Intuitionistic Fuzzy; Interval-Valued Intuitionistic Fuzzy; Hesitant Fuzzy; Interval-Valued Hesitant Fuzzy; Picture Fuzzy; Spherical Fuzzy; Neutrosophic Fuzzy; Single-Valued Neutrosophic; Interval Neutrosophic; Rough Fuzzy; Grey-Fuzzy; Fuzzy Linguistic; Linguistic Fuzzy; Triangular Fuzzy Number
MCDM	MCDA; Multi-Criteria Decision Making; Multi Criteria Decision Making; Multi-Criteria Decision Analysis; Multi-Attribute Decision Making; Multi-Attribute Decision Making; MADM; Decision Making; Group Decision Making; Fuzzy Decision Making; Hybrid MCDM
Logistics Location Selection	Logistics Location Selection; Logistics Facility Location; Logistics Center Location; Logistics Hub Location; Logistics Park Location; Logistics Terminal Location; Logistics Site Selection; Logistics Network Location; Logistics Base Location; Freight Village Location; Intermodal Terminal Location; Multimodal Terminal Location; Dry Port Location; Inland Port Location; Container Terminal Location; Port Hinterland Location; Cargo Terminal Location; Distribution Center Location; Regional Distribution Center Location; Warehouse Location; Fulfillment Center Location; Urban Logistics Facility Location; Last-Mile Logistics Facility Location

Bibliometric analysis began with a search in the WoS database to identify publications focusing on the role of fuzzy MCDM approaches in logistics location selection. Accordingly, the search strategy was structured around three main thematic keyword groups. The first group focused on Fuzzy, the second on multi-criteria decision-making approaches, and the last on logistics location selection issues. These three keyword groups were combined using Boolean Operators to ensure that only publications directly related to the research topic were included in the analysis. The search equation used in the search process is detailed in Table 3.

Table 3
Search Equation

Database	Equation Search
WoS	("fuzzy logic" OR "fuzzy set theory" OR "fuzzy sets" OR "type-1 fuzzy" OR "type-2 fuzzy" OR "interval type-2 fuzzy" OR "intuitionistic fuzzy" OR "interval-valued intuitionistic fuzzy" OR "hesitant fuzzy" OR "interval-valued hesitant fuzzy" OR "picture fuzzy" OR "spherical fuzzy" OR "neutrosophic fuzzy" OR "single-valued neutrosophic" OR "interval neutrosophic" OR "rough fuzzy" OR "grey-fuzzy" OR "fuzzy linguistic" OR "linguistic fuzzy" OR "triangular fuzzy number") AND ("MCDA" OR "multi-criteria decision making" OR "multi criteria decision making" OR "multi-criteria decision analysis" OR "multi attribute decision making" OR "multi-attribute decision making" OR "MADM" OR "decision making" OR "group decision making" OR "fuzzy decision making" OR "hybrid MCDM") AND ("logistics location selection" OR "logistics facility location" OR "logistics center location" OR "logistics hub location" OR "logistics park location" OR "logistics terminal location" OR "logistics site selection" OR "logistics network location" OR "logistics base location" OR "freight village location" OR "intermodal terminal location" OR "multimodal terminal location" OR "dry port location" OR "inland port location" OR "container terminal location" OR "port hinterland location" OR "cargo terminal location" OR "distribution center location" OR "regional distribution center location" OR "warehouse location" OR "fulfillment center location" OR "urban logistics facility location" OR "last-mile logistics facility location")) AND (LIMIT-TO (OA, "Open Access")) AND (LIMIT-TO (DOCTYPE, "Article" OR "Review Article")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (WOSINDEX, "SCI-EXPANDED" OR "SSCI" OR "ESCI")) AND (LIMIT-TO (WOS CATEGORIES, "Operations Research & Management Science" OR "Transportation" OR "Mathematics" OR "Engineering, Industrial" OR "Computer Science, Information Systems"))

3. Results

This section presents visual maps resulting from a bibliometric analysis of 35,566 articles and their interpretations.

3.1. An Overview of the Publication Years

The bibliometric analysis was conducted on 35,566 articles. Figure 1 presents the annual publication number of these articles from 1982 to 2025.

Figure 1 illustrates the annual distribution of publications related to fuzzy MCDM-based logistics location selection in the WoS database. This field first emerged in 1982 with two publications, but research output remained relatively low, especially during the 1990s and until the mid-2010s. However, following 2016, publication activity surged, peaking in 2025.

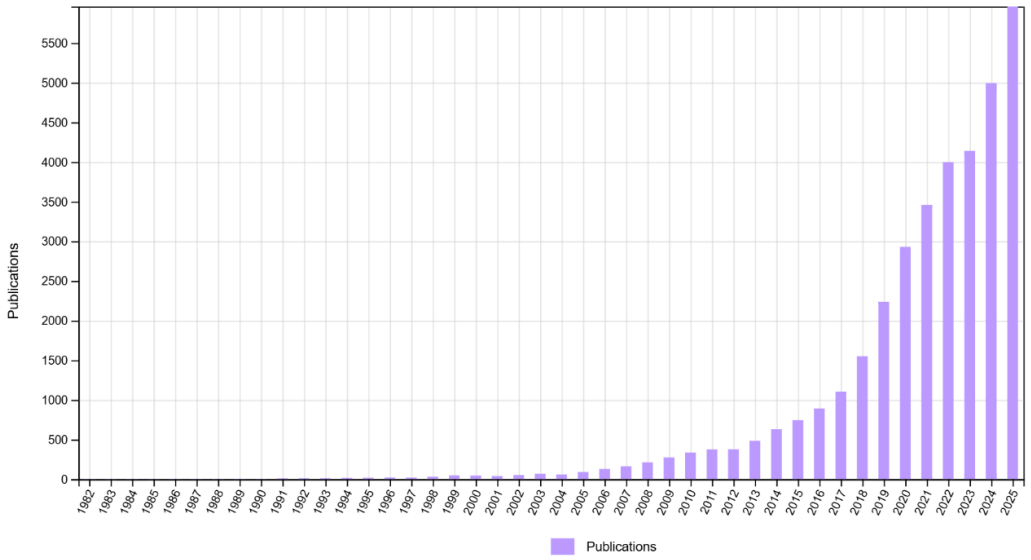

Fig. 1. Distribution of Publications

3.2. Keyword Network Analysis

This study utilizes keyword network analysis to visualize the conceptual framework of the literature and to clarify the boundaries and dynamics of the research domain. This analytical method reveals knowledge clusters within a particular field of study and illustrates their interrelationships by mapping networks of keywords [45]. In the literature, the strength of the connections between keywords reflects the proximity of related concepts and thematic coherence within the field [46]. Figure 2 depicts the most frequently used keywords in scientific articles addressing fuzzy MCDM concerning logistics location selection.

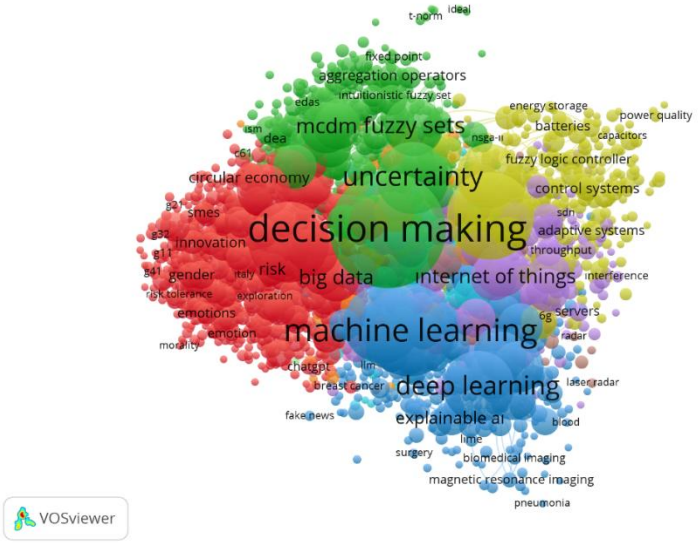

Fig. 2. Most used keywords

A total of 79,466 keywords were analyzed in the publications examined in this study. To improve the analysis's effectiveness, only keywords that appeared more than 10 times were included in the evaluation. As a result of this filtering, 2342 keywords meeting the threshold were identified. In the attached visualization, node size represents the frequency of each keyword's appearance in the publications. According to the findings, the keyword "Decision Making" emerged as the most frequently used concept in the literature, with 2,134 occurrences, while "Machine Learning" ranked second with 1,356 occurrences. The fact that the keyword "Fuzzy Logic" was used 1,216 times in third place indicates that fuzzy approaches maintain their strong position in the literature for modeling uncertainty. When examining keywords directly related to logistics location selection, concepts such as "optimization" (667 occurrences), "Sustainability" (455 occurrences), "Internet of Things" (350 occurrences), and "Big Data" (346 occurrences) stand out.

3.3. Leading Countries and Authors by Publication Output

A bibliometric analysis was conducted to evaluate the geographical and author-level distribution of research outputs in the field of fuzzy MCDM approaches for logistics location selection. To enhance the clarity and interpretability of the network visualization, a minimum threshold of five publications and five citations was established. As a result, 127 out of 169 countries and 1,740 out of 92,597 authors met the specified criteria. Figures 3 and 4 illustrate the countries and authors with the most notable publishing activity in the domain of fuzzy MCDM approaches to logistics location selection.

Figure 3 illustrates variations in publication output across countries regarding fuzzy MCDM approaches in the logistics location selection literature. The data reveals that China is the leading country in this field, boasting an impressive 6,855 publications. Following behind are the United

States with 4,390 publications and the United Kingdom with 3,783 publications. Among European nations, notable contributions come from Spain (2,071 publications), Germany (1,719 publications), and the Netherlands (1,582 publications). Additionally, India (2,328 publications) and Australia (1,624 publications) are also prominent players in the global literature.

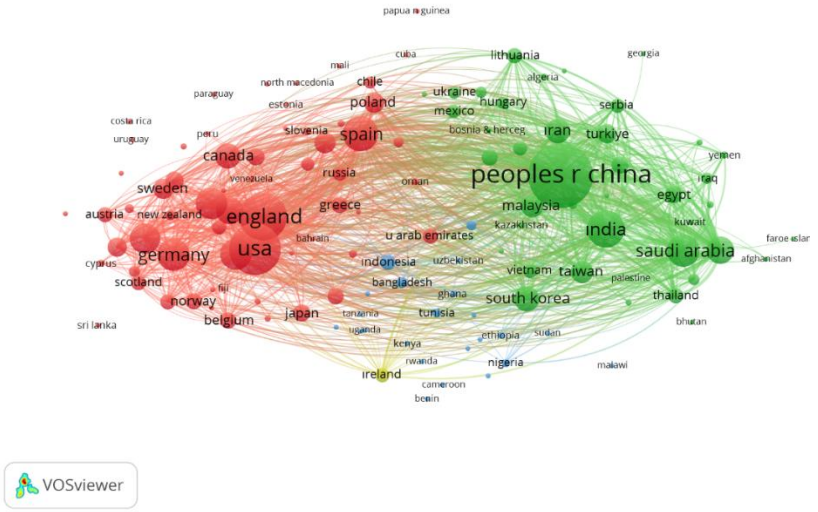

Fig. 3. Top publishing countries

Figure 4 shows the analysis of author productivity, highlighting Edmundas Kazimieras Zavadskas as the most prolific and influential researcher in the field, with an impressive total of 109 publications. His extensive publication record, coupled with a high citation count and a wide array of collaborations, emphasizes his pioneering role in shaping methodological trends within the literature. Following him are Dragan Pamucar, with 92 publications, and Tahir Mahmood, with 86 publications, both of whom have made substantial contributions to the academic landscape. Additionally, researchers such as Zeshui Xu (71 publications), Muhammet Deveci (67 publications), and Guiwu Wei (66 publications) are recognized as prominent contributors, distinguished by their remarkable publication performance and extensive collaboration networks.

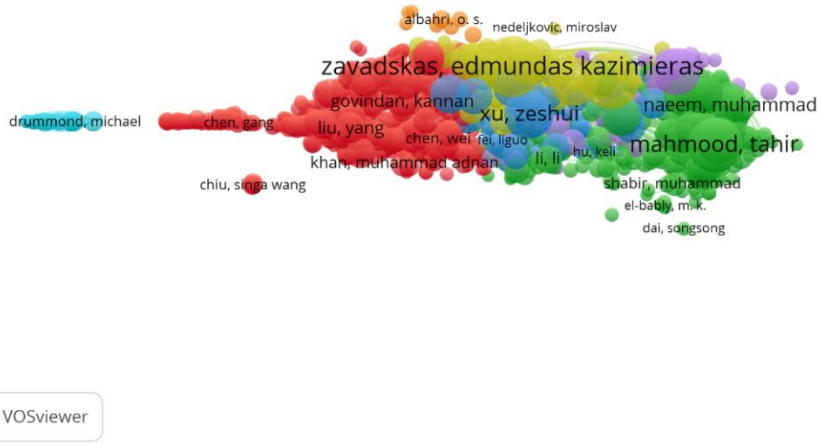

Fig. 4. Top publishing authors

3.4. Co-Authorship Analysis

This study utilizes author collaboration analysis to uncover the networks of scientific collaboration and social interaction among researchers in the field. As one of the most widely used

techniques in bibliometric literature, this analysis visualizes the social structure of the scientific community based on co-authorship frequency [47]. Co-authorship networks illustrate a framework for how researchers are interconnected, facilitating the transmission of knowledge through these links [48]. This analysis highlights dominant research groups, the intensity of collaborations, and the academic communities within the field [49]. In our study, we identified 127 countries, 2,785 institutions, and 1,740 authors with at least 5 publications and citations. Figures 5–7 demonstrate the countries, institutions, and researchers with the highest levels of co-authorship in fuzzy MCDM approaches for logistics location selection.

The visualization presented in Figure 5 depicts the density of co-authorship networks among countries, represented through variations in node sizes and color distributions. On the map, countries with limited co-authorship are shown in lighter hues, while those with a higher collaboration density are highlighted in more prominent shades. In this context, the United Kingdom stands out as the leader in international co-authorship networks, boasting the highest total connection strength at 5,153. The United States is second with 4,666 connections, while China ranks third with 3,957 connections. These findings suggest that these countries not only achieve significant publication output in their respective fields but also sustain a dense, centralized structure of international collaboration.

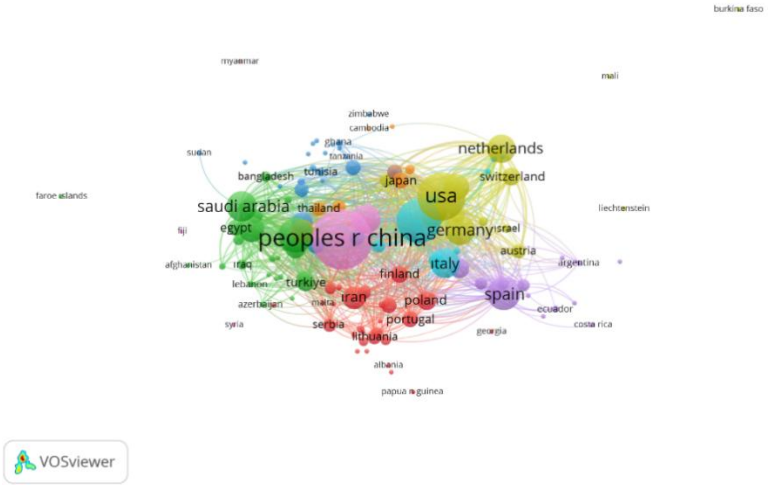

Fig. 5. Countries with the most Co-Authorization

Figure 6 illustrates the network of institutional relationships, where connections between nodes indicate collaborative interactions among institutions, and variations in node color indicate differing levels of co-authorship intensity. Within this framework, King Abdulaziz University stands out as a prominent institution in international co-authorship networks, with an impressive total connection strength of 613. Following closely are King Saud University (590) and Erasmus University (481). Furthermore, institutions such as Delft University of Technology, Vilnius Gediminas Technical University, and Hong Kong Polytechnic University significantly influence institutional collaborations in the literature, due to their central positions and high connection density.

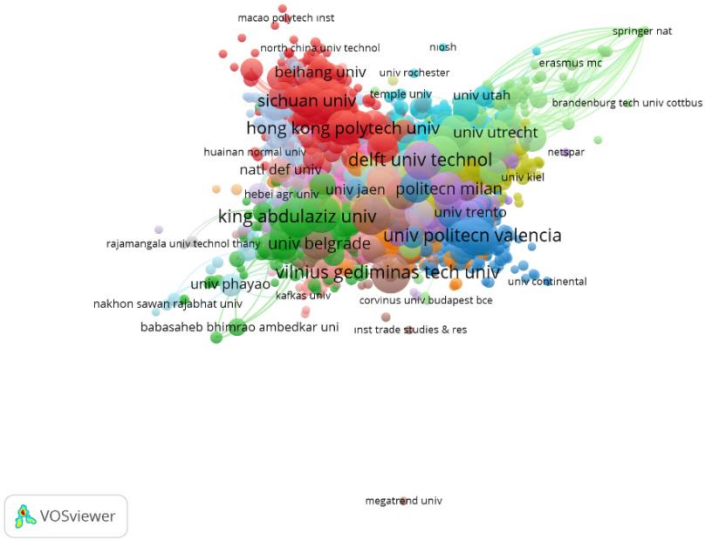

Fig. 6. Organizations with the most Co-Authorization

In the node-based visualization depicted in Figure 7, each node represents its respective author, with color intensity reflecting varying levels of co-authorship. Edmundas Kazimieras Zavadskas stands out as the most central figure within the author collaboration network, achieving a total connection strength of 223. He is closely followed by Tahir Mahmood, who has a connection strength of 208, and Dragan Pamucar, with a connection strength of 196. These authors play a crucial role in shaping the landscape of collaborative authorship in literature.

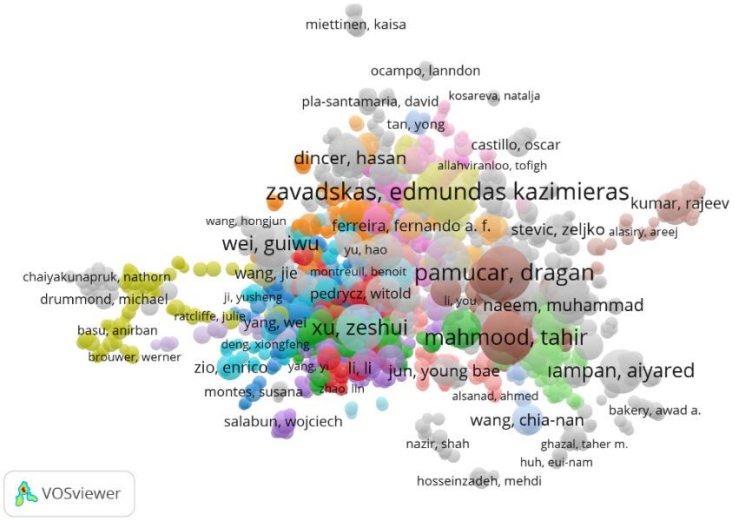

Fig. 7. Authors with the most Co-Authorization

3.5. Citation Analysis

In this study, citation analysis was employed to identify the most influential research and key sources within literature. This method uses the frequency of citations a publication receives as an objective indicator of its impact and significance within the scientific community. A work that amasses a high number of citations is viewed as significant by peers in the field, highlighting its considerable contribution to the existing body of knowledge [47]. On the other hand, citation counts are indicators of the quality and recognition of scientific output [50]. Elevated citation numbers

reflect the dissemination power and acceptance of knowledge. The results of the bibliometric analysis indicate that 127 out of 169 countries have achieved at least five citations, categorizing them as nations with notable citation counts. Additionally, citations in published works emphasize the impact of particular research topics. Among the 34,040 publications with high citation counts, 18,479 received at least 5 citations. Figures 8 and 9 depict the countries and documents with the highest citation counts in the field of fuzzy MCDM approaches for logistics location selection.

Figure 8 presents a density visualization of countries ranked by the number of citations. A deeper color on the map indicates greater citation impact in the literature. In this context, the United States, with 139,704 citations, occupies the most densely shaded area, indicating it holds the highest level of impact. Following closely are the United Kingdom (120,412 citations) and China (105,862 citations), both recognized as prominent research hubs on a global scale.

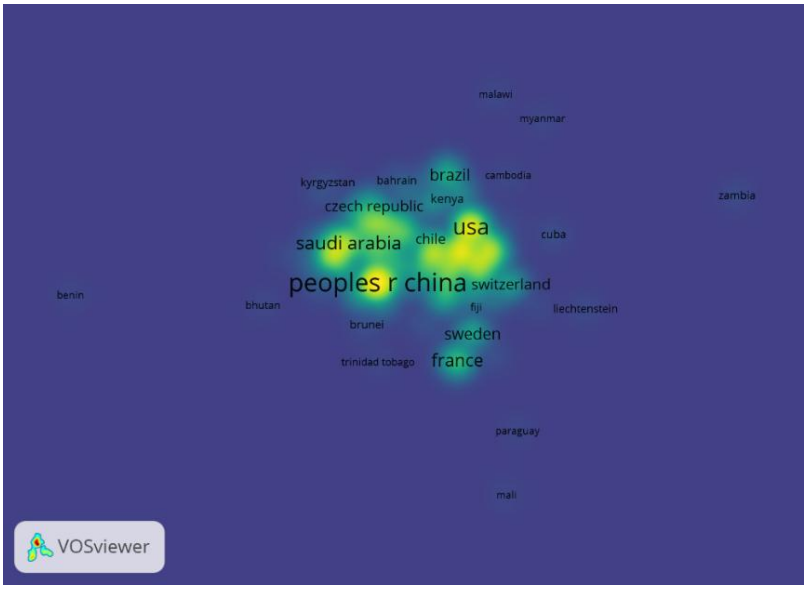

Fig. 8. Most cited countries

Figure 9 illustrates the documents with the highest citation counts using a density visualization. In this context, Al-Fuqaha's [51] study, boasting 4,948 citations, occupies the most densely populated area of the map, positioning it as a key reference point within the field. Following closely is Lusardi & Mitchell [52] with 2,131 citations, and Janiesch [53] with 1,585 citations.

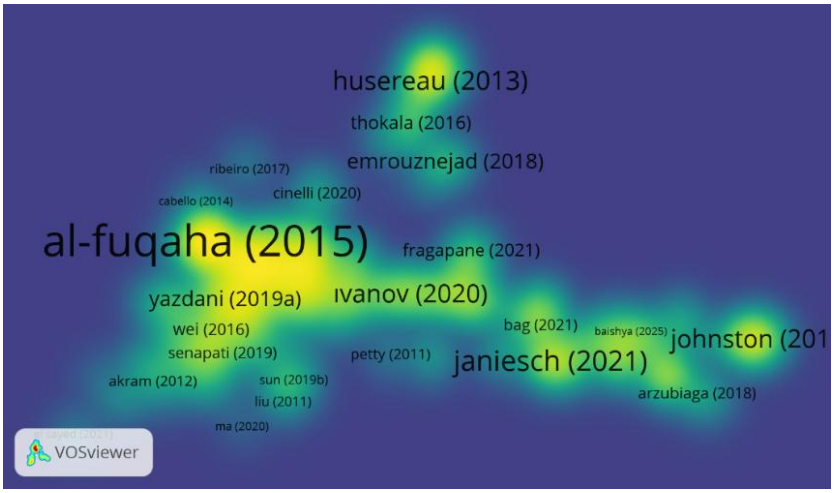

Fig. 9. Most cited documents

3.6. Most Prominent Journals

Ellegaard and Wallin [54] highlight that academic journals serve as valuable resources for researchers, offering strategic insights into identifying the most appropriate target audience and publication avenues for their work. In light of this, the present study analyzed leading journals to determine which platforms are central to knowledge production within the research field and which journals are influential in shaping the discipline. Table 4 presents a list of journals exhibiting the highest publication rates, along with the distribution of their contributions in the area of fuzzy MCDM approaches for logistics location selection. Notably, IEEE Access is the leading journal in this field, with 268 published articles. Following closely is Mathematics (MDPI) with 879 articles, while Electronics (MDPI) contributes 135 publications.

Table 4
Top Ten Journals

Journal Name	Number of Documents	H-Index (2024)	Subject Area and Category
IEEE Access	4655	290	Computer Science, Engineering, Materials Science
Mathematics (MDPI)	1723	84	Computer Science, Engineering, Mathematics
Electronics (MDPI)	879	110	Computer Science, Engineering
Information (MDPI)	441	72	Computer Science
Expert Systems with Applications (Elsevier)	427	290	Computer Science, Engineering
ISPRS International Journal of Geo-Information (MDPI)	405	84	Earth And Planetary Sciences, Social Sciences
Computers, Materials & Continua	365	67	Computer Science, Engineering, Materials Science, Mathematics
AIMS Mathematics	353	44	Mathematics
European Journal of Operational Research (Elsevier)	332	319	Computer Science, Engineering, Mathematics, Decision Sciences
Technological and Economic Development of the Economy	310	70	Economics, Econometrics, and Finance

3.7. Most Prominent Publishers

This section highlights the most notable publishing houses within the research domain. Tennant *et al.,* [55] underscore that the distribution networks and access policies of these publishers significantly influence the speed and impact of information dissemination. The purpose of this analysis is to identify the most prolific publishing houses in the field and to illustrate the channels through which the literature reaches researchers. Table 5 presents the top 10 publishers with the highest number of publications in the field of fuzzy multi-criteria decision-making approaches for logistics location selection, along with the distribution of their publications. Elsevier leads the list with 7,250 publications, followed by IEEE with 5,387 and MDPI with 4,327.

3.8. An Overview of the SDGs

A bibliometric analysis was conducted to identify the key SDGs associated with research on fuzzy MCDM approaches in logistics location selection. Table 6 presents the SDGs ranked by the volume of publications, highlighting their relative importance within the literature. The findings indicate that the most frequently discussed goals in literature are Industry, Innovation, and Infrastructure, with a total of 4,640 publications. This is closely followed by Sustainable Cities and Communities, which has

4,596 publications, and Well-being and Health, with 4,519 publications. Additionally, Responsible Consumption and Production, with 2,455 publications, and Climate Action, with 2,153 publications, emerge as significant sustainability goals that attract considerable academic attention.

Table 5
Most prominent publishers

Publisher Name	Country of Origin	Number of Publications
Elsevier	Netherlands	7250
IEEE	United States	5387
MDPI	Switzerland	4327
Springer Nature	United Kingdom	3159
Wiley	United States	2175
Taylor & Francis	United Kingdom	1732
Emerald Group Publishing	United Kingdom	745
SAGE	United States	707
AIMS (Amer. Inst. Math. Sci.)	United States	572
Vilnius Gediminas Tech Univ. Press	Lithuania	494

Table 6
Distribution of the SDGs

Sustainable Development Goals	Relevant Indicator	Number of Publications
Industry, Innovation and Infrastructure	SDG 9	4640
Sustainable Cities and Communities	SDG 11	4596
Good Health and Well-Being	SDG 3	4519
Responsible Consumption and Production	SDG 12	2455
Climate Action	SDG 13	2153
Affordable and Clean Energy	SDG 7	1583
No Poverty	SDG 1	1469
Zero Hunger	SDG 2	1231
Reduced Inequalities	SDG 10	1062
Decent Work and Economic Growth	SDG 8	1023

4. Discussion and Conclusion

As highlighted by Demir *et al.,* [30], the growth in scientific output on MCDM topics is impressive. However, there is a paucity of studies that analyze bibliometric data from research publications across various fields. In this context, the present research seeks to conduct a thorough bibliometric analysis of studies that focus on logistics location selection using Fuzzy MCDM techniques. Additionally, this study serves as a valuable resource for understanding the growing interest in Fuzzy MCDM research concerning logistics location selection within the existing literature. To the best of the author's knowledge, this research represents the first bibliometric analysis of the application of Fuzzy MCDM methods in logistics location selection in the WoS database. The objective is to assess the scientific output that has developed over the past four decades (1982-2025). In this context, a comprehensive review was conducted to identify the most prolific authors, significant research, organizations, countries, academic disciplines, and SDGs.

The annual distribution of publications shows that the initial endeavors began in 1982 in the relevant field with two publications. However, research output remained relatively low, especially during the 1990s and continuing until the mid-2010s. In recent years, particularly after 2016, the number of publications has increased significantly, with a peak projected for 2025. The results from the keyword network analysis reveal that "Decision Making" emerged as the most frequently used

term, closely followed by "Machine Learning" in second place and "Fuzzy Logic" in third. In the context of logistics location selection, several keywords stand out, notably "optimization", "Sustainability", "Internet of Things", and "Big Data".

The findings suggest that China leads this field, with the United States and the United Kingdom closely trailing behind. Within Europe, Spain, Germany, and the Netherlands have made noteworthy contributions. An analysis of author productivity highlights Edmundas Kazimieras Zavadskas as the most prolific and influential researcher in this domain. Additionally, Dragan Pamucar and Tahir Mahmood have made significant contributions to the academic landscape.

The results reveal that the United Kingdom leads the way in international co-authorship networks, followed by the United States in second place and China in third. Among institutions, King Abdulaziz University stands out in the global collaboration landscape, closely trailed by King Saud University and Erasmus University. Additionally, Edmundas Kazimieras Zavadskas emerges as the most prominent figure in the author collaboration network, with Tahir Mahmood and Dragan Pamucar ranking second and third, respectively, among the key researchers in this collaborative space.

The citation analysis reveals that the United States leads with nearly 140,000 citations, showcasing the highest impact in the field. The United Kingdom and China follow closely behind, both recognized as significant global research hubs. Additionally, Al-Fuqaha's [51] study stands out with nearly 5,000 citations, making it a crucial reference point. It is followed closely by the works of Lusardi and Mitchell [52] and Janiesch [53]. The findings indicate that IEEE Access ranks as the top journal in this field, with Mathematics (MDPI) closely following, and that Electronics (MDPI) also contributes publications. Notably, Elsevier emerges as the leading publisher, followed by IEEE and MDPI.

The analysis emphasizes the essential role of Fuzzy MCDM in relation to the United Nations Sustainable Development Goals (SDGs), particularly focusing on SDGs 9, 11, and 3. The application of Fuzzy MCDM in selecting logistics locations serves as a prime example of its alignment with global priorities. Additionally, the review indicates that the most frequently discussed topics in the literature are Industry, Innovation, and Infrastructure, followed by Sustainable Cities and Communities and Well-being and Health.

Overall, this research presents a comprehensive examination of global scholarly contributions to Fuzzy MCDM techniques specifically for logistics location selection, utilizing data from the WoS database. The study has successfully identified leading researchers within this field and mapped the geographical distribution of publications. Notably, China emerged as the country with the most published papers. Edmundas Kazimieras Zavadskas was acknowledged as the most prolific author in this bibliometric review. The United Kingdom distinguished itself through its extensive international co-authorship networks. King Abdulaziz University was underscored as a pivotal institution in promoting global collaborations, with Zavadskas highlighted as a significant figure within the author collaboration network. Additionally, the journal IEEE Access was recognized as the most frequently cited for related publications. Key terms frequently used by authors included Decision Making, Machine Learning, and Fuzzy Logic. By providing an in-depth summary of research on Fuzzy MCDM methods in logistics location selection, we aim to offer valuable insights and guidance for future research directions in the rapidly evolving field of MCDM. Based on these findings, several academic and managerial implications have been proposed as follows:

i. The identification of key authors, institutions, countries, and journals provides a structured overview of the Fuzzy MCDM literature on logistics location selection. This framework can guide researchers in their forthcoming investigations and collaborations.

ii. The prominence of nations such as China, along with international co-authorship networks—particularly with the UK and Gulf countries—underscores the significance of global partnerships in advancing knowledge and methodologies within Fuzzy MCDM.
iii. Key terms such as Decision Making, Machine Learning, and Fuzzy Logic reflect a trend toward integrating advanced techniques in the field, suggesting that future research will likely continue to investigate these methodologies.
iv. By mapping essential studies and citation trends, this research identifies research gaps and potential new avenues for exploration, thereby assisting scholars in aligning their contributions with prevailing research areas and aiding practitioners in effectively applying Fuzzy MCDM in logistics decision-making.
v. In particular, integrating environmental, operational, and policy criteria into logistics location selection supports SDG 9 (Industry, Innovation, and Infrastructure), SDG 11 (Sustainable Cities and Communities), and SDG 3 (Good Health and Well-Being).

The current research offers a comprehensive analysis of trends and insights in the relevant field; it has some limitations. This study was conducted based on data from a specific database—WoS—which may not encompass all applicable publications, potentially overlooking significant contributions from other sources such as Dimensions, Scopus, and PubMed. Additionally, the current study used the VOSviewer tool; however, future research could enhance its findings by incorporating additional tools, such as the R program and CiteSpace, to generate more robust results.

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Conflicts of Interest
The authors declare no conflicts of interest.

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