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Bibliometric Analysis of "Accuracy of Multi Criteria Decision Making (MCDM) of Assistance Recipients with Fuzzy Logic Algorithm"

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ABSTRACT

The issue of making decisions accurately and swiftly is crucial in the present and is bolstered by an abundance of data; therefore, making correct decisions can save the future. With a large amount of data and numbers, however, the decision-making process will become even more muddled if the statistical ranking values are identical. Therefore, a method is required to determine whether a hazy decision becomes clearer or a decision that is nearly identical is the best. The method used has existed for more than 50 years, and it is fuzzy logic. In the selection of fuzzi, the term Multi-Criteria Decision Making (MCDM) is frequently used, and it continues to be used and expanded. As a result, the increasing number of articles that contain information about Fuzzy Logic Multi-Criteria Decision Making (MCDM) can be used as research material using Bibliometric analysis based on the Scopus. With Bibliometric analysis, tens of thousands of related articles can be analyzed and displayed with VOSviewer software using a variety of categories including authors, titles, citations, updates, and other information to demonstrate the most recent direction of future research on fuzzy logic Multi Criteria Decision Making (MCDM).

Keywords: *Fuzzy Logic, Multi Criteria Decision Making (MCDM), Bibliometric Analysis, Publish or Perish, VOSviewer.*

INTRODUCTION

Complex Event Processing Decision-Based Processing This system has conducted sufficient research recent interests Thus, well-managed distribution operators are required to improve the performance of Fuzzy Event Complex Processing-based decision-making.[1] The research in the fuzzy science originated almost 50 years ago on the Fuzzy set, allowing the classic Boolean set to use multi-value logic. Initially, the study did not attract much attention, and received much criticism in the scientific community. [2] Fuzzy logic is a fuzzy inference system (FIS), which is a rule-based mechanism that builds relationships between a series of input and output sets. There are two basic types of FIS, namely the Mamdani model and the Takagi-Sugeno-Kang model. [3] Classical mathematical models can be complicated due to extensive information collection and data processing. There are also some important real-life parameters that are difficult to model classically due to uncertainty and lack of data availability. Unlike the classic models, the blur optimization model can be applied to multicriteria problems and combines the subjective input from decision makers exactly as described with less information needed for the Fuzzy model. [4] A type of artificial intelligence known as Fuzzy Logic consists of knowledge that allows computers to mimic human intelligence to perform tasks that require human expertise. In its most basic form, fuzzy logic is a multi-value logic that can set values between simple criteria such as right or wrong, yes or no. From blurred, fragile, and inaccurate information, fuzzy logic allows final conclusions to be drawn. [5] The fuzzy set theory (FST), which represents uncertainty in human beliefs, can be used effectively with the MCDM approach to produce more sensitive, real, and accurate findings [6].

The future research direction is proposed from three aspects. This article provides insights for researchers and practitioners interested in the MCDM model [7] In this environment, organizations can find utilities in multi-criteria decision-making (MCDM) tools that can help in evaluating and selecting suppliers by considering a mixture of conventional and environmental criteria. [8] Specific criteria based on their importance in the presence of the objective introduce some

important features of the MCDM as available algorithms and highlights its various features. [9] As a tool for expressing uncertain information, interval techniques can effectively prevent information loss and improve the accuracy of decision making. In this regard, many scientists apply interval and extension analysis techniques that confuse them to solve the problem of multi-criterion decision-making. (MCDM) [7] The MCDM approach is a useful tool for solving decision-making challenges [6].

Bibliometric analysis is the quantitative study of bibliographic material. It provides an overview of the fields of research that can be classified by papers, authors, and journals.[10] Biometrics can solve the above problems. This is a research method that is widely used by libraries and researchers. It uses quantitative and statistical analysis to find patterns of publication in a particular field. It has been widely used by researchers to analyze publications in journals. [11] A bibliometric survey using subheadings of management science textbooks as keywords is also interesting to compare this growth path with the growth of science in general. [12]

Table 1. Multi Criteria Decision Making (MCDM) with Fuzzy Logic

Author & Year	Number Document Analyzed	Source	Findings
[2]	45,700	SCOPUS	A science called bibliometrics uses numbers to examine bibliographic content. It is particularly helpful for categorizing material according to many factors, such as journals, institutions, and nations. This study provides a broad review of bibliometric indicator-based research in the fuzzy sciences. The key benefit is that these indicators provide a broad view and highlight some of the most important studies in this field. Key aspects of the study are focused on pertinent journals, publications, authors, institutions, and nations. Although some surprising outcomes are also obtained, the majority of the results are consistent with what we already know. Keep in mind that this paper's goal is informational and that the majority of this field's basic research is identified by these markers. However, if they are not included in the Web of Science database, which is utilized to do the bibliometric study, some very significant concerns could be overlooked.
[4]	2333	SCOPUS	One of the things that people worry about now is how to make energy in a sustainable way that is sustainable. To reduce carbon dioxide pollution while still meeting energy needs, different energy methods and production processes must be thought about. Optimization is one of the most important tools for making sure that energy systems are designed in the best way possible. The goal of this study is to look at how the fuzzy optimization method is being used in current research on energy and ecology. For the study, bibliometric methods based on the Web of Science core collection information are used. 87% of the 96 papers that were found were journal pieces. Analysis was done on the trends of these pieces, such as how often they were mentioned.
[11]	2488	SCOPUS	This study analyzes all 354 Pythagorean fuzzy set (PFS) works from 2013 to 2020 to understand their growth,

			existing condition, and anticipated future. Design/methodology/approach: This document first discusses the PFS articles' data, annual trend and projection, and fundamental features. Second, review criteria reflect the most active and influential authors, countries/regions, institutions, and most-cited works. Third, VOSviewer is used to graph PFS article growth by authors, countries/regions, institutions, and keywords. Finally, Cite Space downloads keyword burst identification, time zone review, and timeline review to investigate PFS hotspots and growth trends. Results: PFSs reports indicate a rising tendency. The most prolific author is Chinese Wei Guiwu. Wei Cun and Guiwu are most likely to collaborate. Research limitations/implications: Students interested in PFSs need to grasp the hotspots in this topic as soon as feasible. This is the first bibliometric study of PFS papers. It helps PFS students rapidly find their way.
[10]	200	SCOPUS	Bibliographic analysis is quantitative. It depicts a scientific field by articles, authors, and journals. This study reviews operations research bibliometrics. recent decades. This study uses Web of Science data to identify relevant research and emerging trends in this sector. The most influential journals, 200 most referenced publications, and most productive and influential authors are analyzed. Despite minor differences, the results match conventional wisdom.
[7]	59	Routledge Taylor & Francis Group	Stakeholders influence hotel and tourism choices. Multi-criteria decision-making (MCDM) is popular in hotels and tourism. MCDM models are utilized in hotels and tourism; however, they didn't discuss how fuzzy individual thinking is in an uncertain setting. These surveys also didn't include the hotel and tourism industries' bibliometrics and content analysis. This research examines 85 hotel and tourism fuzzy MCDM model publications from 1997 to 2022. Analyzing how fuzzy MCDM approaches are employed in different sectors can help guide future research. Based on bibliometric analysis, methodologies, and applications, analytic hierarchy process (AHP) and TOPSIS methods are the most popular MCDM methods, and tourism evaluation, hotel evaluation and selection, and tourism destination evaluation and selection are the most interesting hospitality and tourism research topics. Finally, three perspectives recommend new research paths. Fuzzy MCDM models are useful for students and hotel and tourism workers.
[3]	295	DOAJ	This study's objective is to report the findings of a thorough literature assessment on the creation of fuzzy-based models for time series forecasting for the years 2017 through 2021. In order to understand and analyze the primary methodologies used in the research topic of interest, the study was undertaken utilizing a well-established review process and a few potent tools for bibliometric analysis. We examined 118 papers from peer-

reviewed journals that were included in the Web of Science's 2020 Journal Citation Reports. This gave us the opportunity to offer a thorough performance analysis and a scientific mapping about the state of fuzzy time series forecasting and modelling at the moment. The results of this research serve as a useful foundation for other studies that approach this subject from a methodological and applicable standpoint.

As far as we are aware, there does not appear to be a bibliometrics food fraud issue analysis. This paper aims to respond to the following questions:

1. How can fuzzy logic decide decisions on several criteria?
2. What are the future trends in decision making using algorithms?
3. Which research topics are more published about decision making using fuzzy logic?
4. What provides an opportunity for further research on the application of fuzzy logic in multi-criteria decision-making?

This article covers an evaluation of some literature on decision making using fuzzy logic based on previous findings. In addition, some sections such as Part 1 contain research objectives, in Part 2 will discuss fuzzy logic as well as use for everything included in Multi Criteria Decision Making (MCDM), in Part 3 in discussing the stages of bibliometric study methodology related to the use of databases, in part 4 the results will be displayed using VOSviewer, in the Part 5 contains about the idea of researchers and conclusions related to research along with its boundaries.

METHODS

The creation of this article is to analyze how the Fuzzy Logic Multi Criteria Decision Making (MCDM) article is classified. Then, to find out what are the research trends of Fuzzy Logic Multi Criteria Decision Making (MCDM), to know which research topics will be the subject of more publication, and to analyze what topics of fuzzy logic are used for the multi-criteria decision making (MCDM) in the future that provide an opportunity for further investigation. 2.1. Search for specific journals on the topic Fuzzy Logic Multi Criteria Decision Making (MCDM).

Biometrics can solve the above problems. This is a research method that is widely used by libraries and researchers. It uses quantitative and statistical analysis to find patterns of publication in a particular field. It has been widely used by researchers to analyze publications in journals. [11]. Applied Soft Computing (ASC), Applied Sciences (AS), Emerald Insight (EI), Economic Research-Ekonomska Istraživanja (EREI), Management Science (MS), Omega The International of Management science (OTIOMS), International Jurnal of energy Research (IJORE).

2.2. Journal Reputation

At this stage, magazines with good rankings have been selected and are still in the process today. Table 2 shows the results of the journal examination.

Table 2. Profile of a journal with a special topic on Fuzzy Logic Multi Criteria Decision Making (MCDM)

Point of View	ASC	AS	EI	EREI	MS	OTIOMS	IJORE
Publisher	Elsevier	MDPI	Emerald	Taylor & Francis	Inform	Omega	Willey
First published	2013	2022	2020	2022	2008	2014	2020

Last published	2014	2022	2020	2022	2008	2016	2020
Scopus Indexed	Yes	YES	Yes	YES	Yes	Yes	Yes
Web of Science Indexed	No	No	No	No	No	No	No
Impact factor by SJR	1,88	0, 49	0,64	0,61	5,32	2,68	9,04

Based on table 2, there are only 4 journals that are indexed Scopus with the ASC classified in Q1, the U.S. classified at Q2, the EI classified on Q2, EREI classificated in Q2, MS EREi classified by Q1, OTIOMS classified to Q1, IJORE classified into Q1 in this case is also important to be analyzed as it is the first journal specifically on Fuzzy Logic Multi Criteria Decision Making (MCDM).

2.3. Journal Metrics Information

This section explicitly describes the profiles and metrics of the two selected journals, namely OTIOMS, MS and IJORE. Table 3 shows some important things to know from the three selected journals. This metric information was obtained from metadata information using the Publish or Perish (PoP) application on June 12, 2023.

Table 3. Metrics Information of Selected Journals

Metrics data	ASC	OTIOMS	IJORE
Publication years	2015-2015	1984-2022	2020
Citation years	8	39	1
Papers	2	200	1
Citations	563	65261	28
Cites/year	70,38	1673,36	28,00
Cites/paper	281,50	326,31	28,00
Authors/paper	3,00	4,82	3,00
h-index	1	148	1
g-index	2	200	1
hI,norm	1	69	1
hI,annual	0,13	1,77	1,00
hA-index	1	39	1

2.4. Reference Management

After all, the article has been downloaded from two journal sites, and the next step is to set up references using the Mendeley app. References are needed to ensure that metadata for each article is complete, such as information about the author, keywords, abstracts, and other information is arranged more easily and fully.

2.5. Bibliometric Analysis

Once all the metadata of the article is fully confirmed, the next step is to perform bibliometric analysis. The application used in analyzing bibliometrics in this article is VosViewer based on the.csv database file that is downloaded from the Scopus site with fuzzy logic search keywords Multi Criteria Decision Making (MCDM).

RESULTS AND DISCUSSION

To meet the first purpose of this paper on how the article Fuzzy Logic Multi Criteria Decision Making (MCDM) is classified, several journals based on the database of csv doing downloaded from the Scopus past for my analysis using VosViewer software, through the creation of maps based on text data using titles and abstract fields, with binary calculation methods there are 5533 terms found.

With the minimum number of incidents from a 10-time period, 162 thresholds were found. However, for each of the 163 terms, relevance scores will be counted. Based on this score, the most relevant terms will be automatically selected by default at 60%, so we get the 162 most relevant words. However, the verification process still has to be done manually by removing unrelated words, such as editorial, sample, abstract, and others. So, the total words that can be inserted in creating a map is 128 words.

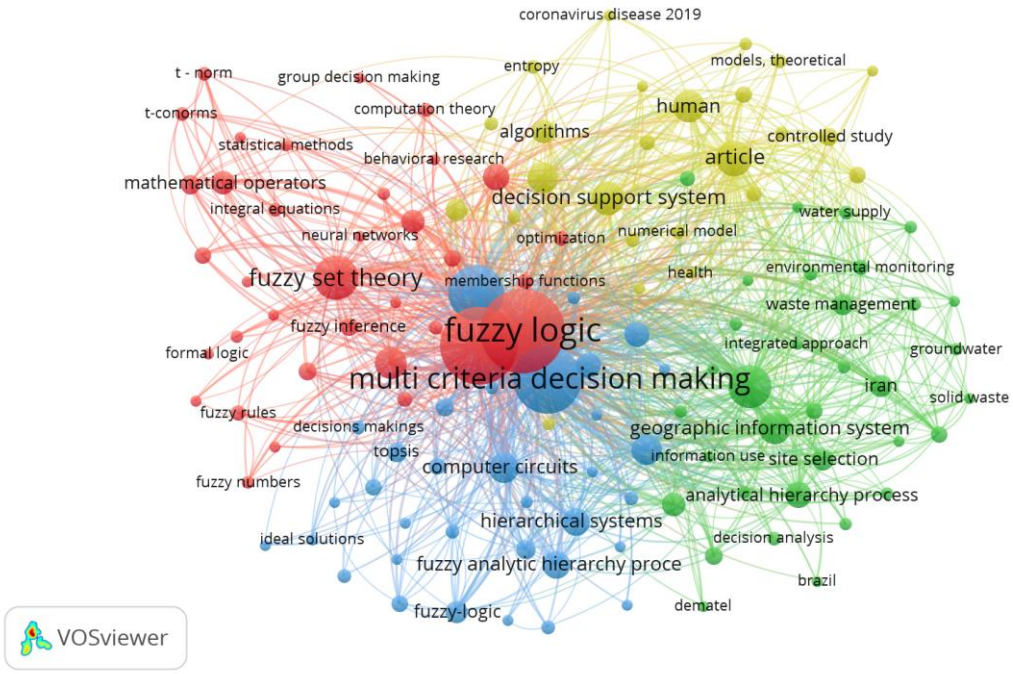

Figure 1. Network Visualization Map of Keywords

Based on Figure 1, there are several groups marked with blue, yellow, red, and green. Based on the total article, a few words in the cluster appear most often. This cluster shows that, so far, there are five classifications of articles published. More detailed can be seen in Table 4.

Table 4. Clusters and Keywords Therein

Cluster	Total items	Most frequent keywords (occurrences)	Keywords
1	35	Fuzzy (5) Mathematical (2)	energy efficiency, artificial intelligence, behavioral research, choquet integral, computation theory, decision makers, decision making, decision theory, evaluation criteria, formal logic, fuzzy inference, fuzzy logic, fuzzy numbers, fuzzy rules, fuzzy set theory, fuzzy system, group decision making, information management, integral equations, intelligent systems, intuitionistic fuzzy, knowledge based systems, mathematical model, mathematical operators, membership functions, multicriteria, neural networks, numerical methods, optimization, preference

			relation, problem solving, soft computing, statistical methods, t - norm, t-conorms
2	34	Eviromental (2) Information (2) Waste (2) Water (2)	agriculture, analytical hierarchy process, assessment method, brazil, decision analysis, dematel, environmental monitoring, environmental protection, forestry, fuzzy mathematics, geographic information system, groundwater, information systems, information use, integrated approach, iran, land fill, land use, location, multi-criteria evaluation, municipal solid waste, prioritization, refuse disposal, site selection, solid waste, spatial analysis, sustainability, sustainable development, turkey, urban area, waste disposal, waste management, water quality, water supply
3	34	AHP (2) Dicision (3) Economic (2) Energy (2) Fuzzy (6) Multicriteria (2) Risk (2)	ahp, analytic hierarchy process, climate change, computer circuits, decision-making, decision-making problem, decisions makings, economic and social effects, economics, energy efficiency, energy policy, expert system, fuzzy, fuzzy - multi criteria decision making, fuzzy analytic hierarchy process, fuzzy decision making, fuzzy topsis, fuzzy-logic, hierarchical systems, ideal solutions, investments, mcdm, multi criteria decision making, multicriteria decision, pair-wise comparison, project management, promethee, renewable energy resources, risk assessment, risk management, sensitivity analysis, supplier selection, supply chain management, topsis
4	25	Dicision (2) Eviromental (2)	algorithms, article, china, comparative study, computer simulation, controlled study, coronavirus disease 2019, decision support system, decision support techniques, entropy, environmental impact, environmental management, health, human, linguistics, methodology, models, theoretical, multiobjective optimization, numerical model, priority journal, procedures, reliability, reproducibility of results, theoretical model, uncertainty analysis

Then, to answer what is the Fuzzy Logic Multi Criteria Decision Making (MCDM) research trend, we can look at the actual answer from the cluster itself. Figure 2 shows a visualization of article density. Cluster 1, with the words Fuzzy Logic and riteria Decision Making (MCDM) being the most common words.

Figure 2. Density Visualization Map of Keywords

There is a cluster of mapping results that appears at least in the keyword, namely cluster 1. This cluster covers topics about Fuzzy Logic and Criteria Decision Making (MCDM). Also, in each cluster, a few words rarely appear in keywords, health, economy, neural network and others. Meaning, there is still a research gap that is highly likely to become a future trend, which, of course, is adapted to the conditions of the world today and in the future. From the researchers' side, there are four clusters, as shown in Figure 3.

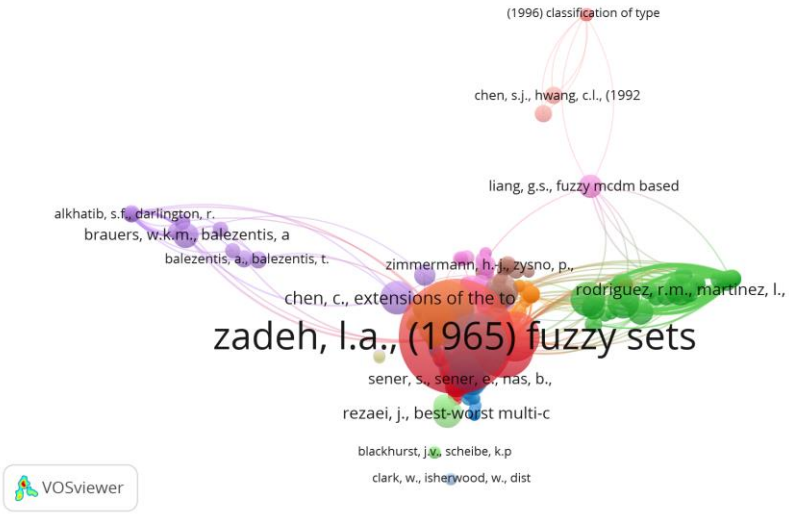

Figure 3. Network Visualization Map of Authors

Based on Figure 3, it can be seen that there are five big names of each cluster that are marked by big points in each cluster. In the image, only the authors associated in their publications are displayed. However, if the prohibition is removed, the author with the most significant points is L. A. Zadeh was the founder of fuzzy logic calculation about 58 years ago.

Table 4. The Top Ten Cited Documents in Fuzzy Logic Multi Criteria Decision Making (MCDM)

Citations	Authors and year	Title
11830	RE Bellman, LA Zadeh 1970	Decision-making in a fuzzy environment
2344	Z Xu, RR Yager 2006	Some geometric aggregation operators based on intuitionistic fuzzy sets
2138	RM Rodriguez, L Martinez, ... 2011	Hesitant fuzzy linguistic term sets for decision making

Citations	Authors and year	Title
1554	MJ Cobo, AG López-Herrera, E Herrera-Viedma, ... 2011	An approach for detecting, quantifying, and visualizing the evolution of a research field: A practical application to the Fuzzy Sets Theory field
1301	A Kumar, B Sah, AR Singh, Y Deng, X He, ... 2017	A review of multi criteria decision making (MCDM) towards sustainable renewable energy development
1240	T Terano, K Asai, M Sugeno 1992	Fuzzy systems theory and its applications
1044	J Wallenius, JS Dyer, PC Fishburn, ... 2008	Multiple criteria decisions making, multiattribute utility theory: Recent accomplishments and what lies ahead
776	EK Zavadskas, Z Turskis, S Kildienė 2014	State of art surveys of overviews on MCDM/MADM methods
573	SK Pal, A Skowron 1999	Rough-fuzzy hybridization: a new trend in decision making
561	JM Merigó, AM Gil-Lafuente, RR Yager 2015	An overview of fuzzy research with bibliometric indicators

From 1965 to 2020, the majority of fuzzy logic documentation included direct quotations. Only if the author has conducted extensive background investigation will you find numerous quotations in the most recent material. Then, let's examine Table 5 to determine which academic disciplines have produced the most scientific articles.

Table 5. The 10 Most and Fewer Occurrences Terms in Fuzzy Logic Multi Criteria Decision Making (MCDM)

Most Occurrences		Fewer Occurrences	
Occurrences	Term	Occurrences	Term
563	fuzzy logic	5	aggregation operators
475	decision making	5	ahp method
165	multicriteria analysis	5	analysis
147	fuzzy mathematics	5	analytic network process
143	fuzzy sets	5	analytical network process
105	Article	5	animals
88	multi criteria decision making	5	biomass
85	decision theory	5	case study
85	multicriteria decision-making	5	cities
78	human	5	classification

Table 5 not only outlines the most frequently discussed topics in published works, but also emphasizes the overall objective of this paper, which is to identify issues with fuzzy logic Multi Criteria Decision Making (MCDM). It can be seen that the relevant documents on fuzzy logic date back to 1965, while the most recent development of fuzzy logic concerns t-norms and t-conorms, which are expected to be completed around 2020. Except for authors who have previously conducted research in the field and are well-known, the most recent materials are rarely mentioned.

CONCLUSION

The current study reviews a series of 414 articles on topics related to Fuzzy Logic Multi Criteria Decision Making (MCDM). This article is collected from Applied Soft Computing (ASC), Applied Sciences (AS), Emerald Insight (EI), Economic Research-Ekonomska Istraživanja (EREI), Management Science (MS), Omega the International of Management science (OTIOMS),

International Journal of Energy Research (IJORE). In the context of this research, we concluded that some of the above journals have a more significant impact in the field of Fuzzy Logic Multi Criteria Decision Making (MCDM) today because in the application of FUZZY LOGIC MCDM can be used as the topic of the article.

Current studies have at least two limitations. First, the study is largely based only on journals that have index Scopus although many other journals are qualified as in the thomson reuters journal, although the study uses formal tools (PoP software, VOSviewer, and Mendeley), subjective judgments by the authors exist and can still lead to erroneous identification. Future studies should use complex sample sizes involving from several other sources, although not indexed by Scopus.

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