

Mapping the Research Landscape of Multi-Objective Optimization by Ratio Analysis (MOORA) within Multi-Criteria Decision-Making: A Comprehensive Bibliometric and Science Mapping Analysis from 2012 to 2024

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Abstract—The Multi-Objective Optimization by Ratio Analysis (MOORA) method has become an increasingly prominent technique within the multi-criteria decision-making (MCDM) family due to its computational simplicity, mathematical stability, and strong capacity to rank alternatives under conflicting criteria, yet the intellectual structure of this rapidly expanding field remains fragmented and insufficiently mapped. This study aims to systematically chart the global research landscape of MOORA within the MCDM domain and to identify its leading contributors, foundational works, dominant publication outlets, and prevailing thematic structures. A bibliometric research design guided by the PRISMA protocol was adopted, drawing on 275 English-language documents retrieved from the Scopus database for the period 2012 to 2024. The data were analysed using VOSviewer and Scopus analytical tools to examine annual publication trends, subject-area distribution, leading sources, co-citation networks, and keyword co-occurrence patterns. The results reveal a field that has accelerated sharply since 2018 and again after 2020, reaching a peak of seventy-one documents in 2024, with output concentrated in Engineering and Computer Science and disseminated through a heterogeneous ecosystem of mechanical-engineering, cleaner-production, and intelligent-systems outlets. Co-citation analysis confirms a theoretical base anchored in the canonical contributions of Brauers and Zavadskas, while keyword mapping shows MOORA functioning as a central decision-making nucleus closely tied to ratio analysis, optimisation, and surface-roughness applications, with TOPSIS, AHP, and WASPAS emerging as salient companion techniques. The novelty of this study lies in its focused mapping of the MOORA intersection rather than MCDM in general, exposing a loosely integrated thematic structure and a reliance on a narrow citation canon dominated by methodological pioneers. Its principal contribution is a consolidated knowledge map that clarifies the field's foundations and directs future methodological, fuzzy-extension, and interdisciplinary innovation.

Keywords: multi-criteria decision-making; multi-objective optimization by ratio analysis; MOORA method; bibliometric analysis; science mapping

1. INTRODUCTION

Decision-making in the contemporary scientific and industrial era is increasingly characterised by complex environments that involve numerous, interdependent, and frequently conflicting evaluation criteria. The acceleration of industrialisation, digital transformation, and sustainability-oriented planning has intensified the need for structured decision-support frameworks capable of handling multidimensional problems under conditions of uncertainty. In many real-world settings, decision-makers must evaluate competing alternatives where the available information is incomplete, heterogeneous, and difficult to reconcile through intuition alone. Traditional single-criterion approaches have therefore proven insufficient to address the complexity of modern engineering, managerial, and environmental challenges [1],[2]. This condition has driven the widespread adoption of Multi-Criteria Decision-Making (MCDM) as a rigorous analytical framework across operations research, engineering, and management science. MCDM enables the systematic evaluation of alternatives by integrating both quantitative and qualitative factors within a transparent decision model. Its flexibility allows application across diverse domains such as supplier selection, material evaluation, manufacturing optimisation, and infrastructure planning. The growing global emphasis on data-driven and defensible decisions has further strengthened the role of MCDM in supporting strategic and operational decision processes. Consequently, MCDM has become a foundational methodology for addressing the complexity of multidimensional decision problems worldwide.

Within the MCDM framework, the Multi-Objective Optimization by Ratio Analysis (MOORA) method has become one of the most widely applied techniques owing to its mathematical simplicity, computational efficiency, and robustness in ranking alternatives. Introduced as a ratio-based system that simultaneously accommodates beneficial and non-beneficial criteria, MOORA requires fewer mathematical operations than many competing methods while maintaining stable and reliable outcomes [3]. The method is frequently praised for its low computational burden and its resistance to rank reversal, which makes it attractive for both academic research and practical engineering applications. Despite these strengths, conventional MOORA has been criticised for its limited



capacity to handle vagueness and subjective uncertainty in human judgement. To overcome this limitation, fuzzy and grey extensions of MOORA, as well as integrations with weighting techniques such as the Analytic Hierarchy Process and entropy, have been developed to enhance decision robustness. The combination of MOORA with complementary methods has therefore emerged as a powerful hybrid strategy that balances objectivity and interpretability in MCDM applications. These hybrid models are increasingly applied in material selection, manufacturing process optimisation, energy planning, and environmental assessment. As a result, MOORA-based methodologies have become a prominent and rapidly diversifying trend within contemporary decision-science research [4].

The rapid expansion of MOORA- and MCDM-related publications over the past decade signals a substantial growth in scholarly interest across multiple scientific disciplines. Research evidence indicates that MOORA applications are particularly concentrated in engineering, computer science, and manufacturing optimisation, while extending steadily into energy and environmental domains. Bibliometric techniques such as co-citation analysis, keyword co-occurrence mapping, and network visualisation have been widely employed to explore the intellectual structure of MCDM research. However, most existing bibliometric studies treat MCDM as a broad and undifferentiated methodological category without focusing on specific methods such as MOORA. This limitation restricts a deeper understanding of how individual techniques evolve, mature, and diversify within the wider MCDM landscape. Furthermore, prior studies often fail to capture the dynamic evolution of research themes and the collaboration structures that shape global knowledge production. Evidence also suggests that MCDM research is geographically concentrated in a limited number of highly active countries, producing uneven patterns of scholarly output. Therefore, a focused bibliometric investigation is required to systematically map the development of MOORA within the MCDM literature [5].

Ratio-based weighting and optimisation methods such as MOORA have gained increasing attention because of their ability to deliver transparent and reproducible rankings grounded in the structure of the decision matrix. In contrast to purely subjective approaches, MOORA relies primarily on the intrinsic data of the alternatives, which makes it well suited to data-driven and engineering-oriented decision environments. The integration of MOORA with fuzzy logic, grey theory, and complementary weighting schemes has been extensively applied to improve model reliability in uncertain conditions. For instance, hybrid MOORA frameworks have been successfully implemented in landslide-susceptibility mapping, mineral-prospectivity analysis, and water-quality assessment. In manufacturing and machining studies, MOORA-based models have demonstrated strong performance in optimising surface roughness and process parameters under multiple conflicting objectives. Similarly, sustainability and energy studies have shown that combining MOORA with allied methods improves decision accuracy relative to single-method approaches. Recent advancements further incorporate neutrosophic, Pythagorean, and spherical fuzzy information to enhance the capacity of MOORA models in handling complex uncertainty. Nevertheless, methodological fragmentation across different application domains persists, limiting the consolidation of knowledge in this research area. A systematic bibliometric synthesis is therefore essential to provide a comprehensive overview of research trends and developments in this field [6],[7],[8].

Although research employing MOORA within the MCDM domain has experienced rapid growth, the intellectual structure of this field remains fragmented and not yet fully consolidated. Existing studies tend to emphasise application-based contributions rather than providing a holistic understanding of global research dynamics and knowledge evolution. Furthermore, there is a scarcity of comprehensive bibliometric analyses that simultaneously examine publication trends, leading sources, citation foundations, and thematic structures within this specific methodological domain. Previous research has frequently limited its focus to isolated case studies without exploring the co-evolution of MOORA and its hybrid extensions across the broader MCDM framework. This gap prevents researchers from clearly identifying emerging trends and promising future directions in ratio-based decision-making methodologies. In addition, the absence of integrated science mapping restricts an understanding of how knowledge clusters develop and interact across different research communities. As a result, there is a strong need for a systematic bibliometric study that comprehensively maps the development and diffusion of MOORA within the MCDM literature. Addressing this gap is crucial for advancing theoretical understanding and guiding future methodological development in decision science [7] [9].

This study aims to systematically map the global research trends related to the MOORA method within the MCDM domain over the period 2012 to 2024. It seeks to identify publication performance, influential documents, leading journals, and the foundational works contributing to this research area. The study further analyses co-citation networks and keyword co-occurrence patterns using advanced bibliometric techniques in order to reveal the intellectual and conceptual structure of the field. In addition, it aims to uncover the emerging research clusters and thematic relationships that characterise MOORA-oriented decision-making studies. The scientific contribution of this research lies in providing a comprehensive knowledge map of MOORA development at a global scale, an objective rarely pursued in prior reviews. It also contributes theoretically by clarifying the foundational lineage and methodological diversification of ratio-based decision approaches. Practically, the findings are expected to assist researchers and practitioners in identifying future research opportunities in MOORA-based decision-support systems. Moreover, this study enhances methodological transparency in bibliometric research on MCDM literature. Ultimately, it provides a strong foundation for future innovation in MOORA-integrated decision-making models [10],[11].

2. RESEARCH METHODOLOGY

The present study uses a bibliometric research design based on a systematic literature review approach to map the intellectual structure of MOORA research within the multi-criteria decision-making domain. The analysis concerns the application and methodological development of the Multi-Objective Optimization by Ratio Analysis method in decision-making studies across engineering, computational, and managerial fields. The methodological framework follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol to ensure transparency and reproducibility. Bibliometric analysis is employed to identify publication patterns, research trends, and scientific collaboration structures within the selected domain. The flow of the overall research procedure is illustrated in Figure 1, which represents the PRISMA flow diagram for the study identification, screening, and inclusion process. This structured approach allows for the systematic reduction of the literature from database extraction to the final preparation of the dataset for analysis.

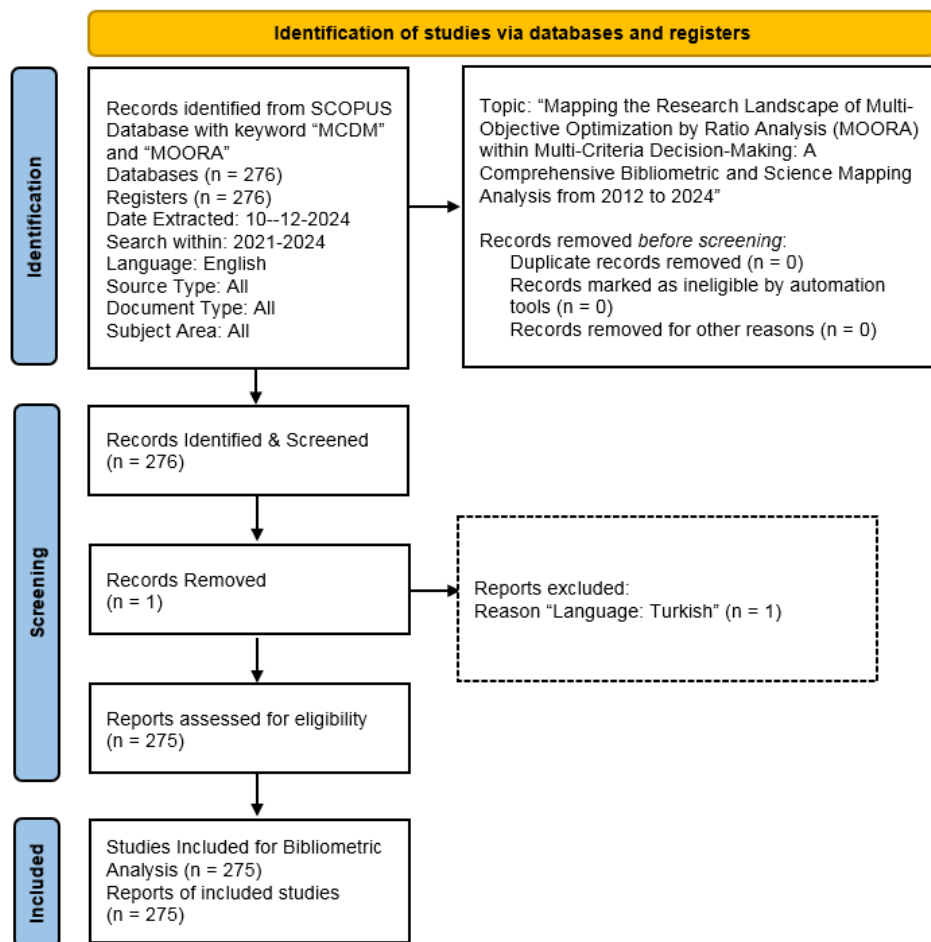


Figure 1. PRISMA flow diagram for the selection of publications on MOORA and MCDM research (2012–2024)

The primary source of data for the literature search was the Scopus database, as it indexes a wide range of peer-reviewed scientific publications with reliable bibliographic and citation metadata. The search strategy involved a structured keyword query designed to retrieve studies related to multi-criteria decision-making and the MOORA method. The search string in Scopus was: TITLE-ABS-KEY (mcdm) AND TITLE-ABS-KEY (moora) AND (LIMIT-TO (LANGUAGE , "English")). This query was designed to ensure high relevance while keeping the dataset focused on the research objectives. Only publications written in English were retained in order to maintain consistency in the analysis and interpretation of the textual data. The steps of the search process and filtering criteria are summarised in Figure 1 within the identification phase of the PRISMA framework [12],[13],[14].

In the identification stage of the PRISMA framework, a total of 276 records were retrieved from the Scopus database on the basis of the predefined search query. The total number of documents before screening was therefore 276. During the initial extraction process, no duplicate records were identified, which ensured the uniqueness of the dataset at the identification level. Likewise, no records were excluded for technical reasons such as automation filtering or incomplete metadata. The search covered the publication period from 2012 to 2024 in order to ensure comprehensive temporal coverage of the research domain. This identification process is depicted in Figure 1, which shows the initial retrieval of records in the PRISMA flow diagram.

All 276 records identified were subsequently assessed for relevance and conformity with the inclusion criteria during the screening phase. One record was excluded because it did not satisfy the language requirement, having been published in Turkish rather than in English. Consequently, after screening, 275 records remained eligible for further analysis. The eligibility assessment was confined to peer-reviewed English-language documents in the final dataset. This step was essential to preserve methodological consistency and to safeguard the reliability of the bibliometric outputs. Figure 1 clearly illustrates the screening and exclusion process, showing the reduction of records from identification to final inclusion.

In this study, the bibliometric analysis was conducted using VOSviewer software together with Scopus analytical tools to achieve comprehensive scientific mapping. The dataset was processed in VOSviewer to construct and visualise co-citation networks and keyword co-occurrence maps, thereby exposing the intellectual and conceptual structure of the field. In addition, the Scopus Analysis tools were employed to examine publication trends over time, subject-area distribution, and source-based performance indicators. The analysis specifically focused on the annual publication trend, the distribution of publications by subject area, the leading sources and documents, the co-citation network, and the network of keyword co-occurrence. These analytical outputs collectively provide a comprehensive understanding of the development and structure of MOORA research within the MCDM domain. Figure 1 summarises the overall analytical workflow and the stages of dataset processing, encompassing the complete PRISMA process from identification to analysis preparation.

3. RESULT AND DISCUSSION

3.1 Meta-Analysis

3.1.1 Publication Trend by Year

The temporal distribution of scientific output offers one of the most direct indicators of how a research field matures, gains legitimacy, and attracts sustained scholarly attention. Examining the number of documents produced in each year makes it possible to trace the rhythm of intellectual activity surrounding the application of the MOORA method within multi-criteria decision-making. Across the retrieved corpus of 275 documents, scholarly production spans a thirteen-year window from 2012 to 2024, which provides sufficient temporal depth to observe both the emergence and the consolidation of the field. Figure 2 presents the annual publication count for this period, allowing the underlying growth pattern to be read at a glance [15],[16],[17],[18]. The visualisation reveals a trajectory that begins modestly, with only a handful of documents recorded in the earliest years, and culminates in a pronounced surge during the most recent period. Rather than expanding in a smooth linear fashion, the field appears to have evolved through several distinct developmental stages separated by periods of relative stability. The earlier portion of the timeline is marked by sporadic and low-volume activity, suggesting that MOORA remained a niche concern among a limited circle of researchers. The later portion, by contrast, displays a steep upward gradient that signals a clear movement toward mainstream adoption. Interpreting these dynamics therefore requires distinguishing the formative years from the acceleration phase, since each reflects a different set of drivers behind the growth shown in Figure 2.

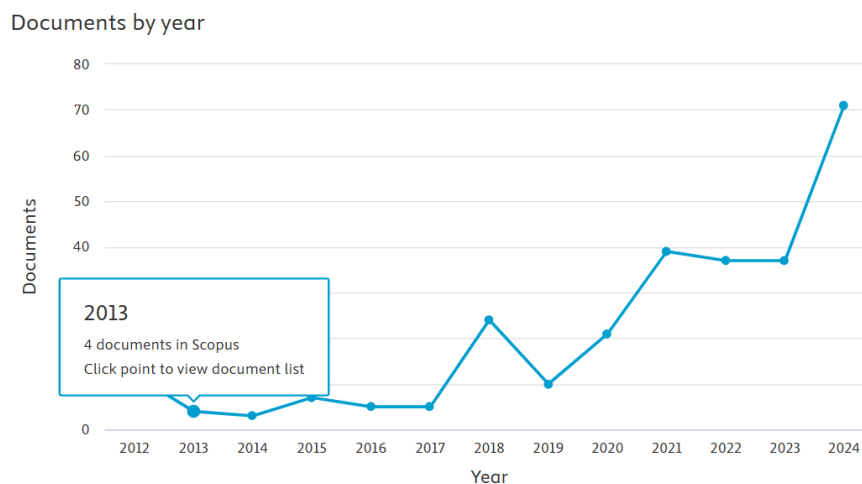


Figure 2. Annual distribution of publications on MOORA within MCDM (2012–2024)

A closer reading of Figure 2 indicates that the field passed through three identifiable phases of development between 2012 and 2024. The first phase, extending roughly from 2012 to 2017, can be described as a nascent and intermittent stage, during which annual output rarely exceeded a dozen documents and several years registered very limited activity. This irregular pattern implies that MOORA was, at that time, an exploratory technique applied only occasionally and without a coherent research community behind it. A second, transitional phase becomes visible

between 2018 and 2020, when the field recorded a striking jump to twenty-four documents in 2018, followed by a temporary contraction to ten in 2019 and a renewed rise to twenty-one in 2020. This volatility hints at the gradual formation of a more consistent scholarly base, even though year-to-year output remained unstable. The third and most striking phase unfolds from 2021 onward, where the curve climbs sharply from thirty-nine documents in 2021 to thirty-seven in both 2022 and 2023, before reaching its highest recorded level of seventy-one documents in 2024. This pronounced rebound suggests that the brief plateau across 2022 and 2023 reflected ordinary fluctuation rather than any genuine loss of interest in the topic. The accelerating momentum observed after 2020 is plausibly driven by the growing demand for transparent and data-driven ranking techniques, the increasing complexity of engineering and sustainability-related decision problems, and the rising popularity of fuzzy, grey, and hybrid MOORA extensions that combine the method with complementary weighting and ranking approaches. The wider availability of decision-support software and openly accessible datasets has likewise lowered the barrier to applying MOORA across diverse application domains, as reflected in the steep upward slope at the right-hand end of Figure 2. Taken together, the pattern displayed in Figure 2 portrays a field that has moved decisively from the margins toward the mainstream of decision-science research, and should the prevailing trajectory persist, annual output is expected to continue its upward course, with hybrid MOORA frameworks likely to diversify further into emerging areas such as artificial-intelligence-assisted decision-making and large-scale sustainability assessment [19],[20].

3.1.2 Publication by Subject Area

Beyond the temporal dimension, the disciplinary composition of a corpus reveals where a methodological approach finds its most fertile ground and how widely its relevance extends across the scientific landscape. Mapping the distribution of documents across subject areas therefore helps clarify whether the application of MOORA is confined to a single discipline or, instead, functions as a cross-cutting analytical tool. Within the present corpus, Scopus classifies the retrieved documents into a broad spectrum of fields, and the resulting proportions are summarised in Figure 3. The distribution shown there is notably uneven, with a small number of technical disciplines accounting for the majority of scholarly output. Engineering emerges as the single most prominent field, representing 23.3 percent of all documents and confirming that decision problems involving multiple conflicting criteria are deeply rooted in engineering practice. Computer Science follows at 15.7 percent, which reflects the computational nature of ranking algorithms, weighting procedures, and the software implementations that operationalise MOORA models. Mathematics contributes 8.5 percent, underlining the formal and quantitative foundations on which the ratio-analysis logic of MOORA is built. Business, Management and Accounting accounts for 7.2 percent, while Energy represents 6.0 percent, signalling that strategic evaluation and resource-allocation problems form an important application context. Read collectively, the leading shares in Figure 3 suggest that the field is anchored in technically intensive disciplines while still maintaining visible connections to managerial and energy-related concerns.

Documents by subject area

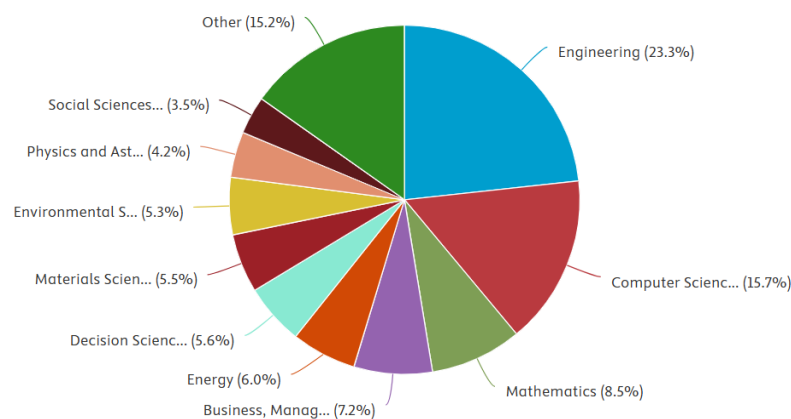


Figure 3. Distribution of publications by subject area

A more detailed inspection of Figure 3 highlights the inherently multidisciplinary character of research on the MOORA method, since the remaining documents are dispersed across a wide range of complementary fields. Decision Sciences accounts for 5.6 percent of the output, a share that is conceptually significant because it represents the disciplinary home of multi-criteria decision-making itself and confirms that the methodological core of the field remains actively cultivated. Materials Science contributes 5.5 percent, while Environmental Science represents 5.3 percent, indicating that the same ranking and optimisation techniques are readily transferred to material-selection and sustainability-oriented decision contexts. Physics and Astronomy add a further 4.2 percent and Social Sciences 3.5 percent, while the residual category labelled "Other" comprises 15.2 percent, which captures the long tail of niche

applications scattered across numerous additional disciplines. This dispersion demonstrates that MOORA is not the property of any single domain but rather a portable methodological framework adaptable to heterogeneous problem settings. The dominance of Engineering and Computer Science is academically meaningful because these fields supply both the practical decision problems that demand structured evaluation and the computational machinery required to solve them efficiently. The substantial presence of Materials Science, Energy, and Environmental Science, meanwhile, reinforces the growing alignment between ratio-based MCDM methods and the evaluation of complex material, resource, and sustainability challenges. The coexistence of these technical, environmental, and managerial fields illustrates a productive interdisciplinary convergence in which objective ranking approaches are mobilised to address real-world decisions. Taken as a whole, the subject-area profile portrayed in Figure 3 positions MOORA as a versatile and discipline-spanning methodology whose continued diffusion across emerging fields is likely to deepen its multidisciplinary footprint in the years ahead.

3.1.3 Top Sources and Documents

Identifying the outlets that publish most actively in a given field clarifies where its scholarly conversation is concentrated and which venues shape the diffusion of its core ideas. Figure 4 compares the annual document counts of the leading sources across the study period, making the relative momentum of each outlet directly observable.

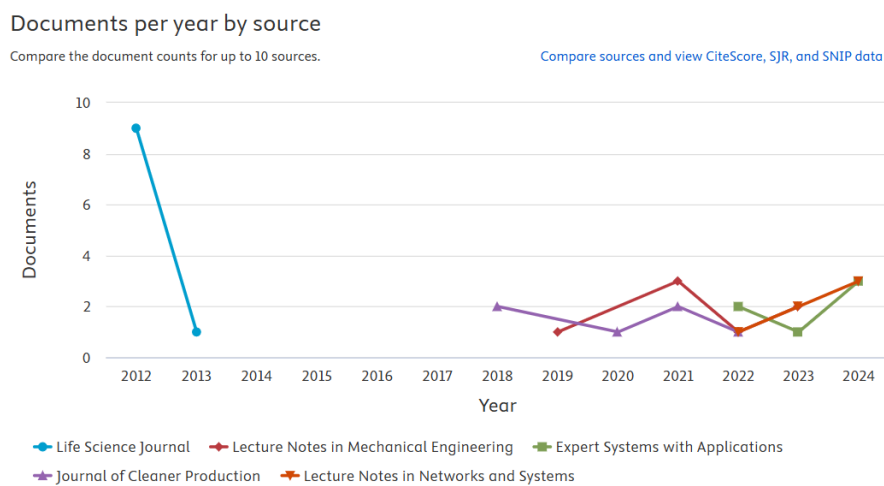


Figure 4. Annual document output of the leading publication sources

As shown in Figure 4, the publication of research on the MOORA method is distributed across a comparatively wide set of outlets rather than being dominated by a single flagship journal, which is characteristic of an interdisciplinary and still-consolidating field. The most productive source overall is the Life Science Journal, which contributes ten documents, although its output is concentrated in the earliest years of the study window and reflects an early burst of activity rather than sustained recent momentum. Among the venues displaying more durable engagement, the Lecture Notes in Mechanical Engineering series accounts for seven documents, while the Lecture Notes in Networks and Systems series, Expert Systems with Applications, and the Journal of Cleaner Production each contribute six documents. Because two of these leading outlets are conference-based series, their prominence indicates that a substantial share of the field's recent activity is being channelled through fast-moving conference venues that favour rapid dissemination of methodological applications. The recurring presence of mechanical-engineering and cleaner-production outlets reinforces the earlier finding that material selection, manufacturing optimisation, and sustainability problems constitute major application contexts for ratio-based ranking methods. At the same time, the appearance of Expert Systems with Applications signals sustained interest in the computational and intelligent-systems underpinnings of these techniques, extending the field's reach toward broad and reputable readerships. The reputational profile of these outlets is generally favourable, as several are well-indexed international journals with solid standing in their respective domains, which lends credibility to the body of work and supports its further circulation. The coexistence of high-throughput conference proceedings alongside reputable archival journals suggests a dual publication culture in which preliminary and applied contributions are introduced through conferences before more developed studies migrate to established journals. Taken together, the source distribution portrayed in Figure 4 indicates that the development of MOORA research is driven less by a single dominant venue and more by a diverse ecosystem of technically oriented outlets, a pattern that typically accompanies a field still expanding its disciplinary boundaries.

3.1.4 Co-citation Network

Co-citation analysis examines how frequently pairs of references are cited together across a corpus, thereby revealing the foundational works that collectively define a field's intellectual base. Figure 5 presents the co-citation network

generated from the retrieved documents, in which node size reflects citation influence and colour denotes distinct clusters of jointly cited references.

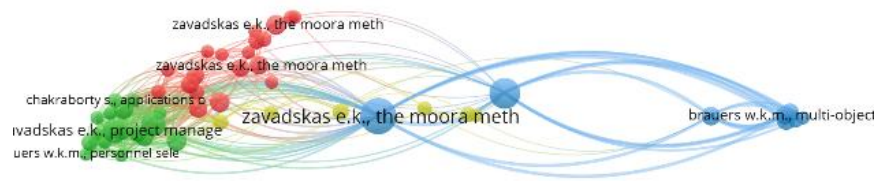


Figure 5. Co-citation network of cited references

The co-citation map displayed in Figure 5 makes clear that the intellectual foundation of MOORA research rests on a relatively small set of seminal contributions that anchor the entire field. The most influential nodes by a considerable margin correspond to the foundational works of Zavadskas on the MOORA method and its multi-objective extensions, whose labels dominate the central region of the network and confirm that this methodological lineage remains the theoretical cornerstone on which the literature is built. A closely related and highly prominent node corresponding to the original formulation of MOORA by Brauwers appears on the right-hand side of the map, indicating that the canonical statement of the method continues to be cited together with its later refinements as a coherent intellectual canon. The presence of Chakraborty's applied contributions on the use of MOORA for decision-making and personnel or project selection occupies an important position on the left of the network, since it represents the broader applied tradition within which the method has been operationalised and connects otherwise separate citation neighbourhoods. Around these core references, several distinct colour-coded clusters can be discerned, each grouping together works that are habitually cited in combination and therefore reflect identifiable streams of theoretical and applied scholarship. The tightly bound red cluster surrounding the principal Zavadskas nodes suggests a dense methodological core in which foundational and applied studies reinforce one another, whereas the green cluster associated with Chakraborty's application-oriented works represents a more practice-driven line of inquiry that extends the established base. The spatial separation between the central methodological cluster and the right-hand foundational node, linked through dense bridging connections, illustrates how the field integrates a foundational ratio-analysis tradition with more recent hybrid and application-driven developments. This structure indicates an intellectual base that is simultaneously concentrated, in that a few canonical works command disproportionate co-citation influence, and diversified, in that multiple satellite clusters elaborate distinct thematic directions. Such a configuration is characteristic of a maturing research domain whose theoretical foundations are firmly settled while its application frontiers continue to expand. Overall, the co-citation structure visualised in Figure 5 demonstrates that the scholarly identity of MOORA research is firmly rooted in the methodological contributions of Brauwers and Zavadskas, which together supply the conceptual scaffolding upon which contemporary hybrid and fuzzy extensions are constructed.

3.1.5 Co-Occurrence Network

Keyword co-occurrence analysis maps the terms that authors use together within their publications, thereby exposing the conceptual structure of a field and the thematic relationships that bind its sub-topics. Figure 6 displays the co-occurrence network of author keywords, where node size represents the frequency of each term and colour distinguishes the thematic clusters into which related concepts are grouped.

The keyword network presented in Figure 6 reveals a densely interconnected conceptual structure organised around a small number of high-frequency anchor terms that collectively define the field. The most influential keywords, indicated by the largest nodes, are "decision making", "moora", "mcdm", and "multi-criteria decision making", which together confirm that the literature is built upon the application of ratio-based optimisation within multi-criteria evaluation. It is analytically important to note that "topsis" and "ahp" appear as prominent terms despite the field's explicit framing around MOORA, which signals that complementary weighting and ranking procedures are integral companions to MOORA rather than peripheral techniques. The network resolves into several thematic clusters, each occupying a distinct region of the map and representing a coherent line of inquiry. The green cluster, centred on "multi-criteria decision making", "analytic hierarchy process", "materials selection", and "hierarchical systems", captures an applied methodological stream concerned with weighting, material evaluation, and structured problem formulation. The yellow cluster, anchored by "topsis", "ratio analysis", "surface roughness", and "moora method", reflects a manufacturing- and machining-oriented stream in which MOORA is used to optimise process parameters and product quality. The blue cluster, organised around "vikor", "waspas", "codas", "edas", and "optimization", represents the broader family of comparative ranking methods with which MOORA is frequently benchmarked. The red cluster, encompassing "entropy", "prioritization", and region-specific applications, denotes a weighting- and assessment-oriented domain, while the purple cluster surrounding "standard deviation", "performance", and "multi-objective optimization" reflects a statistical and performance-evaluation perspective. The central bridging position of "moora" and "decision making" between these clusters is particularly telling, as it demonstrates that the method functions as the conceptual connective tissue linking abstract decision theory to concrete

applications toward advances the current literature has not yet delivered, so the fragmentation revealed by the maps becomes the clearest signpost toward where original contributions can be made.

These contributions are nonetheless bounded by limitations intrinsic to bibliometric inquiry, which must be stated transparently. The analysis relies on a single database and a deliberately restrictive query, so relevant studies indexed elsewhere or phrased differently may have been excluded, and the resulting corpus of 275 documents, although substantial for a single-method study, remains modest by broad bibliometric standards. This dataset size renders the co-citation and co-occurrence structures more sensitive to outliers and threshold choices than larger corpora would be. Author and affiliation disambiguation poses a further risk, since name-indexing variation can inflate the apparent productivity of particular authors or countries and distort the patterns underlying Figure 4. Including conference proceedings alongside journal articles broadens coverage but introduces heterogeneity in quality and citation behaviour, while citation-based measures inevitably favour older work, leaving the recent studies in 2023 and 2024 underrepresented in Figures 5 and 6. The framing also emphasises MOORA, whereas the keyword evidence reveals the comparable salience of TOPSIS, AHP, and WASPAS, so the analytical lens may not perfectly mirror the field's true centre of gravity. To mitigate these constraints, future work should integrate multiple databases such as Scopus and Web of Science, apply rigorous disambiguation, and complement frequency-based mapping with longitudinal thematic-evolution analysis and qualitative content analysis of the most influential documents. Addressing these limitations directly would yield a more comprehensive and methodologically resilient account of how MOORA continues to evolve.

4. CONCLUSION

This study set out to map the global research landscape on the application of the Multi-Objective Optimization by Ratio Analysis method within multi-criteria decision-making, and the bibliometric evidence fulfils that aim by revealing a field that has shifted decisively from sporadic early activity to rapid expansion, peaking at seventy-one documents in 2024. The analysis shows that scholarly output is anchored in technically intensive disciplines, led by Engineering and Computer Science, and is disseminated through a diverse ecosystem of mechanical-engineering, cleaner-production, and intelligent-systems outlets rather than a single dominant venue. The co-citation structure confirms that the field rests on the canonical foundations of Brauers and Zavadskas, while the keyword network demonstrates that MOORA operates as a central decision-making nucleus tightly linked to ratio analysis, optimisation, and surface-roughness applications, with TOPSIS, AHP, and WASPAS emerging as salient companion techniques. Theoretically, these findings reframe MOORA as one interconnected component of a broader evaluation logic rather than an isolated ranking tool, and practically they indicate that ratio-based ranking enhances the transparency and credibility of decisions in material selection, manufacturing optimisation, and sustainability planning. The evidence also exposes a loosely integrated thematic structure and a reliance on a narrow citation canon, signalling that the field still lacks a unifying framework for systematically combining MOORA with complementary weighting and ranking methods. These results must be interpreted in light of several limitations, namely the reliance on a single database, a deliberately restrictive search query, a corpus of 275 documents, and the disambiguation and heterogeneity issues that accompany mixed document types. Future research should therefore integrate multiple databases such as Scopus and Web of Science, apply rigorous author disambiguation, and develop standardised protocols that couple MOORA frameworks with fuzzy, neutrosophic, and artificial-intelligence techniques while extending them into under-represented domains such as healthcare, public policy, and climate adaptation. By consolidating its fragmented themes and diversifying both its methods and its application contexts, the field is well positioned to evolve from established applications toward genuinely novel theoretical and methodological contributions in decision science.

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