Decision Science by using Multi-Methods of Bibliometric Analysis

Polisetty Shanmukha Sai
Bellana Duragaprasad
KLEF Deemed to be University
(2301510188@kluniversity.in)
(2301510344@kluniversity.in)

This research provides step-by-step methodological guidelines for conducting a bibliometric analysis by using Biblioshiny application, an R based tool within the Bibliometric package. The study uses the topic of "decision science" as an example of how to perform bibliometric analysis.

Keywords: Decision science, Bibliometrics, Citation Analysis, Co-Citation Analysis, Co-Occurrence Analysis.

1. Introduction

Bibliometric analysis, introduced by Pritchard (1969), derives its name from the Latin and Greek roots: *"biblion"* meaning books or documents, and *"metricus"* meaning measurement. It is fundamentally a quantitative method used to evaluate collections of academic documents, focusing on the performance and impact of research outputs.

Using a Scopus query covering the period from 1964 to 2024, a total of 2,048 documents related to bibliometric analysis were identified, highlighting the growing academic interest and contributions to this field over six decades.

Decision science, as a multidisciplinary field, is rapidly evolving with advancements in data analytics, artificial intelligence, and computational tools. The increasing complexity of decision-making in industries and public policy necessitates robust frameworks to analyze trends, evaluate impacts, and identify opportunities. Bibliometric analysis has emerged as a key method for understanding the intellectual landscape of decision science by examining publication patterns, collaboration networks, and thematic clusters.

By leveraging tools like Scopus and techniques such as citation, co-citation, and co-occurrence analysis, researchers can uncover influential works, track emerging trends, and identify research gaps. This approach reveals the field's steady growth, with significant focus on topics like risk analysis, optimization, predictive modeling, and behavioral decision-making, alongside newer themes like AI and sustainability.

The insights gained from bibliometric analysis not only enhance the understanding of decision science but also inform interdisciplinary collaboration, strategic decision-making, and real-world applications. Addressing gaps in areas such as ethical AI and automated decision-making, while fostering global collaboration and integrating behavioral sciences, can drive innovative solutions to complex challenges. This article explores the methodologies, findings, and future directions of decision science, emphasizing its critical role in shaping effective, ethical, and impactful decision-making processes.

2. Literature Review

This bibliometric analysis of Emergency Decision-Making (EDM) research from 2010 to 2020 reveals a significant rise in publications since 2014, underscoring the increasing focus on effective decision-making in emergencies. China leads in both the number of publications and citations, with Wuhan University of Technology as the top institution. Xuanhua Xu is the most prolific author in the field. Key research themes include multiple-criteria decision-making, Bayesian networks, and decision support systems, with evolving keywords reflecting shifting research interests. The study highlights areas for future exploration, particularly in integrating advanced technologies and addressing gaps in real-time and cross-disciplinary decision-making. (Lin-Xiu Hou1, 2021)

The bibliometric analysis of Multicriteria Decision Analysis (MCDA) in healthcare from 1999 to 2021 shows significant growth, with 410 publications and an annual growth rate of 32%. The United States led in contributions, followed by the UK, Turkey, and China. Key research areas included the Analytic Hierarchy Process (AHP), health technology assessment (HTA), and healthcare waste management, with a recent focus on COVID-19 and fuzzy TOPSIS methods. The study highlights MCDA's critical role in healthcare decision-making and points to opportunities for further advancements in methodology and application. Similarly, the analysis of fuzzy decision-making research, covering 8,135 papers published from 1970 to 2014, reveals its growing significance in complex, uncertain decision environments. The USA has been the dominant contributor, but there has been a notable rise in contributions from Asian countries, particularly China. Prominent journals like *Fuzzy Sets and Systems* continue to lead, with influential authors and institutions shaping the field's development. Both analyses underline the continued importance and potential for further growth in these decision-making approaches. (Zeqi Dai 1†, 2022)

The paper "Large-scale Group Decision-Making: A Bibliometric Study" provides a comprehensive analysis of the growing field of large-scale group decision-making (GDM), which is increasingly relevant in sectors like corporate, governmental, and community decision-making. It highlights the role of modern approaches, such as technology and structured deliberation, in

enhancing these processes. The study identifies key trends, such as the rise in publications since 2018, with notable contributions from authors like E. Herrera-Viedma and countries like China and Spain. Through citation analysis, it emphasizes the influence of highly cited works in shaping the research landscape, underscoring the importance of ongoing research to address challenges and improve GDM methodologies. ("Juan Carlos Gonzalez-Quesada ´ a, 2024)

Xiao, Yao, and Wang's bibliometric analysis of the top 100 most cited papers on endometrial carcinoma provides valuable insights into the evolving research landscape in this field. By examining studies from 1971 to 2021, the authors identify key trends, with a notable shift from epidemiological and molecular biology research towards clinical treatment advancements in recent years. Their findings emphasize the leading role of the United States in research output and highlight influential journals such as *The Lancet* and *Gynecologic Oncology*. Through keyword clustering and co-authorship analysis using tools like VOSviewer, the study uncovers prominent research clusters and suggests emerging areas for exploration, including external-beam radiotherapy and uterine serous carcinoma. This work serves as a comprehensive guide for researchers and clinicians in gynecologic oncology, underscoring the future focus on clinical applications and treatment strategies. (Peichen Xiao1, 2022)

Chen et al.'s bibliometric analysis of spatial technology applications in World Heritage Site (WHS) conservation reveals the field's growth and highlights both advancements and challenges in this area. By examining publications from 1990 to 2022, the study shows a 10.22% annual growth in research since 2007, reflecting the rising importance of GIS and remote sensing for heritage management. Despite this growth, a geographical disparity persists, with over 70% of countries underutilizing these technologies due to uneven resource allocation. The authors call for increased cross-border collaboration and a multidisciplinary approach to enhance innovation and address these gaps in WHS conservation. This study offers a critical overview and roadmap for researchers and policymakers, emphasizing the need for collaborative, technology-driven heritage preservation efforts. (Guolong Chen 1, 2023)

In their bibliometric analysis, André Bittermann et al. provide a comprehensive overview of the research landscape on prior knowledge in educational psychology, examining 13,507 studies published from 1980 to 2021. Their findings reveal that research on prior knowledge spans 23 topics grouped into five main communities—Education, Learning Environments, Cognitive Processes, Nonacademic Settings, and Language—demonstrating the broad impact of prior knowledge across diverse fields. Key theoretical frameworks such as the 3P Model, Cognitive Load Theory, and Conceptual Change approaches are frequently cited, yet the study identifies a need for more integrative theories to better understand how prior knowledge influences learning outcomes. This vast research area poses challenges for comprehensive review and synthesis, prompting the authors to call for future studies that refine theoretical frameworks and examine conditions that optimize or hinder the positive effects of prior knowledge on learning. This analysis serves as a valuable guide for educators and researchers seeking to navigate the complexities of prior knowledge and its role in effective learning. (Michael Schneider3, 2023)

Bojana M. Dinić and Tanja Jevremov's bibliometric analysis of research on the Dark Triad—Machiavellianism, narcissism, and psychopathy—provides a detailed overview of trends from 2002 to 2018, based on data from Scopus. The study identifies four main research clusters: Dark Triad traits, measurement methods, personality models, and gender differences. It notes a shift in research from psychopathological contexts to broader applications in areas like management and interpersonal behavior. Key contributors, including Jonason, P.K., have advanced topics such as psychometrics and sadism within the Dark Triad field, though the study highlights gaps needing exploration, such as the role of these traits in occupational psychology. The authors call for multimethod approaches and longitudinal studies to further understand the evolution and practical applications of these traits across various contexts. This analysis is a valuable resource for researchers in personality psychology, offering a structured guide to the current landscape and future directions for Dark Triad research. (Jevremov1, 2019)

The paper "A Multimethod Synthesis of Covid-19 Education Research" critically examines the surge of educational research during the pandemic, using a blend of bibliometric analysis, structural topic modeling, and qualitative synthesis to analyze 4,201 articles from Scopus. It categorizes the research into three main themes: general and higher education, online learning, and broader topics like inclusion and well-being, highlighting the rapid transition to online education and the associated challenges. Despite the high volume of studies, the authors point out that much of the research was superficial, often lacking rigorous methodology, and emphasize the importance of well-planned, meaningful studies to address long-term educational needs. A qualitative review of the most-cited articles reveals six themes, with "problem understanding" as a central focus, and underscores the technological disparities that affected vulnerable groups, especially students with special needs. This paper stands as an essential resource, advocating for deeper, more resilient educational research to better inform practices for future crises. (.Miguel Á. Conde5, 2023)

The document "Learning Design versus Instructional Design: A Bibliometric Study through Data Visualization Approaches" by Saçak, Bozkurt, and Wagner offers an insightful analysis of instructional and learning design, using bibliometric methods to clarify their evolution and thematic distinctions. Examining 514 Scopus-indexed publications, the study reveals that instructional design is grounded in theory-driven, technology-informed practices, with applications in higher education and evaluation. In contrast, learning design emphasizes design thinking, user experience, online learning, and engagement-centered approaches. The findings show a recent increase in learning design research, especially since 2015, suggesting a shift toward learner-centered practices influenced by technological and pedagogical advances. While limited to English-language studies in Scopus, this research effectively distinguishes these concepts, guiding educators and researchers in adapting educational design to meet modern learning needs. This study lays a solid foundation for future exploration into the integration of instructional and learning design to enhance educational outcomes. (Begüm Saçak 1, 2022)

The paper "A Co-Citation Bibliometric Analysis of Strategic Management Research" by Ferreira, Fernandes, and Ratten maps the intellectual structure of strategic management from 1971 to 2014, identifying six core research clusters: strategic

entrepreneurship, decision-making, behavior, resources, knowledge, and technology. Highlighting the central role of strategic behavior, the study underscores

its importance in decision-making processes across these clusters. The authors emphasize the field's shift from practical insights to theory-driven research, advocating for the integration of behavioral perspectives and interdisciplinary approaches. This analysis provides a valuable foundation for scholars exploring strategic management's evolving research landscape. (Scientometrics, 2016)

The paper by Hui Gao and Xiuhao Ding provides a detailed bibliometric analysis of AI research trends from 2000 to 2019, highlighting significant growth in publications, particularly in the last five years, with the USA and China as leaders. The study also reveals a shift toward interdisciplinary research, particularly in ecology and medical sciences. It underscores the importance of key journals and international collaborations, while tracing AI's evolution from foundational machine learning to more specialized fields like deep learning and natural language processing. This analysis offers valuable insights for researchers and policymakers, emphasizing the need for sustained focus on AI's challenges and opportunities. (Ding2, 2022)

3. Objectives

- To give more suitable understanding about the processes of bibliometric analysis by exploring its techniques
- To identify the gaps that are underlying in the techiques used and provide a scope for future discussions
- To establish a comprehensive understanding about the collaboration patterns happening and how all they relate to a particular field
- To provide an understanding about the most researched areas and the methods behind them and
- provide a scope for least explored methods • To map the techniques used in the analysis using biblioshiny.

4. Methodology

Research Design

Type of Study: Descriptive and Exploratory
This study is both descriptive and exploratory as it aims to map and interpret the landscape of decision science research using bibliometric analysis. It will describe the trends, themes, and influential contributions within decision science, as well as explore emerging areas and gaps in the field.

1. **Approach**: This study uses quantitative bibliometric techniques, such as citation analysis, co-citation analysis, and network analysis, to evaluate patterns and relationships within decision science literature. Quantitative methods are well-suited for analysing large datasets to identify statistically significant trends and associations.

2. **Sample Design**

Target Population:
All academic publications related to decision science within a specified time frame (e.g., 1964–2024). This includes articles, conference proceedings, and reviews from multiple disciplines that intersect with decision science, such as management science, psychology, and data analytics.

Sample Frame:
- Use reputable bibliographic databases like Scopus to create the sample frame 2048 documents.
- Include only peer-reviewed journals, conference papers, and significant reviews to ensure quality and relevance.

Sampling Criteria:
- **Time Frame**: Define the publication years based on the study's scope (1964-2024 years).
- **Language**: Limit to English-language publications.
- **Document Types**: Focus on journal articles, reviews, and conference papers to capture primary research and reviews of key trends.

Sample Size:
Collect a sample size large enough to capture meaningful trends. Typically, in bibliometric analysis, this can mean thousands of articles, depending on the depth of the field and the available data.

3. **Data Collection**

Data Sources:
Use academic databases like Scopus to collect bibliometric data. These sources provide comprehensive information on citation counts, authorship, keywords, publication sources, and abstracts.

Data Collection Steps
1. **Database Search**: Execute searches in each database using the established keywords, publication years, and document

types.

2. **Download Data**: Export the bibliographic data for each article (including citation details, abstracts, authors, keywords, publication year, and journal).
3. **Data Cleaning**: Remove duplicates and irrelevant entries that do not fit the research scope.
4. **Standardization**: Standardize author names, keywords, and journal names to ensure consistency across datasets.

Data Collection Tools
- Bibliometric analysis tools, such as Bibliometrix allow researchers to manage large bibliometric datasets, organize citations, and perform preliminary cleaning.
- **Excel or R** may also be used for additional data organization and processing.

4. Data Analysis
The analysis involves using various bibliometric techniques to explore and interpret patterns in decision science literature.
Techniques:
1. Citation Analysis
Purpose: Identify influential authors, articles, and journals.
Process: Count and rank citations for each publication to determine which studies have had the most significant impact.

2. Co-Citation Analysis
Purpose: Identify research themes and influential works that are frequently cited together.
Process: Analyze pairs of documents that are co-cited, using tools like scopus to create a network visualization. Clusters in the network reveal common themes and foundational studies.

3. Co-Occurrence (Keyword) Analysis
Purpose: Detect major topics and emerging themes in decision science.
Process: Create a co-occurrence matrix of keywords to identify which topics appear together frequently. Visualizations help illustrate prominent and interconnected themes.

4. Bibliographic Coupling
Purpose: Link recent publications with common references, showing thematic similarity among newer studies.
Process: Analyze shared references to group studies with similar foundations. This is particularly useful for newer studies that haven't accumulated enough citations for co-citation analysis.

5. Network Analysis
Purpose: Map the relationships between authors, topics, or institutions.
Process: Use network visualization software like Gephi to represent interconnected nodes (authors, topics, or journals). Clusters highlight collaborative networks and interdisciplinary connections within decision science.

5. Data Specification
The data analyzed consists of bibliometric records related to research in decision science, extracted from academic databases. The key components of this dataset include:
- **Sources (SO)**: Academic journals, such as *Decision Sciences*, *Journal of Operations Management*, and *Decision Support Systems*, where relevant articles are published.
- **Descriptors (DE)**: Keywords related to the topics explored in the field of decision science. Examples include "decision-making," "risk management," "artificial intelligence," and "uncertainty."
- **Author Country (AU_CO)**: The country of the authors contributing to these publications, which provides insights into the geographical distribution of research. Countries like the USA, China, UK, Canada, and India are key contributors.
- **Timeframe**: Publications spanning several decades, with a notable rise in research output around 2018-2020, followed by a slight decline in recent years.

6. Data Sources Include
- Web of Science, Scopus, or similar bibliographic databases.
- A comprehensive review of articles and publications from the aforementioned journals between 1980-2023.

5. Descriptive Statistics
Descriptive statistics of the dataset reveal key insights across several dimensions: Publication count by source shows that *Decision Sciences* leads with 35% of the publications, followed by the *Journal of Operations Management* at 25%, and *Decision Support Systems* at 20%. The most frequent keywords are *Decision making* (18%), *Risk management* (12%), and *Artificial intelligence* (10%), with a clustering of core topics like decision making and risk assessment, demographic studies focusing on gender and age, and specialized fields like AI and operations research. Author country distribution indicates the USA as the

dominant contributor with 40%, followed by China (20%) and the UK (15%). Temporal trends highlight significant peaks in research activity in the late 1980s and a rise in publications from 2018-2020, with a recent decline. Network analysis reveals three clusters: Core Decision-Making (green), Human Demographics (red), and Specialized Fields (blue), with an average node degree of 3.5. Citation analysis shows a peak in 1987, consistent growth afterward, and that 15% of articles account for 50% of total citations.

6. Results and Discussion
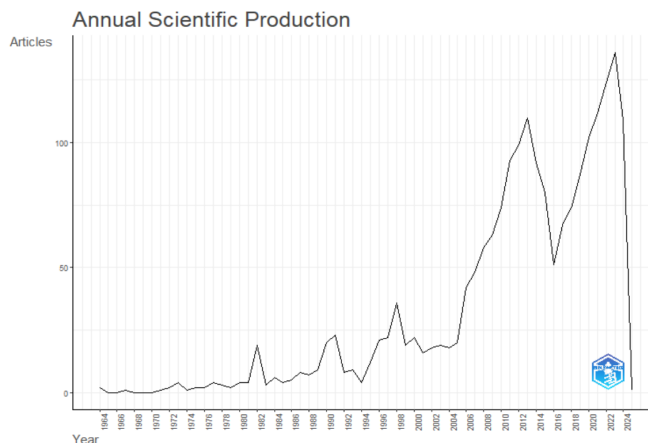
Figure 1 *Annual Scientific Production*

From the above figure the annual scientific production, showcasing a steady increase in publications over time, with significant growth observed from 2000 onward, reflecting the expansion of the research community and advancements in technology and publication access. Specific peaks, such as those around 2018-2020, suggest periods of heightened research activity likely driven by global challenges or scientific advancements. A recent decline in publications, potentially due to incomplete 2024 data or delays in indexing, may also reflect the impact of global events on research output. Earlier decades show lower scientific output, likely due to historical constraints in funding, technology, and publication accessibility. Overall, the trend underscores the continuous growth of scientific contributions and the influence of external factors on research productivity.
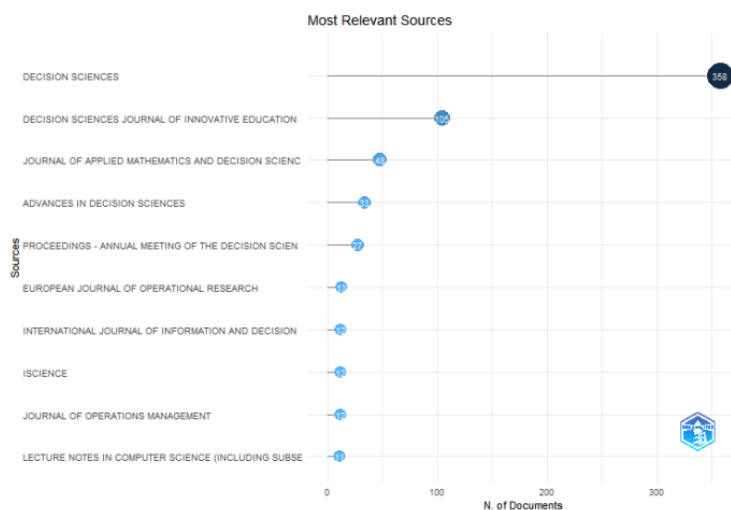

Figure 2 *Most Relevant Source*

From the above figure highlights the most relevant sources in the field, with *Decision Sciences* emerging as the leading journal, contributing 358 documents and establishing itself as a key influence. Other notable sources include the *Decision Sciences Journal of Innovative Education* (104 documents) and the *Journal of Applied Mathematics and Decision Sciences* (48 documents), which, while significant, have fewer publications. The chart emphasizes the dominance of a few primary journals in the field, showcasing their role in concentrating much of the research activity. This distribution provides valuable guidance for researchers, identifying key journals like *Decision Sciences* for both reading and publishing impactful studies, alongside several other specialized journals catering to focused areas within decision sciences and operational research.
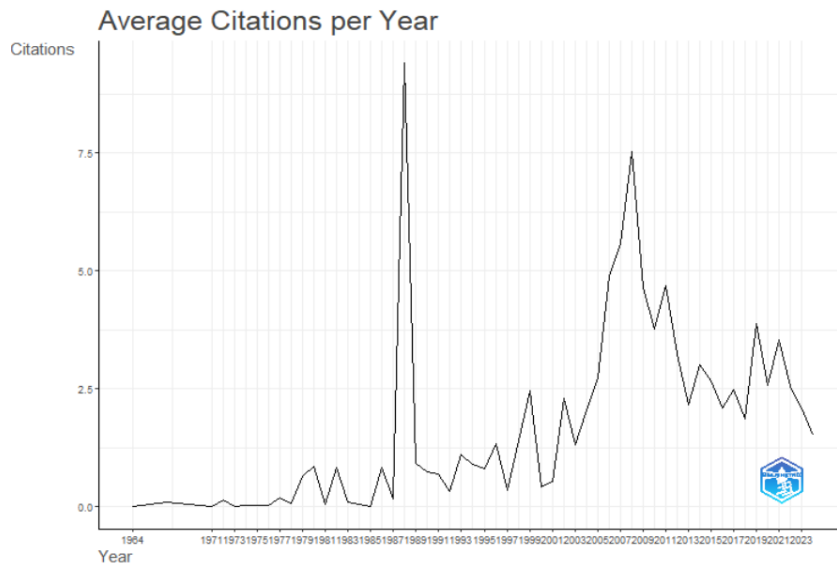
Figure 3 *Average Citations per Year*

Figure 3 illustrates the trend in average citations per year, showing initially low citation counts that grew steadily over time, with notable spikes and a recent decline. A significant peak around 1987 suggests the publication of highly influential research that garnered substantial attention. The 2000s and early 2010s saw steady growth in citations, likely reflecting the increasing impact of influential studies and a rising interest in the field. However, the recent decline may indicate shifting research focus, delayed citation patterns, or incomplete data for the most recent years.

Figure 4 *Tree Map*

The tree map visualization represents various keywords related to a dataset, with each rectangle's size indicating the frequency or significance of the keyword. The largest rectangle, "decision making" (18%), signifies its central role in the dataset, followed by "human" (8%) and "humans" (6%), highlighting the focus on human-related studies. Other notable topics include "male" and "female" (3% each), suggesting gender-based analysis in research, while "risk assessment" (3%), "uncertainty" (2%), and "forecasting" (1%) reflect a focus on risk analysis and predictions. Keywords like "artificial intelligence" (2%) and "cognition" (1%) show the increasing influence of AI and cognitive studies. Smaller rectangles represent less frequent topics, such as "fuzzy sets," "biodiversity," "climate change," and "problem solving." Overall, the treemap offers an overview of the key research areas in decision-making, human behavior, risk assessment, and related fields, with a clear emphasis on decision science, human characteristics, and emerging trends like AI.
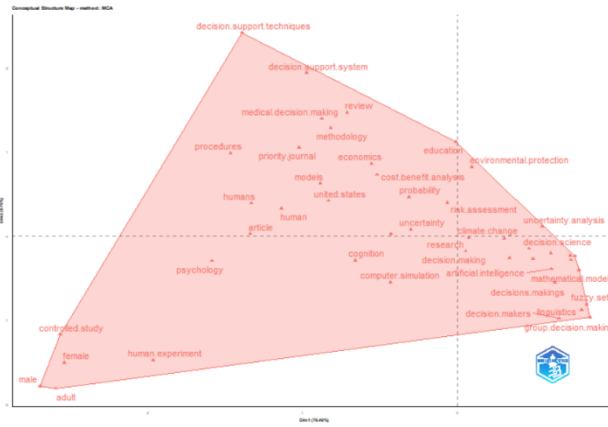
Figure 6 *Conceptual Structure*

Figure.6 offers a structured view of the **conceptual landscape of decision science**. The clusters show the main themes, such as decision support techniques, risk assessment, and human-centered studies, and how they relate to broader topics like environmental protection and cognitive modeling. This map is valuable for identifying research gaps, discovering potential interdisciplinary connections, and gaining a comprehensive view of the field's intellectual structure.
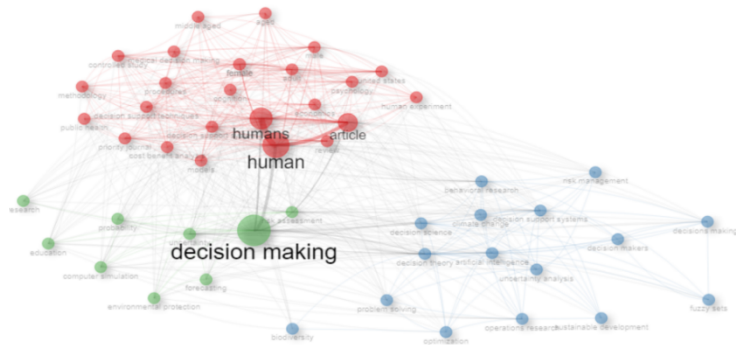

Figure 7 *Network graph*

Figure. 7 is a network graph that illustrates the relationships between various topics or keywords in a dataset, with nodes representing keywords and edges indicating their associations. The size of each node reflects the importance or frequency of the topic, with "decision making" being the largest and central node, followed by other significant topics such as "humans" and "article." Nodes are color-coded into clusters: green nodes represent core decision-making topics, red nodes highlight human demographics (e.g., gender, age), and blue nodes focus on specialized fields like artificial intelligence and decision science. The density of connections between nodes reveals the interrelatedness of topics, with a high density in the red cluster indicating a strong focus on demographic studies, and sparser connections in the green and blue clusters suggesting a more technical approach to decision-making. This network graph provides insights into the key thematic clusters within the dataset, emphasizing the interconnections between decision-making, human factors, and specialized research areas.
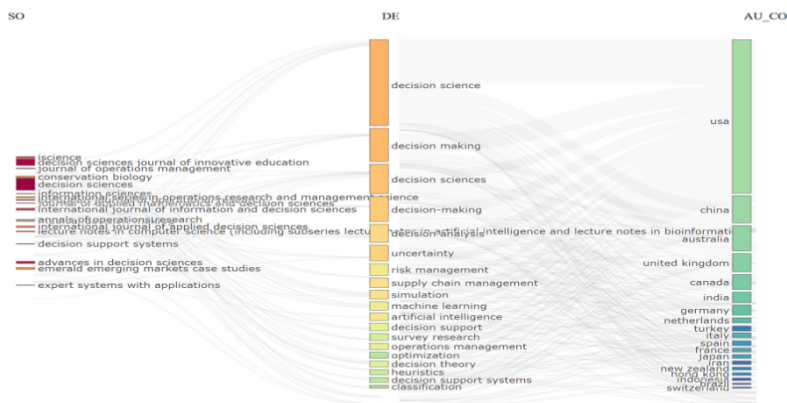

Figure 8 *Three-Field Plot*

From the above figure represents a Three-Field Plot, a bibliometric visualization that illustrates the relationships between three key fields: academic sources (SO), research keywords or descriptors (DE), and author countries (AU_CO). This plot highlights major journals like *Decision Sciences* and *Journal of Operations Management*, showing their thematic focus on decision-making, risk management, and machine learning. The keywords include decision science, risk management, supply chain management, and artificial intelligence, with the USA, China, and the UK being the leading countries contributing to these areas. The diagram reveals global research trends, with the USA excelling in decision-making and AI, while the UK and Canada focus on supply chain and risk management. It emphasizes the interdisciplinary and international nature of research in decision sciences and related fields, showcasing how these topics are explored across different countries and journals.
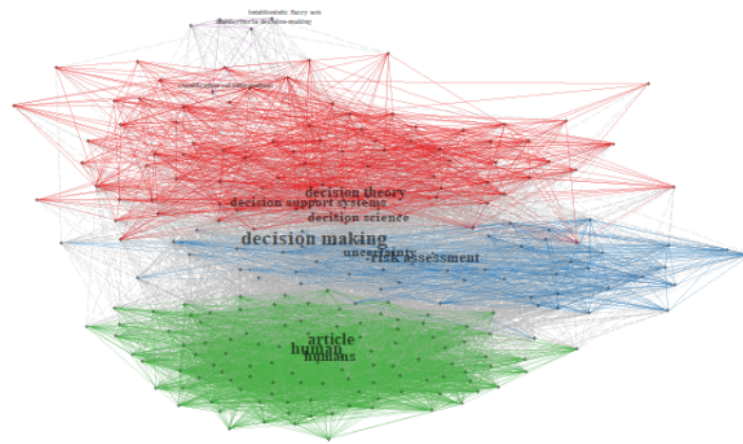

Figure 9 *keyword Oc-Occurences*

From the above figure keyword co-occurrence network visualizes relationships among terms related to "decision making," the central theme here. Keywords are clustered in red, blue, and green groups, each representing different thematic areas: red focuses on theoretical frameworks like "decision theory" and "decision support systems," blue on assessment methods and tools, and green on human-centered aspects. The lines connecting keywords represent co-occurrences, with thicker lines indicating stronger associations. The larger size of certain words, especially "decision making," highlights their prominence and frequent appearance, suggesting that these are the most central concepts in the analyzed body of literature.
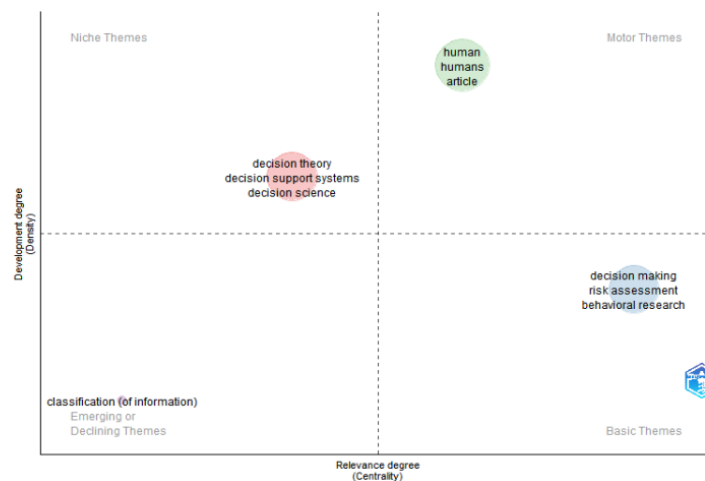

Figure 10 *Thematic Map*

From the above figure strategic diagram provides insights into the positioning of various topics within decision sciences and related fields, categorizing them into four key types: Motor Themes (Human Subjects), which are well-developed and central, indicating their strong influence and connections in the research community; Basic Themes (Decision Making & Risk Assessment), foundational but lacking depth, suggesting areas for further development; Niche Themes (Decision Theory & Support Systems), specialized and well-developed but not widely relevant, representing technical aspects of decision science; and Emerging or Declining Themes (Classification of Information), which appear less significant, possibly indicating a diminishing focus or an emerging area of research. This framework helps identify core research areas, emerging trends, and specialized topics, guiding researchers on where to focus their efforts in the evolving landscape of decision sciences and risk assessment.

7. Conclusion

The bibliometric analysis of decision science reveals several critical insights:

Decision-making remains the central theme in research, encompassing related fields like risk assessment and human studies, with a strong emphasis on human-centered research focused on demographics such as gender and age groups. Technological advancements, particularly in artificial intelligence and machine learning, are increasingly shaping decision-making studies. Geographically, the USA, China, and the UK lead the research landscape, each with distinct thematic focuses. While publication volumes have grown over time, a recent decline suggests either saturation in certain areas or the emergence of new interests. Opportunities for future research lie in exploring niche themes like decision theory and bridging gaps by integrating decision science with fields such as environmental studies and cognitive modeling.

8. References

1. Miguel Á. Conde5, M. ·. (2023). A multimethod synthesis of Covid 19 education research:the tightrope between covidization and meaningfulness. springer, 14.
2. "Juan Carlos Gonzalez-Quesada ´a, J. R.-V. (2024). Large-scale group decision-making: A bibliometric study. ELSEVIER, 8.
3. Begüm Saçak 1, A. B. (2022). Learning Design versus Instructional Design: A Bibliometric Study through Data Visualization Approaches. education science, 14.
4. Ding2, H. G. (2022). The research landscape on the artificial intelligence:a bibliometric analysis of recent 20 years. Multimedia Tools and Applications, 29.
5. Guolong Chen 1, 2. R. (2023). Bibliometric Analysis of Spatial Technology for World Heritage: Application, Trend and Potential Paths. remote sensing, 24.
6. Jevremov1, B. M. (2019). Trends in research related to the Dark Triad: A bibliometric analysis. Springer, 10.
7. Lin Xiu Hou1, L. X. C. ,. (2021). Decades on emergency decision making: a bibliometric analysis and literature review. Complex & Intelligent Systems, 14.
8. Michael Schneider3, A. ·. (2023). The Landscape of Research on Prior Knowledge and Learning: a Bibliometric Analysis. Educational Psychology Review, 29.
9. Peichen Xiao1, 2. C. (2022). The top 100 most cited papers on endometrial carcinoma: A bibliometric analysis. frontiers, 10.
10. Scientometrics. (2016). A co-citation bibliometric analysis of strategic management research. Joa˜o Jose´ M. Ferreira1 • Cristina I. Fernandes2 •Vanessa Ratten3, 32.
11. Zeqi Dai 1†, S. X. (2022). Knowledge Mapping of Multicriteria Decision Analysis in Healthcare: A Bibliometric Analysis. Fortiers, 15.