Krakow Review of Economics and Management
Zeszyty Naukowe Uniwersytet Ekonomiczny w Krakowie
1 (1011)
2026

KREM, 2026, 1(1011): 25–44
ISSN 1898-6447
e-ISSN 2545-3238
https://doi.org/10.15678/krem.18725

The Review of Applications of Decision-making Techniques in Supply Chain Management

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Suggested citation: Tatarczak, A. (2026). The Review of Applications of Decision-making Techniques in Supply Chain Management. *Krakow Review of Economics and Management / Zeszyty Naukowe Uniwersytetu Ekonomicznego w Krakowie*, 1(1011), 25–44. https://doi.org/10.15678/krem.18725

ABSTRACT

Objective: The objective of the article is to provide a systematic literature review of Multi-criteria Decision-making (MCDM) techniques in supply chain and logistics management. It aims to fill a research gap by offering an objective overview of the latest advancements in decision-making techniques and their impact on supply chain performance.

Research Design & Methods: The paper employs a systematic literature review to examine the application MCDM techniques in supply chain management. The review follows a five-step process: 1) formulation of research questions, 2) identification of relevant studies through the Scopus database, focusing on English-language journal articles published between 2006 and 2023, 3) selection and evaluation of studies using structured keyword searches and content screening, resulting in a final sample of 348 peer-reviewed articles, 4) analysis and synthesis of the selected literature in relation to the research questions, and 5) reporting the findings to identify research gaps and suggest future research directions.

Findings: The review reveals the diverse applications of MCDM tools and models in addressing complex supply chain challenges, including demand forecasting, inventory management, distribution optimisation, and risk assessment. Furthermore, the study underscores the substantial value added by these techniques, as they lead to improved decision-making processes, enhanced

operational efficiency, cost reduction, and overall performance optimisation of supply chains. The findings also provide valuable recommendations for future research, promoting knowledge accumulation and creation in the field of MCDM techniques for supply chain management.
Implications/Recommendations: The study's findings have important implications for supply chain management, demonstrating how MCDM methodologies may improve decision-making, efficiency, and performance. The recommendations emphasise the continuous application and research of these strategies in diverse supply chain contexts. Future research is recommended to better understand and broaden the use of MCDM approaches in supply chain settings.
Contribution: This article is unique in that it provides a full examination of MCDM strategies related to supply chain and logistics management. It synthesises a wide variety of previous research to offer a comprehensive overview of the present status and promise of MCDM approaches for improving supply chain operations and results.

Article type: original article.

Keywords: multi-criteria decision-making, supply chain management, systematic literature review, decision-making techniques.

JEL Classification: C44, D81, M11.

1. Introduction

The supply chain (SC) is a fusion of operational procedures transforming raw materials into end products or services, meeting the needs of customers. The typical representation of the SC involves the progression of information, financial transactions, and materials across its stages. On the other hand, supply chain management (SCM) entails the coordination, execution, and oversight of this network (Grida, Mohamed & Zaid, 2020). In a period characterised by heightened ambiguity in demand, elevated risk in the supply domain (Cheng *et al*., 2021), and intensifying competition, achieving excellence in SC frequently depends on the organisation's capacity to seamlessly integrate and coordinate the comprehensive range of end-to-end processes. These processes encompass the acquisition of materials or components, their transformation into finished goods, and the subsequent delivery to customers (Min, 2010). Acknowledging the growing importance of information in achieving success in the SC, professionals in this field have investigated diverse approaches to enhance information management and utilise it more effectively for informed business decision-making (Min, 2010). In this research paper, we consider the following SC function: supplier selection, manufacturing, warehousing and logistics (see Fig. 1).

The implementation of MCDM methodologies in the SCM has attracted substantial interest, reflecting the rising complexity of criteria crucial for organisations in making optimum SCM decisions (Khan, Chaabane & Dweiri, 2018).

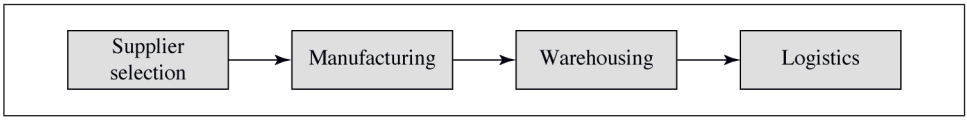

Fig. 1. Supply Chain Functions
Source: the author, based on Salomon (2018).

In recent years, several academics have focused on the investigation of MCDM methodologies in order to address the complexities of decision-making in various industry sectors. The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and its version, Fuzzy TOPSIS, which add components of fuzziness to accommodate uncertainty, are key MCDM approaches that have been extensively recognised and adopted. Furthermore, the Analytical Hierarchy Process (AHP) and its derivative, Fuzzy AHP, provide formal frameworks for making difficult decisions. Furthermore, Data Envelopment Analysis (DEA) takes a non-parametric approach to efficiency analysis, whereas Vlse Kriterijumska Optimizacija Kompromisno Resenje (VIKOR) concentrates on multi-criteria optimisation problems. The incorporation and implementation of these various MCDM approaches in SCM highlights their importance in improving decision-making processes, allowing for more nuanced and informed decisions that reflect the multidimensional character of current corporate contexts. MCDM goes well beyond just reducing procedures for decisive results in the context of supply chain management. It is a comprehensive instrument that allows researchers and managers to balance and harmonise a wide range of criteria, many of which have competing aims or purposes. The work of Sarkis and Talluri (2002) and Chai, Liu and Ngai (2013), who depict the complicated interaction of many components in the decision-making process, highlights this delicate balancing act. As observed by Banasik *et al*. (2018), the application of MCDM becomes especially important in scenarios where trade-offs are required, not only in environmental settings, but also in managing operational, financial, and strategic elements of supply chains. The research of Bai and Sarkis (2010) indicates how MCDM may combine varied objectives, providing a solid technique for harmonising distinct company aims. This integration is vital for fulfilling the complex demands of modern supply chain management, emphasising the importance of MCDM in strategic planning and operational efficiency. Organisations may negotiate the multiple issues inherent in supply chain operations by embracing MCDM, assuring a more coherent and successful management strategy.

Therefore, there is a lack of detailed discussions on MCDM in SCM research (Sahoo & Goswami, 2023). This gap presents an opportunity for a systematic review to check what has been said across a broad range of MCDM studies and use that info to build theories for SCM. Thus, the specific objective of this paper is

to provide a systematic literature review on the application of MCDM methods in SCM. This study is an attempt to answer the following research questions:

RQ1: What are the present focuses of decision-making in SCM in the reviewed literature?

RQ2: What is the distribution of MCDM methods applications in term of area of application?

RQ3: What is the distribution of MCDM methods applied at each SC decision levels: strategic, tactical and operational?

The rest of the paper is arranged as follows: The methodology adopted for the study is explained in section 2. Section 3 carries out the categorical classification of the reviewed papers and presents the results. Discussion on classified analysis results is carried out in section 4. Finally, the paper ends up with a conclusion in section 5.

2. Research Methodology

Literature reviews serve as valuable and thorough examinations utilised to explore research in evolving fields and to provide direction for future research endeavours (Junior & Godinho Filho, 2010; Govindan, 2013). Following the five--step process recommended by Denyer and Tranfield (2009) the method involves: 1) question formulation, 2) finding relevant research, 3) study selection and evaluation, 4) analysis and synthesis, and 5) sharing results (Abdirad & Dossick, 2016).

Step 1: *Question formulation*

First, the authors analysed the general research trends in the literature based on how many studies have been done on MCDM within the supply chain, looking into the study settings and the various approaches used. Subsequently, the authors evaluated the body of existing research, assessing its current state, along with the strengths and weaknesses of prior works. Then, three questions (RQ1, RQ2, RQ3) were formulated to navigate the subsequent processes of data procurement and analytical scrutiny.

Step 2: *Locating studies*

Scopus database was considered for the study because of its wide coverage of peer-reviewed academic literature. The review focused on articles issued from January 2006 through 2023, to collate peer-reviewed academic insights. Only English-language articles with a concentration on management topics were selected for examination. To ensure the high standard of the content, the review excluded conference papers, working documents, technical reports, and book sections.

Step 3: *Study selection and evaluation*

Structured keyword “supply chain management” and “MCDM” was used to search for related articles in the field. This initial query yielded over 600 articles in

the database. To narrow down the selection, the term "supply chain management" was specifically sought in the titles, abstracts, and keywords of articles listed in the Scopus online database. A total of 489 articles were generated in the first step. To evaluate relevant studies on this topic, the author reviewed the content of each paper. Preliminary refinement of the total articles left us with 389 usable articles. After a final round of refinement, 348 peer-reviewed articles remained for in-depth analysis. The information required for the study was systematically compiled using an Excel spreadsheet to facilitate the full paper analysis.

Step 4: *Analysis and synthesis*

At this stage, each study was examined in light of the three queries previously outlined in the introduction.

Step 5: *Reporting and using results*

Following the outlined methodology, this phase involves displaying the research findings by evaluating the chosen papers according to the categories that will be detailed in the forthcoming section on results. This article identifies existing research gaps and suggests directions for future studies. The paper concludes with a summary and a set of conclusions drawn from the research.

3. Results

3.1. Analysis of Articles According to Publication Years

Frequency analysis of the final sample (348 articles) based on the articles published year wise is shown in Figure 2. The examination of publication data on decision-making strategies in supply chain management from 2006 to 2023 demonstrates a considerable and consistent growth in academic interest. Beginning with a single paper in 2006, the field suffered an insignificant early phase but witnessed a significant increase in publications from 2008 forward, suggesting a rising acknowledgement of the relevance of decision-making in this industry. In response to RQ1, the analysis reveals that the focus of decision-making in SCM has progressively shifted towards the application of data-driven methodologies, particularly MCDM techniques, to enhance supply chain performance.

The significant growth in yearly publications, particularly from 2016 to 2023, highlights the expanding role of MCDM approaches in addressing the growing complexities of global supply chains. The increasing integration of artificial intelligence, machine learning, and big data analytics in SCM decision-making has been a key factor influencing this upward trend. Moreover, the surge in publications reflects an increasing emphasis on supply chain resilience, sustainability, and risk management, underscoring the role of decision-support tools in optimising supply chain operations. The peak of 60 publications in 2023 reinforces the need for advanced decision-making frameworks, emphasising how MCDM techniques

contribute to improved strategic planning, operational efficiency, and risk mitigation in modern supply chains (Althaqafi, 2023; Khan *et al*., 2023a; Liu, Gu & Chen, 2023; Tsai, Shen & Lin, 2023).

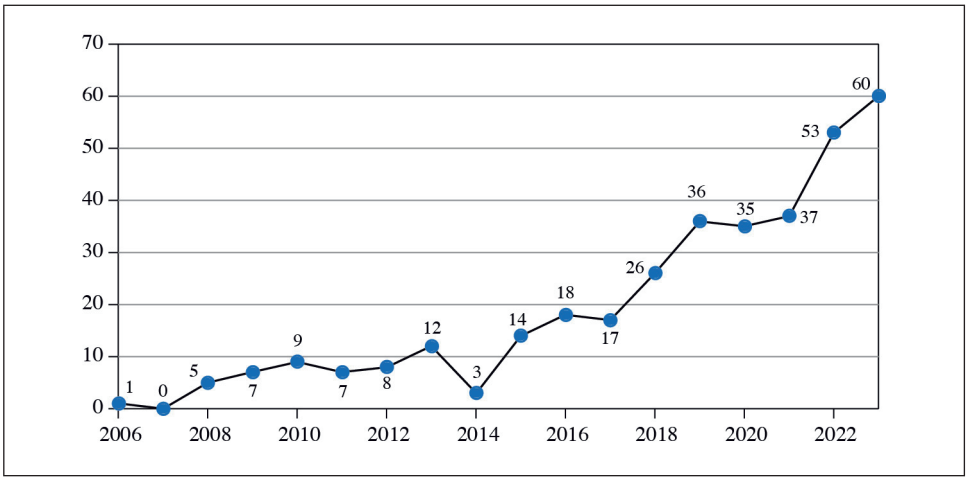

Fig. 2. Number of Review Papers Published by Year (2006–2023)
Source: the author.

3.2. Authors Actively Involved in Publishing

Within the prolific landscape of scholarly work focused on DM in SCM, a corpus of 348 articles has been analysed, drawing contributions from a diverse array of 510 authors. An overview of the leading contributors, detailed in Table 1, reveals that a select group of 17 authors has significantly impacted the field, collectively authoring 79 papers, which accounts for a notable 22.7% of the total output. Among these, D. Pamucar stands out as the foremost contributor, with a portfolio of 8 articles, comprising 2.3% of the entire collection of works analysed.

Table 1. Contribution of Main Authors by Number and Percentage of Articles

Authors	Number of Articles	Percentage
Pamucar, D	8	2.3
Ghosh, S.	5	1.4
Govindan, K.	5	1.4
Mandal, M. C.	5	1.4
Ray, A.	5	1.4
Sarkis, J.	5	1.4
Stević, Ž.	5	1.4

Table 1 cnt'd

Authors	Number of Articles	Percentage
Zavadskas, E. K.	5	1.4
Ali, Y.	4	1.1
Antucheviciene, J.	4	1.1
Hashemkhani Zolfani, S.	4	1.1
Kabak, M.	4	1.1
Kusi-Sarpong, S.	4	1.1
Liu, H. C.	4	1.1
Luthra, S.	4	1.1
Riaz, M.	4	1.1
Tomaskova, H.	4	1.1
Others	269	–

Source: the author.

3.3. Analysis of Papers by Authors' Geographical Distribution

The geographical distribution of the sources of the evaluated publications adds an intriguing feature to the entire research in the context of the comprehensive literature review done for this research (see Fig. 3). Notably, India emerges as the largest contributor with 105 articles, demonstrating the country's active participation in supply chain decision-making processes. China comes in second with 52 publications, demonstrating the country's enormous investment in establishing complex supply chain systems. Turkey, Iran, and Taiwan all provide significant contributions, with 45, 44, and 33 publications, respectively, indicating a growing interest and body of knowledge in these regions. Western nations such as the United States and the United Kingdom, which have historically been seen as pioneers in this subject, have made less contributions in this assessment.

The keyword frequency data provided for the paper is presented on Figure 3. The most frequent terms are "supply" (147 mentions) and "chain" (132 mentions) showing the papers' core focus on supply chain management. Terms like "decision" (34 instances), "decision-making" (26 mentions), and "making" (29 mentions) suggest a high emphasis on decision-making procedures in the context of supply chain management. The use of particular tools such as "fuzzy" (28 occurrences), which refers to fuzzy logic or fuzzy set theory, and "vikor" (7 mentions), which refers to another MCDM method, suggests that the study addresses multiple models and techniques for improving decision-making processes. The terms "supplier" (74 occurrences) and "selection" (53 occurrences) indicate an emphasis on the process of selecting suppliers as a significant decision-making area in SCM.

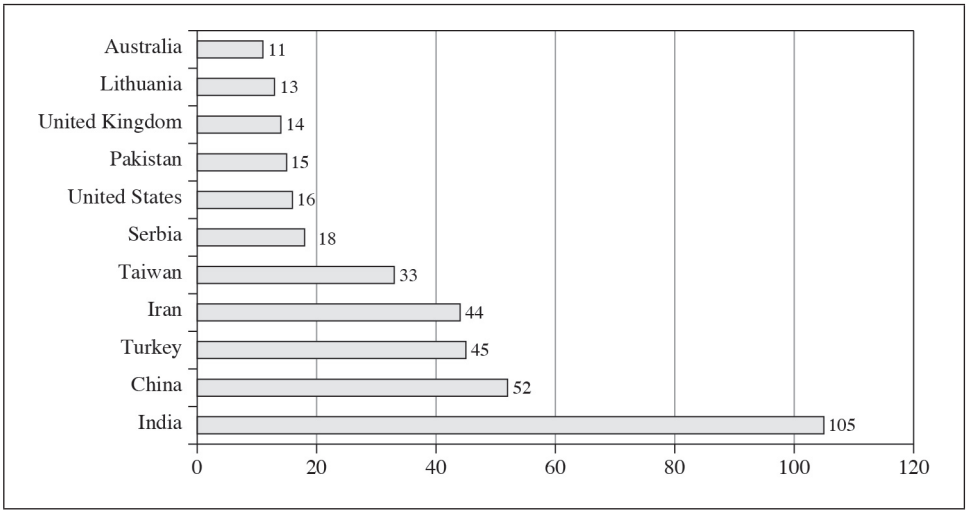

Fig. 3. Distribution of Reviewed Papers over Country
Source: the author.

Researchers employ several MCDM methodologies to model, evaluate, and assist supply chain decision-making. Table 2 displays the various MCDM approaches reported in the 348 publications under consideration. There are 133 articles that employ MCDM approaches for decision-making. TOPSIS is the most widely used approach, with 33 applications, and is praised for its capacity to handle complicated decision-making circumstances by ranking alternatives through an optimum solution. DEMATEL comes in second with 28 occurrences, demonstrating its efficacy in visualising and evaluating complicated causal links inside decision-making situations. VIKOR and AHP are also frequently used, with 24 and 21 applications, respectively, proving their robustness in dealing with multi-criteria decision-making challenges by prioritising options and selecting the optimum course of action. Fuzzy set theory is mentioned in 13 works, demonstrating its usefulness in dealing with uncertainty and imprecision in decision-making. Other approaches, such as ELECTRE, ANP, and DEA, have fewer articles (6, 4, and 4 respectively), indicating a more specialised use or a possibility for development in their acceptance in SCM research. The diverse use of these MCDM approaches emphasises their significance in tackling the various difficulties of supply chain optimisation, ranging from logistics to risk assessment and resource allocation.

TOPSIS technique has emerged as a critical instrument for improving SCM decision-making procedures (Zulqarnain *et al*., 2021; Ali *et al*., 2024). This strategy, which is based on the principle of selecting the alternative that is closest to the ideal solution and farthest from the negative-ideal solution, has been used in a variety of

SCM applications. For example, Behzadian *et al*. (2012) used TOPSIS to evaluate suppliers based on several factors to ensure optimal selection, which is a vital task in SCM. Similarly, Chai, Liu and Ngai (2013) demonstrated the use of TOPSIS in analysing supply chain sustainability, offering a complete framework for examining environmental, social, and economic issues. Furthermore, Govindan, Khodaverdi and Vafadarnikjoo (2015) broadened the scope of TOPSIS by combining it with additional approaches such as AHP to examine the complexity and dynamism of green supply chain operations. These examples demonstrate TOPSIS's adaptability and efficiency in tackling numerous aspects of SCM, ranging from supplier selection (Liao & Kao, 2011; Freeman & Chen, 2015) and performance evaluation (Tyagi, Kumar & Kumar, 2014; Moharamkhani, Bozorgi-Amiri & Mina, 2017) to the incorporation of sustainability and green practices (Büyüközkan & Çifçi, 2012; Chaharsooghi & Ashrafi, 2014; Ansari & Kant, 2017; Dhull & Narwal, 2018). As a result, TOPSIS is a strong analytical tool that aids in the complicated decision-making processes that define modern supply chain management.

Table 2. Frequency of MCDM Methods Used in Articles

MCDM Technique	Number of Papers
TOPSIS	33
DEMATEL	28
VIKOR	24
AHP	21
Fuzzy set theory	13
ELECTRE	6
ANP	4
DEA	4
BWM	3

Source: the author.

DEMATEL approach, a well-known tool in systems engineering, has been successfully adapted for a variety of SCM applications (Giri, Molla & Biswas, 2022; Saroha, Garg & Luthra, 2022). This technique excels at assessing complicated cause-and-effect interactions within system components, making it important for SCM decision-making. Kaur *et al*. (2018) present a DEMATEL-based analysis of barriers to Green Supply Chain Management (GSCM) in the Canadian electronic goods sector, identifying key obstacles in knowledge, commitment, and product design that hinder the implementation of environmentally sustainable practices. Chang, Chang and Wu (2011) use the fuzzy DEMATEL method to identify key factors in supplier selection for SCM, evaluating supplier performance to improve

decision-making in SCM supplier selection, with findings indicating stable delivery as the most influential criterion. The adaptability of the DEMATEL method in SCM is demonstrated by its use in diverse areas such as evaluating key factors in supplier selection, analysing green supply chain practices (Hsu *et al*., 2013; Abdel-Basset *et al*., 2018), and assessing the impact of external pressures on SCM performance (Najmi & Makui, 2010; Senvar, Tuzkaya & Kahraman, 2014), thereby significantly improving decision-making processes by revealing intricate interdependencies and impact patterns.

AHP is used to prioritise and choose suppliers by evaluating them against a set of weighted criteria (Yücenur, Vayvay & Demirel, 2011; Ayhan, 2013; Zekhnini *et al*., 2021). Fuzzy set theory is used to handle uncertainty and imprecision in areas such as demand forecasting and risk assessment (Moeinzadeh & Hajfathaliha, 2009), making it an important tool in supply chain management. The ELECTRE approach is used in complicated decision-making settings such as selecting the best logistics service provider based on several competing factors (Celik, Gumus & Erdogan, 2016; Govindan *et al*., 2019). The ANP is utilised in the network structure of supply chain choices to capture the interdependencies among various elements such as costs, quality, and delivery time (Raisinghani & Meade, 2005). The DEA is used to monitor and benchmark the efficiency of supply chain organisations such as warehouses and distribution facilities (Ross & Droge, 2002; Hahn, Brandenburg & Becker, 2021; Rajak, Parthiban & Dhanalakshmi, 2021). Finally, the BWM is used to optimise procurement strategies by identifying the best and worst criteria, resulting in better supplier selection and assessment throughout the supply chain (Oly Ndubisi *et al*., 2005; Shemshadi *et al*., 2011; Rezaei *et al*., 2016; Khan *et al*., 2023b).

Fig. 4. Keywords Frequency

Source: the author, using WordClouds (https://www.wordclouds.com/).

In response to RQ2, the findings indicate that MCDM methods are widely applied in SCM, particularly in supplier selection, performance evaluation, and risk assessment. The keyword analysis (Fig. 4) highlights a strong focus on supplier evaluation (supplier – 74 occurrences, selection – 53 occurrences). Table 2 identifies TOPSIS (33 applications) and DEMATEL (28 applications) as the most frequently used techniques, valued for ranking alternatives and analysing causal relationships. Additionally, VIKOR, AHP, and fuzzy set theory are commonly applied across various SCM contexts, demonstrating their adaptability in addressing complex decision-making challenges.

3.4. Analysis of Papers by Subject Area

The review emphasises an interdisciplinary approach to supply chain management decision-making processes (see Table 3). Engineering (146 publications) is at the forefront of the research, demonstrating technical solutions to supply chain difficulties. Following that are Computer Science (118) and Business, Management, and Accounting (110), emphasising the importance of computational tactics and financial considerations in supply chain choices. The works in Decision Sciences (83), Environmental Science (79), and Social Science (64) reflect various analytical, sustainable, and sociological issues that are essential to supply chain management. Mathematics (55), Energy (48), and Materials Science (16) studies integrate optimisation and energy management with supply chain operations, while Economics, Econometrics, and Finance (24), and Materials Science (16) contribute economic and material-specific insights. A smaller group of Multidisciplinary (7) publications and articles classified as "Others" (40) demonstrate the broad scope of decision-making applications. This mosaic of research underscores the value of integrating various academic disciplines to enhance supply chain decision-making frameworks.

Table 3. Distribution of Papers According to Subject Area: Numbers and Percentage

Subject Area	Number of Papers	Percentage
Engineering	146	18
Computer Science	118	15
Business, Management and Accounting	110	14
Decision Sciences	83	11
Environmental Science	79	10
Social Science	64	8
Mathematics	55	7
Energy	48	6

Table 3 cnt'd

Subject Area	Number of Papers	Percentage
Economics, Econometrics and Finance	24	3
Materials Science	16	2
Multidisciplinary	7	1
Others	40	5

Source: the author.

The distribution of MCDM methods across different decision-making levels in SCM is evident from the reviewed literature. In response to RQ3, the findings indicate that at the strategic level, methods such as AHP and ANP are predominantly employed for long-term decision-making, particularly in supplier selection and supply chain network design. At the tactical level, DEMATEL and ELECTRE are widely applied for supplier performance evaluation, logistics optimisation, and managerial decision-making. At the operational level, DEA and BWM are frequently utilised to enhance resource allocation, inventory management, and real-time decision support. This categorisation aligns with Table 3, further reinforcing the interdisciplinary nature of SCM decision-making research. The findings confirm the versatility of MCDM approaches in addressing decision-making challenges across strategic, tactical, and operational levels, demonstrating their essential role in optimising supply chain performance across various domains.

4. Discussion

The research provides a thorough evaluation of 348 peer-reviewed publications published between 2006 and 2023 on the application of MCDM in SCM. The research paper organises all available literature according to the following criteria: increasing number of publications over time and pioneering journals, research methodology and research design used, type of industry focused in research, scholars' contribution to research topic, and countries actively involved. The findings of these categories allow us to identify research gaps and establish new research possibilities. But, before we get into that, let's go over some of the study's key results that will help us grasp the current status of the subject.

The growing interest in decision-making techniques within supply chain management, as demonstrated by the literature, suggests an increasing recognition of the complexity and critical nature of supply chain decisions. The field has evolved considerably over the years, with 2023 marking a zenith in research productivity.

Geographically, the distribution of research highlights the active engagement of countries like India and China in enhancing their supply chain decision-making processes. The commitment of these countries to advancing SCM research is

particularly noteworthy, given their roles as major global economic players and manufacturing hubs. It underscores the strategic importance they place on optimising supply chain operations, which is essential for maintaining competitive advantages in the global market.

The interdisciplinary nature of the research showcases the convergence of different academic disciplines in addressing the multifaceted challenges of SCM. Engineering, Computer Science, and Business, Management, and Accounting have emerged as the leading areas, indicating a strong link between technical, computational, and economic aspects of SCM. The involvement of Decision Sciences, Environmental Science, and Social Science reflects the broader impact of SCM decisions on society and the environment, highlighting the need for sustainable and ethically grounded decision-making frameworks.

The following material gathered from the evaluated literature gives insights into the research issues stated in the study. For RQ1, which focuses on current decision--making in SCM, the literature stresses the use of MCDM approaches. TOPSIS, Fuzzy TOPSIS, AHP, and Fuzzy AHP are well-known approaches for dealing with difficulties in several industry sectors. These techniques are critical for dealing with the increasing difficulties of making optimum SCM decisions. In response to RQ2, which concerns the distribution of MCDM approaches in terms of application areas, the literature illustrates the flexibility of these methods across a range of SCM applications. The DEMATEL technique, for example, is used to evaluate critical supplier selection variables, analyse green supply chain practices, and examine the influence of external pressures on SCM performance, demonstrating its adaptability. In answer to RQ3, which asks about the distribution of MCDM approaches in SCM across strategic, tactical, and operational decision levels, numerous methods are mentioned for their unique uses. The ELECTRE approach is used in complex decision settings such as logistics service provider selection, ANP for capturing interdependencies in supply chain decisions, DEA for efficiency monitoring and benchmarking in supply chain organisations, and BWM for optimising procurement strategies, all of which contribute to better decision-making across the supply chain. These findings demonstrate the extensive and multidimensional impact of MCDM approaches in improving decision-making processes in the field of SCM, addressing a variety of difficulties and decision-making levels ranging from strategic to tactical.

5. Future Work

In light of the evolving landscape of SCM, the relevance of MCDM has never been more pronounced. While AI garners widespread attention, it is the nuanced capabilities of MCDM that hold profound potential for SCM. Given the breadth of current literature and emerging trends, we propose a focused trajectory for MCDM research and application within SCM. First, there is a compelling need to explore

how MCDM methods can be amalgamated with big data analytics. This research could develop MCDM frameworks designed to capitalise on the vast amounts of data available, enhancing decision-making accuracy and scope, particularly in the realms of demand forecasting and market analytics. Second, as environmental and social governance become more fundamental to business objectives, MCDM can help companies make decisions that are both sustainable and ethical. Future research might focus on developing decision-making models that balance profit and purpose, weighing trade-offs between economic efficiency, environmental stewardship, and social responsibility. Third, because global supply networks are dynamic, comprehensive risk management frameworks are required. MCDM research may be focused toward the creation of risk-evaluation and risk-mitigation models, with an emphasis on supply chain resilience, vulnerability assessments, and disruption response techniques. Following that, a significant study subject is tailoring MCDM techniques to improve vendor selection criteria such as capabilities, compatibility, and stability. In addition, utilising MCDM models to optimise supply chain network architecture for cost, speed, and flexibility may help organisations adjust to changing market needs and technology changes. Finally, there is a clear demand for powerful and user-friendly MCDM tools and software solutions. Future research should focus on developing scalable and adaptable tools to assist practitioners in many sectors in modelling diverse scenarios and making effective strategic decisions. Addressing these objectives has the potential to considerably improve the strategic application of MCDM in SCM, ensuring that decision-making is not only economically sound but also adaptive, forward-thinking, and socially responsible.

6. Concluding Remarks

The study emphasises the importance of MCDM techniques in tackling the complexity of decision-making in SCM across many industrial sectors. The applicability of methodologies such as DEMATEL, ELECTRE, ANP, DEA, and BWM across many SCM applications and decision levels, from strategic to tactical to operational, emphasises their contribution to more successful SCM decision-making. These findings show the broad and diverse influence of MCDM techniques in navigating different problems and decision-making levels in SCM, consequently improving overall efficiency and strategic planning in the area.

In response to RQ1, the findings confirm that the growing complexity of SCM decision-making has increased reliance on structured, data-driven approaches, with MCDM methods playing a key role in supplier selection, risk management, logistics, and supply chain design. Regarding RQ2, MCDM techniques demonstrate broad applicability, particularly in supplier evaluation and network design, enabling a comprehensive assessment of tangible and intangible criteria (Rajasekaran *et al*., 2016; Manucharyan, 2021). Additionally, decision-support models effectively

address risk-benefit trade-offs in global supply chains (Reich, Wakolbinger & Kinra, 2020), though further innovation in non-conventional selection models remains an area for development (Manucharyan, 2021). For RQ3, MCDM methods are systematically applied across SCM decision levels: AHP and ANP at the strategic level for long-term supplier selection and network optimisation, DEMATEL and ELECTRE at the tactical level for supplier performance and logistics, and DEA and BWM at the operational level for resource allocation and inventory management. This structured application enhances efficiency, adaptability, and resilience in supply chain operations.

The versatility of these MCDM techniques enables their use in a variety of scenarios, allowing companies to efficiently solve complex and varied issues. Whether optimising logistics, improving resource allocation, or controlling risks, MCDM approaches provide detailed analysis that leads to educated, robust, and strategic decisions. This broad application demonstrates the importance of MCDM techniques in improving operational efficiency and strategic planning within SCM. Furthermore, the insights gained from these methodologies allow firms to not only respond to urgent operational needs but also foresee future issues and opportunities, promoting proactive management practices. This dynamic approach to decision-making is critical in today's fast-changing market settings, where agility and strategic foresight are essential. Furthermore, combining MCDM methodologies with future technologies like AI and big data analytics has the potential to significantly transform SCM procedures (Yasmin *et al*., 2020). This collaboration can result in the creation of more complex decision-support systems that increase accuracy, lower costs, and overall supply chain resilience.

Acknowledgement and Financial Disclosure

The author would like to express their gratitude for the opportunity to undertake a scientific internship at Georgian Technical University, Georgia. This article is a direct outcome of that internship. Special thanks are extended to Prof. Rezo Tedoradze for his valuable comments on the draft version of this paper and for inspiring further research study. The paper was supported under the Zawacka NAWA Programme (BPS/ZAW/2023/1/00098).

Conflict of Interest

The author declares no conflict of interest.

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