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Abstract: The textile industry plays a vital role in the global economy and faces increasing pressures related to sustainability and efficiency. Given the industry's significant environmental impact and the need for improved operational strategies, our review addresses the critical intersection of decision-making methodologies and sustainable practices. Specifically, This review aims to explore the applications of Multi-Criteria Decision-Making (MCDM) techniques within the textile supply chain to enhance operational performance and decision-making processes. Utilizing a systematic literature review method, we analyzed articles from Scopus, Web of Science, and Google Scholar, focusing on those that address MCDM applications in the textile supply chain. The findings reveal a strong emphasis on supplier selection and evaluation as determinants of competitive advantage, with significant trends toward integrating fuzzy set theory and advanced MCDM methodologies to address uncertainties. Additionally, Sustainability emerges as a core theme, emphasizing the necessity for firms to incorporate green practices into decision frameworks. The insights suggest that by adopting innovative analytical techniques, organizations can improve supplier relationships and operational efficiency.

Keywords: textile industry; multi criteria decision-making; supply chain; sustainability

1. Introduction

The textile industry has been crucial in shaping human civilization throughout history, serving as a key sector for countries worldwide to boost their economies. It remains a dominant player in the global market, characterized by an intricate manufacturing chain and diverse structure [1]. However, adopting a globalization strategy in this industry nearly had disastrous consequences. It resulted in the closure of numerous manufacturers, a significant reduction in the workforce, and a drastic lowering of production costs [2]. Supply chain management is essential to every industry, and adherence to environmental and sustainable standards is crucial for development. A sustainable supply chain incorporates social, environmental, and human considerations in product manufacturing and marketing, covering all stages from sourcing raw materials to the sale and transportation of finished products [3]. The supply chain is the foundation of the dynamic textiles industry, managing the movement of materials, data, and funds from the raw material stage to the finished product delivered to the customer [4]. The textile supply chain involves complex decision-making processes at both tactical and operational levels. Integrating seasonal forecasting with inventory management techniques can minimize waste and strengthen supply chains [5]. An effective supply chain provides numerous advantages to businesses, including cost efficiencies and competitive product pricing. The primary goal of the supplier selection process is to minimize purchasing risks, optimize the overall value for the buyer, and foster close, enduring relationships between buyers and suppliers. Consequently, selecting the appropriate supplier is critical in determining an organization's success or failure [6,7]. Therefore, the careful selection of suitable

decision-making criteria, along with the appropriate decision-making technique is essential in pinpointing the ideal supplier. A well-organized and systematic decision-making process is vital for ensuring the alignment and attainment of the purchasing organization's corporate and business strategy [8]. The decision-making process plays a crucial role in modern organizations and industries as it directly impacts the overall success or failure of the entity. Understanding the factors influencing decision-making is important for organizational effectiveness, especially in uncertain environments [9]. Multiple Criteria Decision-Making (MCDM) techniques provide a structured approach for addressing decision challenges that encompass multiple goals, a range of criteria, and differing preferences [10]. Several MCDM techniques have been introduced, each varying in their theoretical approach, input requirements, and resulting outcomes [11]. For instance, Behzadian et al. conducted a comprehensive literature review in 2012 to analyze and understand the current and developing issues related to the implementation of the TOPSIS methodology [12]. In 2021, Khan et al. conducted a meta-analysis that systematically explored sustainable supply chain management (SSCM) literature from 2004 to 2019, categorizing research into drivers, barriers, MCDM techniques, and research methods. It identified emerging trends and gaps, highlighting the dominance of firm-level studies and the extensive use of MCDM techniques in SSCM research [13]. Some studies highlight other methods and techniques used in the textile and apparel industry. For example, Guo et al. provided a comprehensive overview of artificial intelligence (AI) applications within the apparel industry. They conducted a systematic review of existing literature, focusing on various research issues and methodologies driven by AI. Their research issues align with operational facets of the industry: apparel design, manufacturing, retailing, and supply chain management [14]. Dal Forno et al. performed a systematic review of the progress of Industry 4.0 within the textile and apparel sector. Their study aimed to highlight various concepts and examples from the literature regarding the implementation of key principles and technologies such as IoT, cloud computing, Big Data, autonomous robots, 3D printing, augmented reality, virtual prototyping, horizontal and vertical system integration, and cybersecurity [15]. In another research, Arora and Majumdar (2022) presented bibliometric, network, and content analysis on research articles in the field of machine learning and soft computing applications within the textile and clothing supply chain. The study examined publications from 2000 to 2020 to gain insights into the present state and identify potential research areas for the future [16]. Despite these contributions, there is a lack of comprehensive reviews specifically addressing the applications of MCDM techniques in the textile supply chain.

Therefore, recognizing the various applications of MCDM techniques in the textile industry is important due to their ability to enhance decision-making processes, improve operational efficiency, and ensure sustainability throughout the supply chain. This study aims to explore several critical aspects of the supply chain in the textile sector. Specifically, it will address the following research questions:

1. What are the fundamental aspects that underline the significance of the textile industry?
2. What are the key components and functionalities of the supply chain within this sector, and why is it imperative to analyze and understand them?
3. How are decision-making methods applied within the supply chain of textiles, and what are their implications for operational efficiency and strategic planning?
4. How can the management and design of the supply chain be categorized based on decision-making methodologies?
5. What trajectories and considerations should be taken into account for advancing decision-making processes within the supply chain, and what potential avenues exist for future research and development in this domain?

By addressing these questions, this research seeks to provide a comprehensive understanding of the supply chain complexities, enhance decision-making processes, and offer insights into future advancements in the textile industry.

The rest of this paper is formed as follows: Section 2 outlines the methodology employed in conducting the systematic literature review, Section 3 presents the findings related to the research

questions, Section 4 discusses the implications of these findings, and Section 5 concludes the paper with recommendations for future research and practice in the textile supply chain.

2. Methodology

Conducting a literature review is a crucial aspect of every research. It enables the researcher to navigate and evaluate the relevant academic landscape to formulate a research question that contributes to advancing the existing knowledge base [17]. A systematic literature review (SLR) is a comprehensive and structured method of analyzing and integrating current research on a specific topic or research question, showing great potential for examining past literature [18]. This research follows the SLR method to answer the research questions concerning the applications of MCDM methods in the textile industry. The SLR process begins with the formulation of specific research questions designed to achieve the study's objectives. This study aims to highlight the significance of the textile industry, delineate key components and operations within its supply chain, explore the application and effects of various decision-making methods, categorize supply chain management based on these methodologies, and identify potential directions for future research. To this end, a detailed protocol was established, specifying comprehensive search strategies, inclusion and exclusion criteria, data extraction methodologies, and protocols for quality assessment and data synthesis. A thorough search was conducted across multiple academic databases, including Scopus, Web of Science, and Google Scholar, using a combination of targeted keywords and logical operators to retrieve relevant articles. The screening process involved a two-step approach: initially evaluating the titles and abstracts of the search results, followed by a full-text analysis. To guarantee study credibility, a quality assessment was done. It evaluated methodological soundness, research design, data analysis, and findings relevance. Studies meeting the quality threshold were included. Data synthesis involved qualitative and quantitative analysis by grouping studies into themes. Thematic analysis categorized studies by MCDM techniques' impact on supply chain components. This identification highlighted patterns, commonalities, and differences in MCDM techniques across the textile supply chain. Figure 1 provides a visual representation of the detailed protocol.

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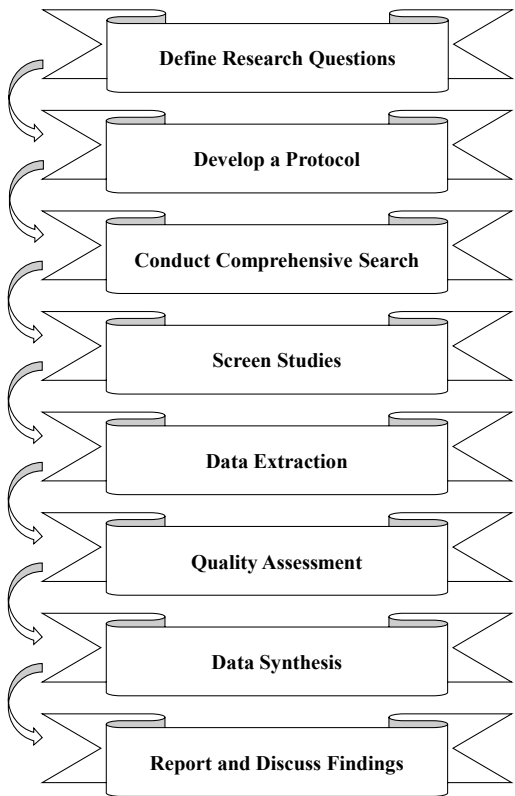
Figure 1. Research methodology based on SLR.

In this review, a collection of published papers on three well-known databases – Google Scholar, Scopus, and Web of Science – was used to capture a wide range of literature. The search strings were crafted by selecting keywords commonly found in the literature and relevant to the review topic. A gradual refinement approach was adopted, starting from broad keywords and gradually moving towards more specific phrases, as described below:

- Scopus: TITLE-ABS-KEY (("MCDM" OR "multiple criteria decision making" OR "multiple criteria decision-making") AND ("textile*") AND ("supply-chain" OR "supply chain")) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English"))
- WoS: ("MCDM" OR "multiple criteria decision making" OR "multiple criteria decision-making") AND ("textile*") AND ("supply-chain" OR "supply chain") (Topic) and Article or Proceeding Paper (Document Types) and English (Languages)

The inclusion criteria for this review encompass journal articles published in English that specifically explore the application of MCDM methods in the textile supply chain, with no restriction on publication year. On the contrary, exclusion criteria involve conference papers and book chapters, as well as studies that do not address the application of MCDM in the textile supply chain or duplicated studies among databases. These criteria were implemented to ensure the selection of high-quality, relevant studies that directly contribute to the analysis of MCDM techniques in the textile supply chain. Figure 2 illustrates the literature review process.
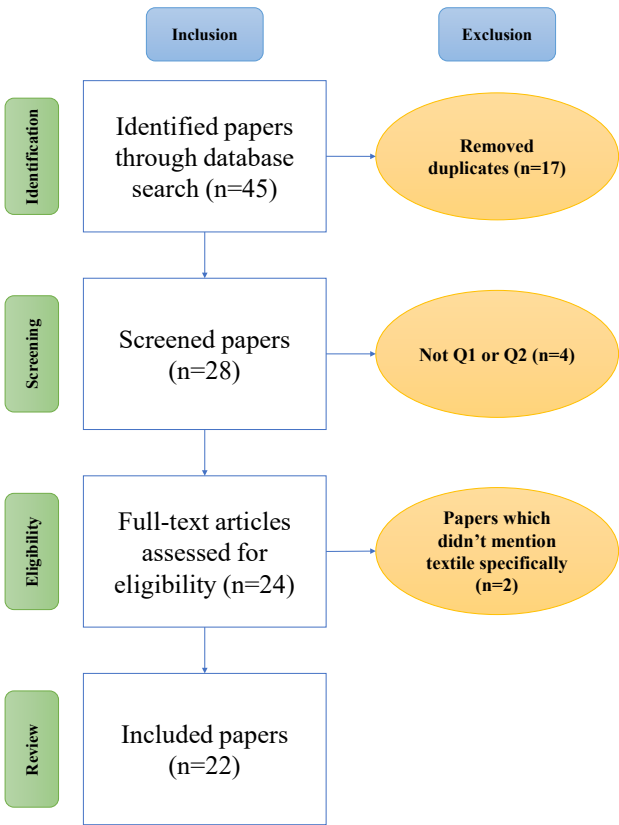

Figure 2. Literature review process.

3. Insights and Analysis

In this section, we delve into the purpose of RQs, which is to explore the fundamental significance of the textile industry. We analyze key components and functionalities of the supply chain, examine decision-making methods and their implications for operational efficiency, and categorize supply chain management approaches based on these methodologies. Each finding aims to provide insights that enhance understanding and inform future advancements within the textile sector.

Table 1. Literature review.

Paper	RQ1				RQ2		RQ3			RQ4		RQ5
	Fundamental Aspects	Textile Industry Significance	Supply Chain Components	Supply Chain Functions	Importance of Analysis	Decision-Making Methods	Implications for Efficiency and Planning	Supply Chain Management and Design Categorization	Advancing Decision-Making Processes	Future Research Avenues		
Guneri et al. 2009 [19]	Integrated Fuzzy and Linear Programming Model for Supplier Selection	Critical for achieving a competitive advantage by selecting optimal suppliers in the textile industry	Supplier selection criteria, decision-making inputs	Supplier evaluation, order assignment	Enhances strategic purchasing through a comprehensive MCDM approach incorporating both tangible and intangible factors	Fuzzy set theory, linear programming	Streamlines the supplier selection process by quantifying criteria and constraints, leading to improved resource allocation	Provides a structured framework for evaluating multiple sourcing options in complex supply chains	Facilitates better relationships between buyers and suppliers through systematic selection methodologies	Encourages further exploration of hybrid approaches combining fuzzy set theory with other decision-making methods to address various operational challenges		

Chithambaranathan et al. 2015 [20]	Performance Analysis Framework for Supply Chains	Essential for optimizing the performance of textile supply chains through effective member evaluation	Supply chain members, performance metrics	Performance analysis, benchmarking, member integration	Crucial for continuous improvement and competitive advantage in supply chains	Fuzzy-TOPSIS, VIKOR	Facilitates systematic performance assessment and improvement strategies, enhancing decision-making	Provides a structured approach for evaluating and comparing supply chain member performance	Supports organizations in achieving synergy among supply chain partners through collaborative performance metrics	Promotes exploration of additional MCDM methodologies and the adaptation of the framework for evaluating environmental performance
Fallahpour et al. 2017 [21]	Supplier evaluation and selection using gene expression programming (GEP)	Vital for enhancing accuracy and efficiency in selecting suppliers in the textile supply chain	Supplier performance criteria, evaluation models	Supplier evaluation, prioritization	Essential for improving decision-making processes in supplier selection	Gene Expression Programming (GEP)	Offers a robust mathematical model to guide supplier performance assessments, reducing evaluation timelines	Positions GEP as a superior alternative to traditional AI methods for supplier selection	Facilitates comprehensive evaluations and simulations for supplier performance enhancement	Encourages incorporation of sustainability criteria and fuzzy data representation in future models, exploring advanced AI methodologies like SA-GP and MGGP

Burney and Ali 2019 [22]	Fuzzy-AHP for Supplier Selection in Textile Industry - Pakistan	Crucial for enhancing supplier evaluation and optimizing procurement in the textile industry	Suppliers, procurement criteria, supply chain management	Supplier evaluation, supplier ranking, contract negotiation	Vital for ensuring cost-effectiveness and quality in sourcing decisions	Fuzzy-AHP	Facilitates improved decision-making under uncertainty, leading to better supplier performance	Addresses complex decision-making scenarios with multiple conflicting criteria in the textile sector	Empowers procurement managers with a structured approach to evaluate and select suppliers	Encourages exploration of alternative fuzzy membership functions and additional criteria for a comprehensive supplier selection framework
Raut et al. 2019 [23]	Barriers to Sustainable Development in T&A Supply Chains	Essential for understanding and overcoming challenges to ensure the sustainability of the textile and apparel sector	Government policies, infrastructure, investment, stakeholder engagement	Supplier evaluation, risk management, policy development	Crucial for enabling sustainable practices in the T&A industry and addressing socio-economic impacts	not mentioned	Aids in identifying and ranking key barriers to sustainable development, enabling targeted interventions	Identifies critical factors influencing sustainability and guides decision-makers in T&A supply chain management	Provides a framework for systematically analyzing interrelationships among barriers to sustainability	Suggests further validation of the ISM model using complementary methods like SEM to enhance robustness and accuracy

Study	Model	Context	Supplier Type	Evaluation	Importance	Methods	Benefit	Integration	Framework	Recommendation
Ulutaş 2019 [24]	Integrated Fuzzy MCDM Model for Supplier Selection	Crucial for improving supplier performance and overall supply chain efficiency in the Turkish textile sector	Fabric suppliers, evaluation criteria	Supplier evaluation, performance ranking	Essential for addressing uncertainties in supplier performance assessments	Fuzzy-AHP, Fuzzy-OCRA	Enhances decision-making accuracy and reduces risks associated with supplier selection	Utilizes fuzzy logic to manage ambiguity in expert evaluations during the supplier selection process	Offers a comprehensive model that integrates multiple fuzzy decision-making techniques for supplier selection	Encourages exploration of Fuzzy OCRA in other MCDM scenarios, such as logistics, warehousing, and machinery selection
Ali et al. 2020 [25]	Fuzzy-AHP-TOPSIS Decision Support System for Supplier Selection	Essential for enhancing supplier selection processes in Pakistan's textile sector, particularly under volatile market conditions	Cotton suppliers, evaluation criteria	Supplier evaluation, procurement, cost management	Vital for improving production efficiency and meeting customer demands in a competitive environment	Fuzzy-AHP, TOPSIS	Optimizes supplier selection, reduces procurement costs, and enhances supply chain efficiency	Integrates fuzzy logic with established decision-making techniques to address complexities in supplier selection	Establishes a novel framework that can guide decision-makers in selecting suppliers effectively	Encourages further research into the applicability of the model across different industries in Pakistan and beyond
Wang et al. 2020 [6]	Supplier Selection Model for the Textile and Garment Industry	Critical for enhancing competitiveness and adapting to market changes in Vietnam's textile sector	Raw material suppliers, evaluation criteria	Supplier evaluation, relationship management, risk reduction	Essential for improving supplier selection dynamics amidst market volatility	Fuzzy-AHP, PROMETHEE II	Aids in decision-making by optimizing supplier selection criteria, enhances overall process efficiency	Integrates qualitative and quantitative criteria for a comprehensive assessment of suppliers	Provides a systematic framework for evaluating suppliers based on multiple criteria, reducing subjectivity in decision-making	Encourages application of the model in other sectors, e.g., finance and construction, promoting cross-industry adaptability

Reference						Method				
Yang and Wang 2020 [26]	Green Innovation Criteria for Sustainable Supply Chain Management	Crucial for the competitive edge and compliance in China's textile manufacturing sector	Suppliers, economic, environmental, and social criteria	Supplier selection, green procurement, innovation implementation	Key to addressing sustainability challenges and enhancing operational efficiency	Fuzzy-AHP, Fuzzy-TOPSIS	Improves selection accuracy of suppliers aligned with sustainability goals, enhances overall supply chain performance	Integrates diverse criteria into decision-making for more sustainable supply chain operations	Implements a novel decision framework to facilitate the adoption of green practices	Suggests exploring additional MCDM methods and criteria across different sectors for comprehensive evaluations
Celik et al. 2021 [27]	Green Supplier Selection in the Textile Industry	Essential for improving environmental performance and compliance in the textile supply chain	Green suppliers, evaluation criteria, sub-criteria	Supplier evaluation, green procurement, risk management	Vital for aligning procurement practices with sustainability goals	BWM with interval type-2 fuzzy numbers (IT2FBWM) interval type-2 fuzzy TODIM (IT2F-TODIM)	Enhances the decision-making process by incorporating uncertainties, improving supplier selection accuracy	Integrates both qualitative and quantitative criteria for a holistic view of green supplier performance	Provides a robust framework for decision-makers, addressing uncertainties in GSS assessments	Encourages application in diverse sectors, such as sustainable material selection and landfill site selection, while improving expert involvement in evaluations

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Wang et al. 2021 [28]	Three-Layer Fuzzy MCDM Approach	Critical for the efficient selection of outsourcing manufacturers in the apparel and textile industry	Outsourcing manufacturers, sustainability criteria, performance metrics	Supplier selection, performance evaluation, risk management	Enhances the accuracy and robustness of supplier evaluations under uncertainty	Fuzzy-AHP, Fuzzy-TOPSIS	Improves supplier selection processes, increases competitiveness, and ensures sustainability in supply chain operations	Combines qualitative and quantitative criteria for comprehensive supplier assessment	Integrates best practices from multiple decision-making frameworks, providing a structured approach for managers	Encourages exploration of heuristic algorithms and simulation techniques to handle uncertainty and evaluate more suppliers in future studies
Ulutaş et al. 2022 [29]	Sustainable Supplier Selection in the Textile Industry	Vital for minimizing environmental impacts and enhancing social responsibility within the textile supply chain	Suppliers, sustainability criteria (economic, environmental, social)	Supplier evaluation, procurement strategies, risk management	Addresses the complexity of selecting sustainable suppliers through a structured decision-making approach	Grey BWM, Grey WISP	Increases transparency in supplier selection, fosters stronger supplier relationships, and ensures compliance with sustainability standards	Categorizing suppliers based on sustainability performance; Strengthening eco-conscious supplier networks	Integrates expert judgments into a robust framework for sustainability assessment, adaptable to various decision-making contexts	Encourages exploration of additional sustainability criteria, application to other industries, and incorporation of objective data for improved accuracy in supplier evaluations

Reference	Title	Importance	Criteria/Parameters	Process	Methods	Benefits	Application	Framework	Future Directions
Bait et al. 2022 [30]	Optimal Foreign Location Selection in Emerging Markets	Crucial for enhancing textiles and clothing sector competitiveness by strategically locating production facilities	Potential host countries, workforce, infrastructure, technology suppliers	Location planning, investment decision-making, risk assessment	Provides a structured approach to evaluate and mitigate risks associated with establishing manufacturing plants in emerging markets	AHP, TOPSIS	Facilitates informed decision-making for investors, minimizes investment risk, and aligns operations with local market conditions	Integration of MCDM models to evaluate emerging markets' suitability for foreign investment	Offers a comprehensive framework for decision-makers to assess country gaps and risks, enhancing overall investment strategies	Encourages future exploration of network analysis methods, local data integration for improved accuracy, and application across diverse manufacturing sectors to identify optimal investment opportunities
Paul et al. 2022 [31]	Integrated Supplier Selection in the Textile Industry	Essential for ensuring timely and cost-effective delivery of raw materials in the textile industry, impacting production efficiency	Suppliers, Raw materials (cotton, yarn, fabric), chemicals, machinery	Supplier evaluation, procurement processes, operational planning	Helps identify optimal suppliers amidst complex, conflicting criteria to ensure seamless production	IRN, BWM, EDAS	Enhances decision-making accuracy and reduces biases, ultimately leading to improved supplier relations and operational effectiveness	Application of MCDM methods in supplier selection; proactive risk management in supply chain	Offers a structured framework for collective decision-making, utilizing expert opinions to refine supplier selection	Encourages exploration of additional MCDM tools and decision support frameworks to handle operational parameter changes and improve solution accuracy in supplier rankings

| Tuş and Aytaç Adali 2022 [32] | Green Supplier Selection in the Textile Industry | Critical for achieving sustainability goals in the textile industry; highlights the importance of environmental considerations in supplier partnerships | Green suppliers, raw materials, production processes | Supplier selection, procurement, sustainability assessments | Green supplier selection significantly impacts both the ecological footprint and overall operational efficiency of textile firms | Fuzzy Stepwise Weight Assessment Ratio Analysis (SWARA-F), Fuzzy Measurement Alternatives, and Ranking according to the COmpromise Solution (MARCOS-F) | Supports cost efficiencies and environmental improvements, leading to enhanced competitiveness in a green economy | Integration of sustainability into supply chain management; fostering environmentally responsible practices | Provides a robust framework for decision-makers to evaluate suppliers based on comprehensive green criteria | Future research can expand criteria applicability, utilize more complex MCDM approaches, and involve diverse industries to generalize findings; explore various fuzzy membership and defuzzification methods to enhance decision-making accuracy |

| Kao 2022 [33] | MCDM Model for Supplier Selection during COVID-19 | Addresses the unique challenges faced by the clothing and textiles industry due to the pandemic, emphasizing stable supplier relationships critical for SCM | Suppliers, manufacturers, resources | Supplier evaluation, selection, logistics | The integration of qualitative and quantitative criteria enhances decision-making in uncertain environments | Fuzzy-TOPSIS, Multisegment Goal Programming (MSGP) | Improved supplier selection processes optimize resource use and enhance competitiveness, especially in volatile market conditions | Sustainable supply chain management; supplier resilience and reliability in crisis scenarios | Provides guidelines for decision-makers, making it easier to adapt supplier selection processes to current challenges | Exploring other MCDM methods and extending applicability beyond C&T to other sectors facing similar challenges; comparisons with existing frameworks for improving supplier selection practices |

Author	Title	Importance	Focus	Application	Description	Method	Results	Benefits	Application	Future research
Caristi et al. 2022 [34]	Supplier Selection in the Textile Industry Amid Global Market Evolution	Enhances competitive advantage by enabling firms to effectively evaluate and select suppliers, which is critical for meeting customer demands and sustainable production	Raw material suppliers, outsourcing partners, logistics	Supplier selection, procurement, performance evaluation	A structured model helps navigate complex supplier evaluations amidst qualitative and quantitative criteria, aligning with customer and environmental needs	Fuzzy-TOPSIS	Improved supplier selection processes lead to reduced costs, enhanced sustainability, improved service quality, and increased customer satisfaction	Sustainable supply chain management; integration of green purchasing practices	Facilitates a practical application of supplier selection criteria in real-world contexts; bridges the gap between theoretical models and industry practices	Further empirical validation of the model across varied contexts; comparative analysis with other MCDM models in the textile sector; expansion of the criteria set based on diverse industry needs
Rahman et al. 2022 [35]	Sustainable Supplier Selection in the Textile Dyeing Industry, Bangladesh	Critical for achieving sustainability in Bangladesh's textile dyeing industry, reducing reliance on harmful chemicals; supporting compliance with environmental standards	Suppliers, chemical inputs, waste management	Supplier selection, performance evaluation, sustainability compliance	Developing a framework for identifying sustainable suppliers enhances decision-making, mitigating environmental toxicity from chemical usage	Stepwise Weight Assessment Ratio Analysis (SWARA), Weighted Aggregated Sum Product Assessment (WASPAS)	A structured approach leads to better supplier choices that align with sustainability goals, improving long-term viability and environmental impact	Sustainable supplier selection; supplier evaluation in chemical-intensive industries	Integration of MCDM methods provides a comprehensive evaluation of supplier sustainability; promotes understanding of multi-criteria considerations	expansion on additional criteria for evaluation, apply the framework to other sectors, and investigate the impacts of sustainability disruptions on supply chain practices

Author/Year	Title									
Wang et al. 2022 [36]	Hybrid MCDM model for Supplier Selection in the Garment Industry, Vietnam	Vital for enhancing supply chain efficiency in Vietnam's textile and garment sector; addresses dependency on foreign raw materials, promoting sustainable local sourcing	Suppliers, raw material sources, production facilities	Supplier evaluation, procurement, performance ranking	Aids decision-makers in navigating complex supplier selection processes under uncertainty, directly impacting operational and financial outcomes	Fuzzy-AHP, TOPSIS	Improved supplier selection processes enhance quality control, reduce procurement costs, and foster stronger supplier relationships; and better alignment with market demands	Supplier selection optimization; enhancement of procurement strategies in textile supply chains	Fostering the integration of fuzzy decision-making methods in supplier selection; promoting better clarity and reliability in complex decision contexts	explore hybrid models with other MCDM methods, conduct comparisons of existing models, and assess supplier performance in post-pandemic scenarios
Ecer and Torkayesh 2024 [37]	Sustainable Circular Supplier Selection (SCSS) framework using stratified fuzzy decision-making, Turkey	Enhances sustainable practices and environmental efficiency in textile production; addresses waste reduction and resource usage	Suppliers, raw materials, end-of-life products	Procurement, production, waste management, reverse logistics	Identifies and prioritizes suppliers based on sustainability and circular economy criteria; considers uncertainty in decisions	Stratified Fuzzy Full Consistency Method (SFUCOM-F) and Mixed Aggregation by Comprehensive Normalization Technique (MACONT-F)	Improved decision-making leads to optimized supplier choices, waste reduction, and enhanced sustainability; circular economy principles integrated into sourcing strategy	Circular supply chain management; sustainable supply chain design	Development of decision support tools that incorporate future uncertainties; integration of economic, social, and environmental aspects in supply chain decisions	Exploration of advanced decision-making tools using machine learning; analysis of larger datasets for improved selection criteria; use of new fuzzy set extensions

Hashim et al. 2024	Supply Chain Reliability (SCR) risk identification and mitigation methodology, Pakistan	Critical for maintaining operational consistency and customer satisfaction in the textile sector; impacts profitability and competitiveness	Supply chain partners, logistics, manufacturing facilities, regulatory frameworks	Risk management, prevention strategies, performance evaluation	Identifying and prioritizing risks to enhance supply reliability and mitigate disruptions, especially in uncertain environments	Fuzzy - FMEA, Fuzzy-AHP, Fuzzy-TOPSIS	Effective risk management strategies lead to improved supply reliability, reduced costs, and minimized disruptions; enhance decision-making under uncertainty	Supply chain risk management (SCRM); crisis management in textile supply chains	Developing comprehensive risk mitigation strategies; enhancing SCR through multi-faceted approaches to risk assessment	Research on inter-relationships between identified risks; applying advanced techniques like ISM, DEMATEL, SWARA, ANP, and VIKOR in risk management; comparative studies across textile supply chains in various economies

Pamucar et al. 2024	Green Supplier Selection Decision Support Tool	Supplier evaluation metrics, green technology, sustainability criteria	Supplier selection, environmental management, compliance assessment	Essential for improving the environmental performance of textile companies and meeting sustainability goals; enhances competitive advantage	Provides a structured approach to selecting environmentally friendly suppliers, incorporating both economic and environmental criteria	Fermatean Fuzzy Preference Selection Index (FF-PSI), Fermatean Fuzzy Combined Compromise Solution (FF-CoCoSo)	Streamlined selection processes for green suppliers lead to cost-effective and sustainable operational practices; support strategic sourcing decisions aligning with environmental goals	Green supply chain management; environmentally conscious supplier selection	Integration of fuzzy logic into MCDM tools for more effective decision-making in supplier selection; addressing complexities in evaluating environmental and economic factors	Future studies can expand on integrating social criteria into supplier evaluations; incorporate objective data collection methods; explore applications of FF methods in various industries like health, agriculture, and logistics

3.1. Fundamental Importance of the Textile Industry

The textile industry is a vital component of the global economy, influencing various sectors and providing millions of jobs worldwide. It serves as one of the largest manufacturing industries, with significant implications for economic development, trade, and environmental sustainability. As consumer demands shift and sustainability becomes increasingly important, understanding the fundamental aspects that underpin the significance of the textile industry is crucial for stakeholders aiming to foster innovation and sustainable practices.

RQ1. *What are the fundamental aspects that underline the significance of the textile industry?*

This research question was chosen due to the textile industry's critical role in global economies and its environmental implications. By delving into the literature on this topic, we seek to uncover the key themes that not only affirm the industry's importance but also highlight areas for improvement and innovation. Understanding these fundamental aspects is essential, as it can guide stakeholders in making informed decisions that enhance sustainability, efficiency, and overall competitive advantage in the textile sector.

Based on the literature review, several fundamental aspects underline the significance of the textile industry. A recurring theme across multiple papers is the critical role of supplier selection and evaluation in enhancing competitive advantage and supply chain efficiency. For instance, Guneri et al. (2009) emphasize the importance of selecting optimal suppliers for achieving competitive advantage, while Burney and Ali (2019) and Ali et al. (2020) focus on enhancing procurement

processes through effective supplier evaluation. Many studies underscore the significance of sustainability within the textile industry, with Raut et al. (2019) and Ulutaş et al. (2022) discussing the need to overcome barriers to sustainable development and minimize environmental impacts. Papers by Yang and Wang (2020) and Celik et al. (2021) highlight the importance of green innovation and compliance with environmental standards as critical factors for maintaining competitiveness. Optimizing supply chain performance is a fundamental aspect noted in the literature, as emphasized by Chithambaranathan et al. (2015) and Wang et al. (2022), directly impacting production effectiveness and operational consistency. The ability to adapt to changing market conditions is also highlighted as essential for maintaining competitiveness, with Wang et al. (2020) and Caristi et al. (2022) noting that effective supplier evaluation and selection enable firms to meet customer demands and respond to global market evolution. Additionally, Bait et al. (2022) discuss the importance of optimal foreign location selection, enhancing competitiveness in the textile and clothing sector by strategically positioning production facilities. The impact of external factors, such as the COVID-19 pandemic, is addressed by Kao (2022), emphasizing the need for stable supplier relationships to navigate challenges and maintain supply chain reliability, which is critical for profitability and competitiveness. Finally, the integration of innovative approaches, such as fuzzy decision-making models for supplier selection (Ecer and Torkayesh, 2024), highlights the significance of technology in enhancing operational practices and improving decision-making processes within the textile industry. Collectively, these aspects contribute to the industry's resilience and ability to meet both market demands and sustainability goals.

Figure 3 presents a word cloud that encapsulates the key themes and concepts prevalent in the study of the textile supply chain. The varying sizes of the words indicate their relative importance and frequency within the research context, with larger words signifying greater significance. The prominence of terms like "Supplier Selection" and "Sustainable" suggests a strong emphasis on choosing the right suppliers and adopting sustainable practices. Additionally, the frequent appearance of words such as "Fuzzy" and "MCDM" indicates the use of advanced decision-making methodologies in the reviewed literature.

Figure 3. Word cloud of fundamental aspects.

3.2. Key Components of the Textile Supply Chain

Investigating the key components of the textile supply chain is essential for understanding how various elements interact to drive efficiency, sustainability, and innovation within the industry. By identifying and analyzing these components, organizations can optimize their operations, reduce costs, and enhance their competitive edge. Additionally, a thorough understanding of the supply

chain's key components helps in addressing environmental and social challenges, ensuring that the industry aligns with global sustainability goals.

RQ2. *What are the key components and functionalities of the supply chain within the textile sector, and why is it imperative to analyze and understand them?*

This research question is particularly relevant given the increasing complexity of textile supply chains, which are influenced by global market dynamics, sustainability demands, and technological advancements. Understanding these components is critical for organizations aiming to improve efficiency, reduce costs, and foster sustainable practices. By examining the literature on this topic, we expect to gain insights into the interconnectedness of various supply chain elements and their respective functions. This analysis will not only highlight the importance of strategic supplier selection and performance evaluation but also elucidate how these practices can lead to competitive advantage in a rapidly changing environment. Additionally, we aim to uncover the implications of external factors, such as regulatory frameworks and performance metrics, on the overall functioning of the supply chain in the textile industry. The reviewed literature presents a diverse range of insights that highlight the complexity and interconnectivity of various elements within this sector. The primary components of the textile supply chain identified in the reviewed papers are suppliers at various stages, including raw material suppliers (cotton, yarn, fabric, chemicals), as well as manufacturing partners and logistics providers. These components encompass different supplier selection criteria, such as performance metrics, sustainability criteria (economic, environmental, social), and specific procurement requirements. This multifaceted structure emphasizes how essential different types of suppliers (such as green suppliers and outsourcing manufacturers) are for ensuring a comprehensive and effective supply chain. The functionality of these components is geared towards crucial processes such as supplier evaluation, performance analysis, procurement, and risk management. Many studies underscore functions like decision-making inputs in supplier selection, performance benchmarking, and integrating sustainable practices. For instance, supplier evaluation not only aids in better procurement processes but also enhances overall operational efficiency and effectiveness.

Understanding the importance of analyzing these components and functionalities is crucial for several reasons. Firstly, it enables firms to develop strategic purchasing practices by incorporating both quantitative and qualitative criteria, which are vital for maintaining a competitive advantage. Performance analysis is essential for continuous improvement and fostering innovation within supply chains, allowing companies to benchmark their performance and integrate key metrics effectively. Additionally, the synthesis of sustainability challenges in supplier selection processes is pivotal in addressing environmental impacts and aligning with corporate social responsibility goals. Moreover, insights into government policies, industry infrastructure, and stakeholder engagement illuminate how external factors influence the textile supply chain's dynamics. A comprehensive evaluation of these elements can guide firms in making informed decisions that align with market volatility and regulatory requirements, thereby facilitating risk management and sustainable growth.

3.3. Decision-Making in Textile Supply Chains

Effective decision-making is vital in textile supply chains, as it directly affects operational efficiency, cost management, and overall competitiveness. The rapidly evolving landscape of the textile industry, characterized by demands for sustainability and adaptability, necessitates robust decision-making frameworks. Identifying the most commonly used methods in this area allows organizations to better navigate complexities, streamline processes, and enhance supplier relationships. By concentrating on these decision-making methods, companies can optimize their supply chain strategies, balance trade-offs, and improve responsiveness to market dynamics.

RQ3: *How are decision-making methods applied within the supply chain of textiles, and what are their implications for operational efficiency and strategic planning?*

This research question is pivotal as decision-making methods directly influence both the efficiency of operations and the strategic direction of organizations in the textile sector. Understanding how these methods are applied not only sheds light on current practices but also guides future improvements in decision-making processes. By delving into the literature, we expect to identify effective methodologies that can enhance supplier selection, resource allocation, and overall supply chain performance, ultimately contributing to more sustainable and competitive practices within the industry.

In the textile supply chain domain, decision-making methods play a crucial role in enhancing operational efficiency and facilitating strategic planning. The diverse methodologies employed across various studies reflect a trend toward leveraging advanced analytical techniques to optimize critical supply chain decisions. A significant number of papers (Guneri et al., Ali et al., Wang et al.) illustrate the application of fuzzy set theory and MCDM methods such as AHP (Analytic Hierarchy Process), TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), and VIKOR. These approaches aid in quantifying and prioritizing supplier selection criteria, leading to improved resource allocation, reduced procurement costs, and enhanced supply chain efficiency. For instance, Guneri et al. emphasized that fuzzy set theory and linear programming streamline the supplier selection process, thereby optimizing resource allocation. Similarly, Ali et al. showcased how fuzzy AHP and TOPSIS improve supplier selection, which not only reduces costs but also enhances operational efficiency. Furthermore, the integration of models like the Supply Chain Operations Reference (SCOR) framework (Wang et al., Caristi et al.) provides a systematic approach to evaluating and improving supply chain performance. The SCOR model, combined with fuzzy methodologies, assists organizations in optimizing supplier selection criteria and enhancing overall process efficiency. This integration reflects a growing recognition of the importance of structured frameworks for strategic planning within supply chains. Moreover, integrating models like the Supply Chain Operations Reference (SCOR) framework (Wang et al., Caristi et al.) offers a systematic approach to evaluating and improving supply chain performance. The SCOR model, combined with fuzzy methodologies, helps organizations optimize supplier selection criteria and enhance overall process efficiency. This integration reflects a growing recognition of the importance of structured frameworks for strategic planning within supply chains. Additionally, the refined decision-making capabilities provided by Gene Expression Programming (Fallahpour et al.) and interval type-2 fuzzy methodologies (Celik et al.) demonstrate a move toward more sophisticated analytical models that can effectively manage uncertainties in supplier assessments, ultimately reducing evaluation timelines. The implications of these methodologies extend to fostering stronger supplier relationships and ensuring compliance with sustainability standards, as highlighted by Ulutaş et al. and Paul et al. In terms of efficiency, methods like the Best-Worst Method (BWM) and its adaptations (as evidenced in papers by Celik et al. and Rahman et al.) reveal how incorporating uncertainties enhances decision-making processes. These methodologies not only improve supplier selection accuracy but also facilitate targeted interventions to address barriers to sustainable development, which Raut et al. identified through their use of Interpretive Structural Modeling.

Overall, the application of progressive decision-making methods within the textile supply chain landscape underscores their role in supporting informed strategic sourcing decisions and improving operational outcomes. As demonstrated across the literature, these methods provide critical insights that align supplier capabilities with market demands while fostering sustainability and efficiency, thus reinforcing the strategic planning capabilities of organizations within the textile industry.

Figure 4 presents a bar chart comparing the counts of different methods. The "Fuzzy-AHP" method has the highest count, reaching 8, indicating its predominant use. Following this, the "Fuzzy-TOPSIS" method shows a count of 6, making it the second most utilized method, while the "TOPSIS" method has a count of 3. This distribution suggests a preference for the "Fuzzy-AHP" and "Fuzzy-TOPSIS" methods over the others in the reviewed literature.
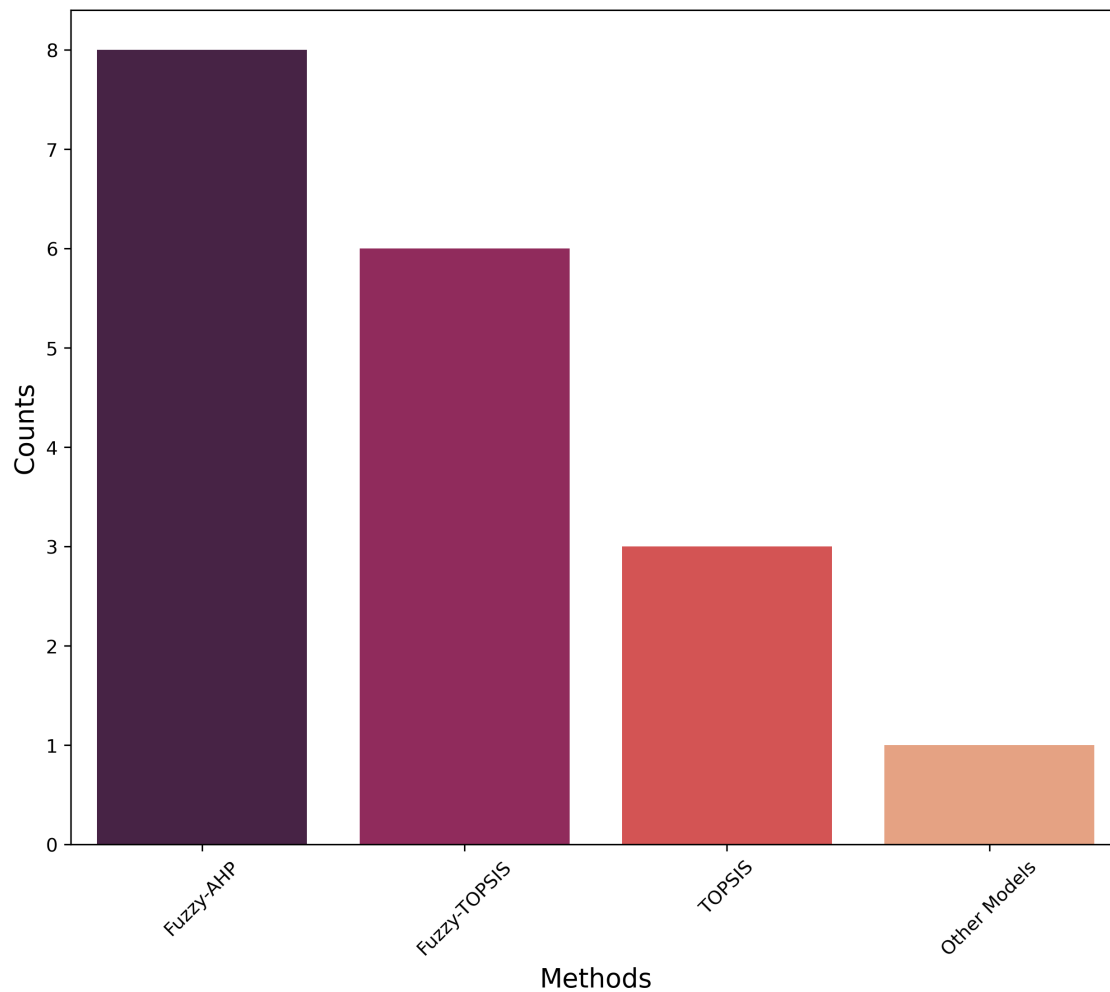
Figure 4. Bar chart of MCDM models usage.

3.4. Categorizing Supply Chain Management Approaches

Categorizing SCM approaches is essential for optimizing organizational operations. By examining various decision-making methodologies, we can better understand the frameworks and tools available for effective SCM. These methodologies not only aid in structuring complex decision processes but also enhance the ability to respond to dynamic market conditions and uncertainties. This categorization highlights the importance of aligning decision-making techniques with supply chain objectives, ensuring organizations are equipped to navigate challenges in a competitive environment.

RQ4. *How can the management and design of the supply chain be categorized based on decision-making methodologies* ?

In categorizing the management and design of the supply chain based on decision-making methodologies, various approaches highlighted in the literature review papers were identified. The categorization can be primarily divided into three distinct methodologies: traditional decision-making frameworks, MCDM models, and integrated fuzzy logic approaches.

- Traditional Decision-Making Frameworks: Some papers emphasize structured frameworks and methodologies that focus on evaluating and comparing various options in the supply chain. For instance, Guneri et al. provide a structured framework for evaluating multiple sourcing options in complex supply chains, while Chithambaranathan et al. focus on the structured evaluation of supply chain member performance. These approaches gather performance-related data to

facilitate informed decision-making, particularly in environments characterized by complexity and conflicting criteria, as discussed by Burney and Ali.

- MCDM Models: A significant number of studies employ MCDM models to assess multiple factors involved in supply chain decisions. For example, Bait et al. analyze the suitability of emerging markets for foreign investment using MCDM approaches, and Paul et al. implement these methods in supplier selection while addressing proactive risk management. Furthermore, various studies combine qualitative and quantitative criteria for a more comprehensive assessment. Both Wang et al. and Celik et al. demonstrate this integration, focusing on supplier performance and sustainability, respectively. These MCDM approaches enable decision-makers to handle multiple conflicting criteria, which is essential in today's complex supply chain environments.

- Integrated Fuzzy Logic Approaches: Several papers adopt fuzzy logic to better manage uncertainties in supply chain decision-making. Ulutaş utilizes fuzzy logic to navigate ambiguity in expert evaluations during supplier selection, while Ali et al. integrate fuzzy logic with established decision-making techniques to address supplier selection complexities. This methodology helps in making more robust decisions where ambiguity and vagueness are prevalent, particularly in sectors requiring sustainability considerations, as noted in the papers by Raut et al. and Tuş and Aytaç Adali.

Overall, the categorization of supply chain management approaches, based on decision-making methodologies, reveals a diverse landscape of frameworks ranging from structured evaluations to advanced multi-criteria and fuzzy logic techniques. This variety reflects the complexities and dynamic nature of today's supply chains, enabling organizations to make informed and strategic decisions crucial for efficiency, sustainability, and competitive advantage.

3.5. Future Directions in Supply Chain Decision-Making

Future research and development in supply chain decision-making are crucial for adapting to an increasingly complex and dynamic global landscape. As supply chains face challenges such as rapid technological advancements, shifting consumer preferences, and environmental sustainability pressures, exploring innovative decision-making frameworks will be pivotal. This will not only enhance operational resilience but also improve competitive advantage by enabling organizations to respond swiftly to market changes. Moreover, prioritizing future research avenues will facilitate the identification of best practices and eliminate inefficiencies, ultimately contributing to a more sustainable and agile supply chain ecosystem.

RQ5. *What trajectories and considerations should be taken into account for advancing decision-making processes within the supply chain, and what potential avenues exist for future research and development in this domain?*

To advance decision-making processes within the supply chain, several interrelated trajectories and considerations emerge from the literature. A key focus is enhancing collaborative frameworks, as highlighted by Guneri et al. and Chithambaranathan et al., who underscore the significance of systematic selection methodologies and collaborative performance metrics. Such approaches can significantly improve supplier-buyer relationships and foster synergy among supply chain partners. Additionally, the integration of sustainability criteria into decision-making frameworks is vital, as seen in the works of Fallahpour et al. and Ulutaş et al. This integration not only enhances performance evaluations but also enables adaptation to a more environmentally conscious market. The exploration of advanced AI methodologies, like SA-GP and MGGP, further bolsters the robustness of these decision-making processes. The literature also highlights the need for comprehensive assessments that consider varying criteria across different contexts. Other studies, such as those by Ali et al. and Wang et al., advocate for systematic MCDM frameworks to minimize subjectivity in supplier evaluations, suggesting that future research should extend these models to diverse industries for greater adaptability and relevance. Furthermore, embracing expert judgments and hybrid

approaches that combine different MCDM methods, as recommended by Ulutaş et al. and Wang et al. (2024), can address the complexities of supply chain environments, leading to more reliable decision outcomes. This reflects a growing trend toward integrating subjective and objective data to enhance the accuracy and applicability of decision-support frameworks. Future research should also focus on the application of new fuzzy set extensions and machine learning to improve decision-making criteria, as highlighted by Ecer, Torkayesh, and Pamucar et al. Emphasizing larger datasets and advanced analytics will pave the way for innovative decision-support tools that are adaptable to future uncertainties, further solidifying the role of technology in decision-making.

Figure 5 presents a roadmap for advancing decision-making frameworks, highlighting five key areas: Hybrid Approaches, Sustainability Evaluation, Data Representation, Cross-Industry Applications, and Validation Research. Each area focuses on integrating decision models, enhancing sustainability, developing data techniques, exploring cross-industry applications, and validating frameworks to improve decision-making across various sectors, ensuring adaptability and efficiency.
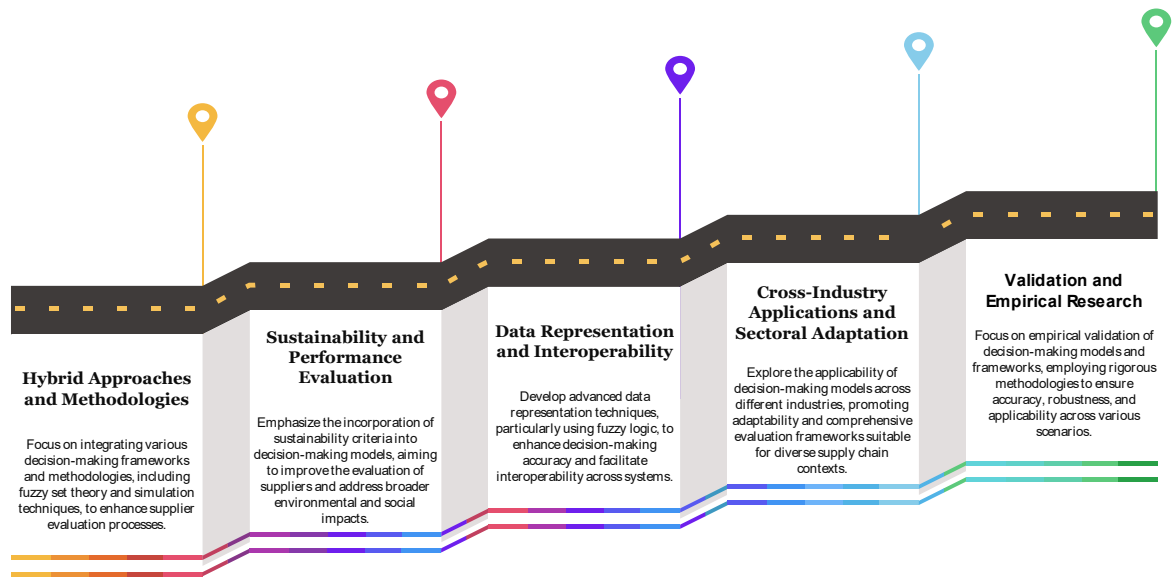

Figure 5. Roadmap of future avenues.

4. Discussion

The findings of this research underscore the intricate dynamics of decision-making processes within the textile supply chain, highlighting the critical role of MCDM methods in enhancing operational efficiency and sustainability. The literature reveals a consensus on the importance of supplier selection and evaluation as pivotal elements that influence competitive advantage and overall supply chain performance. The integration of advanced methodologies, such as fuzzy set theory and various MCDM techniques, has emerged as a significant trend, enabling organizations to navigate the complexities of supplier assessments effectively. Moreover, the emphasis on sustainability within the textile industry reflects a growing awareness of environmental impacts and the necessity for green practices. The incorporation of sustainability criteria into decision-making frameworks is not merely a trend but a fundamental requirement for organizations aiming to thrive in an increasingly eco-conscious market. The exploration of collaborative frameworks and the integration of artificial intelligence methodologies further enhance the robustness of decision-making processes, fostering stronger relationships among supply chain partners. The diverse methodologies employed across studies indicate a shift towards more sophisticated analytical models that can manage uncertainties and improve decision outcomes. However, there remains a need for

comprehensive assessments that consider varying criteria across different contexts. Future research should focus on extending MCDM frameworks to diverse industries, thereby enhancing their adaptability and relevance. Additionally, the integration of subjective and objective data through hybrid approaches can lead to more reliable decision outcomes, addressing the complexities inherent in supply chain environments.

5. Conclusions

The textile industry faces significant challenges in optimizing its supply chain management, particularly in the context of globalization, sustainability, and technological advancements. Effective decision-making processes within this sector are crucial, as they directly impact operational efficiency, competitive advantage, and environmental sustainability. As organizations strive to navigate these complexities, the need for robust frameworks that facilitate supplier selection and evaluation becomes increasingly critical. This research aimed to explore the applications of Multi-Criteria Decision-Making (MCDM) methods within the textile supply chain, focusing on enhancing decision-making processes and identifying future research avenues. By conducting a systematic literature review, the study sought to delineate key components of the supply chain, assess the significance of various decision-making methodologies, and highlight potential directions for future exploration. The significance of this research lies in its contributions to understanding the intricate dynamics of the textile supply chain and the role of MCDM techniques in fostering sustainable practices.

The findings reveal that effective supplier selection and evaluation are paramount for enhancing competitive advantage and operational performance. Furthermore, integrating sustainability criteria into decision-making frameworks is essential for organizations aiming to adapt to an environmentally conscious market. The exploration of advanced methodologies, such as fuzzy logic and artificial intelligence, underscores the potential for improved decision outcomes and stronger supplier-buyer relationships. Key findings indicate that the textile industry must prioritize sustainability and innovation in its supply chain practices. The literature emphasizes the importance of collaborative frameworks and the need for comprehensive assessments that consider varying criteria across different contexts. Additionally, integrating subjective and objective data through hybrid approaches can enhance the reliability of decision-making processes. The implications for practice and policy are significant. Organizations in the textile sector should adopt MCDM techniques to optimize supplier selection and evaluation, thereby improving operational efficiency and sustainability. Policymakers should encourage the adoption of sustainable practices within the industry, facilitating the development of frameworks that support environmental considerations in decision-making.

However, this research acknowledges certain limitations. These include the potential for publication bias in the reviewed literature, the focus on specific MCDM methods that may not encompass the full spectrum of available techniques, and the limited geographical scope of the studies reviewed, which may not reflect global practices. Additionally, the dynamic nature of the textile industry means that findings may quickly become outdated as new technologies and practices emerge. Future research should aim to address these limitations by exploring a broader range of methodologies and extending the applicability of MCDM techniques across diverse industries. Additionally, further studies could investigate the integration of emerging technologies, such as IoT for real-time data collection, advanced simulation techniques, machine learning, and big data analytics, to enhance decision-making frameworks in the textile supply chain.

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