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A Systematic Literature Review of Multi-Criteria Decision-Making Applications within Food Supply Chains using the TCM-ADO Framework

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Abstract
Multi-Criteria Decision Making (MCDM) models are valuable tools for addressing complex decision-making within multiple domains of supply chain management. Considering the complex and uncertain environments that Food Supply Chains (FSCs) operate in, MCDM applications are crucial for optimizing FSC performance across multiple dimensions. Consequently, several research studies focused on the application of MCDM methods within FSCs, with a few focusing on reviewing the literature. However, the literature studies till date revolved around a particular type of FSC or towards enhancing specific FSC capabilities. Besides, no review has used innovative frameworks – such as TCM-ADO, TCCM, 5W+H, etc. to synthesize the existing literature. Hence, this article uses Theories-Contexts-Methods-Antecedents-Decisions-Outcomes (TCM-ADO) framework to enhance the scope of the review. This framework for research synthesis stands unique in comparison with the regular systematic reviews, as it covers holistic synthesis of literature through handling both fronts of research aspects i.e., "what (content)" and "how (methodology)'. The results and findings highlight concentration of studies: a) within specific contexts (agri-food chains-31%, generic-food chains-30%, etc.), b) addressing specific capabilities (sustainability-28%), and c) additionally reveal a research gap in developing unique, hybrid MCDM models to address other contexts (cold chains, perishable food chains etc.) and other capabilities (food quality, food safety, food security, etc.).

Keywords- MCDM, FSCs, Systematic literature review, TCM-ADO framework.

1. Introduction
Multi-Criteria Decision-Making (MCDM) relates to a special category of operations research methods concerned with the design of computational and mathematical tools to support decision makers with the subjective evaluation of performance criteria. The MCDM techniques stand significant with regards to enhancing the decision-making environment through a structured, comprehensive, and inclusive approach. Thus, enabling the decision maker to involve multiple criteria, objectives, and stakeholder perspectives. Furthermore, the methods enable informed choices, enhance decision-making transparency, and promote optimal decision outcomes within complex and uncertain decision environments (Sahoo & Goswami, 2023). Alternatively, MCDM methods stand applicable within the supply chain domain, as Supply Chain Management (SCM) decisions (strategic & tactical) are made with due consideration for conflicting criteria such as maximizing profits/customer satisfaction while minimizing the risks and involving inputs from various SC functions/multiple SC actors involved within the decision process (Khan et al., 2018).

Further, a Food Supply Chain (FSC) is a unique type of supply chain that includes the following activities: distribution, transportation, retailing, handling, storage, processing, and packaging of raw food supplies

(Haessner et al., 2024). Based on the kinds of food they carry (fruits, vegetables, dairy, staple foods, organic produce, meat, poultry, seafood, etc.) and the types of food they carry (fresh, frozen, refrigerated, and ambient), each FSC is distinct from the others (Angarita-Zapata et al., 2021). **Figure 1** portrays the major activities within an FSC (Tzounis et al., 2017).

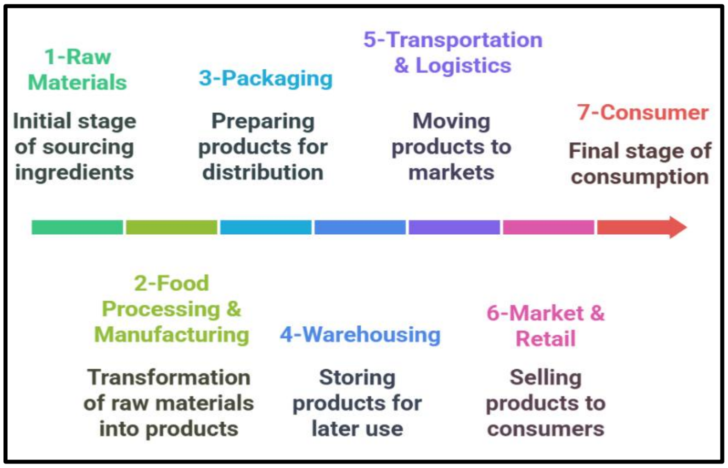

Figure 1. Food supply chain.

FSCs can also be categorized as frozen, chilled, and ambient depending on the mode of handling the food product in relation to temperature control, storage, distribution technologies, and packaging materials employed to withhold the freshness of the product (Amit et al., 2017). Equally, food plays a significant role in human life and acts as an instrumental tool for good health and survival (Arshad et al., 2021). Besides, FSCs are growing rapidly to satisfy the increasing demand for food across the globe (Abideen et al., 2021). With the global population's expected growth to 9.7 billion by 2050, the global food demand is also expected to increase by 56% in 2050 compared to the demand in the year 2010, calling out for an increase of 70% in food availability (van Dijk et al., 2021). In addition, the deployment of refrigerated assets for storing, transporting, and preserving food across the globe to address food loss, significantly impacts the environment, due to usage of high GWP (Global Warming Potential) refrigerants within the refrigeration systems employed, and higher emissions due to the fossil-fuel burning within frozen and chilled chains in comparison to ambient chains (Kumar et al., 2023c).

1.1 Research Gap

With due consideration of the complex and uncertain decision environments portrayed by the FSCs (Li & Song, 2022), the MCDM applications for decision-making within FSCs stand crucial towards delivering economical and healthy food to consumers across the globe (Lu et al., 2021; Singh et al., 2018a), by simultaneously accommodating conflicting objectives within the decision-making scenarios. In consequence, several studies were conducted by scholars worldwide, with a particular emphasis on adopting MCDM techniques in FSCs. A couple of these studies also included a review of the literature on MCDM applications within FSCs. However, the review concentration was centred on certain types of FSCs, or on improving specific FSC capabilities, hence their total scope was quite restricted. Accordingly, scope of the review can be expanded to discover MCDM applications in various contexts throughout FSCs and to emphasise applications that address performance enhancement across numerous dimensions within FSCs.

Additionally, the methodology employed within the review studies till date lacked novelty, as they did not include innovative frameworks for research synthesis such as TCM-ADO (Theories-Contexts-Methods-Antecedents-Decisions-Outcomes), TCCM (Theories, Contexts, Characteristics, Methods), 5W+1H (Who, What, Where, When, Why, How), IMO (Input-Mediators-Outcomes), ADO (Antecedents-Decisions-Outcomes), etc. Catering to this research gap, the current study aims at conducting a systematic literature review of MCDM applications within FSCs using the TCM-ADO Framework, providing a more structured approach of reviewing existing literature through integration of theoretical, contextual, and methodological insights and consequently through analysis of antecedents, decisions, and outcomes of previous studies undertaken in this regard. Likewise, the study methodology stands highly influential and distinct from conventional systematic reviews, since it brings together a comprehensive synthesis of the literature by addressing both the "what (content)" and "how (methodology)" aspects of the research. (**Table 1** below, details the scope and focus of previous review studies undertaken along with the time frame of the review).

Table 1. Review papers on MCDM applications within FSCs- till date.

Sr. No.	Article title	Authors	Scope & focus of the review	Time frame	No. of articles reviewed
1.	Life cycle tools combined with multi-criteria and participatory methods for agricultural sustainability: insights from a systematic and critical review.	De Luca et al. (2017)	Sustainability within Agri-Food Chains	2007-2016	32
2.	Multi-criteria decision and multivariate statistical approaches improve olive supply chains: a review.	Kumar (2017)	Olive oil supply chains	2000-2015	63
3.	Diversity and potentiality of multi-criteria decision analysis methods for agri-food research.	Gésan-Guiziou et al. (2020)	Agri-food chains	2007-2017	954
4.	Methods and approaches of decision support system for coconut agroindustry development and down-streaming: a systematic literature review and future agenda.	Wardah et al. (2020)	Coconut-agroindustry	2000-2018	146
5.	Bibliometric analysis for sustainable food waste using multicriteria decision.	Priyambada et al. (2023)	Sustainable food waste management	2014-2023	146
6.	Integrating multi-criteria techniques in life-cycle tools for the circular bioeconomy transition of agri-food waste biomass: a systematic review.	Romero-Perdomo & González-Curbelo (2023)	Agri-food waste management	-	23

1.2 Research Objectives

The research study stands unique in comparison to review studies undertaken till date, as it aims at delivering three major contributions to the existing literature on FSCs. Firstly, the study offers an updated assessment of the use of MCDM models within different types of food chains to address diverse FSC challenges within a single article through deployment of the TCM-ADO framework to holistically review 165 Scopus Q1 articles published between 2014-2024, which sets it apart from the review publications mentioned above. Besides, it identifies unique hybrid MCDM models that are tailored to handle specific challenges within specific FSCs. Finally, it highlights the limitations within the existing FSC research works and proposes future research directives based on the gaps identified.

The subsequent sections of this review paper are organized as follows. The research methodology used to carry out the literature review is presented within Section 2. The study findings derived from the evaluated literature are highlighted in Section 3 using the TCM-ADO framework. Finally, conclusions and recommendations for future research are outlined within Section 4.

2. Research Methodology

The management of the wide spectrum of knowledge sources within a particular field of study is facilitated by a systematic literature review (SLR) procedure. Further, the researcher might use SLR to map out and assess the key scientific results in the area of interest. Additionally, by conducting a thorough and impartial search and synthesising the fragmented literature in the subject of research in a systematic, transparent, and reproducible way, the SLR enhances the quality of the review process (Tranfield et al., 2003). The three steps employed for the current review process included "Sourcing", "Screening" and "Synthesis". Additionally, the study adapted the TCM-ADO framework for in-depth article analysis.

2.1 Sourcing

A search was conducted towards identifying all the potential sources of publications addressing MCDM applications within FSCs. In order to carry out the search, a list of initial keywords had been derived from relevant prior literature review studies (Gésan-Guiziou et al., 2020; Priyambada et al., 2023; Romero-Perdomo & González-Curbelo, 2023; Wardah et al., 2020). Pilot searches were utilised to further refine the initial list of keywords to align with the study's focus. Following that, the below query string was created using the final keyword list.

("MCDM" OR "MADM" OR "MODM" OR "MCDA") AND ("Food Supply Chain" OR "Cold Chain" OR "Perishable Foods" OR "Agri-Food")

The search was carried out using the keywords, abstract, and title of the publications from the Scopus database, which is one of the biggest index and citation databases with extensive coverage of books, conference proceedings, and highly qualified scientific journals (Baas et al., 2020). The search was restricted to publications from 2014 to 2024 and usage of "English- language" for publication.

2.2 Screening

A total of 3005 documents that fit the search criteria were found during the search procedure. Initially, the search results were filtered to remove duplicate records, because few of the keyword combinations might result in duplication of articles. After duplicates were removed, 3000 records were left for additional screening. The initial screening of the articles was based on the inclusion criteria specified within the **Table 2** below. Consequently, the references within the chosen papers were additionally scanned in order to find pertinent publications for the review that the search process had missed. Followed by further screening to examine the content within the titles and abstracts, towards weeding out any records that did not meet the exclusion criteria specified within **Table 2** below. Finally, the articles' contents were thoroughly inspected, in order to further filter out any extraneous ones. In the end, the systematic search and screening processes, resulted in the selection of 165 articles for extensive analysis. The following **Figure 2** provides a summary of the article selection and screening process.

Table 2. Inclusion and exclusion criteria for screening.

Inclusion criteria	Exclusion criteria
All the articles that were ranked as Scopus Q1 (Only 219 out of 3000).	All the articles addressing MCDM applications within Supply Chains other than "Food" (35 out of 230).
	Articles addressing Food Chains without the deployment of MCDM models (14 out of 230).
	Articles with a primary focus on formulation of optimization models rather than decision making models (7 out of 230).
	Articles concentrating on pre-harvesting stages (5 out of 230).

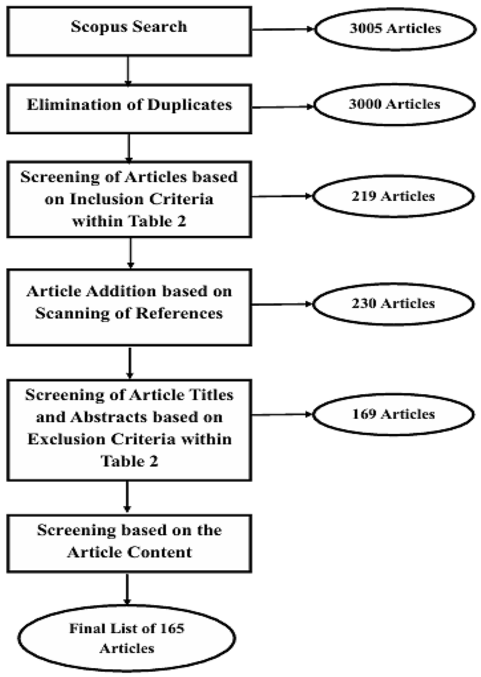

Figure 2. Article selection and screening process.

2.3 Synthesis (Descriptive Analysis)

The selected articles were then analysed to deduce patterns with regards to the year of publication, type of journal indexing, kinds of food supply chains explored, and supply chain attributes addressed. Consequently, the distribution of articles by year of publication in **Figure 3** below illustrates the steady acceleration in the publication of scientific papers. Likewise, **Figure 4** below demonstrates the article distribution based on the type of journal indexing- indicating the credibility of articles selected for the review. Additionally, **Figure 5** below portrays the distribution of articles based on the kind of FSCs explored, highlighting a predominant focus on generic-food chains and agri-food chains. Similarly, the distribution of articles by the supply chain attributes addressed within **Figure 6** below, reflects the notable emphasis on enhancing the sustainability features within the FSCs.

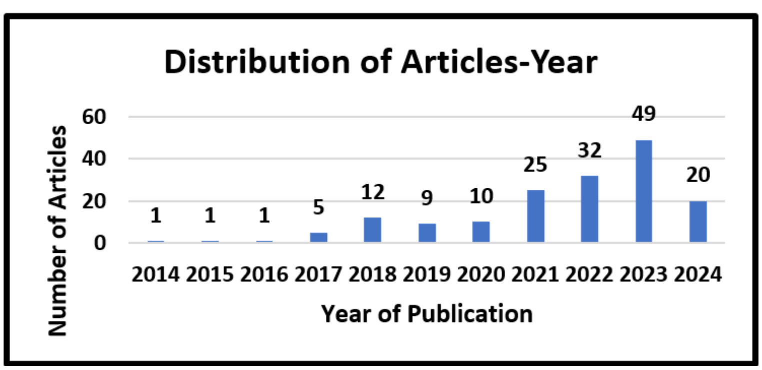

Figure 3. Distribution of articles by the year of publication.

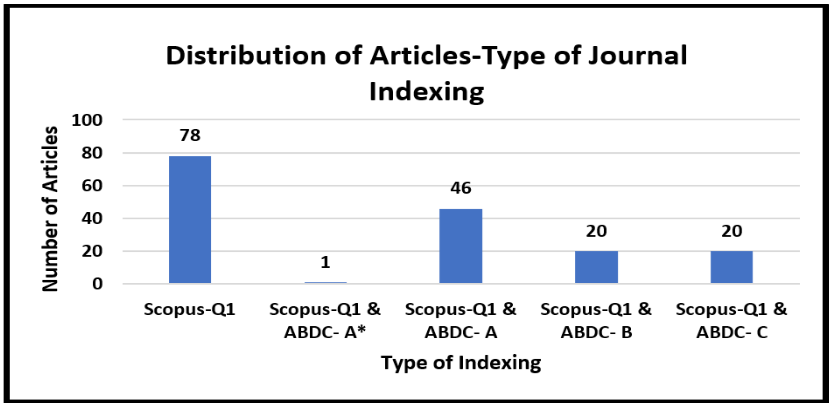

Figure 4. Distribution of articles by the type of journal indexing.

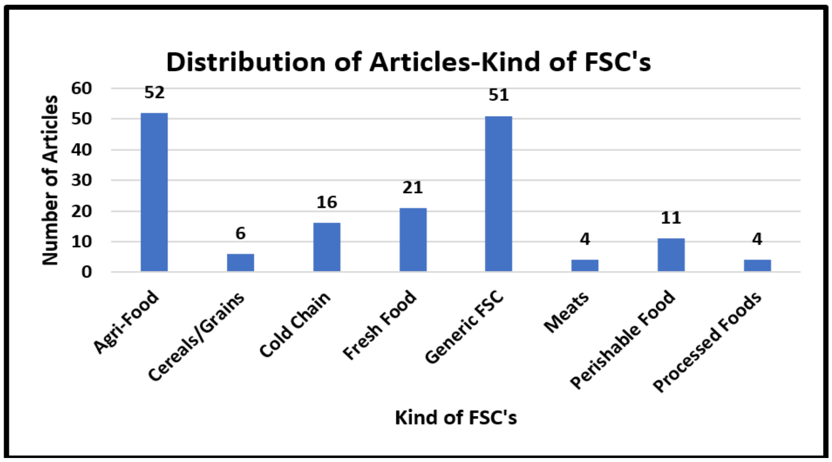

Figure 5. Distribution of articles by the kind of food chains explored.

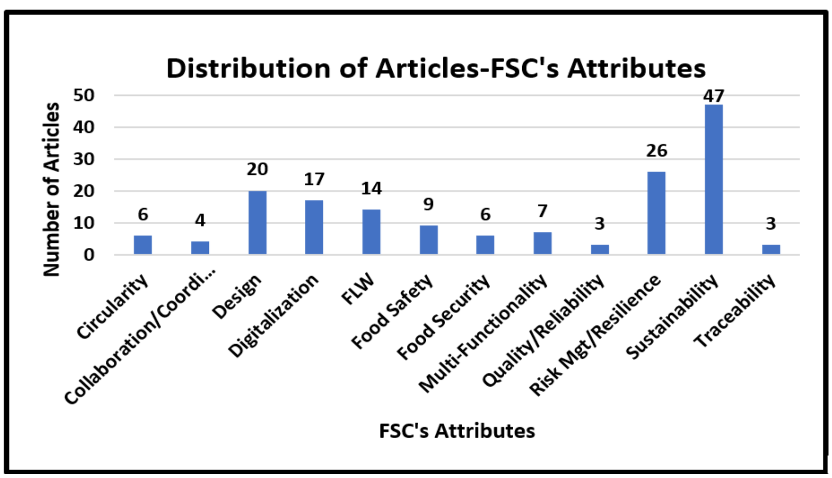

Figure 6. Distribution of articles by the FSC attribute addressed.

2.4 TCM-ADO Framework

To avoid duplication of research efforts and to provide a clear roadmap for future research endeavours, framework-based reviews assist in the rigorous synthesis of prior research, using a robust organisation pattern to convene reconciliation of fragmented bodies of knowledge. The current study deploys a hybrid approach for systematic review, by merging two such frameworks, i.e., TCM Framework (Theories, Contexts, and Methods) and ADO Framework (Antecedents, Decisions, and Outcomes) in order to capitalize on the strengths and overcome the weaknesses pertinent to each of the individual frameworks.

The "TCM" framework was introduced by Paul et al. (2017), demonstrates an extraordinary approach to offer organised perspectives on the construct's theoretical, contextual, and methodological underpinnings, wherein *Theories* (*T*) aim at highlighting the theoretical underpinnings and paradigms used to clarify the inter-relationships between the constructs, *Contexts* (*C*) represent the real-life conditions that influence the study environment, and *Methods* (*M*) define the methodological approaches, analytical tools and frameworks employed for the research study. Likewise, the "ADO" framework was introduced by Paul & Benito (2018), illustrates a remarkable means to organize the research results pertaining to a construct and its relationships in a structured manner, wherein *Antecedents* (*A*) represent the primary factors that influence whether a behaviour is engaged in or not, *Decisions* (*D*) describe the numerous behavioural performance categories and a construct's dimensionality structure, and *Outcomes* (*O*) elucidates the repercussions of engaging in or refraining from a particular kind of behaviour (Paul et al., 2024). Thus, using both the frameworks cohesively, the current study seeks to offer genuine insights towards advancing the review's comprehensiveness (Tham et al., 2023).

3. Significant Findings from the Literature-based on the TCM-ADO Framework

The results of the integrated TCM-ADO framework-organized systematic review are presented within **Figures 10** and **11** (Appendix I) and summarised within the subsequent sections.

3.1 TCM based MCDM Review within Food Chains

3.1.1 Theories

Theories and Frameworks offer a way to guide and promote advancement of understanding regarding the topic under study. Many underpinning theories and frameworks were put forth in the literature to apply MCDM models within food chains (**Table 3**).

Table 3. Underpinning theories & frameworks.

S. No.	Underpinning theories/Frameworks	References
1.	Complexity/Risk/Resilience theories	Gupta et al. (2023), Karwasra et al. (2024), Khan et al. (2021), Kuizinaitė et al. (2023), Kumar et al. (2021), Prakash et al. (2017), Shafiee et al. (2022), Shanker et al. (2022), Wang et al. (2024b), Yazdani et al. (2022a).
2.	Digitalization theories	Jain et al. (2023), Khan et al. (2023), Lau et al. (2021), Narwane et al. (2022), Nayal et al. (2023), Srivastava & Dashora (2022), Yadav et al. (2023b).
3.	Economic theories	Duret et al. (2019), Liao et al. (2020), Magableh (2023), Scott et al. (2024), Singh et al. (2018a), Zkik et al. (2023).
4.	Entrepreneurship theories	Hajiagha et al. (2022), Joshi et al. (2023).
5.	Marketing theories	Lau et al. (2018), Srinivasan et al. (2023), Yontar (2023).
6.	Networking theories	Ben Abdallah et al. (2024), Görçün et al. (2023), Govindan et al. (2017); Hajiaghaei-Keshteli et al. (2023), Khamseh (2021), Khan & Ali (2021), Krstić et al. (2023), Magalhães et al. (2021b), Melkonyan et al. (2020), Molist et al. (2024), Raut et al. (2019), Rezaei et al. (2016), Rong et al. (2022), Shi et al. (2018), Singh et al. (2018b), Wang & Liao, (2023), Yadav et al. (2021a, 2022), Yazdani et al. (2022b).
7.	Organizational theories	Abdel-Fattah & Al Hiary (2023), Faibil et al. (2021), Farooque et al. (2019), Lu et al. (2021), Sharma et al. (2025a), Zenouz et al. (2021).
8.	Performance frameworks	Leung et al. (2021), Liao et al. (2023a), Mor et al. (2018), Ramos et al. (2022), Yadav et al. (2021b), Zhao et al. (2024).

Table 3 continued…

9.	Public governance frameworks	Niu et al. (2021), Zhang et al. (2022).
10.	Quality tools & frameworks	Ali et al. (2019), Daultani et al. (2025), Di Nardo et al. (2022), Jagoda et al. (2023), Liao et al. (2023b), Liu et al. (2018).
11.	Acts & standards	Agyemang et al. (2022), Singh et al. (2023).
12.	Sustainability theories	Almuflih et al. (2022), Anand & Barua (2022, 2023), Agnusdei et al. (2023), Ardra & Barua (2022, 2023), Coluccia et al. (2024), D'Adamo (2023), Dania et al. (2022), Darmian et al. (2023), Das et al. (2023a, 2023b), Delouyi et al. (2023), Fagioli et al. (2017), Ghadge et al. (2017), Ghosh et al. (2024), Grippo et al. (2019), Haider & Choubey (2024), Kashyap et al. (2024), Kashyap & Shukla (2023), Krstić et al. (2023), Kaur (2021), Kazançoğlu et al. (2021), Kumar et al. (2020, 2022b, 2023a, 2023b, 2024), Kumar & Choubey (2023), Lahane et al. (2023), La Scalia et al. (2021), Lau et al. (2020), Liu et al. (2019), Lombardi & Todella (2023), Mishra et al. (2023), Mohammadkhani & Mousavi (2023), Quayson et al. (2024), Rad & Sonesson (2024), Raut & Gardas (2018), Sharma et al. (2023b), Surucu-Balci & Tuna (2021), Tseng et al. (2022), Wang et al. (2023, 2024a), Wohner et al. (2020).

3.1.1.1 Complexity/ Risk/ Resilience Theories

Consistent with the complexity theory, FSCs stand vulnerable to a variety of risks due to factors such as globalization, unpredictable business climates, pandemic outbreaks, and complicated relationships between the numerous entities that make up the chain, such as manufacturers, suppliers, and service providers. Hence, Karwasra et al. (2024), Kumar et al. (2021), Shafiee et al. (2022) and Shanker et al. (2022) focused on analysing risks and supply chain vulnerabilities emerging from pandemic situations such as Covid-19 and deployed MCDM methods to examine interrelationships between the risk factors and additionally to prioritize risks as a means to formulate apt mitigation strategies and contingency plans to reduce the impacts from such similar incidents within the future. Additionally, Gupta et al. (2023), Khan et al. (2021), Kuizinaitė et al. (2023), & Prakash et al. (2017) aimed at risk prioritization through MCDM within Dairy chains, Agri-food chains and Halal chains, respectively. Equally, Wang et al. (2024b) & Yazdani et al. (2022a) pursued studies to foster resilience and performance by leveraging on MCDM models for efficient risk management.

3.1.1.2 Digitalization Theories

With due consideration for the "Technology Adoption Model", defining the ways in which various individuals respond to, embrace, and accept novel technologies, few of the studies utilized MCDM models to foster identification/prioritization of key drivers/factors/enablers for technology deployment within food chains (Jain et al., 2023; Narwane et al., 2022; Srivastava & Dashora, 2022; Yadav et al., 2023b) and additionally towards identification/prioritization of key barriers for technology implementation within food chains (Khan et al., 2023).

Similarly, few studies aimed at leveraging on Artificial Intelligence and MCDM methods through "Federated Learning Models (facilitating training of central models through decentralized data to overcome the problems related to data governance and privacy)" for risk assessment within cold chains (Lau et al., 2021) and through "Machine Learning Prediction Models" for mitigating the Covid-19 effects within agri-food chains (Nayal et al., 2023).

3.1.1.3 Economic Theories

Mindful of the behavioural economic models i.e., "Cumulative Prospect theory", few of the studies exploited MCDM models to facilitate decision making under risk and uncertainty, for digitalization through Block Chain Technologies (Zkik et al., 2023) and additionally for selection of new green cold chain logistics distribution centres (Liao et al., 2020). Similarly, Magableh (2023) based their study on the "Law of Demand and Supply" to convene evaluation of the suppliers employing fuzzy MCDM models. As per the study flexibility, communication, country of origin, expenses (price and costs), delivery (time, place, and cost), and importer's dependability and solvency are the important factors to select a supplier. Likewise, Duret et al. (2019) deployed “cost-benefit analysis” and MCDM models towards selecting the best intervention action to reduce the economic and environmental impact within a cold chain of cooked Ham. The study indicates 4°C home refrigerator is optimised for power consumption and food preservation, also display cabinet's airflow rate significantly reduces power consumption but does not improve food preservation. Besides, Singh et al. (2018a) harnessed the “Porters Generic Value Chain Model” towards enhancing value to the customers, through selection of an apt Third-Party Logistics (3PL) service providers using a MCDM model, as logistics stands out as one of the primary activities within a value chain.

In addition, Scott et al. (2024) emphasized on the importance of the “location theory” to determine apt locations for economic activities i.e., food businesses within developing nations and used MCDM models to identify the priority factors for location decisions. Based on the study, the most important location decision criteria are government regulations and constraints, closeness to consumers, parking capacity, supply chain strategy, and socio-economic status.

3.1.1.4 Entrepreneurship Theories

Hajiagha et al. (2022) aimed at identification of key success factors for international collaboration through deployment of MCDM models, as international collaboration stands important for entrepreneurship, particularly within developing nations and emerging economies, since it can assist entrepreneurs in promoting global innovation and success through embracing cultural intelligence, fostering collaboration, and gaining access to larger markets. On a similar note, Joshi et al. (2023) highlighted the importance of innovation for resilience enhancement fostered through identification/assessment of innovative practices using MCDM models. According to the study, business strategy innovation is the most important requirement to create resilient food supply chains, followed by technical innovation. Further, the study states that, in order to increase the resilience of SMEs and domestic supply chains, FSCs must provide flexibility in a number of areas, sources, and labour access, as well as in the choice of sustainable technologies, financial resilience, e-platforms, tax incentives, etc.

3.1.1.5 Marketing Theories

Lau et al. (2018) operationalized the “order qualifier and winner paradigm developed by Hill” to convene the evaluation of fresh food suppliers through application of MCDM models. The study identified ten major criteria i.e., product, quality, food safety, price, delivery, serviceability, commercial position, supplier relationship, risk factors, and CSR (Corporate Social Responsibility) towards supplier selection. Likewise, Srinivasan et al. (2023) and Yontar (2023) anchored onto the “PESTEL analysis” to analyse and monitor macro-economic factors using MCDM for integrating block chain technology within an agri-food chain and to overcome the barriers for lean and green practices implementation within a food chain respectively.

3.1.1.6 Networking Theories

In the light of “Network Theory”, enhanced coordination and cooperation within the network would foster the overall performance of the entire network, as the supply chain is a network of stakeholders/entities. Thus, Krstić et al. (2023) focused on evaluation and ranking of e-traceability drivers through deployment of MCDM methods towards identification of key drivers for enhanced coordination and communication among different actors within an agri-food chain to foster enhanced performance with regards to improved transparency/accountability and reduction of the risks within agri-food chains (AFSC). The findings show that sustainability, technological advancement, and efficient supply chains are the key drivers. Further, it deduced that these drivers are important and have a significant influence on how well e-traceability solutions are implemented and adopted. Policymakers, business professionals, and researchers may develop frameworks and policies that support effective, cutting-edge, and sustainable e-traceability systems through utilizing the insights provided by the recognition and ranking of such drivers. In addition, the network theory was used in coordination with MCDM models for green, lean, efficient supplier, and 3PL/reverse logistics service provider selections (Ben Abdallah et al., 2024; Görçün et al., 2023; Hajiaghaei-Keshteli et al., 2023; Wang & Liao, 2023). Likewise, Yadav et al. (2021a) integrated networking theory with MCDM models to drive IoT (Internet of Things) enabled multi-tier supply chain system for sustainability enhancement.

On a similar note, "stakeholder theory" stands crucial towards achieving organizational success and longevity through making decisions using MCDM with due consideration for stakeholder interests for sustainability enhancement (Molist et al., 2024) and further to create an effective and supportive IoT based coordinating system using MCDM models in order to improve the AFSCs coordinating mechanism during natural outbreaks like Covid-19 (Yadav et al., 2022). Moreover, when local food supply chains utilized distributed network tactics grounded in "crowd logistics principles", they outperformed centralized and decentralized distribution alternatives in terms of sustainability, hence MCDM models were deployed to investigate the sustainability potential of last-mile distribution and logistics strategies based on the concept of crowd logistics (Melkonyan et al., 2020). Furthermore, Magalhães et al. (2022) employed the "supply chain coordination theory" along with MCDM models for prioritising food loss and waste mitigation strategies within a fruit and vegetable supply chain (FVSC). Based on the findings from the study, the following five mitigation strategies should be operational: a) sharing and keeping track of information about a product's remaining shelf life, b) educating employees about safe handling techniques, c) guaranteeing communication between FSC stages, d) putting automated demand forecasting systems into place, and e) creating and utilising intelligent packaging to keep an eye on the safety and quality of products. These strategies are mostly classified as information-related strategies, which enhance the flow of information along the FVSC to guarantee that there is enough data to support the decision-making process.

3.1.1.7 Organizational Theories

Zenouz et al. (2021) applied the MCDM techniques for the selection of the right Knowledge Management System (an integration of technology-based systems and organizational practices) for a food industry, towards enhancing organization efficiency, performance, and survival within a competitive market, as "Knowledge Based View" stands out as an important approach towards organizational learning facilitated through the establishment of human capital involvement into the structural and routine activities of the firm. Likewise, Sharma et al. (2025a) used MCDM to critically examine the resources and competencies within a fresh food supply chain, through the theoretical lens of "Resource Based View" in order to identify and analyse GRAS (Green, Resilient, Agile, and Sustainable) enablers. The primary enablers, according to this study are, financial strength, environmental certification programs, and organizational culture. These further influence other enablers such as green supply chain practices, supply chain flexibility, responsiveness to market needs, resilience and agility towards enhancing sustainability.

Equally, Lu et al. (2021) employed MCDM methods to determine and rank the most important operational and institutional factors for enhancing food safety, with due consideration for the "Dynamic Capability View" that aligns business decision-making processes with the resource allocations. Similarly, Abdel-Fattah and Al Hiary (2023) pursued a study aimed at developing an integrated participatory adaptive capacity-building assessment model through the application of a comprehensive Multi-Criteria Decision-Analysis and Training Needs Assessment (MCDA-TNA) technique. In addition, Farooque et al. (2019) conducted a study towards establishing a theoretical framework based on multiple Organizational Theories (Resource-Based View (RBV); Dynamic Capabilities Theory; Contingency Theory; Institutional Theory; Resource Dependence Theory), to convene identification of pertinent barriers for integrating the circular economy ideology into food supply chain management through a MCDM approach. The study identified weak environmental regulations and enforcement; lack of market preference/pressure; and lack of collaboration/support from supply chain actors as the most prominent barriers for integrating circular economy. Furthermore, Faibil et al. (2021) conducted a study on a raw cashew nut supply chain network, and deployed MCDM to methodically identify and evaluate important factors that affect post-harvest losses from the standpoint of "tangible and intangible resources".

3.1.1.8 Performance Frameworks

Mor et al. (2018) and Ramos et al. (2022) employed the "Balance Score Card theoretical framework" to assess the performance of a FSC, as the framework facilitates evaluation of day-to day operations from four perspectives i.e., financial, customer, internal business processes, and learning and growth. Further, the authors resorted to MCDM methods for identification of the key performance indicators or factors and additionally to analyse the interactions between the indicators and factors to determine the impact of the identified indicators and factors on the supply chain performance. Equally, a study by Liao et al. (2023a) concentrated on investigating the "best practices" employed within a developed nations sustainable fresh food CSCs (Cold Supply Chain), and consequently made use of MCDM approaches towards examining how such best practices affect sustainability outcomes within developing nations.

In a like manner, Zhao et al. (2024) performed a "cross-country comparative analysis" to identify agri-food supply chain resilience (AFSCRes) capability factors and then deployed MCDM methods to understand the inter-relationships and cause-and-effect relationships between the identified resilience capability factors. The study concluded that supply chain collaboration activities are beneficial in enhancing supply chains' capacity for anticipating, responding to, and adapting to disturbances by information sharing, cooperative communication, and cooperative relationship building. In an attempt to provide food retailers with systematic and effective evaluation of the received fresh food produce, Leung et al. (2021) introduced a quality benchmarking framework integrated with an MCDM model to foster the grading process of the fresh produce. The authors proposed five general criteria for evaluating the quality of fresh produce i.e., sweetness (which symbolises flavour), look (which represents firmness), colour, weight, and size and provided corresponding weights for each criterion for enhancing food quality. Additionally, Yadav et al. (2021b) exploited "SCOR (Supply Chain Operations Reference) performance framework" towards identifying top level SC processes and thereupon used MCDM approaches to perform a quantitative study of the identified top level SC processes and their performance characteristics.

3.1.1.9 Public-Governance Frameworks

Zhang et al. (2022) relied on "Public Governance Theories" and MCDM Models to identify and evaluate correlations between important dimensions and factors affecting public-public collaboration for food-safety risk management. The study identified the most significant factor influencing public-public cooperation to be legal foundation. Further, it also identified five main factors influencing governance capacity in public-public collaboration for food safety risk management, which are a) laws and regulations in the legal basis dimension, b) professionalism in the behaviour and capabilities dimension, c) legislation-based governance, d) administrative law enforcement-based governance, and e) social environment improvement-based governance. Likewise, to combat enterprise food fraud, Niu et al. (2021) leveraged on the "Social Co-Governance" and MCDM methods to examine important factors and their interrelationships, towards gauging the influence they exert on the food enterprises' decisions about food fraud.

3.1.1.10 Quality Tools & Frameworks

Ali et al. (2019) capitalized on the "Pareto Analysis Diagram" built on the inputs gathered from 130 food industry professionals and MCDM models to develop a sustainability framework for evaluating risks within a food chain and consequently employed the framework for analysing the impact of the identified risks on food waste reduction. Likewise, Liu et al. (2018) leveraged on the "Quality Functional Deployment (QFD) Tool" along with an MCDM model to build two independent relationship matrices accounting for relationships between business strategies vs supplier selection criteria and business strategies vs customer requirements respectively in order to choose apt suppliers for the green fresh products. Results of the study highlighted the importance of management commitment as well as enhancing product standard and pricing for performance augmentation. Similarly, Daultani et al. (2025) resorted to QFD along with MCDM to align specific resilient functions to address specific problems brought about by natural disasters. Findings of the study indicate scarcity of workers in the impacted areas along with food transportation are the primary issues resulting after a natural disaster. The analysis matrix of the study recommends authorities to prioritise information exchange for strengthening robust relief functions. Equally, Jagoda et al. (2023) used a Kano model to translate inputs from customers into insights for "QFD" and there upon created a generalisable framework using MCDM to compare sustainable packaging design solutions in an organised and comprehensive manner, with due consideration for consumer preferences, economic, and environmental factors. Moreover, Di Nardo et al. (2022) formulated a novel MCDM method incorporating dynamic "Failure Mode and Effect Analysis (FMEA)" for reliability enhancement within an agri-food chain, to overcome the critical pitfalls within the traditional FMEA methods. Besides, Liao et al. (2023b) harnessed MCDM to develop an outranking-based "FMEA" with due consideration for risk factors within a food cold chain.

3.1.1.11 Acts & Standards

Singh et al. (2023) employed MCDM to identify and analyse critical growth barriers within a fresh produce supply chain to foster the development of policies in-line with the "Indian agricultural acts of 2020" for mitigation of the identified barriers and convene food waste reductions. According to the study the most prominent barriers that deter the growth are a) partners' lack of cooperation and information sharing, b) improper cold chain facilities, c) inadequate transportation or logistical facilities, d) improper quality and safety protocols, e) lack of processing and packaging facilities, and f) low productivity and efficiency. In a like manner, Agyemang et al. (2022) capitalized on MCDM to identify criteria for social sustainability governed by "ISO 26000" towards proposing holistic standards for attainment of a Socially Sustainable Food Supply Chain (SSSC). Additionally, the authors claim that food safety; labour and work conditions; traceability; child and forced labour are to be prioritized as a pathway for SSSC implementation.

3.1.1.12 Sustainability Theories

Taking into consideration the "Triple-Bottom-Line (TBL) requirement for Sustainable Development (i.e., simultaneous achievement of Economic, Environmental, and Social Goals)" (Ada, 2022), multiple studies have integrated the TBL model along with MCDM approaches: to achieve sustainable food security and to identify enablers for zero hunger through technology deployment (Kaur, 2021; Kumar et al., 2023a); to promote sustainable transportation of fresh fruits and vegetables and sustainable food grain storage (Das et al., 2023a; Raut & Gardas, 2018); to deal with the sustainability challenges faced within a perishable chains operating in an emerging economy like India (Kumar et al., 2020); to stimulate sustainable economic growth within an agro-processing industry (Darmian et al., 2023); to convene collaboration between supply chain stakeholders and leverage on the dynamics of FSCs for successful implementation of sustainability practices (Almuflih et al., 2022; Anand & Baura, 2023; Dania et al., 2022); to deal with the barriers to technology deployment for sustainability enhancement (Kumar et al., 2024; Quayson et al., 2024; Sharma et al., 2023b); to assess the sustainability performance of the current food chains in order to induce strategies for successful transformation into sustainable food chains fostering sustainable production and consumption (Das et al., 2023b; Kumar & Choubey, 2023; Kumar et al., 2022b; Tseng et al., 2022); to elevate the level of trust within consumers through elimination of food fraud facilitated through complete reliance on green suppliers (Lau et al., 2020); to rate food packaging alternatives with regards to packaging related food loss and wastes (Wohner et al., 2020); and finally to assist with the selection of green/sustainable supply chain partners (Liu et al., 2019; Mohammadkhani & Mousavi, 2023).

In a like manner, several research studies emphasized on the importance of attaining "circularity (founded on the idea of reusing and recycling materials, goods, and services to extend their life cycle and reduce waste) within food chains, through application of MCDM methods: to overcome the barriers for achieving circularity and sustainable performance (Ardra & Barua, 2023; Delouyi et al., 2023; Kazançoğlu et al., 2021; Kumar et al., 2023b); to assess the circularity levels within a food chain in order to initiate strategies for circularity enhancement (Coluccia et al., 2024; Ghosh et al., 2024); to evaluate alternate ways to utilize the bio-waste generated during transformation of the harvested crop into an edible product (Grippo et al., 2019; La Scalia et al., 2021; Lombardi & Todella, 2023); and to investigate how digitalization could be leveraged for achieving circularity (Agnusdei et al., 2023; Krstić et al., 2022a).

Likewise, few studies highlighted the significance of aligning strategies and objectives within a food supply chain with the "17 Sustainable Development Goals (SDG) defined by the United Nations" and embraced MCDM models: to address barriers towards reducing FLW within food chains and to overcome challenges to sustainability (Haider & Choubey, 2024; Kashyap et al., 2024; Lahane et al., 2023; Mishra et al., 2023) to assess the value chain under the lens of sustainable development pillars (Fagioli et al., 2017) to evaluate the food waste treatment techniques (Wang et al., 2024a) to investigate and resolve logistics related food loss drivers (Surucu-Balci & Tuna, 2021) and to identify/analyse potential drivers for sustainability enhancement within food chains (D'Adamo, 2023; Rad & Sonesson, 2024).

3.1.2 Contexts

Contexts offer a way to define the characteristics and information pertaining to the phenomenon under study. The literature provided an overview into diverse contexts where MCDM was applied within the Food Supply Chains, i.e., geographic regions, types of food supply chains (e.g., perishable goods, non-perishable goods), scale (local, regional, global), etc (**Table 4**). Also, **Figure 7** (Appendix I) portrays the regional distribution of the studies.

Table 4. Application contexts-regional specific FSCs.

Contexts	Country	References
Regional specific FSCs	Australia	Paul et al. (2023).
	Austria	Melkonyan et al. (2020).
	Bangladesh	Ali et al. (2019).
	Chile	Lu et al. (2021).
	China	Farooque et al. (2019), Lau et al. (2020), Niu et al. (2021), Wang & Liao, (2023), Wang et al. (2024b), Zhang et al. (2022).
	France	Eygue et al. (2020).
	India	Almuflih et al. (2022), Ardra & Barua, (2022, 2023), Dora et al. (2022), Das et al. (2023a, 2023b), Dubey & Tanksale (2022), Ghosh et al. (2024), Govindan et al. (2017), Kaur (2021), Kumar et al. (2022a, 2023a, 2023b), Lahane et al. (2023), Rathore et al. (2017).
	Iran	Delouyi et al. (2023), Shi et al. (2018).
	Lithuania	Kuizinaitė et al. (2023).
	Malaysia	Mohammadkhani & Mousavi (2023).
	Pakistan	Ali et al. (2022).
	Sweden	Rad & Sonesson (2024).
	Thailand	Tseng et al. (2022).
	Turkey	Ögel et al. (2023).

Moreover, FSCs exhibit unique characteristics with respect to maintaining the safety and quality of foods to promote good health to the consumers across the globe. Hence, they tend to take up many forms based on the type of foods they carry. In this pursuit, Agri-Food Chains are uniquely designed to handle Agri-harvests. Likewise, Fresh Food Supply Chains are formulated to handle- fresh produce from the farm- with short-hauls from farms to nearby markets. Equally, Perishable Food Chains aim at safeguarding the utility of foods with shorter shelf lives- dairy and meat. Cold Chains on the other hand tend to handle food products needing long-hauls within the right temperature and humidity conditions to safeguard the quality of foods. In line with the unique attributes exhibited by each form of the food chain, the studies enlisted within **Tables 4** to **10**, highlight the importance of MCDM applications within contexts specific to a particular form of a food chain.

Table 5. Application contexts-regional specific agri-food chains.

Contexts	Country	References
Regional specific agri-food chains	Alboraya (Spain)	Yazdani et al. (2021).
	Andalusia province of Spain	Yazdani et al. (2022a).
	Argentina & France	Zhao et al. (2024).
	Asia & North Africa	Zkik et al. (2023).
	China	Sun et al. (2023).
	India	Chauhan et al. (2020), Gardas et al. (2019), Gupta et al. (2023), Joshi et al. (2023), Kharola et al. (2022), Mishra et al. (2023), Narwane et al. (2022), Nayal et al. (2023), Sharma et al. (2025a), Srivastava & Dashora (2022), Yadav et al. (2023a, b).
	Iran	Banaeian et al. (2018), Darmian et al. (2023), Hajiagha et al. (2022).
	Italy	Di Nardo et al. (2022).
	Jordan	Abdel-Fattah & Al Hiary (2023).
	Lithuania	Baležentis et al. (2021).
	Turkey	Perçin (2022).

Table 6. Application contexts-regional specific cold chains.

Contexts	Country	References
Regional specific cold chains	Australia	Lau et al. (2021).
	China	Liao et al. (2023b), Nisar et al. (2024), Rong et al. (2022), Xu & Tang (2022).
	France	Duret et al. (2019).
	India	Kumar et al. (2022a, b, c), Singh et al. (2018a).
	Pakistan	Khan & Ali (2021).

Table 7. Application contexts -regional specific fresh food supply chains.

Contexts	Country	References
Regional specific fresh food supply chains	Australia. Coles and Woolworths	Lau et al. (2018).
	China	Leung et al. (2021), Liao et al. (2023a), Liu et al. (2018).
	India	Anand & Barua, (2022, 2023), Chauhan et al. (2021), Gardas et al. (2018), Mangla et al. (2018), Raut & Gardas (2018), Raut et al. (2018, 2019), Sharma et al. (2025a), Singh et al. (2023).
	Portugal	Magalhães et al. (2021a, 2022).
	Turkey	Bilisik & Baraçlı (2023), Görçün et al. (2023), Surucu-Balci & Tuna (2021).
	Netherlands	Banach et al. (2021).

Table 8. Application contexts-regional specific dairy chains.

Contexts	Country	References
Regional specific dairy chains.	Iran	Azadnia et al. (2021), Khamseh (2021).
	India	Karwasra et al. (2024), Kumar et al. (2022b), Kumar & Choubey (2023), Mor et al. (2018), Prakash et al. (2017).
	Greece	Ghadge et al. (2017).
	Tunisia	Ben Abdallah et al. (2024).
	Turkey	Kazançoğlu et al. (2021).

Table 9. Application contexts-regional specific perishable food chains.

Contexts	Country	References
Regional specific perishable food chains.	India	Kashyap et al. (2024), Kumar et al. (2020, 2021), Shanker et al. (2022), Sharma et al. (2022), Yadav et al. (2023a, b).
	Iran	Shafiee et al. (2022).

Table 10. Application contexts-others.

S. No.	Application contexts	References
1.	Generic food supply chain	Ajmera et al. (2024), Alsattar et al. (2023), Daultani et al. (2025), Haider & Choubey (2024), Hajiaghaei-Keshteli et al. (2023), Kamble et al. (2019), Khan et al. (2023), Kumar et al. (2024), Long & Liao (2021), Rezaei et al. (2016), Scott et al. (2024), Sonar et al. (2023), Srinivasan et al. (2023), Sufiyan et al. (2019), Wang et al. (2024a), Zenouz et al. (2021).
2.	Agri-food chain	Agnusdei et al. (2023), Arora et al. (2022), Coluccia et al. (2024), Erdoğan (2022), Jain et al. (2023), Krstić et al. (2022a, 2023, 2024), Lombardi & Todella (2023), Qahtan et al. (2023), Sahu et al. (2023), Sharma et al. (2025b), Singh et al. (2018b), Wang et al. (2023), Yadav et al. (2021a, 2021b), Yontar (2023), Zhong et al. (2024).
3.	Fresh-food supply chain	Hong et al. (2024).
4.	Halal supply chain in India	Khan et al. (2021).
5.	Fox nut supply chain in north India	Kashyap & Shukla (2023).
6.	Sugar supply chain in India	Kumar & Kansara (2018), Yadav et al. (2022).
7.	Banana supply chain within the coastal zone of Michoacán, Mexico	García et al. (2014).
8.	Beef supply chain in Brazil	Magalhães et al. (2021b).
9.	Cashew chain in West Africa	Agyemang et al. (2022), Faibil et al. (2021).
10.	Cereal production chain in Basilicata and Puglia (located in Southern Italy)	Grippo et al. (2019).
11.	Cocoa supply chain in Ghana	Quayson et al. (2024).
12.	Coffee supply chain in Italy	La Scalia et al. (2021).
13.	Ketchup production in Austria	Wohner et al. (2020).
14.	Novel protein food chain in Netherlands	Linnemann et al. (2015).
15.	Perishable food chain in Iran	Shafiee et al. (2022).
16.	Pork Supply Chain in France	Liu et al. (2019).
17.	Tomato supply chain in Catalonia (Spain)	Molist et al. (2024).
18.	Rice supply chain in Jordan	Magableh (2024).
19.	Olive oil chains within five European countries	Fagioli et al. (2017).
20.	Peruvian kiwicha supply Chain	Ramos et al. (2022).
21.	Pasta processing-Italy	D'Adamo (2023).
22.	Sugar supply chain in Indonesia	Asrol & Yani (2024), Dania et al. (2022).
23.	Wheat supply chain in Jordan	Magableh (2023).
24.	Wine supply chain in Spain	Yazdani et al. (2022b).

3.1.3 Methods

Methods offer a way for validating the findings on the topic under study. Numerous research studies deployed traditional MCDM methods such as AHP (Analytical Hierarchy Process), TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), and PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) for decision making through prioritization of criteria, ranking of alternatives and establishment of preferential relationships (D'Adamo, 2023; Daultani et al., 2025; Eygue et al., 2020; Yadav et al., 2023a). Alternatively, new methods have also been introduced and applied within multiple research studies (Hafezalkotob et al., 2019; Thakkar, 2021). Additionally, multi-objective decision-making models, i.e., weighted sum model, weighted product model etc., gained prominence towards simultaneously accommodating conflicting objectives within the decision process (Mayatopani, 2023). Similarly, fuzzy and grey models such as fuzzy-AHP/ grey-AHP, fuzzy-TOPSIS/grey-TOPSIS etc., were introduced to tackle uncertainty and impreciseness within the decision-making environment (Das et al., 2023b; Daultani et al., 2025; Lu et al., 2021; Yadav et al., 2023a). Likewise, structural models such as ISM (Interpretive Structural Model), DEMANTEL (Decision Making Trial and Evaluation Laboratory Method) etc., got introduced towards accounting for the relationships between the decision criteria (Hong et al., 2024; Kumar et al., 2024; Narwane et al., 2022; Sonar et al., 2023). Nonetheless, data-driven approaches gained popularity towards leveraging on the large datasets for valuable decision insights. Equally, Hybrid Models combining multiple techniques such as AHP and fuzzy TOPSIS (Liao et al., 2023a); AHP and ELECTRE (ELimination Et Choix Traduisant la REalité) (Duret et al., 2019); ISM and ANP (Analytic Network Process) (Kumar et al., 2020, 2023a) etc., provided a promising direction towards curating more holistic and accurate decision-making frameworks through leveraging on the strengths of individual models.

Consequently, the literature provided insights into various MCDM models being applied within the FSCs to convene efficient and effective decision making (**Table 11**), as MCDM models support complex decision-making within the food chains by providing an organised, comprehensive, and inclusive approach. Moreover, MCDM approaches improve decision outcomes within complex and unpredictable contexts by embracing numerous objectives, criteria, and stakeholder viewpoints, allowing for more informed choices and transparency (Sahoo & Goswami, 2023). The MCDM models applied within food chains range from the basic criteria weighing methods to hybrid models offering enhanced decision support by addressing the limitations related to specific models (**Table 11**). Also, **Figure 8** (Appendix I) portrays the distribution of articles based on the types of models employed.

Table 11. MCDM models.

S. No.	Method category	MCDM models	References
1.	Criteria weighing (Subjective weighing methods)	AHP; ANP; BWM, FARE; LBWA; SWARA	Arora et al. (2022), Banach et al. (2021), D'Adamo (2023), Dora et al. (2022), García et al. (2014), Ghadge et al. (2017), Gupta et al. (2023), Joshi et al. (2023), Khan et al. (2023), Kharola et al. (2022), Kuizinaitė et al. (2023), Lau et al. (2021), Linnemann et al. (2015), Molist et al. (2024), Paul et al. (2023), Raut et al. (2018), Rezaei et al. (2016), Surucu-Balci & Tuna (2021).
2.	Criteria weighing (Objective weighing methods)	EWM; CRITIC	
3.	Ranking of alternatives (Outranking methods)	ELECTRE & PROMETHEE	Eygue et al. (2020), Fagioli et al. (2017).
4.	Ranking of alternatives (Comparative-analysis)	MAIRCA	
5.	Ranking of alternatives (Ratio-analysis)	MOORA; MULTIMOORA	
6.	Ranking of alternatives (Compromise ranking methods)	CoCoSo; VIKOR	
7.	Ranking of alternatives (Distance-based ranking)	ADAM; COBRA; EDAS; TOPSIS	Ali et al. (2022), Wohner et al. (2020).
8.	Ranking of alternatives (Other methods)	MARCOS (Compromise solution), COPRAS (Utility level) & TODIM (Prospect theory)	Almuflih et al. (2022), Khamseh (2021).
9.	Structural models	DEMANTEL; ISM; TISM; MICMAC (Cross-Impact matrix multiplication applied to classification)	Anand & Baura (2022), Das et al. (2023a), Gardas et al. (2018), Hong et al. (2024), Karwasra et al. (2024), Kumar et al. (2024), Magalhães et al. (2021a, 2021b), Mor et al. (2018), Narwane et al. (2022), Prakash et al. (2017), Raut & Gardas (2018), Sonar et al. (2023), Zhao et al. (2024).

Table 11 continued…

10.	Fuzzy & grey models	Fuzzy AHP Fuzzy ANP Fuzzy BWM; Fuzzy DEMANTEL; Fuzzy ISM; Fuzzy TISM; Fuzzy VIKOR; Grey DEMANTEL Grey relationship analysis (GRA)	Ali et al. (2019), Ardra & Barua (2023), Dania et al. (2022), Faibil et al. (2021), Farooque et al. (2019), Jagoda et al. (2023), Kashyap et al. (2024), Kashyap & Shukla (2023), Kaur (2021), Khan et al. (2021), Kumar et al. (2021), Lu et al. (2021), Magableh (2023), Nisar et al. (2024), Singh et al. (2023), Tseng et al. (2022).
11.	Hybrid Models	AHP-ADAM; AHP-COBRA; AHP-ELECTRE III; AHP-Fuzzy AHP; AHP-DEMANTEL-TOPSIS; AHP-Fuzzy TOPSIS; AHP-TOPSIS; ANP-ADAM; ANP-MAIRCA; BWM-COBRA; BWM-Fuzzy MARCOS; BWM-Fuzzy TOPSIS; BWM-GRA BWM-LBWA- CoCoSo; BWM-Shannon Entropy-Fuzzy MULTIMOORA; BWM-SWARA; CRITIC-VIKOR; DEMANTEL-ANP; DEMANTEL-Grey ANP; DEMANTEL-ISM; DEMANTEL-TOPSIS; EWM-BWM-EDAS; EWM-MOORA-COPRAS Fuzzy AHP-TOPSIS; Fuzzy AHP-Fuzzy TOPSIS; Fuzzy AHP-Fuzzy TOPSIS-ELECTRE; Fuzzy AHP-Fuzzy VIKOR; Fuzzy AHP-TOPSIS-ELECTRE; Fuzzy ANP-Fuzzy VIKOR; Fuzzy BWM-Fuzzy TOPSIS Fuzzy BWM-Shannon Entropy-Fuzzy MULTIMOORA; Fuzzy DEMANTEL-ANP; Fuzzy DEMANTEL-Fuzzy AHP; Fuzzy DEMANTEL-Fuzzy ANP; Fuzzy FARE-Fuzzy ADAM; Fuzzy ISM-DEMANTEL; Fuzzy ISM-Fuzzy MICMAC; Fuzzy SWARA-Fuzzy EDAS Fuzzy TOPSIS-VIKOR-GRA; Grey AHP-Grey TOPSIS; Grey-DEMANTEL-ANP; ISM-ANP; ISM-DEMANTEL; ISM-DEMANTEL-ANP; ISM-Fuzzy AHP-VIKOR ISM-Fuzzy DEMANTEL; ISM-Fuzzy MICMAC; ISM-Fuzzy VIKOR; ISM-Grey DEMANTEL; PROMETHEE-II & BWM; Shannon Entropy-Fuzzy TOPSIS; SWARA-EDAS; SWARA-MULTIMOORA; TISM-Fuzzy DEMANTEL; VIKOR & TOPSIS;	Agyemang et al. (2022), Agnusdei et al. (2023), Ardra & Barua (2022), Banaeian et al. (2018), Chauhan et al. (2020), Coluccia et al. (2024), Darmian et al. (2023), Das et al. (2023b), Daultani et al. (2025), Delouyi et al. (2023), Di Nardo et al. (2022), Dubey & Tanksale (2022), Duret et al. (2019), Gardas et al. (2019), Ghosh et al. (2024), Haider & Choubey (2024), Hajiagha et al. (2022), Jain et al. (2023), Kamble et al. (2019), Kazançoğlu et al. (2021), Khan & Ali (2021), Krstić et al. (2022a, 2023, 2024), Kumar & Kansara (2018), Kumar et al. (2020, 2022a, 2022b, 2022c, 2023a, 2023b), Kumar & Choubey (2023), La Scalia et al. (2021), Lau et al. (2018, 2020), Liao et al. (2023a), Liu et al. (2018, 2019), Magableh (2024), Mangla et al. (2018), Mishra et al. (2023), Nayal et al. (2023), Niu et al. (2021), Rad & Sonesson (2024), Ramos et al. (2022), Rathore et al. (2017), Raut et al. (2019), Shanker et al. (2022), Sharma et al. (2023b, 2025a, 2025b), Singh et al. (2018a, 2018b), Srinivasan et al. (2023), Srivastava & Dashora (2022), Sufiyan et al. (2019), Yadav et al. (2021a, 2021b, 2022, 2023a, 2023b), Yazdani et al. (2021, 2022a), Yontar (2023), Zenouz et al. (2021), Zhang et al. (2022), Zhong et al. (2024).

3.1.3.1 Criteria Weighing (Subjective Weighing Methods)

Subjective weighing approaches in multi-criteria decision making (MCDM) are used to assess the relative importance of criteria based on decision makers' preferences and judgements. The methods under this category include Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), Best Worst Method (BWM), Factor Relationship Method (FARE), Level Based Weight Assessment (LBWA), and Stepwise Weight Assessment Ratio Analysis (SWARA). The AHP method aids decision-makers to understand and analyse complicated problems by breaking them down into a hierarchy of criteria and alternatives. Furthermore, the method establishes a uniform framework for comparing criteria and options in a pairwise manner, assuring transparency and mitigating biases.

Equally, ANP deploys network structures and feedback loops, to model complex problems exhibiting interrelationships between the criteria/alternatives and to encapsulate dynamism within the decision problem respectively. Further, the method is capable of incorporating both tangible and intangible criteria within the model, facilitating evaluation of alternatives in a comprehensive fashion (Taherdoost & Madanchian, 2023a). Similarly, BWM provides a structured approach through identification of the best and worst criteria for pair-wise comparisons of criteria/alternatives. Likewise, FARE (Factor Relationship), determines the criteria weights based on the relationships between all the criteria used to describe the phenomenon under consideration. Additionally, the method as a first step, uses expert inputs for a small quantity of early data about the relationships between a subset of the criteria, as well as their strength and direction. Then, depending on the conditions of functioning and the specific features of the entire set of criteria, the relationships between other criteria of the set and their direction are defined analytically in line with those established at the first step (Ginevičius, 2011).

In addition, the LBWA model enables for the determination of weight coefficients using a small number of criteria comparisons. Moreover, the LBWA model's method does not become more complex as the number of criteria increases, making it appropriate for application in complex multi-criteria (MCDM) models with a large number of criteria. Added to that, the method allows for the evaluation of optimal weight coefficient values using basic mathematical apparatus, hence eliminating inconsistencies within expert opinions (Žižović & Pamucar, 2019). Furthermore, SWARA employs a slightly different perspective for estimation of criteria weights in comparison to AHP, ANP and FARE, as it provides an opportunity for decision/policy makers to define the priority based on the context of the problem (i.e., environment and economy) (Zolfani & Saparauskas, 2013).

The above mentioned MCDM methods were diversly used within the studies reviewed, i.e., few researchers employed BWM to evaluate control strategies for preventing cross-contamination during fresh-cut lettuce washing, to evaluate strategies for managing risks within a smart, sustainable Agri-logistics sector, to investigate the barriers for Block Chain implementation within food chains, to explore green waste management problems within food chains, to assess most apt measures for mitigating risks within an agri-food chain, to quantify risks within a cold chain, to address sustainability challenges within the food processing sector, and to facilitate optimal supplier selection through integration of traditional and environmental criteria, respectively (Gupta et al., 2023; Khan et al., 2023; Kuizinaitė et al., 2023; Paul et al., 2023).

Equally, few of them deployed AHP to rank the technological alternatives for successful implementation of Industry 4.0 within agri-food chains for efficiency enhancement, to identify and analyse strategic criteria for sustainability initiatives within a pasta processing facility, to select optimal sites for agricultural product warehouses, to analyse the drivers and barriers influencing the implementation of green and environmentally friendly practices within a Greek Dairy Chain, to aid with the supply chain network design for a Novel Protein food chain, to determine the extent to which stakeholders are willing to put measures in place that shorten the supply chain and enable local procurement, to model the drivers of post-harvest losses, and to investigate logistics-related food loss drivers within a fresh fruit and vegetable supply chain, respectively (Arora et al., 2022; D'Adamo, 2023; Molist et al., 2024; Surucu-Balci & Tuna, 2021). Similarly, a select few adopted SWARA to analyse critical success factors impacting diffusion of artificial intelligence within food supply chains, and to evaluate a framework developed based on the opinions of the decision makers within the food business to identify and assess innovative methods for resilience enhancement within food chains, respectively (Dora et al., 2022; Joshi et al., 2023).

3.1.3.2 Criteria Weighing (Objective Weighing Methods)
Within this category of MCDM methods, the Entropy Weight Method (EWM) avoids the interference of human factors in determining the weights, as it evaluates the weights based on the degree of differentiation or dispersion of the measured value (Zhu et al., 2020). The method is based on the principle that data distributions that diverge significantly from a uniform distribution have lower entropy (i.e., more informativeness), hence the method assigns higher weights to indicators with lower entropy values. On a similar note, the CRITIC (Criteria Importance Through Inter-criteria Correlation) method arrives at the objective weights through quantification of the information content within each objective obtained with the aid of contrast intensity and conflict measurements (Anand et al., 2022).

3.1.3.3 Ranking of Alternatives (Outranking Methods)
Under this category of MCDM techniques, ÉLimination Et Choix Traduisant la REalité (ELECTRE) and Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) tend to be the two most prominent methods often employed to compare alternatives and rank them depending on how effectively they align with the needful criteria. However, the two methods adopt different approaches to rank the alternatives, i.e., the ELECTRE method examines the relationship between all possible pairs of options and evaluates each option using a set of common criteria to produce a measure of how much each alternative outranks the others. In contrary, the PROMETHEE method employs preference functions to assign differences between options within judgements for outranking (Belton et al., 2002). The PROMETHEE method was deployed by Eygue et al. (2020) for ranking of Triplets (Habit-Hazard-Health Effect)- based on potential biological and chemical risks and Fagioli et al. (2017) relied upon the ELECTRE method to assess a framework depicting multi-functional value indicators within an agri-food chain.

3.1.3.4 Ranking of Alternatives (Comparative Analysis)
A relatively new method called MIARCA (Multi-Attributive Ideal-Real Comparative Analysis) was introduced by the University of Defence in Belgrade (Pamučar et al., 2014). The method was based on evaluating the gaps between the ideal and real assessments. The alternatives would be ranked based on the sum of the gaps and the alternative with the least sum of gaps would be ranked as an optimal solution. Further, the alternative with minimum gap would have all its criteria values closest to the ideal values.

3.1.3.5 Ranking of Alternatives (Ratio Analysis)
The Multi-Objective Optimization on the Basis of Ratio Analysis Method (MOORA) leverages a ratio system in which each alternative's response to an objective is compared to a denominator representing all alternatives to that objective (Thakkar, 2021) and in a like manner the MULTIMOORA (Multi-Objective Optimization by Ratio Analysis plus the Full Multiplicative From) supplements the MOORA with a full multiplicative form (Hafezalkotob et al., 2019).

3.1.3.6 Ranking of Alternatives (Compromise Ranking Methods)
The VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje) method selects an optimal alternative through determining a ranking index based on closeness to the ideal solution by adopting a specific measure (Taherdoost & Madanchian, 2023b). Alternatively, the Combined Compromise Solution (CoCoSo) Method is centred on an integrated basic additive weighting and compromise exponentially weighted product model (Yazdani et al., 2019).

3.1.3.7 Ranking of Alternatives (Distance-Based Ranking Methods)
Most of the research studies opted for TOPSIS (technique for order performance by similarity to ideal solution) for ranking of the alternatives. The method ranks the alternatives based on the distances from

Positive Ideal Solution (PIS) and Negative Ideal Solution (NIS), and the alternative with the least distance from PIS and greatest distance from NIS is ranked as the optimal as per the TOPSIS. Likewise, the Axial-Distance-Based Aggregated Measurement (ADAM) Method evaluates alternatives by calculating the volume of complex polyhedra defined by points in a three-dimensional coordinate system.

Similarly, The Evaluation Based on Distance from Average Solution (EDAS) method evaluates alternatives using two measures: PDA (Positive Distance from Average) and NDA (Negative Distance from Average). In addition, the COmprehensive distance Based RAnking (COBRA) method ranks the alternatives through integrating two types of distances, Euclidian and Taxicab, from three types of solutions: ideal, nadir, and average (Krstić et al., 2022b).

Besides, the distance- based ranking method- TOPSIS was deployed by Ali et al. (2022) to assess the barriers towards the adoption of circular economy practices for food waste reduction within a developing economy context and by Wohner et al. (2020) for environmental and economic assessment of food-packaging systems with a special focus on food waste reduction, respectively.

3.1.3.8 Ranking of Alternatives (Other Ranking Methods)

The other ranking methods that are predominantly used within the literature include- Measurement of Alternatives and Ranking according to COmpromise Solution (MARCOS)- where the measurement of alternatives is based on the relationship between the alternative and two reference points (ideal and anti-ideal alternatives); Complex Proportional Assessment (COPRAS)- where the ranking of alternatives is based on the utility level; and Tomada de Decisión Inerativa Multicritero (TODIM)- where the ranking of alternatives is based on prospect theory. Equally, Almuflih et al. (2022) employed TODIM by leveraging on the FSC dynamics to explore and analyze potential sustainable action at each working tier of an FSC and Khamseh (2021) equally deployed TODIM to convene the selection of a time-dependent sustainable–flexible supplier within an Iranian dairy industry.

3.1.3.9 Structural Models

The Interpretive Structural Modelling (ISM) and Decision-Making Trial and Evaluation Laboratory (DEMANTEL) are respectively used to investigate complicated systems through understanding the interconnections structure of different variables or factors within the system and to illuminate intricate interconnections and interactions in order to provide a complete picture of the decision-making challenge. Alternatively, Total Interpretive Structural Modelling (TISM) is an extension of the ISM methodology, wherein few of the transitive links between the variables or factors are analyzed to provide a better explanatory framework.

Few scholars relied upon the DEMANTEL method: to model the primary factors that contribute to post-harvest loss and wastage of fruits and vegetables within the agri-fresh produce supply chain, to unlock adoption challenges for IoT deployment within Indian Agricultural and Food Supply Chains, to evaluate the critical causal factors for Post-Harvest Losses (PHL) within the fruit and vegetables supply chains in India, to analyse the critical barriers for Industry 4.0 adoption for sustainability enhancement, and to investigate the barriers affecting circular economy adoption within a FSC, respectively (Anand & Barua, 2022; Kumar et al., 2024; Narwane et al., 2022; Sonar et al., 2023). Similarly, few researchers deployed ISM: to analyse key drivers for supply chain vulnerability during pandemic situations such as covid-19, to address FLW issues within a Brazilian beef supply chain, to model the causes for FLW within a fruit and vegetable supply chain, to benchmark the interactions among performance indicators within a dairy supply chain, to analyse the dynamics between the risks identified within a dairy food chain, to study the interrelationships between the barriers to sustainable transportation of fruits and vegetables within a fresh food supply chain, and to assess risks within an imported fresh food supply chain respectively (Hong et al., 2024; Karwasra et al., 2024; Magalhães et al., 2021a, 2021b). Also, a few studies made use of the TISM method: to analyze the challenges for sustainable food grain storage management, and to model the enablers for resilience enhancement within AFSCs, respectively (Das et al., 2023a; Zhao et al., 2024).

3.1.3.10 Fuzzy and Grey Models

Fuzzy-based MCDM techniques improve decision-making by addressing vagueness and uncertainties in a more practical manner and similarly grey models are better suited for decision problems involving limited or imprecise data because they are capable of dealing with uncertain and incomplete information effectively (Sahoo & Goswami, 2023).

Many studies leveraged on the fuzzy and grey models to reduce the impreciseness arising from the subjective expert inputs. Thus, Ali et al. (2019), Ardra & Baura (2023), Nisar et al. (2024), and Singh et al. (2023) relied on grey DEMANTEL to formulate a framework for analyzing the risks within an FSC, to analyze the causal relationships between the barriers to circularity in an FSC operating within developing nations such as India, to explore the BCT adoption barriers within a fisheries supply chain, and to model the growth barriers of fresh produce supply chain in the Indian context, respectively. Equally, Dania et al. (2022) and Jagoda et al. (2023) employed a fuzzy ANP to assess the collaboration quality within a sugar supply chain in Indonesia, and to compare sustainable packaging design alternatives, respectively. In a like manner, Faibil et al. (2021), Farooque et al. (2019), Kashyap et al. (2024), and Tseng et al. (2022) made use of the fuzzy DEMANTEL to evaluate the drivers for post-harvest losses within a raw cashew nut supply chain in Africa, to investigate the barriers to circularity within FSCs in China, to unravel the barriers to FLW within a perishable food supply chain, and to analyze/visualize the interrelationships among the attributes responsible for building a sustainable food system in Thailand, respectively.

Similarly, Khan et al. (2021) and Kumar et al. (2021) deployed fuzzy BWM for assessing the risks within a halal supply chain, and to investigate the interactions between the risk mitigation strategies and contingencies within a perishable food chain, respectively. Likewise, Kashyap & Shukla (2023) and Kaur et al. (2021) adopted fuzzy ISM to analyze the critical barriers for sustainability achievement within Makhana (Foxnut) MSMEs, and to study the interactions among the technological factors towards designing an IoT based sustainable food security system, respectively. Moreover, Lu et al. (2021) utilized fuzzy AHP to determine the priorities for the criteria and sub-criteria pertaining to food safety within an FSC in Chile. Besides, Magableh (2023) formulated a fuzzy VIKOR model to foster the selection of Jordanian wheat suppliers.

3.1.3.11 Hybrid Models

Hybrid MCDM methods, particularly integrating different methods, exhibit immense potential for improving decision-making accuracy and comprehensiveness. These methods blend different methods to produce synergistic models that surpass limitations within stand-alone methods (Sahoo & Goswami, 2023).

Throughout the literature, several scholars leveraged on the Hybrid MCDM models to achieve the desired outcomes. In this regard, Kumar & Kansara (2018) deployed an **AHP** and **Fuzzy AHP** approach to investigate the information technology barriers within an Indian sugar supply chain; Agnusdei et al. (2023) evaluated the critical factors for circularity within an agro-industry using the **ANP**, and consequently used **ADAM** to rank the strategic alternatives; Coluccia et al. (2024) developed a multi-level tool using **AHP** and **ADAM** to support the circular economy decision-making process in agri-food entrepreneurship; Darmian et al. (2023) formulated a model to rank the potential process industries in South Khorasan province using **Fuzzy EDAS** and the ranking was convened by **Fuzzy SWARA** through establishment of weights for various criteria and sub-criteria pertaining to the sustainable development of process industries; Das et al. (2023b) integrated **Fuzzy AHP** and **Fuzzy TOPSIS** to facilitate the selection of optimal strategies for risk reduction in order to promote sustainable development within a food grain supply chain; Daultani et al. (2025) and Yadav et al. (2023a) employed **Fuzzy AHP** and **TOPSIS** to model resilient functions within a perishable FSC for successful translation into a sustainable FSC, and to assess and rank international markets based on stringency of food safety measures, respectively; Liao et al. (2023a) made use of **AHP** and **fuzzy TOPSIS** to assess the sustainable performance within a fresh food cold supply chain; Singh et al. (2018a) proposed a Hybrid MCDM Model integrating **Fuzzy AHP** and **Fuzzy TOPSIS** for 3PL provider selection within a cold chain; Kumar et al. (2022b) blended **Fuzzy AHP** and **Fuzzy TOPSIS** to assess the performance of a circular driven sustainable agri-food supply chain towards the achievement of sustainable production and consumption; Liu et al. (2019) proposed a fuzzy decision tool employing **AHP** and **TOPSIS** to evaluate the sustainable performance of suppliers in an agrifood value chain; Rathore et al. (2017) synergized **Grey AHP** and **Grey TOPSIS** to foster risk assessment within an FSC; Krstić et al. (2022a) merged **AHP** and **COBRA** to convene the deployment of Logistics 4.0 towards circular economy enhancement within an Agri-food sector; Krstić et al. (2023) combined **FARE** and **ADAM** for prioritization of e-traceability drivers within an Agri-food chain; and Yazdani et al. (2021) presented a multi-criteria framework for agriculture supply chain risk management under a circular economy context consolidating **SWARA**, FMEA and **EDAS** methods.

In a same way, Krstić et al. (2024) fused **BWM** and **COBRA** to analyse risks within an Agri-food chain for circularity achievement; Mishra et al. (2023) synergized **BWM** and **SWARA** to explore the issues associated with sustainable development of an agri-food chain; Zenouz et al. (2021) explored the synergy of **BWM** and **Fuzzy TOPSIS** to evaluate knowledge management systems for enhanced performance; Srinivasan et al. (2023) made use of **Fuzzy BWM** and **Fuzzy TOPSIS** to prioritize the mitigation strategies in order to overcome the lean and green barriers for sustainable transformation; Di Nardo et al. (2022) mixed **BWM, EWM** and **EDAS** to overcome the shortcomings of the traditional Failure Mode and Effect Analysis, in order to enhance system reliability within an Italian agri-food sector; Agyemang et al. (2022) integrated **BWM** and **GRA** methods to evaluate the criteria for social sustainability. Also, Kumar et al. (2022c) unified **SWARA** and **MULTIMOORA** to study the impact of covid-19 on a cold chain carrying perishable foods; Liu et al. (2018) built a novel two-stage integrated model using **Fuzzy BWM**, **EWM** and **MULTIMOORA** for supplier selection of green fresh product; and Magableh (2024) formulated two hybrid models i.e., **EWM** and **MOORA/EWM** and **COPRAS** to facilitate rice supplier selection.

Likewise, Chauhan et al. (2020) formulated a hybrid model consisting of the **ANP, DEMANTEL, and ISM** to investigate and select a sustainable supply chain for Agri-produce in India; Delouyi et al. (2023) merged **ANP** and **DEMANTEL** to explore the barriers to the circular economy implementation within an FSC; Dubey & Tanksale (2022), and Zhang et al. (2022) used **ANP** and **DEMANTEL** to study and analyse the barriers for adoption and growth of food banks in India, and to investigate the key influencing factors fostering Public-Public collaboration for food safety risk management, respectively; Niu et al. (2021) integrated **ANP** and **DEMANTEL** to scrutinize key factors for food fraud from a social governance perspective; Haider & Choubey (2024), and Shanker et al. (2022) consolidated **GREY ANP** and **DEMANTEL** to investigate factors resulting in FLW within a fruit and vegetable supply chain in order to drive sustainable production and consumption and to enhance resiliency within a perishable chain, respectively; Hajiagha et al. (2022) unified **Fuzzy ANP** and **Fuzzy DEMANTEL** to promote international entrepreneurial partnerships; Sufiyan et al. (2019) proposed for combined usage of **Fuzzy DEMANTEL** and **ANP** to assess the performance of an FSC; Raut et al. (2019) made use of **Fuzzy DEMANTEL** and **Fuzzy AHP** to evaluate cold third party logistics providers based on their abilities to reduce FLW within a fruit and vegetable supply chain; Kumar et al. (2020) pooled **ANP** and **ISM** to examine the challenges for sustainable achievement within a perishable chain, operating in a developing economy; Kumar et al. (2023a) fused **ANP** and **ISM** to explore enablers for zero hunger achievement through deployment of IoT and Bloch Chain Technologies (BCT); Nayal et al. (2023) proposed a hybrid approach integrating **Delphi-ISM**, **Fuzzy MICMAC**, and **ANP** to analyse and rank the challenges and formulate strategies for the successful deployment of AI-ML (Artificial Intelligence and Machine Learning) towards mitigating the uncertainties faced by Covid-19; and Singh et al. (2018b) coupled **fuzzy AHP**, **DEMATEL**, and **TOPSIS** methods to formulate a Big data cloud computing framework for low carbon supplier selection within a beef supply chain. Equally, Duret et al. (2019) merged **AHP** and **ELECTRE III** to test the impact of eight intervention factors on food safety, cost of refrigeration, and amount of food waste generated within a perishable food chain; and Lau et al. (2018, 2020) formulated hybrid models deploying **fuzzy AHP**, **TOPSIS** and **ELECTRE** to convene fresh food supplier evaluation and organic food supplier evaluation, respectively. Also, Yontar (2023) unified ANP and MAIRCA to convene successful deployment of BCT within an agri-food chain.

In a like manner, Ardra & Barua (2022) formulated a hybrid model to be implemented in three phases, within the first phase, **ISM** was used to determine the relationship between the challenges related to reducing FLW by 50%, consequently the challenges were ranked and quantified using **fuzzy AHP** technique within the second step, and finally within the third phase **VIKOR** was used to rank possible strategies to address these challenges within emerging economies for FLW reduction; Jain et al. (2023) coupled **fuzzy AHP** and **fuzzy VIKOR** to build a technology acceptance model for deployment of Industry 4.0 within an AFSC; Kazançoğlu et al. (2021) put together **Fuzzy ANP** and **Fuzzy VIKOR** to enhance the circularity within dairy chains through introduction of digital solutions; and Kumar & Choubey (2023) synthesized **Fuzzy AHP** and **Fuzzy VIKOR** to assess the sustainable performance of a dairy chain towards achieving sustainable production and consumption. In a similar fashion, Khan & Ali (2021) united **ISM** and **Fuzzy VIKOR** for sustainable supplier selection within a cold supply chain, operating in a developing economy; and Rad & Sonesson (2024) used **DEMANTEL** and **TOPSIS** to explore drivers for a more sustainable future food system.

Moreover, Gardas et al. (2019), Kamble et al. (2019), and Yadav et al. (2022) devised an integrated structural model by synergizing **ISM** and **DEMANTEL** to assess the challenges towards enhancing the efficiency of an AFSC in India, to model the IoT adoption barriers within a food-retail supply chain, and to develop a framework for IoT induced coordination within an agri-food chain, respectively; Sharma et al. (2025b) resorted to a combo of **ISM** and **Fuzzy DEMANTEL** to integrate BCT into an agri-food chain for circularity enhancement; Kumar et al. (2022a) introduced a hybrid model combining the **ISM** and **Fuzzy DEMANTEL** to explore the enablers for resilience enhancement within an FSC; Kumar et al. (2023b) consolidated **ISM** and **Grey DEMANTEL** to explore the circular economy adoption challenges within an FSC for sustainable development; Mangla et al. (2018), and Yadav et al. (2021a) fused **ISM** and **Fuzzy DEMANTEL** to explore the enablers for implementation of sustainable initiatives within an agri-food chain and to investigate enablers for IoT based Multi-tier Sustainable Food Security System, respectively; Sharma et al. (2025a) curated an hybrid **Fuzzy ISM** and **DEMANTEL** model to investigate cause-and effect relationships between green, resilient, agile, and sustainable enablers within fresh food retail chain in India; Ramos et al. (2022) built a model integrating **ISM** and **Fuzzy MICMAC** methods for measuring agri-food supply chain performance; Srivastava & Dashora (2022) synergized **Fuzzy ISM** and **Fuzzy MICMAC** to investigate enablers for successful adoption of e-traceability within agri-food chains; Yadav et al. (2023b) curtailed an integrated model using **TISM** and **Fuzzy DEMANTEL** to analyse block chain adoption drivers to achieve sustainable food security in the Indian context; and Zhong et al. (2024) merged **DEMANTEL-ISM-MICMAC** to explore resilience capability factors within an agri-food chain.

Additionally, Ghosh et al. (2024) built a hybrid model combining **CRITIC** and **VIKOR** to convene the translation from a linear economy to a circular economy with an objective to achieve the SDG; Sharma et al. (2023b) deployed an integrated model built using **BWM, LBWA**, and **CoCoSo** to overcome the barriers for digital technology implementation for sustainable production and consumption. Further, Banaeian et al. (2018) compared **-Fuzzy TOPSIS, Vikor and GRA** methods for supplier selection based on environmental criteria within an agri-food industry; and La Scalia et al. (2021) made use of **VIKOR** and **TOPSIS** to analyse the performance of the novel bio-composite mortars for coffee biowaste valorisation fostering a circular economy. Furthermore, Yadav et al. (2021b) explored the synergy of merging **EWM** and **Fuzzy TOPSIS** to develop an IoT based data-driven agriculture supply chain performance measurement framework; and Yazdani et al. (2022a) pooled **BWM** and **Fuzzy MARCOS** to measure resiliency in an FSC.

3.2 ADO based MCDM Review within Food Chains

3.2.1 Antecedents

Antecedents play a crucial role within the ADO framework influencing both the decisions and the outcomes. They stand crucial as they identify factors or conditions that lead to the application of MCDM models within FSCs. Wherein the factors or conditions addressed within the literature include i.e. *Capabilities* (dire need to foster resilience or adaptive capabilities); *Challenges* (implementation of advanced digital technologies, sustainability reporting, limited shelf life of foods, demand and supply imbalances resulting from post-harvest food losses, providing access to safe, healthy, and high-quality foods, implementation of green practices, high carbon-foot prints, circularity assessments, determinantal effects from Covid-19, and sustainable development); *Commitments* (to achieve SDG goals, to reduce FLW, to implement green practices, to ensure sustainable production and consumption, to foster collaboration between SC partners, and to transition from linear to circular economies); *Complexities* (arising from the nature of foods and the network design); *Compliance* (safety and quality regulations, and cross boundary governance of foods); *Concerns* (food fraud, increasing FLW, raising hunger levels, holistic performance assessment, high eco-logical foot prints, economic losses, value-degradation of foods, and economic / environmental impacts of refrigeration); *Network Characteristics* (unique characteristics portrayed by each type of an FSC, and partner selection); and *Risks & Disruptions* (globalization, natural calamities, man-made calamities, health & safety, dynamic external environments, pandemic situations, last-mile logistics, food-handling, and geo-political environments). The list of research studies from the literature portraying the application of MCDM models to address the above antecedents is depicted within **Table 12** below.

Table 12. Antecedents leading to the use of MCDM in FSC.

S. No.	Type of antecedent	References
1.	Capabilities	Abdel-Fattah & Al Hiary (2023), Ben Abdallah et al. (2024), Joshi et al. (2023), Kumar et al. (2022a), Sharma et al. (2025a), Yazdani et al. (2022a), Zhong et al. (2024).
2.	Commitments	Almuflih et al. (2022), Ardra & Baura (2022), Asrol & Yani (2024), Dania et al. (2022), Delouyi et al. (2023), Farooque et al. (2019), Ghosh et al. (2024), Kashyap et al. (2024), Kazançoğlu et al. (2021), Krstić et al. (2023), Liao et al. (2023a), Molist et al. (2024), Raut et al. (2018), Sahu et al. (2023), Sharma et al. (2023b), Sonar et al. (2023), Srinivasan et al. (2023).
3.	Challenges	Ali et al. (2019), Alsattar et al. (2023), Anand & Baura (2022), Arora et al. (2022), Baležentis et al. (2021), Chauhan et al. (2021), Coluccia et al. (2024), D'Adamo (2023), Das et al. (2023b), Dora et al. (2022), Dubey & Tanksale (2022), Ghadge et al. (2017), Hajiaghaei-Keshteli et al. (2023), Jain et al. (2023), Khamseh (2021), Kumar et al. (2022b, 2023b), Kumar & Kansara (2018), Lahane et al. (2023), Liu et al. (2019), Mishra et al. (2023), Narwane et al. (2022), Nayal et al. (2023), Nisar et al. (2024), Paul et al. (2023), Percin (2022), Qahtan et al. (2023), Singh et al. (2018b), Yadav et al. (2023b), Yontar (2023), Zkik et al. (2023).
4.	Compliance	Banach et al. (2021), Yadav et al. (2023a), Zhang et al. (2022).
5.	Complexities	Kamble et al. (2019), Kumar et al. (2024), Lau et al. (2020), Liu et al. (2018), Mohammadkhani & Mousavi (2023), Yazdani et al. (2022b).

Table 12 continued…

6.	Concerns	Agnusdei et al. (2023), Agyemang et al. (2022), Ali et al. (2022), Anand & Barua (2023), Ardra & Barua (2023), Di Nardo et al. (2022), Duret et al. (2019), Erdoğan (2022), Fagioli et al. (2017), Faibil et al. (2021), Gardas et al. (2018), Govindan et al. (2017), Grippo et al. (2019), Haider & Choubey (2024), Kaur (2021), Kashyap & Shulka (2023), Khan et al. (2023), Kumar & Choubey (2023), Kumar et al. (2020, 2023a), Krstić et al. (2022a, 2024), Lu et al. (2021), Magalhães et al. (2021a, 2021b, 2022), Mangla et al. (2018), Mor et al. (2018), Ögel et al. (2023), Priyambada et al. (2023), Ramos et al. (2022), Raut et al. (2019), Raut & Gardas (2018), Singh et al. (2023), Srivastava & Dashora (2022), Sun et al. (2023), Surucu-Balci & Tuna (2021), Wang et al. (2024a), Yadav et al. (2021b).
7.	Network characteristics	Banaeian et al. (2018), Bilisik & Baraçlı (2023), Görçün et al. (2023), Khan & Ali (2021), Lau et al. (2018), Liao et al. (2020), Long & Liao (2021), Magableh (2024), Magableh (2023), Rezaei et al. (2016), Rong et al. (2022), Shi et al. (2018), Singh et al. (2018a), Sufiyan et al. (2019), Wang & Liao (2023).
8.	Risks & disruptions	Azadnia et al. (2021), Chauhan et al. (2020), Daultani et al. (2025), Eygue et al. (2020), Gupta et al. (2023), Hong et al. (2024), Karwasra et al. (2024), Khan et al. (2021), Kumar et al. (2021, 2022c), Kuizinaitė et al. (2023), Lau et al. (2021), Melkonyan et al. (2020), Niu et al. (2021), Prakash et al. (2017), Rathore et al. (2017), Shafiee et al. (2022), Shanker et al. (2022), Sharma et al. (2022), Wang et al. (2023, 2024b), Xu & Tang (2022), Yadav et al. (2021a, 2022), Yazdani et al. (2021), Zhao et al. (2024).

3.2.2 Decisions

This component of the framework aids with examining the key decisions and characteristics towards employing MCDM within FSCs. Further, the **Table 13** below, reflects on the key decisions identified from the literature. Additionally, **Figure 9** (Appendix I) portrays the distribution of articles based on the key decision areas.

Table 13. Key decisions.

S. No.	Key decisions	References
1.	To develop efficient risk mitigation strategies.	Azadnia et al. (2021), Das et al. (2023b), Eygue et al. (2020), Gupta et al. (2023), Hong et al. (2024), Karwasra et al. (2024), Khan et al. (2021), Krstić et al. (2024), Kuizinaitė et al. (2023), Kumar et al. (2021), Lau et al. (2021), Liao et al. (2023b), Prakash et al. (2017), Rathore et al. (2017), Shafiee et al. (2022), Sharma et al. (2022), Xu & Tang (2022), Yazdani et al. (2021).
2.	To develop strategies fostering adaptive capacities.	Abdel-Fattah & Al Hiary (2023).
3.	To formulate strategies for enhancing food quality.	Chauhan et al. (2021), Di Nardo et al. (2022), Leung et al. (2021).
4.	To formulate strategies for enhancing food safety.	Garre et al. (2020), Lau et al. (2020), Niu et al. (2021).
5.	To formulate strategies for deployment of new digital technologies.	Ajmera et al. (2024), Alsattar et al. (2023), Arora et al. (2022), Banach et al. (2021), Dora et al. (2022), Erdoğan (2022), Jain et al. (2023), Kamble et al. (2019), Kaur (2021), Khan et al. (2023), Krstić et al. (2022a, 2023), Kumar & Kansara (2018), Kumar et al. (2024), Lahane et al. (2023), Narwane et al. (2022), Nayal et al. (2023), Nisar et al. (2024), Quayson et al. (2024), Qahtan et al. (2023), Sharma et al. (2023b, 2025b), Srivastava & Dashora (2022), Yadav et al. (2021a, 2022, 2023b), Yontar (2023), Zkik et al. (2023).
6.	To formulate strategies for deployment of sustainability and circularity initiatives.	Agnusdei et al. (2023), Agyemang et al. (2022), Ajmera et al. (2024), Ali et al. (2022), Almuflih et al. (2022), Ardra & Barua (2023), Asrol & Yani (2024), Azadnia et al. (2021), Coluccia et al. (2024), D'Adamo (2023), Delouyi et al. (2023), Duret et al. (2019), Farooque et al. (2019), Ghadge et al. (2017), Ghosh et al. (2024), Grippo et al. (2019), Jagoda et al. (2023), Kashyap & Shukla (2023), Kumar et al. (2020, 2023b), Kazançoğlu et al. (2021), La Scalia et al. (2021), Liao et al. (2023a), Mangla et al. (2018), Melkonyan et al. (2020), Molist et al. (2024), Mishra et al. (2023), Mohammadkhani & Mousavi (2023), Perçin (2022), Rad & Sonesson (2024), Raut & Gardas (2018), Sahu et al. (2023), Sharma et al. (2025a, 2025b), Sonar et al. (2023), Srinivasan et al. (2023), Tseng et al. (2022), Yontar (2023).
7.	To formulate strategies for enhanced collaboration among supply chain partners.	Anand & Barua (2023), Dania et al. (2022), Hajiagha et al. (2022), Yadav et al. (2022), Zhang et al. (2022).
8.	To formulate strategies for enhancing resilience capabilities.	Baležentis et al. (2021), Daultani et al. (2025), Joshi et al. (2023), Kumar et al. (2021, 2022a, 2022c), Paul et al. (2023), Shanker et al. (2022), Wang et al. (2024b), Yazdani et al. (2022a), Zhao et al. (2024), Zhong et al. (2024).
9.	To formulate strategies for enhancing food security.	Anand & Barua (2023), Dubey & Tanksale (2022), Kumar et al. (2023a).

Table 13 continued…

10.	To design a performance management framework with key indicators.	Kumar et al. (2022b), Kumar & Choubey (2023), Mor et al. (2018), Ramos et al. (2022), Sufiyan et al. (2019), Wang et al. (2023), Yadav et al. (2021b).
11.	To formulate strategies for FLW reduction.	Ali et al. (2019), Anand & Barua (2022), Ardra & Barua (2022), Das et al. (2023a), Faibil et al. (2021), Gardas et al. (2018), Haider & Choubey (2024), Kaur (2021), Kashyap et al. (2024), Lu et al. (2021), Lombardi & Todella (2023), Magalhães et al. (2021a, 2021b, 2022), Ögel et al. (2023), Priyambada et al. (2023), Raut et al. (2018, 2019), Singh et al. (2023), Surucu-Balci & Tuna (2021), Wang et al. (2024a).
12.	To optimally evaluate and select supply chain partners for efficient supply chain design.	Banaeian et al. (2018), Ben Abdallah et al. (2024), Chauhan et al. (2020), Görçün et al. (2023), Govindan et al. (2017), Hajiaghaei-Keshteli et al. (2023), Khamseh (2021), Khan & Ali (2021), Lau et al. (2018), Linnemann et al. (2015), Liu et al. (2018, 2019), Long & Liao (2021), Magableh (2024), Magableh (2023), Rezaei et al. (2016), Rong et al. (2022), Shi et al. (2018), Singh et al. (2018a, 2018b), Sun et al. (2023), Wang & Liao (2023), Yazdani et al. (2022b).

3.2.3 Outcomes

The outcomes provide a means to assess the results or impacts of applying MCDM techniques within FSCs. Moreover, the outcomes from the research studies are featured within the **Table 14** below.

Table 14. Study outcomes.

S. No.	Study outcomes	References
1.	Circularity enhancement	Agnusdei et al. (2023), Ajmera et al. (2024), Ali et al. (2022), Ardra & Barua (2023), Coluccia et al. (2024), Farooque et al. (2019), Ghosh et al. (2024), Grippo et al. (2019), Kazançoğlu et al. (2021), Krstić et al. (2022a), Perçin (2022), Sharma et al. (2025b), Sonar et al. (2023), Yontar (2023).
2.	Competitive edge	Zenouz et al. (2021).
3.	Customer value enhancement	Fagioli et al. (2017), Khan et al. (2023), Magableh (2024), Melkonyan et al. (2020), Singh et al. (2018a).
4.	Digitalization	Ajmera et al. (2024), Alsattar et al. (2023), Arora et al. (2022), Erdoğan (2022), Jain et al. (2023), Kamble et al. (2019), Krstić et al. (2022a), Kumar & Kansara (2018), Kumar et al. (2024), Lahane et al. (2023), Narwane et al. (2022), Nayal et al. (2023), Nisar et al. (2024), Quayson et al. (2024), Qahtan et al. (2023), Sharma et al. (2025b), Yadav et al. (2022), Yontar (2023), Zkik et al. (2023).
5.	Economic growth enhancement	Darmian et al. (2023).
6.	Efficiency enhancement	Gardas et al. (2019).
7.	Efficient SC design	Banaeian et al. (2018), Bilisik & Baraçlı (2023), García et al. (2014), Govindan et al. (2017), Hajiaghaei-Keshteli et al. (2023), Khamseh (2021), Khan & Ali (2021), Linnemann et al. (2015), Liu et al. (2018), Long & Liao (2021), Magableh (2024), Melkonyan et al. (2020), Mohammadkhani & Mousavi (2023), Rezaei et al. (2016), Rong et al. (2022), Scott et al. (2024), Shi et al. (2018), Wang & Liao (2023), Yazdani et al. (2022b).
8.	Food quality enhancement	Görçün et al. (2023), Leung et al. (2021).
9.	Food safety enhancement	Banach et al. (2021), Garre et al. (2020), Lau et al. (2018, 2020), Lu et al. (2021), Niu et al. (2021), Yadav et al. (2023a), Zhang et al. (2022).
10.	Food security enhancement	Das et al. (2023a), Dubey & Tanksale (2022), Gardas et al. (2018), Kashyap et al. (2024), Kaur (2021), Kumar et al. (2023a), Magableh (2023), Singh et al. (2023), Yadav et al. (2021a, 2023b).
11.	Performance assessment & improvement	Mor et al. (2018), Ramos et al. (2022), Sufiyan et al. (2019), Sun et al. (2023), Wang et al. (2023), Yadav et al. (2021b).
12.	SC collaboration enhancement	Anand & Barua (2023), Dania et al. (2022), Hajiagha et al. (2022), Liu et al. (2019), Yadav et al. (2022).
13.	Traceability enhancement	Dora et al. (2022), Krstić et al. (2023), Srivastava & Dashora (2022).
14.	Reduced FLW	Ali et al. (2019), Alsattar et al. (2023), Anand & Barua (2022, 2023), Ardra & Barua (2023), Erdoğan (2022), Faibil et al. (2021), Haider & Choubey (2024), Kharola et al. (2022), Lombardi & Todella (2023), Magalhães et al. (2021a, 2021b, 2022), Ögel et al. (2023), Priyambada et al. (2023), Raut et al. (2019), Surucu-Balci & Tuna (2021), Wang et al. (2024a), Wohner et al. (2020).
15.	Resilience enhancement	Baležentis et al. (2021), Daultani et al. (2025), Joshi et al. (2023), Kumar et al. (2022a, 2022c), Lau et al. (2021), Nisar et al. (2024), Paul et al. (2023), Shanker et al. (2022), Sharma et al. (2022), Wang et al. (2024b), Yazdani et al. (2022a), Zhao et al. (2024), Zhong et al. (2024).

Table 14 continued...

16.	Risk mitigation	Azadnia et al. (2021), Das et al. (2023b), Eygue et al. (2020), Gupta et al. (2023), Hong et al. (2024), Karwasra et al. (2024), Khan et al. (2021), Krstić et al. (2024), Kuizinaitė et al. (2023), Lau et al. (2021), Liao et al. (2023b), Nayal et al. (2023), Prakash et al. (2017), Rathore et al. (2017), Shafiee et al. (2022), Xu & Tang (2022), Yazdani et al. (2021).
17.	Sustainability enhancement	Agyemang et al. (2022), Almuflih et al. (2022), Arshadi (2021), Asrol & Yani (2024), Azadnia et al. (2021), Banaeian et al. (2018), Ben Abdallah et al. (2024), Chauhan et al. (2020), Coluccia et al. (2024), D'Adamo (2023), Dania et al. (2022), Das et al. (2023b), Delouyi et al. (2023), Duret et al. (2019), Fagioli et al. (2017), Gardas et al. (2018), Ghadge et al. (2017), Görçün et al. (2023), Govindan et al. (2017), Haider & Choubey (2024), Hajiaghaei-Keshteli et al. (2023), Jagoda et al. (2023), Kashyap & Shukla (2023), Khan & Ali (2021), Kumar & Choubey (2023), Kumar et al. (2020, 2021, 2022b, 2023b, 2024), Lahane et al. (2023), La Scalia et al. (2021), Liao et al. (2023a), Liu et al. (2018, 2019), Long & Liao (2021), Mangla et al. (2018), Molist et al. (2024), Mishra et al. (2023), Mohammadkhani, & Mousavi (2023), Paul et al. (2023), Quayson et al. (2024), Rad & Sonesson (2024), Raut et al. (2018), Raut & Gardas (2018), Sahu et al. (2023), Qahtan et al. (2023), Sharma et al. (2023b, 2025a), Singh et al. (2018b), Srinivasan et al. (2023), Tseng et al. (2022), Wang et al. (2024a), Yadav et al. (2021a), Zkik et al. (2023).

4. Conclusions and Future Research Directions

This study presents a systematic literature review on MCDM applications in FSCs embracing a novel research synthesis framework (TCM-ADO). Additionally, this article is the first to pursue a holistic review of MCDM applications within all types of food chains to address diverse challenges. Furthermore, the review has highlighted the studies in terms of underpinning theories, application contexts, methodologies used, and antecedents that influence both decision environments and outcomes resulting from the use of MCDM models within FSC settings.

Further, the study provided multiple insights for key stakeholders within the FSC domain, in the form of underpinning theories facilitating the application of diverse and unique MCDM approaches within multiple contexts, fostering key decisions to address multitudinous antecedents promoting visible outcomes in the form of multifaceted FSC capabilities.

The descriptive analysis highlighted that about 82% of the reviewed papers were published over the last five years. It also revealed that most of the reviewed papers focused on agri-food chains (31%) and generic-food chains (30%). Additionally, about 28% of the papers reviewed concentrated on the application of MCDM to address sustainability within food chains.

Nonetheless, the study also highlighted the deployment of MCDM models towards identifying key areas that stand vulnerable to disruptions within dairy chains, consequently aiding the primary stakeholders to promote risk reduction, resilience, and agility within the dairy chains through formulation of appropriate mitigation strategies for addressing the key vulnerabilities identified. Likewise, the review also underlined the significance of aligning strategies and objectives within food chains i.e., Foxnut supply chains with the "17 Sustainable Development Goals (SDG) defined by the United Nations" by embracing MCDM models to address barriers with regard to reducing food losses and wastes (FLW). Equally, the article featured the operationalization of prominent marketing theories (the "order qualifier and winner paradigm developed by Hill") within a supermarket chain based out of Australia. Coles and Woolworths to convene the evaluation of fresh food suppliers based on safety performance criteria through formulation of unique hybrid MCDM models. In addition, the literature synthesis also indicated the prominence of MCDM methods towards formulating strategies for deployment of new digital technologies fostering traceability enhancements within Indian food chains.

The systematic review further identified several gaps within the FSC literature, highlighting the need for additional focused research. This section concludes with recommendations for further study to address noted gaps.

- Based on the descriptive analysis, a bulk of research studies concentrated on addressing sustainability within food chains. However, with increased food fraud and increasing levels of FLW across the globe, there is a dire need to deploy MCDM within FSCs for enhancing food safety and food security.
- Besides, the scope of studies reviewed pertained to a single nation or specific types of foods, leading to problems with regards to generalization of the study results, hence there lies a need to replicate the studies within other similar nations or different types of foods for generalization of results.
- In addition, there lies a need for longitudinal examination to assess the impact of strategies formulated based on insights gathered from the deployment of MCDM approaches.
- Equally, only 40% of the studies employed fuzzy or grey concepts to address the vagueness and uncertainties within the subjective inputs received from the experts. Subsequently, reflecting a need to develop future MCDM only through incorporation of fuzzy and grey concepts as the MCDM models are solely dependent on expert inputs towards evaluation of criteria weights and for alternative ranking.
- Likewise, most of the studies lacked validation of the results through comparative analysis using alternative MCDM approaches.
- Further, only 11% of the studies focused on embracing MCDM to aid with the digitalization efforts, reflecting a need to further deploy MCDM as an important tool for digital transformation which stands out as a one-stop solution to address many of the challenges faced by FSCs.
- Furthermore, a predominant focus on agri-food chains emphasizes a need for increased focus on cold and perishable chains that are extensively deployed within the current globalized era reflecting increased food trade among nations, towards addressing food safety and quality risks arising from increased food miles across the globe.
- Additionally, the studies focusing on CSCs (Cold Chains) independently concentrated on the application of MCDM on aspects such as identification and assessment of sustainable good practices, sustainability indicators, sustainability challenges, key performance indicators/critical success factors, evaluation criteria for selection of suppliers / Cold Third Party Logistic Service Providers (CTPLs), barriers to FLW reductions, criteria for high energy consumptions and environmental emissions, risks and risk contributing factors, remedial/mitigation strategies, key drivers for Supply Chain Vulnerability (SCU), temperature monitoring trends, food-loss drivers, criteria for product quality grading, barriers to food security and sustainable transportation etc., highlighting the need for the development of unique hybrid MCDM models to comprehensively address multiple aspects in an integrated fashion.
- Moreover, only a few studies concentrated on the application of MCDM models towards identification and analysis of criteria for CSCs performance assessment. Nonetheless, the studies lacked incorporation or consideration of an extensive list of criteria for assessing and ranking performance under multiple dimensions and failed to assess and rank the holistic performance of CSCs addressing all FSC challenges such as quality, security, safety, traceability, resilience, circularity, efficiency, and sustainability in an integrative fashion.

5. Limitations of the Study

This scope of this study was limited to articles published in English within the Scopus Q1 Journals in the time frame ranging between 2014 to 2024. Thereupon, article publications within other Journals (Scopus Q2, Q3, Q4, ABDC, etc.), Conference Proceedings, Books, Industry Reports, and within other additional sources, were not included within the preview of this study. In addition, the article search was limited to only Scopus database, indicating a probability of missing out on articles with relevant significance from other academic research databases. Besides, relevance determined by the title, abstract, and keywords led to the selection of 165 articles, including 11 cross-referenced papers, from a total list of 219 Scopus Q1 publications. Hence, there lies a possibility of skipping out on few relevant documents that the search query might have overlooked. Moreover, there is a chance that some of the research gaps may get addressed by other researchers by the time the article is available for readers. Furthermore, considering July 6, 2024, as the cut-off date, and the limits imposed on the review scope by the query string keywords used for the Scopus search, the authors assert that the results presented in this study stand reliable and accurate.

Conflict of Interest
The authors confirm that there is no conflict of interest to declare for this publication.

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AI Disclosure
During the preparation of this work the author(s) used generative AI in order to improve the language of the article. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

Appendix I

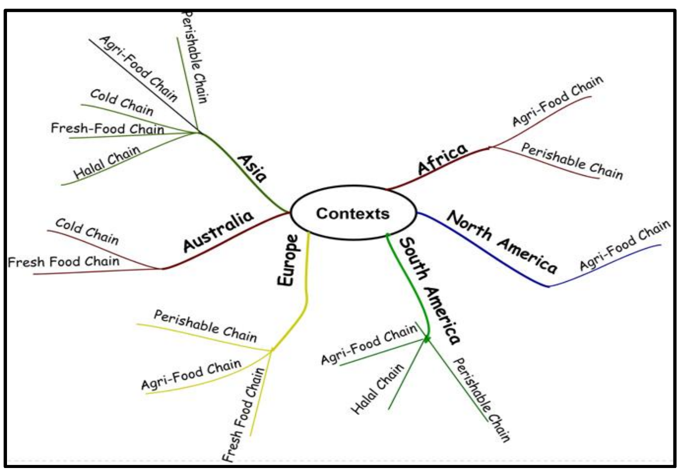

Figure 7. Geographic distribution based on the context.

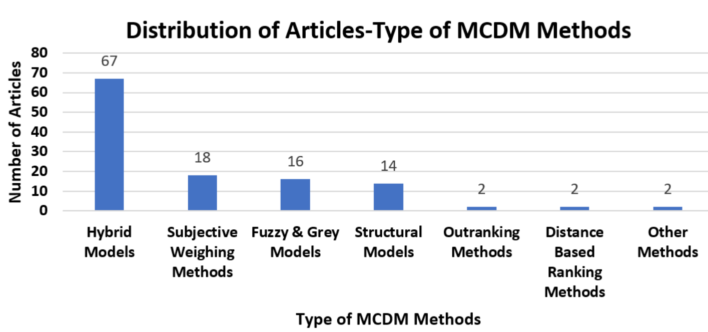

Figure 8. Distribution of articles based on the types of MCDM models employed.

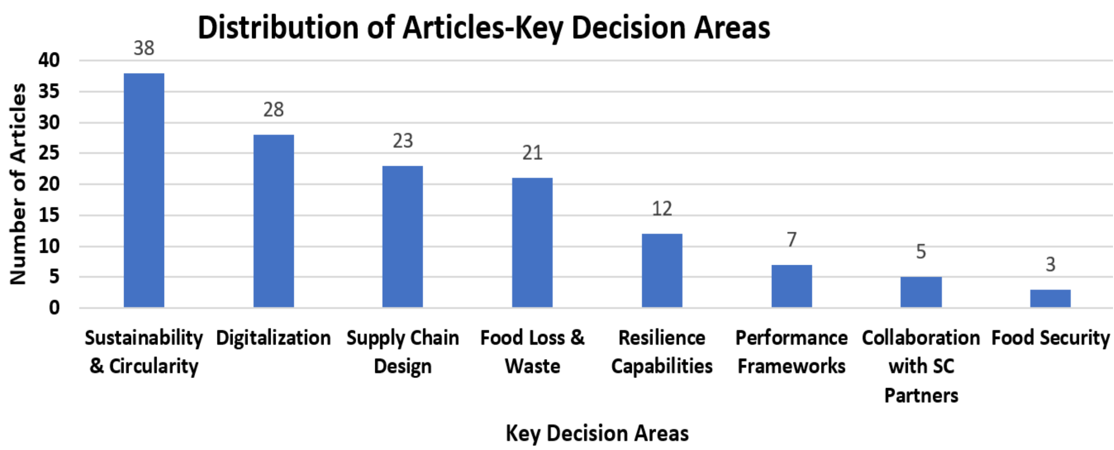

Figure 9. Distribution of articles based on the key decision areas.

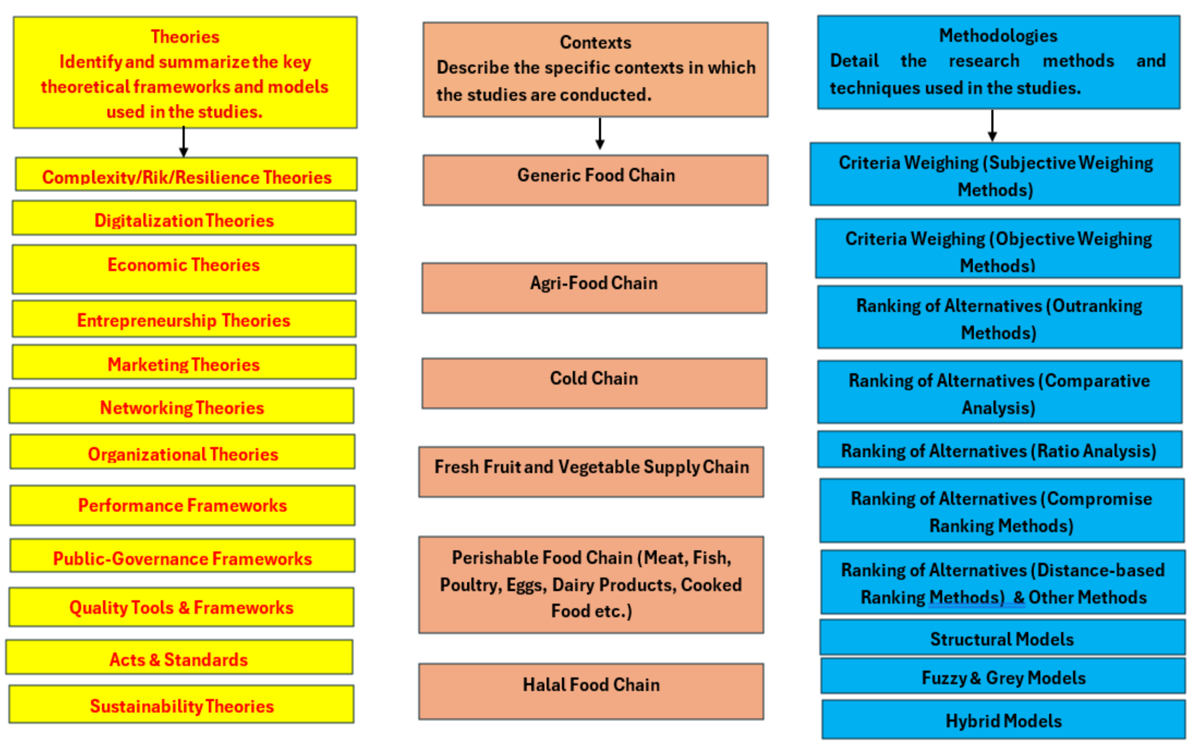

Figure 10. Results derived based on TCM analysis.

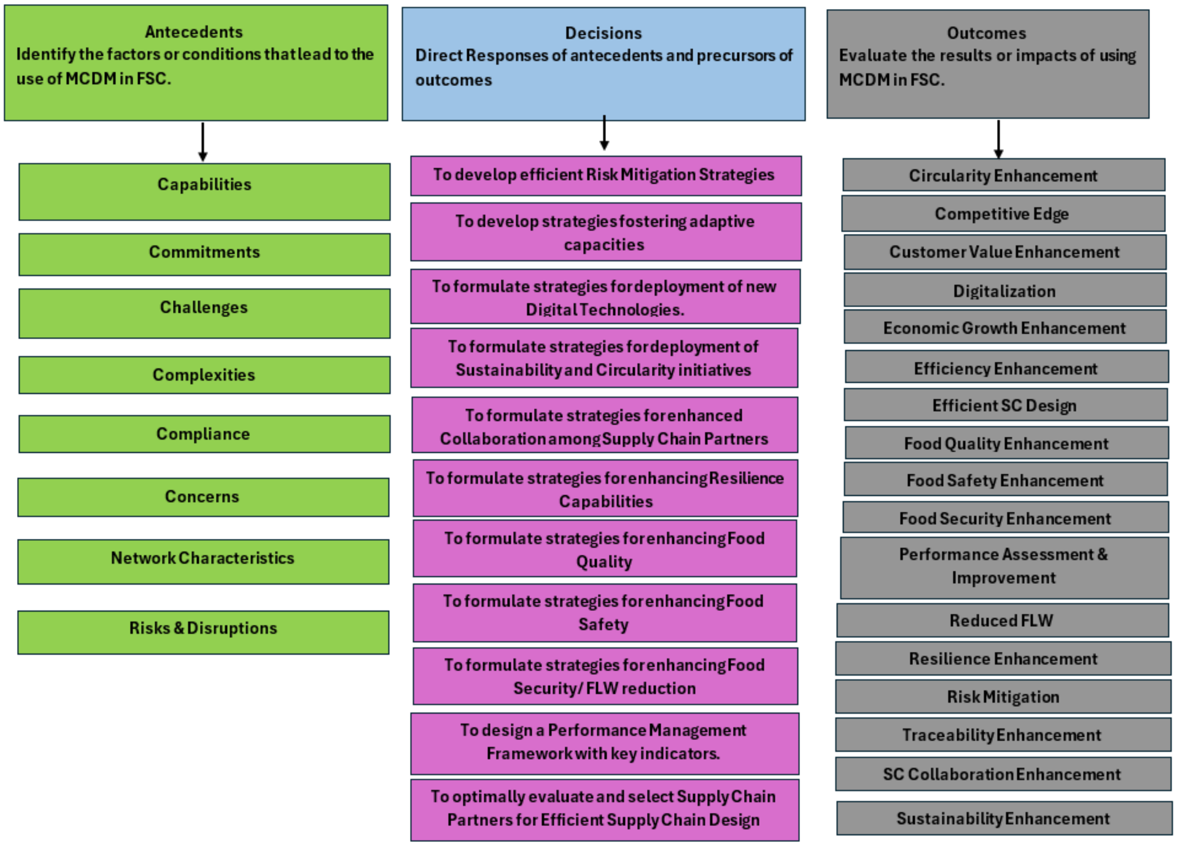

Figure 11. Results derived based on ADO analysis.

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