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REVIEW ARTICLE

Exploring the shortcomings in formal criteria selection for multicriteria decision making based inventory classification models: a systematic review and future directions

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ABSTRACT
Criteria selection significantly impacts the reliability and utility of multicriteria decision making (MCDM) models. While criteria may vary across industries, a formalised criteria selection process is influential in determining MCDM model outcomes. This article analyses and compares the criteria selection approaches used in 62 articles that apply MCDM-based inventory classification models, contrasting them with methodologies outside the field. Our findings reveal a conspicuous absence of formal criteria selection methods within MCDM-based inventory classification research. The limited application of quantitative and qualitative approaches indicates that this field has not kept pace with methodological advances in criteria selection. To bridge this gap, we advocate for further research aimed at developing a conceptual framework for criteria selection tailored to inventory classification. We also suggest evaluating the impact of formal criteria selection processes on inventory management decisions and exploring the benefits of integrating artificial intelligence into criteria selection for inventory classification studies. Additionally, this article identifies several limitations related to criteria selection for practitioners employing MCDM-based inventory classification models.

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KEYWORDS
Multicriteria decision making; inventory classification; criteria selection; criteria selection process; inventory management

1. Introduction

Inventory classification is a classic MCDM problem, whereby a set of objects (i.e. inventory items) is categorised into predefined classes based on selected criteria, with each object being assigned to a single class (Hu et al. 2017). Classifying inventory serves multiple purposes such as determining optimal order or production quantities, establishing reorder points, calculating safety stock, and other related metrics based on multiple criteria (Van Kampen, Akkerman, and Van Donk 2012). Inventory classification relies on relevant and effective criteria that simplify inventory management by reducing the necessity for multiple inventory management policies, thus enhancing an organisation's competitive advantage (Hadi-Vencheh and Mohamadghasemi 2011; Liu et al. 2016). Consequently, inadequate criteria selection may lead to suboptimal inventory management decisions, resulting in adverse economic and operational outcomes.

Criteria selection involves the careful identification and choice of specific attributes or measures that are used to compare decision alternatives within MCDM models. It is a systematic process that aims to pinpoint the most relevant factors that directly contribute to the decision objective. A robust formal criteria selection process ensures that the chosen criteria effectively reflect key aspects of the decision context, thereby enabling accurate evaluation and comparison of alternatives, in this case inventory items. Effective criteria selection should consider multiple factors related to the decision objective, simultaneously avoiding overlap, duplication, and misalignment (de Souza et al. 2021; Lima-Junior and Carpinetti 2016). It also involves ensuring that each criterion adds unique value to the decision making process, fostering transparency, and ensuring comparable and consistent model results (Kügemann and Polatidis 2022).

MCDM approaches are effective at incorporating multiple criteria and have been pivotal in advancing the theory of inventory classification beyond the suboptimal, Pareto-based, mono-criterion ABC method favoured by practitioners (Ishizaka et al. 2018). Although MCDM-based inventory classification has demonstrated improved outcomes compared to mono-criterion approaches, research in this domain has faced criticism,

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particularly regarding weaknesses in the development of robust classification objectives and a continued reliance on product and volume-based criteria for classification purposes (Hu et al. 2018; Van Kampen, Akkerman, and Van Donk 2012). Additionally, Rezaei and Dowlatshahi (2010) emphasise the need for selecting important criteria but stop short of defining 'importance' or suggesting a formal criteria selection method for this purpose. Kabir (2012) acknowledges the negative impact of selecting unimportant criteria but does not offer a definition of criteria importance relative to the classification objective, nor a formal criteria selection method that accounts for these factors. Furthermore, there is a lack of evidence evaluating how the choice of criteria affects the outcomes of MCDM models for inventory classification. This underscores a gap in the literature for the development of a formal criteria selection process (de Souza et al. 2021; Kügemann and Polatidis 2022; Niknazar and Bourgault 2017; Yurdakul and Tansel 2009).

However, researchers aiming to develop a formal criteria selection process for MCDM models have encountered several shortcomings. These include difficulties in justifying the chosen criteria, evaluating their effectiveness in achieving decision objectives (Yurdakul and Tansel 2009), the tendency to select identical criteria for different objectives (Niknazar and Bourgault 2017), and the lack of consistent industry-focused benchmark criteria sets for model comparison (Kügemann and Polatidis 2022).

Various fields have examined aspects of these shortcomings, including *construction* (Cuoghi and Leoneti 2019), *environmental sciences* (Abdullah et al. 2022; Ali and Abraham 2021) and *transportation* (Kügemann and Polatidis 2022). However, the inventory classification domain has yet to contribute significantly to this discussion and no field has yet managed to develop a universally effective process. Therefore, this research aims to critically assess the criteria selection process for MCDM-based inventory classification, drawing on insights from diverse fields. It is necessitated by the significant yet underexamined influence of criteria selection on inventory classification outcomes. The link between inadequate criteria selection and suboptimal decision making underscores the need for a formalised criteria selection process. Such a process would ensure the relevance and effectiveness of criteria and align them with classification objectives. This examination across different fields seeks to identify and address gaps in MCDM-based inventory classification, aiming to enhance decision making through improved criteria selection. Guided by this aim, the study poses the following research questions:

(1) How do criteria selection methods used in MCDM-based inventory classification research compare with those used in similar problems outside the inventory classification field?
(2) What are the gaps in criteria selection methods within MCDM-based inventory classification research, and which areas of the criteria selection process offer the most significant future research opportunities?

This review aimed to achieve several objectives: to examine criteria selection methods used in MCDM-based inventory classification research, to explore how criteria selection could enhance the reliability and utility of MCDM models for inventory classification, to introduce a conceptual perspective of the criteria selection process, to identify research opportunities to improve criteria selection, and outline the weaknesses of criteria selection within MCDM-based inventory classification to researchers and practitioners in the field. These goals were accomplished through a comprehensive literature analysis, which examined the strengths and weaknesses of existing criteria selection approaches and suggested areas for future research. These contributions underscore the gaps in the formal criteria selection process, which may impact the reliability and utility of MCDM-based inventory classification models.

The remainder of the article is structured as follows: Section 2 provides a background on criteria selection and introduces a stylised conceptual model. Section 3 describes our methodology. In Section 4, we examine criteria selection from the perspectives of MCDM-based inventory classification and non-inventory classification. Section 5 discusses criteria validation approaches. A discussion of the findings from preceding sections is presented in Section 6. The article concludes with a summary of findings, limitations, and future research directions in Section 7.

2. Overview of the criteria selection process

Criteria selection is a crucial step in applying MCDM models. However, a universally applicable criteria selection process for MCDM-based inventory classification has yet to be developed. To address the absence of a formal criteria selection process for MCDM-based inventory classification, we present a stylised process depicted in Figure 1, which serves as a visual aid and clarifies our perspective on the topic. For clarity, the five-step process represents the entirety of criteria selection, whereas (Step 3), specifically, refers to the methods used to select criteria following the identification of potential criteria. Table 1 describes Steps 1–4 in greater detail.

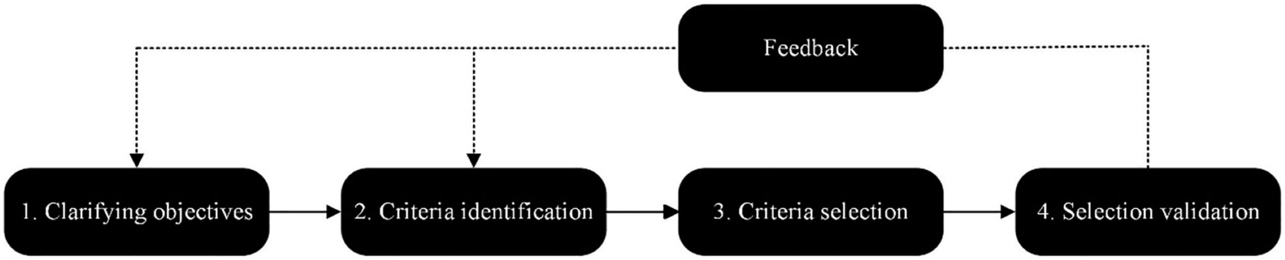

Figure 1. Stylised MCDM criteria selection process.

Table 1. Description of steps within the criteria selection process.

Step	Description
1	Clarifying objectives: Aligning stakeholders on strategic and performance goals related to the decision problem.
2	Criteria identification: Extracting and identifying criteria using multiple sources such as the literature, industry publications, databases, and experts.
3	Criteria selection: Applying qualitative and quantitative methods to reduce criteria lists to those most applicable to the decision problem.
4	Criteria validation: Applying qualitative and quantitative methods to evaluate alignment between criteria selection and the decision objective.
5	Feedback: Use input from validation step to correct any areas of misalignment in the preceding steps

Iterating through the steps presented in Figure 1 operationalises the criteria selection process. Additionally, this process corresponds with the problem structuring and model-building phases of the MCDM process described in (Belton and Stewart 2002). Although Figure 1 suggests independence between each step, this review finds that these steps often intersect. For example, Benites, Henrique, and Deo (2023) employ the Delphi technique for simultaneous criteria identification, selection, and validation. However, for clarity, we discuss Steps 2, 3, and 4 as distinct phases. It should be noted that the objective clarification (Step 1) and feedback loop are less emphasised in the MCDM-based inventory classification literature, yet are important to overall effectiveness of the criteria selection process.

To facilitate understanding, this review includes a hypothetical company undertaking an MCDM-based inventory classification study. Figure 2 provides further elaboration.

Figure 2 provides a generic illustration of the criteria selection process. It is important to note that while the overall criteria selection process is consistently applied, the specific methods for criteria identification, selection and validation methods may differ according to stakeholder preferences, skillsets, and data availability. These methods will be discussed in the forthcoming sections. Figure 2 is intended to serve as a reference for the reader.

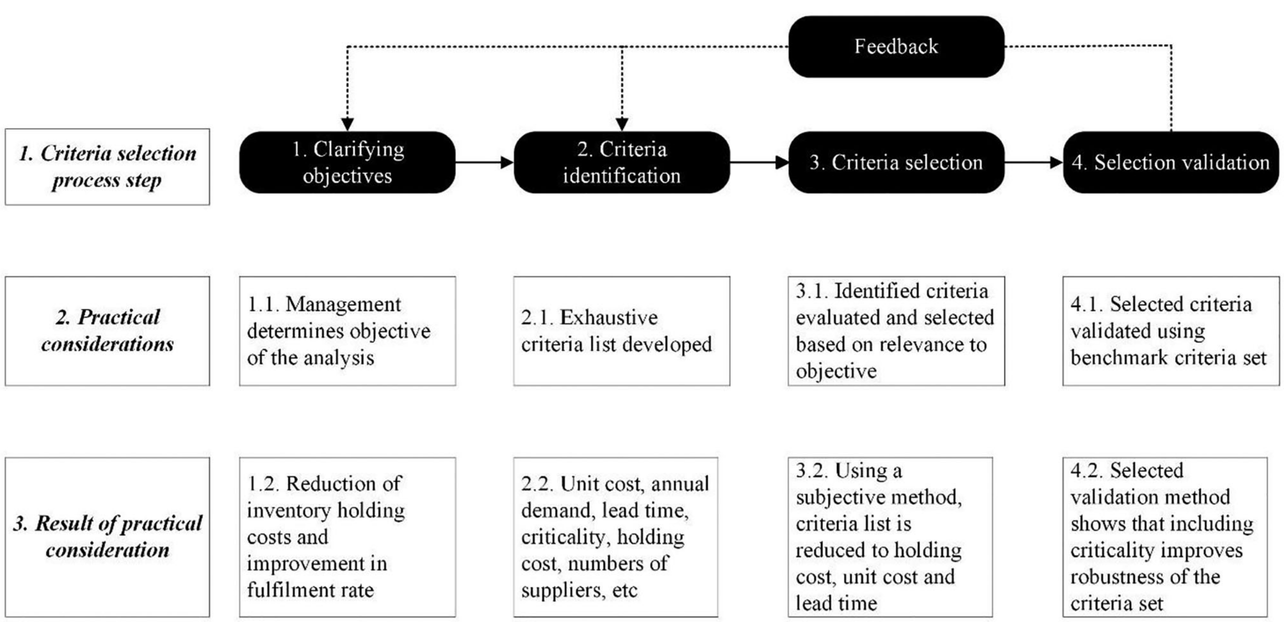

Figure 2. Example application of criteria selection process.

The next section outlines the research methodology and publication trends in the MCDM-based inventory classification field.

3. Research methodology

This study adheres to the PRISMA guidelines for conducting systematic literature reviews, which are designed to standardise review approaches and reduce bias. Tranfield, Denyer, and Smart (2003) and Liberati et al. (2009) provide detail on the method. Figure 3 outlines the research process guiding the review and closely follows the framework proposed by Ghadge et al. (2022).

The subsequent subsections detail each phase of the research process depicted in Figure 3, demonstrate adherence to the PRISMA guidelines, and provide a brief descriptive analysis of publication trends in MCDM-based inventory classification.

3.1. Research question development

A thematic analysis conducted during a pilot study of the MCDM-based inventory classification literature revealed an unexplored problem related to criteria selection in the field. This discovery prompted the formulation of corresponding research questions. Consequently, the pilot search was employed to systematically structure the study, demonstrating a transparent and structured approach to the development of research questions.

3.2. Search strategy and eligibility criteria

A comprehensive search strategy was employed, using both peer-reviewed and non-peer-reviewed databases to identify relevant literature for inclusion. The search spanned from 1987 to 2021 and used the search strings 'multi∗ inventory classification' and 'multi∗ ABC classification'. The article types were limited to research articles, reviews, conference papers, and conference reviews, all published in English. Out of a total of 332, 62 articles remained after a full-text review. No duplicates were found during the screening process, which is depicted in Figure 4 in accordance with PRISMA guidelines.

3.3. Data extraction and synthesis

The study utilised a standardised coding template to extract and synthesise data, facilitating a systematic analysis and integration of themes pertaining to criteria selection in both MCDM-based inventory classification and non-inventory classification fields. This thematic analysis entailed a critical evaluation of criteria selection methods, encompassing their strengths, weaknesses, and broader discourse within the literature.

3.4. Publication trend of MCDM-based inventory classification research

This section presents the publication trends in the MCDM-based inventory classification field, including the top ten publication outlets. MCDM-based approaches comprise 36.51% of the total literature on multicriteria inventory classification. However, as demonstrated by Figure 5, there is an observed decrease in this trend, while non-MCDM-based applications are on the rise.

3.5. Publication outlet

Figure 6 displays the top ten publication outlets, accounting for 41.94% of total publications in the MCDM-based inventory classification field. The remaining 58.06% are disseminated across a diverse range of journals and conference proceedings. The diversity of interest in this field is evidenced by the distribution of research across thirty-six unique publication titles, each contributing a single article.

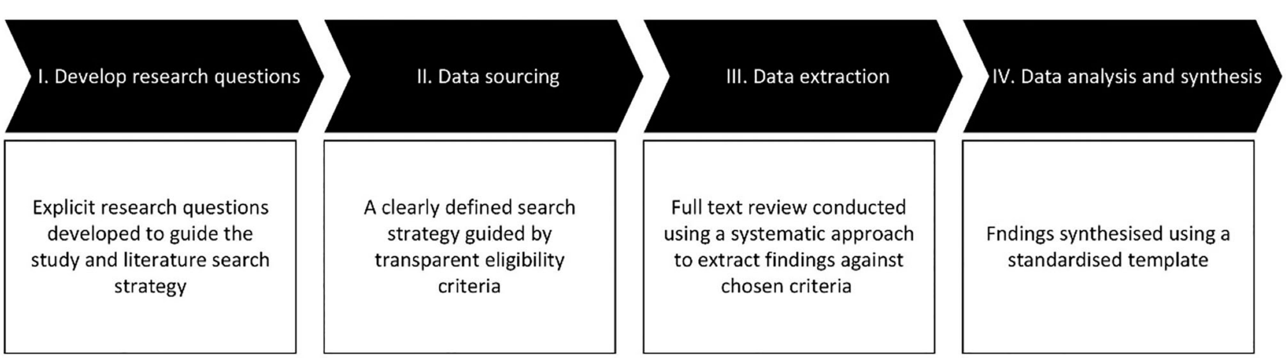

Figure 3. Process used to conduct the research, adapted from Ghadge et al. (2022).

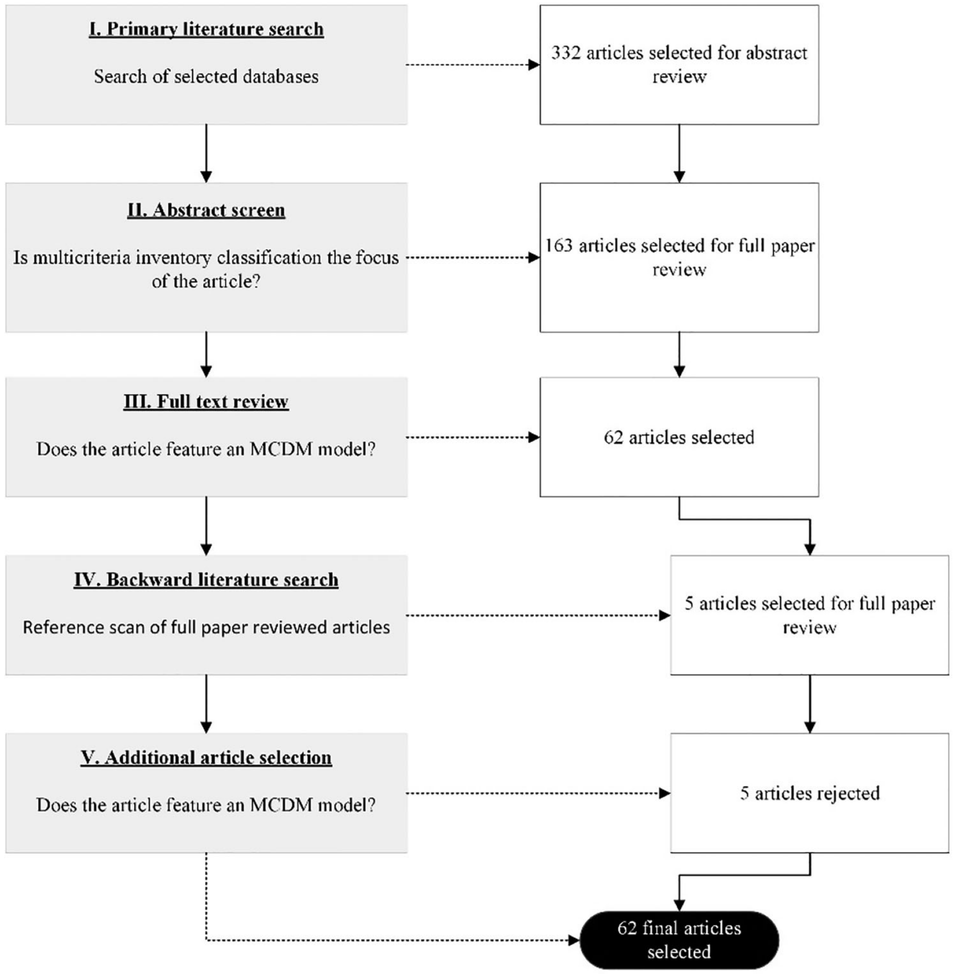

Figure 4. PRISMA data screening flow diagram.

4. Overview of criteria selection research contributions

This section explores criteria selection methods used in non-inventory classification MCDM-based fields and compares them with those in MCDM-based inventory classification research. The goal is to identify overlaps, note differences, and suggest potential areas for future research. Particular attention is placed on the criteria identification (Step 2), selection (Step 3), and validation (Step 4) stages of the criteria selection process.

4.1. Overview of MCDM-based non-inventory classification related criteria selection research contributions

Criteria selection has received extensive attention in fields such as *sustainability* (Abdullah et al. 2022; Ali and Abraham 2021; Benites, Osmond, and Deo 2023; Dias, Freire, and Geldermann 2019; Kügemann and Polatidis 2022; Shao et al. 2020; Singh and Gupta 2020), *supplier selection* (Lima-Junior and Carpinetti 2016; Ristono, Santoso, and Tama 2018), *project management* (de Souza et al. 2021; Niknazar and Bourgault 2017; Souza, Silva, and Soma 2020), *engineering* (Azhar et al. 2022; Yurdakul and Tansel 2009), and *agriculture* (Deepa and Ganesan 2016). Comparative research includes Bureš et al. (2020) who explore the effect of random and systematic criteria selection on the inconsistency of pairwise comparisons in the Analytic Hierarchy Process (AHP) and Zolfani and Derakhti (2020), who apply text mining to criteria selection.

4.2. Criteria identification literature in non-inventory classification MCDM applications

Criteria identification is key to aligning decision goals, objectives, and criteria. While formal methods like literature surveys and expert opinions are commonly employed for this purpose, they often overlook the specific goals and objectives inherent to a decision problem within its context. For example, relying in these traditional methods may result in a comprehensive criteria

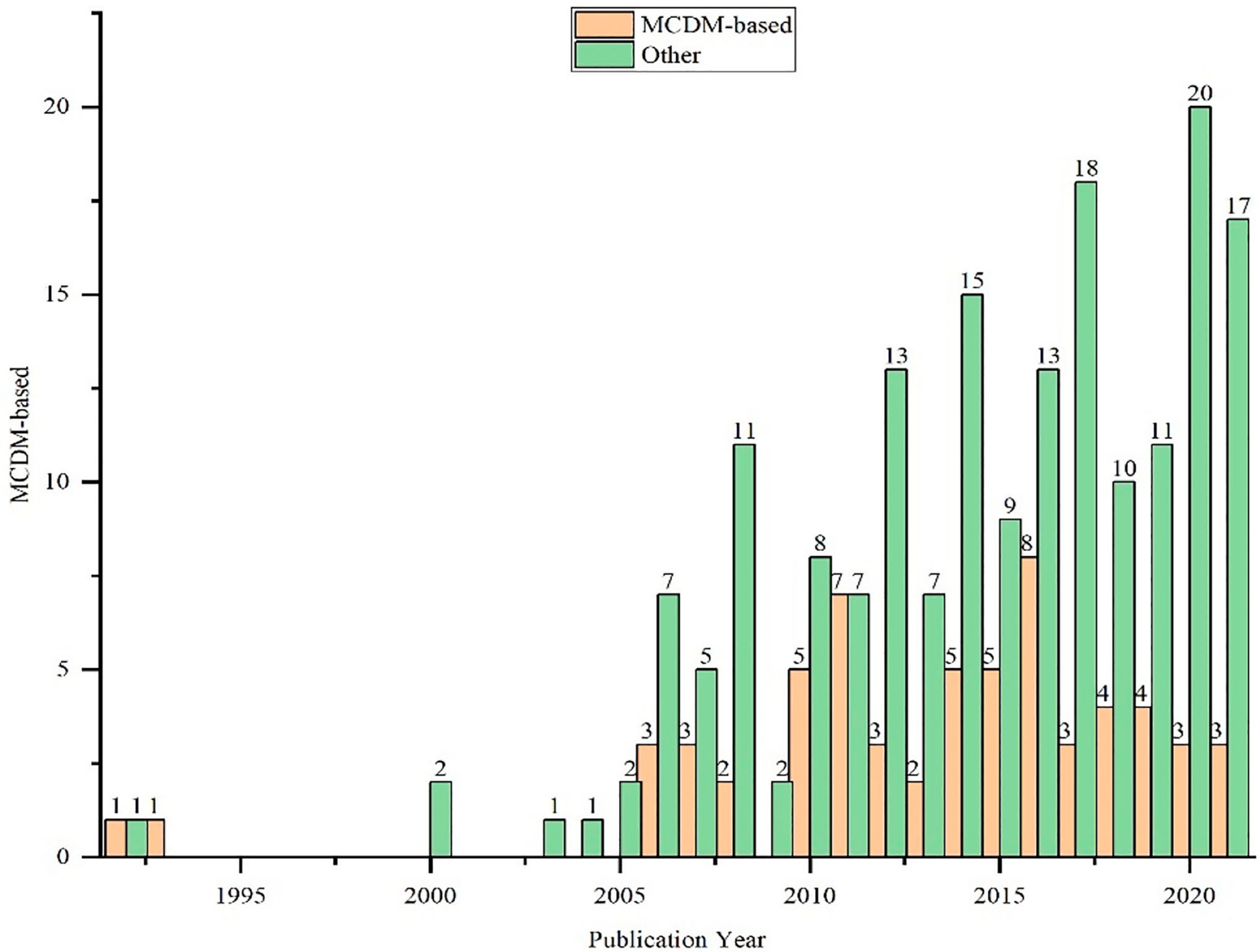

Figure 5. Comparison of publication trends for MCDM-based and non-MCDM-based inventory classification articles.

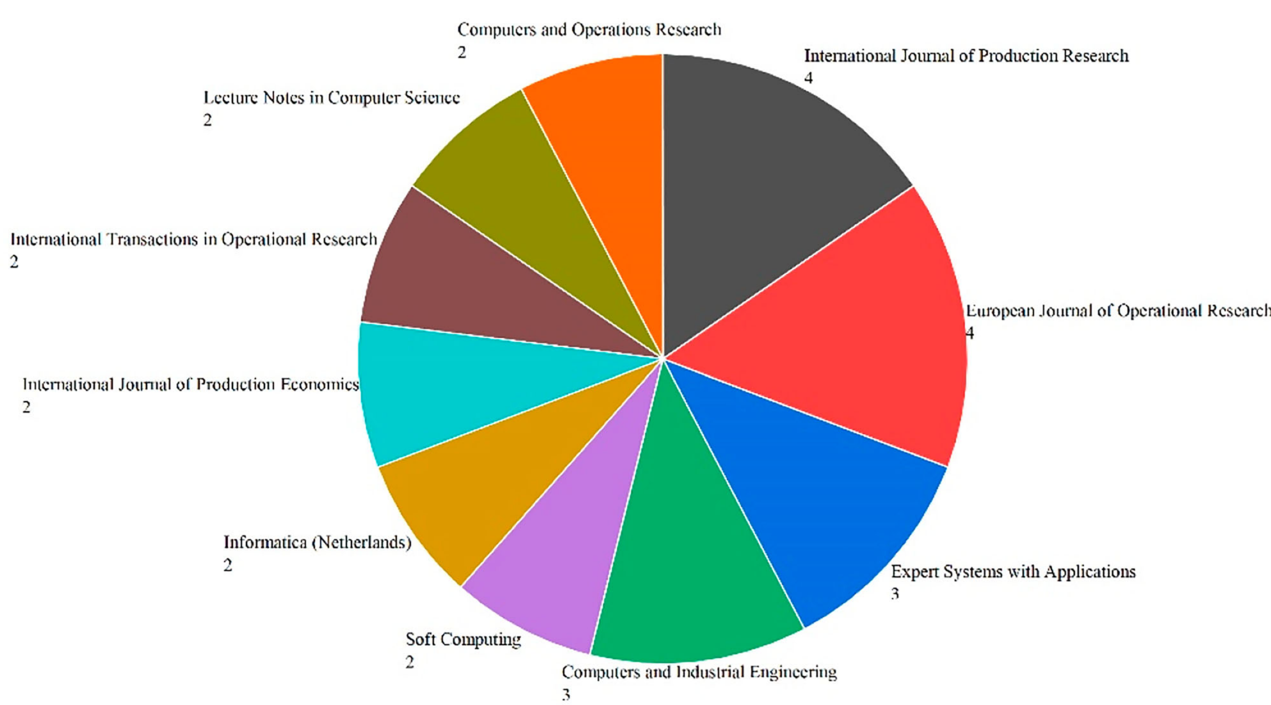

Figure 6. Top ten publication outlets for MCDM-based inventory classification research.

set that, although relevant, may not directly address the nuanced requirements of the decision problem, as shown in Step 2.1 of Figure 2. This section presents an overview of the methods applied by various authors.

Kügemann and Polatidis (2022) utilise an MCDM model to select optimal road transport fuels and vehicles, incorporating Life Cycle Sustainability Analysis (LCSA) for criteria identification and selection. LCSA effectively connects the technical aspects of criteria selection with the decision objectives and context. While LCSA is versatile and can be adapted to different contexts, it is rarely subjected to rigorous validation and comparative analysis. Additionally, to assess the suitability of LCSA for criteria identification and selection beyond the sustainability field, it is necessary to integrate conceptual frameworks from other domains.

Abdullah et al. (2022) use PESTEL analysis to structure criteria identification for the development of flood management plans. This method systematically pinpoints relevant criteria by evaluating and refining established best practices within the domain of the decision problem. While PESTEL is useful for identifying criteria for analysis, like LCSA, it requires adaptation to align with the specific objectives of the decision problem and has not undergone comparative analysis.

Ali and Abraham (2021) employ the fuzzy-Delphi method to identify relevant criteria and indicators for community resilience following the 2018 floods in Kerala. The method facilitated the discovery of additional criteria and sub-criteria that are often neglected, proving useful in constructing benchmark criteria reference sets.

Benites, Henrique, and Deo (2023) utilise the Delphi method to identify criteria for implementing closed-loop resource plans with urban stakeholders. While they find the combination of the Delphi method combined with a literature review effective, they caution against potential subjectivity and reliance on participant expertise during the selection process. To mitigate this risk, they recommend engaging an expert facilitator to ensure the inclusion of all relevant criteria.

4.3. Criteria selection literature in non-inventory classification MCDM applications

Zolfani and Derakhti (2020) and Shao et al. (2020) stress the significance of appropriate criteria selection for MCDM model reliability and utility. However, formal criteria selection processes are underdeveloped (de Souza et al. 2021). In particular, researchers highlight that criteria are often selected arbitrarily and frequently lack justification (Lima-Junior and Carpinetti 2016; Muhamad et al. 2017; Niknazar and Bourgault 2017; Yurdakul and Tansel 2009). Fuzzy and statistical methods have been applied to address this weakness within the criteria selection process.

4.3.1. Fuzzy approaches to criteria selection in non-inventory classification MCDM applications

Chang, Chang, and Wu (2011) used fuzzy-DEMATEL to evaluate the effect of criteria on supplier selection at a Taiwanese electronics company. They identified four crucial criteria, with stable delivery having the highest influence and relationship to other criteria. Mavi and Shahabi (2015) applied fuzzy-DEMATEL to assess the impact of factors such as planning, partnership, and collaboration on supplier selection criteria in the manufacturing industry. The DEMATEL method helped identify dominant criteria and evaluate the effect of each criterion on the criteria set developed during the identification phase of the criteria selection process i.e. (Step 2).

Lima-Junior and Carpinetti (2016) applied a fuzzy-QFD method to supplier selection, combining fuzzy logic and Quality Function Deployment (QFD). This approach used linguistic preference ratings to reduce subjectivity and allowed for the inclusion of supplier-focused criteria. Although validated by internal experts, comparisons with other methods are needed to evaluate the effectiveness of this method.

Souza, Silva, and Soma (2020) integrate a fuzzy-AHP Extent Analysis and fuzzy-based DEMATEL model for criteria selection to select projects at ANEEL, the Brazilian Electricity and Regulatory Agency. Initially, fuzzy-DEMATEL determines each criterion's influence on others, clarifying the problem's structure through cause-and-effect relationships. Next, fuzzy-AHP ranks the criteria by importance using pairwise comparisons and DEMATEL's influence levels. Lastly, the authors merge both methods' coefficients to prioritise the criteria. Therefore, aside from the fuzzification step, DEMATEL and AHP are applied in their standard form. Although expert validation confirmed the selected criteria's practical alignment with the broader field, the model's sensitivity to the size of the criteria set and the lack of comparative analysis with other models are limitations.

4.3.2. Statistical approaches to criteria selection in non-inventory classification MCDM applications

The Mahalanobis Taguchi System (MTS), applied by Deepa and Ganesan (2016) and Muhamad et al. (2017) resembles a fuzzy approach and identifies important criteria. Deepa and Ganesan (2016) utilised MTS for crop selection, incorporating a graphical output to visualise the highest-value criteria. Muhamad et al. (2017) developed a hybrid MTS-Kanri Distance method for Master of Business Administration (MBA) candidate selection. The advantages of MTS include criteria reduction; however, it necessitates a preceding step of criteria identification, pairwise inputs for correlation analysis, the inclusion of sub-criteria and benchmark values to yield meaningful results. Consequently, the multi-step method may not be attractive to practitioners who lack the required expertise.

Yurdakul and Tansel (2009) used Spearman's correlation coefficient for criteria reduction in a machine tool selection problem. This approach proves effective for criteria reduction but requires pairwise input and may necessitate a trial-and-error approach to finalise the criteria set. Despite the utility of this approach, Principal Components Analysis and Factor Analysis are considered more powerful and versatile statistical methods for criteria reduction (Chen, Hsieh, and Wee 2016; Imeri et al. 2015; Lam, Ran, and Lam 2010; Mohanty and Gahan 2011).

4.4. Overview of MCDM-based inventory classification related criteria selection research contributions

The predominance of numerical studies in MCDM-based inventory classification, accounting for 55% of all research in the field apply standardised and predetermined criteria sets, for example: Flores, Olson, and Dorai (1992), Ramanathan (2006), Ng (2007), Hadi-Vencheh (2010), Mohammaditabar, Ghodsyour, and O'Brien (2012) and Ladhari, Babai, and Lajili (2016) and Mohamadghasemi (2020). This limits an exploration of methodologies employed for criteria selection in the field. Therefore, this review focuses on case-based studies, which offer limited but valuable insights into criteria selection approaches within the field. Table 2 details the twenty-eight case-based studies included in the review.

Figure 7 depicts criteria selection and identification methods in the reviewed articles, highlighting a significant proportion without reported methods and a reliance on internal experts. The literature on MCDM-based inventory classification criteria selection is limited, with only a few studies utilising internal expert interviews such as those by Chu, Liang, and Liao (2008), Çebì, Kahraman, and Bolat (2010), Rezaei and Dowlatshahi (2010), along with a single study employing a fuzzy-Delphi method, namely Kabir (2012).

MCDM-based inventory classification models include full aggregation, fuzzy-based methods, and goal/reference level approaches, as detailed in Table 3. Common

Table 2. Case-based inventory classification literature included in the review.

Year	Authors	MCDM Classification	MCDM model
1993	Partovi & Burton	Full aggregation approach	Analytic Hierarchy Process
2014	Balaji K., Kumar V.S.S.	Full aggregation approach	Analytic Hierarchy Process
2017	Ishizaka A., Gordon M.	Full aggregation approach	MACBETHSort
2011	Kabir & Hasin	Fuzzy-based approaches	Analytic Hierarchy Process
2017	Hu Q., Chakhar S., Siraj S., Labib A.	Fuzzy-based approaches	Dominance-based rough set approach
2008	Cakir, O., Canbolat, M, S.,	Fuzzy-based approaches	Fuzzy Analytic Hierarchy Process
2010	Çebi F., Kahraman C., Bolat B.	Fuzzy-based approaches	Fuzzy Analytic Hierarchy Process
2010	Rezaei J., Dowlatshahi S.	Fuzzy-based approaches	Fuzzy inference
2011	Mohamadghasemi A., Hadi-Vencheh A.	Fuzzy-based approaches	Fuzzy inference
2013	Kiriş S.	Fuzzy-based approaches	Fuzzy-ANP
2015	Sarmah S.P., Moharana U.C.	Fuzzy-based approaches	Fuzzy-Inference Based Classification
2019	Mallick B., Das S., Sarkar B., Das S.	Goal, aspiration, or reference level approach	Modified similarity method
2007	Bhattacharya A., Sarkar B., Mukherjee S.K.	Goal, aspiration, or reference level approach	TOPSIS
2011	Kabir, Hasin & Khondokar	Hybrid	Fuzzy Analytic Hierarchy Process
2011	Mahendrawathi E.R., Nurul Laili E., Kusumawardani R.P.	Hybrid	Fuzzy-ABC
2021	Yung K.L., Ho G.T.S., Tang Y.M., Ip W.H.	Hybrid	Fuzzy-ABC
2008	Chu, C., Liang, G., & Liao	Hybrid	Hybrid ABC-Fuzzy Classification
2016	Keren B., Hadad Y.	Hybrid	Hybrid AHP-Data Envelopment Analysis
2018	Ishizaka A., Lolli F., Balugani E., Cavallieri R., Gamberini R.	Hybrid	Hybrid AHP-Data Envelopment Analysis
2014	Lolli, Ishizaka & Gamerini	Hybrid	Hybrid AHP-K means
2016	Baykasoilu A., Subulan K., Karaslan F.S.	Hybrid	Hybrid Combinatorial Optimization-Fuzzy set
2014	Tavassoli M., Faramarzi G.R., Saen R.F.	Hybrid	Hybrid Data Envelopment Analysis-Discriminant Analysis
2020	Xu, N., Xu, W.	Hybrid	Hybrid Delphi-Super Efficient DEA model
2011	Hadi-Vencheh A., Mohamadghasemi A.	Hybrid	Hybrid Fuzzy Analytic Hierarchy Process-Data Envelopment Analysis
2021	Razavi Hajiagha S.H., Daneshvar M., Antucheviciene J.	Hybrid	Hybrid Fuzzy Programming-Stochastic programming
2012	Kabir G.	Hybrid	Hybrid Fuzzy-Delphi Method-Fuzzy AHP
2019	Mohamadghasemi A., Hadi-Vencheh A., Hosseinzadeh Lotfi F., Khalilzadeh M.	Hybrid	Hybrid TOPSIS-Gaussian Interval Type-2 Fuzzy Set
2016	Liu, J., Liao, X., Zhao, W., & Yang, N.	Hybrid	Hybrid-ELECTRE-Clustering-Simulated Annealing

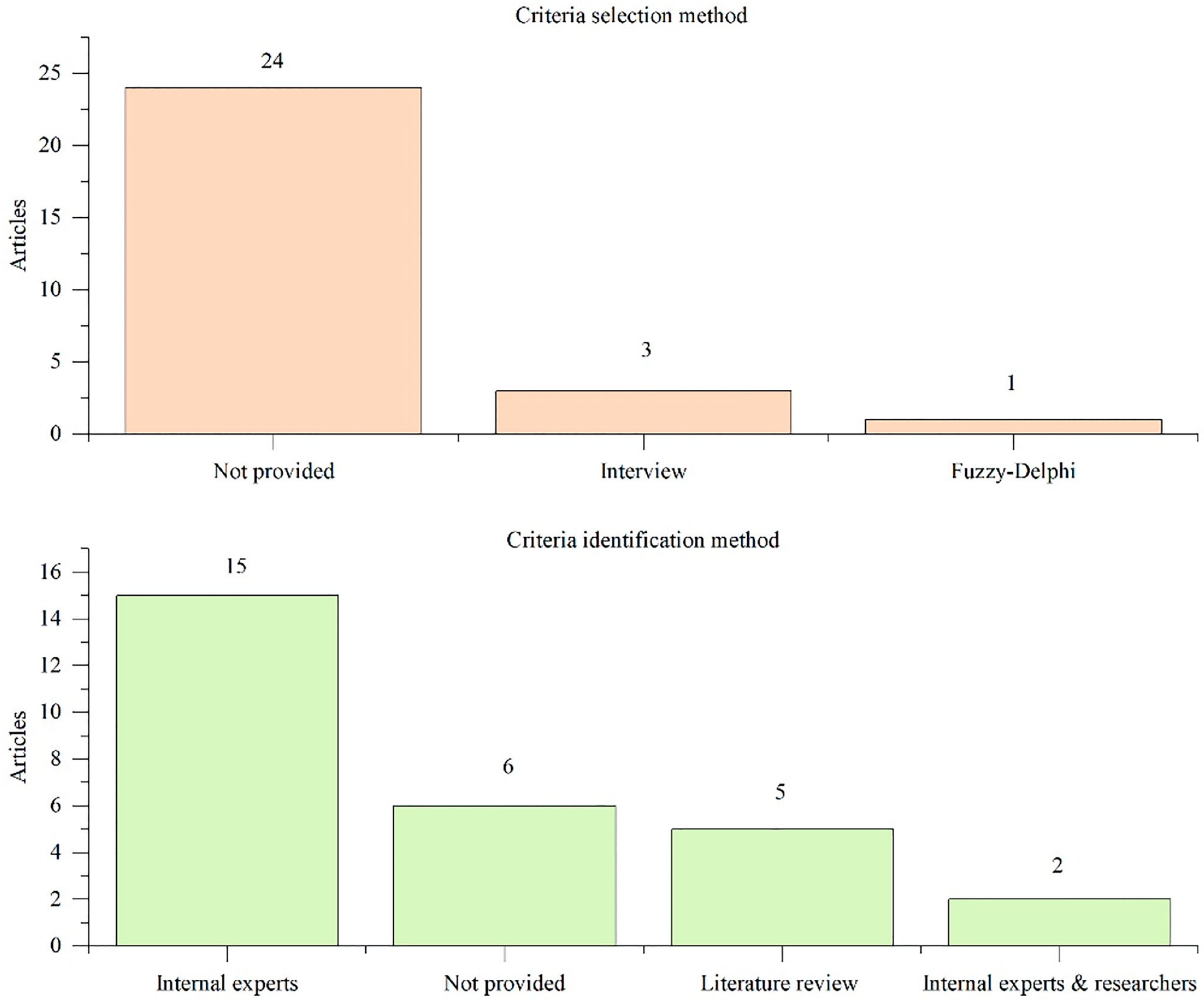

Figure 7. Criteria identification and selection methods used in case-based MCDM-based inventory classification research by MCDM model classification.

fuzzy-based methods encompass fuzzy inference models, fuzzy-Analytic Hierarchy Process (FAHP), fuzzy-Analytic Network Process (FANP), and the dominance-based rough set approach. Criteria selection in these studies often relies on internal experts, as in Sarmah and Moharana (2015) or on self-selection by researchers, as shown by Chen et al. (2008). Additionally, some researchers conduct interviews with internal experts to select criteria, as detailed by Çebì, Kahraman, and Bolat (2010) and Rezaei and Dowlatshahi (2010). Nevertheless, 75% of the studies reviewed do not provide details on their criteria selection process.

AHP and MACBETHSort are the predominant full aggregation models in MCDM-based inventory classification research included in this review. AHP has been utilised by researchers such as Partovi and Burton (1993), Kabir and Hasin (2011), and Balaji and Kumar (2014) to assess the relative importance of criteria and applying the resulting weights to inventory items for classification. Thus, AHP is not directly used for criteria selection but rather for scoring criteria, which could to some extent assist in the selection process. Balaji and Kumar (2014) involve internal experts, yet provide no detail on the method used for criteria selection. Partovi and Burton (1993) discuss the characteristics of criteria selection but do not elaborate on the selection method or its influence on their decision making process. Ishizaka and Maynard (2017) employ MACBETHSort for inventory classification at a Turkish manufacturing company. The authors do not specify a criteria selection process, but they mention that eight criteria were selected by internal company experts.

Goal, aspiration, or reference level models account for 7.14% of the research in MCDM-based inventory classification research. Bhattacharya, Sarkar, and Mukherjee (2007) employ the Technique for Order Preference

Table 3. Definitions of MCDM model classifications used in this review.

MCDM Model Type	Definition	Author/s
Full Aggregation approaches	MCDM models that use the total performance of each alternative to rank and classify items, e.g. AHP and MACBETH	Ishizaka and Maynard (2017)
Fuzzy-based methods	MCDM models that employ fuzzy logic to handle imprecise or uncertain data in the classification process, e.g. dominance-based rough set approach	Hu et al. (2017)
Goal, Aspiration, or reference level approaches	MCDM models that use the distances between each alternative and the ideal solution (or reference level) to classify inventory items, e.g. Evaluation based on Distance from Average Solution (EDAS). Model type includes DEA and optimisation-based models, e.g. Weighted Linear Optimisation	Ramanathan (2006), Keshavarz-Ghorabaee et al. (2015)
Hybrid methods	MCDM models that use a combination of two or more MCDM or other model types, e.g. hybrid-ELECTRE-Clustering-Simulated Annealing	Liu et al. (2016)

by Similarity to Ideal Solution (TOPSIS) method, while Mallick, Das, and Sarkar (2019) apply a modified similarity method. Despite the differing approaches, both studies rely on internal experts for criteria selection; however, like other studies in the field, they do not disclose the specific criteria selection methods used.

Except for four studies, 85.71% of case-based research in MCDM-based inventory classification fails to specify a formal criteria selection method. This finding is consistent with similar observations in the broader MCDM literature, as evidenced by Yurdakul and Tansel (2009), Niknazar and Bourgault (2017), de Souza et al. (2021) and Kügemann and Polatidis (2022).

This suggests a weakness in the objective setting phase of MCDM-based inventory classification research, where ill-defined goals prevent the use of more specific and advanced criteria selection methods. Corroborating this view, Van Kampen, Akkerman, and Van Donk (2012) identified a lack of robust objective setting as a gap in the field, arguing that focusing solely on volume and product-related criteria may be insufficient for effective inventory classification. Moreover, Hites et al. (2006) suggests evaluating decision outcomes based on well-defined objectives, but this remains untested in MCDM-based inventory classification research. Thus, we recommend future research that explores formal criteria selection through the lens of robust objective setting and examines its impact on inventory classification. Future studies could undertake comparative analysis of inventory classification outcomes obtained using diverse criteria sets, with a particular focus on how these align with well-defined inventory management objectives.

This section reviewed criteria selection methods in MCDM-based literature outside of inventory classification and contrasted them with methods used within the MCDM-based inventory classification field. We have pinpointed potential research areas and emphasised key considerations for identifying and selecting criteria when applying MCDM models to inventory classification. The following section will explore criteria selection validation approaches.

5. Criteria selection validation

Validating selected criteria is crucial for ensuring accurate decision making and enhancing the reliability and utility of MCDM models. Criteria validation methods have been adopted across various fields including healthcare, sustainability, engineering, supply chain management, transportation, finance, and social services. Common approaches entail the use of self-administered surveys, questionnaires, and soft operational research (soft-OR) methods that involve significant stakeholder participation. This section will discuss approaches such as survey instruments, structured interviews, the Advanced Value Framework (AVF), and Value Focused Thinking (VFT), which are pivotal in securing the effectiveness and reliability of the decision making process. With these approaches providing a foundation for robust decision making, we now turn to examining how structured validation processes, or the lack thereof, are represented in MCDM-based inventory classification studies.

5.1. Overview of MCDM-based non-inventory classification related criteria validation research contributions

The criteria validation process confirms that the criteria selected accurately define the objective of the decision making process (Munier, Hontoria, and Jiménez-Sáez 2019). Additionally, criteria validation drives systematic improvements across the MCDM process (Ishizaka et al. 2022). Criteria validation methods are widely reported across diverse fields, including *healthcare*, (Angelis et al. 2017; Cruden et al. 2020; Debnath et al. 2023; Sukma and Dachyar 2021), *sustainability*, (Ishizaka et al. 2022; Khan et al. 2018; Münch, Benz, and Hartmann 2022; Söbke and Lück 2022; Wittstruck and Teuteberg 2011), *engineering*

(Cuoghi and Leoneti 2019; Oltean-Dumbrava, Watts, and Miah 2014), *supply chain* (Khan et al. 2022; Kumar et al. 2018), *transport,* (Gagatsi, Giannopoulos, and Aifandopoulou 2014; Khalifa and Daim 2021; Putra, Pratama, and Dachyar 2022), *finance*, (Borenstein and Betencourt 2005) and *social services* (Kushwaha, Sharma, and Singh 2023). Commonly, research employs self-administered survey instruments or questionnaire research followed by soft-OR methods to validate criteria, all characterised by high levels of participation from stakeholders, decision makers or subject matter experts in a structured manner. The upcoming sections will discuss the following approaches:

- Expert opinion and survey instruments
- Expert opinion and structured interviews
- Advanced Value Framework
- Value Focussed Thinking

5.2. Expert opinion and survey instruments

Survey instruments are a popular method for gathering expert opinions to validate criteria. Researchers typically conduct a literature review (Step 2), construct criteria sets (Step 3), and then present these sets to experts using structured surveys. Participating experts subjectively rate or score the criteria using Likert scales, for a detailed discussion, refer to Borenstein and Betencourt (2005), Wittstruck and Teuteberg (2011), Oltean-Dumbrava, Watts, and Miah (2014), Khalifa and Daim (2021), Sukma and Dachyar (2021) and Ishizaka et al. (2022) for detail. Table 4 summarises the findings from these studies.

5.3. Expert opinion and interviews

Interviews provide an effective means for criteria validation through direct interaction with experts. While structured data capture tools facilitate this engagement, the application of formal criteria validation methods is not always evident. Nevertheless, the validation step is proven to be valuable, as it may reveal unexpected yet pertinent criteria, a finding supported by the work of Cruden et al. (2020) and Debnath et al. (2023). Table 5 summarises research that employs a combined approach of expert opinions and interviews.

5.4. Soft-OR approaches

Table 6 summarises the application of soft-OR approaches for criteria validation. Specific methods include the Fuzzy-Delphi method, AVF, and VFT. These approaches provide structured methods to interact with decision makers.

5.5. Overview of inventory classification related criteria selection validation research contributions

This review finds that formal validation processes for criteria selection are largely absent across MCDM-based inventory classification studies. Since researchers typically rely on expert opinions, literature reviews, or personal interviews for criteria identification and selection, the lack of criteria validation raises concerns regarding subjective bias and criteria validity.

The absence of formal criteria validation processes may result in the selection of irrelevant criteria or the omission of important ones, leading to an inaccurate representation of decision objectives. For example, Liu et al. (2016) observed that an increased number of criteria can affect the consistency of decision maker's judgment, and non-compensation between criteria should be considered for criteria validity assessment. Without a validation step, it is impossible to detect and resolve these issues. Nevertheless, several authors skip the criteria validation step despite the associated risks. For instance, Ishizaka and Maynard (2017) and Balaji and Kumar (2014) advance to criteria weight evaluation without validating their criteria selection, and Hadi-Vencheh and Mohamadghasemi (2011) and Tavassoli, Faramarzi, and Saen (2014) select criteria directly from the literature without prior validation.

On the other hand, studies such as those by Sarmah and Moharana (2015) and Kabir (2012) provide detailed justifications for their criteria selection; however, they do not include a validation step. The absence of validation may be due to insufficient emphasis on its importance in the MCDM-based inventory classification research process, and/or the complexity involved in conducting robust formal validation. This lack of a formal validation process or comparative analysis diminishes the relevance and utility of inventory classification models in general (Hu et al. 2018).

In summary, criteria validation is an essential step in MCDM-based inventory classification research. This step aligns the criteria selection with the decision objective, thereby giving practitioners confidence in the research and classification results. Current MCDM-based inventory classification literature reveals that numerous studies in the field neglect to conduct a formal validation for their criteria selection, resulting in the potential for subjective bias and an inaccurate representation of the decision objective. Therefore, further research on the criteria validation process in MCDM-based criteria selection

Table 4. MCDM-based non-inventory classification studies applying expert opinion and survey instruments for criteria validation.

Author/s	Context	Criteria Validation Approach	Strengths	Weaknesses
Borenstein and Betencourt (2005)	IT investment evaluation	Survey approach	Streamlines, speeds up, and enhances credibility of decision-making processes	Participants challenged by ambiguity of criteria definitions; subjective input reduces reliability of method
Wittstruck and Teuteberg (2011)	Recycling supplier selection	Survey approach	Provides quick access to a broad audience; Likert scale for criteria scoring offers basis for meaningful and transparent statistical analysis	Fails to consider the interrelationships between criteria leading to important criteria being omitted, subjective input reduces reliability of method
Oltean-Dumbrava, Watts, and Miah (2014)	Sustainability assessment	Survey approach	Provides quick access to a broad audience; Likert scale for criteria scoring offers basis for meaningful and transparent statistical analysis	Limitations of the survey approach such as inability to quantitatively compare criteria and associated interrelationships, incomplete surveys, skewed results due to average scores based on response numbers, lack of explanation on the robustness of selected criteria and how these would be managed as they change over time, subjective input reduces reliability of method
Sukma and Dachyar (2021)	Prioritising telehealth implementation	Expert opinion and Likert scale	Transparent benchmark criteria assessment acceptance scores for selected criteria	Study offers limited insight into criteria validation process and the choice of acceptance benchmark level is open to discussion, subjective input reduces reliability of method
Khalifa and Daim (2021)	Project assessment criteria Selection	Survey approach with structured hierarchy of increasing expertise and criteria acceptance benchmark	Conducted multiple rounds of surveys and selecting experts in a structured hierarchy of increasing expertise, setting a fixed criteria assessment acceptance range and using a simplified criteria acceptance benchmark improved efficiency	The choice of criteria assessment acceptance benchmark level is open to discussion, subjective input reduces reliability of method
Ishizaka et al. (2022)	3PL supplier selection	Survey approach with DEMATEL	Simple validation through the combination of a yes/no option in their survey and DEMATEL analysis, benchmark criteria set developed during validation can be used to reduce time and cost of validating less important criteria	Subjective input reduces reliability of method

research is needed to enhance the relevance and utility of MCDM-based inventory classification models.

6. Discussion

This review explores the criteria selection process in MCDM-based inventory classification research. Overall, the field does not apply best practice approaches compared to similar studies in other disciplines. Shortcomings in the field span the entire criteria selection process, including clarifying objectives, criteria identification, selection, and validation. Unlike other fields, MCDM-based inventory classification relies primarily on the subjective judgment of internal experts for criteria identification and selection. Furthermore, the lack of evidence for criteria validation in MCDM-based inventory

Table 5. MCDM-based non-inventory classification studies applying expert opinion and interviews for criteria validation.

Author/s	Context	Criteria Validation Approach	Strengths	Weaknesses
Cruden et al. (2020)	Evidence-based child maltreatment prevention programs	Expert opinion, interviews, and structured data capture tool	Transparency of structured data capture tool, multi-party validation improved validation results, method provided a simple way to edit criteria during the validation process, method surfaced relevant and unexpected criteria, validated criteria aligned with other healthcare studies	Small participant sample size, did not address dynamic and temporal aspects of criteria and method is context specific, subjective input reduces reliability of method
Ishizaka et al. (2022)	Pharmaceutical supplier selection	Group decision approach	Potential for systematic improvements to criteria selection process using benchmark criteria sets	Limited details on how experts validated criteria, case company nominated experts, subjective input reduces reliability of method
Debnath et al. (2023)	Healthcare supplier selection	MCDM model	Produced expected results with validated criteria, used judgemental sampling approach to select experts to reduce the risk of including weak or inexperienced participants	Criteria list may not be exhaustive, subjective input reduces reliability of method

classification research highlights a critical weakness in aligning the objectives of a classification exercise with representative criteria. The deficiencies undermining the practical value of MCDM-based inventory classification are discussed below.

6.1. Objective setting and the influence of structured approaches on criteria selection

Van Kampen, Akkerman, and Van Donk (2012) emphasise the need for future research into robust objective clarification in inventory classification, arguing that relying solely on volume and product-related criteria is insufficient to meet classification objectives. Since these objectives can vary based on the problem's aim and context, criteria must be sufficiently discriminatory to yield relevant results (Kügemann and Polatidis 2022). A comprehensive analysis of complex decisions necessitates clear objectives and attributes that measure the extent to which these objectives are achieved (Keeney and Raiffa 1993). Thus, developing and evaluating a formal, standardised, and structured criteria selection process is imperative.

Figure 2 presented a stylised example of the criteria selection process. The process begins with an objective setting step, which lays the foundation for subsequent steps and enables a rational evaluation of selected criteria. Although Lolli, Ishizaka, and Gamberini (2014) acknowledge the need to align criteria with classification objectives, inventory classification researchers often omit the objective-setting step and directly apply product and/or volume-related criteria, as demonstrated by Rezaei and Dowlatshahi (2010) or contextually related criteria, as shown by Hadi-Vencheh and Mohamadghasemi (2011). However, external dynamics may render these criteria irrelevant or invalid (Münch, Benz, and Hartmann 2022). Utilising an effective objective-setting approach counters the risk of criteria irrelevance.

Structured, robust objective-setting approaches are also effective in surfacing and counteracting redundancy in criteria selection. In other fields, methods such as VFT, Fuzzy-Delphi, LCSA, and PESTEL clarify decision objectives and help identify suitable criteria for decision making. These approaches offer valuable frameworks for future research in robust objective setting in MCDM-based inventory classification research.

The absence of structured approaches in MCDM-based inventory classification may stem from the significant number of studies using standardised criteria sets, which often result in prioritising the classification method over the criteria selection process. This is evident in existing research, which demonstrates a bias towards model development and criteria weight evaluation.

Another factor is the possible overreliance on subjective opinions and expertise. This reliance may diminish

Table 6. Soft-OR approaches used for criteria validation in non-inventory classification MCDM-based studies

Author/s	Context	Criteria Validation Approach	Strengths	Weaknesses
Kumar et al. (2018)	Supplier selection	Fuzzy-Delphi	Reduces uncertainty and incorporates adjustable threshold values for acceptance, narrows criteria down to essential few	No information on implementation details, subjective input reduces reliability of method
Kushwaha, Sharma, and Singh (2023)	Work-life balance for single mothers	Fuzzy-Delphi	Method requires no more than five experts	Details on implementation lacking, concerns regarding the bias of experts included, subjective input reduces reliability of method
Angelis et al. (2017)	Healthcare technology assessment	Advanced Value Framework	Comprehensive validation approach that includes criteria evaluation, elicitation of expert feedback, preference value construction. Criteria was reduced but no further criteria needed to be added. Group stakeholder participation	Limited to simulated decision, validation of method needed, implementation did not factor evaluating criteria against theoretical properties required for multicriteria decision making, subjective input reduces reliability of method
Cuoghi and Leoneti (2019)	Dam construction in Brazil	Value Focussed Thinking (VFT)	Good method to clarify decision problems, useful as a problem structuring tool that incorporates criteria validation, can be applied in a range of contexts	Objectives established during the process could not be linked to associated criteria, subjective input reduces reliability of method

the validity of results from MCDM-based inventory classification models. It also contradicts a core MCDM objective: defining the optimal set of criteria (Zolfani and Derakhti 2020). Applying structured approaches to objective setting, as seen in non-inventory classification studies, could provide opportunities to evaluate the impact of these methods on MCDM-based inventory classification results. Such approaches could also influence inventory management practices, especially in dynamic operating environments.

6.2. Formal criteria selection approaches

de Souza et al. (2021) emphasise that formal criteria selection approaches for MCDM models remain underdeveloped, a gap that is particularly evident in MCDM-based inventory classification research. Kabir (2012) is the single study identified that employs a formal approach, specifically the Fuzzy-Delphi method. Moreover, only 10.71% of inventory classification studies rely on interviews with internal experts for criteria selection, while 85.71% do not disclose their methods. These findings highlight a methodological deficiency in the criteria selection process when applying MCDM-based inventory classification models. This lack of formalisation is a concern echoed by several authors, including Yurdakul and Tansel (2009), Niknazar and Bourgault (2017), de Souza et al. (2021) and Kügemann and Polatidis (2022).

Formal criteria selection approaches, such as the stylised example shown in Figure 2, aim to provide transparency and comparability in MCDM model results. This is achieved by detailing the alignment of decision objectives and criteria, rational selection from identified criteria and ensuring objective validation (Kügemann and Polatidis 2022). Furthermore, structured criteria selection processes help to prevent duplication, overlap, and any misalignment of criteria and decision objectives (de Souza et al. 2021).

Since the disclosure of criteria selection methods in MCDM-based inventory classification research is limited, it is impossible to evaluate the benefit of formal approaches on model results. In contrast, studies in other fields provide more insight into the criteria selection methods used. Studies that apply formal criteria selection methods report several benefits, including reducing the number of criteria (Yurdakul and Tansel 2009), determining the relevance of a criterion in relation to a decision objective (Deepa and Ganesan 2016), and evaluating the interdependencies and relationships between criteria (Muhamad et al. 2017).

In contrast, 32.14% of the MCDM-based inventory classification studies reviewed demonstrate gaps in criteria selection. However, these studies do not propose a formal criteria selection process as a solution. This perspective is apparent in the works of Cakir and Canbolat (2008), Çebì, Kahraman, and Bolat (2010), Rezaei and Dowlatshahi (2010), Hadi-Vencheh and Mohamadghasemi (2011), Kabir (2012), Kiriş (2013), Sarmah and Moharana (2015), Liu et al. (2016) and Baykasoğlu, Subulan, and Karaslan (2016).

Practical steps to address issues in criteria selection within MCDM-based inventory classification are rare. Notable case-based efforts include Kabir (2012), who employed the Fuzzy-Delphi method for criteria reduction and Kiriş (2013) who applied ANP to account for feedback and interrelations between criteria. Beyond case-based research, Mohamadghasemi (2020) innovatively integrates the CRITIC method with Ramanathan (2006) and Zhou & Fan's (2007) weighted linear optimisation models, enhancing criteria selection by objectively assessing and weighting each criterion's distinctiveness and independence. However, the lack of comparative studies assessing the effectiveness of formal criteria selection processes hinders a definitive evaluation of the methods used by Kabir (2012), Kiriş (2013) and Mohamadghasemi (2020). This limitation is not unique to inventory classification; for example, the study by Bureš et al. (2020) stands out as the singular research found that evaluates the impact of random versus systematic criteria selection on the inconsistency of AHP results, shedding light on the effects of different selection methods. A similar comparative analysis is conspicuously absent in MCDM-based inventory classification research, yet it would be greatly advantageous.

6.3. *Criteria selection validation approaches*

Criteria selection validation is notably underdeveloped within MCDM-based inventory classification research. With formal validation approaches largely absent, a mere 25% of studies provide justification for their chosen criteria, while the majority move directly to criteria weighting without a preceding validation step. Such omissions prevent a reliable assessment of whether the criteria effectively represent the decision objectives (Munier, Hontoria, and Jiménez-Sáez 2019). This casts doubt on the relevance of any inventory classification results (Hu et al. 2018). Moreover, it indicates a departure from the recommended MCDM process described by Belton and Stewart (2002), which suggests finalising studies with a sensitivity and/or robustness analysis. However, traditional sensitivity and robustness analysis may not suit the unique needs of the MCDM-based inventory classification criteria selection process.

These needs include ensuring criteria relevance amidst market fluctuations, maintaining alignment with evolving strategic objectives, and confirming the relevance and suitability of criteria in reflecting the real-world complexities of inventory management. Traditional sensitivity analysis primarily examines the impact of varying criteria weights on decision outcomes but does not challenge the relevance or representativeness of the criteria themselves. The criteria set is assumed to be valid without considering whether alternative criteria should be included, excluded, or redefined to effectively capture the nuances of the decision context. Similarly, robustness analysis tests the stability of decision outcomes amidst uncertainty and variability in model inputs but typically overlooks the strategic alignment and adaptability of the criteria set. This approach operates under the assumption that the selected criteria will remain relevant, an assumption that may not be valid in dynamic environments where the importance of criteria can shift over time. To overcome the limitations of traditional sensitivity and robustness analyses, an integrated criteria validation analysis that considers both the impact of criteria weights and the strategic relevance of each criterion is proposed. This analysis should not only adjust the weights of criteria but also critically evaluate their selection, relevance, and strategic fit, ensuring that the criteria set remains relevant and effective as the decision environment evolves. We acknowledge that while components of sensitivity and robustness analysis are well-established, their application in an integrated analysis as outlined is not documented in the MCDM-based inventory classification literature and requires further development.

Although sensitivity and robustness analysis are often not reported in non-inventory classification research, other qualitative methods such as expert opinion surveys or structured interviews, and soft-OR approaches, are applied for criteria selection validation in these fields. These methods improve the criteria identification phase by incorporating a scoring round using a Likert scale or by presenting selected criteria to a second panel of experts for face validity assessment. However, like the criteria identification and selection methods, the validation methods have not been comparatively evaluated. They are inherently subjective and exhibit methodological limitations. For example, Ishizaka et al. (2022) report a biased selection of internal experts chosen by the case company, indicating potential subjectivity in the validation process. Khan et al. (2022) use a simplified yes-or-no questionnaire, which might oversimplify the complex nature of criteria validation. The concern that the criteria selected for validation may not be exhaustive is noted by (Debnath et al. 2023), questioning the thoroughness of the validation efforts. Cruden et al. (2020) and Münch, Benz, and Hartmann (2022) observe that the temporal aspects of criteria are often not validated, neglecting how criteria relevance changes over time. The need for intensive stakeholder engagement can lead to a protracted validation process (Oltean-Dumbrava, Watts, and Miah 2014), potentially delaying decision making. Lastly, Angelis et al. (2017) highlight gaps in ensuring all criteria possess the theoretical properties required for multicriteria evaluation, potentially compromising the method's integrity.

Future research could benefit from the development and application of the proposed integrated criteria validation analysis method. Reducing the reliance on qualitative methods for criteria validation and offsetting the shortcomings of traditional sensitivity and robustness analysis are expected advantages. These methods provide a formal approach for validating criteria against decision objectives. Furthermore, the development of domain-specific benchmark criteria reference sets for comparative evaluation and testing could facilitate this process. Such an approach is supported by findings from Borenstein and Betencourt (2005), Abdullah et al. (2022), Ishizaka et al. (2022), Khan et al. (2022) and Kügemann and Polatidis (2022).

7. Conclusion

This review confirms a lack of a formal, structured process for criteria selection within MCDM-based inventory classification research. Meanwhile, an expanding body of research outside this field is emerging to tackle this issue. Works pertaining to criteria selection for MCDM models can be categorised into four primary areas: criteria identification, selection, validation, and literature reviews. Nevertheless, the literature specific to criteria selection in the domain of MCDM-based inventory classification remains unreported. This gap underscores the need for research dedicated to criteria selection within this field, which could significantly enhance the relevance and applicability of these models for both researchers and practitioners.

In the context of criteria selection methods, we observe that both within and outside the MCDM-based inventory classification field, methods are often characterised by a high degree of subjectivity. Such subjectivity introduces risks of bias and inconsistency, which in turn justify the need for a formal criteria selection process. Implementing a formalised process can ensure that selected criteria are aligned with the decision objectives, thereby adding rigour to the problem structuring and model building phases of the MCDM process applied within this field. This alignment is a critical advantage of a formal approach to criteria selection, reinforcing the argument for more robust objective setting in inventory classification research, as outlined by Van Kampen, Renzo Dirk Akkerman, and Van Donk (2012).

The challenge of robust objective setting outside the scope of MCDM-based inventory classification research has been tackled using methods such as AVF, VFT, LCSA and PESTEL analysis. Assessing the applicability of these methods within MCDM-based inventory classification research represents an immediate research opportunity. Furthermore, practitioners might directly employ these approaches to improve the objective setting phase in MCDM-based inventory classification projects.

MCDM-based inventory classification research has not kept pace with developments to criteria identification and selection methods. Unlike MCDM-based applications in non-inventory classification contexts, inventory classification research seldom incorporates fuzzy and statistical methods for criteria identification and selection. Instead, it often relies on the subjective judgment of internal experts. Furthermore, many studies fail to report the use of any criteria selection methods, contributing to a lack of transparency. This issue is compounded by the relatively high number of numerical studies that employ a standardised dataset for model development and evaluation. Adopting criteria identification and selection methods reported in this review from outside the field and the CRITIC-based method published within the field present an ideal opportunity to evaluate the effectiveness and improve the results of MCDM models applied to inventory classification.

Criteria selection validation is overlooked in MCDM-based inventory classification research. There is a notable absence of studies explicitly reporting the use of a formal validation approach for criteria selection. This omission can lead to subjective biases and an inaccurate representation of the decision objective. To mitigate this risk, researchers in other fields employ survey instruments, structured interviews, and methods such as AVF and VFT. These tools provide qualitative and semi-quantitative frameworks for validating criteria. Nevertheless, the application of robust quantitative methods like sensitivity analysis and robustness analysis remains unexplored in relation to criteria selection validation. Employing sensitivity and robustness analysis in the context of MCDM-based inventory classification could significantly improve the validation of criteria sets under varying parameter settings (sensitivity) and their ability to withstand diverse future scenarios (robustness).

Given these findings, we suggest the following future research directions:

- Formalise the stylised criteria selection process introduced in this review. Further development of the proposed conceptual model is necessary to align the perspectives of researchers and practitioners.
- Investigate whether criteria selection methods applied outside the inventory classification field can improve the results of MCDM-based inventory classification models and positively influence inventory management policy.
- Assess the impact of a formal criteria selection process on the results of MCDM-based inventory classification models.
- Develop and evaluate an integrated criteria validation method for MCDM-based inventory classification that considers the impact of criteria weights, the strategic relevance of each criterion and ensures that the criteria set remains relevant as the decision environment evolves.
- Explore the benefits of applying artificial intelligence to address complexities, mitigate the risk of subjectivity, and reduce the computational effort required throughout the entire criteria selection process.

Despite the valuable insights offered, we acknowledge four limitations in our review. Firstly, the selection of articles is confined to those applying MCDM models within and outside the inventory classification domain. Secondly, our selection from outside this domain was based on theexclusive focus of these articles on criteria selection, potentially overlooking a broader cross-section of MCDM literature that may employ computationally advanced criteria selection methods. Thirdly, the scant evidence of the criteria selection process in the selected MCDM-based inventory classification articles has necessitated some conjecture on our part, introducing a degree of subjectivity into this review. Fourthly, our review does not include articles from the inventory classification literature published post-2021, and it is possible that recent developments in criteria selection have been missed.

Future research could remedy these limitations. Addressing the first, investigations could extend to non-MCDM applications in inventory classification. To counter the second limitation, researchers could widen the search parameters to include MCDM model applications in related supply chain fields, such as supplier selection. Addressing the third limitation calls for more meticulous reporting of MCDM methodologies in inventory classification research. Lastly, subsequent reviews should aim to incorporate more recent articles.

Despite these constraints, the current review still sheds significant light on the criteria selection process in MCDM-based inventory classification, highlighting several avenues for future research and pinpointing the gaps in formal criteria selection practices within this research domain.

Data availability statement

Data sharing is not applicable to this article as no data were created or analysed in this study.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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