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MULTICRITERIA ASSESSMENT IN TECHNOLOGICAL DECISION MAKING: A COMPARATIVE SYSTEMATIC REVIEW BETWEEN THE SAPEVO-M AND SAPEVO-H²

AVALIAÇÃO MULTICRITÉRIO NA TOMADA DE DECISÃO TECNOLÓGICA: UMA REVISÃO SISTEMÁTICA COMPARATIVA ENTRE OS MODELOS SAPEVO-M E SAPEVO-H²

EVALUACIÓN MULTICRITERIO EN LA TOMA DE DECISIONES TECNOLÓGICAS: UNA REVISIÓN SISTEMÁTICA COMPARATIVA ENTRE LOS MODELOS SAPEVO-M Y SAPEVO-H²

Mauricio Cintra do Prado de Salles Penteado[1], Marcos dos Santos[2], Carlos Francisco Simões Gomes[2]

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ABSTRACT

This study aimed to conduct a systematic literature review to compare the applicability, methodological characteristics, and limitations of the SAPEVO-M and SAPEVO-H² models in supporting technological decision-making, seeking to understand how these methods can contribute to more consistent and effective processes in complex scenarios. It is a Systematic Literature Review (SLR), conducted according to the PRISMA 2020 protocol, with searches carried out in the Scopus, ScienceDirect, and IEEE Xplore databases. The analysis, of a qualitative and comparative nature, selected 15 studies. The results reveal a predominance of SAPEVO-M, applied in business and sectoral contexts such as supplier evaluation, employee performance, reverse logistics, health, and agriculture, highlighting its methodological flexibility and practical applicability. Several studies also explored hybrid versions of the model, combining it with methods such as FAHP, TOPSIS, and PROMETHEE, which reinforces its versatility. In contrast, SAPEVO-H² appeared in only three publications, all linked to the same research group, suggesting an early stage of dissemination. Despite its low representativeness, it showed potential for high-complexity decision-making, especially in public policy and national defense, by structuring multiple hierarchical levels and integrating different decision-making scales. It is concluded that the SAPEVO family models represent promising tools in the field of multicriteria decision-making, but they are at different stages of maturity. While SAPEVO-M is already consolidated in practical applications, SAPEVO-H² requires further empirical exploration.

KEYWORDS: Multicriteria decision analysis. SAPEVO-M; SAPEVO-H². Decision-making models. Innovation assessment.

RESUMO

Este estudo teve como objetivo realizar uma revisão sistemática da literatura para comparar a aplicabilidade, as características metodológicas e as limitações dos modelos SAPEVO-M e SAPEVO-H² no apoio à tomada de decisão tecnológica, buscando compreender como esses métodos podem contribuir para processos mais consistentes e eficazes em cenários complexos. Trata-se de uma Revisão Sistemática da Literatura (RSL), conduzida segundo o protocolo PRISMA 2020, com buscas nas bases Scopus, ScienceDirect e IEEE Xplore. A análise, de caráter qualitativo e comparativo, resultou na seleção de 15 estudos. Os resultados revelam a predominância do SAPEVO-M, aplicado em contextos empresariais e setoriais, como a avaliação de fornecedores, o desempenho de colaboradores, a logística reversa, a saúde e a agricultura,

[1] Department of Materials and Metallurgical Engineering of the Polythecnical School of the University of São Paulo. São Paulo – SP, Brazil.
[2] Department of Industrial Engineering of Fluminense Federal University. Rio de Janeiro – RJ, Brazil.

evidenciando flexibilidade metodológica e aplicabilidade prática. Diversos estudos também exploraram versões híbridas do modelo, associando-o a métodos como FAHP, TOPSIS e PROMETHEE, o que reforça sua versatilidade. Já o SAPEVO-H² apareceu em apenas três publicações, todas vinculadas ao mesmo grupo de pesquisa, o que sugere estágio inicial de difusão. Apesar da baixa representatividade, mostrou potencial para tomar decisões de alta complexidade, sobretudo em políticas públicas e na defesa nacional, ao estruturar múltiplos níveis hierárquicos e integrar diferentes escalas de decisão. Conclui-se que os modelos da família SAPEVO representam ferramentas promissoras no campo da decisão multicritério, mas encontram-se em fases distintas de maturidade. Enquanto o SAPEVO-M já se apresenta consolidado em aplicações práticas, o SAPEVO-H² exige maior exploração empírica.

PALAVRAS-CHAVE: Análise de decisão multicritério. SAPEVO-M; SAPEVO-H^2. Modelos de tomada de decisão. Avaliação de inovação.

RESUMEN
Este estudio tuvo como objetivo realizar una revisión sistemática de la literatura para comparar la aplicabilidad, las características metodológicas y las limitaciones de los modelos SAPEVO-M y SAPEVO-H² en el apoyo a la toma de decisiones tecnológicas, con el fin de comprender cómo estos métodos pueden contribuir a procesos más consistentes y efectivos en escenarios complejos. Se trata de una Revisión Sistemática de la Literatura (RSL), realizada según el protocolo PRISMA 2020, con búsquedas en las bases de datos Scopus, ScienceDirect e IEEE Xplore. El análisis, de carácter cualitativo y comparativo, resultó em la selección de 15 estudios. Los resultados revelan el predominio de SAPEVO-M, aplicado en contextos empresariales y sectoriales, como la evaluación de proveedores, el desempeño de empleados, la logística inversa, la salud y la agricultura, lo que demuestra flexibilidad metodológica y aplicabilidad práctica. Varios estudios también han explorado versiones híbridas del modelo, asociándolo con métodos como FAHP, TOPSIS y PROMETHEE, lo que refuerza su versatilidad. SAPEVO-H² apareció en solo tres publicaciones, todas vinculadas al mismo grupo de investigación, lo que sugiere una etapa inicial de difusión. A pesar de la baja representación, mostró potencial para tomar decisiones altamente complejas, especialmente en políticas públicas y defensa nacional, al estructurar múltiples niveles jerárquicos e integrar diferentes escalas de decisión. Se concluye que los modelos de la familia SAPEVO constituyen herramientas prometedoras en el ámbito de la toma de decisiones multicriterio, pero se encuentran en distintas etapas de madurez. Si bien SAPEVO-M ya está consolidado en aplicaciones prácticas, SAPEVO-H² requiere una mayor exploración empírica.

PALABRAS CLAVE: Análisis de decisiones multicriterio. SAPEVO-M. SAPEVO-H^2. Modelos de toma de decisión. Evaluación de la innovación.

INTRODUCTION

Decision-making in technological contexts often involves multiple, often conflicting, criteria, making the analytical process complex and uncertain. In this scenario, Multi-Criteria Decision Models (MCDM) stand out, as their application seeks to support decision-makers in evaluating alternatives by combining quantitative and qualitative criteria (Lima Jr. *et al.*, 2013; Chakraborty *et al.*, 2020). These methods have proven relevant across areas such as supplier selection, strategic planning, investments, and risk management, precisely because they enable the integration of economic, social, and environmental aspects into a structured analysis process (Wang, 2010).

According to Lima Jr. *et al.* (2013), multicriteria methods can be divided into Multiple Attribute Decision Making (MADM), which aims to choose or classify alternatives in discrete

spaces, and Multiple Objective Decision Making (MODM), which is applied to problems with continuous variables, multiple objective functions, and restrictions. The first approach, by prioritizing feasibility and practical implementation, is widely used in real problems, while the second, although more complex, offers greater modeling power.

Among the most widely used methods are the Analytic Hierarchy Process (AHP), proposed by Saaty (1996), which structures problems into hierarchical levels to facilitate comparisons between criteria, and ELECTRE, which progressively eliminates less desirable alternatives. Other relevant approaches include TOPSIS, PROMETHEE, and veto methods, which, according to Yavrucuk (2023), offer different strategies for dealing with subjectivity, uncertainty, and individual preferences. In this regard, multicriteria models not only provide organized and methodical solutions to complex problems but also enable the incorporation of subjective judgments, value functions, and sensitivity analyses, promoting greater transparency in the decision-making process (Schmidt, 2003).

Although established methods such as AHP, TOPSIS, and PROMETHEE have wide applicability, they have limitations related to computational complexity, the difficulty of handling essentially qualitative criteria, and the reliance on strict consistency in evaluations. In this context, SAPEVO (Simple Aggregation of Preferences Expressed by Ordinal Vectors), proposed by Gomes, Mury, and Gomes (1997), emerges as a simpler and more intuitive alternative, based on preference ordering. Its evolution led to SAPEVO-M, which incorporated multiple decision-makers, standardized assessment matrices, and greater methodological consistency (Santos *et al.*, 2019; Teixeira *et al.*, 2019). This advancement enabled the development of SAPEVOWeb, expanding its potential for practical application in organizational and technological environments (Teixeira *et al.*, 2019).

More recently, SAPEVO-H² (Hybrid and Hierarchical) was proposed, which expands the potential of SAPEVO-M by integrating the assessment of multiple decision-makers within a hierarchical structure. This model allows the formation of evaluation subgroups to analyze specific parts of a problem and incorporates quantitative assignments through cardinal inputs. By combining ordinal and cardinal aspects, SAPEVO-H² seeks to offer greater robustness in strategic and complex contexts, overcoming some of the restrictions observed in SAPEVO-M (Moreira *et al.*, 2023).

Therefore, the comparison between SAPEVO-M and SAPEVO-H² is justified by the need to understand how each model meets different technological decision-making demands. While SAPEVO-M stands out for its simplicity, practical applicability, and lower implementation cost, SAPEVO-H² proposes greater methodological sophistication by combining multiple levels of analysis and different types of data. Therefore, evaluating their potential and limitations can help

identify the scope and limits of each approach, providing support for both researchers and managers seeking methodologies better suited to technological decision-making scenarios.

Given this panorama, this research aims at carrying out a systematic review of the literature in order to compare the applicability, methodological characteristics, and limitations of the SAPEVO-M and SAPEVO-H² models in the context of technological decision-making, by seeking to understand how such methods can contribute to more consistent and effective decision-making processes in complex scenarios.

1. METHODOLOGY

This study is characterized as a Systematic Literature Review (SLR), conducted based on the guidelines of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol, to ensure transparency, reproducibility, and methodological rigor at all stages.

The research question, which guides the review, was defined in the following terms: What are the main differences between the SAPEVO-M and SAPEVO-H² models in terms of methodological structure, applicability, and potential to support technological decision-making?

The search for studies was conducted in three broad databases relevant to engineering and the applied sciences: Scopus, ScienceDirect, and IEEE Xplore. These databases were chosen for their international scope and for indexing high-quality research on multi-criteria decision support methods. For each database, specific search strings were developed, composed of descriptors related to the models of interest (SAPEVO-M and SAPEVO-H²) combined with terms linked to multicriteria analysis and technological assessment. The search strategies, detailed in Table 1, also included language filters (English, Portuguese, and Spanish), document type (original research articles, excluding reviews), and full-text availability.

Table 1. Search strategies used in the Scopus, ScienceDirect and IEEE Xplore databases

Database	*String* Search	Applied Filters	Remarks
Scopus	TITLE-ABS-KEY("SAPEVO" OR "SAPEVO-M" OR "SAPEVO H2")	Language: English, Portuguese, Spanish- Document Type: *Article* (excluding *Review*) - Availability: Full text	Manually review duplicates and irrelevant items; export to reference manager
ScienceDirect	("SAPEVO-M" OR "SAPEVO H2") AND ("multicriteria" OR "multi-criteria" OR "decision making" OR "technology assessment")	Language: English, Portuguese, Spanish- Document Type: Research Articles- Availability: Full text	Use *Research Article* filters and languages in the side panel

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IEEE Xplore	("SAPEVO-M" OR "SAPEVO H2") AND ("multi-criteria" OR "decision analysis")	Language: English, Portuguese, Spanish- Document Type: *Articles* (not *Reviews*)- Availability: Full Text	IEEE Xplore may have few results in PT/ES; manually review

Source: Prepared by the author (2025).

The selection of studies followed previously defined criteria. Original articles published in established languages and available in full format were included. On the other hand, duplicate studies, abstracts without access to the full text, publications outside the scope of the research, and review articles were excluded. The screening process was carried out in two stages. Firstly, titles and abstracts were read to identify potentially eligible studies. Then, the pre-selected articles were read in full to confirm their adherence to the established inclusion and exclusion criteria.

For the included studies, systematic data extraction was carried out, covering the type of model used (SAPEVO-M or SAPEVO-H²), the context and objectives of the application, the structure of the criteria used, the participation of experts in the decision-making process, the results achieved, the limitations reported, and the conclusions presented by the authors.

Data analysis was conducted qualitatively and comparatively, seeking to highlight convergences and divergences among the models evaluated, as well as their potential and limitations. The results were presented using a PRISMA flowchart, which represents the process of identification, screening, eligibility, and inclusion of studies, complemented by comparative tables and a critical descriptive analysis about the differences between SAPEVO-M and SAPEVO-H² in terms of applicability, methodological structure, and contributions to technological decision-making.

2. RESULTS

The survey, screening, and selection process for studies was conducted in accordance with the PRISMA protocol and is shown in the corresponding flowchart (Figure 1).

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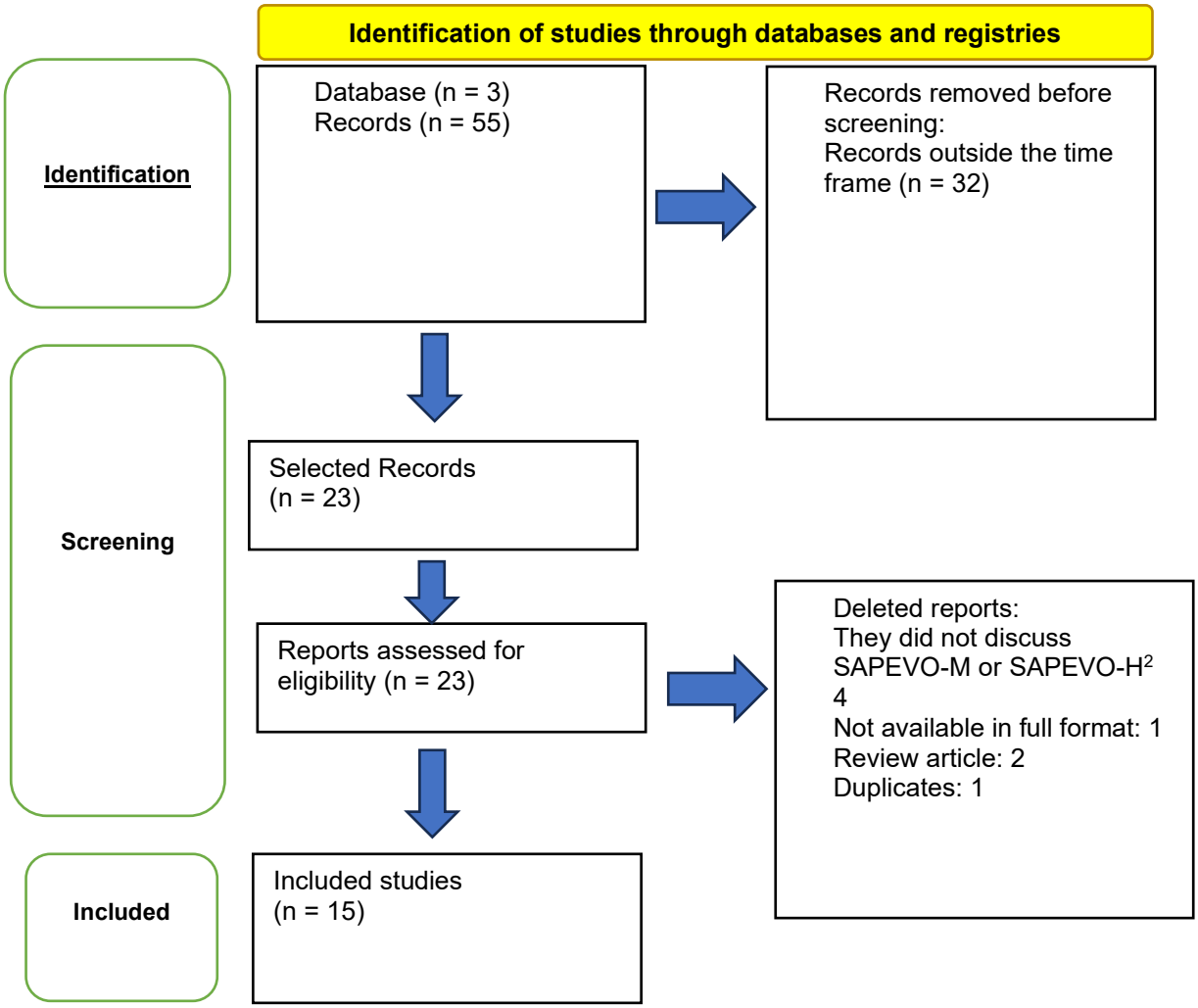
Figure 1. PRISMA Flowchart



Source: Adapted from Page *et al.* (2021).

The initial search across the three databases yielded 55 records (Scopus = 45; ScienceDirect = 9; IEEE Xplore = 1). After applying filters for the period (2020–2025), language (English, Portuguese, and Spanish), and document type (original articles), 23 articles were retained for detailed reading.

In the Scopus database, 45 studies were identified and reduced to 13 after applying the filters. Of these, four were excluded because they did not specifically address the SAPEVO-M or SAPEVO-H² models: one due to the unavailability of the full text, and one because it was a review article, resulting in 7 articles selected.

In ScienceDirect, the search returned 9 records, all within the established temporal and linguistic range. During the screening, 1 article was excluded as a review, and 8 articles were included in the final analysis. Finally, in IEEE Xplore, only 1 study was identified. After applying the

criteria, one duplicate record was found, with no articles from this database included. Thus, the final corpus of the systematic review was composed of 15 eligible articles, distributed between the Scopus (7) and ScienceDirect (8) databases.

The number of studies that use the SAPEVO-M and SAPEVO-H² methodologies is quite small, reflecting the relative novelty and specificity of these multi-criteria models in the scientific literature.

Table 2 presents a systematization of the results found in the research selected for the study.

The studies analyzed were published between 2021 and 2025, which shows that the application of SAPEVO models is relatively recent and still in the process of consolidation. The oldest work identified is that of Moreira *et al.,* (2021), which used the hybrid model PROMETHEE-SAPEVO-M1, by pointing out from the beginning the researchers' concern in combining SAPEVO with other multi-criteria support methods, increasing its robustness. From 2022 onwards, there will be an increase in the number of publications, such as the publications of Maêda *et al.,* (2022), Santos Júnior *et al.,* (2022), Silva *et al.,* (2022), Tenório *et al.,* (2022), Tocchio *et al.,* (2022) and Pereira *et al.,* (2022a, 2022b), who explored different variations of SAPEVO-M, either in a non-compensatory version, compared to other methods, or associated with computational platforms and hybrid tools.

Table 2. Systematization of results found in research

Authors (year)	Model used	Context and objectives of the application	Structure of the criteria used	Participation of experts	Results achieved	Reported limitations	Conclusions presented
Abrão *et al.* (2025)	SAPEVO-M	Evaluate the performance of employees in a private company, creating a robust and transparent performance evaluation system.	Performance in skills, Quality of work, Technical competence, Innovation, Communication, Absenteeism, Education and Training.	Two managers acted as decision makers, evaluating seven employees.	Employee A performed best (32.77%), followed by G (25.57%) and F (14.48%). The model proved to be effective in differentiating performances	Laborious process to evaluate many employees; difficulty in quick adjustments; model needs to be recalculated in case of inconsistencies	SAPEVO-M is a viable tool for performance assessments, allowing for more objective decisions aligned with organizational objectives. It is recommend

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							ed to expand criteria (e.g.: leadership, emotional intelligence) and integrate with AI for predictive analysis.
Diniz *et al.* (2024)	SAPEVO-M	Select the most suitable irrigation method for planting corn in a Local Production Arrangement (APL) in Northeast Brazil.	7 criteria: Growth phase, Water application rate, Water distribution, Cost, Area size, Climate and Water availability.	3 experts (APL owners), through unstructured interviews and brainstorming.	Drip was indicated as the best alternative, followed by furrow and conventional sprinkler. Each expert presented different rankings, but in the aggregate result the trickle prevailed.	Study limited to a specific case (corn APL in the Northeast), based on the perceptions of only three experts, which restricts the generalization of the results.	SAPEVO-M allowed a structured decision based on multiple criteria, pointing to dripping as the most efficient solution. The method contributes to democratizing complex decisions in rural communities.
Maêda *et al.* (2022)	SAPEVO-M-NC	Select the most suitable Brazilian regions for planting African mahogany (Khaya ivorensis species), as an alternative to	4 criteria: (C1) Average temperature, (C2) Average annual precipitation, (C3) Average land value (VTI/ha), (C4)	3 professionals from the agricultural sector interested in commercial reforestation.	The state of Roraima (Boa Vista) was indicated as the best alternative, corroborating the current expansion of the species in	Reduced sample of experts; analysis restricted to seven specific locations; results not necessarily generalizable	SAPEVO-M-NC proved to be effective in reducing the cognitive effort of decision makers and allowing

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		mitigate deforestation and diversify forestry investments.	Logistics infrastructure		the region. The method made it possible to visualize the dominance index between the alternatives.	to other species or reforestation contexts.	clear analyzes of the degree of dominance between alternatives. The study reinforces its practical usefulness for forest planning and as a non-compensatory decision support tool.
Moreira *et al.* (2025a)	SAPEVO-H²	Analyze Brazil's National Defense Policy, hierarchically structuring strategic variables and evaluating their interdependencies.	Hierarchy composed of 15 Defense Principles (PDP), 8 National Defense Objectives (NDO), 18 Strategic Guidelines (DS) and 87 Strategic Actions (SDA). Pair-by-pair evaluation and additive aggregation of levels.	Officers from the three Armed Forces participated in the assessment in a hypothetical scenario.	The method demonstrated the ability to prioritize variables and identify relationships of influence between strategic, operational and tactical levels, offering an integrated view of national defense priorities.	Lack of clear justification for choosing hypothetical cases; officer selection criteria were not made explicit; low representation of participants; limitations for generalizing the results.	The model proved to be suitable for supporting decisions in complex and uncertain contexts, allowing integrated analysis of strategic variables. It is recommended to expand the study with a greater diversity of actors and scenarios, in addition to exploring the

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							applicability in other areas of public policies.
Santos Júnior *et al.* (2022)	SAPEVO-M	Apply reverse logistics for Big Bags in a mining company, with Business Intelligence support, aiming to select the best supplier for the reuse service.	Three criteria: Price, Lead time and Reliability (the latter with greater weight, evaluated qualitatively on a scale of 0 to 5).	There is no mention of external experts; data collected via on-site visits, unstructured interviews, photos, videos and analysis of indicators in Power BI.	83% of Big Bags could be reused via reverse logistics. SAPEVO-M indicated company D as the best supplier, followed by C, A and B. The most important criterion was reliability.	Single case study in a mining company; lack of detail on the criteria for choosing companies and the representativeness of the sample; dependence on self-reported data from suppliers.	The method demonstrated efficiency in structuring multi-criteria decisions and integrating BI data into the selection process, reinforcing the potential of reverse logistics for environmental and economic gains.
Silva *et al.* (2022)	SAPEVO-M (non-compensatory), compared to PROMETHEE-SAPEVO-M1 and AHP-TOPSIS-2N	Selection of truck to transport live cargo in a livestock company (Estância 3M, Pará-Brazil); objective of comparing multi-criteria methods and indicating the best alternative	Price, reliability, delivery time and comfort	Company manager, through unstructured interviews	Mercedes-Benz Atego 1719 indicated as the best option in all methods; divergence in 2nd place (SAPEVO-M - Iveco Tector 17280; other methods - Volkswagen Constellation 17230)	Need for reevaluation in case of veto of the best option, due to divergence between methods in 2nd place	Study achieved the objective of supporting the purchasing decision; Combined use of methods increases the robustness of the analysis.
Tenório *et al.* (2022)	SAPEVO-	Support	Criteria:	Three	Tijuca was	Study limited to	SADEMON

	M, implemented on a computational platform (SADEMON)	decision on the location of a new supermarket chain branch in Rio de Janeiro; objective of testing and validating the SADEMON platform with multiple decision makers	Target audience, Logistics, Accessibility, Proximity to competition	managers from the supermarket chain participated as decision makers	the most favorable neighborhood, followed by Méier; Campo Grande considered less attractive	a specific case; need for new tests in different contexts	proved to be an effective tool for integrating multiple decision-makers, aggregating preferences in a transparent and interactive way; possibility of application in other scenarios and future improvements
Tocchio *et al.* (2025)	SAPEVO-M (implemented on an online platform)	Selection of the most suitable antiparasitic for a medium-sized veterinary clinic in Brasília, aiming to standardize prescriptions, optimize stock, reduce costs and improve relationships with suppliers	Criteria: cost, duration of action, form of administration, number of vectors covered	Participation of clinic managers and team of veterinarians (4 decision makers)	The method indicated FrontMax as the best alternative (25.42%), followed by Scalibor, Advocate and Vectra 3D; Bravecto and Simparic presented lower performance	It did not consider variables such as adverse effects, parasite resistance, seasonality, owner adherence or market fluctuations; subjectivity in assigning weights; lack of sensitivity analysis	SAPEVO-M proved to be effective, structured and transparent, supporting clinical and strategic decisions; contributed to standardizing protocols, greater operational efficiency, reducing waste and strengthening relationships with customers and

							suppliers
Bozic *et al.* (2025)	SAPEVO-M (integrated with FAHP and FCOBRA)	Confectionery in Serbia. Objective: select sustainable and efficient material handling equipment (MHE) in warehouse operations.	12 criteria, grouped into three categories: technical–technological, economic and social–ecological.	Company decision-makers participated in the process, comparing criteria and alternatives.	Implementation of AGVs (Automated Guided Vehicles) (Alternative A1) identified as the optimal solution: cost reduction (20%), increased efficiency (30%) and CO_2 reduction (25%).	Selection restricted to 12 criteria and 4 alternatives; specific company context; results not fully generalizable; high initial cost and need for infrastructure adaptation.	The hybrid model proved to be efficient for selecting sustainable MHE, strengthening the efficiency and sustainability of the food supply chain. It is recommended to expand criteria, alternatives and contexts in future studies.
Matos *et al.* (2024)	SAPEVO-M	Electric motor industry, focus on the packaging production chain. Objective: select the best production strategy, considering outsourcing versus internalization of processes, to optimize efficiency, quality and logistical control.	Various criteria: cost, quality, flexibility, environmental impact, supply risk, assessed quantitatively and qualitatively.	A group of decision-makers from the company participated in the process, providing preferences and evaluating alternatives.	The internalization of packaging assembly was identified as the most advantageous alternative (43.27%), allowing greater control over production variables, increasing operational efficiency and product	Comparison limited to SAPEVO-M (no comparative analysis with other MCDA methods); focus on a specific industry, restricting generalization; human subjectivity influences decisions.	SAPEVO-M has proven to be effective in complex production decisions, integrating qualitative and quantitative criteria and supporting the justification of strategic decisions. It is recommended to

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					competitiveness.		validate the method in other sectors and contexts to increase robustness and applicability.
Moreira *et al.* (2025b)	SAPEVO-H²	Automotive industry, focus on sustainability projects. Objective: prioritize projects to reduce polluting emissions considering multiple objectives and decision levels.	Hierarchical structure of five levels, with quantitative and qualitative criteria, evaluated at different strategic, tactical and operational levels.	Decision-makers segmented by level of responsibility; asynchronous participation permitted, ensuring expert assessments.	The model proved to be flexible and robust for prioritizing projects, allowing detailed sensitivity analyzes and comparisons of superiority between variables.	Future studies needed to test the model in other contexts; it still depends on the development of an online platform for real-time integration of multiple decision-makers.	SAPEVO-H² is effective for complex hierarchical decisions, integrating multiple decision makers and varied criteria, with potential for application in different sectors and decision environments.
Moreira *et al.* (2021)	PROMETHEE-SAPEVO-M1	Evaluation of attack helicopters for the Brazilian Navy, aiming to support strategic acquisition decisions, considering multiple specifications with different levels of importance.	Ordinal evaluation integrated into the PROMETHEE cardinal procedure, with analysis using three preference models (partial, complete and outranking by intervals) and intra-	Operational, tactical and strategic experts involved in the assessment; structured participation via web platform.	Model demonstrated robustness, allowing detailed sensitivity analyses, reverse rank and comparisons with PROMETHEE; provided transparent quantitative and qualitative	Need for expansion to other scenarios and application contexts; future adjustments to the axiomatic model and computational platform.	PROMETHEE-SAPEVO-M1 is a flexible and robust tool, applicable to several real problems, contributing to high-level decisions; It is recommended to expand its

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			criteria analysis using veto threshold; allows pairwise evaluation to obtain weights.		support for the final decision.		use in prospective scenarios and new areas of application.
Moreira *et al.* (2023)	SAPEVO-H²	Assessment of defense strategies against RPAS (Remotely Piloted Aircraft Systems) of the Brazilian Navy, considering multiple strategic, tactical and operational objectives.	Multilevel hierarchical structure, with integration of qualitative (ordinal) and quantitative (cardinal) data; additive aggregation analysis and outranking between elements at each level.	Group of decision makers divided into strategic, tactical and operational levels, according to expertise; assessments carried out in a structured and consistent manner.	Classifications of anti-RPAS technologies and strategies at all hierarchical levels; enabled detailed exploration of preferences and interactions between the evaluated elements.	Future studies need to include new alternatives and objectives, improve model robustness and develop an online computational platform for real-time evaluation.	Flexible and adaptable model to complex decision contexts; potential for application in other high-level scenarios; evolution of the model and integration of an online platform for dynamic decision support is recommended.
Pereira *et al.* (2022a)	THOR 2 and PROMETHEE-SAPEVO-M1	Assessment of the feasibility of implementing a Hospital Information System (HIS) for the Brazilian Navy, aiming to better manage hospital processes and control preventive and	Criteria defined based on interviews and analysis of organizational processes; evaluation of alternatives (purchase of commercial software vs	Group of BN military decision-makers, analyzing alternatives and criteria according to expertise and responsibilities; structured and transparent	Identification of the most favorable alternatives for implementing HIS; parallel application of the two methods provided coherent, robust and	Need to include more variables and alternatives in future studies to increase scope and generalization; study focused on the BN context.	Robust and replicable methodologies, capable of ordering alternatives in a coherent way; structured and transparent results;

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		curative medicine.	free software + customization) with a focus on operability, applicability and alignment with organizational culture.	assessment.	interpretable results in numerical and graphical form; applicable methodology without adapting internal processes.		multi-criteria approach useful for decisions in complex operational, tactical and strategic contexts; recommends expansion into other areas of military management.
Pereira *et al.* (2022b)	PROMETHEE-SAPEVO-M1 + Factor Analysis	Assessment of the quality of life of 38 countries based on the OECD's Better Life Index (BLI), reducing 11 original dimensions into three main factors to reduce the complexity of the decision.	Three factors extracted by factor analysis: (1) personal development and support, (2) financial balance, (3) insecurity in the job market. Criteria weighted according to the variance explained by each factor (0.5; 0.389; 0.111).	There was no direct human expert decision; the model applied statistically derived weights and evaluated countries automatically, providing ranking and positive/negative flows.	Ranking of the 38 countries, highlighting Denmark, Iceland and Switzerland as the best; South Africa, Mexico, Türkiye and Brazil as worst. Comparison with VIKOR and ELECTRE-MOr methods showed very similar results, validating the robustness. 94% reduction in decision-makers' cognitive	Study limited to 38 countries, mainly OECD members; need to expand the methodology to more countries and explore other downsizing and aggregation techniques.	Efficient and replicable hybrid methodology; provides quantitative ranking and relative distance analysis between alternatives; reduces cognitive effort and increases transparency; applicable to public policies, investment prioritization and academic problems; Comparison with other

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					effort.		methods confirms consistency.

Source: Prepared by the authors (2025).

Between 2023 and 2025, there is a thematic expansion, but still restricted to the same group of researchers, especially the group led by Moreira *et al.*, which appears in four publications (2021, 2023, 2025a, and 2025b). This fact confirms that the field is still dominated by a few authors, which can be interpreted as a limitation, as the wider dissemination of the method across different contexts and by different groups has not yet been consolidated. Other authors, such as Pereira, Matos, Bozic, and Abrão, also contribute, but in fewer studies, reinforcing that scientific production related to SAPEVO still focuses on specific networks.

In terms of applied models, the majority of observed publications employ SAPEVO-M in different variations (traditional, non-compensatory, integrated with other methods or implemented on digital platforms). Cases like Bozic *et al.,* (2025) and Silva *et al.,* (2022) illustrate this hybridization trend well by combining SAPEVO-M with FAHP, FCOBRA, AHP-TOPSIS-2N, and PROMETHEE-SAPEVO-M1. This multiplicity suggests that researchers recognize the model's flexibility and seek to adapt it to complex decision-making scenarios, particularly in technological contexts.

As for SAPEVO-H², although it represents an important methodological evolution, there remains a shortage of publications. Only three studies were found: Moreira *et al.* (2023), Moreira *et al.*, (2025a), and Moreira *et al.,* (2025b), all linked to the same group of researchers. This demonstrates that the diffusion of H² is still in its early stages, requiring further investigation into its applicability across different domains. Hybrid models, such as PROMETHEE-SAPEVO-M1 (Moreira, 2021; Pereira, 2022a; 2022b) and their combinations with factor analysis or other outranking methods, reinforce the versatility and the potential to integrate SAPEVO with consolidated multicriteria approaches, contributing to more consistent analyses.

The analyzed studies demonstrate that the structuring of the criteria varied greatly depending on the context of application, ranging from simpler situations, with 3 to 4 criteria (such as reverse logistics of Big Bags, cattle transport and selection of antiparasitics), to highly complex scenarios, such as the Brazilian National Defense Policy (with more than 120 variables organized hierarchically) and the evaluation of strategies against RPAS (Remotely Piloted Aircraft Systems), where qualitative and quantitative data were integrated at multiple strategic, tactical and operational levels.

In business and private management cases (e.g., employee performance evaluation, supplier selection, supermarket location, truck choice), the emphasis was on practical, directly measurable criteria (cost, quality, time, reliability). In contrast, in studies focused on national

defense and public policies, the criteria were organized into more sophisticated hierarchical structures that integrated strategic, operational, and social dimensions.

Another observed aspect is that, in some studies, such as Silva *et al.,* (2022) and Moreira *et al.,* (2021, 2023), there was a need to combine SAPEVO with other multi-criteria methods (e.g., PROMETHEE, AHP, factor analysis), either to treat a large volume of variables or to strengthen the decision-making process in complex scenarios. This confirms the versatility of SAPEVO but also highlights that the isolated model may not be sufficient in highly complex situations, requiring hybrid approaches. In the studies analyzed, SAPEVO-H² has been identified as applied in more complex scenarios, such as national defense (evaluation of strategies against RPAS (Remotely Piloted Aircraft Systems) and analysis of defense policies), where the multiplicity of objectives and variables requires robust and flexible methods.

The analysis of the studies highlights different forms of involvement of specialists in the decision-making process, ranging from the participation of single managers (as in the case of selecting trucks for cargo transport) to the composition of multidisciplinary groups segmented by strategic, tactical, and operational levels (as in national defense studies with SAPEVO-H²). This diversity reinforces the models' flexibility, which can adapt to both more restricted scenarios (internal decisions in private companies or veterinary clinics) and highly complex situations (the definition of military strategies and defense policies).

The results demonstrate that SAPEVO-M has been widely used in business and sectoral contexts, with emphasis on its practical applicability to local-scale problems, presenting concrete solutions such as identifying the most reliable suppliers, choosing production alternatives, or evaluating employee performance. SAPEVO-H², applied in fewer studies, proved more suitable for hierarchically structured problems with multiple decision-making levels, providing sensitivity and robustness analyses that offer greater transparency in highly complex strategic contexts.

The comparative analysis of the studies reveals that, although the SAPEVO family models have proven to be effective in different contexts (business, agricultural, environmental, clinical, military, and public policy), they all presented important limitations that need to be considered. Among the most recurrent issues, the following stand out: a small sample of experts, a focus on single-case studies, limited generalizability of results, and subjectivity in the attribution of weights and criteria. In some cases, there was also a need for reevaluation when methods diverged, as well as for greater clarity in the choice of participants and in the justifications for selecting scenarios and criteria. Furthermore, technical restrictions were highlighted, such as dependence on platforms still under development, high initial costs, and a lack of more in-depth sensitivity analyses.

Despite these limitations, the conclusions converge on the recognition that the SAPEVO models provide structured, transparent, and robust support for the decision-making process,

enabling the integration of qualitative and quantitative criteria and reducing the cognitive effort of decision-makers. SAPEVO-H², although less explored, proved especially effective for complex hierarchical problems involving multiple decision levels and detailed sensitivity analyses, highlighting its potential in highly complex strategic sectors. Hybrid versions, such as PROMETHEE-SAPEVO-M1, increased flexibility and demonstrated applicability in prospective scenarios.

There was consensus among studies on the need to expand to other contexts, to include new criteria and alternatives, and to integrate with computational tools and artificial intelligence to increase the scalability, applicability, and reliability of results in future scenarios.

3. DISCUSSION

The analysis of the selected studies shows that the SAPEVO family of methods has broad applicability and increasing relevance in complex multi-criteria decision-making. SAPEVO-M, applied in different sectors, has demonstrated the ability to structure decision problems, integrate multiple criteria, and provide consistent solutions, even in contexts with a limited number of decision makers. The study by Abrão *et al.,* (2025), for example, applied SAPEVO-M to evaluate employees' performance at a private company, considering seven main criteria, including performance in skills, quality of work, technical competence, innovation, communication, absenteeism, and training. The results indicated employee A as the best aggregate performer (32.77%), followed by employees G (25.57%) and F (14.48%). Despite the model's robustness, the authors highlighted limitations related to the complexity of the process when applied to a larger number of employees, which require recalculations in the event of inconsistencies. Even so, the method proved to be strategic for people management, allowing for more objective, impartial decisions aligned with organizational objectives, and recommending the inclusion of new criteria, such as leadership and emotional intelligence, and the integration of artificial intelligence tools for predictive analysis.

In rural and environmental contexts, SAPEVO-M has also proven effective. Diniz *et al.,* (2024) applied the method to choose the most suitable irrigation system for planting corn in a Local Production Arrangement in Northeast Brazil. Considering seven criteria defined through interviews with producers, the aggregate decision indicated that drip was the best alternative. Despite being restricted to a single context and with just three experts, the study reinforces the usefulness of SAPEVO-M for organizing complex decisions, democratizing the decision-making process and providing solutions adapted to the local reality. Similarly, Maêda *et al.* (2022) used SAPEVO-M-NC to evaluate regions suitable for planting African mahogany, considering four strategic criteria. The method indicated Boa Vista (RR) as the most promising region, validating the approach to forest planning and deforestation mitigation and demonstrating that the non-compensatory version of

SAPEVO-M reduces the cognitive effort of decision-makers. Limitations of these studies include the limited number of experts and the geographic concentration of the analyses, which limit the generalizability of the results.

The complexity of SAPEVO is even more evident in hierarchical and strategic applications. SAPEVO-H², as demonstrated by Moreira *et al.,* (2025a, 2025b), was applied to decisions related to the National Defense Policy and the prioritization of industrial sustainability projects. In both contexts, the model made it possible to organize multiple decision levels, adding quantitative and qualitative criteria and segmenting decision-makers into strategic, tactical and operational levels. The method proved capable of prioritizing critical variables, highlighting interdependencies between hierarchical elements, and offering detailed sensitivity analyses. Highlighted limitations include the need for validation across different contexts, the expansion of the number of stakeholders, and the development of online platforms that enable real-time assessments. These studies show that, although still limited in some cases, SAPEVO-H² has great potential for complex hierarchical decision-making in high-uncertainty environments.

Integration with hybrid tools has also demonstrated positive results. Moreira *et al.,* (2021) applied PROMETHEE-SAPEVO-M1 to evaluate Brazilian Navy attack helicopters, integrating ordinal and cardinal analyses, pairwise evaluation, and veto thresholds. The participation of strategic, tactical, and operational decision makers was structured by a web platform, allowing detailed sensitivity analyses, reverse ranking, and comparisons with traditional methods. Likewise, Pereira *et al.,* (2022a, 2022b) applied PROMETHEE-SAPEVO-M1 and factor analysis to evaluate public policies and quality of life in countries. In these cases, the model provided quantitative rankings that identified relative distances between alternatives and reduced cognitive effort by up to 94%. Comparison with methods such as VIKOR and ELECTRE-MOR showed high coherence in the results, reinforcing the robustness of the hybrid model for complex strategic decisions.

Industrial and business applications also confirm the flexibility of SAPEVO-M and its hybrid versions. Studies on reverse logistics of Big Bags (Júnior *et al.*, 2022), live cargo transportation (Silva *et al.*, 2022), choice of branch locations (Tenório *et al.*, 2022) and selection of handling equipment in confectionery companies (Bozic *et al.*, 2025) demonstrate that the method allows structuring complex decisions, integrating preferences of multiple decision-makers and providing sustainable and cost-effective advantageous solutions. The main limitation of these studies lies in the specificity of the context and the limited number of criteria and alternatives, which may compromise generalization. However, the use of computational platforms such as SADEMON highlights a promising path to expanding participation among decision makers and improving the robustness of analyses.

Despite the various applications and advantages observed, the studies indicate common limitations: small sample sizes of decision-makers, limited contextual scope, the need to

recalculate the model in the event of inconsistencies, subjectivity in defining weights and criteria, and the scarcity of research on SAPEVO-H² outside the military or industrial sectors. These aspects reinforce the need for new research to validate the method across different contexts, expand the range of alternatives and criteria, implement more integrated computational platforms, and explore possible combinations with artificial intelligence to increase the effectiveness and speed of decision-making.

The systematic review carried out allows us to observe that both SAPEVO-M and SAPEVO-H² have relevant applicability in technological decision-making contexts, but with important differences in terms of maturity, scope, and limitations. SAPEVO-M stands out as the most consolidated model in the literature, applied across sectors such as people management, agriculture, reverse logistics, industrial production, veterinary health, and sustainability.

This diversity highlights its methodological flexibility and its ability to integrate multiple qualitative and quantitative criteria, enabling structured, transparent analyses even in environments with a limited number of decision-makers. Among its main methodological characteristics, the relative simplicity of application, the clarity in structuring the criteria, and the possibility of combining it with other multi-criteria methods or computational platforms, such as SADEMON and Business Intelligence tools, stand out. However, recurring limitations were highlighted: high cognitive effort in analyses involving many decision makers or alternatives, the need to recalculate the model in the event of inconsistencies, subjectivity in defining criteria, and generalization limitations due to application in specific case studies.

On the other hand, SAPEVO-H² still appears to be at an early stage of practical application, with a limited number of studies identified and concentrated, for the most part, in strategic areas of national defense and industrial sustainability. Its main methodological contribution lies in the multilevel hierarchical structure, which allows organizing complex problems into different layers (strategic, tactical, and operational) and integrating the preferences of decision makers distributed across different levels. This characteristic increases the robustness of the decision-making process in high-complexity, high-uncertainty scenarios, while also enabling the analysis of interdependencies between variables and the performance of more sophisticated sensitivity analyses. However, the literature points out that the model still needs validation in other sectors and contexts, as well as the development of online platforms that enable real-time integration of multiple decision-makers. Thus, it can be inferred that, although promising, SAPEVO-H² still lacks applied research and faces practical challenges that limit its dissemination.

Comparing the two models, it is possible to conclude that SAPEVO-M is more suitable for operational and tactical problems, in which simplicity, clarity, and integration of objective and subjective criteria are sufficient to guide the decision. SAPEVO-H² is more appropriate for strategic and hierarchical scenarios, in which complexity demands organization across multiple decision-

making levels and greater detail in the interdependencies among alternatives. Thus, regarding their contribution to more consistent and effective decision-making processes, the SAPEVO family methods meet different levels of complexity, being complementary: SAPEVO-M for more direct applications and adapted to organizational and sectoral realities, and SAPEVO-H² for contexts of greater scope, uncertainty, and strategic impact.

4. CONSIDERATIONS

The systematic review confirmed that the SAPEVO-M and SAPEVO-H² models stand out as promising tools for supporting technological decision-making in complex scenarios, even across different stages of modernity. SAPEVO-M proved to be the most consolidated in the literature, with diverse applications across areas such as people management, agriculture, health, reverse logistics, and industrial sustainability, demonstrating flexibility, methodological rigor, and practical applicability. SAPEVO-H², although less empirically explored, presented great potential for contexts of high complexity and hierarchical nature, such as those linked to defense and strategic management, standing out for its multilevel structure and the ability to integrate decisions at different levels. Taken together, the results indicate that the SAPEVO family of models is highlighted to make decision-making processes more transparent, consistent, and aligned with organizational and strategic demands, each with specific advantages depending on the scale and nature of the decision.

However, this study has some important limitations. Firstly, the number of applied research is still small, especially for SAPEVO-H², which limits the comparison between models in terms of empirical robustness. Furthermore, most of the studies analyzed are exploratory or case studies, which limits the generalizability of the results to other sectors or contexts. There was also a lack of direct comparative analyses between SAPEVO and other consolidated multicriteria methods, making it difficult to evaluate their advantages and limitations more comprehensively. Finally, the lack of standardization in the definition of criteria, number of experts, and forms of data collection in the studies analyzed contributes to methodological heterogeneity, which poses challenges to the comparative synthesis.

Given these limitations, future research advances are suggested to expand the application of the models across different sectors, especially in emerging technological areas and dynamic business environments, to validate their robustness and adaptability. Furthermore, the relevance of investigating integration with artificial intelligence and predictive analytics is highlighted, expanding the capacity of these models to support real-time decisions in high-uncertainty scenarios.

Thus, conclusions are drawn to have SAPEVO family models offer a relevant and innovative contribution to the multi-criteria decision support literature, while still requiring empirical

consolidation and methodological advances to fully explore their potential in increasingly complex and challenging technological contexts.

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