algorithms

MDPI

Article

A Systematic Approach to the Management of Military Human Resources through the ELECTRE-MOr Multicriteria Method

Igor Pinheiro de Araújo Costa [1,*], Adilson Vilarinho Terra [2], Miguel Ângelo Lellis Moreira [1,2], Maria Teresa Pereira [3,4], Luiz Paulo Lopes Fávero [5], Marcos dos Santos [1,6] and Carlos Francisco Simões Gomes [2]

1 Operational Research Department, Naval Systems Analysis Center (CASNAV), Rio de Janeiro 20091-000, Brazil
2 Production Department, Fluminense Federal University (UFF), Niteroi 24210-346, Brazil
3 School of Engineering of Porto (ISEP), Polytechnic of Porto, 4200-072 Porto, Portugal
4 Instituto de Ciência e Inovação em Engenharia Mecânica e Engenharia Industrial (INEGI), Rua Dr. Roberto Frias, 400, 4200-465 Porto, Portugal
5 School of Economics, Business and Accounting, University of São Paulo, Sao Paulo 05508-010, Brazil
6 Systems and Computing Department, Military Institute of Engineering (IME), Urca 22290-270, Brazil
* Correspondence: costa_igor@id.uff.br

Abstract: Personnel selection is increasingly proving to be an essential factor for the success of organizations. These issues almost universally involve multiple conflicting objectives, uncertainties, costs, and benefits in decision-making. In this context, personnel assessment problems, which include several candidates as alternatives, along with several complex evaluation criteria, can be solved by applying Multicriteria Decision Making (MCDM) methods. Uncertainty and subjectivity characterize the choice of personnel for missions or promotions at the military level. In this paper, we evaluated 30 Brazilian Navy officers in the light of four criteria and 34 subcriteria. To support the decision-making process regarding the promotion of officers, we applied the ELECTRE-Mor MCDM method. We categorized the alternatives into three classes in the modeling proposed in this work, namely: Class A (Promotion by deserving), Class B (Promotion by seniority), and Class C (Military not promoted). As a result, the method presented 20% of the officers evaluated with performance corresponding to class A, 53% of the alternatives to class B, and 26.7% with performances attributed to class C. In addition, we presented a sensitivity analysis procedure through variation of the cut-off level λ, allowing decision-making on more flexible or rigorous scenarios at the discretion of the Naval High Administration. This work brings a valuable contribution to academia and society since it represents the application of an MCDM method in state of the art to contribute to solving a real problem.

Keywords: multicriteria decision making (MCDM); ELECTRE-MOr; decision making; personnel selection; Brazilian navy

Citation: Costa, I.P.d.A.; Terra, A.V.; Moreira, M.Â.L.; Pereira, M.T.; Fávero, L.P.L.; Santos, M.d.; Gomes, C.F.S. A Systematic Approach to the Management of Military Human Resources through the ELECTRE-MOr Multicriteria Method. *Algorithms* **2022**, *15*, 422. https://doi.org/10.3390/a15110422

Academic Editors: Debora Di Caprio and Francisco Javier Santos-Arteaga

Received: 24 September 2022
Accepted: 7 November 2022
Published: 9 November 2022

1. Introduction

Complex environments, conflicting criteria, uncertainties, and inaccurate information are characteristic of many decision problems in the real world. Efficiency in decision-making consists of choosing the alternative that, as far as possible, offers the best results. The viable alternatives for achieving the objective, and selected for evaluation, are compared according to criteria and under the influence of several attributes [1].

In this sense, the Multicriteria Decision Making (MCDM) methodology contributes to making the decision-making process more rational [2,3]. The MCDM methods support the decision-making process because they consider value judgments and not only technical issues to evaluate alternatives in real problems, presenting high multidisciplinarity [4].

The MCDM methodology comprises multiple criteria to help stakeholders and groups explore relevant decisions [5]. The essential components of MCDM are a set of alternatives, criteria, and at least one decision-maker (DM). MCDM assists in decision-making, especially concerning problems of choosing, ordering, or classifying actions [6]. Another vital feature is that multicriteria methods are not designed to seek the best alternative concerning all criteria. The problem's difficulty originates from more than one criterion [7].

The problems of choice imply the selection of a subset containing the best alternatives; classification problems provide the alternatives, from the best to the worst; classification problems distribute the alternatives into predefined and ordered categories [8].

We emphasize the relevance of the hierarchy between data, information, and knowledge when applying the methods. The data, when processed and analyzed, become information. When such information is recognized and applied in decision-making, it generates knowledge. Similarly, the reverse hierarchy can also be applied since knowledge, when disseminated or explained, becomes information that, when dismembered, can generate a data set [9]. Figure 1 presents this logic, which is fundamental to MCDM.

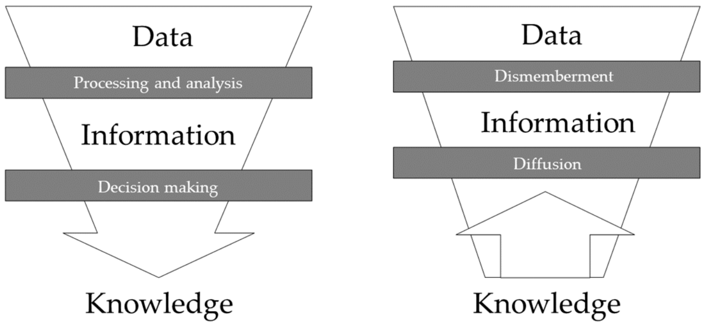

Figure 1. Importance of hierarchy between Data, Information, and Knowledge in MCDM.

The people represent one of the most significant resources of an organization. Therefore, personnel selection is one of the problems that organizations are increasingly facing [10]. According to [11], staff selection is a significant task for any organization that aims to select the most suitable candidates to fill well-defined vacancies. In the recruitment process, several characteristics are involved, such as leadership, analytical skills, independent thinking, innovation, endurance, and personality.

In this context, a vital division in any organization is the Human Resources (HR) department, responsible for personnel recruitment and selection [12]. In the knowledge economy, human capital is a crucial factor in any organization achieving sustainable competitive advantage.

Thus, personnel selection is the most important function of HR managers [13]. However, the numerous criteria, alternatives, and goals make choosing between several candidates excessively complex and confusing. Inaccuracy and uncertainty characterize the decision-making environment, making it difficult to express the exact criteria [10].

Multicriteria techniques can help to address personnel assessment problems, which include several candidates as alternatives, along with several complex evaluation criteria [12–15]. As suggested by [16], decision-aid methods should enable an integrated algorithm to evaluate qualitative and quantitative data. That is, tools should be able to structure and analyze variables in situations where the DM cannot define a precise numeric entry. In this context, subjectivity in MCDM modeling plays an important role [17]. It transcribes the preferences of the DM by the method implemented, being transparent regarding the manipulations and attributions in the evaluation problem [18].

Within the Armed Forces (AF), multicriteria methods are routinely employed because precise decision-making is a decisive factor for success and can reduce spending and increase defense capacity [19]. The study [20] exposes that military decisions are of great importance because they affect the sovereignty and security of countries. The MCDM methods have been applied to several recent military problems, such as [21–26]. The choice of personnel for missions or promotion in the military and other areas of knowledge is uncertain and subjective. Thus, the question that expresses the research problem is: How can decisions be configured to prioritize the Military of the Brazilian AF for positions and promotions transparently and reasonably?

This work aims to propose a methodology for the choice of military personnel, seeking to treat the subjectivity inherent to this type of decision through the association of qualitative and quantitative data. We expect that the modeling proposed in this work will contribute to a transparent and robust decision-making process for personnel selection, with the possibility of analyzing quantitative and qualitative data intrinsic to issues related to human resources.

In addition, we presented a simple and intuitive computational tool [27] that seeks to make the decision-making process more flexible, reliable, and faster, greatly facilitating complex calculations that involve MCDM. The modeling presented in this work will deliver an axiomatic structure for multiple decision-makers, allowing them to indicate their preferences and subjectivities regarding the analyzed data, aggregating their points of view and making the decision-making process more reliable and democratic.

This work can contribute to academia and society, presenting an integrated, practical, and valuable model for various operational and strategic tactical applications. Given its dual nature, the developed framework will enable online applications in military and civil environments.

The present study is divided into six chapters to introduce and contextualize the problem we addressed in this work. Section 2 presents the main applications of MCDM in problems related to personnel selection, mapping the state of the art of this theme, and identifying trends to guide the research of this paper. Section 3 discusses the background of the ELECTRE-MOr method. Section 4 aims to structure the problem, obtaining the criteria and subcriteria that make up the analysis. Section 5 presents the case study, while Section 6 concludes this paper, presenting the respective conclusions to the study and the proposition of future research.

2. Literature Review

The literature presents few studies that apply MCDM methods to the problem of personnel selection in the military environment. We found few studies that address the themes, such as in the selection of war games [28] and the designation of military personnel to positions of trust [29]. On the other hand, there are many examples of MCDM applications in personnel selection. For [30], project performance will be affected without an adequate and accurate method for HR problems. A suggested viable methodology for these types of problems is MCDM. The authors used the Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP) methods for personnel selection.

Daǔdeviren [31] developed a hybrid model that employed the ANP and modified the Technique for Order Preferences by Similarity To Ideal Solution (TOPSIS) method into a personnel selection problem. The authors used the ANP method to analyze the structure of the personnel selection problem and determine the criteria weights. In contrast, the TOPSIS method obtained the final ordering. According to the author, the company's management considered the application and the results satisfactory and implementable in its personnel selection process.

Baležentis and Zeng [32] proposed a general methodology for the field of HR management and performance management, using the MULTIMOORA method with fuzzy sets type 2, providing the means for MCDM related to inaccurate assessments.

According to [33], many individual attributes considered for personnel selection, such as organizational ability, creativity, personality, and leadership, exhibit inaccuracy. In this context, fuzzy set theory represents an essential tool to provide a decision-making framework that incorporates inaccurate judgments inherent in the personnel selection process. The authors used an algorithm composed of the fusion of diffuse information and the Additive Ratio Assessment (ARAS) and Step-wise Weight Assessment Ratio Analysis (SWARA) method. They also illustrated the structure through an architect's selection problem.

According to [34], given the uncertain, ambiguous, and vague nature of personnel selection, this process requires the application of MCDM methods for robust and fair recruitment. The authors used the Fuzzy-MULTIMOORA method for group decision-making (MULTIMOORA-FG) to aggregate subjective evaluations of decision-makers and performed personnel selection procedures. The authors applied the method in a company with four decision-makers to choose the best candidate to fill a vacancy. The committee decided to consider eight qualitative attributes expressed in linguistic variables.

According to [35], multiple criteria and qualitative and quantitative factors make the decision-making process more complex. The authors proposed a hybrid approach to decision-making, allowing the combination of qualitative and quantitative factors. They used Fuzzy ANP techniques, Fuzzy TOPSIS, and Fuzzy ELECTRE (Elimination Et Choix Traduisant la Realité) to select snipers and applied them to a real case.

Chen and Cheng [36] developed a computer-based group decision support system to increase recruitment productivity and compare their method with other fuzzy number classification methods. In another scenario, Sang et al. [37] proposed an analytical solution to the Fuzzy-TOPSIS method. The authors provided detailed comparations and applied the proposed methodology in personal selection. Krylovas et al. [38] presented a new approach to the Kemeny Median Indicator Ranks Accordance (KEMIRA) method to determine the weights of priority and selection criteria to solve MCDM problems. The authors illustrated the method in a numerical example for the elite selection of security personnel.

Nabeeh et al. [39] contributed to supporting the personnel selection process by integrating the Neutrosophic AHP and TOPSIS methods to illustrate an ideal solution for different candidates for personnel selection, and Rouyendegh and Erkan [40] highlighted an actual application for academic staff selection using expert opinion applied to a Fuzzy ELECTRE method model. There were ten qualitative criteria for selecting the best candidate from five possible applications.

Karabasevic et al. [41] state that, in contracting with companies, DMs underuse MCDM methods for personnel selection. Under uncertainty, the authors established a framework for selecting candidates during the recruitment process based on the SWARA and ARAS methods. They used the methods in a case study of the selection of the candidate for the sales manager position.

Heidary Dahooie et al. [13] presented a skills framework with five criteria for choosing the best specialist in Information Technology (IT) among five alternatives. The authors used SWARA and ARAS-Grey methods to derive the criteria weights and provide the final alternative. The results revealed that technical competence is the main criterion in the selection of IT personnel.

Karabasevic et al. [42] provided an efficient approach to recruiting and selecting candidates in the mining industry. They proposed an approach based on using the SWARA and MULTIMOORA methods. The authors considered the proposed approach in the numerical example of choosing a candidate for the underground mining engineer position.

Urosevic et al. [43] proposed an approach to staff selection for the sales manager position in the tourism sector using the SWARA and Weighted Aggregates Sum Product Assessment (WASPS) methods. In a similar approach, Keršuliene and Turskis [44] integrated the ARAS method with Fuzzy numbers (ARAS-F) and the AHP method to manage evaluated information using numerical and linguistic scales in a decision-making problem to select an accounting director.

Ulutaş et al. [10] proposed and used the Grey Pivot Pairwise Relative Criteria Importance Assessment (PIPRECIA-G) method to determine the criteria of importance for personnel selection. They applied the Grey Operational Competitiveness Rating Analysis (OCRA-G) method for the final ranking of the candidates considered.

Kilic et al. [14] proposed a methodology integrated by the Decision Making Trial and Evaluation Laboratory (DEMATEL) and ELECTRE methods under the Fuzzy Intuitionistic Environment (IF). The authors used the IF-DEMATEL method to obtain the weights of the criteria. Then, the IF-ELECTRE method was formulated and applied to classify the candidates based on cardinal and ordinal evaluations.

Raj Mishra et al. [45] chose the best IT candidate integrating the IF-ARAS method with divergence measure, better scoring function, and IF aggregation operators. Dwivedi et al. [46] suggested an optimized model to select the best employees using MCDM for a supply chain company by applying the AHP and TOPSIS methods.

Ijadi Maghsoodi et al. [12] extended the CLUSter analysis to improve the Multiple Criteria Decision Analysis (CLUS-MCDM) approaches. They integrated it with the Best–Worst Method (BWM). The methodology was applied to solve big data decision-making problems in various scenarios. The authors investigated multiple personnel selection and risk assessment problems with various scenarios within several departments simultaneously.

Abdel-Basset et al. [11] proposed a new multicriteria structure composed of the Neutrosophic ANP and TOPSIS methods under bipolar neutrons. The authors applied a structure for selecting a Chief Executive Officer (CEO) in a case study in Egypt.

Krishankumar et al. [15] proposed a new decision-making framework consisting of two steps. In the first stage, the authors proposed a new extension of the VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) method under the IF context. The ideal positive and negative solutions were determined, and they calculated the parameters of the VIKOR method using the transformation procedure. The authors applied the methodology to a personnel selection problem to validate the proposed framework.

The literature review revealed several applications that combine MCDM to support decision-making in personnel selection problems. In most cases, the authors applied one method to obtain the weights of the criteria and another to evaluate the alternatives, taking advantage of the characteristics of each model. In this work, we analyzed the models and methods of MCDA most applied in personnel problems (Table 1). The sum of the percentages is more than 100% because, in several articles, the authors applied more than one method.

Table 1. Distribution of MCDM models and methods.

Modeling/Method	Percentage
Fuzzy Logic	45.76%
TOPSIS	28.81%
AHP	18.64%
ANP	16.95%
VIKOR	11.86%
SWARA	11.86%
MULTIMOORA	10.17%
Dematel	8.47%
ARAS	8.47%
ELECTRE	6.78%
DELPHI	3.39%
MOORA	3.39%
PIPRECIA-G	1.69%
OCRA-G	1.69%
Interactive and multiple attribute decision making (TODIM)	1.69%
BWM	1.69%
COmbinative Distance-based Assessment (CODAS)	1.69%
PROMETHEE	1.69%
EDAS	1.69%
WasPAS	1.69%
KEMIRA	1.69%

Analyzing the results, we observed that fuzzy logic is the most applied modeling in personnel selection problems with MCDM, present in 45% of the analyzed articles. Given the significant subjectivity and uncertainties related to personnel selection, the preponderance is that diffuse approaches deal better with inaccuracy and uncertainty [15].

These findings corroborate the impressions of several authors, such as Baležentis and Zeng [34], Kabak et al. [35], and Kilic et al. [14]. They applied fuzzy logic concepts in conjunction with MCDM methods to deal with data characterized by inconsistency and uncertainty in multicriteria problems.

Among the methods of MCDM, the TOPSIS and VIKOR stand out, characteristic of problems of ordering or choice. In most of the articles analyzed, the authors used the methods to obtain a ranking of candidates or to select the best employee of a given company.

In addition, the AHP, ANP, and SWARA methods are also among the most applied, mainly because they allow the analysis of qualitative and quantitative data. In most cases, we found that these methods are used to obtain the weights of the criteria and other methods of ordering or selection for evaluating alternatives.

In general, in this type of problem, there is a preference for compensatory methods to the detriment of non-compensatory methods. We observed several tactical, operational and strategic applications, presenting many hybrid models, combining the characteristics of different multicriteria methods.

In addition, significant subjectivity and uncertainties are present in decision-making for personnel selection. In this context, for a methodology to present transparent and reliable results, it is necessary to analyze quantitative and qualitative data in situations where it is impossible to define a precise numerical scale to specific subjective criteria.

3. Background

This chapter discusses the main concepts of the ELECTRE family's methods and presents the axiomatics of the ELECTRE-MOr method and the proposed computational tool.

The decision-making process usually involves a choice between several alternatives, which must be viable for achieving the objective and evaluated according to criteria and under the influence of attributes [1]. The methods of MCDM are instrumental in supporting the decision-making process in these cases because they consider value judgments, and not only technical issues, to evaluate alternatives to solve real problems, presenting themselves in a highly multidisciplinary way [47].

3.1. The Methods of the ELECTRE Family

The methods of the ELECTRE family are based on non-compensatory logic to establish outranking relationships between pairs of alternatives [48]. An alternative to outranks an alternative b (aSb) if it is at least as good as b in the criterion under consideration; this is the central idea expressed by the concept of outranking [49].

The peer-to-peer comparisons allow for evaluating the importance of different alternatives to obtain a final classification using an appropriate [50]. Such a process requires the DM to declare the performance of each alternative about the established criteria and allows the expression of its knowledge about the problem to be solved [51].

According to Figueira et al. [52], the modeling of preference relationships considers indifference, strict preference, and incomparability relationships. Cutting plans are established by minimum levels of agreement and maximum disagreement [53].

The ELECTRE methods cover two main procedures: the construction of one or more overcoming relationships and, later, an exploration procedure [52])

Since the first ELECTRE, described fifty years ago, other authors developed other methods, constituting the ELECTRE family: ELECTRE I [54]; ELECTRE II [55]; ELECTRE III [56]; ELECTRE IV [57]; ELECTRE IS [58]; ELECTRE TRI [59]; ELECTRE TRI-B [60]; ELECTRE TRI-C [60]; ELECTRE-TRI-nC [49]; ELECTRE TRI-rC [61]; and ELECTRE TRI-nB [62].

Several extensions, variations, and proposals related to ELECTRE methods have been found in the literature and identified as cardinal methods. In cardinal methods, DMs must express their preferences for each alternative or another in each criterion. In contrast, in the ordinal methods, it is sufficient to order the alternatives for each [63].

According to [64], there were no ELECTRE methods with the input of ordinal weights. The ELECTRE-MOr method covered this gap in the literature, allowing the entry of ordinal weights and evaluation of quantitative and qualitative criteria.

3.2. The SAPEVO-M Method

The Simple Aggregation of Preferences Method Expressed by Ordinal method Vectors—Multi Decision Makers (SAPEVO-M), proposed by Gomes et al. [65], can be understood as an axiomatic evolution of the SAPEVO method [66]. The SAPEVO-M method introduced an evaluation for multiple DMs in the decision-making process and the previously developed axiomatic model, thus increasing its consistency.

Using ordinal scales transcribed by linguistic terms, it is possible to express an opinion about a variable [66], representing a relative value of importance and this information by cardinal data. Gomes et al. [65] claim that the main characteristic of the method is related to the process of ordinal transformation of the data used to obtain the relations of the degrees of preference between the alternatives in each criterion, in addition to obtaining the degrees of importance of the criteria, generating their respective weights.

The axiomatic structure is based on a pairwise evaluation, aiming to express the respective preferences of the DMs. A seven-point scale provides cardinal preference relationships through the scores [66].

3.3. The ELECTRE-MOr Method

The ELECTRE MOr, proposed by [64], is a method of classification of multiple criteria with the input of ordinal weights, which includes multiple DMs, and distributes the alternatives into predefined categories. For the establishment of preference relationships, the method establishes three fundamental situations of comparison between alternatives and predefined class limits:

- Weak preference (q): There are clear and positive reasons that do not imply a strict preference in favor of one (well-defined) of the two actions, but these reasons are insufficient to assume a strict preference in favor of another or the indifference between [67];
- Strict preference (p): There are clear and positive reasons that justify a significant preference in favor of one (well defined) of the two actions [67]; and
- Veto (v): Limit defined for each criterion that sets a value for the difference $g_j(b)$–$g_j(a)$ (difference with criterion j and discordant from the statement aSb), from which the proposition aSb [68].

We developed ELECTRE-MOr procedures in two stages:

1. Transform criteria ordinal preferences into a vector of criteria weights;
2. Integrate the vector criteria of different decision-makers.

In constructing the overcoming relationships, ELECTRE-Mor adapts the SAPEVO-M method to generate the weights. This first step brings together two steps:

- Step 1: the relationship is associated with the following five-point scale, ranging from −2 to 2, according to Table 2 [69]:
- Step 2: This relationship associated with a scale allows the decision maker to transform the matrix $D_k = [\delta_{ij}]$, where k = decision makers, into a column vector $[v_i]$ in such a way that (1):

$$\sum_{j=1}^{m}(c_i),\ \text{for } i = 1, \ldots, m \text{ and } k = 1, \ldots, n \quad (1)$$

where c_i represents the degrees assigned in the pairwise evaluation of the criteria, according to the scale of Table 2. After finishing the matrix integration process, the resulting vector is normalized, which ensures the generation of non-negative values (2):

$$\overline{c_i} = \left(\frac{a_{ij} - \min a_{ij}}{\max a_{ij} - \min a_{ij}} \right) \quad (2)$$

Table 2. Relationship and scale.

Relation	Scale
$\prec\prec$ is much less important than	−2
$\prec$ is less important than	−1
$\approx$ is just as important as	0
$\succ$ is more important than	1
$\succ\succ$ is much more important than	2

The indices of agreement, disagreement, and credibility were developed based on the characteristics of the methods of the ELECTRE family. In the second step of the method, the procedure is to calculate these indexes according to the following formulas [70]:

Agreement index:

The condition (p > q) must be met so that the result of the calculation is not equal to zero (3):

$$c_j(a, b_h) = \begin{cases} 0 \text{ if } g_j(b_h) - g_j(a) \geq p_j(b_h) \\ 1 \text{ if } g_j(b_h) - g_j(a) \leq q_j(b_h) \\ \text{if } p_j \geq g_j(b_n) - g_j(a) > q_j \\ 1 - \left(\frac{-g_j(b_h) + g_j(a) + q_j}{-p_j - q_j} \right) \end{cases} \quad (3)$$

Global agreement index (4):

$$c(a, b_h) = \frac{\sum_{j \in F} w_j c_j(a, b_h)}{\sum_{j \in F} w_j} \quad (4)$$

Disagreement index:

The condition (v > p) must be met so that the result of the calculation is not equal to zero (5):

$$d_j = \begin{cases} 0 \text{ if } g_j(a) - g_j(b) \leq p \\ 1 \text{ if } g_j(a) - g_j(b) > v \\ \text{if } v > g_j(a) - g_j(b) \geq p \\ \left(\frac{g_j(a) - g_j(b) - p}{v - p} \right) \end{cases} \quad (5)$$

Credibility index (6):

$$\sigma(a,\ b_h) = c(a,\ b_h)_{j \in F}^{\Pi} \frac{1 - d_j(a,\ b_h)}{1 - c(a,\ b_h)} \quad (6)$$

Obtaining class boundaries:

Two ways of profiling delimit classes:

- Set Bh = $\{bh_1, bh_2, \ldots, bh_p\}$; and
- Set Bn = $\{bn_1, bn_2, .\}$.

The authors obtain the bh thresholds considering the number of *p* profiles established by the DMs, dividing the interval between the maximum and minimum values of each criterion into p + 1 equal parts (classes) [70]. Be $g_j{}^*$ and $g_j{}^-$ the maximum and minimum values, respectively, presented by the alternatives in each criterion. The interval h_j is defined between consecutive profiles by (7) and (8):

$$h_j = \frac{{g_j}^* - {g_j}^-}{p+1} \quad (7)$$

$$bh_i = {g_j}^- + i * h_j; \quad i = 1, \ldots, p \quad (8)$$

Figure 2 exposes the establishment of the class profiles obtained through the bh procedure:

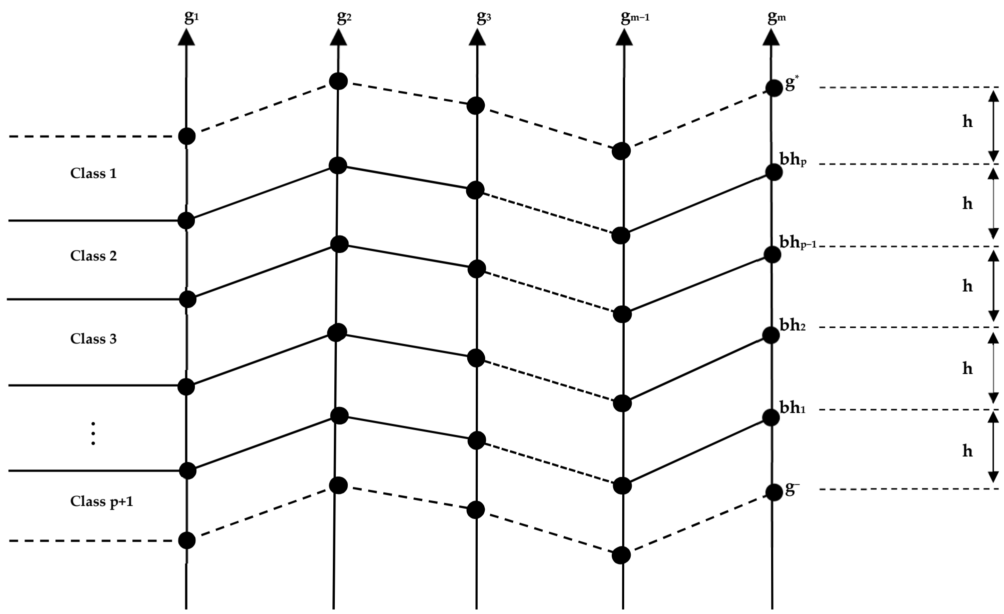

Figure 2. Procedure bh of the ELECTRE-MOr method.

The bn procedure establishes profiles for each criterion so that each subclass has the same number of alternatives. Whether the number of alternatives is *n*, in the bn procedure, the authors established a descending pre-order of the alternatives so that the $a_i = \{a_1, a_2, a_3, \ldots, a_n\}$, in which a_1 represents the score of the alternative with the best performance in a given criterion, and a_n, the worst score. For the definition of bn thresholds, the authors calculated a parameter *k*, which serves as the basis for obtaining the indexes and values of the profiles (9):

$$k = \frac{n}{p+1} \quad (9)$$

After setting the value of k, the bn profiles are obtained, such as $bn_i = \{bn_p = a_k, bn_{p-1} = a_{2k}, \ldots, bn_1 = a_{pk}\}$, where *p* is the number of profiles. The bn_p profile represents the lower bound of the highest class (Class 1), and bn_1, the upper bound of the worst class (Class p + 1). Figure 3 presents the establishment of class profiles obtained through the bn procedure:

Cutting level:

The statement aSb_h means that "the alternative a has no worse performance than the bh profile. In validating the statement aSb_h, the authors calculated a σ credibility index (a,b_h), which expresses the degree of confidence of the statement "a is not worse than b_h. The cut-off level λ (10) is adopted to define the outranking ratio:

$$aSb_h \leftrightarrow \sigma\,(a, b_h) \geq \lambda \quad (10)$$

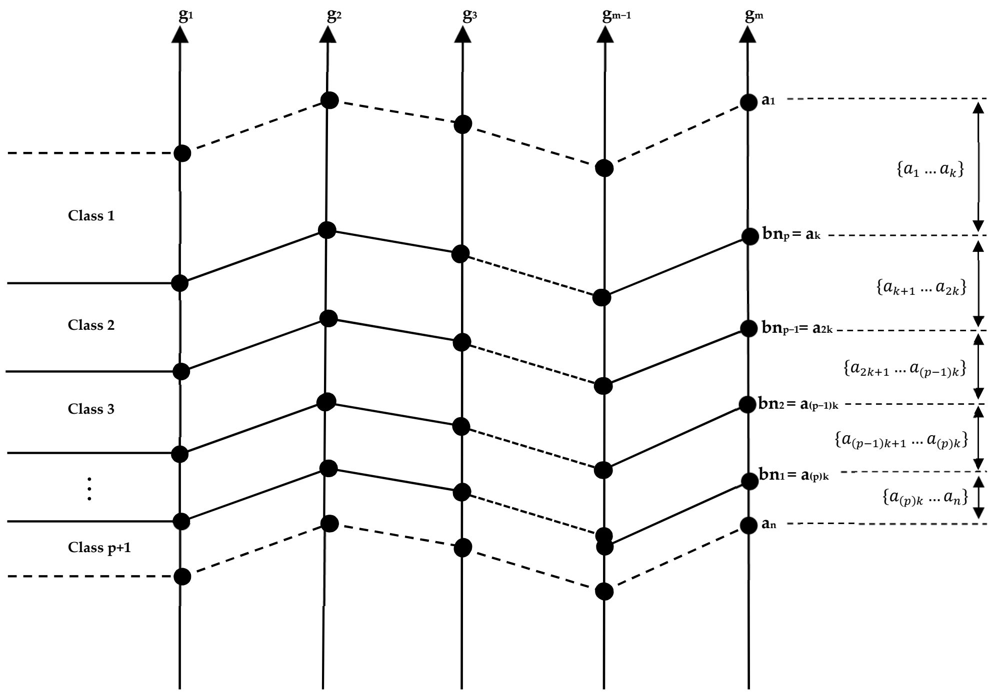

Figure 3. Procedure bn of the ELECTRE-MOr method.

The cut-off level λ indicates the credibility of accepting the outranking [71]. Two procedures make up the distribution:

- Optimistic: consists of comparing the alternative *a* successively to alternative b, from the last profile (category, class);
- Pessimistic: It compares alternative *a* to alternative *b* successively, starting from the first profile (category, class), which is the most demanding classification.

Because it presents two ways of obtaining the predefined class thresholds (bh and bn), ELECTRE-MOr presents two pessimistic and optimistic distributions of alternatives.

3.4. The ELECTRE-MOr Web Software

A relevant characteristic of a method of decision-making support is the availability of software implementing its axiomatic part and its graphic representation and exploitation of results [72]. Thus, to facilitate the use of the method by society in general, the computational implementation of the method was performed. We developed the Software ELECTRE-MOr WEB [27] from a partnership between the technical staff of the Center for Analysis of Naval Systems (CASNAV), a research group of the Graduate Program in Production Engineering of the Fluminense Federal University (UFF), and a research group of the Graduate Program in Systems Engineering and Computing of the Military Institute of Engineering (IME). We registered the software with the PTO via the Navy's Technological Innovation Center, based at the Navy's Directorate-General for Nuclear and Technological Development (DGDNTM).

The Decision Support System (DSS) was developed by integrating Python, JavaScript, and HTML computing languages to present a simple and intuitive interface, allowing easy use by users.

3.5. ELECTRE-MOr Web Tool Applications

It is possible to see the ELECTRE-MOr method supporting the decision-making process in various tactical, operational, logistical, and strategic problems with the help of ELECTRE-MOr web software. The main applications of the tool stand out: classification of hospital aircraft to be used in the fight against the COVID-19 pandemic [69]; composition of a portfolio of IT courses offered by a training and development company [70]; edaphoclimatic and economic evaluation of regions of Brazil for the planting of African mahogany [73];

classification of boats to be acquired by the BN in the fight against COVID-19 in the Amazon [74]; and classification of the OECD Countries [75].

4. Structuring the Problem

A particular officer can be promoted by merit, seniority, or not receive the promotion. With these assumptions defined and keeping in mind the characteristics intrinsic to military problems and personnel selection, we concluded that the ELECTRE-MOr method is an MCDM tool that presents good adherence to the conditions of the problem to be studied.

We chose the method because it distributes the alternatives in predefined classes and allows the analysis of a data set considering quantitative and qualitative criteria, structuring the weights of criteria by ordinal inputs. In addition, the method presents a hybrid algorithm because it uses compensatory concepts in obtaining the weights of the criteria and non-compensatory in establishing outranking relationships. These characteristics contribute to the method's excellent adherence to this research's problem.

Thus, we defined that the military will be evaluated using the ELECTRE-MOr method and distributed into three classes, namely:

- Promotion by deserving—Class A: military personnel whom the Naval High Administration should prioritize for presenting the best performances in the evaluated criteria, being awarded the promotion by deserving;
- Promotion by seniority—Class B: military personnel who have intermediate performance, getting the promotion according to the time of service in each patent;
- Unpromoted military—Class C: a group that, in the light of the criteria analyzed, obtained the worst classification, being depressed by the other two groups for promotion purposes.

4.1. Definition of Criteria

After defining the objective, we can establish the problem criteria. The selection of personnel in military environments must be strategically established [76], not only considering the technical knowledge of the soldier to be evaluated, but also considering social issues, aligned with the histories of behavior or attitudes on the part of each evaluated soldier; in this context, according to that exposed in Figure 4, four criteria, at a macro level, are listed, such as Professional Profile, Moral Profile, Character, and Social Profile.

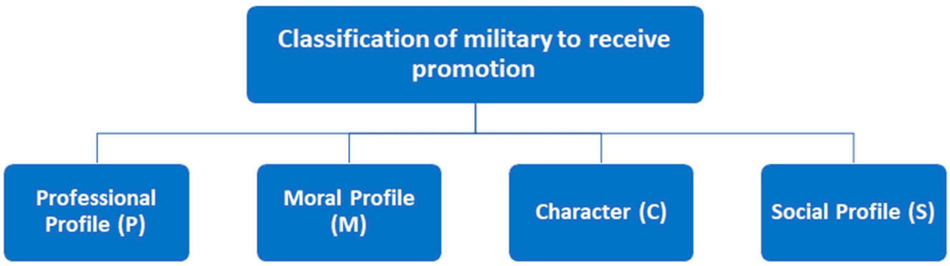

Figure 4. Presentation of the objective and criteria of the problem.

At the highest level of the figure above, it is possible to observe the objective of applying the ELECTRE-MOr method, which is the strategic objective. For a better comprehension of criteria implementation, the mean of each criterion is explored below:

- Professional Profile (P): the criterion in question reflects an observation based on a set of professional characteristics based on each candidate, reflecting points of commitment and discipline towards the organization, to enable the alignment of the professional profile with the objectives of the military organization;
- Moral Profile (M): the given criterion transcribes the perceptions of morality towards each candidate, based on their records of past actions, which can be positive or negative, it is worth mentioning that a given variable will be analyzed based on a set of variables interconnected to the principles of civil and military morality;

- Character (C): the variable reflects technical performances and perceptions of cultural knowledge, seeking to align knowledge with the necessary needs in the activities performed in their respective military organizations;
- Social Profile (S): the criterion presents a construction of social perception on the part of the candidate, evidencing their attitudes, oral expression, and history of behavior based on their employment in the civil and military environment.

4.2. Definition of Subcriteria

With the defined criteria, we verify the need to divide them into subcriteria. This step is vital to make the process of elicitation of the criteria weights by pairwise comparison more reliable and intuitive for the DMs. Therefore, based on [77], the four criteria were subdivided into 33 subcriteria.

4.2.1. Subcriteria of the Criterion "Professional Profile"

The Professional Profile criterion was subdivided into 12 subcriteria, as illustrated in Figure 5.

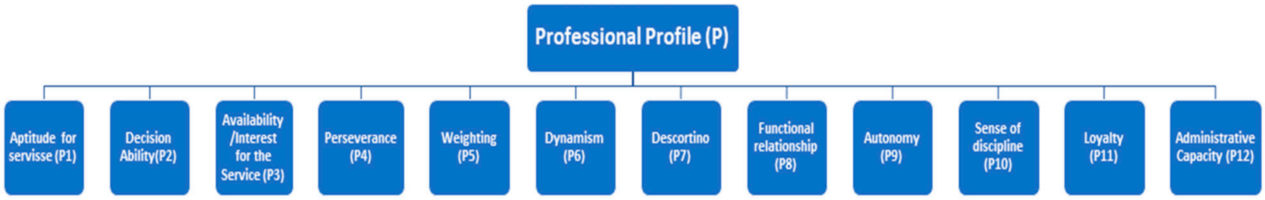

Figure 5. Subcriteria of the Professional Profile criterion.

We take the definitions of the subcriteria used in the analysis proposed in this study from [78]:

- Aptitude for service (P1): natural plight for the career and marked possession of body spirit, adaptability to the conditions inherent to the profession, sailor spirit, vocation, dedication, enthusiasm for career, and belief;
- Decision Ability (P2): ability to analyze available data and make correct, timely, and appropriate decisions, even in difficult situations or under stressful conditions;
- Availability/Interest for the Service (P3): commitment to have your time, combined with the degree of interest and dedication, aiming to conduct the tasks entrusted to it and achieve the best results in the execution of activities, even in adverse situations. Always be ready to act in the interest of the service, even in situations that require personal sacrifice. Not to present arguments to stop acting in situations that require their participation and presence;
- Perseverance (P4): ability to act with continuity and firmness in the conduct of tasks and services to achieve established goals, even in the face of adverse conditions and demotivating situations;
- Weighting (P5): ability to act and reflect with balance on situations and facts, using value judgment following circumstances and common sense, which enables correct and fair decisions and attitudes. Overlap with rational control and promote by acts and words, solutions devoid of emotional content that may harm the interest of the service;
- Dynamism (P6): ability to remain committed to the execution of various tasks, acting enthusiastically and permanently, aiming to achieve the goals that are collimated;
- Sagacity (P7): the ability to anticipate and identify situations and conditions projected in time, to visualize or obtain information to support future decisions and planning, and to take initiatives that provide favorable solutions in advance for the benefit of the service;
- Functional relationship (P8): ability to relate well to other people, looking at the hierarchy for the benefit of service and interpersonal harmony;

- Autonomy (P9): ability to perform its function effectively, without the need for constant supervision. Ability to self-govern, presenting positive results for the service;
- Sense of discipline (P10): the ability to comply, enforce orders, and respect regulations, regardless of personal ideas and conceptions. Faculty to imbue one's spirit with the orders given and the purposes to be achieved;
- Loyalty (P11): correction of procedures with their peers, their superiors, and subordinates; fidelity to the word given; frankness and sincerity; honesty on purpose; commitment to comply with the decisions of their superiors, especially when, deep down, he does not agree with them;
- Administrative Capacity (P12): the ability to identify problems and difficulties and to clearly and intelligently plan your solutions. Ability to guide, sort, and control the execution of planned actions. Ability to organize.

4.2.2. Subcriteria of the Criterion "Moral Profile"

The Moral Profile criterion comprises 11 subcriteria, as shown in Figure 6.

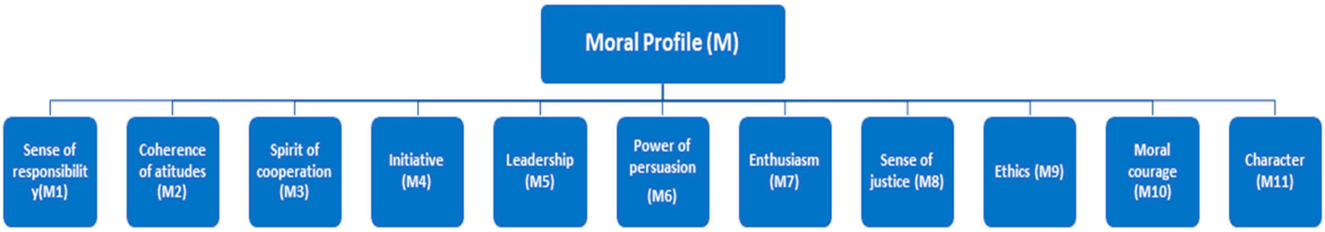

Figure 6. Subcriteria of the Moral Profile criterion.

The military assessment standard describes the 11 attributes as follows: [78]:

- Sense of responsibility (M1): the ability to fulfill its duties and those required by the administration, be aware of the consequences of its acts and omissions, and always be ready to answer for them;
- Coherence of attitudes (M2): the faculty to maintain, over time, a logical and harmonic relationship between their actions and between them and their expressed ideas;
- Spirit of cooperation (M3): the ability to work in harmony and goodwill with others for the same purpose, considering others and respecting their legitimate interests, needs, and points of view. Ability to assist efficiently and selflessly and strive for a common cause's benefit. Ability to understand the needs and priorities of the organization globally, without only tethering in the peculiar and limited problems of its function;
- Initiative (M4): ability to implement ideas and actions. Faculty to deliberate and act in unforeseen circumstances or outside its sphere of activity, in the absence of orders or the absence of superiors;
- Leadership (M5): manifest ability to lead men and know how to give orders. Moral and professional ancestry. Inability to influence other people. Ability to infuse respect and obedience and obtain efficiency and dedication of subordinates;
- Power of persuasion (M6): the ability to convince people or groups to adopt ideas, attitudes, or behaviors through logical and concatenated argumentation, opposing prejudices, and ingrained ideas;
- Enthusiasm (M7): satisfaction with doing or developing something. Ability to work with pleasure and determination, feeling happy;
- Sense of justice (M8): the ability to judge, with criterion and exemption of spirit, individual or collective acts and procedures and to act consistently with this understanding;
- Ethics (M9): an attribute that induces compliance with the rules of conduct compatible with the moral principles and values enshrined in the naval, military, and national environment. Dedication and fidelity to the duties and obligations of citizens and professionals;

- Moral courage (M10): manifestation or action of conformity with his conviction of right and wrong for the benefit of the interest of the service because he thinks it may displease others. Take responsibility and consequences for your acts. Face and overcome obstacles and defend interests that it considers legitimate, avoiding risking personal interests or generating unpopularity;
- Character (M11): an attribute that induces to conduct itself in a manner consistent with social, cultural, moral, and ethical norms, sustaining with firmness and conviction the maintenance, by acts and procedures, of community values, compatible with time and the environment where it lives.

4.2.3. Subcriteria of the Criterion "Character"

We subdivided the Character criterion into four subcriteria (Figure 7).

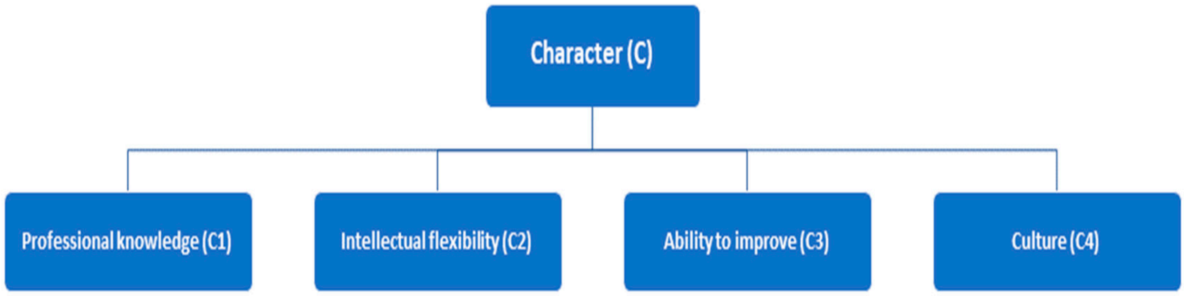

Figure 7. Subcriteria of the Character criterion.

We described the four subcriteria below:

- Professional knowledge (C1): theoretical and practical knowledge of his profession and specialty. Ability to use their professional knowledge for the benefit of the service. Mastery of fields of knowledge related to the profession;
- Intellectual flexibility (C2): the ability to learn, make use of, and remain receptive to new knowledge, information, and situations, integrating with knowledge already acquired for reformulation of analysis and conclusions previously conceived;
- Ability to improve (C3): the ability to develop solutions that improve systems, methods, and standards belonging to or affecting BN. Inventive capacity, combined with the initiative, results in the aggregation of values and goods for the service;
- Culture (C4): degree of knowledge of subjects unrelated to the profession. Ability to monitor and analyze situations and facts of an individual nature and national and international scope, resulting from a collection of accumulated knowledge and experiences.

4.2.4. Subcriteria of the Criterion "Social Profile"

Figure 8 exposes the Criterion Social Profile and its seven subcriteria, described below [78]:

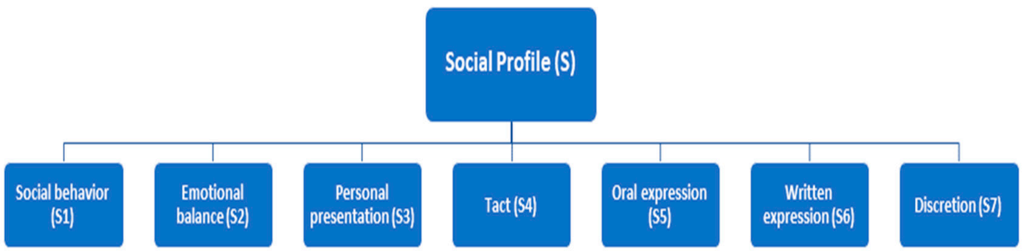

Figure 8. Subcriteria of the Social Profile criterion.

- Social behavior (S1): correcting attitude and courtesy in all social circles he attends. Fulfillment of citizen duties. Exemplary procedure in private and family life. Civil education, chivalry, civility, and good manners;
- Emotional balance (S2): ability to maintain control over their emotional reactions so as not to compromise personal and social relationships and good performance in the service;
- Personal presentation (S3): military support, combined with the plates of civilian and military attire and the care of physical appearance required of the military;
- Tact (S4): faculty to deal with and solve issues with others. Faculty of being timely in words, gestures, orders, solutions, compliments, and criticisms;
- Oral expression (S5): the ability to present, orally, ideas, thoughts, facts, and situations with organization, clarity, precision, objectivity, and language property;
- Written expression (S6): the ability to present, in writing, ideas, thoughts, facts, and situations with correction, organization, clarity, precision, objectivity, conciseness, and refined style;
- Discretion (S7): faculty to manifest, measuredly, in attitudes, manners, and language. Ability to know how to report and comment on facts or situations, or even to remain silent, taking into account the interests of the service and social coexistence.

4.2.5. The Hierarchical Structure of the Problem

After presenting the objective, criteria, and subcriteria, the complete hierarchical structure of the problem is obtained (Figure 9).

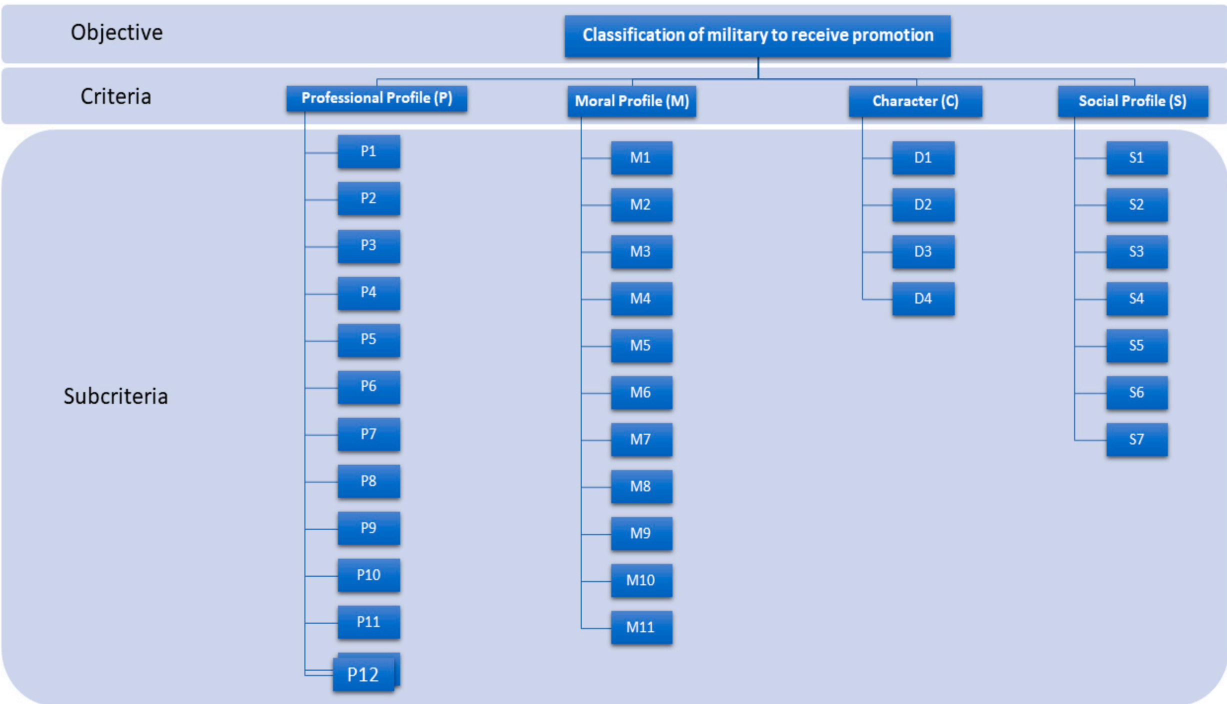

Figure 9. The hierarchical structure of the problem.

We elaborated the hierarchical structure to divide the 33 subcriteria into four different criteria, aiming to facilitate the process of obtaining weights through a peer evaluation by three decision-makers. With this structure, it was possible to aggregate the weights of the subcriteria and analyze the alternatives in light of these attributes.

4.3. Methodology

According to the classification proposed by [79], this research can be characterized as mixed qualitative-quantitative, combining case studies and mathematical modeling [80].

The selection of military personnel is the research object, as previously presented in Sections 1 and 2.

The theoretical framework and details of the case study are presented in Sections 4 and 5, respectively. MCDM's mathematical modeling goes through five main steps, summarized in Figure 10.

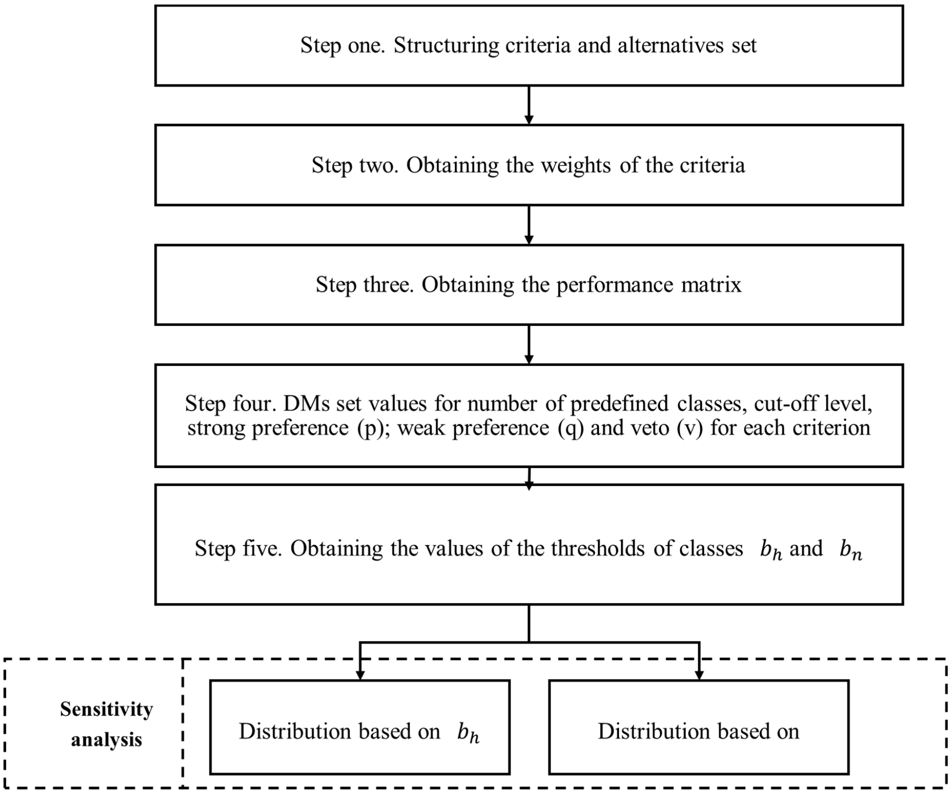

Figure 10. Steps of the applied methodology.

We conducted Step 1 through interviews with three BN officers (DMs) with recognized experience in evaluating and selecting military personnel for promotion. Considering that BN already has a set of 33 criteria for evaluating its military, we decided to use the attributes already used by the Force, evaluated by applying the ELECTRE-MOr method. In order to make the paired evaluation process of the criteria more intuitive and with less cognitive effort, the criteria were divided into subcriteria.

In Step 2, the DMs established their ordinal preferences about the subcriteria by applying the ELECTRE-MOr method, which made it possible to obtain cardinal values for the weights of each subcriterion.

In the third stage, the performance matrix was obtained, choosing 30 fictitious military personnel to compose the set of alternatives for the case study. Together with the decision-makers, we analyzed random and fictitious data to avoid exposing confidential data regarding BN military personnel. Moreover, analyzing random data did not imply a limitation to the results presented in this study.

In the next stage, we conducted a new interview with the specialists simultaneously, seeking to obtain the thresholds of strong, weak, and veto preference for each subcriterion analyzed. In addition, we arbitrated the cut-off level equal to 0.8, a value that provided a very coherent distribution of alternatives in the predefined classes. It is possible to note that the value of the cut-off level varied more and less to observe the changes in the distributions of the alternatives.

In step 5, we obtained the results after applying the ELECTRE-MOr method, with distributions by bh and bn procedures. The fact that it presents two distinct classifications already allows the ELECTRE-MOr method a sensitivity analysis [70].

However, to present additional information to the decision-taker and verify the behavior of the alternatives in the most diverse analysis scenarios, the cut-off level was varied, and several different distributions were verified, as will be discussed in Section 5.

5. Case Study

This section will address the case study by applying the ELECTRE-MOr method to distribute 30 BN officers in three predefined classes. The objective of the case study is to support the decision-making process of the Naval High Administration regarding the promotion by deserving, seniority, or non-promotion of military personnel of the Force.

Table 3 summarizes the criteria and respective subcriteria chosen to analyze the alternatives for officers to receive promotions.

Table 3. Definition of the criteria and subcriteria of the problem.

Criteria	Professional Profile (P)	Moral Profile (M)	Social Profile (S)	Character (C)
Subcriteria	Fitness for service (P1)	Sense of responsibility (M1)	Social behavior (S1)	Professional knowledge (C1)
	Decision Capacity (P2)	Coherence of attitudes (M2)	Emotional balance (S2)	Intellectual flexibility (C2)
	Availability/Interest for the Service (P3)	Spirit of cooperation (M3)	Personal presentation (S3)	Ability to improve (C3)
	Perseverance (P4)	Initiative (M4)	Tact (S4)	Culture (C4)
	Weighting (P5)	Leadership (M5)	Oral expression (S5)	
	Dynamism (P6)	Power of persuasion (M6)	Written expression (S6)	
	Sagacity (P7)	Enthusiasm (M7)	Stealth (S7)	
	Functional relationship (P8)	Sense of justice (M8)		
	Autonomy (P9)	Ethics (M9)		
	Sense of discipline (P10)	Moral courage (M10)		
	Loyalty (P11)	Character (M11)		
	Administrative Capacity (P12)			

With the subcriteria duly established, there were similar comparisons between the subcriteria, taking into account the opinions of the three DMs and the scale presented in Table 2 on Section 3.3.

5.1. Obtaining the Weights of the Criteria

We considered the number of subcriteria subordinated to each to obtain the criteria weights. We adopted this procedure due to the significant disparity in the number of subcriteria assigned to each criterion. Thus, the criteria with a higher number of subcriteria obtained a proportionally higher weight in the proposed analysis.

Table 4 presents the criteria weights, obtained proportionally to the number of subcriteria assigned to each criterion concerning the total number of subcriteria analyzed.

Table 4. Criteria weights.

Criterion	Proportion	Criterion Weight
Professional Profile (P)	12/34	35.29%
Moral Profile (M)	11/34	32.35%
Social Profile (S)	7/34	20.59%
Character (C)	4/34	11.77%

With the weights of the established criteria, a similar analysis was performed between the subcriteria in the light of each specific criterion, taking into account the opinions of the three BN specialists.

5.2. Weights of the Subcriteria of the Criterion "Professional Profile"

Table 5 presents the comparisons alongside the subcriteria of the "Professional Profile" criterion with greater weight, considering the analyses of the three DMs.

Table 5. Paired comparison between the subcriteria of the "Professional Profile".

		Professional Profile														
Decision-Makers		**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**	**P12**	**Sum**	**Normalization**	**Consolidated Weight**
DM1	P1	0	−1	0	1	−1	1	1	1	−1	−1	−1	−1	−2	0.32	5.62%
	P2	1	0	1	1	1	1	0	0	0	0	0	1	6	0.74	16.48%
	P3	0	−1	0	−1	1	1	−1	−1	−1	−1	−2	0	−6	0.11	3.22%
	P4	−1	−1	1	0	1	−1	−1	0	−1	−1	−2	−1	−7	0.05	2.37%
	P5	1	−1	−1	−1	0	1	−1	−1	−1	−1	−1	−1	−7	0.05	3.38%
	P6	−1	−1	−1	1	−1	0	−1	−1	−1	0	−1	−1	−8	0.0005	2.02%
	P7	−1	0	1	1	1	1	0	1	0	0	0	1	5	0.68	12.09%
	P8	−1	0	1	0	1	1	−1	0	−1	−1	−1	0	−2	0.32	4.10%
	P9	1	0	1	1	1	1	0	1	0	0	−1	0	5	0.68	9.56%
	P10	1	0	1	1	1	0	0	1	0	0	−1	0	4	0.63	13.26%
	P11	1	0	2	2	1	1	0	1	1	1	0	1	11	1.00	19.73%
	P12	1	−1	0	1	1	1	−1	0	0	0	−1	0	1	0.47	8.17%
DM2	P1	0	−1	0	1	−1	1	1	1	−1	−1	−1	−1	−2	0.23	
	P2	1	0	1	1	1	1	0	0	0	0	0	1	6	0.85	
	P3	0	−1	0	0	1	1	1	−1	1	−1	−1	0	0	0.38	
	P4	−1	−1	0	0	1	−1	−1	0	1	−1	−1	−1	−5	0.0002	
	P5	1	−1	−1	−1	0	1	−1	1	0	0	−1	−1	−3	0.15	
	P6	−1	−1	−1	1	−1	0	1	−1	1	0	0	1	−1	0.31	
	P7	−1	0	−1	1	1	−1	0	1	0	0	0	1	1	0.46	
	P8	−1	0	1	0	−1	1	−1	0	−1	−1	−1	0	−4	0.08	
	P9	1	0	−1	−1	0	−1	0	1	0	0	−1	0	−2	0.23	
	P10	1	0	1	1	0	0	0	1	0	0	−1	0	3	0.62	
	P11	1	0	1	1	1	0	0	1	1	1	0	1	8	1.00	
	P12	1	−1	0	1	1	−1	−1	0	0	0	−1	0	−1	0.31	
DM3	P1	0	−1	0	1	−1	1	1	1	−1	−1	−1	−1	−2	0.31	
	P2	1	0	1	1	1	1	0	0	0	0	0	1	6	0.92	
	P3	0	−1	0	−1	1	1	−1	−1	−1	−1	−2	0	−6	0.0002	
	P4	−1	−1	1	0	1	0	−1	0	1	−1	0	−1	−2	0.31	
	P5	1	−1	−1	−1	0	1	−1	0	1	−1	1	−1	−2	0.31	
	P6	−1	−1	−1	0	−1	0	1	−1	−1	0	−1	0	−6	0.0002	
	P7	−1	0	1	1	1	−1	0	1	0	0	0	1	3	0.69	
	P8	−1	0	1	0	0	1	−1	0	−1	−1	−1	0	−3	0.23	
	P9	1	0	1	−1	−1	1	0	1	0	0	−1	0	1	0.54	
	P10	1	0	1	1	1	0	0	1	0	0	−1	0	4	0.77	
	P11	1	0	2	0	−1	1	0	1	1	1	0	1	7	1.00	
	P12	1	−1	0	1	1	0	−1	0	0	0	−1	0	0	0.46	

We highlight that the subcriteria that would present values of weights equal to zero, after analysis of a given DM, assumed 1% of the lowest subsequent value, a procedure explained and proposed by Gomes et al. [65] to avoid zero-weight criteria which would be excluded from the decision-making process.

The consolidated weight of the subcriteria was obtained based on the average of the evaluations of the three DMs, making the process of elicitation of the importance of the criteria democratic and transparent. It is possible to observe that the subcriteria with greater importance after analysis of the specialists were Loyalty (P11), Decision Ability (P2), and Sense of Discipline (P10), making up approximately 50% of the total weight of the criterion "Professional Profile".

5.2.1. Weights of the Subcriteria of the "Moral Profile"

Similarly, we obtained the weights of the subcriteria of the second criterion, as summarized in Table 6.

Table 6. Paired comparison between the subcriteria of the "Moral Profile".

								Moral Profile								
		M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**	**M11**	**Sum**	**Normalization**	**Consolidated Weight**
	M1	0	−1	0	0	−2	1	1	0	−2	−1	−2	−6	0.17	6.08%
	M2	1	0	1	1	−1	0	1	−1	−1	−1	−1	−1	0.38	14.98%
	M3	0	−1	0	1	−1	1	0	−1	−1	−1	−2	−5	0.21	4.06%
	M4	0	−1	−1	0	−1	2	1	−1	−1	−1	−2	−5	0.21	4.44%
	M5	2	1	1	1	0	2	1	0	0	0	−1	7	0.71	9.28%
DM1	M6	−1	0	−1	−2	−2	0	1	−1	−1	0	−1	−8	0.08	1.88%
	M7	−1	−1	0	−1	−1	−1	0	−1	−1	−1	−2	−10	0.0008	7.32%
	M8	0	1	1	1	0	1	1	0	0	0	−1	4	0.58	5.92%
	M9	2	1	1	1	0	1	1	0	0	0	−1	6	0.67	10.17%
	M10	1	1	1	1	0	0	1	0	0	0	−1	4	0.58	14.58%
	M11	2	1	2	2	1	1	2	1	1	1	0	14	1.00	21.30%
	M1	0	−1	0	1	−1	1	1	1	−1	−1	−1	−1	0.27	
	M2	1	0	1	1	1	1	0	0	0	0	0	5	0.82	
	M3	0	−1	0	0	1	1	1	−1	1	−1	−1	0	0.36	
	M4	−1	−1	0	0	1	−1	−1	0	1	−1	−1	−4	0.0018	
	M5	1	−1	−1	−1	0	1	−1	1	0	0	−1	−2	0.18	
DM2	M6	−1	−1	−1	1	−1	0	1	−1	1	0	0	−2	0.18	
	M7	−1	0	−1	1	1	−1	0	1	0	0	0	0	0.36	
	M8	−1	0	1	0	−1	1	−1	0	−1	−1	−1	−4	0.0018	
	M9	1	0	−1	−1	0	−1	0	1	0	0	−1	−2	0.18	
	M10	1	0	1	1	0	0	0	1	0	0	−1	3	0.64	
	M11	1	0	1	1	1	0	0	1	1	1	0	7	1.00	
	M1	0	−1	0	1	−1	1	1	1	−1	−1	−1	−1	0.42	
	M2	1	0	1	1	1	1	0	0	0	0	0	5	0.92	
	M3	0	−1	0	−1	1	1	−1	−1	−1	−1	−2	−6	0.0025	
	M4	−1	−1	1	0	1	0	−1	0	1	−1	0	−1	0.42	
	M5	1	−1	−1	−1	0	1	−1	0	1	−1	1	−1	0.42	
DM3	M6	−1	−1	−1	0	−1	0	1	−1	−1	0	−1	−6	0.0025	
	M7	−1	0	1	1	1	−1	0	1	0	0	0	2	0.67	
	M8	−1	0	1	0	0	1	−1	0	−1	−1	−1	−3	0.25	
	M9	1	0	1	−1	−1	1	0	1	0	0	−1	1	0.58	
	M10	1	0	1	1	1	0	0	1	0	0	−1	4	0.83	
	M11	1	0	2	0	−1	1	0	1	1	1	0	6	1.00	

The subcriteria considered as most important in the second criterion were Character (M11), Moral Courage (M10), and Coherence of Attitudes (M2), totaling about 51% of the total weight in this criterion.

5.2.2. Weights of the Subcriteria of the "Social Profile"

Table 7 consolidates the weights of the subcriteria of the third criterion evaluated.

In this criterion, written expression (S6), oral expression (S5), and social behavior (S1) stand out, with about 60% of the total weight.

5.2.3. Weights of the Subcriteria of the Criterion "Character"

Table 8 exposes the achievement of the weights of the Character subcriteria.

Among the subcriteria, professional knowledge (D1) and Intellectual Flexibility (D2) stand out, with about 80% of the total weight of the criterion.

Table 7. Paired comparison between the subcriteria of the "Social Profile".

Social Profile											
		S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**Sum**	**Normalization**	**Consolidated Weight**
DM1	S1	0	−1	0	1	−1	−1	1	−1	0.40	17.86%
	S2	1	0	1	1	−1	−1	1	2	0.70	11.61%
	S3	0	−1	0	1	−1	−1	1	−1	0.40	15.48%
	S4	−1	−1	−1	0	−1	−1	0	−5	0.0004	2.98%
	S5	1	1	1	1	0	0	1	5	1.00	20.24%
	S6	1	1	1	1	0	0	1	5	1.00	22.32%
	S7	−1	−1	−1	0	−1	−1	0	−5	0.00	9.52%
DM2	S1	0	0	0	1	−1	−1	1	0	0.60	
	S2	0	0	1	1	−1	−1	0	0	0.60	
	S3	0	−1	0	0	1	1	1	2	1.00	
	S4	−1	−1	0	0	1	−1	−1	−3	0.0004	
	S5	1	1	−1	−1	0	1	−1	0	0.60	
	S6	1	1	−1	1	−1	0	1	2	1.00	
	S7	−1	0	−1	1	1	−1	0	−1	0.40	
DM3	S1	0	1	0	1	−1	1	1	3	1.00	
	S2	−1	0	1	1	−2	−2	0	−3	0.0033	
	S3	0	−1	0	−1	1	1	−1	−1	0.33	
	S4	−1	−1	1	0	1	0	−1	−1	0.33	
	S5	1	2	−1	−1	0	1	−1	1	0.67	
	S6	−1	2	−1	0	−1	0	1	0	0.50	
	S7	−1	0	1	1	1	−1	0	1	0.67	

Table 8. Paired comparison between the subcriteria of the criterion "Character".

Character								
		C1	**C2**	**C3**	**C4**	**Sum**	**Normalization**	**Consolidated Weight**
DM1	C1	0	1	1	1	3	1.00	46.60%
	C2	−1	0	0	−1	−2	0.00	33.98%
	C3	−1	0	0	−1	−2	0.00	3.88%
	C4	−1	1	1	0	1	0.60	15.53%
DM2	C1	0	1	0	1	2	1.00	
	C2	−1	0	1	1	1	0.75	
	C3	0	−1	0	0	−1	0.20	
	C4	−1	−1	0	0	−2	0.00	
DM3	C1	0	−1	0	1	0	0.40	
	C2	1	0	1	1	3	1.00	
	C3	0	−1	0	−1	−2	0.00	
	C4	−1	−1	1	0	−1	0.20	

5.3. Global Subcriteria Weights

After performing the peer comparisons by the three decision-makers, it was possible to obtain a cardinal value for the weights of each of the 34 subcriteria evaluated, as shown in Table 9.

Analyzing the global weights of the subcriteria, we observed that those who presented the highest importance in the light of each specific criterion, as a rule, presented good overall performance. In fact, the criteria weights that were established proportionally to the number of subordinate subcriteria caused no significant discrepancies between the cardinal values of the weights of the attributes.

Table 9. Global weights of the subcriteria.

Criterion	Criterion Weight	Subcriterion	Weight of the Subcriterion
Professional Profile (P)	35.29%	Fitness for service (P1)	1.98%
		Decision Capacity (P2)	5.82%
		Availability/Interest for the Service (P3)	1.14%
		Perseverance (P4)	0.84%
		Weighting (P5)	1.19%
		Dynamism (P6)	0.71%
		Sagacity (P7)	4.27%
		Functional relationship (P8)	1.45%
		Autonomy (P9)	3.37%
		Sense of discipline (P10)	4.68%
		Loyalty (P11)	6.96%
		Administrative Capacity (P12)	2.88%
Moral Profile (M)	32.35%	Sense of responsibility (M1)	1.97%
		Coherence of attitudes (M2)	4.85%
		Spirit of cooperation (M3)	1.31%
		Initiative (M4)	1.44%
		Leadership (M5)	3.00%
		Power of persuasion (M6)	0.61%
		Enthusiasm (M7)	2.37%
		Sense of justice (M8)	1.91%
		Ethics (M9)	3.29%
		Moral courage (M10)	4.72%
		Character (M11)	6.89%
Character (C)	11.76%	Professional knowledge (C1)	5.48%
		Intellectual flexibility (C2)	4.00%
		Ability to improve (C3)	0.46%
		Culture (C4)	1.83%
Social Profile (S)	20.59%	Social behavior (S1)	3.68%
		Emotional balance (S2)	2.39%
		Personal presentation (S3)	3.19%
		Tact (S4)	0.61%
		Oral expression (S5)	4.17%
		Written expression (S6)	4.60%
		Stealth (S7)	1.96%

We presented the consolidated weight results of the subcriteria to the three specialists consulted, who validated the values obtained by cardinalizing their ordinal preferences.

5.4. Performance Matrix

We defined the alternatives that make up the case study by defining the criteria, subcriteria, and their respective weights. In all, 30 officers were chosen and evaluated in light of the established subcriteria.

We defined the thresholds of Weak Preference (q), Strict Preference (p), and Veto (v) by consensus among the three specialists. The bh and bn values were obtained by applying Equations (7)–(9) and are automatically calculated by the computational tool ELECTRE-MOr Web. In addition, we established that the 30 alternatives would be distributed into three classes.

Table 10 presents the alternatives, with their performances established by scores from 0 to 10 in each subcriterion.

Table 10. Officers' performance matrix.

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	C1	C2	C3	C4	S1	S2	S3	S4	S5	S6	S7
OF1	7	9	9	7	9	7	6	9	7	9	7	6	9	6	8	7	10	7	10	9	6	10	8	9	8	8	7	6	8	8	8	7	9	7
OF2	9	6	9	9	7	8	10	10	9	8	9	8	10	10	8	9	8	9	9	8	9	9	8	8	8	7	9	9	10	9	7	9	10	6
OF3	10	10	9	8	8	6	7	8	6	9	8	10	8	9	8	9	7	9	7	6	8	8	10	8	9	10	9	10	8	9	10	8	9	9
OF4	9	8	10	8	9	8	6	9	9	8	7	9	6	9	10	6	7	7	7	7	9	8	10	8	10	6	8	10	9	9	9	10	10	7
OF5	8	7	8	7	9	10	7	7	9	6	9	10	7	8	6	8	8	8	7	10	10	6	8	8	6	6	7	8	6	7	7	9	6	9
OF6	9	10	9	8	8	10	7	8	8	10	7	6	7	8	8	8	9	10	8	10	6	8	8	7	9	8	8	8	10	6	8	9	10	7
OF7	9	9	10	9	6	7	6	8	8	8	8	7	9	7	9	6	8	9	8	8	8	8	6	9	8	8	8	9	9	7	7	9	10	9
OF8	6	9	8	9	10	7	7	9	8	8	10	10	9	10	7	8	10	10	9	8	8	8	10	10	10	8	6	8	9	6	9	10	8	9
OF9	10	9	8	7	10	8	8	10	7	10	6	8	8	10	9	9	9	9	8	6	7	6	10	9	7	9	7	7	9	10	9	7	8	7
OF10	9	9	7	7	8	7	8	7	7	10	9	6	9	6	8	9	6	6	8	7	9	9	8	8	9	10	7	8	9	6	8	7	7	8
OF11	7	8	10	8	9	8	7	7	9	8	10	7	9	9	8	9	6	8	6	8	8	9	8	8	8	9	10	10	8	10	10	9	7	6
OF12	9	9	8	7	6	10	7	9	6	9	9	8	9	9	8	6	7	6	9	7	6	8	7	10	9	10	6	9	6	7	7	7	6	8
OF13	9	6	8	7	7	7	9	7	7	8	8	9	6	9	9	6	8	7	8	9	7	6	10	6	7	7	8	6	8	9	6	10	7	10
OF14	8	9	9	9	7	8	8	7	9	10	8	10	8	7	6	6	7	7	8	8	9	10	9	9	9	7	8	9	6	7	9	8	10	8
OF15	9	9	10	8	6	8	7	7	8	9	7	10	9	8	7	9	8	9	7	8	8	7	10	8	6	6	9	6	9	8	9	6	6	8
OF16	6	8	7	7	7	7	6	8	8	7	8	6	9	7	8	7	9	9	8	7	8	7	9	10	8	9	7	9	6	8	7	9	7	10
OF17	8	8	6	6	8	9	9	10	8	10	9	8	7	8	6	7	6	9	6	9	9	9	6	9	10	9	9	8	9	9	9	6	9	8
OF18	9	7	8	9	6	8	8	7	7	7	9	9	9	9	8	8	9	7	7	9	6	7	9	7	10	10	7	6	7	8	8	9	6	7
OF12	9	8	6	7	8	10	7	10	10	9	9	6	7	7	9	9	9	7	9	9	9	7	8	8	7	7	10	10	8	7	6	8	9	8
OF20	6	10	7	8	9	6	7	7	9	7	7	8	9	9	10	8	7	6	8	10	6	9	7	9	10	10	10	6	8	9	9	7	7	9
OF21	9	10	8	6	10	10	8	10	9	6	8	9	7	9	9	7	9	6	8	9	7	8	6	9	7	6	8	6	8	8	6	7	8	7
OF22	7	9	8	8	7	9	9	7	10	9	7	9	9	6	8	7	8	7	9	7	6	6	9	7	9	8	8	6	8	9	7	9	7	9
OF23	8	7	10	7	10	10	10	8	6	9	8	10	6	9	7	7	10	7	9	8	9	9	9	9	7	7	9	6	8	9	6	7	7	7
OF24	8	7	9	7	9	10	9	8	6	9	8	10	7	9	10	10	9	6	10	8	8	9	9	10	9	8	8	7	10	9	10	9	7	9
OF25	6	10	9	8	7	9	8	9	9	10	9	6	9	8	6	10	9	8	7	9	8	9	7	9	10	9	8	9	8	10	7	10	7	6
OF25	8	7	9	9	6	7	10	7	7	9	10	9	9	9	10	6	7	8	7	9	9	7	7	8	8	8	6	7	10	9	8	7	9	8
OF27	8	10	7	6	7	6	8	9	8	6	6	7	8	10	8	9	7	9	9	10	7	6	7	10	6	9	8	9	10	7	8	9	8	6
OF28	7	9	7	7	9	8	10	7	9	9	8	8	10	10	6	7	10	8	10	10	8	7	8	9	9	7	10	6	9	8	9	7	8	9
OF22	9	9	8	7	9	10	9	8	9	6	10	7	9	8	7	7	6	9	9	7	7	6	6	8	7	7	9	7	7	6	10	8	7	8
OF30	10	8	6	7	7	7	7	9	7	8	8	9	7	9	9	10	8	8	10	8	7	7	6	6	7	9	9	7	8	9	9	8	7	8
q	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
p	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
v	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Table 10. *Cont.*

	P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**	**P12**	**M1**	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**	**M11**	**C1**	**C2**	**C3**	**C4**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**
Weights	0.02	0.06	0.01	0.01	0.01	0.01	0.04	0.01	0.03	0.05	0.07	0.03	0.02	0.05	0.01	0.01	0.03	0.01	0.02	0.02	0.03	0.05	0.07	0.05	0.04	0.00	0.02	0.04	0.02	0.03	0.01	0.04	0.05	0.02
bh 2	8.7	8.7	8.7	8.2	8.6	8.7	8.6	8.8	8.5	8.7	8.7	8.7	8.7	8.6	8.7	8.6	8.5	8.6	8.7	8.7	8.5	8.4	8.5	8.7	8.7	8.7	8.6	8.7	8.6	8.7	8.8	8.8	8.7	8.6
bh 1	7.4	7.4	7.4	7.1	7.3	7.5	7.3	7.7	7.3	7.4	7.3	7.3	7.5	7.4	7.5	7.3	7.4	7.3	7.4	7.4	7.2	7.3	7.3	7.4	7.4	7.4	7.4	7.3	7.4	7.4	7.6	7.6	7.5	7.3
bn 2	9.0	9.1	8.8	8.0	8.7	8.7	8.3	8.6	8.5	8.9	8.5	8.9	8.7	9.2	8.5	8.7	8.5	8.6	8.6	9.0	8.3	8.3	8.6	8.9	8.8	8.9	8.8	8.5	8.9	9.1	8.8	8.7	8.3	8.5
bn 1	7.5	7.5	7.4	6.8	6.9	7.1	6.8	7.2	6.8	7.6	7.1	6.7	7.0	7.5	7.0	6.7	7.3	6.7	7.0	7.5	6.7	6.9	7.1	7.7	7.0	7.0	7.2	6.3	7.6	6.9	7.0	6.9	6.8	7.2

5.5. Results Achieved

After the application of all stages of ELECTRE-MOr, with the support of the ELECTRE-MOr Web software, optimistic and pessimistic distributions were obtained for the two forms of standardization (bh and bn), for a cut-off level of 0.8, chosen in conjunction with the experts for presenting good discrimination in the classification of alternatives (Table 11).

Table 11. Result obtained after application of ELECTRE-MOr.

	Lambda				
	0.8				
	Bh		Bn		Consolidated
	Pessimist	Optimistic	Pessimist	Optimistic	
OF1	C	B	B	B	B
OF2	B	A	B	A	B
OF3	B	A	B	A	B
OF4	B	A	B	A	B
OF5	C	B	C	A	C
OF6	B	A	B	A	B
OF7	C	B	B	B	B
OF8	B	A	B	A	B
OF9	C	A	B	A	A
OF10	C	A	B	A	A
OF11	B	A	B	A	B
OF12	C	A	C	A	C
OF13	C	A	C	B	C
OF14	B	A	B	A	B
OF15	C	A	B	B	B
OF16	C	B	C	A	C
OF17	C	A	B	A	A
OF18	C	A	C	A	C
OF12	B	A	B	A	B
OF20	C	A	B	A	A
OF21	C	A	B	B	B
OF22	C	A	C	B	C
OF23	C	A	B	A	A
OF24	B	A	B	A	B
OF25	B	A	B	A	B
OF25	C	A	B	A	A
OF27	C	A	C	A	C
OF28	B	A	B	A	B
OF22	C	A	C	B	C
OF30	C	B	B	B	B

The results after the application of the method present four classifications, which allow for a transparent and robust analysis [70]. For the grouping of alternatives, aiming to obtain the categorization of the officers into three predefined classes, we used the following criterion:

An alternative that presents a result compatible with a particular class in three or four scenarios is categorized in this class; an alternative that presents a specific classification in two of the four scenarios will be categorized into the lower class.

The OF1 alternative will be used in class B because it presents a performance in three of the four scenarios. The OF2 alternative will be answered in class B since it presents two classifications corresponding to class A and two to class B, which is the worst classification presented by the alternative. Table 12 shows the consolidated classifications for a λ value of 0.8.

Table 12. Consolidated classification of alternatives, with a cut-off level of 0.8.

Alternatives	Class
OF9 OF10 OF17 OF20 OF23 OF25	A
OF1 OF2 OF3 OF4 OF6 OF7 OF8 OF11 OF14 OF15 OF12 OF21 OF24 OF25 OF28 OF30	B
OF5 OF12 OF13 OF16 OF18 OF22 OF27 OF22	C

Analyzing the results, we observed that only 6 of the 30 (20%) officers evaluated presented class A performance, which corresponds to promotion by deserving. Class B has 16 officers (about 53% of the alternatives) who would gain promotion for service time. In comparison, according to the proposed modeling, eight officers (or 26.7%) had the worst possible performance and would not be promoted.

We emphasize that it is possible to approach the results differently, analyzing only one way to obtain the classes (bh or bn) at the DM's discretion.

5.6. Sensitivity Analysis

The ELECTRE-MOr method also allows sensitivity analyses, varying the cut-off level and verifying the distribution of alternatives [70]. Table 13 exposes the sensitivity analysis, with the consolidated classification of the alternatives after variation λ. To verify more demanding and flexible scenarios, the following values were used for the cut-off level λ: 0.75; 0.85; 0.9; 0.95 and 1).

After the sensitivity analysis, we verified that the results presented by the proposed methodology are coherent. As the λ value was increased (making the analysis more demanding), there was a downward trend of alternatives in classes A and B, that is, military personnel who would be promoted by merit or time of service, and an increase of alternatives distributed in classes C (not promoted). Analyzing the most flexible scenario (cut-off level equal to 0.75), we observed that only 13.3% of the officers would not gain promotion.

Table 13. Sensitivity analysis of the result, varying the cut-off level.

			Lambda			
	0				**0.75** **0.8** **0.85** **0.9** **0.95**	**1**
OF1	B	B	C	C	C	C
OF2	B	B	B	A	A	C
OF3	B	B	B	A	A	C
OF4	B	B	A	C	C	C
OF5	C	C	C	C	C	C
OF6	B	B	A	C	C	C
OF7	B	B	C	C	C	C
OF8	B	B	B	A	A	C
OF9	A	A	A	C	C	C
OF10	B	A	C	C	C	C
OF11	B	B	B	A	A	C
OF12	B	C	C	C	C	C
OF13	B	C	C	C	C	C
OF14	B	B	B	C	C	C
OF15	B	B	C	C	C	C
OF16	B	C	C	C	C	C
OF17	B	A	C	C	C	C
OF18	C	C	C	C	C	C
OF12	B	B	A	C	C	C
OF20	A	A	A	C	C	C
OF21	B	B	C	C	C	C
OF22	B	C	C	C	C	C
OF23	A	A	A	C	C	C
OF24	B	B	A	C	C	C
OF25	B	B	A	A	A	C
OF25	B	A	A	C	C	C
OF27	C	C	C	C	C	C
OF28	B	B	A	A	A	C
OF22	C	C	C	C	C	C
OF30	B	B	B	C	C	C
Class A	10					0.00% 20.00% 33.33% 20.00% 20.00% 0.00%
Class B	76					0.67% 53.33% 20.00% 0.00% 0.00% 0.00%
Class C	13.33%	26				0.67% 46.67% 80.00% 80.00% 100.00%

In addition, we observed that, for the most demanding case possible, with λ=1, all officers were allocated to the lower class. Thus, the sensitivity analysis provided additional information to the decision-maker because it verified the changes in the distributions of the alternatives when the cut-off level was varied (from 0.75 to 1). With this analysis, the decision maker can make decisions based on more flexible or rigorous scenarios at the discretion of the Naval High Administration. In other words, the decision maker can use the variation of λ and, consequently, of the distributions, as a way to prioritize alternatives that remain in the higher classes with the increase of the cut-off level.

6. Discussion

The addressed study provided a comprehensive analysis concerning evaluating a set of candidates under multiple criteria, exposing the construction of three classes of performance through the results of ELECTRE-MOr implementation. Contextualizing decision-making in a high-level environment, envisioning a more favorable personnel evaluation process assessment to military organizations, the methodological approach allowed the treatment of data and evaluation of personal and deterministic information, respectively, the preferences of the decision-makers in each for the sets of variables established.

The main gains aligned to the methodological approach reflect the analysis performed hybrid axiomatic model, providing different kinds of data manipulations, thus enabling the sensitivity analysis between the results obtained and gaining robustness in the decision-making process.

It is emphasized that given applications to the military environment brought gains in mitigation in decision making, clarifying criteria that were not previously evaluated and exposing the forms of solutions more adherent to the preferences established. In a complementary way, we should emphasize that all the perspectives presented in the study are directly linked to the vision of a Brazilian public military organization, not representing the vision of the other military forces.

Some limitations were listed in the research in question as a contribution to the discussion. As a first point, it should be noted that qualitative assessments, based on subjective factors of decision-makers, do not yet have an analysis format to assess the consistency of assignments, and this factor is axiomatic as an improvement for future studies. Finally, we emphasize that the study in question brings a perception of decision-making restricted to the evaluation of personnel selection scenario for a military organization, thus being able to present differences in perceptions if the model is applied in other scenarios that use similar criteria.

7. Conclusions

This work proposed a methodology to support the decision-making process of promoting AF officers, considering multiple decision-makers' opinions and qualitative and quantitative data, bringing transparency and a better understanding of the problem under analysis. We highlight that other authors can replicate the methodology for various situations involving meritocracies, such as command scale, direction, and choice of the military for permanent commissions abroad.

The research was applied in the BN, providing the classification of the officers by the ELECTRE-MOr method, showing a consolidated categorization into three classes, in a prioritized manner, based on the meritocracy of the military, transparently and fairly.

The initial steps of the ELECTRE-MOr method allowed, through paired evaluation of the subcriteria, for transforming ordinal preferences into cardinals, considering the views of several decision-makers. This characteristic brings a vital sociological characteristic since all specialists have equal weights in the proposed analysis, which makes the decision-making process more transparent and democratic.

We highlight the importance of bibliometric studies on the use of MCDM in personnel selection and military problems, verifying the main characteristics and nuances of the problems. The bibliometric studies provided a better understanding and structuring of the problematic situation.

We emphasize the development of a computational platform based on the proposal of the method, completely open, without the need for registration or payment by users. This tool helped us expand applications in different areas of science, by experts and nonspecialists, at operational, tactical, and strategic levels, providing satisfactory results simply and intuitively.

To illustrate the applicability of the ELECTRE-MOr method, we analyzed a real BN problem regarding the promotion of officers. The presentation of two pessimistic and optimistic categorizations by the ELECTRE-MOr method allows for verifying the behavior of alternatives in several scenarios. These categorizations allowed us to choose several parameters of analysis, either considering the highest number of occurrences of classifications, as was achieved in this work, or considering only one of the two forms of distribution (bh or bn). This analysis flexibility provides additional information to the DM, offering possible decisions in the most diverse scenarios.

Given the above, the objective of the work was achieved, with the proposition of a framework aimed at supporting the decision-making process regarding the promotion of AF officers, considering qualitative and quantitative data, in addition to the aggregation of opinions of multiple decision-makers. We emphasize that other researchers can apply the methodology presented in this research to several fundamental problems from the tactical, operational, and strategic levels.

Finally, we suggest that future researchers apply this distribution model to predefined classes of alternatives using ELECTRE-MOr in conjunction with other methods from MCDM. This combination can help the researchers in ordering or choosing alternatives in the higher classes, serving as a basis to support the decision-making process in the most diverse areas of the public and private sectors.

Author Contributions: Conceptualization, I.P.d.A.C. and M.Â.L.M.; methodology, I.P.d.A.C. and M.Â.L.M.; software, A.V.T. and M.Â.L.M.; validation, I.P.d.A.C.; formal analysis, A.V.T. and I.P.d.A.C.; investigation, M.Â.L.M.; resources, M.T.P. and M.d.S.; data curation, L.P.L.F.; project administration, C.F.S.G. and M.d.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Not Applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Cardoso, R.S.; Xavier, L.H.; Gomes, C.F.S.; Adissi, P.J. Uso de SAD no apoio à decisão na destinação de resíduos plásticos e gestão de materiais. *Pesqui. Oper.* **2009**, *29*, 67–95. [CrossRef]
2. Hatami-Marbini, A.; Tavana, M. An extension of the Electre I method for group decision-making under a fuzzy environment. *Omega* **2011**, *39*, 373–386. [CrossRef]
3. Almeida, I.D.P.D.; Corriça, J.V.D.P.; Costa, A.P.D.A.; Costa, I.P.D.A.; Maêda, S.M.D.N.; Gomes, C.F.S.; Santos, M.D. Study of the Location of a Second Fleet for the Brazilian Navy: Structuring and Mathematical Modeling Using SAPEVO-M and VIKOR Methods. *ICPR-Am. 2020 Commun Comput. Inf. Sci.* **2021**, *1408*, 113–124.
4. Basílio, M.P.; Pereira, V.; Costa, H.G.; Santos, M.; Ghosh, A. A Systematic Review of the Applications of Multi-Criteria Decision Aid Methods (1977–2022). *Electronics* **2022**, *11*, 1720. [CrossRef]
5. Belton, V.; Stewart, T. *Multiple Criteria Decision Analysis: An Integrated Approach*; Springer Science & Business Media: Berlin/Heidelberg, Germany, 2002; ISBN 079237505X.
6. Greco, S.; Ehrgott, M.; Figueira, J.R. *Multiple Criteria Decision Analysis State of the Art Surveys*, 2nd ed.; Springer: New York, NY, USA, 2016; ISBN 038723067X.
7. Tenório, F.M.; Santos, M.D.; Gomes, C.F.S.; Araujo, J.D.C. Navy warship selection and multicriteria analysis: The THOR method supporting decision making. In *International Joint conference on Industrial Engineering and Operations Management*; Springer: Cham, Switzerland, 2020; pp. 27–39.
8. Corrente, S.; Greco, S.; Słowiński, R. Multiple criteria hierarchy process for ELECTRE Tri methods. *Eur. J. Oper. Res.* **2016**, *252*, 191–203. [CrossRef]
9. Fávero, L.P.; Belfiore, P. *Data Science for Business and Decision Making*; Academic Press Elsevier: Cambridge, MA, USA, 2019; ISBN 0128112174.
10. Ulutaş, A.; Popovic, G.; Stanujkic, D.; Karabasevic, D.; Zavadskas, E.K.; Turskis, Z. A new hybrid mcdm model for personnel selection based on a novel grey piprecia and grey OCRA methods. *Mathematics* **2020**, *8*, 1698. [CrossRef]
11. Abdel-Basset, M.; Gamal, A.; Son, L.H.; Smarandache, F. A bipolar neutrosophic multi criteria decision making framework for professional selection. *Appl. Sci.* **2020**, *10*, 1202. [CrossRef]

12. Ijadi Maghsoodi, A.; Riahi, D.; Herrera-Viedma, E.; Zavadskas, E.K. An integrated parallel big data decision support tool using the W-CLUS-MCDA: A multi-scenario personnel assessment. *Knowl. Based Syst.* **2020**, *195*, 105749. [CrossRef]
13. Heidary Dahooie, J.; Beheshti Jazan Abadi, E.; Vanaki, A.S.; Firoozfar, H.R. Competency-based IT personnel selection using a hybrid SWARA and ARAS-G methodology. *Hum. Factors Ergon. Manuf.* **2018**, *28*, 5–16. [CrossRef]
14. Kilic, H.S.; Demirci, A.E.; Delen, D. An integrated decision analysis methodology based on IF-DEMATEL and IF-ELECTRE for personnel selection. *Decis. Support Syst.* **2020**, *137*, 113360. [CrossRef]
15. Krishankumar, R.; Premaladha, J.; Ravichandran, K.S.; Sekar, K.R.; Manikandan, R.; Gao, X.Z. A novel extension to VIKOR method under intuitionistic fuzzy context for solving personnel selection problem. *Soft Comput.* **2020**, *24*, 1063–1081. [CrossRef]
16. Malloy, T.F.; Zaunbrecher, V.M.; Batteate, C.M.; Blake, A.; Carroll, W.F.; Corbett, C.J.; Hansen, S.F.; Lempert, R.J.; Linkov, I.; McFadden, R.; et al. Advancing alternative analysis: Integration of decision science. *Environ. Health Perspect.* **2017**, *125*, 066001. [CrossRef]
17. Durbach, I.N.; Stewart, T.J. Modeling uncertainty in multi-criteria decision analysis. *Eur. J. Oper. Res.* **2012**, *223*, 1–14. [CrossRef]
18. Danesh, D.; Ryan, M.J.; Abbasi, A. Multi-criteria decision-making methods for project portfolio management: A literature review. *Int. J. Manag. Decis. Mak.* **2018**, *17*, 75–94. [CrossRef]
19. Van Hoan, P.; Ha, Y. ARAS-fucom approach for VPAF fighter aircraft selection. *Decis. Sci. Lett.* **2020**, *10*, 53–62. [CrossRef]
20. Jardim, R.R.J.; Santos, M.; Neto, E.; da Silva, E.; de Barros, F. Integration of the waterfall model with ISO/IEC/IEEE 29148:2018 for the development of military defense system. *IEEE Lat. Am. Trans.* **2020**, *18*, 2096–2103. [CrossRef]
21. Maêda, S.M.D.N.; Costa, I.P.D.A.; Junior, M.A.P.D.C.; Fávero, L.P.; Costa, A.P.D.A.; Corriça, J.V.d.P.; Gomes, C.F.S.; dos Santos, M. Multi-criteria analysis applied to aircraft selection by Brazilian Navy. *Production* **2021**, *31*, 1–13. [CrossRef]
22. Costa, I.P.D.A.; Costa, A.P.D.A.; Sanseverino, A.M.; Gomes, C.F.S.; dos Santos, M. Bibliometric Studies on Multi-Criteria Decision Analysis (mcda) Methods Applied in Military Problems. *Pesqui. Oper.* **2022**, *42*, 1–26. [CrossRef]
23. De Almeida, I.D.P.; de Araújo Costa, I.P.; de Araújo Costa, A.P.; de Pina Corriça, J.V.; Lellis Moreira, M.Â.; Simões Gomes, C.F.; dos Santos, M. A multicriteria decision-making approach to classify military bases for the Brazilian Navy. *Procedia Comput. Sci.* **2022**, *199*, 79–86. [CrossRef]
24. Moreira, M.L.; Gomes, C.F.S.; dos Santos, M.; Basilio, M.P.; Costa, I.P.D.A.; Junior, C.d.S.R.; Jardim, R.R.-A.J. Evaluation of drones for public security: A multicriteria approach by the PROMETHEE-SAPEVO-M1 systematic. *Procedia Comput. Sci.* **2022**, *199*, 125–133. [CrossRef]
25. Barbosa de Paula, N.O.; de Araújo Costa, I.P.; Drumond, P.; Lellis Moreira, M.Â.; Simões Gomes, C.F.; dos Santos, M.; do Nascimento Maêda, S.M. Strategic support for the distribution of vaccines against Covid-19 to Brazilian remote areas: A multicriteria approach in the light of the ELECTRE-MOr method. *Procedia Comput. Sci.* **2022**, *199*, 40–47. [CrossRef] [PubMed]
26. Rodrigues, M.V.G.; Duarte, T.E.; dos Santos, M.; Gomes, C.F.S. Prospective scenarios analysis: Impact on demand for oil and its derivatives after the COVID-19 pandemic. *Braz. J. Oper. Prod. Manag.* **2021**, *18*, e20211215. [CrossRef]
27. Costa, I.P.; de Castro Junior, M.A.P.; dos Santos, M.; Gomes, C.F.S. ELECTRE-MOr WEB Software (v.1). Available online: http://electremor.com (accessed on 23 September 2022).
28. Bastian, N.D.; Boguchwal, L.; Langhans, Z.; Evans, D. A multi-criteria, network analytic approach to war game participant selection. *J. Def. Model. Simul.* **2016**, *13*, 183–194. [CrossRef]
29. Korkmaz, I.; Gökçen, H.; Çetinyokuş, T. An analytic hierarchy process and two-sided matching based decision support system for military personnel assignment. *Inf. Sci.* **2008**, *178*, 2915–2927. [CrossRef]
30. Cheng, E.W.L.; Li, H. Contractor selection using the analytic network process. *Constr. Manag. Econ.* **2004**, *22*, 1021–1032. [CrossRef]
31. Dağdeviren, M. A hybrid multi-criteria decision-making model for personnel selection in manufacturing systems. *J. Intell. Manuf.* **2010**, *21*, 451–460. [CrossRef]
32. Baležentis, T.; Zeng, S. Group multi-criteria decision making based upon interval-valued fuzzy numbers: An extension of the MULTIMOORA method. *Expert Syst. Appl.* **2013**, *40*, 543–550. [CrossRef]
33. Keršuliene, V.; Turskis, Z. Integrated fuzzy multiple criteria decision making model for architect selection. *Technol. Econ. Dev. Econ.* **2011**, *17*, 645–666. [CrossRef]
34. Baležentis, A.; Baležentis, T.; Brauers, W.K.M. Personnel selection based on computing with words and fuzzy multimoora. *Expert Syst. Appl.* **2012**, *39*, 7961–7967. [CrossRef]
35. Kabak, M.; Burmaoğlu, S.; Kazançoğlu, Y. A fuzzy hybrid MCDM approach for professional selection. *Expert Syst. Appl.* **2012**, *39*, 3516–3525. [CrossRef]
36. Chen, L.-S.; Cheng, C.-H. Selecting IS personnel use fuzzy GDSS based on metric distance method. *Eur. J. Oper. Res.* **2005**, *160*, 803–820. [CrossRef]
37. Sang, X.; Liu, X.; Qin, J. An analytical solution to fuzzy TOPSIS and its application in personnel selection for knowledge-intensive enterprise. *Appl. Soft Comput. J.* **2015**, *30*, 190–204. [CrossRef]
38. Krylovas, A.; Zavadskas, E.K.; Kosareva, N.; Dadelo, S. New KEMIRA method for determining criteria priority and weights in solving MCDM problem. *Int. J. Inf. Technol. Decis. Mak.* **2014**, *13*, 1119–1133. [CrossRef]
39. Nabeeh, N.A.; Smarandache, F.; Abdel-Basset, M.; El-Ghareeb, H.A.; Aboelfetouh, A. An Integrated Neutrosophic-TOPSIS Approach and Its Application to Personnel Selection: A New Trend in Brain Processing and Analysis. *IEEE Access* **2019**, *7*, 29734–29744. [CrossRef]

40. Rouyendegh, B.D.; Erkan, T.E. An application of the Fuzzy ELECTRE method for academic staff selection. *Hum. Factors Ergon. Manuf.* **2013**, *23*, 107–115. [CrossRef]
41. Karabasevic, D.; Zavadskas, E.K.; Turskis, Z.; Stanujkic, D. The Framework for the Selection of Personnel Based on the SWARA and ARAS Methods Under Uncertainties. *Informatica* **2016**, *27*, 49–65. [CrossRef]
42. Karabasevic, D.; Stanujkic, D.; Urosevic, S.; Maksimovic, M. Selection of candidates in the mining industry based on the application of the SWARA and the MULTIMOORA methods. *Acta Montan. Slovaca* **2015**, *20*, 116–124.
43. Urosevic, S.; Karabasevic, D.; Stanujkic, D.; Maksimovic, M. An approach to personnel selection in the tourism industry based on the SWARA and the WASPAS methods. *Econ. Comput. Econ. Cybern. Stud. Res.* **2017**, *51*, 75–88.
44. Keršuliene, V.; Turskis, Z. A hybrid linguistic fuzzy multiple criteria group selection of a chief accounting officer. *J. Bus. Econ. Manag.* **2014**, *15*, 232–252. [CrossRef]
45. Raj Mishra, A.; Sisodia, G.; Raj Pardasani, K.; Sharma, K. Multi-criteria it personnel selection on intuitionistic fuzzy information measures and aras methodology. *Iran. J. Fuzzy Syst.* **2020**, *17*, 55–68. [CrossRef]
46. Dwivedi, P.; Chaturvedi, V.; Vashist, J.K. Efficient team formation from pool of talent: Comparing AHP-LP and TOPSIS-LP approach. *J. Enterp. Inf. Manag.* **2020**, *33*, 1293–1318. [CrossRef]
47. Kilgour, D.M.; Chen, Y.; Hipel, K. Multiple Criteria Approaches to Group Decision and Negotiation. In *Trends in Multiple Criteria Decision Analysis*; Ehrgott, M., Figueira, J.R., Greco, S., Eds.; Springer: New York, NY, USA, 2010; p. 430. ISBN 9781441959041.
48. Nepomuceno, L.D.D.O.; Costa, H.G. Analyzing perceptions about the influence of a master course over the professional skills of its alumni: A multicriteria approach. *Pesqui. Oper.* **2015**, *35*, 187–211. [CrossRef]
49. Almeida-Dias, J.; Figueira, J.R.; Roy, B. A multiple criteria sorting method where each category is characterized by several reference actions: The Electre Tri-nC method. *Eur. J. Oper. Res.* **2012**, *217*, 567–579. [CrossRef]
50. Kulakowski, K. Inconsistency in the ordinal pairwise comparisons method with and without ties. *Eur. J. Oper. Res.* **2018**, *270*, 314–327. [CrossRef]
51. Petrović, M.; Bojković, N.; Stamenković, M.; Anić, I. Supporting performance appraisal in ELECTRE based stepwise benchmarking model. *Omega* **2018**, *78*, 237–251. [CrossRef]
52. Figueira, J.; Mousseau, V.; Roy, B. ELECTRE methods. In *Multiple Criteria Decision Analysis: State of the Art Surveys*; Springer: Berlin/Heidelberg, Germany, 2005; pp. 133–153.
53. Gomes, C.F.S.; Costa, H.G. Aplicação de métodos multicritério ao problema de escolha de modelos de pagamento eletrônico por cartão de crédito. *Production* **2015**, *25*, 54–68. [CrossRef]
54. Roy, B. Classement et choix en présence de points de vue multiples. *Rev. Française D'informatique Rech. Opérationnelle* **1968**, *2*, 57–75. [CrossRef]
55. Roy, B.; Bertier, B. Le methods ELECTRE II: Une methode de classement en presence de criteres multiples, note de travail no. 142. Dir. Sci. Groupe Metra v. 142. 1971.
56. Roy, B. ELECTRE III: Un algorithme de classements fondé sur une représentation floue des préférences en présence de critères multiples. *Cah. Centre Rech. Operat.* **1978**, *20*, 3–24.
57. Roy, B.; JC, H. Classement des prolongements de lignes de metro en banlieue parisienne: Presentation d'une methode multicritere originale. *Cah. Cent. Etud. Rech. Oper.* **1982**, *24*, 153–171.
58. Roy, B.; Skalka, J.M. ELECTRE IS: Aspects méthodologiques et guide d'utilisation. *Doc. Du Lamsade* **1984**, *30*, 125.
59. Roy, B.; Bouyssou, D. *Aide Multicritère à la Décision: Méthodes et cas*; Economica: Paris, France, 1993; ISBN 2717824731.
60. Almeida-Dias, J.; Figueira, J.R.; Roy, B. Electre Tri-C: A multiple criteria sorting method based on characteristic reference actions. *Eur. J. Oper. Res.* **2010**, *204*, 565–580. [CrossRef]
61. Kadziński, M.; Tervonen, T.; Figueira, J.R. Robust multi-criteria sorting with the outranking preference model and characteristic profiles. *Omega* **2015**, *55*, 126–140. [CrossRef]
62. Fernández, E.; Figueira, J.R.; Navarro, J.; Roy, B. ELECTRE TRI-nB: A new multiple criteria ordinal classification method. *Eur. J. Oper. Res.* **2017**, *263*, 214–224. [CrossRef]
63. Lansdowne, Z.F. Ordinal ranking methods for multicriterion decision making. *Nav. Res. Logist.* **1996**, *43*, 613–627. [CrossRef]
64. Sanseverino, A.M. *Metodologia Para Delineamento de Estratégias e Tomada de Decisão para Atuação no Cargo Técnico em Assuntos Educacionais*; Universidade Federal Fluminense: Niterói, Brasil, 2020.
65. Gomes, C.F.S.; Dos Santos, M.; Teixeira, L.F.H.D.S.D.B.; Sanseverino, A.M.; Barcelos, M.R.D.S. SAPEVO-M a group multicriteria ordinal ranking method. *Pesqui. Oper.* **2020**, *40*, 1–20. [CrossRef]
66. Gomes, L.; Mury, A.-R.; Gomes, C.F.S. Multicriteria ranking with ordinal data. *Syst. Anal.* **1997**, *27*, 139–146.
67. Roy, B.; Figueira, J.R.; Almeida-Dias, J. Discriminating thresholds as a tool to cope with imperfect knowledge in multiple criteria decision aiding: Theoretical results and practical issues. *Omega* **2014**, *43*, 9–20. [CrossRef]
68. Gomes, L.; Gomes, C.F.S. *Princípios e Métodos para a Tomada de Decisão: Enfoque Multicritério*, 6th ed.; Atlas: São Paulo, Brazil, 2019.
69. Costa, I.P.d.A.; Sanseverino, A.M.; Barcelos, M.R.D.S.; Belderrain, M.C.N.; Gomes, C.F.S.; dos Santos, M. Choosing flying hospitals in the fight against the COVID-19 pandemic: Structuring and modeling a complex problem using the VFT and ELECTRE-MOr methods. *IEEE Lat. Am. Trans.* **2021**, *19*, 1099–1106. [CrossRef]
70. Costa, I.P.D.A.; Moreira, M.L.; Costa, A.P.D.A.; Teixeira, L.F.H.D.S.D.B.; Gomes, C.F.S.; Dos Santos, M. Strategic Study for Managing the Portfolio of IT Courses Offered by a Corporate Training Company: An Approach in the Light of the ELECTRE-MOr Multicriteria Hybrid Method. *Int. J. Inf. Technol. Decis. Mak.* **2021**, *21*, 351–379. [CrossRef]

71. Rocha, C.; Dias, L.C. An algorithm for ordinal sorting based on ELECTRE with categories defined by examples. *J. Glob. Optim.* **2008**, *42*, 255–277. [CrossRef]
72. Cinelli, M.; Kadziński, M.; Gonzalez, M.; Słowiński, R. How to support the application of multiple criteria decision analysis? Let us start with a comprehensive taxonomy. *Omega* **2020**, *96*, 102261. [CrossRef] [PubMed]
73. Maêda, S.; Costa, I.P.; da Mota, I.S.; Gomes, C.F.S.; dos Santos, M. Avaliação edafoclimática e econômica de regiões para o plantio de mogno africano: Uma abordagem à luz do método ELECTRE-MOr. *Congr. Int. XXXI EPIO—XXXIII ENDIO Y RED-M IX*, 2020.
74. Costa, I.P.; Sanseverino, A.M.; Barcelos, M.R.; Gomes, C.F.S.; dos Santos, M. Desenvolvimento axiomático e implementação computacional do método híbrido ELECTRE-MOr: Apoiando à decisão da Marinha do Brasil na aquisição de lanchas no combate à COVID-19. *Congr. Int. XXXI EPIO—XXXIII ENDIO y RED-M IX 2020*, 2020.
75. Pereira, D.A.D.M.; Dos Santos, M.; Costa, I.P.d.A.; Moreira, M.A.L.; Terra, A.V.; Junior, C.d.S.R.; Gomes, C.F.S. Multicriteria and Statistical Approach to Support the Outranking Analysis of the OECD Countries. *IEEE Access* **2022**, *10*, 69714–69726. [CrossRef]
76. Sørlie, H.O.; Hetland, J.; Dysvik, A.; Fosse, T.H.; Martinsen, Ø.L. Person-Organization Fit in a military selection context. *Mil. Psychol.* **2020**, *32*, 237–246. [CrossRef]
77. Gomes, C.F.S. THOR–Um Algoritmo Híbrido de Apoio Multicritério à Decisão para Processos Decisórios com Alternativas Discretas. Ph.D. Thesis, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil, 1999.
78. *Brasil DGPM-313: Normas para Avaliação de Militares, Organização, Funcionamento e Procedimentos da Comissão de Promoções de Praças, Aplicação da Quota Compulsória, Alteração de Dados Cadastrais e Cômputo e Registro de Tempos*, 2012.
79. Creswell, J.W.; Creswell, J.D. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*; Sage publications: New York, NY, USA, 2017; ISBN 1506386717.
80. Bertrand, J.W.M.; Fransoo, J.C. Operations management research methodologies using quantitative modeling. *Int. J. Oper. Prod. Manag.* **2002**, *22*, 241–264. [CrossRef]