Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 214 (2022) 248–256

Procedia Computer Science

www.elsevier.com/locate/procedia

9th International Conference on Information Technology and Quantitative Management

Demand Prioritization on Supply Chain by the Integration of Value-Focused Thinking Approach and THOR 2 Method

Fernanda Márcia da Silveira Esteves [a], Miguel Ângelo Lellis Moreira [a,b], Igor Pinheiro de Araújo Costa [a,b], Guilherme Portilho Joaquim [a], Carlos Francisco Simões Gomes [a], Marcos dos Santos [b,c]

[a] *Fluminense Federal University, Niterói, RJ 24210-240, Brazil*
[b] *Naval Systems Analysis Center, Rio de Janeiro, RJ 20091-000, Brazil*
[c] *Military Institute of Engineering, Urca, RJ 22290-270, Brazil*

Abstract

One of the significant challenges in the Procurement area of large companies is the prioritization of demands, given the high volume of daily requests and the reduced amount of labor. Therefore, it is necessary to seek a service strategy to meet all demands promptly and with the required quality. Therefore, this study aims to sort requisitions into service priorities according to the urgency in the generation of purchase orders. Through the Value-Focused Thinking (VFT) approach, it is possible to extract the understanding of values by experts by developing a hierarchy of fundamental objectives and a network of objectives. Then, to evaluate the alternatives because of the established criteria, the Multi-criteria Decision Support Method THOR 2 is used for its ability to perform the ordering of alternatives. With this work, we exposes an approach to support decision-making processes regarding the prioritization of demands in various sectors and companies.

Keywords: VFT; MCDA; THOR 2; Prioritization of demands.

1. Introduction

The Procurement area of a multinational industrial and medicinal gases company, whose headquarters is in Rio de Janeiro - RJ, is responsible for meeting the demands of all its units in the Brazilian territory. However, the volume of demands is significant compared to the low number of employees in this sector. According to [1], modern organizations have prioritized forming small teams to solve tactical, operational, and strategic situations [2].

Therefore, ordering these requests is necessary so that there are no severe consequences due to non-service in a timely manner, such as a stop at some industrial plant, monetary loss, impacts on internal and external suppliers and customers, etc [3]. As exposed in [4], the result of demand decisions directly influences the process of the company. Thus, techniques and tools are needed to analyze and assist decision-making [5].

10.1016/j.procs.2022.11.172

Regarding real-world decision-making problems rarely contain a single criterion, with high complexity in seeking an appropriate solution [6, 7]. As the ordering of the demands in question is not simply because they have several criteria and are conflicting, it is essential to implement a multi-criteria method of decision support [8, 9]. Thus, it is possible to visualize the priority demands, those that must be met soon after the most urgent ones, and those that can wait a little longer without generating losses for the company [10–12].

To refine the THOR 2 Multi-criteria Decision Analysis (MCDA) method, a problem structuring model can be implemented, in this case, Value-Focused Thinking (VFT) contributed to a better choice of criteria [13]. The VFT helps identify decision-makers objectives and values since, in complex situations, the best thing to do is to think about what is expected in achieving with a given decision rather than focusing on which alternative to choose [14].

The notability of this study is justified by the fact that, with the use of a problem structuring model, followed by an MCDA method, it was possible to provide a solution that makes there an improvement in the attendance to requests and avoids inappropriate consequences for not complying with what was requested within the necessary practice [15]. A significant problem of prioritization of demands occurs both in the company and several others is solved [16].

It is interesting to verify that the use of VFT, the behavioral aspects of multicriteria analysis are noted in a more robust and coherent way, since there is a greater direction to decision makers to what is being analyzed, as well as the alternatives and criteria involved, generating greater acceptance of the use of analytical assistance to decision making [17, 18].

In the first section, the introduction is presented, containing the contextualization of the proposed theme, the objective, and the structure of the work. Section 2 discusses the theoretical framework for the most relevant subjects of the study: the VFT approach and the THOR 2 method. Section 3 describes the study methodology. In section 4, the results of the case study are exposed. Finally, in section 5, the final considerations are presented.

2. Theoretical Framework

2.1. Value-Focused Thinking (VFT)

The VFT, proposed by Keeney in 1992 [19], can be described as an approach to structuring problems with value-focused thinking. In other words, the values desired to be achieved are observed, not only the alternatives and objectives. In a decision problem, identifying the decision-makers objectives are more relevant than comparing alternatives [20]. It is essential to identify decision-makers' values since it is possible to verify new decision opportunities [21].

In VFT, it is necessary to determine what you want and then go in search of how to achieve it. Four procedures help the use of the method, they are: identifying the objectives, classifying the objectives, creating alternatives, and examining the objectives for identifying decision-making opportunities [22]. In the first stage, identifying the objectives related to values involves interviews with decision-makers and stakeholders, in which techniques can be used to stimulate creativity [23].

By using the techniques, redundant objectives can be generated, which are easily identified when listed. The focus should be on collecting new goals. For this, it is possible to use questions that stimulate the interviewee, such as working with resources that differentiate the alternatives. After the identifying objectives process, one should focus on the alternatives so that it is possible to find the ones that best suit the objectives listed [24].

2.2. Methods THOR and THOR 2

Concerning [25], making decisions is intrinsic to human nature. A decision must be made whenever you are faced with a problem with more than one alternative to your solution [26–28]. Even when, to solve a problem, there is a single action to take, there are alternatives to whether to take that action [29].

The THOR method [30] consists on three axiomatic theories: preference modeling (resembling the French

School – non-compensatory model), multi-attribute utility theory (approaching the American School – compensatory model), and theories that deal with inaccurate information. The combination of these theories allows quantifying the attractiveness of each alternative, creating a non-transitive aggregation function, allowing faster and more efficient analysis of alternatives [31–33], considering the non-determinism of the weight allocation, and quantifying this non-determinism, reapplying it in the process of ordering the alternatives [30].

In using the THOR method, given two alternatives, *a* and *b*, scenarios S1, S2, and S3 should be analyzed: S1, S2 and S3. Comparing the alternatives, the criteria are verified where *a*P*b (strong* preference of *a* over *b*), *aQb* (weak preference of *a* concerning *b*), *aIb* (indifference between alternatives), and disagreement. The associations *P*, *I* and *Q* are exposed, in equations 1, 2, and 3, respectively.

$$aPb \leftrightarrow g(a) - g(b) > p \tag{1}$$

$$aIb \leftrightarrow -q \leq |\, g(a) - g(b)\,| \leq q \tag{2}$$

$$aQb \leftrightarrow q < |\, g(a) - g(b)\,| \leq p \tag{3}$$

Regarding [34], in situations S2 and S3, the scenarios are a little more flexible, since with a smaller difference between the alternatives in each criterion it is possible to classify an alternative as better than another. It is possible to observe situations S1, S2 and S3 in equations 4, 5 and 6, respectively.

$$S1\colon \sum_{j=1}^{n}(w_j |\, aP_jb) > \sum_{j=1}^{n}(w_j |\, aQ_jb + aI_jb + aR_jb + bQ_ja + bP_ja) \tag{4}$$

$$S2\colon \sum_{j=1}^{n}(w_j |\, aP_jb + aQ_jb) > \sum_{j=1}^{n}(w_j |\, aI_jb + aR_jb + bQ_ja + bP_ja) \tag{5}$$

$$S1\colon \sum_{j=1}^{n}(w_j |\, aP_jb + aQ_jb + aI_jb) > \sum_{j=1}^{n}(w_j |\, aR_jb + bQ_ja + bP_ja) \tag{6}$$

The THOR method underwent an axiomatic evolution, in which some modifications were made before an analysis of the original algorithm, together with the review of the American and French schools' main methods, until the THOR 2 method was reached [35]. The main differences sets below:

- The distinction in the assignment of weights in the sum of scores for aI_jb and aQ_jb in S1, S2 and S3:
  - Comparations in which aI_jb they occur: half the weight of the respective criterion;
  - Comparations in which aQ_jb they occur: a ratio between half the weight of the criterion (aI_jb) and the totalweight (aP_jb), expressed in equation 7.

$$weight_i * (((a_i - q_i)/(p_i - q_i)) * 0{,}5 + 0{,}5) \tag{7}$$

- In situations in which they occur aP_jb, aQ_jb and aI_jb: value of the criterion weight is multiplied by the cloudy-approximate index, thus deteriorating the comparison according to the degree of safety of the data.
- The original THOR only considers the multiplication by the index in the situation aQ_jb, deteriorating the gain only in this case. THOR 2 also includes the depreciation of the score in situations of solid preference (aP_jb) and indifference (aI_jb).
- In THOR 2, all uncertainty present in the assignment of alternative and weight classifications is quantified.

3. Methodology

To implement a multi-criteria decision model support for the demands prioritization of the procurement area of the industrial and medicinal gases industry, the study was structured in three phases, which cover the

problem structuring, structuring of MCDA method, and evaluation of alternatives. Figure 1 illustrates the stages of the research from the methodological point of view.

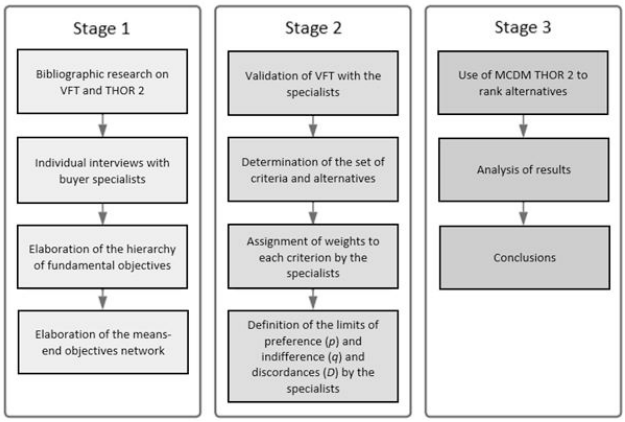

Fig. 1. Stages of development of the study.

Initially, were conducted individual interviews with specialists in the purchasing area. The hierarchy of fundamental objectives elaborated the means-end objectives network and the decision criteria from the extracted answers. Subsequently, was sent a questionnaire to each specialist, who requested the weights for the criteria. The third stage aimed to define the classification of the alternatives of qualitative attributes, in addition to establishing the limits of indifference and preference and disagreements for all criteria.

After that, were defined the alternatives. In this work, it was determined that the preferences of care would be ordered based on the demands of the category of Health, Safety, Environment, and Quality (HSEQ). However, it is essential to note that the criteria can be used for any of the categories in the Procurement area. But since each buyer has management over a portfolio with an average of five categories, it is interesting that the method is used for each category individually. Finally, we implemented the THOR 2 method to rank the alternatives defined in the category of HSEQ.

4. Results

The first phase of the VFT approach included individual interviews with specialists in the purchasing area. It was sought to understand what these professionals value in the process of prioritizing demands in the organization. The specialists elaborated and validated the hierarchy of fundamental objectives (Table 1) and the means-end objectives network (Figure 2).

Table 1. Hierarchy of fundamental objectives

Prioritize Supply Industry Requisitions
1. Attend all demands within the required/anticipated time frame
1.1 Reduce unpredictability
1.2 Reduce risks to the company

2. Achieving annual financial targets 2.1 Maximizing profit 2.2 Minimizing costs and rework
3. Ensure internal customer satisfaction 3.1 Align demand priorities with service users 3.2 Align process time and movement expectations
4. Ensure positive partnership with suppliers 4.1 Speed of return with budgets 4.2 Ensure good quality and assertiveness in the services provided

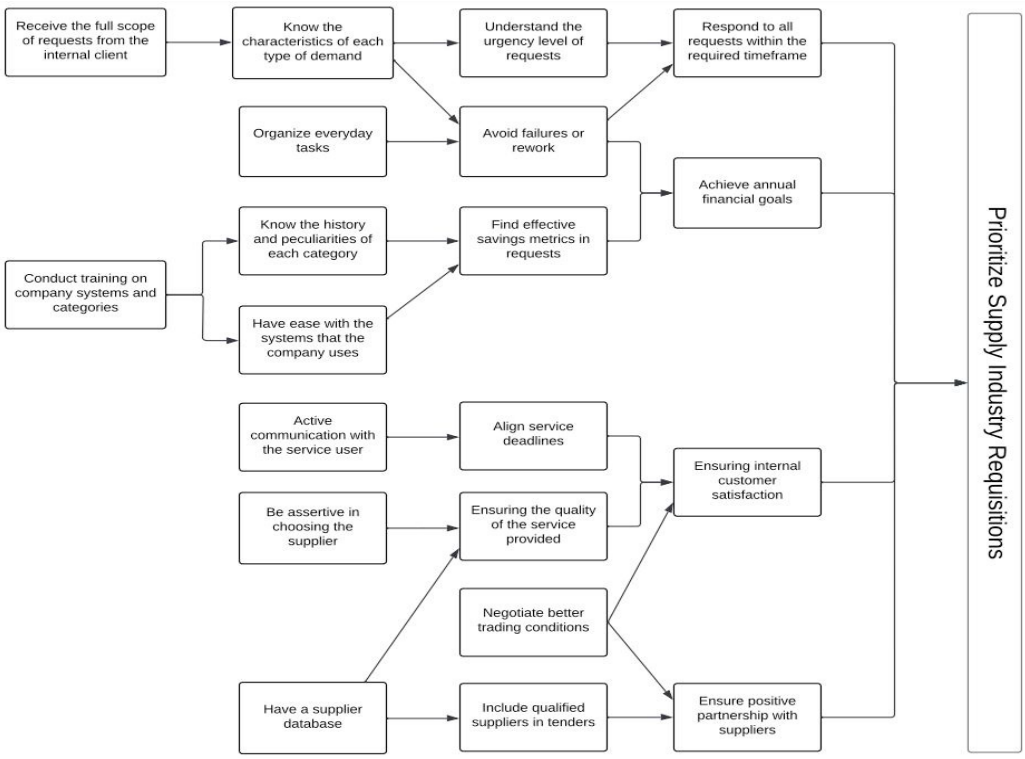

Fig. 2. VFT objectives network

The fundamental objectives are the most essential points for buyers in prioritizing demands. The hierarchy of these objectives is according to the order of importance, with 1 being the most crucial objective and 5 being the least important.

The means-end objectives network composes the fundamental general or strategic objective: "Prioritize requisitions from the Procurement sector". To the left of it are the fundamental goals or ends. Linked to them are the means objectives, which represent how to achieve the objectives is fundamental.

After, were established the criteria for decision-making, divided into quantitative and qualitative. A questionnaire was sent to the purchasing specialists to assign weights from 1 to 7 for each criterion, 1 less essential and 7 more critical. Thus, it is possible to define the degree of relevance of each criterion.

Table 2 shows the weights established to the criteria by the buyers, being C1, C2, C3, and C4, the identification of each specialist.

Table 2. Criteria weights

Criteria	C1	C2	C3	C4
Requisition time (days)	7	5	3	3
Requisition amount (R$)	7	3	6	3
Possible financial gains (R$)	7	6	7	4
Lead Time Delivery (days)	7	6	3	5
Risk of plant downtime	7	7	7	7
Risk of impacting employees	7	7	4	5
Risk of impacting the customer	7	7	5	5

The first four criteria in Table 3 are quantitative, and the last three are qualitative, totaling seven criteria to be evaluated. The qualitative criteria were established in consensus by the buyers with a score on a scale from 1 to 5, 5 of which presented the highest risk and 1, the lowest risk. It is essential to highlight that, in this case, all criteria are monotonic for profit, in other words, the maximum value is sought so that it can have preference over the other in the service.

In a new meeting with the buyers, the values for qualitative criteria, preference threshold (p), indifference (q), and discordance values (D) were also assigned in consensus for the criteria, as shown in Table 4. The weights were aggregated employing the sum of the normalized weights by THOR 2.

In table 3 is shown the pertinences considered for the attribution of the values of each criterion for each alternative. For the pertinence of the weights, was assigned a value of 1.

The alternatives of demands of the HSEQ category to be analyzed in this study (which are the most common among the requests received) are as follows: Operation License, Soil Analysis, Groundwater Analysis, Occupational Noise Analysis, Purchase of PPE, Fire Brigade Training, Maintenance of Fire Extinguishers.

Table 3. Evaluation matrix, criteria weights, and thresholds

	Time (days)	Amount (R$)	Financial gains (R$)	Lead time (days)	Risk of plant downtime	Risk of impacting employees	Risk of impacting the customer
Operation license	10	15000	2000	60	5	5	5
Soil Analysis	8	35000	3000	90	2	1	1
Groundwater Analysis	9	59450	10500	60	2	1	1
Occupation Moise Analysis	10	7900	50	20	2	4	1
Purchase of PPE	11	26676	0	60	2	5	1
Fire brigade training	12	9900	1620	5	1	4	1
Maintenance of fire extinguishers	7	12500	0	25	3	4	2
Weights	2.57	2.71	3.42	3	4	3.28	3.42
p	4	20000	10000	20	1	1	1
q	1	5000	2000	5	0.5	0.5	0.5
d	5.5	56705	11550	93.5	4.4	4.4	4.4

After the VFT stage and the elaboration of the decision matrix and membership matrix, THOR 2 was used, whose calculations performing through the THOR Web platform, available on *the www.thor-web.com* website. Table 4 shows the matrix of weights and normalized weights generated by the computational tool to support decision-making. The platform generates a detailed report of the results obtained. Table 5 shows the ordering of alternatives in scenarios S1, S2, and S3, with S2 and S3 being more flexible.

Table 4. Normalized values

	Time (days)	Amount (R$)	Financial gains (R$)	Lead time (days)	Risk of plant downtime	Risk of impacting employees	Risk of impacting the customer
Operation license	1	1	0.7	1	0.8	0.8	0.8
Soil Analysis	1	1	0.7	1	0.6	0.6	0.6
Groundwater Analysis	1	1	0.7	1	0.6	0.6	0.6
Occupation Moise Analysis	1	1	0.7	1	0.6	0.6	0.6
Purchase of PPE	1	1	0.7	1	0.6	0.6	0.6
Fire brigade training	1	1	0.7	1	0.7	0.7	0.7
Maintenance of fire extinguishers	1	1	0.7	1	0.7	0.7	0.7

The first two alternatives are the same in the three scenarios, confirming that the Operating License and Purchase of PPE are priority requisitions. Fire Brigade Training appears last in scenarios S2 and S3. It is noted that the differences in the scoring of the alternatives increase with the flexibilization of the scenarios.

The software can be used whenever there is a new request, daily, weekly, or as needed, just having to update some information of the other demands (such as the time of the request, for example) and removing from the base the ones already met. This way, it is possible to maintain an organization of all demands and better visualize the priority order of service to requests.

b

Table 5. Ranking alternatives in scenarios S1, S2, and S3.

S1		S2		S3	
Operation license	3.19	Operation license	4.09	Operation license	5.10
Purchase of PPE	3	Purchase of PPE	3.42	Purchase of PPE	3.37
Soil Analysis	3	Groundwater Analysis	3.78	Groundwater Analysis	3.59
Groundwater Analysis	2.57	Soil Analysis	2.54	Soil Analysis	3.19
Maintenance of fire extinguishers	2.5	Maintenance of fire extinguishers	1.57	Maintenance of fire extinguishers	2.24
Fire brigade training	2.5	Occupation Moise Analysis	1	Occupation Moise Analysis	1.43
Occupation Moise Analysis	2	Fire brigade training	0.5	Fire brigade training	0.55

5. Conclusion

The theme study is a real need of the multinational company that guided this study and several others. Through this study, we expect to contribute, in a remarkable way, both to private and public sector companies. Thus, impacting society since demands prioritization is intrinsically linked to the functioning of various organizations and, consequently, to the daily lives of people who depend on them.

The problem in question was solved, focusing on the THOR 2 method. In addition, the VFT approach, a method of structuring problems, was a facilitator for decision-making. Thus, it was possible to prioritize demands so that there is optimized, and timely service of the requests directed to the Supply sector. For future studies, we search for integration of the methodological approaches in other areas of organizations, serving as an aid in the decision-making process.

References

1. de Almeida, A.T., Wachowicz, T.: Preference analysis and decision support in negotiations and group decisions. Group Decision and Negotiation. 26, 649–652 (2017)
2. Drumond, P., Basílio, M.P., Costa, I.P. de A., Pereira, D.A. de M., Gomes, C.F.S., dos Santos, M.: Multicriteria Analysis in Additive Manufacturing: An ELECTRE-MOr Based Approach. Presented at the October 29 (2021)
3. Maêda, S.M. do N., Basílio, M.P., Costa, I.P. de A., Moreira, M.Â.L., dos Santos, M., Gomes, C.F.S., de Almeida, I.D.P., Costa, A.P. de A.: Investments in Times of Pandemics: An Approach by the SAPEVO-M-NC Method. Presented at the October 29 (2021)
4. dos Santos, M., Quintal, R.S., da Paixão, A.C., Gomes, C.F.S.: Simulation of Operation of an Integrated Information for Emergency Pre-Hospital Care in Rio de Janeiro Municipality. Procedia Computer Science. 55, 931–938 (2015). https://doi.org/10.1016/j.procs.2015.07.111
5. Nassim Mellem, P.M., de Araújo Costa, I.P., de Araújo Costa, A.P., Lellis Moreira, M.Â., Simões Gomes, C.F., dos Santos, M., de Pina Corriça, J.V.: Prospective scenarios applied in course portfolio management: An approach in light of the Momentum and ELECTRE-MOr methods. Procedia Computer Science. 199, 48–55 (2022). https://doi.org/10.1016/j.procs.2022.01.007
6. Santos, N., Rocha Junior, C. de S., Moreira, M.Â.L., Santos, M., Gomes, C.F.S., Costa, I.P. de A.: Strategy Analysis for project portfolio evaluation in a technology consulting company by the hybrid method THOR. Procedia Computer Science. 199, 134–141 (2022). https://doi.org/10.1016/j.procs.2022.01.017
7. Jardim, R., dos Santos, M., Neto, E., Muradas, F.M., Santiago, B., Moreira, M.: Design of a framework of military defense system for governance of geoinformation. Procedia Computer Science. 199, 174–181 (2022). https://doi.org/10.1016/j.procs.2022.01.022
8. Maêda, S.M., de Arajo Costa, I.P., Simões Gomes, C.F., dos Santos, M., da Mota, I.S., de Barros Teixeira, L.F.H. de S.: Economic and edaphoclimatic evaluation of Brazilian regions for African mahogany planting - an approach using the SAPEVO-M-NC ordinal method. Procedia Computer Science. 199, 323–330 (2022). https://doi.org/10.1016/j.procs.2022.01.196

9. Costa, I.P. de A., Moreira, M.Â.L., Costa, A.P. de A., Teixeira, L.F.H. de S. de B., Gomes, C.F.S., Santos, M. Dos: 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. International Journal of Information Technology & Decision Making. 1–29 (2021). https://doi.org/10.1142/S0219622021500565
10. Weistroffer, H.R., Li, Y.: Multiple Criteria Decision Analysis Software. In: Greco S., E.M. and Figueira, J.R. (eds.) Multiple Criteria Decision Analysis: State of the Art Surveys. pp. 1301–1341. Springer, New York (2016)
11. Rocha Junior, C. de S., Moreira, M.Â.L., Santos, M.: Selection of interns for startups: an approach based on the AHP-TOPSIS-2N method and the 3DM computational platform. Procedia Computer Science. 199, 984–991 (2022). https://doi.org/10.1016/j.procs.2022.01.124
12. Moreira, M.Â.L., Gomes, C.F.S., Santos, M., Basilio, M.P., Costa, I.P. de A., Rocha Junior, C. de S., Jardim, R.R.-A.J.: Evaluation of drones for public security: a multicriteria approach by the PROMETHEE-SAPEVO-M1 systematic. Procedia Computer Science. 199, 125–133 (2022). https://doi.org/10.1016/j.procs.2022.01.016
13. Costa, I.P. de A., Sanseverino, A.M., Barcelos, M.R. dos S., Belderrain, M.C.N., Gomes, C.F.S., Santos, M. dos: 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 Latin America Transactions. 19, 1099–1106 (2021). https://doi.org/10.1109/TLA.2021.9451257
14. Keeney, R.L.: Value-focused thinking: Identifying decision opportunities and creating alternatives. European Journal of Operational Research. 92, 537–549 (1996). https://doi.org/10.1016/0377-2217(96)00004-5
15. dos Santos, F.B., dos Santos, M.: Choice of armored vehicles on wheels for the Brazilian Marine Corps using PrOPPAGA. Procedia Computer Science. 199, 301–308 (2022). https://doi.org/10.1016/j.procs.2022.01.037
16. Drumond, P., de Araújo Costa, I.P., Lellis Moreira, M.Â., dos Santos, M., Simões Gomes, C.F., do Nascimento Maêda, S.M.: Strategy study to prioritize marketing criteria: an approach in the light of the DEMATEL method. Procedia Computer Science. 199, 448–455 (2022). https://doi.org/10.1016/j.procs.2022.01.054
17. Morais, D.C., Alencar, L.H., Costa, A.P.C.S., Keeney, R.L.: Using value-focused thinking in Brazil. Pesquisa Operacional. 33, 73–88 (2013). https://doi.org/10.1590/S0101-74382013000100005
18. 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. 11, 1720 (2022)
19. Keeney, R.L.: Value-focused Thinking: a Path to Creative Decisionmaking. Harvard University Press, London (1992)
20. Keeney, R.L.: Applying Value-Focused Thinking. Military Operations Research. 13, 7–17 (2008). https://doi.org/10.5711/morj.13.2.7
21. Costa, I.P. de A., Basílio, M.P., Maêda, S.M. do N., Rodrigues, M.V.G., Moreira, M.Â.L., Gomes, C.F.S., Santos, M.: Bibliometric Studies on Multi-Criteria Decision Analysis (MCDA) Applied in Personnel Selection. Frontiers in Artificial Intelligence and Applications. 341, (2021). https://doi.org/10.3233/faia210239
22. 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 Computer Science. 199, 40–47 (2022). https://doi.org/10.1016/j.procs.2022.01.006
23. Logullo, Y., Bigogno-Costa, V., Silva, A.C.S. da, Belderrain, M.C.: A prioritization approach based on VFT and AHP for group decision making: a case study in the military operations. Production. 32, (2022). https://doi.org/10.1590/0103-6513.20210059
24. de Souza, Y.L., Moreira, M.Â.L., Silva, B.T.R.V., Belderrain, M.C.N., Cerqueira, C.S., dos Santos, M., Gomes, C.F.S.: Multimethodology Exploitation Based on Value-Focused Thinking: Drones Feasibility Analysis for National Defense. In: International Conference Innovation in Engineering. pp. 245–256. Springer (2022)
25. Maêda, S.M. do N., Basílio, M.P., Costa, I.P. de A., Moreira, M.Â.L., dos Santos, M., Gomes, C.F.S.: The SAPEVO-M-NC Method. Frontiers in Artificial Intelligence and Applications. 341, 89–95 (2021). https://doi.org/10.3233/faia210235
26. Jardim, R.R.-A.J., Santos, M., Neto, E.C. de O., da Silva, E.D., de Barros, F.C.M.M.: Integration of the waterfall model with ISO/IEC/IEEE 29148:2018 for the development of military defense system. IEEE Latin America Transactions. 18, 2096–2103 (2020). https://doi.org/10.1109/TLA.2020.9400437
27. Moreira, M.Â.L., Gomes, C.F.S., Pereira, M.T., dos Santos, M.: SAPEVO-H2 a Multi-criteria Approach Based on Hierarchical Network: Analysis of Aircraft Systems for Brazilian Navy. Presented at the (2023)
28. Gomes, C.F.S., Rodrigues, M.V.G., Costa, I.P. de A., dos Santos, M.: Ordering of Warships for the Brazilian Navy Using the New Method: AHP-Gaussian with Pearson's Correlation. Presented at the October 29 (2021)
29. 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 Computer Science. 199, 79–86 (2022). https://doi.org/10.1016/j.procs.2022.01.198
30. Gomes, C.F.S., Nunes, K.R.A., Helena Xavier, L., Cardoso, R., Valle, R.: Multicriteria decision making applied to waste recycling in Brazil. Omega. 36, 395–404 (2008). https://doi.org/10.1016/j.omega.2006.07.009
31. Costa, I.P. de A., Basílio, M.P., Maêda, S.M. do N., Rodrigues, M.V.G., Moreira, M.Â.L., Gomes, C.F.S., dos Santos, M.: Algorithm Selection for Machine Learning Classification: An Application of the MELCHIOR Multicriteria Method. Frontiers in Artificial Intelligence and Applications. 341, 154–161 (2021). https://doi.org/10.3233/FAIA210243
32. Costa, I.P. de A., Costa, A.P. de A., Sanseverino, A.M., Gomes, C.F.S., Santos, M. dos: BIBLIOMETRIC STUDIES ON MULTI-CRITERIA DECISION ANALYSIS (MCDA) METHODS APPLIED IN MILITARY PROBLEMS. Pesquisa Operacional. 42, (2022). https://doi.org/10.1590/0101-7438.2022.042.00249414

33. Gomes, C.F.S., Gomes, L.F.A.M., Maranhão, F.J.C.: Decision analysis for the exploration of gas reserves: merging todim and thor. Pesquisa Operacional. 30, 601–617 (2010). https://doi.org/10.1590/S0101-74382010000300006
34. Tenório, F.M., dos Santos, M., Gomes, C.F.S., Araujo, J. de C.: Navy Warship Selection and Multicriteria Analysis: The THOR Method Supporting Decision Making. In: Springer Proceedings in Mathematics & Statistics, vol 337. pp. 27–39. Springer, Cham (2020)
35. Tenorio, F.M., Santos, M. Dos, Gomes, C.F.S., Araujo, J.D.C., De Almeida, G.P.: THOR 2 Method: An Efficient Instrument in Situations Where There Is Uncertainty or Lack of Data. IEEE Access. 9, 161794–161805 (2021). https://doi.org/10.1109/ACCESS.2021.3132864