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An extension of fuzzy TOPSIS for personnel selection

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***Abstract*—Considering the fact that contemporary business settings call for work in groups, team selection and formation is a crucial parameter for the smooth function and therefore the achievement of the specific team and business objectives. The problem of team selection members is particularly complex due to the variety of factors and criteria that need to be taken into consideration. Thus, highlighting the complexity in selecting team members, this paper proposes a multi criteria approach to deal with group decision making under fuzzy environment. A Multi Criteria Decision Making Approach (the fuzzy TOPSIS) for group decision making is considered, incorporating a new measurement, which reflects the minimum requirements of the decision makers for each criterion. In this respect, a new reference point is introduced, apart from the Positive Ideal Solution and the Negative Ideal Solution. Finally, an illustrative example of the proposed approach is presented for the selection of a middle level consulting manager.**

***Keywords*—multi criteria decision making, veto threshold, fuzzy TOPSIS, personnel selection**

I. INTRODUCTION

The current conditions of intent global competition and the rapid changes in the business scene have led modern firms to restructure and reengineer their processes. Strict structures with many hierarchical levels are now considered unsuitable practices. Instead, loose and flexible structures, less managerial levels and decentralized decision making result in better information flow and improved overall management. Under this new managerial approach, organizations have and are continuing to restructure work around teams rather than individual jobs [1]. The use of teams has expanded dramatically in response to competitive challenges and organizational needs of flexibility and adaptation [2].

A great volume of academic research has focused on the issues of team productivity and team efficiency and their relationship to and effect on firm performance. Furthermore, a number of parameters and criteria have been studied that seem to affect team productivity and team performance. Some of the most important are team characteristics [3], team diversity [4], the importance of clear goals [5], and team composition [6, 7]. The latter factor, team composition, has been studied extensively [8,9,10,11,12,13,14], emphasizing on issues such as the validity of selection methods used and the characteristics that are taken into account in the selection process.

Team member selection depends on the firm's specific targets, the availability of means and the individual preferences. Highlighting the complexity of this problem, it should be considered in its multi dimensions. Apart from organizational psychology field, operational research can provide an insight [15]. Multi Criteria Decision Making (MCDM) methods and fuzzy logic ideally cope with the problem, given that they consider many criteria at the same time, with various weights, having the potential to reflect at a very satisfactory degree the vague – most of the times – preferences of the decision makers (DMs).

The rest of the paper is organized as follows: Section II presents the proposed approach to support the decision making, initially providing a short review of the use of TOPSIS and then describing the steps of the algorithm. Section III briefly presents an illustrative example of the proposed approach and finally, limitations and future steps and research challenges are discussed.

II. PROPOSED APPROACH

In this paper, a new technique, based on fuzzy TOPSIS is considered, incorporating the veto threshold as the ultimate reference point for the decision.

TOPSIS [16] has been used in a number of personnel selection problems [17,18,19]. In these, group decision making and fuzzy environment are the key features of the framework under which the decision is supported. Other applications of the method lie among the several aspects of classical business, such as marketing, supply chain, manufacturing as well as the high-tech contemporary problems. Some indicative recent studies are the following: In manufacturing sector, Wang et al. [20] and Chen et al. [21] dealt with the supplier selection problem. The latter proposed a simplified parameterized metric distance to calculate the distance between each point and fuzzy Positive Ideal Solution (PIS) and fuzzy Negative Ideal Solution (NIS). Perçin [22] presented the employment of a new hierarchical fuzzy TOPSIS approach to evaluate the most suitable business process outsourcing (BPO) decision and Bottani and Rizzi [23] presented a TOPSIS-based approach for the selection and ranking of the most suitable 3PL service provider, while Shyjith et al. [24] focused on the use of AHP and TOPSIS to select an optimum maintenance strategy for a textile industry. Since high technology has entered the

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manufacturing industry, specialized industrial robotic systems selection were examined in [25], incorporating technical and economical factors in their evaluation through TOPSIS method. In the same line, Kahraman et al. [26] developed a multi-attribute decision making model for evaluating and selecting among logistic information technologies using hierarchical TOPSIS.

In general, TOPSIS method is intuitive, easy to understand and to implement. All these issues are of fundamental importance for a direct field implementation of the methodology by practitioners. Moreover, it allows the straight linguistic definition of weights and ratings under each criterion, without the need of cumbersome pairwise comparisons and the risk of inconsistencies [23]. Also, according to Zanakis et al. [27], the performance is slightly affected by the number of alternatives and rank discrepancies are amplified to a lesser extent for increasing values of the number of alternatives and the number of criteria.

Here, in order to incorporate the specific preferences of the DMs, we integrate the fuzzy TOPSIS using the veto concept. The proposed method differentiates from fuzzy TOPSIS in the reference point used to rank the alternatives. The steps of fuzzy TOPSIS as well as of the proposed method can be described as follows:

1) Formation of the decision making group

Personnel selection is a critical task for an organization, in particular when it is a part of a broader process at corporate level (e.g., strategic change). In this process, more rational decisions are made by a group of people rather than by a single person. Usually, experts from different organizational departments along with high level managers form the group of the DMs.

2) Definition of a finite set of relevant criteria

Criteria should be defined that cover the requirements of the DMs and relate to the specific job description. The process should take into consideration the market, in which the firm operates, the type and the hierarchical level of the position to be covered. Moreover, criteria associated to the required employee profile (e.g., personality traits and the so-called social skills) should be embedded in the model. Thus, apart from a number of generic criteria, specific ones should be considered case by case. For example, different criteria should be considered for salesmen, high level managers, developers or senior accountants.

3) Choice of appropriate linguistic variables and respective scales for the importance of the criteria and the ratings of the alternatives

A linguistic variable is a variable whose values are linguistic terms, i.e. words or sentences [28]. For example, management skill is a linguistic variable when its linguistic values are poor, fair, good. Each linguistic value can be represented by a fuzzy number which can be assigned to a membership function. In our approach, we consider triangular fuzzy numbers to be associated to the linguistic variables. Based on previous studies, scales of seven points for the importance of the criteria and the ratings of the alternatives are suggested.

4) Selection of criteria importance for each DM

Each DM should assign the importance of each criterion, according to the requirements and the expectations from the position to be filled. It is not uncommon that two DMs have conflicting views on the importance of a criterion. A great volume of research has focused on weighting methods; however this is beyond the scopes of this work.

5) Determination of the veto threshold for each DM

In order to simulate the reality and the behavior of the DMs, veto threshold should be defined by every DM.

In outranking methods, veto threshold indicates situations when the difference between two alternatives with respect to one specified criterion negates any possible outranking relationship indicated by other criteria. This means that when an alternative is significantly bad on one criterion compared to another alternative, it can not outrank the latter, regardless its performance on the other criteria.

We "borrow" this concept, allowing each DM to assign a veto to each criterion. In this respect, veto expresses the power of every DM to negate the selection of an alternative as a solution, when this alternative performs worse than the veto set on the respective criterion.

Since we may face situations when all alternatives perform below a veto, we propose that the preferred alternative is the one with the higher distance from the vetos of all criteria.

6) Establishment of the fuzzy decision matrix

The fuzzy decision matrix is presented as follows

$$\widetilde{D} = \begin{bmatrix} \widetilde{x}_{11} & \widetilde{x}_{12} & \cdots & \widetilde{x}_{1n} \\ \widetilde{x}_{21} & \widetilde{x}_{22} & \cdots & \widetilde{x}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \widetilde{x}_{m1} & \widetilde{x}_{m2} & \cdots & \widetilde{x}_{mn} \end{bmatrix}_{m\times n} \quad (1)$$

$$\widetilde{W} = [\widetilde{w}_1, \widetilde{w}_2, \ldots, \widetilde{w}_m]_{m\times 1} \quad (2)$$

$$\widetilde{T} = [\widetilde{t}_1, \widetilde{t}_2, \ldots, \widetilde{t}_m]_{m\times 1} \quad (3)$$

$$\widetilde{x}_{ij} = \frac{1}{K}[\widetilde{x}_{ij}^1 (+) \widetilde{x}_{ij}^2 (+) \ldots (+) \widetilde{x}_{ij}^K] \quad (4)$$

$$\widetilde{w}_i = \frac{1}{K}[\widetilde{w}_i^1 (+) \widetilde{w}_i^2 (+) \ldots (+) \widetilde{w}_i^K] \quad (5)$$

$$\widetilde{t}_i = \frac{1}{K}[\widetilde{t}_i^{\,1} (+) \widetilde{t}_i^{\,2} (+) \ldots (+) \widetilde{t}_i^{\,K}] \quad (6)$$

$i = 1,2,\ldots,m$, $j = 1,2,\ldots,n$

where $\widetilde{x}_{ij}^K$ is the rating of the K th DM to the j th alternative on the i th criterion, $\widetilde{w}_i^K$ the importance assigned by the K th DM to the i th criterion and $\widetilde{t}_i^{\,K}$ the veto threshold defined by the K th DM to the i th criterion.

K is the number of DMs, n is the number of alternatives, m is the number of criteria, $\widetilde{W}$ is the matrix of the importances of the criteria and $\widetilde{T}$ is the matrix of the veto thresholds. We consider that every DM's opinion has the same weight as of the others'.

7) Construction of the normalized fuzzy matrix

Applying the appropriate operator to each element of the fuzzy decision matrix, we obtain the normalized fuzzy matrix. In this respect, every triangular fuzzy number lies between zero and one. The matrix can be expresses as

$$\widetilde{R} = \left[\widetilde{r}_{ij}\right]_{m\times n} \quad (7)$$

$$\widetilde{T}^{R} = \left[\widetilde{t}_i^{\,R}\right]_{m\times 1} \quad (8)$$

$$\widetilde{r}_{ij} = \left(\frac{x_{ij}^{l}}{c_i^{*}}, \frac{x_{ij}^{m}}{c_i^{*}}, \frac{x_{ij}^{u}}{c_i^{*}}\right) \quad (9)$$

$$\widetilde{t}_i^{\,R} = \left(\frac{t_i^{l}}{c_i^{*}}, \frac{t_i^{m}}{c_i^{*}}, \frac{t_i^{u}}{c_i^{*}}\right) \quad (10)$$

if $i \in B$, with $\widetilde{x}_{ij} = (x_{ij}^{l}, x_{ij}^{m}, x_{ij}^{u})$, $\widetilde{t}_i = (t_i^{l}, t_i^{m}, t_i^{u})$ and

$$c_i^{*} = \max(\max_j x_{ij}^{u}, t_i^{u}) \quad (11)$$

where B is the set of benefit criteria and

$$\widetilde{r}_{ij} = \left(\frac{a_i^{-}}{x_{ij}^{u}}, \frac{a_i^{-}}{x_{ij}^{m}}, \frac{a_i^{-}}{x_{ij}^{l}}\right) \quad (12)$$

$$\widetilde{t}_i^{\,R} = \left(\frac{a_i^{-}}{t_i^{u}}, \frac{a_i^{-}}{t_i^{m}}, \frac{a_i^{-}}{t_i^{l}}\right) \quad (13)$$

if $i \in C$, and

$$a_i^{-} = \min(\min_j x_{ij}^{l}, t_i^{l}) \quad (14)$$

where C is the set of cost criteria, following the linear normalization method [29].

8) Construction of the weighted normalized fuzzy matrix

In this step, we incorporate the importance of each criterion, taking the matrix

$$\widetilde{V} = \left[\widetilde{v}_{ij}\right]_{m\times n} \quad (15)$$

$$\widetilde{T}^{V} = \left[\widetilde{t}_i^{\,V}\right]_{m\times 1} \quad (16)$$

where

$$\widetilde{v}_{ij} = \widetilde{r}_{ij}(\cdot)\widetilde{w}_i \quad (17)$$

and

$$\widetilde{t}_i^{\,V} = \widetilde{t}_i^{\,R}(\cdot)\widetilde{w}_i \quad (18)$$

At this point, fuzzy TOPSIS incorporates the fuzzy PIS and fuzzy NIS while our approach suggests the veto threshold concept. The steps are as follows:

9) Determination of the fuzzy positive ideal and fuzzy negative ideal solutions

The fuzzy PIS $(FPIS, A^{*})$ can be determined as $A^{*} = \left(\widetilde{y}_1^{*}, \widetilde{y}_2^{*}, \ldots, \widetilde{y}_m^{*}\right)$ and the fuzzy NIS $(FPIS, A^{-})$ as $A^{-} = \left(\widetilde{y}_1^{-}, \widetilde{y}_2^{-}, \ldots, \widetilde{y}_m^{-}\right)$ where

$$A^{*} = \left\{\left(\max \widetilde{v}_{ij} \mid i \in J\right), \left(\min \widetilde{v}_{ij} \mid i \in J^{'}\right), j = 1,2,\ldots n\right\} \quad (19)$$

and

$$A^{-} = \left\{\left(\min \widetilde{v}_{ij} \mid i \in J\right), \left(\max \widetilde{v}_{ij} \mid i \in J^{'}\right), j = 1,2,\ldots n\right\} \quad (20)$$

where $J = \{i = 1,2,\ldots m \mid i \in B\}$, $J^{'} = \{i = 1,2,\ldots m \mid i \in C\}$.

10) Calculation of the distance of each alternative from fuzzy PIS and fuzzy NIS

The distance of each alternative from A^{*} and A^{-} can be calculated as

$$d_j^{*} = \sum_{i=1}^{m} d\left(\widetilde{v}_{ij}, \widetilde{y}_i^{*}\right) \quad j = 1,2,\ldots,n \quad (21)$$

$$d_j^{-} = \sum_{i=1}^{m} d\left(\widetilde{v}_{ij}, \widetilde{y}_i^{-}\right) \quad j = 1,2,\ldots,n \quad (22)$$

respectively, according to the vertex method, which implies that the distance between two fuzzy numbers, $A = (a_1, a_2, a_3)$ and $B = (b_1, b_2, b_3)$ is

$$d(A,B) = \sqrt{[(a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2]} \quad (23)$$

A comprehensive summary of distance measures (functions) for TOPSIS can be found in [29].

11) Calculation of the closeness coefficient for each alternative

This is the last step of the TOPSIS method, based on which the ranking order of the alternatives can be determined. The closeness coefficient is calculated as

$$CC_j = \frac{d_j^{-}}{d_j^{*} + d_j^{-}}, \quad j = 1,2,\ldots,n \quad (24)$$

The CC of the positive ideal solution is unity while the negative ideal solution's CC is zero. So, better solutions are the ones of which CC approaches to 1.

12) Calculation of the distance of each alternative from the veto threshold defined for each criterion

In order to calculate the distance of each alternative from the veto threshold defined for each criterion, avoiding also situations of incomparability, we have to compute a scalar from the fuzzy numbers (defuzzification process). We propose the centroid method [30], where each fuzzy number $A = (a_1, a_2, a_3)$ can be expressed as

$$\bar{x}(A)=\frac{\int_{a_1}^{a_2} x\mu^L(x)dx+\int_{a_2}^{a_3} x\mu^R(x)dx}{\int_{a_1}^{a_2} \mu^L(x)dx+\int_{a_2}^{a_3} \mu^R(x)dx} \quad (25)$$

$$\mu(x)=\begin{cases}0, x<a_1\\ \mu^L(x), a_1\le x<a_2\\ \mu^R(x), a_2\le x\le a_3\\ 0, x>a_3\end{cases} \quad (26)$$

$\mu(x)$ being the membership function of the fuzzy number.

The distance of each alternative from the veto is

$$d_j^V=\sum_{i=1}^{m} d(\tilde{v}_{ij},\tilde{t}_i^V),\ j=1,2,\dots,n \quad (27)$$

where $$d(\tilde{v}_{ij},\tilde{t}_i^V)=\bar{x}(\tilde{v}_{ij})-\bar{x}(\tilde{t}_i^V) \quad (28)$$

The preferred alternative is the one with the higher distance from the vetos of all criteria.

13) Rank the alternatives

The one with the maximum value of CC or d_j^V is the best alternative, according to the two different approaches.

III. Illustrative Example

Suppose that a management consulting firm wants to select one from its middle level managers to join a reengineering project team. We assume that after the preliminary selection phase, three candidates (A1, A2, A3) are qualified for the final evaluation. A committee of evaluators is formed, consisting of three persons, a senior manager of the beneficiary company (D1), the Team Leader of the team (D2) and a senior expert in the field of reengineering (D3). The committee members conclude in a set of four benefit criteria, based on technical and social factors. These are technical experience (C1), personality traits (C2), educational background (C3) and interpersonal skills (C4).

According to the methodology described in section II, scales of seven points for the importance of the criteria and the ratings of the alternatives are considered, expressed in triangular fuzzy numbers, as shown in table I.

TABLE I. Linguistic Values and Respective Fuzzy Numbers

Linguistic Values		Fuzzy numbers	
Very Low (VL)	Very Poor (VP)	(0, 0, 1)	(0, 0, 0.1)
Low (L)	Poor (P)	(0, 1, 3)	(0, 0.1, 0.3)
Medium Low (ML)	Medium Poor (MP)	(1, 3, 5)	(0.1, 0.3, 0.5)
Medium (M)	Poor (P)	(3, 5, 7)	(0.3, 0.5, 0.7)
Medium High (MH)	Medium Good (MG)	(5, 7, 9)	(0.5, 0.7, 0.9)
High (H)	Good (G)	(7, 9, 10)	(0.7, 0.9, 1.0)
Very high (VH)	Very Good (VG)	(9, 10, 10)	(0.9, 1.0, 1.0)

Each DM defines the importance for each criterion and the respective veto thresholds, according to his preferences and priorities. Table II depicts the preferences, expressed in linguistic variables.

TABLE II. Importance and veto thresholds of the criteria

	Importances			Veto thresholds		
	D1	D2	D3	D1	D2	D3
C1	H	VH	MH	G	G	MG
C2	VH	VH	VH	MG	MG	MG
C3	VH	MH	M	MG	MG	F
C4	VH	VH	VH	G	MG	MG

The next step is the evaluation of the alternatives by the DMs in each criterion. Table III depicts the DMs' ratings.

TABLE III. Ratings of the Alternatives

criteria	candidates	decision makers		
		D1	D2	D3
C1	A1	MG	G	MG
	A2	G	G	MG
	A3	VG	VG	MG
C2	A1	G	MG	F
	A2	G	G	G
	A3	MG	G	VG
C3	A1	F	G	G
	A2	G	G	G
	A3	G	MG	VG
C4	A1	VG	G	VG
	A2	G	G	G
	A3	G	VG	MG

The fuzzy decision matrix $\tilde{D}$ is constructed from the ratings of DMs, in table IV, followed by matrices $\tilde{W}$ and $\tilde{T}$.

TABLE IV. Fuzzy Decision Matrix $\tilde{D}$

	A1	A2	A3
C1	(5.67, 7.67, 9.33)	(6.33, 8.33, 9.67)	(7.67, 9.00, 9.67)
C2	(5.00, 7.00, 8.67)	(7.00, 9.00, 10.00)	(7.00, 8.67, 9.67)
C3	(5.67, 7.67, 9.00)	(7.00, 9.00, 10.00)	(7.00, 8.67, 9.67)
C4	(8.33, 9.67, 10.00)	(7.00, 9.00, 10.00)	(7.00, 8.67, 9.67)

TABLE V. $\tilde{W}$ and $\tilde{T}$ Matrices

	importance	vetos
C1	(0.70, 0.87, 0.97)	(6.33, 8.33, 9.67)
C2	(0.90, 1.00, 1.00)	(5.00, 7.00, 9.00)
C3	(0.57, 0.73, 0.87)	(4.33, 6.33, 8.33)
C4	(0.90, 1.00, 1.00)	(5.67, 7.67, 9.33)

The normalized and weighted normalized fuzzy decision matrices are shown in tables VI, VII, VIII and IX, respectively. 7.

TABLE VI. $\widetilde{R}$ MATRIX

	A1	A2	A3
C1	(0.59, 0.79, 0.97)	(0.66. 0.86, 1.00)	(0.79. 0.93, 1.00)
C2	(0.50, 0.70, 0.87)	(0.70, 0.90, 1.00)	(0.70, 0.87, 0.97)
C3	(0.57, 0.77, 0.90)	(0.70, 0.90, 1.00)	(0.70, 0.87, 0.97)
C4	(0.83, 0.97, 1.00)	(0.70, 0.90, 1.00)	(0.70, 0.87, 0.97)

TABLE VII. $\widetilde{T}^R$ MATRIX

	vetos
C1	(0.66, 0.86, 1.00)
C2	(0.50, 0.70, 0.90)
C3	(0.43, 0.63, 0.83)
C4	(0.57, 0.77, 0.93)

TABLE VIII. $\widetilde{V}$ MATRIX

	A1	A2	A3
C1	(0.41, 0.69, 0.93)	(0.46, 0.75, 0.97)	(0.56, 0.81, 0.97)
C2	(0.45, 0.7, 0.87)	(0.63, 0.90, 1.00)	(0.63, 0.87, 0.97)
C3	(0.32, 0.56, 0.78)	(0.40,0.66, 0.87)	(0.40, 0.64, 0.84)
C4	(0.75, 0.97, 1.00)	(0.63, 0.9, 1.00)	(0.63, 0.87, 0.97)

TABLE IX. $\widetilde{T}^V$ MATRIX

	vetos
C1	(0.46, 0.75, 0.97)
C2	(0.45, 0.70, 0.90)
C3	(0.25, 0.46, 0.72)
C4	(0.51, 0.77, 0.93)

The distances from the fuzzy positive ideal and fuzzy negative ideal solutions, d_j^* d_j^-, are shown in table X and the closeness coefficients, the ultimate criterion for the ranking of the alternatives is shown in table XI. The third alternative, A3, qualifies as the best solution, according to fuzzy TOPSIS method.

TABLE X. DISTANCES FROM FPIS AND FNIS

	A1-A*	A2-A*	A3-A*	A1-A-	A2-A-	A3-A-
C1	0.191	0.114	0.000	0.000	0.084	0.191
C2	0.300	0.000	0.047	0.000	0.300	0.265
C3	0.151	0.000	0.038	0.000	0.151	0.120
C4	0.000	0.137	0.160	0.160	0.047	0.000
Total	0.642	0.251	0.245	0.160	0.582	0.576

TABLE XI. CLOSENESS COEFFICIENTS (CC_j)

CC1	0.199
CC2	0.699
CC3	0.702

Alternatively, calculating the centroid of $\widetilde{v}_{ij}$ and $\widetilde{t}_i^V$, $\bar{x}(\widetilde{v}_{ij})$ and $\bar{x}(\widetilde{t}_i^V)$, and the respective distances of the crisp values from the veto thresholds, $d(\widetilde{v}_{ij}, \widetilde{t}_i^V)$, we result in the total distance of each alternative from the veto thresholds, d_j^V. Following this approach, the alternative A2 is the best, as shown in table XII.

TABLE XII. CRISP VALUES AND DISTANCES FROM THE VETO TRESHOLDS

	A1	A2	A3	vetos	A1	A2	A3
C1	0.677	0.724	0.776	0.724	-0.047	0.000	0.052
C2	0.672	0.843	0.821	0.683	-0.011	0.160	0.138
C3	0.554	0.641	0.623	0.477	0.077	0.164	0.146
C4	0.906	0.843	0.821	0.737	0.169	0.107	0.084
Total					0.188	0.430	0.420

IV. DISCUSSION

The aim of this paper was to support adequately the decision on project team member selection. Contemporary business settings call for work in groups rather than individually. Team composition is a critical factor for the smooth function, the productivity and effectiveness of the team and therefore for the achievement of the specific team goals. An integrated approach to this problem demands the engagement of an experts' team so that the process take into account the perspective of every involved actor. Moreover, a specificity of this problem consists in dealing with imprecise data, difficulties in retrieving information and expressing an explicit opinion. Fuzzy logic is considered ideal to deal with this type of problems. Finally, every decision problem is closely associated to the DMs. Every DM has specific preferences and demands prerequisites in relation to the profile of the ideal solution. All above mentioned characteristics were taken into consideration in our approach. Thus, fuzzy TOPSIS for group decision making was used and in parallel a new measurement was introduced. This is the veto threshold that reflects the minimum requirements of the DMs from each alternative in each criterion.

Supporting the decision, a combination of TOPSIS with the new measurement is proposed. Depending on the flexibility of the DMs against the imposed vetos, the closeness coefficient or the distance from the vetos can be considered as the final criterion for the decision. However, it is worth mentioning that as concerns cases in which an alternative explicitly outperforms against the others, these two measurements give the same result. The proposed approach can better apply to situations, like the one in the example, in which small differences in the scores of the alternatives occur.

As a future step to this paper could be the potential of a new coefficient, incorporating the veto as a third reference point, apart from the PIS and the NIS. Also, the application of a more strict veto could be studied, eliminating the alternatives that score below the veto (or below the veto at a certain extent) and then applying the TOPSIS closeness coefficient to the rest of them. Finally, in many situations, the DMs do not have equal importance to the final decision. So, equations (4), (5) and (6) must be further elaborated in order to incorporate the relative importance of every DM to the aggregation process.

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