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REFERENCE POINTS-BASED METHODS IN SUPPORTING THE EVALUATION OF NEGOTIATION OFFERS

Scoring the negotiation template and building a scoring system for negotiation offers is a starting point for analysis of negotiation. It is usually done by means of a classical additive scoring model. Recent research confirms, however, that TOPSIS may be a good alternative to SAW-based models, since it significantly facilitates the processes of template definition and elicitation of negotiator's preferences. Fundamental ideas of the TOPSIS, VIKOR and BIPOLAR methods have been analysed and attempts were made to hybridize some of their notions to propose an alternative method for evaluating negotiation offers.

Keywords: *negotiation analysis, preference analysis, evaluation of negotiation template, reference points, TOPSIS, VIKOR, BIPOLAR*

1. Introduction

Multiple criteria decision making methods (MCDM) are often used to support integrative negotiations [17, 18]. They are applied to structuring a negotiation problem, building the negotiation template, eliciting negotiators' preferences and determining their individual scoring systems for negotiation offers. The standard multiple criteria decision support tool most commonly used for negotiation analysis is additive scoring

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model (ASM) [7], known also as SAW (Simple Additive Weighting). It is based on a simple notion of aggregating single-criterion preferences into global preferences described by the multiple attribute value function. Due to its simplicity, it is commonly applied in negotiation support systems and electronic negotiation systems [8, 10, 22].

However, SAW may only be applied to support negotiation problems of a simple structure. It requires a discrete definition of a negotiation problem, but in a real world such negotiations rarely happen. Some negotiation issues are quantitative and have a continuous character. Also, very often, negotiators are not able to identify all the salient options [8] required by SAW. Moreover, negotiators very often misuse and misinterpret scoring systems built by means of SAW which was confirmed by the results of negotiation experiments conducted within the GRIN project [29, 15]. Therefore, it seems vital to develop some alternative approaches and methods for negotiation support that could be used for structuring negotiation problems and constructing scoring systems for negotiation offers.

In this paper, we analyze how the three MCDM methods that are based on reference points may be hybridized to build a tool that helps negotiators in the elicitation of preferences and evaluation of negotiation offers. We focus on: TOPSIS (*Technique for Order Preferences by Similarity to Ideal Solution*) [5], VIKOR (Serb. *Vlse Kriterijumska Optimizacija i Kompromisno Resenje*) [13] and BIPOLAR [9]. In some previous papers, we explored TOPSIS and found it applicable to negotiation support [19]. However, some drawbacks and limitations were pointed out. Here we show how the key notions of VIKOR and BIPOLAR may increase the flexibility and functionality of a TOPSIS-based tool applied to scoring the negotiation template. The final contribution of this paper is defining a formal, theoretical approach to decision support in negotiations, which – as opposed to SAW-based approaches, allows us to build a scoring system for negotiation offers that only requires definition of the reference points, and does not need the complete specification of the negotiation template.

The paper consists of 5 more Sections. In Section 2, we formulate the negotiation problem as such and describe it formally. In Section 3, we present the modified TOPSIS approach, in Section 4, the VIKOR approach and in Section 5, fundamental elements of BIPOLAR that may be applied to hybridize the TOPSIS and VIKOR algorithms. In Section 6, we present a numerical example of using three different scoring approaches that hybridize TOPSIS, VIKOR and BIPOLAR to score a negotiation template and build scoring systems for negotiation offers.

2. Negotiation problems – a formal model

To support negotiators in their pre-negotiation tasks such as defining the negotiation space, eliciting negotiators' preferences and evaluating alternatives to a negotia-

tion agreement [30, 25], the negotiations should be appropriately structured and formalized. To do so, some key important elements of negotiations need to be identified first [8, 19]:

- negotiation issue – a criterion used by a negotiator to evaluate a negotiation compromise,
- option – a resolution level of a negotiation issue,
- package (complete package) – a negotiation offer that specifies the options for all negotiation issues.

Based on the negotiation theory, we assume that within pre-negotiation talks the negotiators define an initial set of feasible packages [30], denoted by **P**. A negotiator faces the problem of evaluating m packages from the set **P** denoted by $P_1, P_2, ..., P_m$. Unfortunately, the evaluation of these packages is not easy, since they are described by the set of negotiation issues $Z = \{Z_1, Z_2, ..., Z_n\}(t_{j+1})$. The set Z consists of two subsets: $Z = I \cup J$. The subset I consists of all the issues the negotiator considers in terms of benefits, i.e. the negotiator prefers higher resolution levels to lower ones (if qualitative issues are considered, we assume the order of the options may be determined according to increasing preferences). The set J is the subset of the issues that negotiator considers in terms of costs, i.e. lower resolution levels are preferred to higher ones.

Any package P_i may be represented by the vector

$$P_i = [x_{i1}, x_{i2}, ..., x_{in}] \tag{1}$$

where x_{ij} is the numerical representation of the option of the j-th issue in the i-th package.

Options may be represented by deterministic values, as well as fuzzy numbers, linguistic variables or verbal descriptors. If qualitative descriptions of options are given, we assume that they are transformed into numerical equivalents before the evaluation procedure.

Negotiators should also define the boundaries of the negotiation space by specifying BATNA* and aspiration levels. Assuming that both these elements are represented by complete packages, we obtain two extreme reference points that we will use in our further analysis. Thus we identify the ideal package $(P_I = [x_{I1}, x_{I2}, ..., x_{In}])$ and the anti-ideal one $(P_{AI} = [x_{AI1}, x_{AI2}, ..., x_{AIn}])$. If the negotiator finds it difficult to identify P_I and P_{AI}, then we may construct them using the information provided by P and Z.

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*BATNA (*Best Alternative to Negotiated Agreement*) is very often called the reservation level. It is used to determine the worst packages that negotiators would accept during the negotiation process. Offers, which are worse than BATNA are rejected, since a negotiator would choose BATNA instead.

Definition 1. The ideal options in P_I are determined as follows:

$$x_{Ij} = \begin{cases} \max\limits_{i=1,\ldots,m} \{x_{ij}\}, & \text{if } j \in I \\ \min\limits_{i=1,\ldots,m} \{x_{ij}\}, & \text{if } j \in J \end{cases} \qquad (2)$$

Definition 2. The anti-ideal options in P_{AI} are determined as follows:

$$x_{AIj} = \begin{cases} \min\limits_{i=1,\ldots,m} \{x_{ij}\}, & \text{if } j \in I \\ \max\limits_{i=1,\ldots,m} \{x_{ij}\}, & \text{if } j \in J \end{cases} \qquad (3)$$

Let $w = [w_1, w_2, \ldots, w_n]$ be a vector of weights that reflect the importance of each negotiation issue j, $j = 1, 2, \ldots, n$ defined by the negotiator. This vector may be defined directly by assigning scores to the issues or some supportive mechanisms may be applied, such as AHP [21] or a swinging weights procedure [3].

Finally, let $\mathbf{S}$ be a set of scores (ratings) determined for the packages from $\mathbf{P}$, i.e. $\mathbf{S} = \{S_i, i = 1, \ldots, m\}$. The differences between the packages' ratings, denoted by $\Delta S_{i/k} = S_i - S_k$, can be interpreted as cardinal measures of concessions made by a negotiator when moving from package P_i to P_k. The way of constructing the set $\mathbf{B}$ depends on the MCDM method applied, usually a simple additive method is used [8, 22]. However, there are some research papers illustrating the application of AHP [11, 26].

The negotiation problem, defined as the decision problem of the negotiator, may be thus defined as the following eight-tuple:

$$(Z, \mathbf{P}, I, J, w, P_I, P_{AI}, \mathbf{S}) \qquad (4)$$

The following elements: Z, I, J, $\mathbf{P}$, are used to define the negotiation template, while w, P_I, P_{AI} and $\mathbf{S}$ are the elements of the scoring system that we obtain having conducted an evaluation of the negotiation template.

When a classical negotiation support approach is applied, such as SAW- or AHP-based ones, the complete definition of the problem as stated in (4) is required. In other words, the negotiation problem is defined in the form of a discrete decision problem, with a predefined set of alternative negotiation offers (packages) for which a scoring system is obtained. Such a representation of the problem is very rigid (inflexible), since it does not take into consideration the possibility of building and scoring any other negotiation package that might consist of intermediate resolution levels

of the issues (between P_I and P_{AI}). In this paper, we will show that using an alternative supportive approach which combines the TOPSIS, VIKOR and BIPOLAR methods; allows the elimination of some restrictions related to the rigid definition of a negotiation problem (4) and reduction in the workload required for the negotiator to define some elements of (4).

3. Extension of the TOPSIS approach to the context of negotiations

TOPSIS was proposed by Hwang and Yoon [5] as a ranking method for discrete decision problems with a predefined decision matrix. Some introductory research has already been carried out by Roszkowska and Wachowicz [19], which confirms TOPSIS to be an effective tool for negotiation support. However, appropriate modifications need to be introduced into the original TOPSIS algorithm to make it applicable to various negotiation problems. As mentioned before, this modified TOPSIS algorithm does not require a complete definition of the set **P** (decision matrix) to build a scoring system for feasible negotiation offers. Consequently, it seems to be more suited to real-world negotiation problems, in which the parties are not usually able to predefine the full set of alternatives, since some negotiation issues are usually quantitative or represented by means of continuous variables. However, according to pre-negotiation theory [30, 23], we allow the negotiator to define the initial set of alternatives as a part of their negotiation strategy but this will not influence the scoring system that will be determined by means of a TOPSIS-based scoring approach.

In modified TOPSIS the set **S** is constructed solely on the basis of the reference points P_I and P_{AI}. This approach only requires the negotiator to define the negotiation space by means of BATNA and aspiration levels. These reference points are the basis for normalization of the issues' options of the package under evaluation required by the TOPSIS algorithm (step 1), while using standard TOPSIS for this normalization, the full decision matrix defined by **P** is used. Here the options are normalized in the following way [27, 19]:

$$\widehat{x}_{ij} = \frac{x_{ij} - x_{AIj}}{x_{Ij} - x_{AIj}} \tag{5}$$

where x_{Ij} (x_{AIj}) is the option for the *j*-th issue in package P_I (P_{AI}).

Then (step 2), for each package P_i, the distances between P_I and P_{AI} are determined (d_i^+ and d_i^-, respectively) using the following formulas:

$$d_i^+ = \sqrt[p]{\sum_{j=1}^{n}\left(w_j - w_j \widehat{x}_{ij}\right)^p} \tag{6}$$

$$d_i^- = \sqrt[p]{\sum_{j=1}^{n}\left(w_j \widehat{x}_{ij}\right)^p} \tag{7}$$

where p is the parameter of the distance measure. For $p = 2$, we obtain the Euclidean distance, the most commonly used in the classical TOPSIS algorithm.

Finally (step 3), the global score (evaluation), S_i, of each package P_i is determined, being the ratio of the distance of a package to P_{AI} to the sum of the distances to P_I and P_{AI}:

$$S_i = \frac{d_i^-}{d_i^+ + d_i^-} \tag{8}$$

where $S_i \in [0, 1]$.

The higher the value of S_i, the better the package is. When $S_i = 1$, the package P_i is equivalent to P_I. Similarly, when $S_i = 0$, the package P_i is the worst (anti-ideal) one.

The modified TOPSIS method of scoring described above is quite straightforward and easy to perform (from the computational point of view) but its applicability is limited to the negotiation space declared by means of the P_I and P_{AI} packages. To score offers outside the feasible space, further modifications are required [19].

4. VIKOR – setting an alternative evaluation criterion

VIKOR is another MCDM method based on the notion of reference points, that aims to choose the best alternative out of a predefined set [13]. It differs from TOPSIS, since it does not measure the distances to P_I and P_{AI}*. Instead, VIKOR determines two ranking measures:

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*Differences between TOPSIS and VIKOR have been described in detail by Opricovic and Tzeng [13].

$$S_i = \sum_{j=1}^{n} w_j \frac{\left| x_{Ij} - x_{ij} \right|}{\left| x_{Ij} - x_{AIj} \right|} \tag{9}$$

which reflects the average weighted distance between P_i and P_I, and

$$R_i = \max_j \left\{ \frac{\left| x_{Ij} - x_{ij} \right|}{\left| x_{Ij} - x_{AIj} \right|} \right\} \tag{10}$$

which reflects the maximum, single-criterion distance between P_i and P_I. These two measures are then used to calculate a global ranking measure Q_i, that takes into consideration the decision maker's (DM) evaluation strategy formulated by means of the tuning coefficient $q \in [0, 1]$.

Formally Q_i is determined as follows

$$Q_i = qS_i + (1-q)R_i \tag{11}$$

The higher the parameter q, the more important the multiple criteria distance measure S_i, and consequently the less important the single criteria deviations R_i.

The classical VIKOR algorithm determines the best alternative out of the set **P** by sorting the packages according to increasing Q_i values. Let P_1 and P_2 denote the first and the second package in the ranking. If the following condition holds

$$Q_1 - Q_2 > \frac{1}{m-1} \tag{12}$$

then the VIKOR algorithm recommends alternative P_1 as the best one (most preferred). If condition 12) is not satisfied, but P_1 is still first in another ranking built according to increasing S_i and/or R_i, it is still considered to be the best one.

Since VIKOR was developed for choosing the best alternative out of a set of predefined alternatives (*P*), it cannot be directly implemented to construct a scoring system for negotiation offers. What is interesting in the VIKOR algorithm, is that it applies an original global scoring formula Q_i. VIKOR is not based on the distance to iP_{AI}*, but on the single-criterion distance R_i instead. The aggregation of Q_i and R_i is

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*Taking into account the fact that VIKOR applies the Manhattan distance, the distance to PAI is equal to $1 - d_i^+$. Thus, there is no gain from using P_{AI}.

additive and weighted by the q coefficient. This makes the global scores more sensitive and specific to the subjective judgments of a DM and – in the context of negotiations – the global scoring system, being the strategic information of the focal negotiator, cannot be so easily discovered by their counterparts. Moreover, it allows some advanced post-negotiation analysis, which aims to find improvements in the negotiated agreement. Such an analysis cannot be so easily and unequivocally conducted when the standard TOPSIS aggregating criterion (Eq. 8)) is applied [28].

We should note that a similar linear aggregating criterion was also proposed by Chen et al. [1]. However, the authors propose a score based on the d_i^+ and d_i^- distances:

$$S_i^\alpha = \alpha d_i^- + (1-\alpha)(1-d_i^+) \tag{13}$$

where α is a parameter that describes how aggressive (or conservative) the DM's decision strategy is. The higher α, the more conservative the DM is (i.e. the more oriented to/afraid of the worst solution).

We will use the VIKOR aggregate criterion, as well as Chen's modification of the classic TOPSIS S_i criterion to construct a scoring system for negotiation offers and try to examine what are the consequences of different choices of q and α.

5. BIPOLAR – defining an alternative reference space

The BIPOLAR method [9] is a MCDM outranking method based on the notion of a synthesizing preference relational system [20]. It is used as a supportive tool for problems involving sorting and ranking, for which limited compensation between issues is assumed. In contrary to TOPSIS and VIKOR, it is not based on single reference alternatives (ideal and anti-ideal ones), but uses sets of reference alternatives: a set of good solutions ($G = \{G_1, G_2, ..., G_{Lg}\}$) and a set of bad ones ($B = \{B_1, B_2, ..., B_{Lb}\}$).

These two sets comprise the reference space $R \cup B$, where $R = \{R_1, R_2, ..., R_{Lg+Lb}\}$ and $R_r = (x_{R_r,1}, x_{R_r,2}, ..., x_{R_r,m})$. The BIPOLAR procedure is similar to other outranking methods and requires: determining the outranking relations for each P_i with respect to each reference alternative, testing concordance and discordance, identifying types of preference relations and conducting BIPOLAR-sorting and BIPOLAR-ranking analysis to find a final ordering of alternatives within the set **P**. As a result of BIPOLAR-ranking, we obtain a partial ordering of alternatives like the one shown in Fig. 1.
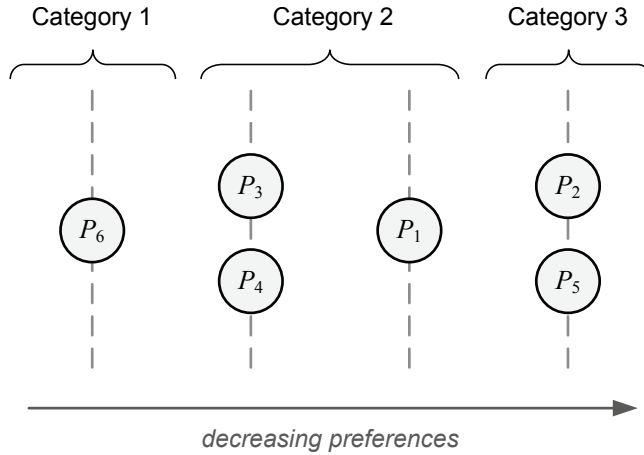
Fig. 1. An Example of BIPOLAR-sorting

As we see, BIPOLAR-sorting allows assigning the alternatives to the categories resulting from the reference space, and then ordering them within each of these categories (indifference may occur), but it gives no information about the strengths of preferences. From a negotiator's point of view, such information may be insufficient. They cannot effectively compare two different offers or find the scale of concession when moving from one to another, since there is no cardinal score assigned to any offer. Consequently, it is impossible to track the progress of negotiations or visualize concession paths that could inform negotiators whether there is a chance to achieve a satisfactory compromise or not [16].

However, the key concept of BIPOLAR may be applied to negotiation support provided by means of a modified TOPSIS algorithm. BIPOLAR may help negotiators to conduct a pre-negotiation analysis and make the process of eliciting preferences easier, since it is not as restrictive in defining the reference system as TOPSIS is. It may be the case that negotiators cannot precisely declare the ideal and anti-ideal solution, since these two alternatives may be too abstract for them (utopian points that could never be reached). BIPOLAR allows them to define sets of alternative offers (which a party is indifferent between) that would represent the ideal (most wanted) and anti-ideal (least wanted) solutions instead. It may be easier for negotiators to give a few examples of offers, since in such a case they may take into consideration possible tradeoffs between the issues.

The idea of reference sets cannot be applied directly to the formal model of negotiation as presented by Eq. (4), in which the set S is obtained by means of a modified TOPSIS algorithm. In step 2 of this algorithm, the distances are determined for each alternative P_i to the unique alternatives P_I and P_{AI} (Eqs. (6) and (7)). Similarly in VIKOR, the criteria S_i and R_i are determined on the basis of the unique ideal and

anti-ideal options. When introducing concepts from the BIPOLAR algorithm into the TOPSIS algorithm, we need to handle the problem of measuring the distance between a set (reference system) and a single alternative (an offer under consideration). The easiest way to solve this problem is to apply solutions proposed by statistical multi-variate analysis, in particular, methods for determining the intra-class distance [4, 2]. The most frequently proposed methods are: the single-link method, complete-link method and the group average link method, the basic idea of which are presented in Fig. 2.
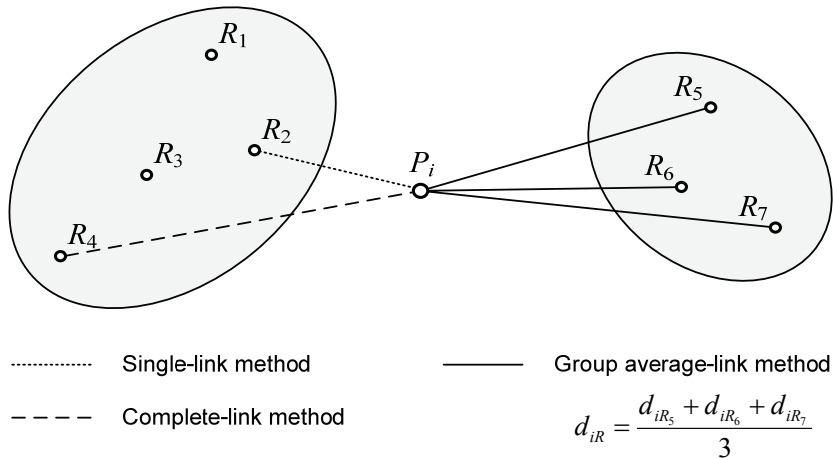

Fig. 2. Examples of intra-class distances

Let us denote by $d(a,b)$ the distance between two objects a and b. According to the notions of distance shown above, the new forms of TOPSIS distances are determined as follows:

Single-link method:

$$d_i^+ = \min_{s=1,\dots,Lg} \{d(P_i, G_s)\} \qquad (14)$$

$$d_i^- = \min_{s=1,\dots,Lb} \{d(P_i, B_s)\} \qquad (15)$$

Complete-link method:

$$d_i^+ = \max_{s=1,\dots,Lg} \{d(P_i, G_s)\} \qquad (16)$$

$$d_i^- = \max_{s=1,\dots,Lb} \{d(P_i, B_s)\} \qquad (17)$$

Group average-link method:

$$d_i^+ = \frac{\sum\limits_{s=1}^{Lg} d(P_i, G_s)}{Lg} \tag{18}$$

$$d_i^- = \frac{\sum\limits_{s=1}^{Lb} d(P_i, B_s)}{Lb} \tag{19}$$

For some reasons it may be desirable to implement another form of intra-class distance measure, namely the centroid method [21]. The major advantage of this method is that within the reference set it fixes a stable and exogenously independent reference point, the same for each alternative under consideration. The centroids are determined in the following way:

$$\tilde{P}_I = \left[\tilde{x}_{Ij} \right]_{\forall j=1, 2, \dots, n}, \qquad \text{where} \qquad \tilde{x}_{Ij} = \frac{1}{Lg} \sum\limits_{s=1}^{Lg} x_{Gsj} \tag{20}$$

$$\tilde{P}_{AI} = \left[\tilde{x}_{AIj} \right]_{\forall j=1, 2, \dots, n}, \qquad \text{where} \qquad \tilde{x}_{AIj} = \frac{1}{Lb} \sum\limits_{s=1}^{Lb} x_{Bsj} \tag{21}$$

6. Example

We will now demonstrate the process of building a scoring system for negotiation offers conducted by means of the methods presented in the previous sections. We will compare the scoring systems obtained using (S1) modified TOPSIS, (S2) modified TOPSIS using α as the weighting factor (α-TOPSIS) and (S3) VIKOR; a hybrid algorithm using the BIPOLAR notion of a reference space.

To make the results comparable, in TOPSIS we will use the distance measure required by the VIKOR algorithm, i.e. the Manhattan metric (L_1) Furthermore, for all the methods we will use the same issue weights. In the VIKOR procedure we will use the Q_i measure for determining the global ranking of the alternatives.

Let us consider business negotiations with the template defined by means of three negotiation issues (Z = {Price, Time of delivery, Time of payment}), where $Z_1, Z_2 \in I$

and $Z_3 \in J$. The negotiator declared the following vector of weights* $w = [0.5, 0.3, 0.2]$ and then defined six alternatives as part of their negotiation strategy (we will assume that they constitute the set **P**), that are listed in Table 1.

Table 1. Set of considered alternatives **P**

Alternative	Z_1	Z_2	Z_3
P_1	300	14	7
P_2	450	7	14
P_3	270	31	2
P_4	380	20	10
P_5	290	15	15
P_6	420	25	5

Let us assume further that the negotiator has declared the following reference sets, according to the requirements of the BIPOLAR algorithm:

- the set of ideal packages: $G = \{(470, 34, 0); (510, 31, 0); (520, 28, 0)\}$,
- the set of anti-ideal packages: $B = \{(220, 14, 18); (260, 7, 20); (270, 0, 25)\}$.

Thus we apply the centroid method to determine the new forms of the ideal and anti-ideal solutions according to Eqs. (20) and (21) and obtain:

$$\tilde{P}_I = \left[\frac{470 + 510 + 520}{3}, \frac{34 + 31 + 28}{3}, \frac{0 + 0 + 0}{3} \right] = [500, 31, 0]$$

$$\tilde{P}_{AI} = \left[\frac{220 + 260 + 270}{3}, \frac{14 + 7 + 0}{3}, \frac{18 + 20 + 25}{3} \right] = [250, 7, 21]$$

Having defined the basic elements of the negotiation problem given by Eq. (4), we may now determine the set of scores **S** using some alternative approaches based on TOPSIS and VIKOR. The form of the distance measure needs to be chosen to conduct the calculations of scores in TOPSIS. Note, the form of the distance function will heavily influence the final scoring system we obtain, so it is recommended to interact with the negotiator to adapt the distance function that describes their preferences in the best possible way [28]. For its simplicity, we will apply here the L_1 distance measure, which combined with the normalization Eq. (5) results in the following relation between the distances d_i^+ and d_i^- :

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*These weights might be assigned directly by means of support mechanisms such as AHP or the swinging weights method.

$$d_i^+ = 1 - d_i^- \tag{22}$$

Therefore, for each version of the TOPSIS algorithm presented, the global score S_i of the i-th package is equivalent to the multiple criteria distance between this package and P_{AI}

$$\forall_{i=1,\ldots,m} S_i = d_i^- \tag{23}$$

Unfortunately, using the L_1 distance measure, α-TOPSIS becomes insensitive to the strategy parameter. We obtain

$$\forall_{\alpha',\alpha'' \in [0,1], i=1,\ldots,m} S_i^{\alpha'} = S_i^{\alpha''} \tag{24}$$

and α-TOPSIS scoring is equivalent to modified TOPSIS scoring. The scoring systems obtained for S_1, S_2 and S_3 with $q = 1$ are shown in Table 2.

Table 2. The scores for predefined alternatives when L_1 is used

Alternative	Modified TOPSIS (S_i)	α-TOPSIS (S_i^α) for $\alpha \in [0, 1]$	VIKOR (Q_i) for $q = 1$
P_1	0.32	0.32	0.68
P_2	0.47	0.47	0.53
P_3	0.52	0.52	0.48
P_4	0.53	0.53	0.47
P_5	0.24	0.24	0.76
P_6	0.72	0.72	0.28

As noted above, the two rankings built by means of modified TOPSIS and α-TOPSIS are equivalent. Moreover, the VIKOR ranking is the same as the TOPSIS one (the scores have different interpretations: TOPSIS – the higher the score, the better, VIKOR – the lower the score, the better). In fact, the VIKOR ranking is equivalent to the TOPSIS ones, since it preserves the same strengths of preferences as the TOPSIS-based ones. Note that for $q = 1$ VIKOR operates solely with the multiple criteria distance to P_I, while TOPSIS operates with the distance to P_{AI}. Since we apply the Manhattan distance L_1, the VIKOR score of the i-th package is equal to 1 minus the TOPSIS score of this package. Interpreting these scores for package P_1, we say that its distance from P_{AI} is 0.32 (TOPSIS scoring), which means its proximity to P_I is 0.68 (VIKOR scoring).

The results will naturally differ if another distance measure is used. If we apply the Euclidean distance (L_2), the following results are obtained (Table 3).

Table 3. The scores for predefined alternatives when L_2 is used

Alternative	Modified TOPSIS (S_i)	α-TOPSIS (S_i^α)			VIKOR (Q_i) for $q = 1$
		$\alpha = 1$	$\alpha = 0.75$	$\alpha = 0.5$	
P_1	0.29	0.19	0.29	0.37	0.46
P_2	0.54	0.41	0.48	0.53	0.34
P_3	0.43	0.35	0.41	0.45	0.46
P_4	0.53	0.32	0.44	0.52	0.29
P_5	0.22	0.14	0.25	0.33	0.49
P_6	0.70	0.44	0.55	0.63	0.18

We should note, however, that VIKOR scoring will differ when the q coefficient changes, even when using the L_1 distance measure. Examples of different VIKOR scorings for different strategy parameters q are presented in Table 4.

Tabela 4. VIKOR scores and rankings for different q parameters and L_1 distance

Alternative	Strategy q									
	$q = 0$		$q = 0.25$		$q = 0.5$		$q = 0.75$		$q = 1$	
	Q_i	Ranking	Q_i	Ranking	Q_i	Ranking	Q_i	Ranking	Q_i	Ranking
P_1	0.80	3	0.77	3	0.74	4	0.71	5	0.68	5
P_2	1.00	6	0.88	6	0.77	5	0.65	4	0.53	4
P_3	0.92	5	0.81	4	0.70	3	0.59	3	0.48	3
P_4	0.48	2	0.48	2	0.48	2	0.47	2	0.47	2
P_5	0.84	4	0.82	5	0.80	6	0.78	6	0.76	6
P_6	0.32	1	0.31	1	0.30	1	0.29	1	0.28	1

It is easy to see that the successive changes of q (from 1 to 0) result in worsening the global scores (Q_i increases). Together with these changes, the ranking varies (e.g. see rankings for $q = 0.75$ and $q = 0.5$). Thus it seems crucial to find an appropriate value of the L_1, a coefficient that describes the negotiator's strategy in the most precise way at the pre-negotiation phase. Changes made at later stages of the negotiation process may make our raking unstable and discourage the negotiator from using the scoring system elicited, since they may perceive it as unreliable or false.

Of key importance are q values from the range [0, 0.5]. Any value taken from this range reflects a strategy in which the negotiator's attention is focused on a single criterion (the worst option according to this criterion), instead of focusing on the potential gains, based on the multiple criteria, produced by each package (an average weighted gain). This changes the perspective from which the whole negotiation problem is per-

ceived. The multiple criteria negotiation problem changes to a quasi-multiple criteria problem, and in extreme situations – to a single criterion one (when $q = 0$). However, we need to remember that the initial definition of the negotiation was multi-criterial, so the negotiator should not set the value of q too low and be aware of the potential results they obtain by decreasing q too much.

7. Conclusions

In this paper, we presented an alternative approach to negotiation support that applies MCDM methods based on reference points. Apart from modified TOPSIS which had been previously exploited in the negotiation context [19], we have also analyzed the fundamental concepts of VIKOR and BIPOLAR that could be hybridized with a TOPSIS-based supportive algorithm. An alternative way of defining the global criterion – proposed by VIKOR or by various TOPSIS extensions [1] which requires the use of some variants of additive aggregation with the aid of a strategy parameter, q or α – results in easier interpretation of the score, as well as creating the possibility for conducting post-negotiation analysis of the negotiated agreement. It is thus possible to draw the negotiation set of the game, and – assuming that one can randomize between alternatives (which is possible only if an additive evaluation function is used) – to find an improvement in the final contract by applying notions of fair bargaining solutions [12, 6]. Moreover, these individual parameters of the subjective decision strategies of negotiators make the scoring system more appropriately adapted to the preferences, interests and positions of the negotiators.

Furthermore, the fundamental idea of BIPOLAR, the construction of reference sets, makes the definition of BATNA and reservation levels during pre-negotiation easier and more flexible. The negotiators are no longer forced to declare abstract ideal and anti-ideal points, but they may give examples of some alternative packages that are comparable, being equally good or bad. It might be worth trying to examine the possibility of applying a classical BIPOLAR algorithm to construct a complete scoring system for negotiation offers. This will require introducing new concepts and extensions, like the ones proposed for ELECTRE TRI that were successfully used for constructing such a scoring system by Wachowicz [27]. However, such a scoring system would have an advantage over the ones prepared by means of TOPSIS and VIKOR, since it would allow analyzing negotiation problems when the idea of compensation is rejected by the negotiators.

The approach proposed in this paper is only a technical and theoretical design of a negotiation support mechanism that could be used as an alternative to SAW-based

ones. It requires tests for its applicability and usefulness, that would allow us to measure users' level of acceptance for this tool, which we plan for future work.

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