

TOPSIS-2NE's PROPOSAL

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ABSTRACT

This document presents a proposal of structuring the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) twice normalized. Instead of using Euclidean distances, TOPSIS was reckoned by the ellipse length because it was necessary to observe a distance without the basic assumption about to know the way where the “pulse” might go it. The computation was changed at the distances, using the elliptical distance. The dataset was observed by other works without grouping as it was possible to observe the distances towards the decision occurred and also the concentration of alternatives at same ranked place, forming a kind of “group” at this proposal, when TOPSIS-2NE compared to TOPSIS-2N showed grouped decisions while TOPSIS-2N kept different distances and places for ranking compensatory alternatives.

KEYWORDS. TOPSIS. TOPSIS-2N. Multicriteria Decision Aid.

AMD – Multicriteria Decision Aid

1. Introduction

Starting an observation using a compensatory/transitive tool method; it was chosen at random the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) to be used as compensatory (transitive) method application example.

The proposal was to observe another possibility to compute TOPSIS; changing the Euclidean distances by the eccentricity elliptical length. At this presentation, the TOPSIS-2NE's (TOPSIS-TWICE Normalized and Euclidean Elliptical) weights was number 1 because the study object was how the ranking was composed on it and also how this TOPSIS-2NE would work on it.

This paper has four sessions: introduction, second section where the TOPSIS-2NE is explained; third section compares TOPSIS-2N with TOPSIS-2NE followed by conclusion.

2. TOPSIS-2NE

Per Hwang and Yoon' seminal work (1981), TOPSIS computation started with the alternatives p computed according to Euclidean distances calculations being A some finite and stable potential alternatives set; between A_i and A^+ (considered as benefits of decision for being positive ideal distances D_i^+) and between A_i and A^- (considered as costs of decision for being negative ideal distances D_i^-), through the equations (1) and (2) [Bhuria and Phipon 2012]:

$$D_i^+ = \sqrt{\sum_{j=1}^n (p_{ij} - p_j^+)^2} \quad (1)$$

And

$$D_i^- = \sqrt{\sum_{j=1}^n (p_{ij} - p_j^-)^2} \quad (2)$$

Whilst the relative proximity calculation considered like the set of criteria $C = \{C_1, C_2, \dots, C_k\}$, where C_i for each alternative A_i considering the ideal positive solution A^+ was generated by equation (3):

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-} \quad (3)$$

Where, $i = 1, \dots, m$ and the index value C_i ranges from 0 and 1. Weight was obtained randomly (see Silva *et al.*, 2017 to TOPSIS compute procedures regarding WIPO dataset, but weights *via* entropy).

It was supposed to know the way *via* "pulse" might traverse, for recognizing the part where might occur a "positive" or a "negative" reaction (considering the negative either positive ideal distances; just observed after the reckoning) with the decision-making by the Decision Maker (DM) [Pudenz *et al* 2002].

Such distances might traverse a positive either a negative way. Hence, TOPSIS-2NE was chosen for illustrating an example traversing a distance without the basic assumption about to know the way where the pulse might go it. To suppose such way, the TOPSIS-2NE presented at this section had the positive and negative distances reckoned by the ellipse length, instead the Euclidean distances, according to the calculation as follows at equations (4), (5) and (6):

$$L = \pi a \left(2 - \frac{e^2}{2} - 3 \frac{e^4}{32} - 5 \frac{e^6}{128} \right) \quad (4)$$

Where:

L = the ellipse length, as it is known,

a = the positive and negative (either "anti") ideal solutions,

e = the elliptical eccentricity, obtained by: $e = \frac{c}{a}$, being $c = \sqrt{a^2 - b^2}$ (5)

c = the possible hypotenuse (considering there is not a predicted way for the neural pulse following), $c^2 = a^2 - b^2$. (6)

3. Comparing TOPSIS-2N with TOPSIS-2NE

The WIPO GII 2015 Central and Southern Asia computed at TOPSIS illustrates this explanation (see [Silva et al. 2017] to procedures regarding WIPO dataset). However, it is used now the standardized as TOPSIS-2N method presented as MACBETH-TOPSIS-2N by M.C. Silva, C.F.S. Gomes and C.L. da Costa Junior [Silva et al. 2018] (whose cardinal numbers were transformed at nominal numbers) and introduced as AHP-TOPSIS-2N by L.P. Souza, C.F.S. Gomes and A. P. Barros [Souza et al. 2018]; where two standardized methods occurred at the proposed TOPSIS. The first and the second normalization methods were presented at equations (7) and (8) being followed:

$$y_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}}, i = 1, 2, \dots, m; j = 1, 2, \dots, n \quad (7)$$

and the second normalization method procedure (8):

$$y_{ij} = x_{ij} / \max x_i \quad (8)$$

Keeping *coeteris paribus* regarding TOPSIS reckoning; the standardized and weighted by sum and average, at Table 1 as follows:

Table 1 – The standardized and weighted by average and sum

Central and Southern Asia GII 2015	Standardized and weighted by average	Standardized and weighted by sum
India	1.5049	0.1368
Kazakhstan	2.6240	0.2385
Sri Lanka	0.8524	0.0775
Iran, Islamic Republic of	0.7247	0.0659
Kyrgyzstan	0.8610	0.0783
Tajikistan	0.6795	0.0618
Bhutan	2.0403	0.1855
Uzbekistan	0.8037	0.0731
Bangladesh	0.5047	0.0459
Pakistan	0.0048	0.0004
Nepal	0.4000	0.0364

Source: Own Elaboration (2019)

Note: It was used 4 decimals digits for avoiding showing only zero results, considering low values.

Instead of using Euclidean distances reckoning, it was used the a (from the elliptical length), where the alternative was multiplied by the standardized weighted by average either sum, according to the positive ideal solution (LEI+) and the negative ideal solution (LEI-). Comparing to TOPSIS-2N method at Euclidean Distances, the distances were dispersed whilst at TOPSIS-2NE the distances were closer (but TOPSIS-2NE average LEI+), as Table 2 as follows:

Table 2 – The ellipse length distances instead Euclidean distances at TOPSIS-2NE versus TOPSIS-2N

Central and Southern Asia GII 2015	TOPSIS-2NE Average	TOPSIS-2NE Sum	TOPSIS-2N Euclidean Distances
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	LEI+	LEI-	LEI+	LEI-	Positive	Negative
India	16.960783	0.030991	0.140172	0.000256	0.041426	0.111901
Kazakhstan	29.573933	0.054038	0.244413	0.000447	0.036424	0.093414
Sri Lanka	9.606829	0.017554	0.079395	0.000145	0.031522	0.106576
Iran, Islamic Republic of	8.167992	0.014925	0.067504	0.000123	0.036980	0.098708
Kyrgyzstan	9.703868	0.017731	0.080197	0.000147	0.043829	0.088646
Tajikistan	7.658505	0.013994	0.063293	0.000116	0.049178	0.095310
Bhutan	22.995264	0.042018	0.190044	0.000347	0.113160	0.046855
Uzbekistan	9.057678	0.016550	0.074857	0.000137	0.044505	0.100197
Bangladesh	5.688206	0.010394	0.047010	0.000086	0.076091	0.060609
Pakistan	0.054038	0.000099	0.000447	0.000001	0.075796	0.069333
Nepal	4.508619	0.008238	0.037261	0.000068	0.116329	0.025103

Source: Own Elaboration (2019).

Note: LEI± meant the ellipse length for positive and negative distances. It was used 6 decimal digits.

Where it was possible to achieve the coefficient and ranking, with TOPSIS-2NE having same positions according to the lengths, whilst TOPSIS-2N continued with different and dispersed coefficients, at Table 3 as follows:

Table 3 – The TOPSIS' coefficient and ranking at TOPSIS-2NE and TOPSIS-2N

Central and Southern Asia GII 2015	Coefficient by average (LEI+ and LEI-) at TOPSIS-2NE		Coefficient by sum (LEI+ and LEI-) at TOPSIS-2NE		Coefficient by TOPSIS-2N
India	0.00183	-1.00183	0.00183	-1.00183	0.72982
Kazakhstan	0.00183	-1.00183	0.00183	-1.00183	0.71947
Sri Lanka	0.00183	-1.00183	0.00183	-1.00183	0.77174
Iran, Islamic Republic of	0.00183	-1.00183	0.00183	-1.00183	0.72746
Kyrgyzstan	0.00183	-1.00183	0.00183	-1.00183	0.66915
Tajikistan	0.00183	-1.00183	0.00183	-1.00183	0.65964
Bhutan	0.00183	-1.00183	0.00183	-1.00183	0.29281
Uzbekistan	0.00183	-1.00183	0.00183	-1.00183	0.69244
Bangladesh	0.00183	-1.00183	0.00183	-1.00183	0.44337
Pakistan	0.00183	-1.00183	0.00183	-1.00183	0.47773
Nepal	0.00183	-1.00183	0.00183	-1.00183	0.17749

Source: Own Elaboration (2019).

Note: 5 decimal digits were presented for avoiding zero numbers.

Table 4 illustrated the possible compensatory ranking to decisions. While TOPSIS-2NE ranking seemed to group, the TOPSIS-2N ranked at different places from the original GII 2015 ranking, except for Nepal belonging to 11th place as the same, as follows:

Table 4 – The possible ranking at TOPSIS-2NE and TOPSIS-2N

Central and Southern Asia GII 2015	Ranking by average (LEI+)	Ranking by average (LEI-)	Ranking by sum (LEI+)	Ranking by sum (LEI-)	Ranking by TOPSIS-2N
India	3	1	2	6	2

Central and Southern Asia GII 2015	Ranking by average (LEI+)	Ranking by average (LEI-)	Ranking by sum (LEI+)	Ranking by sum (LEI-)	Ranking by TOPSIS-2N
Kazakhstan	3	4	8	6	4
Sri Lanka	1	4	2	1	1
Iran, Islamic Republic of	9	1	2	1	3
Kyrgyzstan	3	4	8	6	6
Tajikistan	3	4	8	1	7
Bhutan	1	4	2	6	10
Uzbekistan	3	4	2	1	5
Bangladesh	11	1	11	1	9
Pakistan	9	4	1	6	8
Nepal	3	4	2	6	11

Source: Own Elaboration (2019).

Considering the ranking: both the ranking by the mean and by the sum of the negative elliptical distances had greater grouping in a few positions as observed at Table 3. The Euclidean distance with the premise of a path presents alternatives in more diversified ranking positions than the elliptical distance, without premise, which concentrates to have the perception of decision-making possibilities. The results show groupings and positions of analysis for the decisions that are taken for a better understanding of the decision makers.

4. Conclusion

As after understanding these reckonings, it was possible to observe the distances towards the decision occurs and also the concentration of alternatives at same ranked place, forming a kind of “group”. In a nutshell, the TOPSIS-2NE (the TOPSIS-2N reckoning *via* elliptic length) might also apply other methods for achieving the maximum of decision might be taken it; observing if it will group rather not.

TOPSIS-2NE compared to TOPSIS-2N showed grouped decisions while TOPSIS-2N kept different distances and places for ranking compensatory alternatives.

Thus, observing distances in their positive either negative ideal “pulses” supported the possible solutions and results considering complex decisions of investment, where it was necessary to explore all the possibilities for finding a decision like the best possible solution to be taken, *e.g.*

To a raw decision involving qualitative intrinsic at quantitative perspectives decision-making; it was important to understand trends and complexity to DMs [Vanderpooten 2008]. Although these were initial reckonings for this mindset structure complexity; it was possible to express a different way of computing it.

In this regard, it might be interesting to observe in future works if a MCDA working like a selector business be enable on applying such issue.

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