Summary Overview of the Technical AHP-TOPSIS methodology

Here we briefly present the technical specifics of the AHP-TOPSIS method, explored in Part I, Axelsson *et al.* [18] to describe the internal mechanics of the methodology. In the AHP a decision maker compares two criterion, C_i with C_j to form a square matrix $A = [a_{ij}]$ (eq. 1).

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \quad (1)$$

Where:

(i) $a_{ij} = \frac{1}{aji}$ for $i, j = 1, \dots, n$ and $i \neq j$

(ii) $a_{ij} = 1$ for $i, j = 1, \dots, n$ and $i = j$

During the AHP criteria analysis, the priority weight vector, $\boldsymbol{w}$, of the decision matrix is determined using the row geometric mean method [2] and subsequently tested for consistency using Aguaron and Moreno-Jimenez's [3] interpreted consistency measure, the geometric consistency index (GCI). The GCI values are converted to Saaty's [4] consistency ratio (CR) equivalent values. Acceptable consistency is set to CR 0.2 and above this threshold the matrix is removed from the analysis. A consistency measure (CM) is determined for each decision maker (eq. 2).

$$CM^k = 1 - CR^k \quad (2)$$

Where:

(i) $k = 1, 2, \dots, r$ for the set of decision-makers

The CM values are then normalized to determine the aggregation weight of each decision maker when aggregating the group priority weight vector for each decision matrix. Following, in TOPSIS, the decision maker compares each alternative A_m to the criteria C_n to produce a new matrix $B = [f_{ij}]$ (eq. 3).

$$B^k = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \dots & C_n \end{array} \\ \begin{bmatrix} f_{11} & f_{12} & \cdots & f_{1n} \\ f_{21} & f_{22} & \cdots & f_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ f_{m1} & f_{m2} & \dots & f_{mn} \end{bmatrix} \end{array} \quad (3)$$

Where:

(i) A_i represents the alternative i and C_j represents the criteria j, for $i = 1, \dots, m$ and $j = 1, \dots, n$

(ii) And f_{ij} represents the performance rating of A_i under C_j

(iii) For k=1,2,…,r for the number of decision-makers

Following Shih et al.'s [5] group TOPSIS methodology and integrating the group criteria weights determined during the AHP, the closeness, C, of each alternative to the ideal solution is calculated. Finally, a sensitivity analysis is performed using Li et al.'s [6] method of manipulating targeted percentage change ratios towards specific criteria weights while adjusting the remaining weights proportionally to examine the rank variation of the alternatives dependent on the criteria weights.

References

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