A multi criteria decision making methodology to select best supplier in healthcare industry

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Abstract

Businesses all across the globe are adopting sustainable supply chain practises in an effort to lessen their impact on the environment. Towards reaching that aim, suppliers in healthcare have a crucial role in creating a sustainable supply chain. One of the difficulties in achieving sustainability in supplier selection is the use of competing criteria. The use of several factors in making decisions is essential for sustainable supplier selection (MCDM). This study introduce the Multi-Attributive Border Approximation area Comparison (MABAC) methodology to select best supplier in healthcare industry. The standards and substitutions are collected from the previous works. The weights of criteria are computed, then the alternatives are ranked by the MABAC method. MABAC is a common MCDM methodology for ordering substitutions. The criteria and substitutions are included the vague and incomplete data and information, so the nutrosophic environment is used to overcome uncertainty. The single valued neutrosophic numbers are used in the computations in this work.

Keywords: Healthcare; Supplier Selection; Supply Chain; Neutrosophic Sets; MCDM

1. Introduction

Businesses all across the globe are adopting sustainable supply chain practises in an effort to lessen their impact on the planet. That objective can only be met with the help of a sustainable supply chain, in which suppliers play a crucial role. Successful sustainably managed supply chains requires the assessment and choice of sustainable providers[1]–[4]. Sustainable supplier development is the incorporation of economic, ethical, and climatic factors to conventional supply chain management methods. The efficiency of businesses and their supply chains may greatly benefit from the careful selection of sustainable suppliers[5]–[8]. In addition, selecting a sustainable provider is a major milestone in the overall sustainable supply chain. Successful businesses recognise the importance of resolving difficulties related to the selection of sustainable suppliers. So, it's imperative that businesses adopt an ethical approach to choosing their suppliers[9], [10].

Multiple factors are utilised in making decisions, and these factors sometimes clash with one another, contract or agreement supplier selection difficult. For sustainable supplier evaluation, decision-makers should use MCDM, which requires them to weigh both qualitative and quantitative parameters. Neutrosophic sets are hybrid with the MCDM methods to overcome uncertainty. The MABAC technique is used under single valued neutrosophic environment[11]–[13].

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The rising price of medical treatment is a topic of widespread discussion. Healthcare prices have skyrocketed over the previous decade, much outpacing the CPI, and there has been a widespread push to dramatically reduce these expenses. Concerns that healthcare quality and service would suffer as a result of attempts to save costs have grown in recent years. The subject of cost vs quality in healthcare is commonly discussed in relation to patient treatment, but it is as relevant to the hospital's acquisition of medical equipment and supplies. As hospitals are under increasing pressure to reduce costs in order to compete, they are focusing on purchasing as a primary means of doing so[14], [15].

Multi-Attribute Border Approximation area Comparison (MABAC) is a novel method. Decisions may be based on the clear calculation approach, the systematic process, and the good reasoning that it demonstrates[16]–[19]. Peng and Yang used the MABAC algorithm for ranking and selecting R&D projects, using the benefits of Pythagorean fuzzy sets in the process. For material choice in an interval-valued intuitionistic fuzzy setting, Xue et al. presented an MABAC strategy. However, to the best of our knowledge, no reports of research into the MADM issue using the MABAC approach can be found in the scholarly literature[20]–[22]. Consequently, using the MABAC approach in MADM to rank and achieve the optimal choice in a single-valued neutrosophic setting is a fascinating area for academic inquiry. Inspired by Hadi-Venchen and Mirjaberi, we also present a modified TOPSIS approach for a single-valued neutrosophic setting, which allows for the ideal solution to simultaneously be at the smallest possible distance from both the suitable response (PIS) and the largest possible distance from the bad solution (NIS). Existing methods are compared based on objective data, and the one that produces the most reliable outcomes is selected[23], [24].

2. Preliminaries

Let X be a universe. The neutrosophic sets can be formulated as truth, indeterminacy and falsity membership degrees.

Definition 1:

Let $x = (T_x, I_x, F_x)$ *and* $y = (T_y, I_y, F_y)$ *be two single valued neutrosophic numbers*

$$x^c = (F_x, 1 - I_x, T\_x)$$

$$x \cup y = (\max\{T_x, T_y\}, \min\{I_x, I_y\}, \min\{F_x, F_y\})$$

$$x \cap y = (\min\{T_x, T_y\}, \max\{I_x, I_y\}, \max\{F_x, F_y\})$$

$$x \oplus y = (T_x + T_y - T_x * T_y, \quad I_x * I_y, F_x * F_y)$$

$$x \otimes y = (T_x * T_y, \quad I_x + I_y - I_x * I_y, F_x + F_y - F_x * F_y)$$

$$\curlywedge x = (1 - (1 - T_x)^{\curlywedge}, (I_x)^{\curlywedge}, (F_x)^{\curlywedge}), \curlywedge > 0$$

$$x^{\curlywedge} = (T_x)^{\curlywedge}, 1 - (1 - I_x)^{\curlywedge}, 1 - (1 - F_x)^{\curlywedge}, \curlywedge > 0$$

Definition 2:

Let $x = (T_x, I_x, F_x)$ *and* $y = (T_y, I_y, F_y)$ *be two single valued neutrosophic numbers*

Then the distance of hamming can be computed as:

$$d(x, y) = \frac{1}{3}(|T_x - T_y| + |I_x - I_y| + |F_x - F_y|)$$

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Definition 3:

The single valued neutrosophic weighted geometric can be computed as:

$$w = \left(\prod_{j=1}^{n} (T_j)_j^w \ , 1 - \prod_{j=1}^{n} (I)_j^w \ , 1 - \prod_{j=1}^{n} (F_j)_j^w \right)$$

Definition 4:

The cosine similarity can be computed as:

$$C(x) = \frac{T_x}{\sqrt{T_x^2 + I_x^2 + F_x^2}}$$

Definition 5:

$Let\ N_i\ and\ N_k\ be\ two\ SVNSs, then$

$D^{\Delta}(N_i, N_k) is\ a\ distance\ measure.$

$D^{\Delta}(N_i, N_k) = (1 - \max\{L(N_i, N_k), M(N_i, N_k),$

$R(N_i, N_k)\}, \min\{L(N_i, N_k), W(N_i, N_k),$

$R(N_i, N_k)\}, min\{L(N_i, N_k), M(N_i, N_k), R(N_i, N_k)\}),$

$$where\ L(N_i, N_k) = \frac{\sum_{j=1}^{n} w_j \min\{e^{T_{ij}}, e^{T_{kj}}\}}{\sum_{j=1}^{n} w_j \max\{e^{T_{ij}}, e^{T_{kj}}\}},$$

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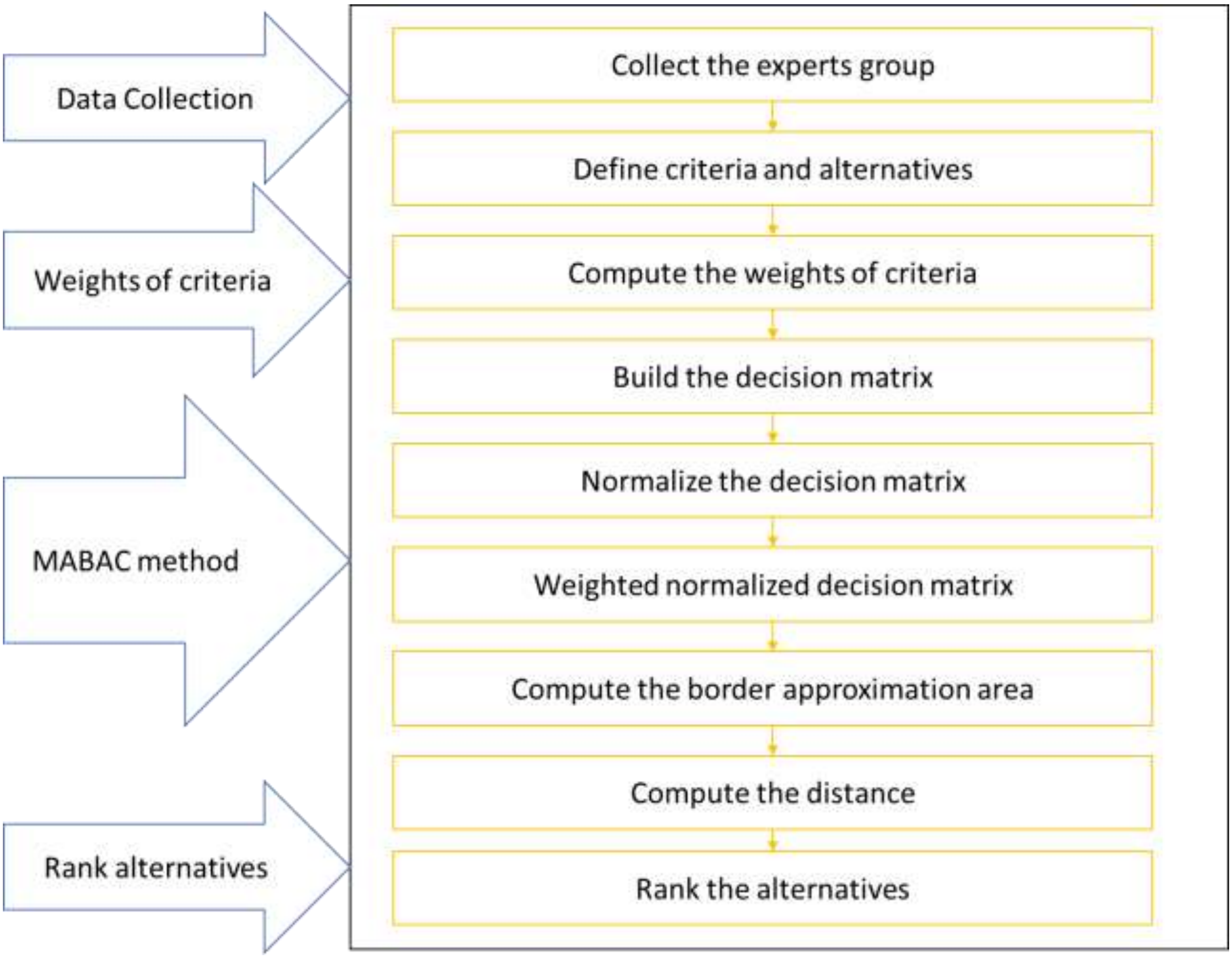

Figure 1: The proposed methodology.

3. The MABAC Method

The MABAC method is used to rank the alternatives.

Step 1: Compute the weights of criteria.

Collect criteria and alternatives and evaluated from the single valued neutrosophic numbers.

Step 2: Build the judgement background

Step 3: Normalize the judgement background

Step 4: Compute the relative weight

Step 5: Compute the weighted judgement background

Step 6: Compute the border approximation area

$$b_j = \left(\prod_{i=1}^{m}(T_j)_j^{1/m}, 1 - \prod_{i=1}^{m}(I)_j^{1/m}, 1 - \prod_{i=1}^{m}(F_j)_j^{1/m}\right)$$

Step 7: Compute the distance matrix

Step 8: Order the substitutions

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4. The results

This section shows the values of the MABAC methodology as

Step 1: Calculate the weights of standards.

This paper works on six criteria and four alternatives that are collected from previous studies. The criteria are economic, quality, innovation, social, environmental, and pollution. Let experts use the single valued neutrosophic numbers to assess criteria. Then compute the weights of standards by the average technique. The weights of standards shown in figure 2. The criterion 4 is the highest weight and criterion 2 is the lowest weight.

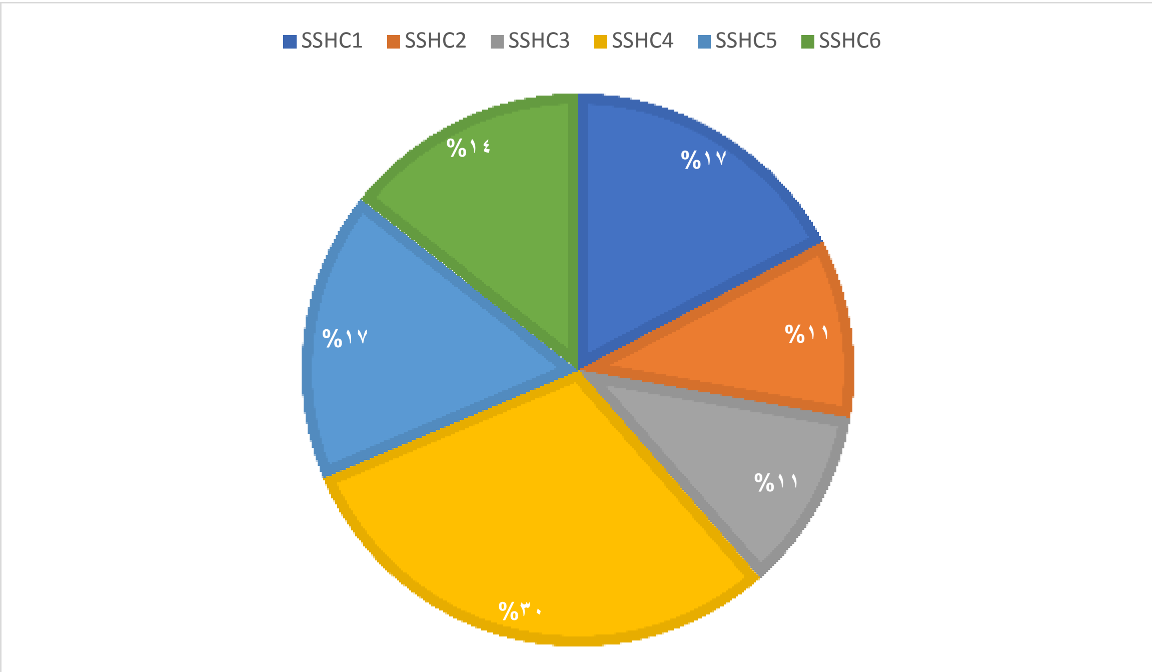

Figure 2: The weights of standards.

Step 2: Build the judgement background

Then build the matrix between criteria and alternatives by the single valued neutrosophic numbers.

Step 3: Normalize the judgement background

Then normalize the judgement background as Table 1.

Table 1: The normalization judgement background.

	SSHC1	SSHC2	SSHC3	SSHC4	SSHC5	SSHC6
SSHA1	0.462505	1.138817	0.100058	-0.19366	0.443757	0.335313492
SSHA2	0.762467	1.105488	0.164335	0.912448	-0.30615	-0.22932596
SSHA3	0.368766	0.738864	0.464294	0.874953	0.912448	-0.17639101

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SS HA 4	0.44 3757	- 0.36 101	0.16 4335	- 0.15 617	1.06 243	0

Step 4: Calculate the relative weight

Then compute the relative weights

Step 5: Compute the weighted judgement background

Then multiply the weights of standards by the normalization matrix to obtain the weighted judgement background as in Table 2.

Table 2: The weighted normalization judgement background.

	SSH C1	SSH C2	SSH C3	SSH C4	SSH C5	SSHC6
SS HA 1	0.09 0675	0.07 0581	0.04 5102	0.01 1289	0.04 4756	0.0614 24421
SS HA 2	0.10 9273	0.06 9481	0.04 7738	0.02 6774	0.02 1509	0.0354 51006
SS HA 3	0.08 4864	0.05 7383	0.06 0036	0.02 6249	0.05 9286	0.0378 86013
SS HA 4	0.08 9513	0.02 1087	0.04 7738	0.01 1814	0.06 3935	0.046

Step 6: Compute the border approximation area

Then compute the border approximation value from the previous section.

Step 7: Compute the distance matrix

Then compute the relative distance as shown in table 3.

Table 3: The relative distance.

	SSH C1	SSH C2	SSH C3	SSH C4	SSH C5	SSHC6
SSH A1	- 0.89 468	- 0.86 272	- 0.90 508	- 0.85 256	- 0.88 26	- 0.90233 558
SSH A2	- 0.87 609	- 0.86 382	- 0.90 244	- 0.83 708	- 0.90 585	- 0.92830 899
SSH A3	- 0.90 05	- 0.87 592	- 0.89 014	- 0.83 76	- 0.86 807	- 0.92587 399
SSH A4	- 0.89 585	- 0.91 221	- 0.90 244	- 0.85 204	- 0.86 342	- 0.91776

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Step 8: Order the substitutions

Then rank the alternatives rendering to the highest value as show in figure 3. The alternative 3 is the greatest alternative and the substitute 4 is the nastiest alternative.

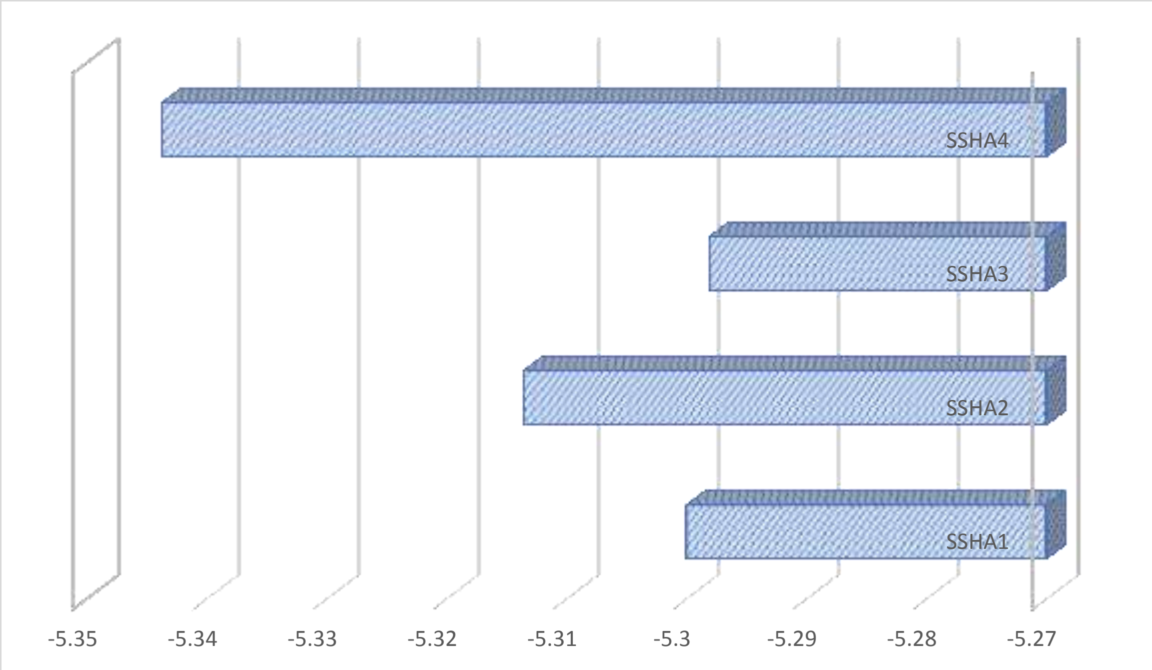

Figure 3: The rank of alternatives.

6. Conclusion

Sustainability in the distribution chain is an increasingly important topic of discussion. In the healthcare sector, public medical organizations priorities long-term viability, whereas private medical organizations priorities profits. In this work, we show how a private healthcare company might use MCDM techniques to identify a supplier that will be there for the long haul. In this study, we introduce MABAC, a novel method to the challenge of MCDM. Options and corresponding values are the foundation of the newly designed MABAC technique. The functional form of options is calculated and ranked with regard to reference values based on these predetermined associations. This paper introduced the MABAC under the single valued neutrosophic sets.

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