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A new approach of tree soft set with MCDM technique for leadership in international climate policy: measuring renewable energy sources and policies

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Abstract
Green technological progress can be achieved by mitigation efforts of leadership in climate policy. Renewable energies need to develop technological innovations for more competitive advantages. This study proposed a decision-making methodology for evaluating renewable energy sources under leadership in international climate policy. This study used the multi-criteria decision-making methodology to deal with conflicting criteria in the decision-making problem. The evaluation is based on the distance from the average solution (EDAS) method, which ranks the alternatives. The criteria weights are computed by using the average method. The neutrosophic set deals with uncertainty and vague information in the evaluation process. The neutrosophic set is integrated with the MCDM methodology. This study uses the concept of TreeSoft Set to deal with the problem as a tree and solve it easily. 15 criteria and 10 alternatives were used in this study. An empirical application was conducted to show the effectiveness of the proposed methodology.

Keywords: Treesoft Set; MCDM; Climate Policy; Leadership; Energy; Policy Making; Organization Ethically and Effectively.

1. Introduction
Countries and governments have the tools to solve the climate crisis in the world. The energy coming from the sun and the wind is not cheap but can be more favorable than conventional technologies[1], [2]. Renewable energy comes from the sky, so technological development is not needed for it[3]. However, using renewable energy at a competitive level requires much effort in developing technological innovations[4], [5].

The green technological program needs effective leadership to materialize and achieve mitigation efforts. Photovoltaics need effective leadership to reduce costs due to the results of policy measures taken by various countries[6], [7]. Hence, these green technologies need to prove the game changers of global climate policy and reduce costs[8], [9].

Multi-criteria decision-making (MCDM) concept is used to deal with various conflicting criteria[10]. MCDM methodology is used to deal with decision-making problems that have various criteria and alternatives. Experts and decision-makers evaluated the criteria and alternatives in decision-making problems[11], [12].

A neutrosophic set (NS) was built to overcome the uncertainty and inconsistency in real issues, and it is better than the fuzzy set (FS)[13]. NS has three aspects in decision-making issues like: truth, indeterminacy, and falsified membership functions. In classical FS, there is only a single membership function of FS[14][15]. NS considers three functions to overcome uncertainty in the evaluation decision-making problem. NS has the indeterminacy function, unlike the intuitionistic Fs[16], [17]. NS membership function helps experts and decision-makers to explain their opinions more accurately[18]. NS has various advantages over the intuitionistic FS, like

- The sum of membership functions may be at most three and can be assigned independently,
- The indeterminacy value cannot depend on the truth and falsify membership degrees.
- They extend decision makers and experts' disagreements.

NS can be applied in decision-making issues such as evaluating renewable sources under leadership and policy.

The Evaluation based on the Distance from Average Solution (EDAS) approach is an MCDM methodology. The EDAS method is efficient in conditions with contradictory criteria. EDAS computes the best alternative by computing the distance of every alternative from the best value. The EDAS method is applied to solve various decision-making problems. The EDAS method has various advantages, such as being comparable to compensatory approaches, allowing criteria to be independent of each other, and converting qualitative criteria to quantitative criteria[19], [20].

The main contributions of this study are:

- This study employed a decision-making methodology for evaluating renewable energy for leadership in international climate policy.
- This study used the neutrosophic set with the MCDM method to overcome uncertainty.
- This study used the treeSoft set with MCDM methodology.
- This study used the EDAS method to rank the alternatives and compute the criteria weights using the average method. It has 15 criteria and 10 alternatives.

The rest of this study is organized as follows: Section 2 defines SVNSs. Section 3 shows the treeSoft set. Section 4 shows the methodology of this study. Section 5 shows the results of this study. Section 6 shows the conclusions.

2. Single-Valued Neutrosophic Sets (SVNSs)

SVNSs are an extension of neutrosophic sets. This part introduces some definitions of SVNSs[21].

Definition 1.
SVNSs can be defined as:

$$0 \leq T_n(x) + I_n(x) + F_n(x) \leq 3 \quad (1)$$

Where $T_n(x), T_n(x), and\ T_n(x)$ refers to the truth, indeterminacy, and falsify functions.

Definition 2.

Let two SVNNs as $a_1 = (T_{a_1}, I_{a_1}, F_{a_1})$ and $a_2 = (T_{a_2}, I_{a_2}, F_{a_2})$ (2)

Some of SVNSs operations can be defined as:

$$a_1 \oplus a_2 = \left(T_{a_1}(x) + T_{a_2}(x) - T_{a_1}(x)T_{a_2}(x), I_{a_1}(x)I_{a_2}(x), F_{a_1}(x)F_{a_2}(x)\right) \tag{3}$$

$$a_1 \otimes a_2 = \begin{pmatrix} T_{a_1}(x)T_{a_2}(x), I_{a_1}(x) + I_{a_2}(x) - I_{a_1}(x)I_{a_2}(x), \\ F_{a_1}(x) + F_{a_2}(x) - F_{a_1}(x)F_{a_2}(x) \end{pmatrix} \tag{4}$$

$$a_1 \cup a_2 = \left(\max\left(T_{a_1}(x), T_{a_2}(x)\right), \min\left(I_{a_1}(x), I_{a_2}(x)\right), \min\left(F_{a_1}(x), F_{a_2}(x)\right)\right) \tag{5}$$

$$a_1 \cap a_2 = \left(\min\left(T_{a_1}(x), T_{a_2}(x)\right), \max\left(I_{a_1}(x), I_{a_2}(x)\right), \max\left(F_{a_1}(x), F_{a_2}(x)\right)\right) \tag{6}$$

Definition 3.

The Euclidean distance and normalized Euclidean distance can be computed as:

$$Distance\ (a_1, a_2) = \sqrt{\sum_{i=1}^{m} \begin{Bmatrix} \left(T_{a_1}(x_i) - T_{a_{12}}(x_i)\right)^2 + \\ \left(I_{a_1}(x_i) - I_{a_2}(x_i)\right)^2 + \\ \left(F_{a_1}(x_i) - F_{a_2}(x_i)\right)^2 \end{Bmatrix}} \tag{7}$$

$$Normalized\ Distance\ (a_1, a_2) = \sqrt{\frac{1}{3m} \times \sum_{i=1}^{m} \begin{Bmatrix} \left(T_{a_1}(x_i) - T_{a_{12}}(x_i)\right)^2 + \\ \left(I_{a_1}(x_i) - I_{a_2}(x_i)\right)^2 + \\ \left(F_{a_1}(x_i) - F_{a_2}(x_i)\right)^2 \end{Bmatrix}} \tag{8}$$

3. TreeSoft Set (TSS)

Let X be a universe disclosure and Y a non-empty subset of X, with $P(Y)$ be a power of Y [22], [23]. Let TSS be a set of criteria for the study,

$$TSS = \{TSS_1, TSS_2, TSS_3, \dots, TSS_n\}, n \geq 1 \tag{9}$$

Where $TSS_1, TSS_2, \dots, TSS_n$ refer to the criteria of the first level of the tree.

Every criterion $TSS_1, 1 \leq i \leq n$ is built by sub-criteria as:

$$TSS_1 = \{TSS_{1,1}, TSS_{1,2}, TSS_{1,3}, TSS_{1,4}, \dots,\} \tag{10}$$

$$TSS_2 = \{TSS_{2,1}, TSS_{2,2}, TSS_{2,3}, TSS_{2,4}, \dots,\} \tag{11}$$

$$TSS_3 = \{TSS_{3,1}, TSS_{3,2}, TSS_{3,3}, TSS_{3,4}, \dots,\} \quad (12)$$

$$TSS_4 = \{TSS_{4,1}, TSS_{4,2}, TSS_{4,3}, TSS_{4,4}, \dots,\} \quad (13)$$

$$TSS_5 = \{TSS_{5,1}, TSS_{5,2}, TSS_{5,3}, TSS_{5,4}, \dots,\} \quad (14)$$

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$$TSS_n = \{TSS_{n,1}, TSS_{n,2}, TSS_{n,3}, TSS_{n,4}, \dots,\} \quad (15)$$

Where $TSS_{i,j}$ refers to the sub-criteria.

The TSS can be built as:

$$F: P\big(Tree(TSS)\big) \rightarrow P(Y) \quad (16)$$

Where $Tree(TSS)$ refers to all nodes and leaves from level 1 to level m.

$P\big(Tree(TSS)\big)$ is the power set of the $Tree(TSS)$

$$Tree(TSS) = \begin{pmatrix} \{TSS_i |\ i_1 = 1,2, \dots\} \cup \{TSS_i | i_1, i_2, i_3 = 1,2,, \dots.\} \\ \cup \dots.,\cup\ (TSS_i | i_1, i_2, \dots, i_m = 1,2, \dots) \end{pmatrix} \quad (17)$$

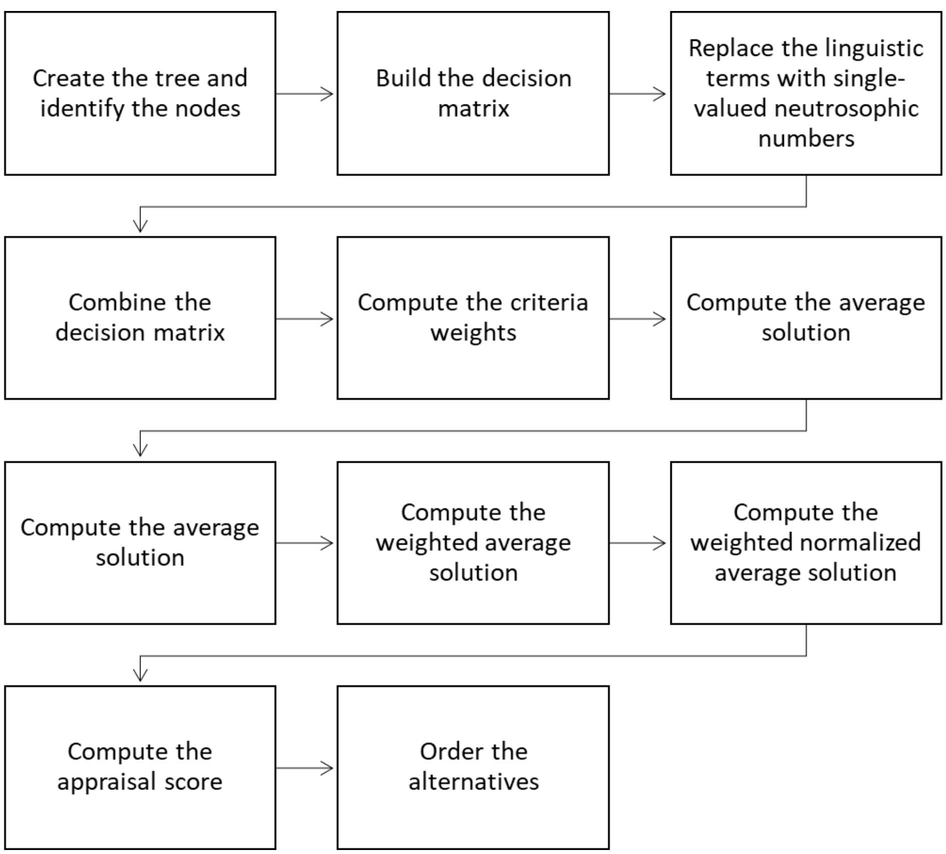

Figure 1. The research methodology

4. TreeSoft Set with MCDM Methodology

This part introduces the steps of TSS with EDAS methodology[24] as shown in Figure 1.

Phase 1: In this phase, Create the tree and identify the nodes. There are various levels in the tree and the criteria are presented in the first level. The second level shows the sub-factors.

Phase 2: In this phase, The decision matrix is built by using the opinions of experts. The experts used the linguistic terms of SVNSs to evaluate the criteria and alternatives.

Phase 3. In this phase, We replaced the linguistic terms with the single-valued neutrosophic numbers. Then we obtain the crisp values. We used the score function to obtain the crisp values[21].

Phase 4. Combine the decision matrix. We combined the opinions of experts into a single matrix as:

$$T = \begin{bmatrix} t_{11} & t_{12} & t_{13} & \cdots & t_{1n-2} & t_{1n-1} & t_{1n} \\ & \vdots & & \ddots & & \vdots & \\ t_{m1} & t_{m2} & t_{m3} & \cdots & t_{m-2n-2} & t_{m-1n-1} & t_{mn} \end{bmatrix}_{ij} i = 1,2, \dots, m; j = 1,2, \dots, n \quad (18)$$

Phase 5. Compute the criteria weights. The criteria weights are computed based on the opinions of experts from the decision matrix by using the average approach. Then we ranked the criteria from highest to lowest.

Phase 6. This phase is used to compute the average solution of every criterion.

$$V_j = \frac{\sum_{i=1}^{m} t_{ij}}{m}; j = 1,2, \dots, n \quad (19)$$

Phase 7. Compute the positive distance from the average solution and the negative distance from the average solution.

$$R_{ij} = \frac{\max\left(0, (t_{ij} - V_j)\right)}{V_j} \quad (20)$$

$$R_{ij} = \frac{\max\left(0, (V_j - t_{ij})\right)}{V_j} \quad (21)$$

$$R_{ij} = \frac{\max\left(0, (V_j - t_{ij})\right)}{V_j} \quad (22)$$

$$R_{ij} = \frac{\max\left(0, (t_{ij} - v_j)\right)}{V_j} \quad (23)$$

Phase 8. In this phase, we compute the weighted average solution from the positive and negative distance as

$$Q_i = \sum_{j=1}^{n} R_{ij} W_j \quad (24)$$

Phase 9. This phase computes the weighted normalized average solution for positive and negative criteria.

$$S_i = \frac{Q_i}{\max_i(Q_i)} \quad (25)$$

Phase 10. Compute the appraisal score

$$D_i = \frac{1}{2}\left(S_{i_{posotive}} + S_{i_{negative}}\right) \quad (26)$$

Phase 11. Order the alternatives. The alternatives are ordered based on the descending orders of the appraisal score.

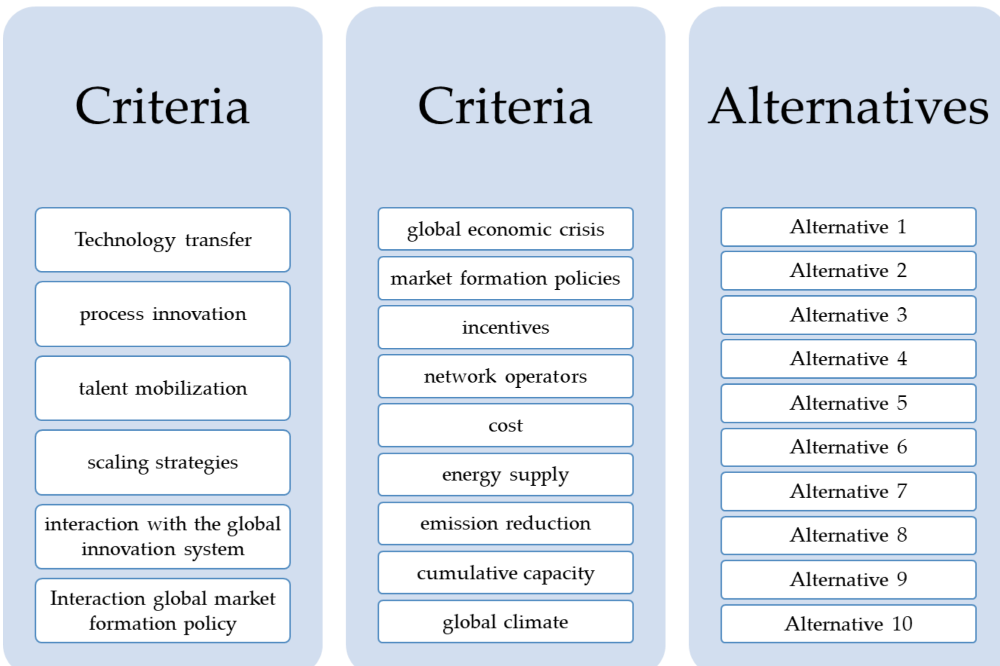

Figure 2. The criteria and alternatives.

5. Results and Discussions

This part shows the results of the SVNS-TSS and EDAS methods.

Phase 1: The tree is built and the nodes are defined. There are 15 criteria collected in this study and 10 alternatives as shown in Figure 2.

Phase 2: The decision matrix between criteria and alternatives is built as shown in Table 1.

Phase 3. Replace the linguistic terms with single-valued neutrosophic numbers.

We obtained the crisp values by using the score function.

Phase 4. The decision matrix is combined to obtain a single decision matrix.

Phase 5. The criteria weights are computed as shown in Figure 3.

We showed that criterion 2 has the highest weight equal to 0.076, followed by criterion 1 with a weight equal to 0.075, and criterion 5 with a weight equal to 0.071. We showed that criterion 3 has the lowest weight equal to 0.0564, followed by criterion 7 with a weight equal to 0.568, and criterion 8 with a weight equal to 0.61.

Table 1. The decision matrix.

	RWR_{1}	RWR_{2}	RWR_{3}	RWR_{4}	RWR_{5}	RWR_{6}	RWR_{7}	RWR_{8}	RWR_{9}	RWR_{10}
RWC_{1}	(0.9,0.1,0.05)	(0.65,0.35,0.30)	(0.8,0.2,0.15)	(0.9,0.1,0.05)	(0.2,0.75,0.80)	(0.35,0.65,0.60)	(0.5,0.5,0.45)	(0.65,0.35,0.30)	(0.8,0.2,0.15)	(0.8,0.2,0.15)
RWC_{2}	(0.8,0.2,0.15)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.5,0.5,0.45)	(0.8,0.2,0.15)	(0.8,0.2,0.15)	(0.9,0.1,0.05)	(0.9,0.1,0.05)	(0.5,0.5,0.45)	(0.9,0.1,0.05)
RWC_{3}	(0.65,0.35,0.30)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.35,0.65,0.60)	(0.35,0.65,0.60)	(0.5,0.5,0.45)	(0.65,0.35,0.30)	(0.2,0.75,0.80)
RWC_{4}	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.9,0.1,0.05)	(0.9,0.1,0.05)	(0.8,0.2,0.15)	(0.9,0.1,0.05)	(0.5,0.5,0.45)	(0.65,0.35,0.30)	(0.8,0.2,0.15)	(0.2,0.75,0.80)
RWC_{5}	(0.35,0.65,0.60)	(0.9,0.1,0.05)	(0.8,0.2,0.15)	(0.8,0.2,0.15)	(0.9,0.1,0.05)	(0.8,0.2,0.15)	(0.65,0.35,0.30)	(0.8,0.2,0.15)	(0.9,0.1,0.05)	(0.35,0.65,0.60)
RWC_{6}	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.9,0.1,0.05)	(0.65,0.35,0.30)	(0.8,0.2,0.15)	(0.9,0.1,0.05)	(0.2,0.75,0.80)	(0.5,0.5,0.45)
RWC_{7}	(0.2,0.75,0.80)	(0.5,0.5,0.45)	(0.5,0.5,0.45)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.5,0.5,0.45)	(0.9,0.1,0.05)	(0.35,0.65,0.60)	(0.35,0.65,0.60)	(0.65,0.35,0.30)
RWC_{8}	(0.9,0.1,0.05)	(0.35,0.65,0.60)	(0.35,0.65,0.60)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.5,0.5,0.45)	(0.8,0.2,0.15)
RWC_{9}	(0.9,0.1,0.05)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.9,0.1,0.05)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.35,0.65,0.60)	(0.5,0.5,0.45)	(0.65,0.35,0.30)	(0.9,0.1,0.05)
RWC_{10}	(0.9,0.1,0.05)	(0.65,0.35,0.30)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.5,0.5,0.45)	(0.8,0.2,0.15)	(0.8,0.2,0.15)	(0.2,0.75,0.80)
RWC_{11}	(0.8,0.2,0.15)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.8,0.2,0.15)	(0.65,0.35,0.30)	(0.9,0.1,0.05)	(0.9,0.1,0.05)	(0.2,0.75,0.80)
RWC_{12}	(0.8,0.2,0.15)	(0.5,0.5,0.45)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.9,0.1,0.05)	(0.8,0.2,0.15)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.35,0.65,0.60)
RWC_{13}	(0.65,0.35,0.30)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.9,0.1,0.05)	(0.9,0.1,0.05)	(0.8,0.2,0.15)	(0.8,0.2,0.15)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.5,0.5,0.45)
RWC_{14}	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.5,0.5,0.45)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.9,0.1,0.05)	(0.8,0.2,0.15)	(0.65,0.35,0.30)	(0.65,0.35,0.30)
RWC_{15}	(0.5,0.5,0.45)	(0.9,0.1,0.05)	(0.8,0.2,0.15)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.9,0.1,0.05)	(0.8,0.2,0.15)
	RWR_{1}	RWR_{2}	RWR_{3}	RWR_{4}	RWR_{5}	RWR_{6}	RWR_{7}	RWR_{8}	RWR_{9}	RWR_{10}
RWC_{1}	(0.9,0.1,0.05)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.35,0.65,0.60)	(0.9,0.1,0.05)	(0.8,0.2,0.15)
RWC_{2}	(0.8,0.2,0.15)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.35,0.65,0.60)	(0.9,0.1,0.05)	(0.9,0.1,0.05)	(0.5,0.5,0.45)	(0.9,0.1,0.05)
RWC_{3}	(0.65,0.35,0.30)	(0.35,0.65,0.60)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.35,0.65,0.60)	(0.9,0.1,0.05)	(0.65,0.35,0.30)	(0.2,0.75,0.80)
RWC_{4}	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.35,0.65,0.60)	(0.9,0.1,0.05)	(0.9,0.1,0.05)	(0.65,0.35,0.30)	(0.8,0.2,0.15)	(0.2,0.75,0.80)
RWC_{5}	(0.35,0.65,0.60)	(0.5,0.5,0.45)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.35,0.65,0.60)	(0.9,0.1,0.05)	(0.9,0.1,0.05)	(0.35,0.65,0.60)
RWC_{6}	(0.2,0.75,0.80)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.35,0.65,0.60)	(0.9,0.1,0.05)
RWC_{7}	(0.2,0.75,0.80)	(0.5,0.5,0.45)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.35,0.65,0.60)	(0.9,0.1,0.05)	(0.35,0.65,0.60)	(0.65,0.35,0.30)
RWC_{8}	(0.9,0.1,0.05)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.35,0.65,0.60)	(0.9,0.1,0.05)	(0.8,0.2,0.15)
RWC_{9}	(0.9,0.1,0.05)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.35,0.65,0.60)	(0.9,0.1,0.05)
RWC_{10}	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.35,0.65,0.60)	(0.9,0.1,0.05)	(0.8,0.2,0.15)	(0.2,0.75,0.80)
RWC_{11}	(0.8,0.2,0.15)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.35,0.65,0.60)	(0.9,0.1,0.05)	(0.2,0.75,0.80)
RWC_{12}	(0.8,0.2,0.15)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.35,0.65,0.60)	(0.9,0.1,0.05)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.35,0.65,0.60)
RWC_{13}	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.35,0.65,0.60)	(0.9,0.1,0.05)	(0.9,0.1,0.05)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.5,0.5,0.45)
RWC_{14}	(0.5,0.5,0.45)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.35,0.65,0.60)	(0.9,0.1,0.05)	(0.35,0.65,0.60)	(0.9,0.1,0.05)	(0.65,0.35,0.30)
RWC_{15}	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.35,0.65,0.60)	(0.9,0.1,0.05)
	RWR_{1}	RWR_{2}	RWR_{3}	RWR_{4}	RWR_{5}	RWR_{6}	RWR_{7}	RWR_{8}	RWR_{9}	RWR_{10}
RWC_{1}	(0.9,0.1,0.05)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)
RWC_{2}	(0.8,0.2,0.15)	(0.5,0.5,0.45)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)
RWC_{3}	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)
RWC_{4}	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.65,0.35,0.30)	(0.8,0.2,0.15)	(0.2,0.75,0.80)
RWC_{5}	(0.35,0.65,0.60)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)
RWC_{6}	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.9,0.1,0.05)	(0.2,0.75,0.80)	(0.5,0.5,0.45)
RWC_{7}	(0.2,0.75,0.80)	(0.5,0.5,0.45)	(0.5,0.5,0.45)	(0.5,0.5,0.45)	(0.2,0.75,0.80)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)
RWC_{8}	(0.9,0.1,0.05)	(0.35,0.65,0.60)	(0.35,0.65,0.60)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)
RWC_{9}	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.65,0.35,0.30)	(0.9,0.1,0.05)
RWC_{10}	(0.9,0.1,0.05)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.8,0.2,0.15)	(0.8,0.2,0.15)	(0.2,0.75,0.80)
RWC_{11}	(0.8,0.2,0.15)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.2,0.75,0.80)
RWC_{12}	(0.8,0.2,0.15)	(0.5,0.5,0.45)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.35,0.65,0.60)
RWC_{13}	(0.65,0.35,0.30)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.5,0.5,0.45)	(0.5,0.5,0.45)
RWC_{14}	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.65,0.35,0.30)	(0.65,0.35,0.30)
RWC_{15}	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.65,0.35,0.30)	(0.65,0.35,0.30)	(0.5,0.5,0.45)	(0.35,0.65,0.60)	(0.2,0.75,0.80)	(0.9,0.1,0.05)	(0.8,0.2,0.15)

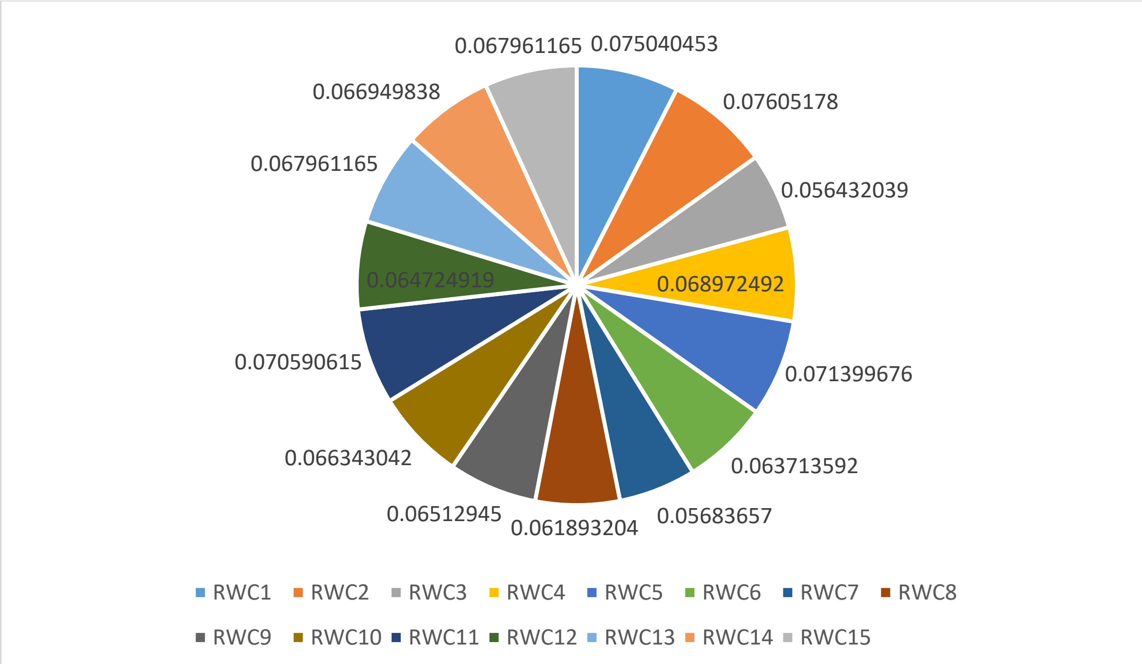

Figure 3. The criteria weighs.

Phase 6. Eq. (19) is used to compute the average solution.

Phase 7. Eqs. (20-23) are used to compute the positive and negative distance from the average solution as shown in Table 2.

Phase 8. Eq. (24) is used to compute the weighted average solution as shown in Table 3.

Phase 9. Eq. (25) is used to compute the weighted normalized average solution as shown in Table 4.

Table 2. The distance from the positive and negative average solution.

	RWR_1	**RWR_2**	**RWR_3**	**RWR_4**	**RWR_5**	**RWR_6**	**RWR_7**	**RWR_8**	**RWR_9**	**RWR_{10}**
RWC_1	0.48248	0.078167	0.078167	0.132075	0	0	0.078167	0	0.132075	0
RWC_2	0.303191	0	0	0	0.143617	0	0.329787	0.25	0	0.090426
RWC_3	0.433692	0.003584	0.003584	0	0	0.003584	0.003584	0.397849	0.218638	0
RWC_4	0	0	0.055718	0.407625	0	0.290323	0	0.173021	0.43695	0
RWC_5	0	0.189802	0.133144	0	0	0.303116	0	0.274788	0.246459	0
RWC_6	0	0.365079	0	0	0.238095	0	0	0.68254	0	0.238095
RWC_7	0	0.103203	0.103203	0	0	0.423488	0.3879	0.281139	0	0.103203
RWC_8	0.797386	0	0	0.013072	0	0	0.111111	0	0.176471	0.20915
RWC_9	0.552795	0	0	0.118012	0	0	0	0	0.055901	0.708075
RWC_{10}	0.432927	0	0	0.036585	0	0	0	0.554878	0.493902	0
RWC_{111}	0.404011	0.146132	0	0	0	0	0.146132	0	0.174785	0
RWC_{12}	0.53125	0	0	0	0.34375	0.03125	0.21875	0	0	0
RWC_{13}	0.10119	0	0	0.428571	0.160714	0.339286	0.25	0	0	0
RWC_{14}	0.02719	0	0	0	0.117825	0	0.329305	0	0.359517	0.208459
RWC_{15}	0	0	0.077381	0	0	0.345238	0.52381	0.255952	0	0

Table 3. The weighted average solution.

	RWR$_1$	RWR$_2$	RWR$_3$	RWR$_4$	RWR$_5$	RWR$_6$	RWR$_7$	RWR$_8$	RWR$_9$	RWR$_{10}$
RWC$_1$	0.036206	0.005866	0.005866	0.009911	0	0	0.005866	0	0.009911	0
RWC$_2$	0.023058	0	0	0	0.010922	0	0.025081	0.019013	0	0.006877
RWC$_3$	0.024474	0.000202	0.000202	0	0	0.000202	0.000202	0.022451	0.012338	0
RWC$_4$	0	0	0.003843	0.028115	0	0.020024	0	0.011934	0.030138	0
RWC$_5$	0	0.013552	0.009506	0	0	0.021642	0	0.01962	0.017597	0
RWC$_6$	0	0.023261	0	0	0.01517	0	0	0.043487	0	0.01517
RWC$_7$	0	0.005866	0.005866	0	0	0.02407	0.022047	0.015979	0	0.005866
RWC$_8$	0.049353	0	0	0.000809	0	0	0.006877	0	0.010922	0.012945
RWC$_9$	0.036003	0	0	0.007686	0	0	0	0	0.003641	0.046117
RWC$_{10}$	0.028722	0	0	0.002427	0	0	0	0.036812	0.032767	0
RWC$_{111}$	0.028519	0.010316	0	0	0	0	0.010316	0	0.012338	0
RWC$_{12}$	0.034385	0	0	0	0.022249	0.002023	0.014159	0	0	0
RWC$_{13}$	0.006877	0	0	0.029126	0.010922	0.023058	0.01699	0	0	0
RWC$_{14}$	0.00182	0	0	0	0.007888	0	0.022047	0	0.02407	0.013956
RWC$_{15}$	0	0	0.005259	0	0	0.023463	0.035599	0.017395	0	0

Table 4. The weighted normalized average solution.

	RWR$_1$	RWR$_2$	RWR$_3$	RWR$_4$	RWR$_5$	RWR$_6$	RWR$_7$	RWR$_8$	RWR$_9$	RWR$_{10}$
RWC$_1$	1	0.162011	0.162011	0.273743	0	0	0.162011	0	0.273743	0
RWC$_2$	0.919355	0	0	0	0.435484	0	1	0.758065	0	0.274194
RWC$_3$	1	0.008264	0.008264	0	0	0.008264	0.008264	0.917355	0.504132	0
RWC$_4$	0	0	0.127517	0.932886	0	0.66443	0	0.395973	1	0
RWC$_5$	0	0.626168	0.439252	0	0	1	0	0.906542	0.813084	0
RWC$_6$	0	0.534884	0	0	0.348837	0	0	1	0	0.348837
RWC$_7$	0	0.243697	0.243697	0	0	1	0.915966	0.663866	0	0.243697
RWC$_8$	1	0	0	0.016393	0	0	0.139344	0	0.221311	0.262295
RWC$_9$	0.780702	0	0	0.166667	0	0	0	0	0.078947	1
RWC$_{10}$	0.78022	0	0	0.065934	0	0	0	1	0.89011	0
RWC$_{111}$	1	0.361702	0	0	0	0	0.361702	0	0.432624	0
RWC$_{12}$	1	0	0	0	0.647059	0.058824	0.411765	0	0	0
RWC$_{13}$	0.236111	0	0	1	0.375	0.791667	0.583333	0	0	0
RWC$_{14}$	0.07563	0	0	0	0.327731	0	0.915966	0	1	0.579832
RWC$_{15}$	0	0	0.147727	0	0	0.659091	1	0.488636	0	0

Phase 10. Eq. (26) is used to compute the appraisal score value as shown in Figure 4.

Phase 11. Order the alternatives

Figure 4 shows the alternative 1 has the highest score, followed by alternative 8 and alternative 7. Alternative 3 has the lowest rank followed by alternative 2 and alternative 5.

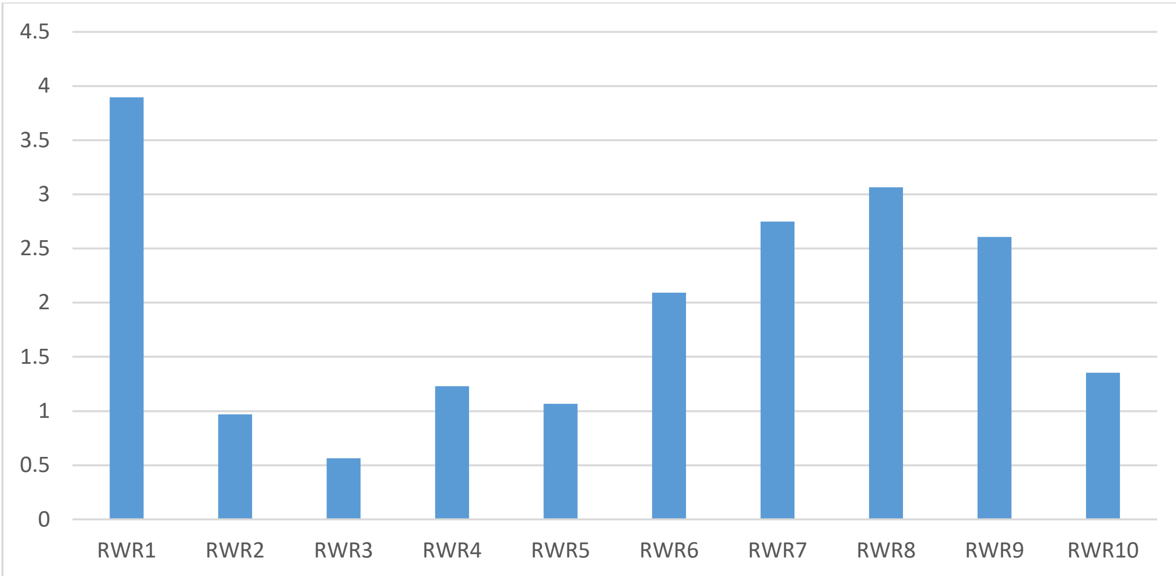

Figure 4. The appraisal score for each alternative.

6. Conclusions

This study proposed a decision-making methodology to evaluate the renewable energy sources under leadership in international climate policy. This study applied the EDAS method to rank the alternatives. A single-valued neutrosophic set is used to deal with vague and uncertain information. Three experts and decision-makers with experience in leadership, policy, and renewable energy are invited to evaluate the criteria and alternatives. They used the linguistic terms of single-valued neutrosophic sets. Then, we replace these terms with single-valued neutrosophic numbers. Then, we obtained the crisp values. Then, we combined the decision matrix into a single decision matrix. This study used the TreeSoft set to deal with the problem as a tree. Fifteen criteria and 10 alternatives were used in this study. The criteria weights are computed by using the average method. The results show that Criterion 2 has the highest importance and Criterion 3 has the lowest. EDAS method is used to rank the alternatives. The average method is computed between criteria and alternatives. The positive and negative distance from the positive and negative criteria are calculated. The rank results show that alternative 1 is the best and alternative 3 is the worst.

Various MCDM methods, such as AHP, BWM, and DEMATEL, can be applied to compute the criteria weights. The relationship between criteria can be calculated. There are various rank methods can be used, such as TOPSIS, VIKOR, etc.

Conflict of interest

The authors declare that there is no conflict of interest in the research.

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Ethical approval
This article does not contain any studies with human participants or animals performed by any of the authors.

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