Neutrosophic TOPSIS for prioritization Social Responsibility Projects

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Abstract

Social responsibility is the most important thing to consider while working on a project. When deciding on a project or taking part in a bid, it is crucial to understand the nature and potential consequences of the risks involved. Attempting to implement projects with cutting-edge technologies appears to be necessary, necessitating up-to-date and continuous planning to implement the relevant matters in light of the ever-increasing growth of urban communities, the need to carry out tasks, and the rising standard of living. Due to the strong demand, these strategies try to improve quality while decreasing prices. In the beginning, Smarandache suggests using neutrosophic sets. These sets are an improvement above traditional fuzzy set theory in reflecting the uncertainty and fuzziness of real-world issues. Three decision-making states are considered: uncertainty, truthiness, and falseness. The fuzzy set degree in Zadeh's classic theory is merely the membership function. On the other hand, three membership functions are considered in a neutrosophic setting. An indeterminacy degree is considered, which is not the case with intuitionistic fuzzy sets. To express decision makers' perspectives on the truthiness (T), falsity (F), and indeterminacy (I) for a fuzzy set concurrently, this paper expands the usual neutrosophic TOPSIS approach to interval-valued neutrosophic. One example of how the suggested strategy might be put to use is to prioritize initiatives in the realm of corporate social responsibility using a combination of expert opinion and objective criteria.

Keywords: Social Personality; Neutrosophic Sets; MCDM; TOPSIS; Interval Valued.

1. Introduction

Selecting suitable projects is the first step in project-based companies' strategic and intentional project management. Two bad outcomes might result from selecting the wrong initiatives. On only one hand, the company loses money because of the time and effort put into unprofitable ventures, while on the other, it generates less money overall. The organization will reap more rewards if the correct initiatives are chosen. It's not uncommon for competing priorities to complicate the project

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selection challenge. Because there are so many projects from which to choose, the project selection issue is difficult. Both Archer and Ghasemzadeh and other practical and academic scientists have stressed the significance of the project selection and prioritizing procedure in project portfolio management. The organizational culture, attitude, and strategy determine how a project is executed [1]–[4].

Projects may also be influenced by the company's project management system and the degree of experience its project managers have. Projects that include external units like mutual investments are influenced by much more than one business. What follows is a description of an organization's structure and features that are likely to impact the project. With the requirement to balance financial and strategic priorities, it may be challenging to determine how best to allocate resources among competing projects. This focus and amalgamation call for methodical decision-making procedures, which are helpful when picking projects for a portfolio. Recent studies have demonstrated the significance of a well-structured decision-making process that includes a logical framework with a sequence of daily tasks in the established stages, the application of appropriate tools and techniques, and the active participation of those making the decisions. It's indisputable that many projects fall short of their intended objectives, resources, expenses, scope, and time because of the inherent uncertainty of initiatives[5]–[8].

The presence of uncertainty and danger in the project has lowered the precision of the goal estimate and slowed the project's progress. With this in mind, we may define project risk as the potential for an event that has the highest potential to impact the project's goals and outcomes negatively. Experts in the field of project risk management have established various meanings and definitions of the term "risk management," the most complete of which was recently offered by Burke and the project investment firm. Burke defines risk management as "the systematic approach to recognizing, understanding, and mitigating the potential for adverse and advantageous outcomes in any given project," which involves "optimizing the good and mitigating the bad". One of the most pressing issues facing modern management consultants and stakeholders is how to properly and thoroughly manage the costs of a project. Due to constraints on the project's ability to be completed within the authorized and projected budget, project management, and notably appropriate cost management, plays a more pivotal role in the case of a crisis[9], [10].

Managing the budget is an integral part of every project manager's responsibilities. One of the primary factors for success is the accurate result of each project at or below the estimated cost. Failing to do so will fail to fulfill the employer's needs and the project's goals. It is the belief of those who practice cost control that no expenses arise from nothing but rather the direct outcome of choices made by upper-level management about allocating the available resources within a company. Managers' actions are heavily influenced by the cost management mindset, which aims to maximize value for everyone involved by combining resources in novel ways.

The company's bottom line is the sum total of all its goals, actions, and financial and manufacturing choices. The loss and profit statement is a summary of the outcomes of the business's operations and business project at the time; it contains the vast majority of the information necessary for evaluating the administrative functions of the firm. Whether or whether a business can consistently turn a profit is referred to as its profitability. Profitability may be assessed by looking at the net income or profit. Profitability analysis is essential for attracting investors and securing financing for businesses. To get the necessary funding, companies must generate sufficient profits to satisfy the expectations of investors and lenders. Businesses can't develop new initiatives or repay debts to shareholders and creditors if they aren't making a profit. The term "corporate social responsibility" (CSR) refers to a company's obligation to positively contribute to society. When it comes to openness and stakeholder responsibility, the best companies act in a highly ethical manner.

These groups advocate for a world where corporations are held socially responsible for their actions and environmental sustainability is prioritized. Their core beliefs center on a commitment to social responsibility. By keeping open communication channels with many interested parties, they cannot only meet but exceed local and international standards and requirements. Companies with a strong commitment to social responsibility have more social capital because they are more likely to have positive connections with their key constituencies. Customers pay more attention to businesses prioritizing social responsibility, and investors are willing to invest more money into such businesses. The risk to the whole system will be lowered.

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Every element of life necessitates some Multi-Attribute Decision Making (MADM). Consumers must consider various factors when purchasing a cell phone online or enrolling in a certain professional development course at a learning center. For a given collection of choices linked by several competing criteria, MADM identifies the one that provides the best level of satisfaction. Numerous methods have been developed to address MADM issues, including PROMETHEE, VIKOR, ELECTRE, AHP, and TOPSIS.

In most cases, no one tactic will perform better than the others. One such option is the TOPSIS approach suggested by Hwang and Yoon. TOPSIS's core principle is that the optimal choice should be the one closest to the PIS and furthest from the NIS[11]–[13].

This paper's goal is to broaden the applicability of the TOPSIS method to single-valued neutrosophic sets (SVNSs) and interval neutrosophic sets (INSs) in the context of MAGDM issues.

The paper is built on the idea of an ideal decision matrix, which we get to by averaging many smaller decision matrices. We use the Hamming distance to quantify how well a given decision matrix corresponds to the "ideal" one. We provide authority to various decision-makers based on their likeness to the group. Following this, we offer two expanded TOPSIS techniques for MAGDM in an SVNS and INS setting. In the suggested TOPSIS techniques, we apply a revised proximity measure to choose the optimal solution[14]–[17].

The distances from the average solution of the normalized criterion scores in the decision matrix are the foundation of the Evaluation Based on Distance from Average Solution (EDAS) technique of evaluative reasoning. This median solution is used to determine how far apart positive and negative ideal answers are. Considering both negative and positive ideal solutions, we choose the optimal option.

Growth in fuzzy decision-making models is occurring in tandem with the expansion of MCDM approaches. Various MCDM approaches use variations on standard fuzzy set extensions. There are many different kinds of fuzzy MCDM procedures, but some common ones include fuzzy TOPSIS, VIKOR, ELECTRE, and PROMETHEE. Keshavarz Ghorabaee et al. created the conventional fuzzy EDAS approach. Kahraman et al. suggested an intuitive fuzzy EDAS approach (2017). The EDAS technique using Interval Grey Numbers has been investigated by Stanujkic et al. Famously, Ghorabaee et al. popularised the expanded EDAS approach using interval type-2 fuzzy sets. This paper presented a unique application of the EDAS approach using the interval-valued form of neutrosophic fuzzy numbers[18]–[21].

A proposition in classical Boolean logic is either correct or false; in traditional set theories, a component may either belong to a collection or not; and in optimization, a method can either be viable or not. However, real-world circumstances are seldom quantifiable to such an exact degree. Fuzzy sets, established to describe the membership degree to correlate to complexity, were developed to account for this ambiguity. Numerous variants have emerged since the introduction of fuzzy sets. To deal with the ambiguity of the membership value in fuzzy set theory, the type-n fuzzy set was created. Independently afterward, presented interval-valued fuzzy sets (IVFSs). To account for human uncertainty in decision-making, the concept of intuitionistic fuzzy sets (IFSs) was first proposed in 1986. Hesitant fuzzy sets (HFSs) are expansions of conventional fuzzy sets where many values are available for the member of a single part[22]–[25].

Despite these elaborations, the possibility of an indeterminacy component in addition to membership and nonmembership has not been examined. Neutrosophic sets (NSs) are an expansion of intuitionistic fuzzy sets that were created by Smarandache. In the neutrosophic set, the degrees of truthiness, indeterminacy, and falsehood for all of the universe's components are inside the quasi-unit interval. Truth (degree of belongingness), falsehood (degree of non-belongingness), and indeterminacy all stand in for the unknown in neutrosophic sets (degree of hesitancy). Neutrosophic sets use this notation to highlight indecision that arises from contradictory data, in addition to indicating the confidence of the system or experts. We think of the true and false values as the

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membership and non-membership functions, and the uncertain value as the hesitation. The question of why neutrosophic sets are used in this investigation is answered by all of their aforementioned characteristics. With this method, we create and use deneutrosophication and subtraction functions for the interval-valued neutrosophic TOPSIS method.

An interval-valued neutrosophic EDAS approach is created and implemented for the first time in the scientific literature to a supplier selection issue of a facility, to the best of our knowledge. Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) and VIKOR are two distance-based multi-attribute purchase decision strategies that are analogous to this one. There is a new formula described for the subtraction operation of neutrosophic integers, and a new deneutrosophication technique is presented that may be used as a classification algorithm for neutrosophic sets. In addition, the factors and options are settled upon by a panel of experts, and the weights of factors and the ratings of the decision matrix are calculated collectively according to the group's consensus.

2. Preliminaries for Neutrosophic Sets

In this example, we will use the generic element x to refer to anything in the space of points (objects) designated by X. Neutrosophic sets in X may be described by their truth, indeterminacy, and falsity membership functions (TA(x), IA(x), and FA(x) respectively) (x). Denoting a neutrosophic set with

In the formula A=x,TA(x),IA(x),FA(x), (1) where TA(x), IA(x), and FA(x) are real standard or non-standard subsets of]0,1+[, that is, TA(x):X]; (2) where x is a real number.

$$-0,1[, IA(x): X \rightarrow]$$

$$As\ in, [and\ FA(x): X][and][0,1+].$$

When added together, the three membership functions TA(x), IA(x), and FA(x) have the following properties:

$$-0 \leq supTA(x) + supIA(x) + supFA(x) \leq 3 +$$

Definition 1:
Consider the realm of conversation to be X. For a set X in the interval neutrosophic space A over X, we have an object of the type

Where $TA(x) \subseteq [0,1], IA(x) \subseteq [0,1], and\ FA(x) \subseteq [0,1]$ are interval numbers and $0 \leq supTA(x) + supIA(x) + supFA(x) \leq 3$ for every x⊆X .

$TA(x), IA(x), and\ FA(x)$ are the intervals that map the degree of truth membership, indeterminacy membership, and falsity membership of x to A. We assume for simplicity $that\ A = [a, b], [c, d], [e, f]$, where

$$TA(x) = [a, b][0,1], IA(x) = [c, d][0,1],$$
$$FA(x) = [e, f][0,1], and\ 0b + d + f3.$$

Definition 2:

$Let\ A1 = [a1, b1, c1, d1, e1, f1] and\ A2 = [a2, b2, c2, d4, e2, f2]$
$be\ two\ interval\ neutrosophic\ sets\ in\ the\ universe\ of\ discourse\ X,$
$respectively. After\ that, the\ following\ procedures\ are\ outlined:$

$A{\sim}1 \oplus A{\sim}2 = \langle[a1 + a2 - a1a2, b1 + b2 - b1b2], [c1c2, d1d2],$

$[e1e2, f1f2]\rangle; \backslash s(14)\ \backslash sA{\sim}1 \otimes A{\sim}2 = \langle[a1a2, b1b2],$
$[c1 + c2 - c1c2, d1 + d2 - d1d2],$
$$[e1 + e2 - e1e2, f1 + f2 - f1f2]\rangle;$$

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$\lambda A{\sim}1 = \langle [a\lambda 1, b\lambda 1], [1-(1-c1)\lambda, 1-(1-d1)\lambda]$
$, [1-(1-e1)\lambda, 1-(1-f1)\lambda]\rangle, for \lambda > 0,$
$(A{\sim}1)\lambda = \langle [a\lambda 1, b\lambda 1], [1-(1-c1)\lambda,$
$1-(1-d1)\lambda], [1-(1-e1)\lambda, 1-(1-f1)\lambda]\rangle, for \lambda > 0,$

Definition 3:

If we take any two neutrosophic numbers in the range

$X = x1, x2, \dots, xn, say\ A1 = [a(1)j, b(1)j], [c(1)j, d(1)j], [e(1)j, f(1)j],$

$$and\ A2 = [a(2)j, b(2)j], [c(2)j, d(1)j], [e(1)j, f(2)j]],$$

$$then\ the\ normalized\ Hamming\ distance\ between\ A1\ and\ A2\ is$$

$$d(A{\sim}1, A{\sim}2) = \frac{1}{6n}\sum_{j=1}^{n}\begin{pmatrix} |a_j^{(1)} - a_j^{(2)}| + |b_j^{(1)} - b_j^{(2)}| \\ +|c_j^{(1)} - c_j^{(2)}| + |d_j^{(1)} - d_j^{(2)}| + \\ |e_j^{(1)} - e_j^{(2)}| + |f_j^{(1)} - f_j^{(2)}| \end{pmatrix}$$

Similarity

$$S(A{\sim}1, A{\sim}2) = 1 - \frac{1}{6n}\sum_{j=1}^{n}\begin{pmatrix} |a_j^{(1)} - a_j^{(2)}| + |b_j^{(1)} - b_j^{(2)}| \\ +|c_j^{(1)} - c_j^{(2)}| + |d_j^{(1)} - d_j^{(2)}| + \\ |e_j^{(1)} - e_j^{(2)}| + |f_j^{(1)} - f_j^{(2)}| \end{pmatrix}$$

Definition 4:

$$Let\ M1 = ([a(1)ij, b(1)ij], [c(1)ij, d(1)ij], [e(1)ij, f(1)ij])mxn$$

$$and\ M2 = ([a(2)ij, b(2)ij], [c(2)ij, d(2)ij], [e(2)ij, f(2)ij])mxn$$

$$be\ any\ two\ matrices\ in\ which\ the\ entries\ are\ expressed\ in\ terms$$

$$of\ INSs\ [a(1)ij, b(1)ij$$

If so, then the difference between M1 and M2 in terms of the normalized Hamming distance is

$$d(M{\sim}1, M{\sim}2) = \frac{1}{6mn}\sum_{i=1}^{m}\sum_{j=1}^{n}\begin{pmatrix} |a_j^{(1)} - a_j^{(2)}| + |b_j^{(1)} - b_j^{(2)}| \\ +|c_j^{(1)} - c_j^{(2)}| + |d_j^{(1)} - d_j^{(2)}| + \\ |e_j^{(1)} - e_j^{(2)}| + |f_j^{(1)} - f_j^{(2)}| \end{pmatrix}$$

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$$S(M\sim1,M\sim2) = 1 - \frac{1}{6mn}\sum_{i=1}^{m}\sum_{j=1}^{n}\begin{pmatrix} \left|a_j^{(1)} - a_j^{(2)}\right| + \left|b_j^{(1)} - b_j^{(2)}\right| \\ +\left|c_j^{(1)} - c_j^{(2)}\right| + \left|d_j^{(1)} - d_j^{(2)}\right| + \\ \left|e_j^{(1)} - e_j^{(2)}\right| + \left|f_j^{(1)} - f_j^{(2)}\right| \end{pmatrix}$$

Definition 5:

$$Let\ A = A1, A2, \ldots, An\ be\ a\ set\ of\ INSs, where$$
$$Aj = [aj], [bj], [cj, dj], [ej, fj](j = 1,2, \ldots, n) and\ if\ Aj$$
$$= [aj], [bj], [cj, dj], [ej, fj](j = 1,2, \ldots, n)\ then$$

$$If\ w = (w1, w2, \ldots, wn)T\ is\ the\ weight\ vector\ of\ Aj(j$$
$$= 1,2, \ldots, n)\ with\ weight\ wj[0,1]\ and\ nj = 1wj$$
$$= 1, then\ INWA\ is\ an\ interval\ neutrosophic\ weighted\ averaging\ (INWA)$$
$$the\ operator\ of\ dimension\ n.$$

An INS is the sum of all INSs, and its definition is

$$INWA(A1, A2, \ldots, An)$$
$$\left[1 - \prod_{j=1}^{n}(1 - a_j)^{w_j}, 1 - \prod_{j=1}^{n}(1 - b_j)^{w_j}\right],$$
$$\left[\prod_{j=1}^{n}(c_j)^{w_j}, \prod_{j=1}^{n}(d_j)^{w_j}\right],$$
$$\left[\prod_{j=1}^{n}(e_j)^{w_j}, \prod_{j=1}^{n}(f_j)^{w_j}\right]$$
$$For\ a\ weight\ vector\ w = \left(\frac{1}{n}, \frac{1}{n}, \ldots, \frac{1}{n}\right)^T,$$
$$INWA\ simplifies\ the\ arithmetic\ aggregation\ operator\ of\ the\ INSs.$$

3. Neutrosophic TOPSIS

Among the many methods for coping with MADM and MAGDM, TOPSIS [6] is often used.

The steps of the TOPSIS approach are briefly outlined here.

1. The first step is to build a decision matrix.

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2. Two, standardize the decision matrix.
3. Step Three: Determine the Normalized Weighted Decision Matrix.
4. Find the optimal positive and negative answers in Part IV.
5. V. Determine how far each potential solution is from the positive and negative ideals.
6. Use distance indicators to determine the relative proximity coefficients.
7. Rate the available choices.

Let's say you're trying to solve an INS-based MAGDM issue in which you have a limited number of attributes and a collection of possible solutions denoted by A=[A1, A2,..., Am]. Consider the property $Cj(j = 1,2,\ldots,n)$, and label it with the $weight\ wj$ $(0wj1\ and\ nj = 1wj = 1)$. $Let\ D = (D1, D2, \ldots, Dp)$ represent the p-member panel of decision-makers and let k(k=1,2,...,p) represent the weight of panel member Dk, where 0k1 and $pk = 1k = 1.$ $Let\ ukij = (Tkij, Ikij, Fkij)$ represent INSs, and let $Uk = [ukij]mn$ be the decision matrix. The subsets $Tkij = [TkLij, TkUij], Ikij = [IkLij, IkUij], and\ Fkij = [FkLij, FkUij]$ of the unit interval [0,1] $that\ fulfil\ 0 \leq sup > sup >\ are\ Tkij, Ikij, and\ Fkij,$ respectively. $T{\sim}kij + sup\ I{\sim}kij + sup\ F{\sim}kij \leq 3$. The assessment information of the characteristic Cj with regard to the option Ai supplied by the decision-making process Dk may be described by the rating value $(Tkij, Ikij, Fkij)$.

The following are the stages of the alternative selection procedure:

First, you'll need to determine how much influence each stakeholder has.

Let's say you're making use of a decision matrix $U^k = (ukij)mxn$, where

$$U^k = \begin{bmatrix} T^k_{11}, I^k_{11}, F^k_{11}. & \cdots & T^k_{1n}, I^k_{1n}, F^k_{1n} \\ \vdots & \ddots & \vdots \\ T^k_{m1}, I^k_{m1}, F^k_{m1} & \cdots & T^k_{mn}, I^k_{mn}, F^k_{mn}. \end{bmatrix}$$

Now, we suggest an ideal matrix, Uk(k=1,2,...,p), by averaging the collection of p decision matrices.

$$U^* = \begin{bmatrix} T^*_{11}, I^*_{11}, F^*_{11}. & \cdots & T^*_{1n}, I^*_{1n}, F^*_{1n} \\ \vdots & \ddots & \vdots \\ T^*_{m1}, I^*_{m1}, F^*_{m1} & \cdots & T^*_{mn}, I^*_{mn}, F^*_{mn}. \end{bmatrix}$$

$$U^* = \frac{1}{p}\sum_{k=1}^{p} U^k = T^k_{11}, I^k_{11}, F^k_{11}$$

$$\left[1 - \prod_{k=1}^{p}(1 - T_j\ )^{\frac{1}{p}}, 1 - \prod_{k=1}^{p}(1 - T_j\ )^{\frac{1}{p}}\right],$$

$$\left[\prod_{k=1}^{p}(I_j\ )^{\frac{1}{p}}, \prod_{k=1}^{p}(I_j\ )^{\frac{1}{p}}\right],$$

$$\left[\prod_{k=1}^{p}(F\ )^{\frac{1}{p}}, \prod_{k=1}^{p}(F_j\ )^{\frac{1}{p}}\right]$$

We employ the notion of Step 1 of Sect. 5 to compute the weights of the decision-makers. As a result, we can calculate how close each choice is to the optimal one by using the formula

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$$1-\frac{1}{6mn}\sum_{i=1}^{m}\sum_{j=1}^{n}\begin{pmatrix}\left|T_j^{(1)}-T_j^{(2)}\right|+\left|T_j^{(1)}-T_j^{(2)}\right|\\ +\left|I_j^{(1)}-I_j^{(2)}\right|+\left|I_j^{(1)}-I_j^{(2)}\right|+\\ \left|F_j^{(1)}-F_j^{(2)}\right|+\left|f_j^{(1)}-f_j^{(2)}\right|\end{pmatrix}$$

Accept $\Psi=(\psi 1,\psi 2,\ldots,\psi p)^T$ to be the weight vector of p decision-makers

$$\Psi=\frac{S_i(U_k,U^*)}{\sum_{k=1}^{p}S_i(U_k,U^*)}$$

Sum the neutrosophic decision matrices over a given interval.

We generate an aggregated interval neutrosophic decision matrix by adding together all the individual matrices representing the various decisions made by each member of the group. U stands for the whole matrix of decisions.

Compute the relative importance of the characteristics.

i. Find the aggregated decision matrix and its weights

ii. Find the range of neutron-friendly optimal solutions

iii. calculations for dividing up

iv. See how near your results are to the perfect ones by determining the relative closeness coefficient.

v. Order the importance

Figure 1 shows the flowchart of the proposed method. Figure 2 shows the overview of the methodology.

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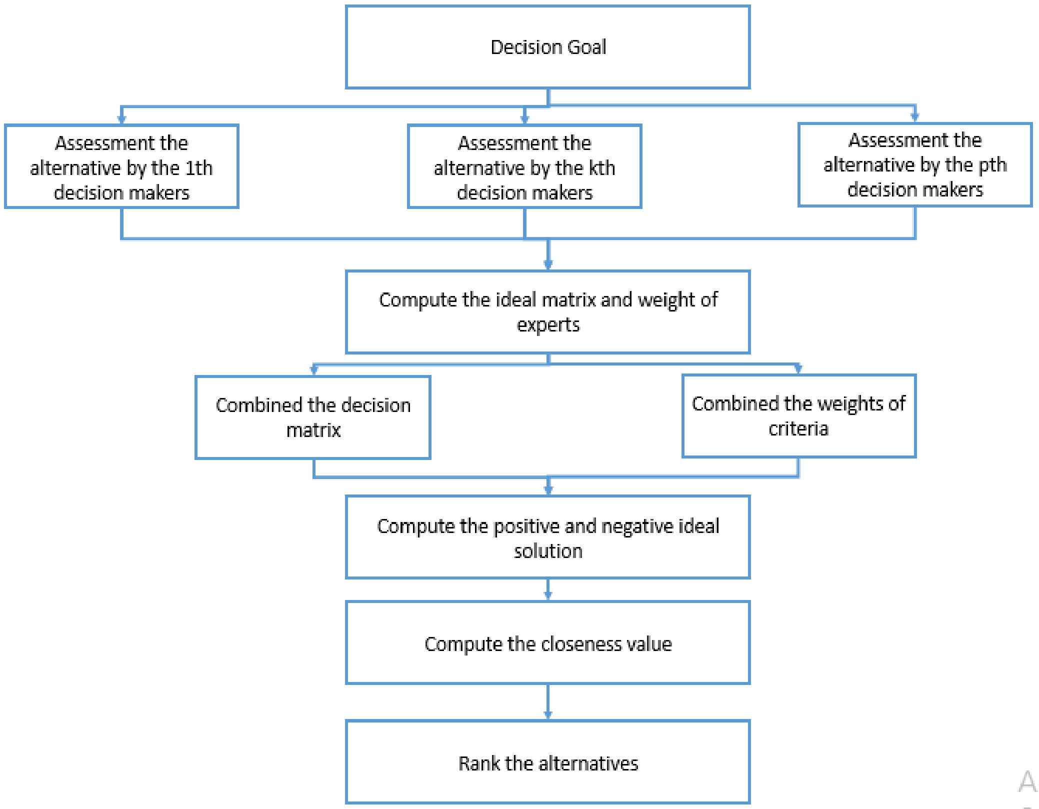

Figure 1: The flowchart of this paper.

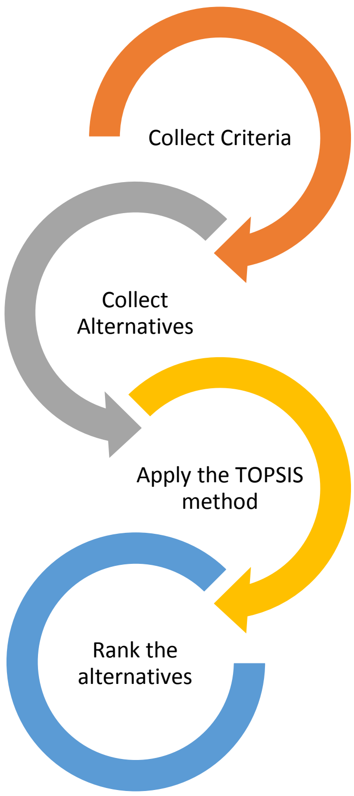

Figure 2: The overview of the methodology.

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4. Illustrative Example

A private company is interested in carrying out corporate social responsibility initiatives. We've set a $6,000,000 price tag for all of these endeavors together. The assessment criteria are listed in previous research [26]. In order to arrive at these standards, a thorough literature search was conducted. The choices and associated costs are shown in the literature review[26].

This section provides an example of how the suggested approach may be used to solve the issue described in Section 3.

First, all expert-related decision matrices.
In this case, linguistic concepts serve as the basis for the ratings. For the sake of brevity, the following tables will be presented by sample columns.

Second, Table 1 displays the aggregated decision matrix, which represents the typical IVN decision matrix (A).

The third step is the aggregate weight matrix of criteria that was constructed. An application of the aggregation procedure.

Table 1 provides the results of Steps 4 and 5: a created matrix of average criterion weights (AV) based on scores and the difference between positive and negative averages. The neutrosophic addition operators provided in the Introduction section are used to get the average weights of the criterion. For both the positively and negatively distances.

Procedures 6–7 are carried out, and the outcomes are listed. All the equations are solved in order, and the resulting solutions are recorded. Table 2 shows the normalized decision matrix. Figure 3 shows the rank of alternatives.

Our technique produces a ranking of A2, A6, A4, A1, A5, and A3 for the top 6 possibilities. With just $6,000,000 available, we can only develop A2, A6, A4, and A5.

Table 1: The combined decision matrix.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	0.522221	0.716667	0.63331	0.3667	0.727757	0.5833	0.716667	0.8833	0.41667	0.727757
A2	0.600011	0.5833	0.7111	0.5833	0.5833	0.8833	0.522221	0.8833	0.572213	0.8833
A3	0.400013	0.3667	0.5833	0.727757	0.36111	0.5111	0.305567	0.772211	0.716667	0.43331
A4	0.655556	0.8833	0.5833	0.322223	0.772211	0.400013	0.63331	0.8833	0.716667	0.7111
A5	0.522221	0.716667	0.63331	0.3667	0.727757	0.5833	0.716667	0.8833	0.41667	0.727757
A6	0.7833	0.6111	0.477766	0.5389	0.577766	0.672211	0.555556	0.727756	0.477767	0.5389

Table 2: The normalized decision matrix.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	0.359617	0.439781	0.425379	0.296165	0.463999	0.381821	0.49419	0.428624	0.299915	0.433118
A2	0.413186	0.357941	0.477629	0.471101	0.371897	0.578198	0.360107	0.428624	0.411873	0.525689
A3	0.275461	0.225025	0.391789	0.587771	0.230234	0.33456	0.210709	0.374718	0.515849	0.257881
A4	0.451435	0.542035	0.391789	0.260243	0.492342	0.261844	0.43671	0.428624	0.515849	0.423205
A5	0.359617	0.439781	0.425379	0.296165	0.463999	0.381821	0.49419	0.428624	0.299915	0.433118

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A 6	0.5394 04	0.375	0.3209 04	0.4352 42	0.3683 68	0.4400 22	0.3830 93	0.3531 46	0.3438 92	0.3207 22

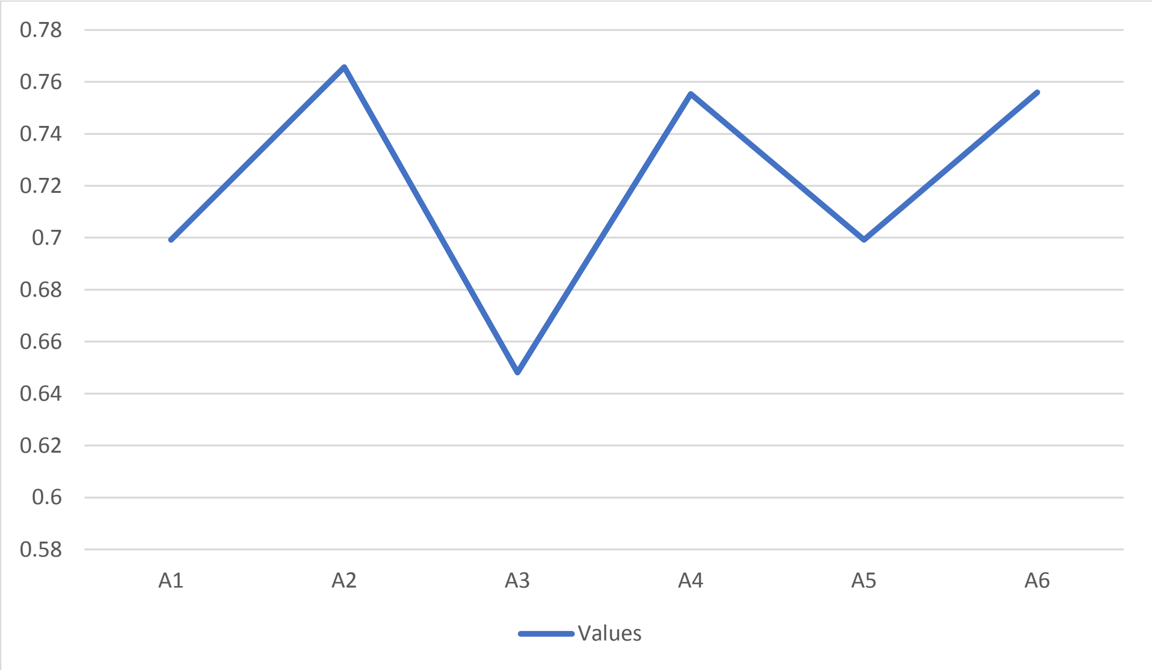

Figure 3: The rank of alternatives.

6. Conclusion

The TOPSIS technique is powerful for handling MADM and MAGDM difficulties in both stable and dynamic settings. Due to the decision maker's limited information processing skills and incomplete understanding of the characteristic, qualitative and quantitative evaluations of the rating values they supply are commonplace in MAGDM scenarios. Alternative methods that may successfully convey inaccurate, partial, and ambiguous data include the neutrosophic interval set. This paper focuses on the TOPSIS method for MAGDM in an interval-valued philosophical setting. Simplified aggregation operations based on neutrosophic arithmetic are used to average the judgments of all involved parties throughout the assessment process. Using the operators, we found the optimal matrix, from which we derived the similarity-measured weights for the decision-makers. Finally, we have synthesized diverse viewpoints into a unified whole.

Additionally, we have compiled attribute weights. An aggregated weighted choice matrix defines neutrosophic positive ideal and neutrosophic negative ideal solutions. Each alternative's updated relative proximity coefficient is derived by calculating its distance from both positive and negative ideal solutions, using the Hamming distance metric. Finally, we have used the suggested TOPSIS techniques to demonstrate their viability and efficiency in two exemplary situations.

Success rates for MADM challenges in many other sectors, including academic personnel selection, project assessment, vendor selection, production system, and many others, are quite high when using the recommended TOPSIS techniques with INS. The suggested TOPSIS techniques may also be expanded in many ways to cover a broader range of decision-making issues in various neutrosophic hybrid settings.

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