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SVNS-based multicriteria methods for the selection of management elements for academic diplomacy

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Abstract. The objective of this study was to demonstrate the usefulness of neutrosophic set theories for the selection of key elements for the management of academic diplomacy in higher education. For this, neutrosophic correlation coefficients were used, as well as multicriteria problem solving methods adapted in the field of neutrosophy. The alternatives to be evaluated were subjected to the methods selected for the study, after which a comparison and analysis of the results was carried out. The application of the methods made it possible to obtain a very well-defined set of the most significant elements for proper management of academic diplomacy, according to the experts involved in the study. The use of indeterminacies during the process, it allowed obtaining results of greater precision and appropriate to the reality of decision-making. It was possible to conclude that there was coherence between the results obtained from both analyses, expressed in the similarities of the results in terms of the most and least preferred alternatives.

Keywords: management, academic diplomacy, COPRAS, correlation coefficient, neutrosophy

1 Introduction

A definitive part of any scientific research process, without a doubt, is found in the decision-making processes. This is an indispensable part of scientific and human functioning.[1]. The inherent need to consider uncertain data for the realization of this decision process, allowed[two]introduce fuzzy set theory (FS) to overcome uncertain and imprecise data.

In the years that followed this, intensive efforts continued to be made in various fields of research to incorporate the vagueness of the initial information. In this way, the ability to solve complex practical problems in real life was sought.[3].

In this framework, Florentín Smarandache presented the theory of neutrosophic sets in 1995 as a generalization of "fuzzy" sets and "intuitionist fuzzy" sets. Neutrosophy is a branch of philosophy that studies the origin, nature, and scope of neutralities.[4]. In this new branch, membership to truth, membership to indeterminacy, and membership to falsehood are understood to be independent and lie in the non-standard unit interval] 0−, 1 + [.[5]

Over the years, the use of neutrosophy has spread to various branches of science, engineering, society, psychology, and others. This has led various specialists in the field to develop neutrosophic models associated with different classical techniques for evaluating problems. In this way, solutions can be given, in a more personalized and real way, to the different problems that arise in these fields.[6]

To facilitate the practical side of neutrosophic ensembles, Wang et al. defined a single-valued neutrosophic set (SVNS) and proposed set-theoretical operations and some properties of SVNS[7]. Associated with this, the use of neutrosophy has recently been proposed, combined with tools for multi-criteria decision making (MCDM)[8]. In these cases, with the objective of incorporating the vagueness of the information to solve problems, decision makers usually use subjective evaluation methods.[9]–[11]

Subsequently, the use of SVNS correlation coefficients was presented, based on the extension of the correlation coefficient of intuitionistic fuzzy sets. This demonstrated that the SVNS cosine similarity measure is a special case of the SVNS correlation coefficient, and was then applied to single-valued neutrosophic numbers applied to decision-making problems.[12]

The field of educational leadership has gradually begun to integrate a wide range of theories and concepts to cope with increasing diversity and the concurrent process of internationalization. However, there is a need for a more systematic and holistic approach to address the many challenges posed by globalization and glocalization. In this sense, the integration of universities as part of the development strategies of nation-states resulted in the adoption of many practices of interstate diplomacy in the field of educational leadership.

Traditional leadership programs in the field of education integrate the teaching of the importance of community-school relations; but this is taught as part of the public policy process and decision-making process. Also, the emphasis is on theories borrowed from public relations and organizational behavior rather than diplomacy.

The development of academic diplomacy within educational leadership requires the integration of traditional diplomacy with educational leadership theories. Thus, while much can be learned from traditional diplomat training programs, those skills and theories must be tailored to the specific needs of educational leadership. While diplomats tend to be generalists by nature and can therefore learn quickly on a wide range of topics, in the field of educational leadership there are some basic topics that are basic knowledge for educational leaders, such as curriculum design and educational administration, among others.

The purpose of this paper is focused on demonstrating the usefulness of neutrosophic set theories for the selection of key management elements of academic diplomacy, applicable in higher education. For this, the extension of the COPRAS-SVNS method is carried out, as well as the use of neutrosophic correlation coefficients and the comparison between them.[13], [14]

For an adequate understanding of the study, the following section presents a description of the methods used to achieve the results, as well as their logic. The third section shows a practical example after which the results achieved and the conclusions derived from the study are described.

2 Preliminaries

2.1 Single - valued neutrosophic sets

Definition 1. Let X be a space of points (objects), with a generic element in X denoted by x. A neutrosophic set A in X is characterized by a truth-membership function $T_A(x)$, an indeterminacy-membership function $I_A(x)$, and a falsity-membership function $F_A(x)$. The functions $T_A(x)$, $I_A(x)$ and $F_A(x)$ are real standard or nonstandard subsets of $]0^-,1^+[$, i.e., $T_A\,(x){:}X\to]0^-,1^+[$, $I_A\,(x){:}X\to]0^-,1^+[$ and $F_A\,(x){:}X\to]0^-,1^+[$. There is no restriction on the sum of $T_A\,(x)$, $I_A\,(x)$ and $F_A\,(x)$, so $0^- \le supT_A(x) + supI_A(x) + supF_A(x) \le 3^+$.

Obviously, it is difficult to apply the neutrosophic set to practical problems. Therefore, introduced the concept of a single valued neutrosophic set (SVNS), which is an instance of a neutrosophic set, to be used in real scientific and engineering applications. In the following, we introduce the definition of a SVNS.

Definition 2. Let X be a space of points (objects) with generic elements in X denoted by x. A SVNS A in X is characterized by a truth-membership function $T_A(x)$, an indeterminacy-membership function $I_A(x)$, and a falsity-membership function $F_A(x)$ for each point x in X, $T_A(x), I_A(x), F_A(x) \in [0,1]$. Thus, A SVNS A can be expressed as

$$A = \{x, T_A(x), I_A(x), F_A(x)\ |x \in X\}$$

Then, the sum of $T_A\,(x)$, $I_A\,(x)$ and $F_A\,(x)$, satisfies the condition $0 \le T_A(x) + I_A(x) + F_A(x) \le 3$.

Definition 3. The complement of a SVNS A is denoted by Ac and is defined as

$$Ac = \{x, F_A(x), 1 - I_A(x), T_A(x)\ |x \in X\}$$

Definition 4. A SVNS A is contained in the other SVNS $B, A \subseteq B$ if and only if $T_A(x) \le T_B(x), I_A(x) \ge I_B(x)$, and $F_A(x) \ge F_B(x)$ for every x in X.

Definition 5. Two SVNSs A and B are equal, written as A = B, if and only if $A \subseteq B$ and $B \subseteq A$

Definition 6. For any two SVNSs A and B in the universe of discourse $X = \{x_1, x_2, \dots, x_n\}$, the correlation coefficient between two SVNSs A and B is defined as follows:[15]

$$M(A,B) = \frac{1}{3n}\sum_{i=1}^{n}[\phi_i(1-\Delta T_i) + \varphi_i(1-\Delta I_i) + \psi_i(1-\Delta F_i)] \qquad (1)$$

Where

$$\phi_i = \frac{3-\Delta T_i - \Delta T_{max}}{3-\Delta T_{min} - \Delta T_{max}}, \qquad \psi_i = \frac{3-\Delta F_i - \Delta F_{max}}{3-\Delta F_{min} - \Delta F_{max}},$$

$$\varphi_i = \frac{3-\Delta I_i - \Delta I_{max}}{3-\Delta I_{min} - \Delta I_{max}}, \qquad \Delta T_i = |T_A(x_i) - T_B(x_i)|\,, \qquad \Delta I_i = |I_A(x_i) - I_B(x_i)|\,,$$

$\Delta T_i = |T_A(x_i) - T_B(x_i)|$,

$\Delta T_{min} = min_i|T_A(x_i) - T_B(x_i)|$,

$\Delta I_{min} = min_i|I_A(x_i) - I_B(x_i)|$,

$\Delta F_{min} = min_i|F_A(x_i) - F_B(x_i)|$,

for any $x_i \in X$ and i = 1, 2, . . ., n

$\Delta T_{max} = max_i|T_A(x_i) - T_B(x_i)|$,

$\Delta I_{max} = max_i|I_A(x_i) - I_B(x_i)|$,

$\Delta F_{max} = max_i|F_A(x_i) - F_B(x_i)|$,

However, the differences of importance are considered in the elements in the universe. Therefore, we need to take the weight of the element $x_i (i = 1, 2, \ldots, n)$ into account. In the following, we introduce a weighted correlation coefficient between SVNSs.

Definition 7. Let w_i be the weight for each element x_i $(i = 1, 2, \ldots, n), w_i \in [0, 1]$, and $\sum_{i=1}^{n} w_i = 1$, then we have the following weighted correlation coefficient between the SVNSs *A* and *B*:

$$M_w(A, B) = \frac{1}{3}\sum_{i=1}^{n} w_i[\phi_i(1 - \Delta T_i) + \varphi_i(1 - \Delta I_i) + \psi_i(1 - \Delta F_i)] \quad (2)$$

Definition 8. Let $A = (T_A, I_A, F_A)$ and $B = (T_B, I_B, F_B)$ be two SVN numbers, then summation between A and B is defined as follows:

$$A + B = (T_A + T_B - T_A t_B, I_A I_B, F_A F_B) \quad (3)$$

Definition 9. Let $A = (T_A, I_A, F_A)$ and $B = (T_B, I_B, F_B)$ be two SVN numbers, then multiplication A and B is defined as follows:

$$A * B = (T_A T_B, I_A + I_B - I_A I_B, F_A + F_B - F_A F_B) \quad (4)$$

Definition 10. Let $A = (T_A, I_A, F_A)$ be a SVN number and $\lambda \in \mathbb{R}$ an arbitrary positive real number, then:

$$\lambda A = \left(1 - (1 - T_A)^{\lambda}, I_A{}^{\lambda}, F_A{}^{\lambda}\right), \lambda > 0 \quad (5)$$

Definition 11. If A= $\{A_1, A_2, \ldots, A_n\}$, and B= $\{B_1, B_2, \ldots, B_n\}$ (i= 1,2,…,m) are two single valued neutrosophic sets, then separation measure between *A* and *B* applying the normalized Euclidian distance can be expressed as follows:

$$q_n(A, B) = \sqrt{\frac{1}{3n}\sum_{j=1}^{n}\left(\left(T_A(x_i) - T_B(x_i)\right)\right)^2 + \left(\left(I_A(x_i) - I_B(x_i)\right)\right)^2 + \left(\left(F_A(x_i) - F_B(x_i)\right)\right)^2}$$

$$(i = 1, 2, \ldots, n) \quad (6)$$

Definition 12. Let $A = (T_A, I_A, F_A)$ be a single valued neutrosophic number, a score function is mapped $\tilde{N}_A$ into the single crisp output $S(\tilde{N}_A)$ as follows

$$S(\tilde{N}_A) = \frac{3 + T_A - 2I_A - F_A}{4} \quad (7)$$

where $S(\tilde{N}_A) \in [0,1]$. This score function is the modification of the score function and allows us to have the results in the same interval as we deal with single valued neutrosophic numbers.

2.2 Decision-making method using the correlation coefficient of SVNSs [15]

In the multiple attribute decision-making problem with single valued neutrosophic information, the characteristic of an alternative A_i $(i = 1, 2, \ldots, m)$ on an attribute C_j $(j = 1, 2, \ldots, n)$ is represented by the following SVNS:

$$A_i = \{C_j, T_{Ai}(C_j), I_{Ai}(C_j), F_{Ai}(C_j) | Cj \in C, j = 1, 2, \ldots, n\}$$

Where $T_{Ai}(C_j)$, $I_{Ai}(C_j)$, $F_{Ai}(C_j)) \in [0, 1]$ and $0 \leq T_{Ai}(C_j)$, $I_{Ai}(C_j)$, $F_{Ai}(C_j) \leq 3$ for $Cj \in C, j = 1, 2, \ldots, n, and\ i = 1, 2, \ldots, m$.

For convenience, the values of the three functions $T_{Ai}(C_j), I_{Ai}(C_j), F_{Ai}(C_j)$ are denoted by a single valued neutrosophic value (SVNV)$d_{ij} = < t_{ij}, i_{ij}, f_{ij} >$ $(i = 1, 2, \ldots, m;\ j = 1, 2, \ldots, n)$, which is usually derived from the evaluation of an alternative A_i with respect to a criterion $C_j$by the expert or decision maker. Thus, we can elicit a single valued neutrosophic decision matrix $D = (d_{ij})_{mxn}$.

In multiple attribute decision making problems, the concept of ideal point has been used to help identify the best alternative in the decision set. Although the ideal alternative does not exist in real world, it does provide a useful theoretical construct against which to evaluate alternatives.

In the decision-making method, an ideal SVNV can be defined by $d_j^* =< t_j^*, i_j^*, f_j^* >=< 1, 0, 0 >$ $(j = 1, 2, \dots, n)$ in the ideal alternative A^*. Hence, by applying Equation (2) the weighted correlation coefficient between an alternative A_i $(i = 1, 2, \dots, m)$ and the ideal alternative A^* is given by:

$$M_w(A_i, A^*) = \frac{1}{3}\sum_{j=1}^{n} w_j\left[\phi_{ij}\left(1 - \Delta t_{ij}\right) + \varphi_{ij}\left(1 - \Delta i_{ij}\right) + \psi_{ij}\left(1 - \Delta f_{ij}\right)\right] \quad (8)$$

Where

$$\phi_{ij} = \frac{3 - \Delta t_{ij} - \Delta t_{i\,max}}{3 - \Delta t_{i\,min} - \Delta t_{i\,max}},$$

$$\varphi_i = \frac{3 - \Delta i_{ij} - \Delta i_{i\,max}}{3 - \Delta i_{i\,min} - \Delta i_{i\,max}},$$

$$\psi_i = \frac{3 - \Delta f_{ij} - \Delta f_{i\,max}}{3 - \Delta f_{i\,min} - \Delta f_{i\,max}},$$

$$\Delta t_{ij} = \left|t_{ij} - t_j^*)\right|,$$

$$\Delta i_{ij} = \left|i_{ij} - i_j^*)\right|,$$

$$\Delta f_{ij} = \left|f_{ij} - f_j^*)\right|,$$

$$\Delta t_{i\,min} = min_j\left|t_{ij} - t_j^*\right|,$$

$$\Delta i_{i\,min} = min_j\left|i_{ij} - i_j^*\right|,$$

$$\Delta f_{i\,min} = min_j\left|f_{ij} - f_j^*\right|,$$

$$\Delta t_{i\,max} = max_j\left|t_{ij} - t_j^*\right|,$$

$$\Delta i_{i\,max} = max_j\left|i_{ij} - i_j^*\right|,$$

$$\Delta f_{i\,max} = max_j\left|f_{ij} - f_j^*\right|,$$

for $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$. By the correlation coefficient $M_w(A_i, A^*)$ $(i = 1, 2, \dots, m)$, we can obtain the ranking order of all alternatives and the best one(s).

2.3 COPRAS-SVNS

The concept of a linguistic variable is very useful for solving decision making problems with complex content. The value of a linguistic variable is expressed as an element of its term set. Such linguistic values can be represented using single valued neutrosophic numbers.

In the COPRAS-SVNS method, there are k-decision makers, m-alternatives and n-criteria. k-decision makers evaluate the importance of the m-alternatives under n-criteria and rank the performance of the n-criteria with respect to linguistic statements converted into single valued neutrosophic numbers. The importance weights based on single valued neutrosophic values of the linguistic terms is given as Table 1.

Linguistic terms	**SVNNs**
Extremely good (EG)/ 10 points	(1.00, 0.00, 0.00)
Very very good (VVG)/ 9 points	(0.90, 0.10, 0.10)
Very good (VG)/ 8 points	(0.80, 0.15, 0.20)
Good (G) / 7 points	(0.70, 0.25, 0.30)
Medium good (MG) / 6 points	(0.60, 0.35, 0.40)
Medium (M) / 5 points	(0.50, 0.50, 0.50)
Medium bad (MB) / 4 points	(0.40, 0.65, 0.60)
Bad (B) / 3 points	(0.30, 0.75, 0.70)
Very bad (VB) / 2 points	(0.20, 0.85, 0.80)
Very very bad (VVB) / 1 point	(0.10, 0.90, 0.90)
Extremely bad (EB) / 0 points	(0.00, 1.00, 1.00)

Table 1: Linguistic variable and SVNSs. Source:[13]

The performance of the group decision making applying COPRAS-SVNS approach can be described by the following steps:

- Step 1. Determine the importance of the experts. In the case when the decision is made by a group of the experts (decision makers), firstly the importance or share to the final decision of each expert is determined. If a vector $\lambda = (\lambda_1, \lambda_2, \ldots, \lambda_k)$ is the vector describing the importance of the each expert, where $\lambda_k \geq 0$ and $\sum_{k=1}^{K} \lambda_k = 1$.
- Step 2. In the framework of this step, each decision maker performs his evaluations concerning the ratings of the alternatives with respect to the attributes and the attribute weights. If we denote by $x_{ij}^{k}, i = 1,2,\ldots,m; j = 1,2,\ldots,n$ the k^{th} expert's evaluation of the i^{th} alternative by the j^{th} criterion. This evaluation is expressed in linguistic terms presented in the table 1. So the decision matrix for any particular expert can be constructed

$$X^k = \begin{bmatrix} x^k{}_{11} & x^k{}_{12} \cdots & x^k{}_{1n} \\ x^k{}_{22} & x^k{}_{22} \cdots & x^k{}_{2n} \\ \vdots & \vdots & \vdots \\ x^k{}_{m1} & x^k{}_{m2} \cdots & x^k{}_{mn} \end{bmatrix} \quad (9)$$

- Step 3. Calculate the weights of the criteria. The aggregated weights of the criteria are determined by

$$\mathrm{w}_j = \lambda_1 \mathrm{w}_j^{(1)} \cup \lambda_2 \mathrm{w}_j^{(2)} \cup \ldots \cup \lambda_k \mathrm{w}_j^{(k)} = \left(1 - \prod_{k=1}^{K}\left(1 - T_j{}^{(w_k)}\right)^{\lambda_k}, \prod_{k=1}^{K}\left(I_j{}^{(w_k)}\right)^{\lambda_k}, \prod_{k=1}^{K}\left(F_j{}^{(w_k)}\right)^{\lambda_k}\right) \quad (10)$$

- Step 4. Construction of the aggregated weighted single valued decision matrix

$$\tilde{X} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} \cdots & \tilde{x}_{1n} \\ \tilde{x}_{22} & \tilde{x}_{22} \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \vdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} \cdots & \tilde{x}_{mn} \end{bmatrix} \quad (11)$$

where any particular element $\tilde{x}_{ij} = (\tilde{T}_{ij}, \tilde{I}_{ij}, \tilde{F}_{ij})$ represents the rating of the alternative A_i with respect to j criterion and is determined as follows

$$\tilde{x}_{ij} = \lambda_1 \mathrm{x}_{ij}^{(1)} \cup \lambda_2 \mathrm{x}_{ij}^{(2)} \cup \ldots \cup \lambda_k \mathrm{x}_{ij}^{(k)} = \left(1 - \prod_{k=1}^{K}\left(1 - T_j{}^{(x_k)}\right)^{\lambda_k}, \prod_{k=1}^{K}\left(I_j{}^{(x_k)}\right)^{\lambda_k}, \prod_{k=1}^{K}\left(F_j{}^{(x_k)}\right)^{\lambda_k}\right) \quad (12)$$

- Step 5. Determine the weighted decision matrix. The weighted decision matrix can be expressed as $D = \lfloor d_{ij} \rfloor, d = 1,2,\ldots,m; j = 1,2,\ldots,n$, where $d_{ij} = \tilde{x}_{ij} * w_j$. a single element of the weighted decision matrix can be calculated as

$$d_{ij} = T_{ij}^{\tilde{x}} T_j^{w}, I_{ij}^{\tilde{x}} + I_j^{w} - I_{ij}^{\tilde{x}} I_j^{w}, F_{ij}^{\tilde{x}} + F_j^{w} - F_{ij}^{\tilde{x}} F_j^{w} \quad (13)$$

- Step 6. Perform summation of the values for the benefit. Let $L_+ = \{1,2,\ldots,L_{max}\}$ be a set of the criteria to be maximized. Then the index of the benefit for each alternative can be determined

$$P_{+i} = \sum_{j=1}^{L_{max}} d_{+ij} \quad (14)$$

- Step 7. Perform summation of the values for cost. Let be $L_- = \{1,2,\ldots,L_{min}\}$ a set of the criteria to be minimized. Then the index of the cost of each alternative can be determined

$$P_{-i} = \sum_{j=1}^{L_{min}} d_{-ij} \quad (15)$$

- Step 8. Determine the minimal value of the P_{-i}.

- Step 9. Determine the score value of each alternative Q_i. At the beginning the score values are calculated from the aggregated values for benefit and the cost $S(P_{+i})$ and $S(P_{-i})$ by using equation (7). The score values of the alternatives van be expressed as

$$Q_i = S(P_{+i}) + \frac{S(P_{-min})\sum_{i=1}^{L_{min}} S(P_{-i})}{S(P_{-min})\sum_{i=1}^{L_{min}} \frac{S(P_{-min})}{S(P_{-i})}} \quad (16)$$

- Step 10. Determine optimality criterion K for the alternatives:

$$K = max_i Q_i; i = 1,2, \dots, m \quad (17)$$

- Step 11. Determine the priority of the alternatives. The greater score value Q_i for the alternative corresponds to the highest priority (rank) of the alternative.

3 Methodology

To some degree, all educational leaders must serve as academic diplomats. Therefore, the need and functions are not new, but the need for a conscious and purposeful understanding of the role is relatively new. Educational leaders understand that they must commit to maintaining good relationships with the community and with a wide range of stakeholders. In addition to good stakeholder relations, educational leaders must also be aware of the need for a wide range of methods to communicate with the broader community.

The challenge is to carve out a clear role and status within the educational leadership community for academic diplomacy. Many universities have internationalization offices that focus on international relations and study abroad programs. Internationalization offices have a range of functions that do not always coincide with those of a diplomatic mission.

One aspect that is often lacking in particular is an office to receive international visitors on official visits. One of several exceptions to this is Harvard University, which has the office of Marshall University. This office supervises the reception of foreign delegations visiting the University. Members of the office are trained in diplomatic etiquette for welcoming a variety of guests, including heads of state. The difference between the Marshall University office at Harvard University and internationalization offices at other universities is that it is designed to receive foreign delegations and is trained to do so following an international standard of etiquette.

In this case, the emphasis is on the role and status of an academic diplomat, and therefore issues of training and basic knowledge of diplomatic etiquette are relevant. Diplomacy involves a certain set of skills employed to promote relationships between entities. Traditionally, diplomacy has focused on the development of a range of skills that combine communication, negotiation and leadership framed in the knowledge of and respect for certain norms and social practices. Therefore, diplomacy transcends technical knowledge in internationalization and international relations in general.

Bearing this in mind, and for the development of this study, the work team selected, through documentary support and brainstorming, the set of elements for analysis. In this sense, eight elements were considered that, in the opinion of the experts, constitute key factors for an adequate management of academic diplomacy in any university organization. These elements were evaluated under 3 decision criteria and tested under each of the initially proposed methods.

For the evaluation of the elements to be evaluated, with respect to the selected criteria, the five experts that make up the work team are asked to complete a small form that includes an evaluation as precise as possible of the subject evaluated. Likewise, they are asked to grant a level of importance to each of the evaluated criteria. For this, the evaluations to be granted must specify to what extent the expert considers that the alternative Ai is good (Tx), bad (Fx) or is not entirely sure (Ix) with respect to the criterion Cj, for which the Table 1. The same level of importance was considered among the experts involved in the study.

The subsequent evaluation and comparison of the results obtained constitutes an effective way of validating the efficient selection or screening of those elements of special importance according to the judgment of the experts.

4 Results and discussion

Based on the evaluations carried out by the experts, and in accordance with the logic proposed by the COPRAS-SVNS method, the necessary transformations were carried out to obtain all the elements that allow obtaining the decision matrix. Subsequently, the application of equation (12) allowed obtaining the weighted decision matrix for this analysis. Table 2 summarizes the results achieved in this regard.

Alternatives	Criterion 1	Criterion 2	Criterion 3
Establish a system of values focused on the commitment to good relations with the community	(0.531;0.469;0.433)	(0.497;0.503;0.466)	(0.277;0.802;0.835)
Properly manage the promotion of participation and the development of beneficial agreements for the parties	(0.531;0.469;0.433)	(0.4;0.6;0.591)	(0.303;0.756;0.775)
Establish a continuous training system on international diplomatic etiquette	(0.753;0.247;0.232)	(0.618;0.382;0.361)	(0.531;0.469;0.413)
Develop skills for negotiating specific articulation agreements	(0.573;0.427;0.383)	(0.581;0.419;0.387)	(0.542;0.458;0.424)
Management of academic leadership oriented to the achievement of objectives	(0.586;0.414;0.394)	(0.495;0.514;0.508)	(0.542;0.458;0.424)
Development of effective methods for an adequate level of communication with the community in general	(0.531;0.469;0.433)	(0.481;0.528;0.494)	(0.428;0.582;0.552)
Promote the opening of channels and structures capable of operating even in cases of political tensions between States	(0.61;0.39;0.34)	(0.537;0.463;0.418)	(0.476;0.534;0.489)
Establish cooperation approaches capable of providing effective and immediate solutions to common problems between the parties	(0.573;0.427;0.383)	(0.497;0.503;0.466)	(0.428;0.582;0.552)

Table 2: Weighted decision matrix. Fuente: own

After obtaining this information, we proceeded to determine the coefficients proposed by the method for the selection between the alternatives. At this point, it is necessary to clarify that criteria 2 and 3 were considered benefit criteria, so their maximization is sought. Criterion 1 was considered a cost criterion, so its minimization is considered a greater benefit. Table 3 shows the results obtained after the analysis and calculation of the data.

Alternatives	Pi+	Pi-	S(P+)	S(P-)	Q
Establish a system of values focused on the commitment to good relations with the community	(0.636; 0.403; 0.389)	(0.531; 0.469; 0.433)	0.61	0.5400	1.26
Properly manage the promotion of participation and the development of beneficial agreements for the parties	(0.582; 0.454; 0.458)	(0.531; 0.469; 0.433)	0.55	0.5400	1.2
Establish a continuous training system on international diplomatic etiquette	(0.821; 0.179; 0.149)	(0.753; 0.247; 0.232)	0.83	0.7570	1.29
Develop skills for negotiating specific articulation agreements	(0.808; 0.192; 0.164)	(0.573; 0.427; 0.383)	0.82	0.5840	1.41
Management of academic leadership oriented to the achievement of objectives	(0.769; 0.235; 0.215)	(0.586; 0.414; 0.394)	0.77	0.5910	1.36
Development of effective methods for an adequate level of communication with the community in general	(0.703; 0.307; 0.273)	(0.531; 0.469; 0.433)	0.7	0.5400	1.35
Promote the opening of channels and structures capable of operating even in cases of political tensions between States	(0.757; 0.247; 0.204)	(0.61; 0.39; 0.34)	0.76	0.6230	1.33
Establish cooperation approaches capable of providing effective and immediate solutions to common problems between the parties	(0.712; 0.293; 0.257)	(0.573; 0.427; 0.383)	0.72	0.5840	1.32

Table 3: Values of Pi, S(P) and Q score value for each alternative. Source: own

As can be seen, in this case, alternative 4 was the one that obtained the highest score level, which makes it the most preferred by the experts. In this case, more preferred alternatives were evaluated to apply to the university process, therefore, a broader set of alternatives is considered, instead of only choosing the one with the highest score. That said, Table 3 indicates the three alternatives that obtained a higher score in the decision index. Alternatives 4, 5 and 6 were the most important according to the experts, although alternatives 7 and 8 could also be considered, taking into account the level of precision and interest of the researchers.

On the other hand, when carrying out the evaluation using the method focused on the neutrosophic correlation indices, the values of the operators φ, μ and ψ were determined to obtain the correlation coefficients, according to the logic of the method. The determination of these elements allowed us to calculate and obtain the correlation coefficients, as shown in Table 4.$M_w(A_i, A^*)$

	φ_{ij}			μ_{ij}			ψ_{ij}			
	C1	C2	C3	C1	C2	C3	C1	C2	C3	M_w
Establish a system of values focused on the commitment to good relations with the community	0.84	1	0.89	0.87	1	0.96	0.96	1	1	0.599
Properly manage the promotion of participation and the development of beneficial agreements for the parties	0.94	1	0.89	0.91	1	1	1	0.96	0.9	0.558
Establish a continuous training system on international diplomatic etiquette	0.9	0.95	1	1	0.96	1	1	0.96	1	0.697
Develop skills for negotiating specific articulation agreements	1	0.9	0.86	1	1	0.96	0.96	1	1	0.704
Management of academic leadership oriented to the achievement of objectives	1	0.95	0.95	0.96	1	0.96	1	1	1	0.612
Development of effective methods for an adequate level of communication with the community in general	1	0.95	0.9	1	0.96	1	1	0.96	1	0.697
Promote the opening of channels and structures capable of operating even in cases of political tensions between States	0.95	1	0.95	1	1	0.96	1	0.96	1	0.697
Establish cooperation approaches capable of providing effective and immediate solutions to common problems between the parties	0.84	1	0.84	1	0.96	0.92	0.96	1	1	0.633

Table 4: Values of φ, μ and ψ and Mw for each selection alternative. Source: own

In this case, the most prominent correlation coefficient was the one referring to the fourth alternative. However, alternatives 3, 6 and 7 were alternatives with a similar level of evaluation, which makes them equally good options to be considered by the evaluators.

When making a comparison between the results obtained from both methods, it was possible to verify the existence of certain similarities in the results achieved in the two cases.

Both with the use of the COPRAS method, and through the use of correlation coefficients, it was possible to obtain a clear preference or significance over alternative 4, referring, in this case, to the development of skills for the negotiation of agreements. Likewise, alternative 5 was selected, in both methods, among those most preferred by the experts.

Similarly, although other alternatives such as 3 and 7 did not have an extremely relevant significance in the COPRAS method, their inclusion within the second method makes it possible to evaluate them as some of the favorites to implement.

For its part, the low significance of alternatives 1 and 2 in each of the methods carried out, can lead to their discarding, or failing that, to a relegation in terms of priority level.

The results obtained make it possible to determine the existence of coherence between the methods used in terms of the selected decision alternatives. In principle, it was found that the most significant alternative for the experts was the same in both methods.

The same happened with the less desired or lower-scoring alternatives. The rest of the alternatives had some variation in terms of the levels of significance or score according to the method; however, these variations could be due to clear differences between the calculation methods between the methods, or even to external factors such as the subjectivity of the experts.

It is considered that, if more precise results were sought, each of the methods could be carried out, as was done in the present study, and select as elements of interest only those that were common and relevant to both methods.

Conclusions

All branches of science, and practically life, have found in neutrosophy a novel tool for solving complex problems in real life. The possibility of incorporating indeterminacies in the decision process allows us to approach real solutions and, therefore, more effective ones. The development of this study allowed us to demonstrate the usefulness of neutrosophic set theories for the selection of different key management elements for academic diplomacy, applicable in higher education. For this, the COPRAS-SVNS method was used, as well as the use of neutrosophic correlation coefficients.

The application of the methods made it possible to obtain a very well-defined set of the most significant elements for proper management of academic diplomacy, according to the experts involved in the study. The use of indeterminacies during the process allowed obtaining results of greater precision and adequate to the reality of decision-making for human beings. Likewise, the analysis carried out allowed the comparison of results between the methods used. It was possible to conclude that there was coherence between the results obtained from both analyses, expressed in the similarities of the results in terms of the most and least preferred alternatives.

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