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Neutrosophic Methods in Corporate Social Responsibility

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Abstract. The purpose of this study was to implement the neutrosophic logic in order to identify the most favorable corporate social responsibility strategies to be applied in the short and medium term in a small and medium-sized food company located in the city of Santo Domingo. To achieve this objective, the COPRAS method approach was expanded by incorporating single-valued neutrosophic sets as an essential part of the decision-making process related to the aforementioned area of study. The adoption of the neutrosophic COPRAS method provided an effective framework for evaluating and prioritizing the various facets of corporate social responsibility, empowering the organization to make more informed and ethical decisions. As a result, it was confirmed that the application of neutrosophic logic proved to be a valuable tool for addressing the inherent uncertainty present in decision-making focused on corporate social responsibility.

Keywords: corporate social responsibility, neutrosophic logic, decision-making, COPRAS, SVNN.

1 Introduction

The decision-making process is an essential element in the dynamics of human beings, both in their personal and professional dimensions. Although each choice that is made is guided by initially defined objectives, in many circumstances, these objectives may conflict [1]. The imperative need to simultaneously address criteria and options in decision dilemmas becomes even more crucial, particularly when faced with data sets characterized by uncertainty.[2]

In recent years, there has been a remarkable increase in the amount of research directed towards the inclusion of the vagueness inherent in the initial information, to address problems of a complex nature. In this context, multi-criteria decision-making methods (MCDM) are widely used [3]. Thus, decision-makers employ subjective evaluation techniques as a response to this challenge.

In the study carried out by [4], the theory of fuzzy sets (FS) was presented to address the problems related to data characterized by its uncertainty and imprecision. Afterward, other variants of fuzzy sets were introduced to expand the scope of this theory [5]. However, despite the efforts made in the application of fuzzy sets to solve multi-criteria decision-making (MCDM) problems, it has been identified that they fail to cover all the forms of uncertainty that arise in the resolution of practical dilemmas in various areas of real life.[6]

To address this challenge, [7] proposed the theory of neutrosophic sets as a generalization of "fuzzy" sets and "intuitionistic fuzzy" sets. Within the framework of neutrosophy, truth membership, indeterminacy membership, and false membership are considered completely independent and fall into the non-standard unitary interval]0−, 1+[[8]. To simplify the practical applicability of neutrosophic ensembles, [9] introduced the notion of a Single-Valued Neutrosophic Set (SVNS) and proposed set-theoretic operations as well as some specific properties of SVNSs.[9]

The applicability of neutrosophic logic in solving complex decisional dilemmas extends to various areas, ranging from industry [10] to business [11] and even the sciences [12]. This is due to their ability to deal with situations in which uncertainty, ambiguity, and contradictory information challenge conventional methodologies. Within the business context, decision-making is critically important, as it can have a substantial impact on the success and sustainability of a company. Each business choice must be based on a thorough analysis that considers a multiplicity of criteria and alternatives. Furthermore, in a business environment characterized by its constant dynamism, the ability to adapt and make decisions based on accurate information become imperative.[13-18]

In the contemporary business context, a growing awareness of companies has been observed in relation to their actions, which are now oriented not only towards obtaining economic resources but also towards the generation of social and environmental well-being. Corporate Social Responsibility (CSR) represents a business perspective that implies that organizations assume ethical and social responsibilities that go beyond their legal and economic obligations. In essence, CSR encompasses the voluntary adoption of business practices and decisions that not only

seek to generate economic benefits but also seek to produce a positive impact on society, the environmental environment, and the stakeholders involved in the company.

Small and medium-sized businesses (SMEs) operating in the food sector in Ecuador make up one of the most prominent and predominant sectors in the country. In this sense, the adoption of appropriate CSR practices can represent a beneficial factor for the gradual growth and consolidation of these small companies in the market. Therefore, the present study aims to apply neutrosophic logic to determine the CSR strategies that are considered most preferable to implement in the short and medium term by an SME in the food sector in the city of Santo Domingo.

To carry out this task, it is suggested to expand the approach of the COPRAS method by incorporating single-valued neutrosophic sets as an integral part of the decision-making process in the context of the aforementioned object of study. For this purpose, the method called COPRAS-SVNS is used, which was proposed by [14-19-21-22] to address this specific problem. To provide a more detailed understanding of the research, a complete description of the COPRAS method is provided in section 2. Then, in section 3, the essential principles related to single-valued neutrosophic sets are set out, along with the underlying logic that guides the application of the method. Finally, in the subsequent sections, the findings and conclusions derived from this study are detailed.

2 The COPRAS method

A decision-making problem consists of *m* alternatives that must be evaluated considering *n* criteria and x_{ij} can be expressed as the value of the i^{th} alternative by the criterion. The main idea of the COPRAS technique consists of the steps described below:

Step1. Select the appropriate set of criteria that describes the chosen alternatives.

Step2. Prepare decision-making matrix *X*:

$$X = \begin{bmatrix} x_{11} & x_{12} \dots & x_{1n} \\ x_{22} & x_{22} \dots & x_{2n} \\ \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & x_{mn} \end{bmatrix} \quad (1)$$

Step 3. Determine the weights of the criteria w_j.

Step 4. Normalize decision-making matrix $\bar{X}$. The values of the normalized matrix are determined as

$$\bar{x}_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}; i = 1,2, \dots, m; j = 1,2, \dots, n \quad (2)$$

Step 5. Compute weighted normalized decision-making matrix D, which components are calculated as

$$d_{ij} = \bar{x}_{ij} \cdot w_j; i = 1,2, \dots, m; j = 1,2, \dots, n \quad (3)$$

Step 6. Compute summation of the criterion values with respect to optimization direction for each alternative

$$P_{+i} = \sum_{j=1}^{L_{max}} d_{+ij};\ P_{-i} = \sum_{j=1}^{L_{min}} d_{-ij} \quad (4)$$

where d_{+ij} values correspond to the criteria to be maximized and d_{-ij} values correspond to the criteria to be minimized.

Step 7. Determine the minimum component of the P_{-i}:

$$P_{-min} = min_i P_{-i}; i = 1,2, \dots, L_{min} \quad (5)$$

Step 8. Determine the score value of each alternative Q_i:

$$Q_i = P_{+i} + \frac{P_{-min} \sum_{j=1}^{L_{min}} P_{-j}}{P_{-i} \sum_{j=1}^{L_{min}} \frac{P_{-min}}{P_{-j}}}; j = 1, \dots, L_{min} \quad (6)$$

Step 9. Determine optimality criterion K for the alternatives:

$$K = max_i Q_i\ ; i = 1,2, \dots, m \quad (7)$$

Step 10. Determine the priority of the alternatives. The greater score value for the alternative corresponds to the higher priority (rank) of the alternative.Q_i

3 Neutrosophic Sets

Definition 1. Let X be a space of the objects and $x \in X$. A neutrosophic set A in X is defined by three functions: truth-membership function $T_A(x)$, an indeterminacy- membership function $I_A(x)$ and falsity-membership function $F_A(x)$. These functions are defined on real standard or real non-standard subsets of $]0^-, 1^+[$. That is

$T_A(x): X \to]0^-, 1^+[, I_A(x): X \to]0^-, 1^+[$ 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 $0^- \leq supT_A(x) + supI_A(x) + supF_A(x) \leq 3^+$.

3.1 Single valued neutrosophic set.

A single-valued neutrosophic set (SVNS) has been defined as described in [9].

Definition 2. Let X be a universal space of the objects and $x \in X$. A single valued neutrosophic set (SVNS) $\tilde{N} \subset X$ can be expressed as

$$\tilde{N} = \{\langle x, T_{\tilde{N}}(x), I_{\tilde{N}}(x), F_{\tilde{N}}(x)\rangle : x \in X\} \quad (8)$$

where $T_{\tilde{N}}(x): X \to][0,1], I_{\tilde{N}}(x): X \to][0,1]$ and $F_{\tilde{N}}(x): X \to][0,1]$

with $0 \leq T_{\tilde{N}}(x) + I_{\tilde{N}}(x) + F_{\tilde{N}}(x) \leq 3$ or all $x \in X$. The values $T_{\tilde{N}}(x)$, $I_{\tilde{N}}(x)$ and $F_{\tilde{N}}(x)$ correspond to the truth-membership degree, the indeterminacy-membership degree, and the falsity-membership degree of x to $\tilde{N}$, respectively. For the case when X consists of a single element, $\tilde{N}$ is called a single-valued neutrosophic number [15][16]. For the sake of simplicity, a single-valued neutrosophic number is expressed by $\tilde{N}_A = (t_A, i_A, f_A)$ where $t_A, i_A, f_A \in [0,1]$ and $0 \leq t_A + i_A + f_A \leq 3$.

Definition 3. Let $\tilde{N}_1 = (t_1, i_1, f_1)$ and $\tilde{N}_2 = (t_2, i_2, f_2)$ be two SVN numbers, then summation between $\tilde{N}_1$ and $\tilde{N}_2$ is defined as follows:

$$\tilde{N}_1 + \tilde{N}_2 = (t_1 + t_2 - t_1 t_2, i_1 i_2, f_1 f_2) \quad (9)$$

Definition 4. Let $\tilde{N}_1 = (t_1, i_1, f_1)$ and $\tilde{N}_2 = (t_2, i_2, f_2)$ be two SVN numbers, then multiplication between $\tilde{N}_1$ and $\tilde{N}_2$ is defined as follows:

$$\tilde{N}_1 * \tilde{N}_2 = (t_1 t_2, i_1 + i_2 - i_1 i_2, f_1 + f_2 - f_1 f_2) \quad (10)$$

Definition 5. Let $\tilde{N} = (t, i, f)$ be an SVN number and $\lambda \in \mathbb{R}$ an arbitrary positive real number, then

$$\lambda\tilde{N} = \left(1 - (1 - t)^{\lambda}, i^{\lambda}, f^{\lambda}\right), \lambda > 0 \quad (11)$$

Definition 6. 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 the separation measure between *A* and *B* applying the normalized Euclidian distance can be expressed as follows:

$$q_n(A, B) = \sqrt{\frac{1}{3n}\sum_{j=1}^{n}\left(\left(t_A(x_i) - t_B(x_i)\right)\right)^2 + \left(\left(i_A(x_i) - i_B(x_i)\right)\right)^2 + \left(\left(f_A(x_i) - f_B(x_i)\right)\right)^2}$$

$$(i = 1,2, \ldots, n) \quad (12)$$

Definition 7. Let A = (a,b,c) 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:

$$S(\tilde{N}_A) = \frac{3 + t_A - 2i_A - f_A}{4} \quad (13)$$

where $S(\tilde{N}_A) \in [0,1]$. This score function is the modification of the score function proposed by [17-20] and allows to have the results in the same interval since single-valued neutrosophic numbers are being used.

The concept of linguistic variables 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 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 are given in Table 1.

Table 1: Linguistic variables and SVNSs. Source: [14]

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)

Linguistic terms	SVNNs
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)

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 experts (decision makers), firstly the importance or share of the final decision of each expert is determined. If a vector $\lambda = (\lambda_1, \lambda_2, \dots, \lambda_k)$ is the vector describing the importance of 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. It is denoted by $x_{ij}^k, i = 1,2,\dots,m; j = 1,2,\dots,n$ 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 Table 1. So, the decision matrix for any particular expert can be constructed.

$$X^k = \begin{bmatrix} x^k{}_{11} & x^k{}_{12} \dots & x^k{}_{1n} \\ x^k{}_{22} & x^k{}_{22} \dots & x^k{}_{2n} \\ \vdots & \vdots & \vdots \\ x^k{}_{m1} & x^k{}_{m2} \dots & x^k{}_{mn} \end{bmatrix} \quad (14)$$

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

$$\mathrm{w}_j = \lambda_1 \mathrm{w}_j^{(1)} \cup \lambda_2 \mathrm{w}_j^{(2)} \cup \dots \cup \lambda_k \mathrm{w}_j^{(k)} = \left(1 - \prod_{k=1}^{K} \left(1 - t_j{}^{(w_k)}\right)^{\lambda_k}, \prod_{k=1}^{K} \left(i_j{}^{(w_k)}\right)^{\lambda_k}, \prod_{k=1}^{K} \left(f_j{}^{(w_k)}\right)^{\lambda_k}\right) \quad (15)$$

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

$$\tilde{X} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} \dots & \tilde{x}_{1n} \\ \tilde{x}_{22} & \tilde{x}_{22} \dots & \tilde{x}_{2n} \\ \vdots & \vdots & \vdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} \dots & \tilde{x}_{mn} \end{bmatrix} \quad (16)$$

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

$$\tilde{x}_{ij} = \lambda_1 \mathrm{x}_{ij}^{(1)} \cup \lambda_2 \mathrm{x}_{ij}^{(2)} \cup \dots \cup \lambda_k \mathrm{x}_{ij}^{(k)} = \left(1 - \prod_{k=1}^{K} \left(1 - t_j{}^{(x_k)}\right)^{\lambda_k}, \prod_{k=1}^{K} \left(i_j{}^{(x_k)}\right)^{\lambda_k}, \prod_{k=1}^{K} \left(f_j{}^{(x_k)}\right)^{\lambda_k}\right) \quad (17)$$

- Step 5. Determine the weighted decision matrix. Following Eq. (3), the weighted decision matrix can be expressed as $D = \left\lfloor d_{ij} \right\rfloor, d = 1,2,\dots,m; j = 1,2,\dots,n$, where $d_{ij} = \tilde{x}_{ij} * w_j$. Applying Eq. (10), a single element of the weighted decision matrix can be calculated.

$$d_{ij} = t_{ij}^{\tilde{x}} t_j^w, i_{ij}^{\tilde{x}} + i_j^w - i_{ij}^{\tilde{x}} i_j^w, f_{ij}^{\tilde{x}} + f_j^w - f_{ij}^{\tilde{x}} f_j^w \quad (18)$$

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

$$P_{+i} = \sum_{j=1}^{L_{max}} d_{+ij} \quad (19)$$

where this summation of the single value neutrosophic numbers is performed applying Eq. (9).

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

$$P_{-i} = \sum_{j=1}^{L_{min}} d_{-ij} \quad (20)$$

- Step 8. Determine the minimum value of the P_{-i}.
- 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 $S(P_{-i})$ applying Eq.(13). The score values of the alternatives can be expressed as:

$$Q_i = S(P_{+i}) + \frac{S(P_{-min})\sum_{i=1}^{L_{min}} S(P_{-i})}{S(P_{-min})\sum_{i=1}^{L_{min}} \frac{S(P_{-min})}{S(P_{-i})}} \quad (21)$$

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

$$K = max_i Q_i; i = 1,2,\dots,m \quad (22)$$

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.

4 Results

The influence of CSR on the image and reputation of a company implies that the implementation of strategies oriented to different levels of CSR can represent a relevant source of competitive advantages for the organization. In this context, the company under study is immersed in the phase of designing and executing strategies focused on the levels of CSR that are most attractive for effective implementation in the medium term. To carry out this process, a panel of five experts will be used and evaluation criteria will be applied to select an appropriate number of strategies on which to focus gradually.

The CSR levels that will be decided on are contemplated below:

Social Dimension:

1. History of evolution, transformation, or merger of business activities.
2. Revelation of mission, vision, and policies.
3. National and international quality, environment, and occupational safety certifications.
4. Administrative, strategic measures and plans aimed at the community.
5. Training and education measures for the workforce.
6. Relations with the competition.
7. Programs aimed at the community and society.

Ethical Dimension:

1. Existence of a Code of Ethics related to interest groups.
2. Evidence of behavioral foundations based on values of honesty, fairness, and integrity.
3. Organizational ethical commitments.
4. Quality and safety of the product offered to the market.
5. It does not offend the competition or discredit it.

Environmental Dimension:

1. Action plan for environmental care.
2. Proactive and purposeful action towards the environment in products and services.
3. Differentiating environmental innovative products and processes.
4. Innovation of business image in improving reputation.

Collaborative Dimension:

1. Implementation of Corporate Governance systems and timely and transparent reporting.
2. Maintenance of good health and occupational safety conditions.
3. Promotion of equal opportunities without discrimination in the workforce.
4. Promotion of the expression of new ideas.

Network Dimension:

1. Availability of an internet portal related to business activity.
2. Offering options in different languages.
3. Use of a slogan related to responsible practices.
4. Use of effective communication channels.
5. Availability of a news section that reports on activities carried out.
6. Publication of financial reports exposed to the public.

For analysis and selection, the application of 4 criteria focused on:

C1. Immediate Impact: Evaluate the potential to generate a short-term positive impact on key stakeholders.

C2. Feasibility and available resources: Analyze whether the company has the necessary resources to implement the strategy effectively in the short term.

C3. Risk Assessment: Evaluate the risks associated with the strategy and determine whether they can be managed effectively in the short term.

C4. Brand awareness: Evaluate whether the strategy can improve the company's brand image and reputation immediately, which can translate into tangible business benefits.

These data are analyzed by the experts selected for the study, who assess the selection alternatives based on the analyzed criteria. Experts are considered to have an equal degree of importance. The weight vector of the criteria is obtained through the evaluations carried out by the experts considering the values provided in Table 1. In this way, Table 2 shows the weight vector obtained after applying equation (15).

Table 2: Vector of weights of the analyzed criteria. Source: own elaboration.

Weights vector	**SVNN**
Immediate Impact (w_1)	(0.82671;0.17329;0.15157)
Feasibility and available resources (w_2)	(0.83428;0.16572;0.15849)
Risk assessment (w_3)	(0.79186;0.20814;0.17411)
Brand recognition (w_4)	(0.82671;0.17329;0.15157)

The evaluation of the options is carried out considering the values recorded in Table 1, and all the starting data are converted into neutrosophic sets. Based on the evaluations carried out by the experts, the transformations required to build the decision matrix are carried out. This process is carried out using equation (17). The results derived from this procedure are presented in Table 3.

Table 3: Initial decision matrix. Source: own elaboration.

Alternatives	**Immediate Impact**	**Feasibility and available resources**	**Risk assessment**	**Brand recognition**
History of evolution, transformation, or merger of business activities.	(0.67,0.33,0.289)	(0.725,0.275,0.251)	(0.35,0.75,0.8)	(0.725,0.275,0.251)
Revelation of mission, vision, and policies.	(0.81,0.19,0.19)	(0.5,0.5,0.5)	(0.383,0.692,0.728)	(0.5,0.5,0.5)
National and international quality, environment, and occupational safety certifications.	(0.88,0.12,0.115)	(0.81,0.19,0.19)	(0.88,0.12,0.115)	(0.81,0.19,0.19)
Administrative, strategic measures and plans aimed at the community.	(0.725,0.275,0.251)	(0.725,0.275,0.251)	(0.88,0.12,0.115)	(0.725,0.275,0.251)
Training and education measures for the workforce.	(0.685,0.315,0.302)	(0.618,0.393,0.398)	(0.685,0.315,0.302)	(0.445,0.588,0.603)
Relations with the competition.	(0.621,0.379,0.347)	(0.601,0.411,0.381)	(0.541,0.472,0.457)	(0.491,0.555,0.552)
Programs aimed at the community and society.	(0.88,0.12,0.115)	(0.88,0.12,0.115)	(0.88,0.12,0.115)	(0.88,0.12,0.115)
Existence of a Code of Ethics related to interest groups.	(0.621,0.379,0.347)	(0.565,0.435,0.416)	(0.445,0.588,0.603)	(0.541,0.472,0.457)
Evidence of behavioral foundations based on values of honesty, fairness, and integrity.	(0.618,0.393,0.398)	(0.618,0.393,0.398)	(0.618,0.393,0.398)	(0.618,0.393,0.398)
Organizational ethical commitments.	(0.601,0.411,0.381)	(0.601,0.411,0.381)	(0.601,0.411,0.381)	(0.601,0.411,0.381)
Quality and safety of the product offered to the market.	(0.618,0.393,0.398)	(0.618,0.393,0.398)	(0.618,0.393,0.398)	(0.618,0.393,0.398)
It does not offend the competition or discredit	(0.601,0.411,0.381)	(0.601,0.411,0.381)	(0.601,0.411,0.381)	(0.601,0.411,0.381)
Action plan for environmental care.	(0.88,0.12,0.115)	(0.88,0.12,0.115)	(0.88,0.12,0.115)	(0.88,0.12,0.115)
Proactive and purposeful action towards the environment in products and services.	(0.725,0.275,0.251)	(0.725,0.275,0.251)	(0.725,0.275,0.251)	(0.725,0.275,0.251)
Differentiating environmental innovative products and processes.	(0.88,0.12,0.115)	(0.88,0.12,0.115)	(0.88,0.12,0.115)	(0.88,0.12,0.115)

Alternatives	Immediate Impact	Feasibility and available resources	Risk assessment	Brand recognition
Innovation of business image in improving reputation	(0.618,0.393,0.398)	(0.618,0.393,0.398)	(0.618,0.393,0.398)	(0.618,0.393,0.398)
Implementation of Corporate Governance systems and timely and transparent reporting.	(0.601,0.411,0.381)	(0.601,0.411,0.381)	(0.601,0.411,0.381)	(0.601,0.411,0.381)
Maintenance of good health and occupational safety conditions.	(0.88,0.12,0.115)	(0.88,0.12,0.115)	(0.88,0.12,0.115)	(0.88,0.12,0.115)
Promotion of equal opportunities without discrimination in the workforce.	(0.618,0.393,0.398)	(0.618,0.393,0.398)	(0.618,0.393,0.398)	(0.618,0.393,0.398)
Encouraging the expression of new ideas	(0.601,0.411,0.381)	(0.601,0.411,0.381)	(0.601,0.411,0.381)	(0.601,0.411,0.381)
Availability of an internet portal related to business activity.	(0.618,0.393,0.398)	(0.618,0.393,0.398)	(0.618,0.393,0.398)	(0.618,0.393,0.398)
Offering options in different languages.	(0.601,0.411,0.381)	(0.601,0.411,0.381)	(0.601,0.411,0.381)	(0.601,0.411,0.381)
Use of a slogan related to responsible practices.	(0.618,0.393,0.398)	(0.618,0.393,0.398)	(0.618,0.393,0.398)	(0.618,0.393,0.398)
Use of effective communication channels.	(0.601,0.411,0.381)	(0.601,0.411,0.381)	(0.601,0.411,0.381)	(0.601,0.411,0.381)
Availability of a news section that reports on activities carried out	(0.618,0.393,0.398)	(0.618,0.393,0.398)	(0.618,0.393,0.398)	(0.618,0.393,0.398)
Publication of financial reports exposed to the public.	(0.601,0.411,0.381)	(0.601,0.411,0.381)	(0.601,0.411,0.381)	(0.601,0.411,0.381)

The initial decision matrix allows obtaining the weighted decision matrix, which is constructed by applying equation (19). At this point, it is necessary to clarify that criteria 1,2 and 4 are considered profit criteria, so their maximization is sought. On the contrary, criterion 3 is considered a cost criterion, so its minimization is considered a greater benefit. Taking this into account, the next step is to determine the coefficients proposed by the method analyzed to select among the alternatives.

Table 4: Values of Pi, S(P), and Q score value for each alternative. Source: own elaboration.

CSR dimensions	Pi+	Pi-	S(P+)	S(P-)	Q
History of evolution, transformation, or merger of business activities.	(0.946; 0.054; 0.042)	(0.289; 0.793; 0.83)	0.949	0.2180	1.1670
Revelation of mission, vision, and policies.	(0.91; 0.09; 0.088)	(0.317; 0.745; 0.769)	0.911	0.2650	1.0750
National and international quality, environment, and occupational safety certifications.	(0.977; 0.023; 0.021)	(0.511; 0.498; 0.489)	0.978	0.5070	1.2550
Administrative, strategic measures and plans aimed at the community.	(0.948; 0.052; 0.044)	(0.511; 0.498; 0.489)	0.95	0.5070	1.2280
Training and education measures for the workforce.	(0.89; 0.118; 0.116)	(0.566; 0.434; 0.408)	0.885	0.5730	1.0290
Relations with the competition.	(0.878; 0.133; 0.115)	(0.447; 0.563; 0.539)	0.874	0.4460	1.0460
Programs aimed at the community and society.	(0.986; 0.014; 0.012)	(0.511; 0.498; 0.489)	0.987	0.5070	1.2570
Existence of a Code of Ethics related to interest groups.	(0.881; 0.122; 0.106)	(0.497; 0.513; 0.475)	0.883	0.4990	1.0880
Evidence of behavioral foundations based on values of honesty, fairness, and integrity.	(0.905; 0.101; 0.102)	(0.511; 0.498; 0.489)	0.9	0.5070	1.2480
Organizational ethical commitments.	(0.895; 0.112; 0.092)	(0.497; 0.513; 0.475)	0.895	0.4990	1.0730
Quality and safety of the product offered to the market.	(0.905; 0.101; 0.102)	(0.511; 0.498; 0.489)	0.9	0.5070	1.2480
It does not offend the competition or discredit	(0.895; 0.112; 0.092)	(0.497; 0.513; 0.475)	0.895	0.4990	1.0730
Action plan for environmental care.	(0.986; 0.014; 0.012)	(0.511; 0.498; 0.489)	0.987	0.5070	1.2570
Proactive and purposeful action towards the environment in products and services.	(0.953; 0.047; 0.038)	(0.497; 0.513; 0.475)	0.955	0.4990	1.1010
Differentiating environmental innovative products and processes.	(0.986; 0.014; 0.012)	(0.511; 0.498; 0.489)	0.987	0.5070	1.2570

CSR dimensions	Pi+	Pi-	S(P+)	S(P-)	Q
Innovation of business image in improving reputation	(0.905; 0.101; 0.102)	(0.497; 0.513; 0.475)	0.9	0.4990	1.0880
Implementation of Corporate Governance systems and timely and transparent reporting.	(0.895; 0.112; 0.092)	(0.511; 0.498; 0.489)	0.895	0.5070	1.0730
Maintenance of good health and occupational safety conditions.	(0.905; 0.101; 0.102)	(0.497; 0.513; 0.475)	0.9	0.4990	1.0880
Promotion of equal opportunities without discrimination in the workforce.	(0.895; 0.112; 0.092)	(0.599; 0.401; 0.365)	0.895	0.6080	1.6080
Encouraging the expression of new ideas	(0.905; 0.101; 0.102)	(0.511; 0.498; 0.489)	0.9	0.5070	1.2480
Availability of an internet portal related to business activity.	(0.895; 0.112; 0.092)	(0.511; 0.498; 0.489)	0.895	0.5070	1.2480
Offering options in different languages.	(0.905; 0.101; 0.102)	(0.497; 0.513; 0.475)	0.9	0.4990	1.0880
Use of a slogan related to responsible practices.	(0.895; 0.112; 0.092)	(0.511; 0.498; 0.489)	0.895	0.5070	1.0730
Use of effective communication channels.	(0.905; 0.101; 0.102)	(0.497; 0.513; 0.475)	0.9	0.4990	1.0880
Availability of a news section that reports on activities carried out	(0.895; 0.112; 0.092)	(0.511; 0.498; 0.489)	0.895	0.5070	1.0730
Publication of financial reports exposed to the public.	(0.905; 0.101; 0.102)	(0.497; 0.513; 0.475)	0.9	0.4990	1.0880

The results obtained after applying the method indicate that the most preferred factors, considering both the opinions of the experts and the evaluation criteria selected for the analysis, include obtaining quality, environmental, and occupational safety certifications both nationally and internationally. In addition, programs aimed at the community and society, the implementation of action plans for the preservation of the environment, innovation in products and processes with a differentiating environmental focus, and the promotion of equal opportunities without discrimination in the workplace are also highlighted.

These results suggest that, according to the experts' assessment and the evaluation criteria applied, these areas represent the main areas of focus and priority for the company in its pursuit of Corporate Social Responsibility (CSR). It is important to note that these findings can serve as a valuable guide for the company in the planning and execution of CSR strategies that contribute to its sustainable development and the generation of competitive advantages in the market.

7 Discussion

The corporate image is linked to CSR, allowing the company to reach a good strategy towards society. Thus, one of the key factors to achieve a good corporate image and reputation is being socially responsible. The application of neutrosophic and neutrosophic multi-criteria methods in corporate social responsibility decision-making represents an innovative and highly relevant approach in the field of business management.

The main advantage of neutrosophy in CSR decision-making lies in its ability to handle information and data that may be ambiguous, incomplete, or contradictory. CSR is constantly evolving and requires careful evaluation of various aspects, from ethical and environmental issues to community and employee relations. Neutrosophic multi-criteria methods allow companies to evaluate these complex interactions more accurately and fairly, considering not only the quantitative aspects but also the qualitative and subjective ones that are crucial in making ethical and socially responsible decisions.

Moreover, the application of neutrosophy and neutrosophic multi-criteria methods in CSR promotes transparency and the participation of multiple stakeholders. By incorporating the diversity of opinions and perspectives, companies can make more equitable and democratic decisions regarding their social commitment. This is especially important in a context where CSR is not only about complying with regulations but also about building strong relationships with society and generating shared value.

Conclusion

Corporate Social Responsibility is a key factor in modern business management. Neutrosophic methods offer an efficient framework for assessing and prioritizing CSR dimensions, which, in turn, enables companies to make more ethical and informed decisions. This study applied neutrosophic logic to identify the most favorable CSR strategies for short-to-medium-term implementation by an SME operating in the food sector in the city of Santo Domingo. The neutrosophic variant of the COPRAS method provided a practical framework for evaluating and prioritizing different dimensions of CSR, allowing the company to make informed and ethical decisions. This

applied neutrosophic logic, which proved to be useful in dealing with uncertainty in decision-making concerning CSR. Uncertainty and ambiguity, common factors in CSR, can be effectively addressed through this methodology, helping to promote more ethical and socially responsible business management.

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