



Neutrosophic Evaluation of CSR Practices in Ecuadorian Companies: Balancing Sustainability, Ethics, and Impact

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Abstract. The analysis of Corporate Social Responsibility (CSR) practices in Ecuadorian companies is a relevant topic due to the indeterminacies existing in their implementation. The general objective of this analysis is to evaluate CSR practices in companies, considering aspects such as environmental sustainability, responsibility to employees, business ethics, and financial performance. To achieve this, the criteria and comprehensive solutions were evaluated through the modeling of the neutrosophic ELECTRE method. The results of the analysis indicate that the implementation of CSR practices can have multiple benefits, and comprehensive solutions with higher scores were identified, such as the implementation of ethics and transparency policies and the implementation of training and professional development programs. To enhance these comprehensive solutions, it is significant to establish clear and transparent policies, train the personnel, and communicate effectively with the community, and other relevant stakeholders. This ensures that CSR practices in Ecuadorian companies have a positive impact on the community.

Keywords: Environmental sustainability, business ethics, corporate social responsibility.

1 Introduction

Corporate social responsibility (CSR) is a topic of debate in Ecuador [1], where companies are increasingly interested in adhering to sustainable and responsible practices [2]. CSR involves organizations committing to the community in response to the social and environmental impacts generated by their production processes. In Ecuador, CSR has become a necessity to address the effects caused by production processes and achieve sustainable development.

The implementation of CSR practices in Ecuadorian companies contributes to improving their image in front of consumers and the community at large [3]. Despite existing regulations and institutions encouraging CSR application in Ecuador, the practice of this model goes beyond mere compliance with laws and regulations; it depends on each company's level of commitment to society. It is crucial to note that CSR in Ecuador is a developing concept, with limited regulations and good practices. However, a shift is needed from business objectives focused solely on profit generation to a business consciousness oriented toward the well-being of society and the environment [4] [5].

In this context, the study aims to analyze the impact of CSR practices on the Ecuadorian community through a multi-criteria analysis [6]. This analysis considers various factors such as the implementation methods, companies' ability to measure and evaluate the real impact, and the perception of society and consumers [7]. To achieve this, the key criteria for measuring CSR practices in Ecuador are defined:

- Environmental Practices: Include the reduction of greenhouse gas emissions, the decrease of carbon footprint, and the promotion of environmental sustainability [8].
- Social Practices: Involve the promotion of gender equality, social inclusion, and community development [9].
- Ethical Practices: Include the promotion of transparency, integrity, and responsibility in business.
- Labor Practices: Encompass the promotion of occupational safety, training, and professional development.
- Innovation Practices: Cover the promotion of research and the development of sustainable products and services.

Companies that implement CSR practices seek to comply with standards and regulations, promote transparency in management, prevent corruption, and respect human rights. Below are some of the most relevant aspects

of business ethics in CSR practices in Ecuador:

- Compliance with standards and regulations: Companies in Ecuador that implement practices to comply with standards and regulations, such as the implementation of compliance policies and the promotion of transparency in management.
- Transparency in management: Companies in Ecuador practice the promotion and transparency in management, such as disclosing information about their CSR practices and implementing transparency policies.
- Corruption prevention: Companies in Ecuador that take actions to prevent corruption, such as the implementation of ethics policies and the promotion of integrity in business.
- Respect for human rights: Companies in Ecuador that respect human rights, such as promoting diversity and inclusion and eliminating discrimination in the workplace [10].

In Ecuador, there are various civil society organizations working to promote CSR practices in companies. Here are some of these organizations:

- Ecuadorian Consortium for Corporate Social Responsibility (CERES): This organization aims to promote CSR in companies in Ecuador through awareness, training, and technical guidance.
- Latin American Future Foundation (FFLA): This organization aims to promote sustainable development in Latin America through the promotion of CSR in companies.
- Network of Companies for Sustainable Development (REDS): This organization aims to promote CSR in companies in Ecuador through awareness, training, and technical guidance.
- United Nations Global Compact: This organization aims to promote CSR in companies worldwide through the advocacy of the United Nations Sustainable Development Goals.
- Association of Companies for Development (AED): This organization aims to promote sustainable development in Ecuador through the promotion of CSR in companies.

In summary, there are various civil society organizations working to promote CSR practices in companies in Ecuador. These organizations promote awareness, training, technical guidance, and the advocacy of the United Nations Sustainable Development Goals. Another point to highlight is related to the profitability of CSR practices in Ecuadorian companies. This can be influenced by various factors such as improved resource efficiency, enhanced brand image, talent attraction, innovation, and regulatory compliance.

Therefore, the analysis for implementing CSR practices depends on incorporating indeterminacies into potential solutions. To achieve this, it is necessary to analyze the importance states of measurement criteria and other factors influencing the results. Thus, the main objective of this study is to evaluate CSR practices in companies in Ecuador through neutrosophic analysis. The specific objectives of the study include identifying and analyzing the challenges companies face in implementing CSR practices, proposing and evaluating comprehensive solutions focused on achieving CSR practices in companies with a positive impact on the community and identifying actions that enhance the best comprehensive solution.

2 Materials and methods

2.1 Neutrosophic ELECTRE

Neutrosophic ELECTRE is a multicriteria decision-making (MCDM) method that enables the selection of the best option from a neutrosophic set of alternatives [11]. The neutrosophic set is defined by the following elements: true μ , indeterminate γ , and false τ of x in S , respectively, and their images constitute standard or non-standard subsets within the range $(0;1)$. For N in the universe of discourse, the neutrosophic set of a unique value S over N is defined as an object in the representation $S = \{(n, \mu_S(n), \gamma_S(n), \tau_S(n)): n \in N\}$.

Where $\mu_S(n), \gamma_S(n), \tau_S(n)$ satisfy the following condition $0 \leq \mu_S(n), \gamma_S(n), \tau_S(n) \leq 3$ for all $n \in N$. So, to define each neutrosophic number, it is expressed in the following way v, i, f for modeling the neutrosophic ELECTRE method.

Next, the following representations of the neutrosophic set are defined: $v = \mu_S(n)$ for the truth membership functions, where $\in \{0,1\}$, $i = \gamma_S(n)$ for the indeterminate membership functions, where $\in \{0,1\}$, and $f = \delta_A(n)$ for the false membership functions, where $\in \{0,1\}$. Therefore, the single value neutrosophic number (SVNN) defined for the study is $S=(v, i, f)$, where $v, i, f \in \{0,1\}$.

Once the neutrosophic elements are defined in the ELECTRE framework, the linguistic terms for evaluating each relevant neutrosophic decision criterion are then defined (see Table 1). Then, the alternatives are evaluated based on the linguistic term defined in the neutrosophic set (see Table 2).

Table 1: Linguistic terms that represent the neutrosophic weight of the importance of the criteria. Source: own elaboration.

Linguistic term I	SVNN
Very Suitable (VS)	(0.9,0.35,0.1)
Moderately Suitable (MS)	(0.7,0.5,0.3)
Suitable (S)	(0.3,0.7,0.75)
Poorly Suitable (PS)	(0.2,0.8,0.85)
Not Suitable (NS)	(0.10,0.90,0.90)

Table 2: Linguistic terms that represent the neutrosophic weight of the importance of alternatives. Source: own elaboration.

Linguistic term	SVNN
Extremely good (EG)	(1,0,0)
Very very good (VVG)	(0.95,0.05,0.15)
Very good (VG)	(0.85,0.15,0.25)
Good (G)	(0.75,0.25,0.35)
Medium good (MG)	(0.65,0.35,0.45)
Medium (M)	(0.55,0.45,0.55)
Moderately bad (MB)	(0.45,0.55,0.65)
Bad (B)	(0.35,0.65,0.75)
Very bad (VB)	(0.25,0.75,0.85)
Very very bad (VVB)	(0.15,0.85,0.95)
Extremely bad (EM)	(0,0.95,1)

Important decisions often involve considering multiple criteria simultaneously, and these criteria can be of an objective or subjective nature with the inclusion of indeterminacy in the analyzed neutrosophic set. Therefore, the neutrosophic ELECTRE method allows decision-makers to evaluate and prioritize [12-20-21], by combining neutrosophic assessments and generating a preference matrix that ranks and prioritizes alternatives [13-18-22]. Once the scales for handling neutrosophic criteria and the inclusion of indeterminacy in the modeling are defined, the steps for developing the method are as follows:

Step 1: Define the initial decision matrix r_{Sij} , as shown:

$$r_{Sij} = \begin{bmatrix} r_{S11} & r_{S12} & \dots & r_{S1n} \\ r_{S21} & r_{S22} & \dots & r_{S2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{Sm1} & r_{Sm1} & \dots & r_{Smn} \end{bmatrix}$$

Step 2: The normalization of the decision matrix allows different scales and units to be transformed between several common criteria. This allows comparison across the criteria, according to Equation (1 and 2).

$$\text{Minimum} \quad R_{Sij} = \frac{\max r_{Sij} - r_{Sij}}{\max r_{Sij} - \min r_{Sij}} \quad (1)$$

$$\text{Maximum} \quad R_{Sij} = \frac{r_{Sij} - \min r_{Sij}}{\max r_{Sij} - \min r_{Sij}} \quad (2)$$

Step 3: Construction of the normalized weighted decision matrix V_{Sij} . For which the normalized decision matrix R_{Sij} is multiplied by its respective weight, expressed in Equation (3) respectively.

$$V_{Sij} = \begin{bmatrix} W_{S1} r_{S11} & W_{S2} r_{S12} & \dots & W_{Sn} r_{S1n} \\ W_{S1} r_{S21} & W_{S2} r_{S22} & \dots & W_{Sn} r_{S2n} \\ \vdots & \vdots & \ddots & \vdots \\ W_{Sn} r_{Sm1} & W_{Sn} r_{Sm2} & \dots & W_{Sn} r_{Smn} \end{bmatrix}$$

$$V_{Sij} = W_{Si} \cdot R_{Sij} \quad (3)$$

Step 4: Calculation of concordance (C_{Yab}) and discordance (D_{Yab}) intervals, where C_{Yab} indicates the most preferable alternative, and D_{Yab} indicates the least preferable alternative. Equations (4), (5), and (6) are used, respectively.

$$Y(S) = \frac{1 + v - 2i - f}{2} \quad (4)$$

$$C_{Yab} = \{j | x_{aj} \geq x_{bj}\} \quad (5)$$

$$D_{Yab} = \{j | x_{aj} \leq x_{bj}\} = j - C_{Yab} \quad (6)$$

Step 5: Determination of the agreement interval matrix C_{Yab} , it is obtained by adding the weights to the weights associated with the criteria in which alternative i is better than alternative j , and vice versa; In the event of a tie, half the weight is assigned to each of the alternatives according to Equation (7).

$$C_{Yab} = \sum_{j=C_{ab}} W_{Sj} \quad (7)$$

Step 6: Determination of the discordance index matrix D_{Yab} , it is calculated as the largest difference between the criteria for which alternative i is dominated by j , then divided by the largest difference in absolute value between the results obtained by alternative i and j , according to Equation (8).

$$D_{Yab} = \frac{\left(\max_{j \in D_{ab}} |V_{Yaj} - V_{Ybj}| \right)}{\left(\max_{j \in J, m, n \in I} |V_{Ymj} - V_{Ynj}| \right)} \quad (8)$$

Step 7: Calculation of the maximum threshold \bar{c} for the concordance index and the maximum threshold \bar{d} for the discordance index, using equations (9 and 10) and respectively.

$$\bar{c} = \sum_{a=1}^m \sum_b^m \frac{c(a,b)}{m(m-1)} \quad (9)$$

$$\bar{d} = \sum_{a=1}^m \sum_b^m \frac{c(a,b)}{m(m-1)} \quad (10)$$

Step 8: Calculation of the dominant concordance matrix. Once the concordance indices and the minimum concordance threshold are determined, the dominant concordance matrix is calculated with the following conditions:

$$cd_{ij} \begin{cases} e(a,b) = 1 \text{ si } c(a,b) \geq \bar{c} \\ e(a,b) = 0 \text{ si } c(a,b) \leq \bar{c} \end{cases}$$

Step 9: Calculation of the dominant discordance matrix. Similarly to the previous step, the values of the dominant discordance matrix are obtained from the discordance index matrix and the maximum discordance threshold, following the condition:

$$dd_{ij} \begin{cases} f(a,b) = 1 \text{ si } d(a,b) \geq \bar{d} \\ f(a,b) = 0 \text{ si } d(a,b) \leq \bar{d} \end{cases}$$

Step 10: Calculation of the upper and lower net value C_a and D_a , using Equations (11) and (12) respectively.

$$C_a = \sum_{a=1}^m c_{(a,b)} - \sum_{a=1}^m c_{(b,a)} \quad (11)$$

$$D_a = \sum_{a=1}^m d_{(a,b)} - \sum_{a=1}^m d_{(b,a)} \quad (12)$$

3 Results

Companies in Ecuador face various challenges in implementing CSR practices. Some of these challenges include:

- Lack of resources: Financial and human resource limitations to implement CSR practices. The implementation of CSR practices can be costly and requires a significant investment in time and resources.
- Lack of knowledge: Lack of awareness about CSR and its benefits can lead to a lack of real commitment to the community and the environment.
- Lack of incentives: There are not enough incentives for companies to implement CSR practices. The lack of incentives can result in a lack of real commitment to the community and the environment.
- Lack of regulation: There are not enough regulations that compel companies to implement CSR practices. The lack of regulation can result in a lack of real commitment to the community and the environment.
- Lack of corporate culture: There is no corporate culture that promotes CSR. The lack of corporate culture can result in a lack of real commitment to the community and the environment.

In this case, the following criteria and weights have been defined: impact on the community (0.3, 0.7, 0.75), environmental sustainability (0.2, 0.8, 0.85), employee responsibility (0.2, 0.8, 0.85), business ethics (0.2, 0.8, 0.85), and financial performance (0.10, 0.90, 0.90). After defining the criteria weights, a scale of values is established for comprehensive solutions aimed at mitigating challenges and achieving CSR practices in Ecuador with a positive impact on the community. This is to support environmental sustainability, employee responsibility, business ethics, and financial performance [14-19]. Among the comprehensive solutions are:

- Implementation of environmental practices (SI-1): Companies in Ecuador can implement environmental practices to reduce their impact on the environment, such as reducing greenhouse gas emissions, decreasing carbon footprint, and promoting environmental sustainability. This can enhance the long-term profitability of companies and improve their brand image.
- Implementation of training and professional development programs (SI-2): Companies in Ecuador can implement training and professional development programs to enhance the skills and knowledge of their employees. This can improve the quality of personnel and the productivity of the company, leading to long-term profitability.
- Promotion of innovation (SI-3): Companies in Ecuador can promote innovation, including the implementation of clean and renewable technologies and the encouragement of research and development of sustainable products and services. This can enhance the competitiveness of companies and their long-term profitability.
- Implementation of ethics and transparency policies (SI-4): Companies in Ecuador can implement ethics and transparency policies to enhance their reputation and relationship with consumers. This can improve the long-term profitability of companies and minimize legal risks and reputational damage.
- Promotion of equal opportunities (SI-5): Companies in Ecuador can promote equal opportunities among their employees, including promoting diversity and inclusion and eliminating discrimination in the workplace. This can improve employee satisfaction and productivity and enhance the company's brand image.

Once the criteria and comprehensive solutions to be evaluated are defined, the next step is to calculate the score for each comprehensive solution based on the weights assigned to each criterion and the assessments made. The results of the evaluation of the proposed comprehensive solutions using the neutrosophic ELECTRE method are presented below (See Tables 3 to 10).

Table 3: Evaluation matrix. Source: own elaboration.

	Impact on the community	Environmental sustainability	Responsibility towards employees	Ethics in business	Financial performance
	SVNN	SVNN	SVNN	SVNN	SVNN
Solutions	C1	C2	C3	C4	C5
SI-1	(0.25,0.75,0.85)	(0.65,0.35,0.45)	(0.45,0.55,0.65)	(0.75,0.25,0.35)	(0.25,0.75,0.85)
SI 2	(0.15,0.85,0.95)	(0.85,0.15,0.25)	(0.55,0.45,0.55)	(0.45,0.55,0.65)	(0.55,0.45,0.55)
SI 3	(0.25,0.75,0.85)	(0.55,0.45,0.55)	(0.15,0.85,0.95)	(0.35,0.65,0.75)	(0.65,0.35,0.45)
SI-4	(0.95,0.05,0.15)	(0.25,0.75,0.85)	(0.45,0.55,0.65)	(0.55,0.45,0.55)	(0.45,0.55,0.65)
SI-5	(0.45,0.55,0.65)	(0.15,0.85,0.95)	(0.65,0.35,0.45)	(0.65,0.35,0.45)	(0.45,0.55,0.65)

Table 4: Calculation of the normalized decision matrix R_{Sij} , using Equation (1) and (2). Source: own elaboration.

	Impact on the community	Environmental sustainability	Responsibility towards employees	Ethics in business	Financial performance
	SVNN	SVNN	SVNN	SVNN	SVNN
	Max	Max	Max	Max	Max
Solutions Comprehensive	C1	C2	C3	C4	C5
SI-1	(0.15,0.85,0.95)	(0.65,0.35,0.45)	(0.45,0.55,0.65)	(1,0,0)	(0,0.95,1)
SI 2	(0,0.95,1)	(1,0,0)	(0.75,0.25,0.35)	(0.35,0.65,0.75)	(0.75,0.25,0.35)
SI 3	(0.15,0.85,0.95)	(0.45,0.55,0.65)	(0,0.95,1)	(0,0.95,1)	(1,0,0)
SI-4	(1,0,0)	(0.15,0.85,0.95)	(0.55,0.45,0.55)	(0.55,0.45,0.55)	(0.55,0.45,0.55)
SI-5	(0.35,0.65,0.75)	(0,0.95,1)	(1,0,0)	(0.95,0.05,0.15)	(0.55,0.45,0.55)
min	(0,0.95,1)	(0,0.95,1)	(0,0.95,1)	(0,0.95,1)	(0,0.95,1)
Max	(1,0,0)	(1,0,0)	(1,0,0)	(1,0,0)	(1,0,0)
Range	(1,0,0)	(1,0,0)	(1,0,0)	(1,0,0)	(1,0,0)

Table 5: Determine the weighted normalized decision matrix V_{ij} , according to Equation (3). Source: own elaboration.

	Impact on the community	Environmental sustainability	Responsibility towards employees	Ethics in business	Financial performance
	C1	C2	C3	C4	C5
Weight	(0.3,0.7,0.75)	(0.2,0.8,0.85)	(0.2,0.8,0.85)	(0.2,0.8,0.85)	(0.10,0.90,0.90)
SI-1	(0,0.95,1)	(0.15,0.85,0.95)	(0,0.95,1)	(0.15,0.85,0.95)	(0,0.95,1)
SI 2	(0,0.95,1)	(0.15,0.85,0.95)	(0.15,0.85,0.95)	(0,0.95,1)	(0,0.95,1)
SI 3	(0,0.95,1)	(0,0.95,1)	(0,0.95,1)	(0,0.95,1)	(0,0.95,1)
SI-4	(0.25,0.75,0.85)	(0,0.95,1)	(0,0.95,1)	(0.15,0.85,0.95)	(0,0.95,1)
SI-5	(0,0.95,1)	(0,0.95,1)	(0.15,0.85,0.95)	(0.15,0.85,0.95)	(0,0.95,1)

Table 6: Concordance index C_{Yab} using Equation (7). Source: own elaboration.

Solutions	SI-1	SI 2	SI 3	SI-4	SI-5
SI-1	0.00	0.51	0.40	0.60	0.60
SI 2	0.49	0.00	0.40	0.49	0.69
SI 3	0.60	0.60	0.00	0.69	0.69
SI-4	0.40	0.51	0.31	0.00	0.51
SI-5	0.40	0.31	0.31	0.49	0.00

Table 7: Discordance index D_{Yab} using Equation (8). Source: own elaboration.

Solutions	SI-1	SI 2	SI 3	SI-4	SI-5
SI-1	0.00	0.62	0.55	1.00	0.77
SI 2	1.00	0.00	0.25	1.00	0.60
SI 3	1.00	1.00	0.00	1.00	1.00
SI-4	0.36	0.55	0.24	0.00	0.50
SI-5	1.00	1.00	0.50	1.00	0.00

Table 8: Dominant concordance matrix. Source: own elaboration.

Solutions	SI-1	SI 2	SI 3	SI-4	SI-5	
SI-1		1	0	1	1	Maximum threshold for concordance index $\bar{c} = 0.50$
SI 2	0		0	0	1	
SI 3	1	1		1	1	
SI-4	0	1	0		1	
SI-5	0	0	0	0		

Table 9: Dominant discordant matrix. Source: own elaboration.

Solutions	SI-1	SI 2	SI 3	SI-4	SI-5	
SI-1		1	1	0	0	Maximum threshold for discordance index $\bar{d} = 0.7470$
SI 2	0		1	0	1	
SI 3	0	0		0	0	
SI-4	1	1	1		1	
SI-5	0	0	1	0		

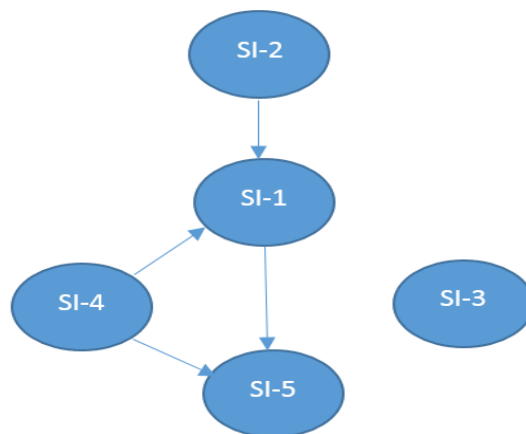
Table 10: Aggregated dominant matrix. Source: own elaboration.

Solutions	SI-1	I 2	SI 3	SI-4	SI-5	Total
SI-1		1	0	0	0	1
SI 2	0		0	0	1	1
SI 3	0	0		0	0	0
SI-4	0	1	0		1	2
SI-5	0	0	0	0		0
Total	0	2	0	0	2	

Results of the neutrosophic ELECTRE method modeling (see Figure 1):

- SI-4 over-classifies SI-1 and SI-5 and is not over-classified by any other comprehensive solution.
- SI-2 over-classifies SI-1 and is not over-classified by any other comprehensive solution.
- SI-3 neither over-classifies nor is over-classified by any other comprehensive solution. Therefore, it is outside the interrelation of the remaining comprehensive solutions.

Figure 1: Representation of integral solutions (ELECTRE graph). Source: own elaboration.



The integral solution with the highest weight determines, in the neutrosophic ELECTRE method, two priority solutions. These are defined as the implementation of ethics and transparency policies, followed by the implementation of training and professional development programs. To enhance these comprehensive solutions, incentives, and regulations that encourage the implementation of CSR practices in Ecuadorian companies should be promoted. The following are possible actions to promote:

- Establish clear and transparent policies in the company that promote ethics in business and responsibility with employees [15]. This may include the implementation of codes of conduct, the promotion of diversity and inclusion, the protection of human and labor rights, and the prevention of corruption.
- Train company personnel on ethics and corporate social responsibility [16]. This would enable staff to understand the importance of these aspects and commit to the implementation of established policies.
- Conduct an internal audit to assess compliance with ethics and transparency policies in the company. This helps identify improvement opportunities and ensures that ethical and corporate social responsibility standards are met [17].
- Communicate ethics and transparency policies effectively to the community and other relevant stakeholders. This ensures building trust and commitment with the company, which can enhance its reputation and maximize its positive impact on the community.

On another note, the implementation of CSR practices in companies in Ecuador can generate various benefits, such as improving reputation, reducing costs, attracting talent, accessing new markets, and complying with regulations. It is significant to promote constructive dialogue between companies, society, and regulators to achieve real commitment to CSR and have a positive impact on the community. Additionally, it is essential to promote incentives and regulations that encourage the implementation of CSR practices in companies in Ecuador.

These measures include promoting CSR, tax incentives, regulation, public-private partnerships, and certifications. It is crucial to foster constructive dialogue between companies, society, and regulators to achieve real commitment to CSR and have a positive impact on the community.

Conclusion

The implementation of CSR practices in companies in Ecuador can have multiple benefits, such as improving the company's reputation, increasing employee satisfaction, enhancing the relationship with customers and the community, and improving the financial performance of the company. To achieve these benefits, it is significant to implement comprehensive solutions that address multiple aspects of corporate social responsibility and focus efforts on improving specific aspects that have a greater impact on the criteria of higher weight.

The neutrosophic ELECTRE method constitutes a useful tool for decision-making in complex situations where multiple alternatives must be evaluated based on multiple criteria. Integral solutions with higher scores, such as the implementation of ethics and transparency policies and the promotion of equal opportunities, can have a positive impact on the community.

Neutrosophic evaluation has allowed for assessing comprehensive solutions and existing indeterminacies in decision-making, helping identify the strengths and weaknesses of each integral solution based on each criterion. To do this, it is necessary to enhance the integral solutions with the greatest impact by establishing policies that can improve environmental sustainability, promote ethics in business, and enhance the financial performance of Ecuadorian companies.

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