A Hybrid Neutrosophic Hierarchical Method with SWOT Analysis to Face Complexity and Uncertainty

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Abstract

This paper addresses the question that is global as decision making in the scenario of ambiguity. Given the conflicting or less dependable information, it also becomes necessary to look for approaches that assist us. Conventional strategic planning approaches work relatively well with straightforward and precise information. These become inadequate with situations that are ambiguous. To address this challenge, we adopt the Neutrosophic Hierarchy Method that integrates with SWOT analysis in addressing the challenge. As such, we learn to evaluate or assess the four components of SWOT: Strengths, opportunities, weaknesses and threats in wider terms. However, we do appreciate that often what we assess is not black and white but in shades of color. The conclusion is that for complex decision-making, this approach seems more appropriate and offers better results than others offer. The key aim of this article is to put forth a novel perspective on how decisions should be made in the face of uncertainty. Most of all, we expect to be helpful to both policymakers and strategists in the sense of providing a tool, which can be useful when it comes to the practical inconsistencies that are quite frequently in excess of reasonable solutions.

Keywords: Indeterminate Likert Scale; Neutrosophic Hierarchical Method; SWOT Analysis; Decision making under uncertainty; Complexity and indeterminacy; Multicriteria strategies; Strategic planning; Neutrosophic evaluation; Data ambiguity; Uncertainty management; Analysis tools

1. Introduction

In recent decades, the protection and promotion of children's rights has gained increasing importance on the international human rights agenda. The adoption of the United Nations Convention on the Rights of the Child in 1989 marked a significant step forward by establishing a set of international standards aimed at safeguarding children's rights in various contexts. Despite the progress made, there are still numerous challenges to the effective implementation of these rights, especially with regard to custody processes. In Ecuador, the guarantee of the rights of minors during these processes has aroused special interest and concern due to its direct impact on the well-being and development of children. Custody processes, which determine the guardianship and care of children following the separation or divorce of their parents, require a delicate balance between the rights and responsibilities of the parents and the best interests of the child.

The Constitution of the Republic of Ecuador enshrines the principle of the best interest of the child as a central axis in decision-making that concerns them, obliging the State, society and the family to promote their comprehensive development and ensure the effective exercise of their rights. This principle emphasizes the

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importance of prioritizing the well-being of the child in any measure that affects them, in line with the mandates of the Convention on the Rights of the Child, underlining the need to adopt specific actions for their protection. Additionally, Ecuadorian legislation, through the Organic Code of Childhood and Adolescence and the Civil Code, specifies mechanisms to ensure that decisions in custody processes favor the well-being of minors, recognizing children as subjects of rights from conception, which strengthens their comprehensive protection from the beginning of their life.

However, despite these legislative advances and policies focused on the protection of children's rights, significant challenges remain in the effective implementation of these rights in custody proceedings. Legal principles, such as the best interests of the child, should guide decision-making in these matters; however, obstacles such as economic constraints, restricted access to justice and difficulties in practical implementation have prevented the full realization of these principles in the legal field. Furthermore, prevailing cultural norms and traditional perceptions about family and parenting can significantly influence the approach to custody proceedings. The existence of stereotypical gender roles and social expectations about parental responsibility can affect judicial decisions and the inclusion of children in these proceedings, despite regulatory advances.

The main purpose of this study is to carry out a comprehensive analysis to identify and demonstrate the essential obstacles that affect the legal protection of the rights inherent to children during custody determination procedures in the Ecuadorian context. A specific focus on the city of Tulcán will allow for a detailed and contextualized investigation into the dynamics and peculiar factors that influence the effective protection of the rights of children involved in these processes.

In order to carry out this study, the implementation of neutrosophic logic was chosen, an approach distinguished by its ability to effectively handle indeterminacy and uncertainty [1] , intrinsic characteristics of human perceptions and value judgments [2] . Neutrosophic logic, by allowing the inclusion of degrees of truth, falsity and indeterminacy simultaneously, presents itself as an ideal analytical tool to address the complexity of social, legal and personal factors involved in the legal protection of children's rights. This approach is particularly relevant to the study of legal and judicial systems, where opinions and decisions can rarely be categorized in absolute terms of right or wrong, but rather often exist on a spectrum of indeterminacy and relativity [3] .

The adoption of this methodology allows for a more nuanced and in-depth analysis of the different layers of influence and the interactions between them, facilitating the identification of strategic solutions that may not be apparent under more traditional analytical approaches. By integrating neutrosophic logic with tools such as the Hierarchical Analytic Process (HAP) and SWOT analysis, the study broadens its spectrum of assessment, allowing for a comprehensive understanding of the obstacles and opportunities to strengthen the protection of children's rights. This comprehensive and deeply reflective approach is essential to formulating recommendations that are both pragmatic and effective in the specific context of Tulcán and, by extension, in similar legal areas where the protection of children's rights requires careful and detailed analysis.

2. Preliminaries

In this segment, several key explanations of Neutrosophic Sets are presented.

Definition 1: In the framework of neutrosophic logic, a set *N* is bounded by a trio of membership functions: the truth membership function, T_A,the indeterminacy membership function I_A,, and the falsity membership function. F_A.Here, *U* represents the universal set, and for each element *x* within *U* , $T_{A(x)}, I_{A(x)}, and\ F_{A(x)}$are subsets of the interval $]-0,1^+[$. It is established that the infimums of$T_{A(x)}, I_{A(x)}, and\ F_{A(x)}$ They are cumulatively bounded below 0 and their cumulative maxima do not exceed 3. It should be noted that $T_{A(x)}, I_{A(x)}, and\ F_{A(x)}$ they could constitute subintervals within [0, 1]. [4]

Definition 2: The construct of a Single Value Neutrosophic Set (SVNS) *N* within the universe *U* is articulated as $A = \{< x;\ T_{A(x)}, I_{A(x)}, F_{A(x)} > : x \in U\}$c, where $T_A: U \rightarrow [0,1]$, $I_A: U \rightarrow [0,1]$,y $F_A: U \rightarrow [0,1]$is such that the sum $T\_A(x) + I\_A(x) + F\_A(x)$ is restricted within the interval [0, 3].

The *single-valued neutrosophic number* (SVNN) is represented by N = (t, i, f), such that 0 ≤t, i, f = ≤1 and 0 ≤t + i + f = ≤3.

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Definition 3: [5] The *single-valued trapezoidal neutrosophic number* , $\tilde{a} = \langle(a_1, a_2. a_3, a_4); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}}\rangle$, represents a neutrosophic set over the real numbers $\mathbb{R}$, where its truth, indeterminacy, and falsity membership functions are defined respectively. This builds a more nuanced representation of neutrosophic values, which allows for a broader interpretation within the spectrum of truth, indeterminacy, and falsity: [6]

$$T_{\tilde{a}}(x) = \begin{cases} \alpha_{\tilde{a}}\left(\frac{x-a_1}{a_2-a_1}\right), a_1 \le x \le a_2 \\ \alpha_{\tilde{a}}, \quad a_2 \le x \le a_3 \\ \alpha_{\tilde{a}}\left(\frac{a_3-x}{a_3-a_2}\right), a_3 \le x \le a_4 \\ 0, \quad otherwise \end{cases} \tag{1}$$

$$I_{\tilde{a}}(x) = \begin{cases} \frac{(a_2-x+\beta_{\tilde{a}}(x-a_1))}{a_2-a_1}, & a_1 \le x \le a_2 \\ \beta_{\tilde{a}}, & a_2 \le x \le a_3 \\ \frac{(x-a_2+\beta_{\tilde{a}}(a_3-x))}{a_3-a_2}, & a_3 \le x \le a_4 \\ 1, & \text{otherwise} \end{cases} \tag{2}$$

$$F_{\tilde{a}}(x) = \begin{cases} \frac{(a_2-x+\gamma_{\tilde{a}}(x-a_1))}{a_2-a_1}, & a_1 \le x \le a_2 \\ \gamma_{\tilde{a}}, & a_2 \le x \le a_3 \\ \frac{(x-a_2+\gamma_{\tilde{a}}(a_3-x))}{a_3-a_2}, & a_3 \le x \le a_4 \\ 1, & \text{otherwise} \end{cases} \tag{3}$$

Where $\alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \in [0,1]$, $a_1, a_2, a_3, a_4 \in \mathbb{R}$and $a_1 \le a_2 \le a_3 \le a_4$.

Definition 4: Given $\tilde{a} = \langle(a_1, a_2, a_3, a_4); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}}\rangle$two $\tilde{b} = \langle(b_1, b_2, b_3, b_4); \alpha_{\tilde{b}}, \beta_{\tilde{b}}, \gamma_{\tilde{b}}\rangle$single-valued trapezoidal neutrosophic numbers and λany nonzero number on the real line, the following operations are defined: [7]

Addition: $\tilde{a} + \tilde{b} = \langle(a_1 + b_1, a_2 + b_2, a_3 + b_3, a_4 + b_4); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}}\rangle$ (4)

Subtraction:$\tilde{a} - \tilde{b} = \langle(a_1 - b_4, a_2 - b_3, a_3 - b_2, a_4 - b_1); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}}\rangle$ (5)

Investment: $\tilde{a}^{-1} = \langle({a_4}^{-1}, {a_3}^{-1}, {a_2}^{-1}, {a_1}^{-1}); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}}\rangle$, where $a_1, a_2, a_3, a_4 \neq 0$. (6)

Multiplication by a scalar number:$\lambda\tilde{a} = \begin{cases} \langle(\lambda a_1, \lambda a_2, \lambda a_3, \lambda a_4); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}}\rangle, & \lambda > 0 \\ \langle(\lambda a_4, \lambda a_3, \lambda a_2, \lambda a_1); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}}\rangle, & \lambda < 0 \end{cases}$ (7)

Division by a scalar number: $\frac{\tilde{a}}{\lambda} = \begin{Bmatrix} \langle(\frac{a_1}{\lambda}, \frac{a_2}{\lambda}, \frac{a_3}{\gamma\lambda}); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}}\rangle \ if \ (\lambda > 0) \\ \langle(\frac{a_3}{\gamma\lambda}, \frac{a_2}{\lambda}, \frac{a_1}{\lambda}); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \beta\gamma_{\tilde{a}}\rangle \ if \ (\lambda < 0) \end{Bmatrix}$ (8)

Division: $\frac{\tilde{a}}{\tilde{b}} = \{ \begin{matrix} \langle(\frac{a_1}{b_3}, \frac{a_2}{b_2}, \frac{a_3}{b_1}); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \theta\beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}}\rangle \ if \ (a_3 > 0, b_3 > 0) \\ \langle(\frac{a_3}{b_3}, \frac{a_2}{b_2}, \frac{a_1}{b_1}); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}}\rangle \ if \ (a_3 < 0, b_3 > 0) \\ \langle(\frac{a_3}{b_1}, \frac{a_2}{b_2}, \frac{a_1}{b_3}); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}}\rangle \ if \ (a_3 < 0, b_3 < 0) \end{matrix}$ (9)

2.2 Neutrosophic AHP (NAHP for short) in SWOT analysis

In the implementation of the Neutrosophic Analytic Hierarchy Process (AHP), a linguistic scale can be employed as an alternative to a numerical scale, offering a more intuitive means for experts to make assessments [8] . The original numerical scale proposed by Saaty is thus converted into a linguistic scale, as illustrated in Table 1. This adaptation facilitates the assessment of ethical components within the supply chain through linguistic terms, which experts find more appropriate compared to numerical assessments.

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Table 1: Saaty scale translated into a neutrosophic triangular scale.

The Saaty scale	Definition	Neutrosophic triangular scale
1	Equally influential	$\tilde{1} = \langle(1,1,1); 0.50, 0.50, 0.50\rangle$
3	Slightly influential	$\tilde{3} = \langle(2,3,4); 0.30, 0.75, 0.70\rangle$
5	Strongly influential	$\tilde{5} = \langle(4,5,6); 0.80, 0.15, 0.20\rangle$
7	Very strongly influential	$\tilde{7} = \langle(6,7,8); 0.90, 0.10, 0.10\rangle$
9	Absolutely influential	$\tilde{9} = \langle(9,9,9); 1.00, 1.00, 1.00\rangle$

Source: [9]

The SWOT-NAHP methodology involves the execution of the following steps:

Step 1: Assemble a team consisting of people who are experts in the SWOT analysis process. In this initial stage, the team uses questionnaires or interviews to outline the internal and external elements that are crucial to conducting the SWOT analysis.

To convert a complex problem into a simpler and more understandable framework, the following step is performed:

Step 2: Develop a hierarchical structure for the problem at hand.

This hierarchical structure consists of four levels: the first level relates to the objective that the organization seeks to achieve; the second level includes the four strategic factors identified by the SWOT analysis, called "criteria"; the third level includes the specific components within each strategic factor outlined in the previous level, called "subcriteria"; and the last level contains the strategies that must be evaluated and compared, recognizing that the central issue revolves around supply chain ethics.

The next step is to evaluate the relative importance of the criteria, subcriteria and strategies (alternatives) based on the experience of the specialists.

Step 3: Formulate the neutrosophic pairwise comparison matrix for the criteria, sub-criteria and strategies using the linguistic terms specified in Table 1. This step is based on synthesizing expert opinions to assess the interrelationships and importance of these elements within the context of ethical supply chain management.

The derivation of the neutrosophic scale is based on the consensus of expert judgment.

The neutrosophic pairwise comparison matrices for criteria, subcriteria and strategies are constructed accordingly:

$$\tilde{A} = \begin{bmatrix} \tilde{1} & \tilde{a}_{12} \cdots & \tilde{a}_{1n} \\ \vdots & \ddots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} \cdots & \tilde{1} \end{bmatrix} \quad (10)$$

The matrix $\tilde{A}$must satisfy the condition $\tilde{a}_{ji} = \tilde{a}_{ij}^{-1}$, according to the inversion operator in Definition 4.

Step 4 – involves evaluating the experts' assessments for consistency. This step is critical to determining the consistency of the pairwise comparison matrix by checking whether it holds a transitive relationship, specifically when $a_{ik} = a_{ija_{jk}}$the condition is met for each possible trio of i , j , and k . The focus of this consistency check is on the lower, middle, and upper bounds of the triangular neutrosophic numbers represented in the comparison matrix, ensuring that these values adhere to the transitivity principle across all item comparisons.

In step 5, the task is to calculate the weights of the factors (S, W, O, T), subfactors, $\{(S_1, \dots, S_n), (W_1, \dots, W_n), (O_1, \dots, O_n), (T_1, \dots, T_n)\}$,and strategies/alternatives ($Alt_1, \dots, Alt_n$)derived from the data in the neutrosophic pairwise comparison matrix). The process involves transforming the neutrosophic matrix into a deterministic format by applying specific equations. This conversion is critical to facilitate quantitative analysis of the matrix, allowing the calculation of weights that reflect the relative importance of each factor, subfactor, and strategy within the context of the analysis.

Let be $\tilde{a}_{ij} = \langle(a_1, b_1, c_1), \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}}\rangle$a singular triangular neutrosophic number; then,

$$S(\tilde{a}) = \frac{1}{8}[a_1 + a_2 + a_3](2 + \alpha_{\tilde{a}} - \beta_{\tilde{a}} - \gamma_{\tilde{a}}) \quad (11)$$

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and

$$A(\tilde{a}) = \frac{1}{8}[a_1 + a_2 + a_3](2 + \alpha_{\tilde{a}} - \beta_{\tilde{a}} + \gamma_{\tilde{a}}) \quad (12)$$

which are the grades of punctuation and precision $\tilde{\alpha}_{ij}$respectively.

To obtain the score and degree of accuracy of $\tilde{\alpha}_{ij}$, the following equations are used:

$$S(\tilde{a}_{ji}) = 1/S(\tilde{a}_{ij}) \quad (13)$$

$$A(\tilde{a}_{ji}) = 1/A(\tilde{a}_{ij}) \quad (14)$$

By evaluating and scoring each triangular neutrosophic number within the pairwise neutrosophic comparison matrix, we obtain the following deterministic matrix:

$$A = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ \vdots & & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & 1 \end{bmatrix} \quad (15)$$

To determine the order of precedence, known as Eigenvector (X), of the given matrix, the process involves the following steps:

1. Normalization of column values: This is achieved by normalizing each entry in a column by dividing it by the sum of all entries in that column. This procedure ensures that each column in the matrix sums to 1, facilitating a comparison on a uniform scale.

2. Calculating the cumulative row average: The next step is to determine the average of the values in each row after standardization. This average represents the relative weight or priority of each factor, subfactor, or strategy within the matrix, providing a preliminary idea of their order of precedence.

Step 6: To determine the overall priority of each strategy (alternative) and thereby establish the final ranking among all strategies, the overall weight value of an alternative (j=1, 2, …, n) is calculated. This calculation involves integrating the relative weights or priorities of the alternatives derived from the normalized pairwise comparison matrix. The overall priority, which encapsulates the overall importance of each alternative within the context of the analysis, can be expressed mathematically using a specific equation (referred to as Equation (16) in the context provided). This equation synthesizes the individual weights or priorities into a holistic measure of importance, thus facilitating the ranking of the alternatives based on their overall priorities.

$$Tw_{\mathrm{Alt}_j} = w_S * \sum_{i=1}^{n} w_{S_i} * w_{\mathrm{Alt}_j} + w_W * \sum_{i=1}^{n} w_{W_i} * w_{\mathrm{Alt}_j} + w_O * \sum_{i=1}^{n} w_{O_i} * w_{\mathrm{Alt}_j} + w_T * \sum_{i=1}^{n} w_{T_i} * w_{\mathrm{Alt}_j} \quad (16)$$

where (i =1, …, n) and $(w_S, w_W, w_O, w_T)$are the weights of the Strengths, Weaknesses, Opportunities and Threats; $(w_{S_i}, w_{W_i}, w_{O_i}, w_{T_i})$are the weights of the subfactors; and $w_{Alt_j}$is the weight of the alternative j , corresponding to its subfactor.

Indeterminate Likert scale

Within the framework established by the advanced interpretation of Smarandache's neutrosophic logic, the following elaborations are presented:

Definition 5: The notion of truth, denoted as T, is segmented into a series of subclasses denoted as $T_1, T_2, \ldots, T_p$; similarly, the concept of indeterminacy, denoted as I, is divided into $I_1, I_2, \ldots, I_r$, and the concept of falsity, denoted as F, is subdivided into $F_1, F_2, \ldots, F_s$, where p, r, and s are positive integers satisfying the equation p + r + s = n. [10]

In this context, Triple-Refined Indeterminate Neutrosophic Sets (TRINS) further dissect the domain of indeterminacy into three unique membership categories, thereby improving granularity and utility in applications such as Likert-scale-like scaling methodologies. TRINS have been leveraged in domains including, but not limited to, personality categorization, offering a nuanced perspective. In comparison, a Double-Valued Neutrosophic Set (DVNS) dichotomizes the realm of indeterminacy into a binary division.

Definition 6: A TRINS A defined within a domain X is characterized by a quintet of membership functions, namely, positive , $P_A(x$negative $N_{A(x)}$,indeterminate , $I_{A(x)}$,positively indeterminate $IP_{A(x)}$,and negatively

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indeterminate , $IN_{A(x)}$,with each function being assigned a respective weight $w_m$within the range [0, 5]. For any element x in X, it is stated that: [11]

$P_{A(x)}, IP_{A(x)}, I_{A(x)}, IN_{A(x)}, N_{A(x)} \in [0,1]$

And, consequently, their weighted formulations:

$w_m P(P_{A(x)}), w_m IP(IP_{A(x)}), w_m I(I_{A(x)}), w_m IN(IN_{A(x)}), w_m N(N_{A(x)}) \in [0,5]$

Under the restriction that:

$0 \leq P_{A(x)} + IP_{A(x)} + I_{A(x)} + IN_{A(x)} + N_{A(x)} \leq 5$

Therefore, TRINS A is outlined as:

$A = \{x, P_{A(x)}, IP_{A(x)}, I_{A(x)}, IN_{A(x)}, N_{A(x)}\} \mid x \in X$

Given two Triply Refined Indeterminate Neutrosophic Sets (TRINS), denoted A and B, within the metric space X, the intersection of A and B yields a third TRNS C, formalized as $C = A \cap B$. The membership function of C in terms of truth, indeterminacy toward truth, indeterminacy, indeterminacy toward falsity, and falsity is set up by the following relational equations based on the membership values in A and B:

$T_{C(x)} = \min(T_{A(x)}, T_{B(x)})$

$IT_{C(x)} = \min(IT_{A(x)}, IT_{B(x)})$

$I_{C(x)} = \min(I_{A(x)}, I_{B(x)})$

$IF_{C(x)} = min(IF_{A(x)}, IF_{B(x)})$

$F_{C(x)} = \max(F_{A(x)}, F_{B(x)})$

In the field of refined neutrosophic logic, a fourth definition is introduced for the computation of a generalized weight. This computation is fundamental to aggregate the influence of all membership functions within a TRINS framework, allowing elucidating the importance and contribution of each membership function to the aggregate value of a neutrosophic set.

3. Method

This research is part of a qualitative exploratory design, aimed at analyzing and making visible the main challenges in the legal protection of children's rights in custody processes in the Ecuadorian context. The main objective is to explore the perceptions and experiences of professionals directly involved in these processes, including family lawyers, judges and other professionals in the judicial system. Through the application of neutrosophic logic and indeterminate Likert scales [12, 13, 14] , this study seeks to deepen the understanding of the complexities and areas of indeterminacy that characterize decision-making in this area.

The selected sample is composed of 37 participants, divided between family lawyers (6), judges (15) and other professionals of the judicial system (16), chosen through an intentional non-probabilistic sampling, with the aim of representing a wide spectrum of experiences and perspectives within the Ecuadorian judicial system. The inclusion of diverse professionals allows capturing a holistic and multifaceted vision of the challenges facing the legal protection of children's rights during custody processes.

Structured questionnaires were designed using an indeterminate Likert scale, adapted to capture not only affirmative or negative responses but also the degrees of indeterminacy experienced by participants in their decision-making and perceptions. The scale includes options ranging from total agreement to total disagreement, adding categories that reflect indeterminacy, thus allowing for a richer and deeper analysis of the data.

Neutrosophic logic is used as a theoretical framework to analyse the data collected, given its ability to address the uncertainty, indeterminacy and contradiction inherent in legal decision-making processes. This approach allows for exploring the areas of indeterminacy that arise in practitioners' perceptions of the challenges in protecting children's rights, offering a more complex and nuanced understanding of the dynamics at play[15].

Data analysis is carried out using qualitative coding and content analysis techniques, adapted to integrate the principles of neutrosophic logic. Patterns, emerging themes and contradictions within the responses are identified, with particular attention to areas of indeterminacy and ambiguity. The aim is to unravel the complexities and challenges in the legal protection of children's rights in custody proceedings, using neutrosophic logic to interpret the variations and uncertainties expressed by the participants.

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Informed consent was obtained from all participants and the confidentiality of the information provided was guaranteed. The ethical principles of respect, beneficence, and justice were followed at all stages of the research. It is important to note that this research is limited to the analysis of a specific sample in the city of Tulcán and therefore the findings may not be generalizable to other regions of Ecuador. Furthermore, due to the qualitative nature of the study, the results reflect the perceptions and experiences of the participants and may be influenced by individual biases [16,17].

4. Results

The scientific analysis of the responses obtained from the participants involved a process of data cleaning and transformation, after which they were represented graphically to facilitate interpretation and visual analysis of the results. Figure 1 illustrates the general findings of the sample studied, using the TRINS format for a detailed categorization of perceptions. The examination of the results revealed that the highest degree of agreement was concentrated on the issue of deficiencies in training and education. Respondents expressed in particular the urgent need to strengthen specific training on children's rights, identifying this area as one of marked dissatisfaction. The convergence on this point suggests a deficiency in the preparation of professionals, which could be negatively affecting the effective protection of children's rights in the judicial field.

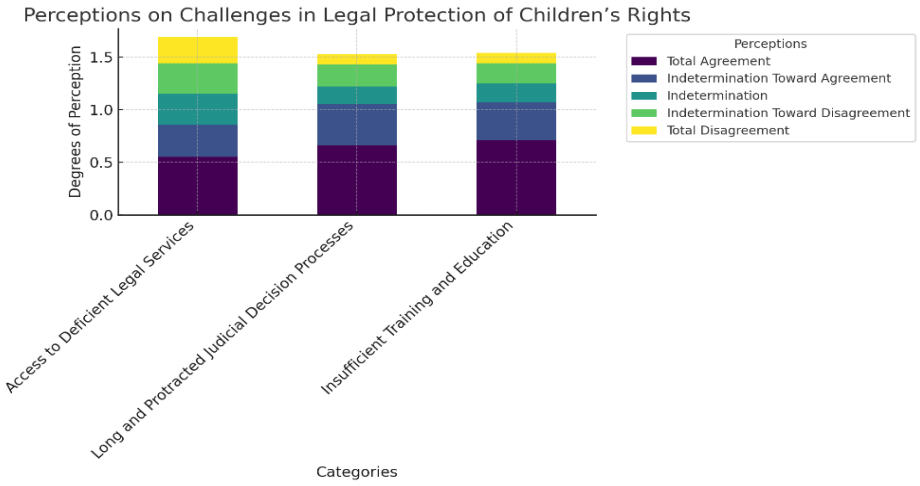

Figure 1 General perceptions on challenges in the legal protection of children

From a scientific perspective, the consistency of the responses points to a critical assessment of the current state of child rights training, implying a call to action for the development of more robust and specialized educational and training programs. These results, reflected in the predominance of agreement on this aspect, highlight the inadequacy of resources and educational strategies aimed at improving specific professional competence in handling child custody and protection cases.

In addition, access to legal services and response times in judicial proceedings were found to have significant deficiencies, as reflected in the data analysed. These deficiencies are manifested in delays and additional costs, affecting the efficiency of the judicial system and, therefore, the legal protection of children's rights. Delays in judicial proceedings and limited access to relevant and effective legal services were identified as critical factors that require immediate attention to avoid the perpetuation of injustices and rights violations.

On the other hand, there was considerable uncertainty among participants regarding equitable access to legal services for children and their families, which could be interpreted as a lack of consensus or clarity on the uniformity and equity of the current legal system. This degree of indecision could be due to a diversity of individual experiences and perceptions or to a lack of sufficient information to make a conclusive judgment.

Furthermore, it is important to note that a significantly low proportion of respondents perceive that judicial decision-making processes are carried out within adequate timeframes, or that there is sufficient training and education to competently handle such cases. This perception points to a critical assessment of procedural efficiency and professional training in the field of child protection. Overall, the results of the study reflect a general dissatisfaction and notable shortcomings in the process of legal protection of children's rights. This dissatisfaction

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points to an urgent need for structural reforms that would optimize judicial response time, improve access to adequate legal services, and expand training and education of professionals involved, in order to strengthen the legal protection framework for children.

The data collected constitute a fundamental basis for the preparation of a SWOT analysis, which will allow for the channelling of appropriate strategies to address the problems identified in the legal protection of the rights of children in Tulcán during custody proceedings. Below, the components of said analysis are broken down based on the information obtained:

Strengths:

1. F1. Strong Legal Framework: Fundamental laws, such as the Constitution of the Republic and the Organic Code of Children and Adolescents, guarantee a robust framework to safeguard children's rights.
2. F 2. Stakeholder awareness: The involvement of parents, lawyers, judges and other justice system professionals reflects a recognition and willingness to enhance the advocacy of children's rights.
3. F3. Willingness to collaborate: The perception of shared challenges suggests the potential to foster inter-institutional alliances and effective collaborations.
4. F4. Best Interests of the Child: The priority given to the best interests of the child in judicial proceedings constitutes an essential basis for the protection of his or her rights.

Weaknesses:

1. D1. Lack of resources: Limited resources and insufficient government support prevent efficient protective action by justice operators.
2. D2. Insufficient training: The lack of specialization in the rights of children and adolescents among judicial personnel affects the quality of defense and judicial decision-making.
3. D3. Delays in processes: Long resolution times can have adverse effects on children's emotional well-being.
4. D4. Lack of inter-institutional coordination: The absence of effective collaboration between institutions denotes challenges in the system that can translate into fragmented protection.

Opportunities:

1. O1. Pro-child legislation: National and international legislation aimed at the well-being of children represents a window to strengthen their well-being.
2. O2. Civil society organizations: The existence of NGOs and support groups offers an opportunity to establish synergies and improve access to services and education on children's rights.
3. O3. Government support: Highlighting current needs can lead to policies and budget allocations aimed at strengthening child protection.

Threats:

1. A1. Lack of awareness: Insufficient understanding of the rights of children in custody can be an obstacle to the proper administration of justice.
2. A2. Resistance to change: Reluctance to adapt existing judicial methods and processes could inhibit the implementation of necessary reforms.
3. A3. Legal complexity: The difficulties inherent in understanding and applying legal norms can complicate the effective protection of the rights of minors.

The analysis combined two complementary methodologies: the neutrosophic version of the AHP method and the SWOT analysis. The neutrosophic variant of the AHP stands out for its ability to incorporate and manage uncertainty and indeterminacy, characteristics frequently present in the evaluation of subjective perceptions and judgments, especially in environments as complex as the legal and judicial one. By applying this neutrosophic approach, it is possible to consider elements that are neither completely true nor false, but that can present degrees of truth, falsehood and indeterminacy simultaneously.

The proposed method is followed, which allows obtaining the results shown in Table 2.

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Table 2: Global analysis for each sub criterion

Criteria	Weight of the criterion	Subcriteria	Subcriteria of global influence
Threats	0.30	**A1**	0.09
		A2	0.05
		A3	0.16
Opportunities	0.30	**O1**	0.13
		O2	0.07
		O3	0.10
Strengths	0.16	**F1**	0.06
		F2	0.03
		F3	0.02
		F4	0.05
Weaknesses	0.24	**D1**	0.07
		D2	0.10
		D3	0.04
		D4	0.03

The analysis conducted allowed to quantitatively elucidate the impact of various variables. This examination was conducted in the past and shed light on the predominant factors affecting the legal system in question. Threat A3: Legal complexity emerged as the sub-criterion with the greatest overall influence. The prominence of legal complexity suggests that it stands as a substantial obstacle in the effective functioning of the child rights protection process in the assessed area. The importance given to this criterion underlines the pressing need to address the legislative and procedural complexity that characterizes the administration of justice in child custody cases.

The evaluation of this sub-criterion shows that its considerable weight not only denotes the magnitude of the threat, but also highlights the urgency of implementing policies to mitigate or neutralize it. The articulation of strategies aimed at simplifying regulations, increasing procedural clarity and improving specialized legal training could contribute decisively to improving the system of protection of children's rights.

On the other hand, within the Opportunities, it was identified that regulations focused on child welfare (O1) and government support (O3) exert a predominant influence on the system. This finding, based on a weight assigned to these subcriteria of 0.13 and 0.10 respectively, underlines the relevance of these areas as potential levers of change. The magnitude of their impact suggests that strategic efforts should be channeled to capitalize on these opportunities, since they represent important vectors to promote and implement improvements in the legal protection system for minors.

On the other hand, insufficient training (D2) with an overall influence weight of 0.10, and lack of awareness (A1) with a weight of 0.09, were presented as significant challenges within the Weaknesses and Threats respectively. These high-weight sub-criteria indicate critical areas that require immediate attention. Insufficient training highlights a gap in the training of legal professionals that directly affects the quality and effectiveness of the service provided in child custody cases. Simultaneously, lack of awareness of children's rights indicates a gap in the understanding and application of existing regulations, which may lead to suboptimal judicial decisions and inadequate protection of children.

From a scientific perspective, the results indicate that corrective measures must be implemented to improve training and awareness raising. This implies not only strengthening legal training related to children and adolescents, but also developing information and education campaigns aimed at all actors in the justice system, as well as society in general. Mitigating these weaknesses and threats is aligned with taking advantage of the

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identified opportunities, and setting up a comprehensive approach that can translate into a positive and sustained impact on the system for protecting children's rights.

Strategic proposal

In response to the findings of the analysis, a structured strategic plan is proposed to mitigate the weaknesses and threats identified and to maximize the use of the strengths and opportunities of the legal protection system for children's rights. This plan is based on four fundamental pillars: institutional strengthening, training and education, awareness and sensitization, and the use of regulatory frameworks and government support, as shown in Table 3.

Table 3: Strategic plan for mitigating identified weaknesses and threats

Institutional strengthening - Implementation of efficient inter-institutional coordination mechanisms to improve the response of the judicial system to the protection needs of children. - Development of digital platforms to streamline judicial processes, thereby reducing complexity and delays in resolving cases.	**Training and education** - Design and implementation of continuing education programs for legal professionals, focused on specialization in the rights of children and adolescents. - Creation of training modules on the practical application of pro-child regulations, in order to improve the quality of legal representation and judicial decision-making.
Awareness and Sensitization - Development of awareness-raising campaigns aimed at society in general and professionals in the legal system, to promote greater knowledge of children's rights. - Organization of multidisciplinary forums and meetings that promote the exchange of experiences and good practices in the legal protection of children's rights	**Taking advantage of regulatory frameworks and government support** - Proposal for legal reforms that simplify and clarify existing regulations, facilitating their effective application in safeguarding the rights of minors. - Management of collaboration agreements with government organizations to ensure the flow of necessary resources and support in the implementation of training and awareness programs.

5. Conclusion

This study made it possible to assess the factors that influence the legal protection of children's rights in the specific context of custody proceedings. Using indeterminate Likert scales and the combined implementation of the AHP method in its neutrosophic version and SWOT analysis, a deep understanding of the complexities inherent in decision-making in the legal and judicial spheres concerning children was achieved. The use of these methods made it possible to break down and prioritize the various variables that influence the effectiveness of the protection of children's rights, distinguishing between aspects of the system that represent strengths and opportunities for improvement, versus weaknesses and threats that require urgent attention. In addition, the adaptation of the AHP to incorporate neutrosophic approaches facilitated the management of uncertainty and ambiguity, characteristics frequently present in the perceptions and opinions of the actors involved in legal processes for the protection of children. The findings of the study highlight the importance of adopting a holistic and coordinated approach that simultaneously addresses weaknesses and threats, strengthens, and builds on existing strengths and opportunities. This provided a scientific basis for the formulation of strategies aimed at improving the legal and judicial system, highlighting the importance of intersectoral cooperation and the adaptation of policies and practices to the specific needs and realities of children in vulnerable situations. The use of indeterminate Likert scales, together with the integration of neutrosophy in the PAH and SWOT analysis, effectively addressed uncertainty and complexity in the assessment of factors influencing the legal protection of children's rights, accessing a more nuanced and strategic interpretation of the data.

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