



Neutrosophic Sentiment Analysis Method Using Orange Data Analysis

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Abstract

The present work tackles an urgent problem in the area of data analytics that is the shifting of sentiment against language in regards to human cognition. Although the science of data mining and machine learning has done much to address the problem of these tools, their scope is still limited regarding the management of human language which has inherent uncertainty and ambiguity. This research seeks to address this gap by illustrating how to apply a machine learning tool in a way that embraces the so-called uncertainty neutrality using the orange data analysis tool for analysis of visualized data. It is also important to note in the research that the combination of neutral and intelligent analysis with using applications such as orange increases the efficiency of sentiment classification and expands the theoretical scope of sentiment data analysis. Their findings underscore that this perspective seeks to illuminate details which other methods tend to ignore and hence offer a much more nuanced understanding of human cognition. Practically, this research presents an efficient paradigm as the new framework can be employed in market intelligence, evaluation of public policy and intelligent interface design, among others. As a result, this research does not only contribute to the body of knowledge within the profession of data science but also explores new dimensions in understanding human cognition.

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1. Introduction

In the context of today's society, the issue of suicide and its impact on people's lives has acquired unprecedented relevance and sensitivity. Given the growing concern to preserve the most fundamental legal interest, which is human life, it is essential to address the issue of instigation or assistance to suicide in a decisive and compassionate manner. The discussion around the instigation or assistance to suicide emerges strongly in the public debate in Ecuador, reflecting a deep division of opinions that cuts across the legal, human rights, mental health and social spheres [1 , 2] .

The Constitution of the Republic of Ecuador and various international human rights treaties underline the importance of the right to life as a pillar of human dignity. However, the absence of specific legislation on incitement or assistance to suicide poses significant challenges in terms of legal security and protection of fundamental rights. The Constitution of the Republic of Ecuador and various international human rights treaties

recognize and protect the right to life as one of the fundamental rights inherent to human dignity. This right is considered the central pillar of human existence and must be guaranteed and respected by the State and society as a whole [1-4] .

In the specific case of the Constitution of the Republic of Ecuador, article 66 establishes the recognition and guarantee of the inviolability of human life. Additionally, article 11, numeral 9, subsection 1, mentions that the highest duty of the State is to respect and enforce the rights guaranteed in the Constitution, including the right to life [5 ,24] .

Likewise, Ecuador is a signatory to various international human rights treaties that enshrine the right to life as a fundamental and inalienable right. For example, the International Covenant on Civil and Political Rights, in its article 6, recognizes the right to life and prohibits arbitrary deprivation of life. Additionally, the American Convention on Human Rights, also known as the “Pact of San José”, establishes in its article 4 that the right to life must be protected by law and that no one may be arbitrarily deprived of it [2-4 , 6] .

The negative influence exerted by third parties on vulnerable people can lead them to make irreparable and tragic decisions. People in situations of emotional vulnerability, such as depression, harassment or loneliness, are especially susceptible to manipulation and the harmful influence of others. It is therefore essential to criminalise the incitement or assistance to suicide, in order to establish legal mechanisms to protect people at risk.

This conduct, which may manifest itself through hurtful words, psychological pressure or the provision of means to carry out the suicidal act, violates the right to legal security of individuals. The lack of specific legislation addressing this issue could leave unpunished those who, consciously or unconsciously, engage in conduct that leads others to attempt against their own lives [1-4 , 7 , 8] .

Legislation regarding assisted suicide has been the subject of intense debates in many countries in recent decades. This debate revolves around ethical, moral, religious, legal and social issues, giving rise to a wide range of opinions and perceptions from different segments of society. In this context, Ecuador has witnessed a growing interest in reforming its legislative framework regarding assisted suicide. The introduction of assisted suicide into legislative discussions has raised several questions and reflections on individual rights, patient autonomy, quality of life, the role of health professionals and the role of the State in regulating these practices. These reflections have been manifested in the opinions and perceptions of various sectors of Ecuadorian society, ranging from academics and health professionals to religious leaders and ordinary citizens [1-4 , 7-9] .

The analysis of these perceptions is fundamental to understanding the complexities and nuances of the discussion on assisted suicide legislative reform in Ecuador. However, it is important to highlight that these perceptions are not necessarily binary or one-dimensional; rather, they may be influenced by a variety of factors and considerations that may not be easily quantifiable or classifiable in simple terms of “positive” or “negative.”

In this context, the present study aims to analyze, from a neutrosophic perspective, the perceptions on the legislative reform of assisted suicide in Ecuador. It seeks to examine the opinions of legal professionals, academics, relatives of deceased persons, health professionals, psychologists, and the general population, in order to understand the emotional and ethical complexity surrounding this issue.

2. Related work

2.1. Neutrosophic logic

Their incorporation into the study ensures that the uncertainty inherent in decision making is taken into account, including indeterminacy where experts will issue their judgments by evaluating linguistic rather than numerical terms, which is the most natural form of measurement in humans [10-15] . Neutrosophic logic and sets in this field of decision making and machine learning are worked with single-valued neutrosophic numbers (SVNN) [11 , 13 , 16-18] . The work with these based on [18 , 19,27] is explained below:

Let be $N = \{(T, I, F): T, I, F \subseteq [0, 1]\}$ a neutrosophic evaluation of an application of a group of propositional formulas to N , and for each sentence p :

$$v(p) = (T, I, F) \tag{1}$$

To facilitate the practical application in real-world problems [7] , the use of Single Value Neutrosophic Sets (SVNS) was proposed, through which it is susceptible to use of linguistic terms to obtain a greater interpretability of the results [8] . Let X be a universe of discourse, an SVNS A over X has the following form [9] : $A = \{(x, u_a(x), r_a(x), v_a(x)): x \in X\}$, where $u_a(x): X \rightarrow [0, 1]$, $r_a(x): X \rightarrow [0, 1]$ and $v_a(x): X \rightarrow [0, 1]$, with $0 \leq u_a(x), r_a(x), v_a(x) \leq 3, \forall x \in X$. The intervals $u_a(x)$, $r_a(x)$ and $v_a(x)$ denote the memberships related to true, indeterminate and false of x in A , respectively [10] . For convenience, a Single Value Neutrosophic Number (SVN) is expressed as $A = (a, b, c)$, where $a, b, c \in [0,1]$ and $0 \leq a + b + c \leq 3$ [20,25] .

Let $A = (a, b, c)$ be a single-valued neutrosophic number, a scoring function S is defined related to a single-valued neutrosophic value, based on the degree of belonging to truth, the degree of belonging to indeterminacy and the degree of belonging to falsehood [21,26] :

$$s(V_i) = 2 + T_i - F_i - I_j \quad (2)$$

3. Corpus design for deep learning based on neutrosophic logic

Definition of the Neutrosophic Sentiment Framework: To establish a framework to classify feelings and perceptions about the legislative reform of assisted suicide in Ecuador not only as positive, negative or Neutrosophic but also according to degrees of truth (T), falsehood (F) and indeterminacy (I). For this purpose, the Neutrosophic linguistic scale proposed in [22 , 23 ,27] was used , as follows:

- ❖ Extremely Positive (EP) (1, 0, 0): Use of superlatives and emphasis to express strong approval of the reform. Represents a firm belief in the benefit and need for legislative reform on assisted suicide. Extremely favorable reactions, with enthusiastic and unequivocal support for the reform. Example: “The reform is absolutely essential and necessary given the current situation.”
- ❖ Very Positive (VP) (0.8, 0, 0.15, 0, 20) : Clear positive expressions without extreme emphasis. Shows support for the reform but with a lower degree of conviction than EP. Positive opinions with some nuances or conditions, but in general in favour of the reform. Example: “The reform is good and necessary for our times.”
- ❖ Slightly Positive (SP) (0.60, 0.35, 0.40): Positive comments with some reservations or lack of emphasis. Indicates a positive opinion but with some doubts. Attitudes that lean towards support, although not overwhelmingly. Example: “The reform could be beneficial, although I have some doubts.”
- ❖ Neutrosophical (N) (0.50, 0.50, 0.50): Sentences that do not express a clear judgment or an impartial opinion. Denotes a balanced position or lack of a firm opinion in one direction or another. Indifferent opinions that do not show a marked inclination. Example: “The reform is a change; we will have to see its effects.”
- ❖ Slightly Negative (SN) (0.40, 0.65, 0.60): Slightly negative expressions or doubts using unfavorable words. Expresses some dissatisfaction or concern about the reform. Unfavorable feelings towards the reform but without open or total opposition. Example: "I am not sure that the reform is the best option."
- ❖ Very Negative (VN) (0.20, 0.85, 0.80): Statements that denote clear opposition without going to extremes. Shows significant disagreement or concern about the reform without being extremely critical. Strong expressions of rejection or disagreement with the reform, indicating a clear negative inclination. Example: “The reform could be harmful to some sectors.”
- ❖ Extremely Negative (EN) (0, 1, 1): Use of superlatives and emphasis to express strong rejection. Indicates unequivocal and categorical rejection of the reform. Extreme repudiation or strong denunciations, indicating deep aversion or contempt. Example: “This reform is terribly wrong and dangerous.”

Building an annotated neutrosophic corpus: Training deep learning models requires large amounts of data. Interview and survey transcripts from previous studies will be selected and annotated according to the neutrosophic sentiment framework in Table 1, using experts to rate sentiments based on degrees of truth, falsity, and indeterminacy. Validation will then be performed through cross-review by other experts to validate the consistency and accuracy of the annotations. At this point, the corpus is ready for the design and training of a deep learning model.

4. Processing with Orange and presenting results

A sample of individuals is selected for the study using the snowball technique among the groups of interest in the research. It is composed as follows:

Table 1: Distribution of the study sample and questionnaires.

Cluster	Amount	Description
Family	40	Family members of people who have died by assisted suicide. This group has direct personal experience with the suffering associated with suicide.
Lawyer	25	Lawyers involved in cases of this nature.
Others	14	A diverse group whose professions include law students and professors and legal assistants in courts.
Health professionals	60	Health professionals familiar with the medical and ethical consequences of assisted suicide.

Extreme responses: Neutrosophic categories with values such as (1, 0, 0) or (0, 1, 1), which represent extremely positive or negative opinions, respectively, are less prevalent compared to more moderate categories. There is a predominance of categories representing moderate opinions, such as (0.6, 0.35, 0.40), which are more common than extreme ones, indicating a tendency towards nuanced positions on the issue.

Indeterminacy: The number of neutrosophic responses and those with linguistic labels indicating a high level of indeterminacy reflect the complexity and ambivalence in participants' attitudes and perceptions toward assisted suicide legislative reform.

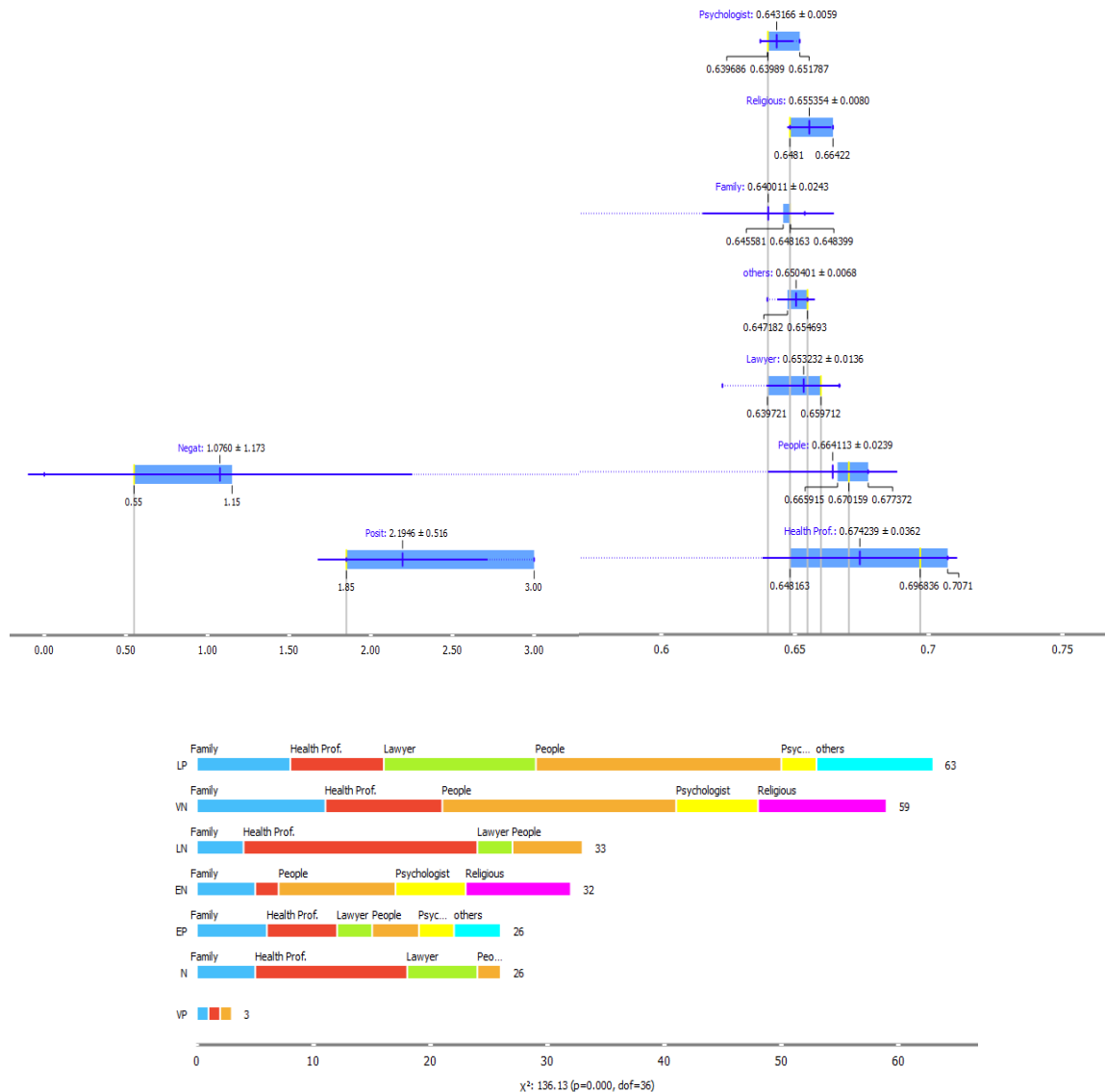


Figure 3. Box plot for polarity analysis by neutrosophic labels and interest groups.

The findings represented in Figure 2 are confirmed, where certain categories are more prevalent in some groups than in others, such as the Very Negative category, which has a significant presence in the People and Psychologists groups. The lines inside the boxes represent the median values, and the boxes themselves mark the interquartile range, indicating a high concentration and low dispersion of responses within the Others, Religion, and Family categories, in contrast to the People, Lawyers, and Health Personnel groups, whose levels indicate more diverse opinions. It is also evident that negative opinions have a higher median and a lower dispersion, indicating a tendency towards a more negative perception in general.

The resulting graph of the K-means analysis using the Scatter Plot tool is shown. Figure 3 shows a multidimensional analysis of the corpus, providing a visualization of a silhouette analysis.

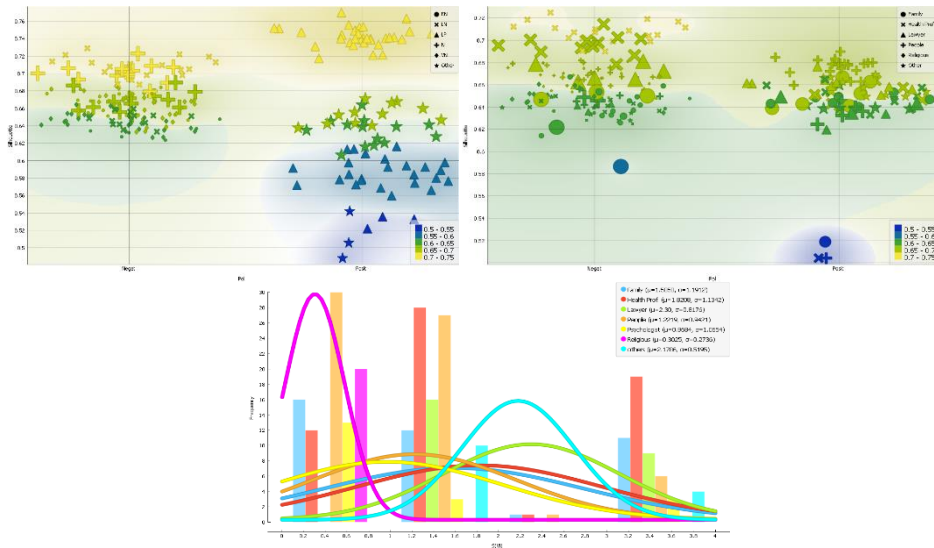


Figure 4. Scatter plot and prediction analysis (normal distribution) after deneutrosification of the values using equation 2. Source: own elaboration.

It is observed that the clusters located at the top of the graph with the highest silhouette score are better grouped, indicating that the responses are more homogeneous or similar to each other. On the contrary, the lower points indicate clusters with lower internal cohesion or greater similarity with points from other clusters. This is confirmed by the areas under the curve of the normal distributions of each group, where those with a wider curve indicate a greater diversification of opinions, and a narrower curve is indicative of a strong cohesion. Therefore, it can be concluded that:

- ❖ Extremely positive responses grouped across all clusters have a low silhouette score, unlike slightly positive responses, which show greater cohesion. In contrast, negative responses with higher scores indicate greater cohesion despite belonging to several interest groups.
- ❖ The “Family” group expresses contrasting opinions and presents a mean score with presence in both polarities, although negative opinions have a higher score. It presents the highest mean ($\mu=1.5850$), indicating a stronger opinion or reaction on average regarding assisted suicide legislation, and also presents the highest standard deviation ($\sigma=1.1912$), implying a wide diversity of opinions within that group.
- ❖ The “Others” group shows a high average score with a predominant presence in favor of implementing the legislation.
- ❖ The health professionals surveyed expressed opinions in both polarities, with significant cohesion in the negative. This includes psychologists, who show a wide polarity.
- ❖ The "Lawyer" group has a wide curve, consistent with its standard deviation, but has a high mean, indicative of strong opinions.

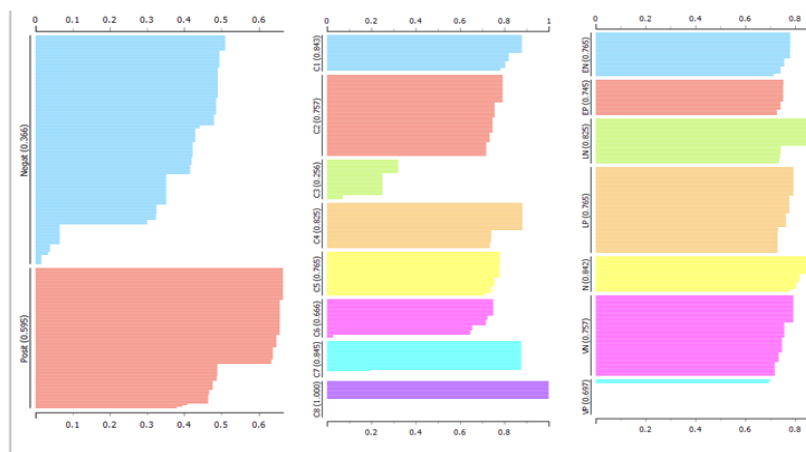


Figure 5. Analysis of the Manhattan distance between polarity, clusters and neutrosophic labels

The Manhattan distance is chosen due to the characteristics of the experiment as a sentiment analysis. In this analysis, positive values indicate a strong belonging of the elements to their group and a high level of consistency. On the other hand, distances close to zero or negative values suggest the need to re-evaluate the grouping of the data, indicating weaknesses. As shown in Figure 5, all the scenarios presented demonstrate a strong consistency in the analysis, indicating the robustness of the experiment. Due to the nature of the experiment, several extreme values affected the results, but their inclusion was necessary to analyze the strength of the opinion state.

3. Results and discussion

The debate on assisted suicide in Ecuadorian society has intensified, revealing a spectrum of opinions spanning multiple areas, from legal and human rights perspectives to mental health and social perspectives. The imperative to protect the right to life as a fundamental pillar is confronted by the lack of clear legislation on assisted suicide, which poses a number of challenges in terms of legal certainty and protection of essential rights.

This discussion framework in Ecuador shows a division of perceptions regarding assisted suicide. Although the country's Constitution and international treaties emphasize the inviolability of the right to life, the need for specific legislation that provides effective legal protection is evident, especially for vulnerable individuals who may be negatively affected in moments of emotional weakness.

Legislation on assisted suicide has become a focus of ethical, moral and legal discussion. In Ecuador, there is a growing interest in reforming the legal framework related to assisted suicide. This discussion has motivated deep reflections on individual rights, patient autonomy and the role of health professionals and the State in regulating these practices.

Opinions on this issue, far from being binary, are influenced by a number of factors that reflect the emotional and ethical complexity of the issue. The debate is not only important for theoretical understanding, but also for informed and sensitive public policy formulation and legislative decision-making.

The importance of using a neutrosophic approach to analyses these perceptions is highlighted, a methodology that allows capturing the breadth and depth of the attitudes and emotions of the various groups involved. This study reveals different patterns that can be associated with the experiences, knowledge and professional orientation of the different groups surveyed, as described below:

- ❖ **Family:** This group displays a complex range of opinions reflecting personal trauma and suffering, resulting in a more emotional and divided stance on the legalization of assisted suicide. Responses from this group show great variability, given direct personal experiences with suicide.
- ❖ **Lawyers:** This group tends to analyze from a legal and ethical perspective, focusing on individual rights and the implications of legalization. Their opinions may be oriented toward legal consequences and interpretation of the law.
- ❖ **Others:** This small group has relevant background knowledge but lacks personal experience with assisted suicide, making their opinions unbiased. Their views are theoretical and less emotional, and show a diversity of perspectives based on academic knowledge and personal reflections.
- ❖ **Health professionals:** As one of the largest groups in the study, their opinions are influenced not only by medical considerations but also by ethical ones, expressing concerns about patient welfare and the Hippocratic Oath. They present more nuanced opinions due to their professional experience and their role in caring for patients at the end of life.
- ❖ **People:** With 64 respondents, this is the largest and probably most diverse group, reflecting a broad spectrum of society. They display a wide spread of opinions, as reflected in the mean and standard deviation, indicating the variety of beliefs and values.
- ❖ **Religious:** This minority group shows strong opposition to assisted suicide, based on religious principles that value the sanctity of life. Their opinions are unanimous against the legalization of assisted suicide.
- ❖ **Psychologists:** This group specializes in the treatment of suicide and offers in-depth insight based on their clinical experience, not only participating in roles within the hospital process but also in processing cases in court and dealing with families. Their views reflect the nuances of human thought that is torn between detailed knowledge of the psychological dynamics of suicide and openness to the benefits of assisted suicide.

This analysis highlights that extremely positive or negative responses are less common compared to more nuanced positions, reflecting indeterminacy and diversity. The study's findings suggest that family groups tend to hold negative opinions, while other groups show a more balanced distribution of perspectives. Furthermore, the Manhattan distance has been used to highlight the internal consistency of groups and the need to review clusters that show weaknesses in their cohesion.

Based on the spectrum of opinions revealed by the study, the implementation of assisted suicide legislation in Ecuador will require carefully calibrated strategies for each stakeholder group. The following course of action is proposed for each of the groups involved in the analysis:

- ❖ Family members of people who have died by suicide: Establish emotional support programs that provide safe spaces to talk about personal experiences, focusing on compassion and psychological support. Develop policies that include the voices of these family members in the formation of the law to ensure that their concerns and perspectives are taken into account.
- ❖ Legal professionals: Organize legal forums and debates to discuss legal and ethical implications, promoting the participation of lawyers in the formulation of legislation. Facilitate continuing education on the ethics of assisted suicide and related jurisprudence at the international level.
- ❖ Health professionals: Provide training that addresses the ethical dilemmas associated with assisted suicide and respects the Hippocratic Oath. Implement clear protocols that guide clinical practice and ensure that patient autonomy and informed consent are the basis for decision-making.
- ❖ General population: Initiate information and educational campaigns to increase public awareness of assisted suicide, ensuring that information is balanced and data-based, and respecting diversity of opinions.
- ❖ Leaders and members of religious communities: Facilitate interreligious and intercultural dialogue by allowing religious communities to express their views, seeking to find common ground or respectful accommodation of the plurality of beliefs.
- ❖ Psychologists and other mental health professionals: Include these experts in planning mental health services for people at risk and ensure that policies reflect best practices in suicide prevention and mental health treatment.

These strategic solutions are framed within a transparent, inclusive and evidence-based legislative process. They are proposed in order to harmonize the right to life with respect for individual dignity and patient autonomy. In this process, effective communication is crucial to address the concerns and expectations of all actors involved, facilitating the implementation of any new legislation in this field.

4. Conclusion

A neutrosophic approach was used to analyze perceptions on the legislative reform of assisted suicide in Ecuador. The opinions of legal professionals, academics, relatives of deceased persons, health professionals, psychologists and the general population were examined to understand the emotional and ethical complexity surrounding this issue. This method of information processing allows for a more human understanding of the social dynamics surrounding assisted suicide and can serve as a basis for creating policies that respect the complexity of perceptions and protect fundamental rights, thus reinforcing legal certainty in this delicate area. The influence of personal and professional experiences in the formation of opinions on assisted suicide is acknowledged. The diversity of viewpoints underlines the need for a legislative approach that considers the multiple facets of this complex issue. Furthermore, it is crucial to recognize that opinions on such sensitive issues as assisted suicide are influenced by personal, cultural, ethical and religious factors and that any legislation or policy must address these concerns with sensitivity and deep respect for the diversity of values and beliefs among citizens.

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