APPLICATION OF THE NEUTROSOPHIC PROMETHEE METHOD TO ENHANCE THE SAFEGUARDING OF THE PRESUMPTION OF INNOCENCE IN DRUG TRAFFICKING CASES IN AMBATO

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ABSTRACT

This study examines the challenges faced by attorneys when defending drug trafficking cases, with a specific focus on preserving the presumption of innocence. By employing the neutrosophic PROMETHEE method, the primary obstacles were identified and prioritized: the defendant's prior reputation, pressure for plea deals, and difficulty in proving a lack of knowledge. These challenges underscored the complexity of ensuring a fair trial, emphasizing the importance of meticulous evidence analysis and the need for due process. Solutions such as legal reforms, ethical training, and strengthening investigative resources were proposed to comprehensively address these challenges. Thus, this holistic approach aims to enhance effective defense and bolster the preservation of the presumption of innocence. The findings suggest that these strategies, if properly implemented, can have a significant impact on the criminal justice system and the legal practice of drug trafficking cases. They ensure equitable treatment for defendants and uphold high standards of justice and professional ethics. Furthermore, they provide a valuable foundation for future improvements in legal defense and underscore the need for coordinated action to address the inherent challenges in these cases.

KEYWORDS: Neutrosophic PROMETHEE, presumption of innocence, drug trafficking, multi-criteria decision-making, legal uncertainty

MSC Codes: 62P25, 03B52, 91D10, 93A30, 68T37

RESUMEN

Este estudio examina los desafíos que enfrentan los abogados al defensor de casos de tráfico de drogas, con un enfoque específico en la preservación de la presunción de inocencia. Utilizando el método neutrosófico PROMETHEE, se identificaron y priorizaron los principales obstáculos: la reputación previa del acusado, la presión para aceptar acuerdos de culpabilidad y la dificultad para probar la falta de conocimiento. Estos desafíos subrayan la complejidad de garantizar un juicio justo, enfatizando la importancia de un análisis meticuloso de la evidencia y la necesidad de un debido proceso. Se propusieron soluciones como reformas legales, capacitación ética y fortalecimiento de los recursos de investigación para abordar de manera integral estos desafíos. Así, este enfoque holístico tiene como objetivo mejorar la defensa efectiva y fortalecer la preservación de la presunción de inocencia. Los hallazgos sugieren que estas estrategias, si se implementan adecuadamente, pueden tener un impacto significativo en el sistema de justicia penal y en la práctica legal de los casos de tráfico de drogas. Aseguran un trato equitativo para los acusados y mantienen altos estándares de justicia y ética profesional. Además, proporciona una base valiosa para futuras mejoras en la defensa legal y subrayan la necesidad de una acción coordinada para abordar los desafíos inherentes a estos casos.

PALABRAS CLAVE: PROMETHEE neutrosófico, presunción de inocencia, tráfico de drogas, toma de decisiones multicriterio, incertidumbre legal.

1. INTRODUCTION

This study focuses on applying the neutrosophic PROMETHEE method to enhance the safeguarding of the presumption of innocence in drug trafficking cases in Ambato, Ecuador. This topic holds critical relevance not only in the legal domain but also in social and ethical contexts, as the presumption of innocence is a fundamental principle of criminal law, recognized as a cornerstone of democratic judicial systems [3]. In a context where criminal justice systems face growing challenges related to handling uncertainty and subjectivity, the implementation of advanced tools such as the neutrosophic approach offers novel perspectives for objective and equitable decision-making.

Historically, the fight against drug trafficking has been characterized by a punitive approach, marked by strict policies that often sacrifice fundamental rights in favor of efficiency [5]. Particularly in Latin America, the criminalization of drug trafficking has resulted in frequent violations of the presumption of innocence, exacerbated by structural biases and negative societal perceptions of defendants [10]. Recently, technological and methodological advancements, such as multi-criteria decision-making systems, have begun to be applied in the

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legal domain to minimize these violations. However, their implementation remains limited and lacks a comprehensive consideration of the uncertainty inherent in judicial cases [20].

In this context, a key question arises that guides the present research: How can the presumption of innocence in drug trafficking cases be safeguarded, considering the multiple dimensions of uncertainty and subjectivity? This problem extends beyond the legal dimension and reflects an underlying ethical tension in justice administration. The difficulty of objectively evaluating the guilt or innocence of an accused person, especially in cases where evidence may be ambiguous or subject to various interpretations, presents a complex challenge that remains unresolved [15].

The neutrosophic approach, grounded in the theory of neutrosophic sets, allows for managing high levels of uncertainty and ambiguity—characteristics inherent in human perceptions and decision-making processes. Meanwhile, the PROMETHEE method, widely utilized in multi-criteria analysis, facilitates the structured evaluation of alternatives in complex scenarios. Integrating both approaches represents an innovative proposal to address the identified problem by enabling a balanced analysis of both objective evidence and subjective perceptions.

The main objective of this study is to analyze the effectiveness of the neutrosophic PROMETHEE method in promoting more objective and equitable decisions in the context of drug trafficking cases. To this end, the study seeks, first, to develop a methodological model that integrates neutrosophic principles and the PROMETHEE method. Second, it aims to apply this model to real cases in the city of Ambato, assessing its impact on protecting the presumption of innocence principle. Finally, it aspires to generate practical recommendations that can be implemented in other judicial contexts with similar characteristics.

Throughout this article, it will be demonstrated how this approach has the potential to redefine judicial procedures by incorporating advanced analytical tools that consider both the indeterminacy inherent in human perceptions and the technical and legal criteria. By contributing to mitigating biases and errors in judicial decision-making, this study aligns with the global effort to strengthen criminal justice systems and ensure respect for human rights.

In the following sections, the theoretical framework underpinning this research is detailed, followed by a methodological description and the results obtained. This innovative approach is expected not only to provide practical solutions to the posed problem but also to inspire new applications of neutrosophic multi-criteria analysis in other areas of criminal law and social justice [18].

2. PRELIMINARIES

The evaluation or decision matrix is established after defining the criteria and assigning weights to the linguistic terms utilized within the Single-Valued Neutrosophic Set (SVNS). This matrix functions as a systematic tool for assessing alternatives, integrating the criteria's significance and the inherent uncertainty expressed through the SVNS linguistic terms. The decision-maker can give, for each of the considered criteria and each alternative, a value within the neutrosophic choice set [9]. Therefore, the following guidelines are defined to be taken into account:

- To establish the weights of the criteria k_j, y_{ij} is defined as a point within the SVNS. In the Neutrosophic CRITIC method, the linguistic terms used to represent the weight of importance are outlined in Table 1. These terms provide a structured way to express the relative significance of each criterion, incorporating the uncertainty and imprecision inherent in human judgment within the neutrosophic framework.

- To establish the weights of the alternatives A_i, g_{ij} is defined as a point within the SVNS. Therefore, the linguistic terms to represent the weights of importance for the Neutrosophic PROMETHEE method are proposed in Table 2.

- For X from the universe of discourse, the Single-Valued Neutrosophic Number (SVNN) over A is defined as an object in the representation.

$$g_A = \{\langle x, \vartheta_A(x), \eta_A(x), \delta_A(x) \rangle : x \in X\}$$
$$y_A = \{\langle x, \vartheta_A(x), \eta_A(x), \delta_A(x) \rangle : x \in X\}$$

similarly, where $\vartheta_A(x), \eta_A(x), \delta_A(x)$ meet the following condition

$$0 \leq \vartheta_A(x), \eta_A(x), \delta_A(x) \leq 3, \text{ for all } x \in X.$$

Linguistic scale	SVNN(h, i, j)
Very Important (VI)	(0.95, 0.15, 0.10)
Important (I)	(0.75,0.30,0.25)
Medium (M)	(0.50,0.45,0.50)
Not Important (NI)	(0.25,0.85,0.75)
Very Not Important (VNI)	(0.15,0.90,0.95)

Table 1: Linguistic terms representing the weight of importance of the criteria. Own elaboration

Criterion	SVNN
Extremely High	(1,0,0)
Very Very High	(0.9,0.07,0.11)
Very High	(0.8,0.17,0.21)
High	(0.7,0.27,0.31)
Slightly Moderate	(0.6,0.37,0.41)
Moderate	(0.5,0.47,0.51)
Moderately Low	(0.4,0.57,0.61)
Low	(0.3,0.67,0.71)
Very Low	(0.2,0.77,0.81)
Very Very Low	(0.1,0.87,0.91)
Extremely Low	(0,0.97,1)

Table 2: Relationship between measurement ranges and neutrosophic scales. Source: Own elaboration.

This table allows an intuitive interpretation of how different challenges can be evaluated under the framework of the neutrosophic PROMETHEE method, integrating the indeterminacy inherent to each situation. Analysts and lawyers can strategically use this methodology to priorize challenges and resources, based on a deeper understanding of the underlying dynamics and the relative probabilities of their impact on the defense process. The application of these neutrosophic scales emphasizes the importance of considering all aspects of each challenge, including those that cannot be clearly classified as true or false. Thus, it reflects the neutrosophic environment in legal practice in drug trafficking cases.

2.1. CRITIC Neutrosophic Method.
The CRITIC (Criteria Importance Through Intercriteria Correlation) method was proposed by Diakoulaki, Mavrotas, and Papayannakis in 1995. The CRITIC method is a multicriteria analysis technique used for decision-making in situations where multiple alternatives must be evaluated and compared based on various criteria. The Neutrosophic CRITIC method is based on assigning neutrosophic weights to the relevant criteria (k_n) and comparing the alternatives based on these weights to make decisions that include indetermination information [11]. Below are the steps for modeling the method:

Step 1: Define the decision matrix by including the weight of the criterion (see Figure 1).

$$
\begin{array}{cccccc}
k_1 & k_2 & \dots & k_j & \dots & k_n \\
w_1 & w_2 & \dots & w_j & \dots & w_n
\end{array}
$$

$$
\begin{array}{c}
A_1 \\
A_2 \\
\vdots \\
A_i \\
\vdots \\
A_m
\end{array}
\begin{bmatrix}
y_{11} & y_{12} & \dots & y_{1j} & \dots & y_{1n} \\
y_{21} & y_{22} & \dots & y_{2j} & \dots & y_{2n} \\
\vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
y_{i1} & y_{i2} & \dots & y_{ij} & \dots & y_{in} \\
\vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
y_{m1} & y_{m2} & \dots & y_{mj} & \dots & y_{mn}
\end{bmatrix}
$$

Figure 1. Decision matrix. Source: own elaboration.

Step 2: Normalize the values of each criterion by the range. Analysis of the elements of the neutrosophic decision matrix:
The decision criteria $k_n = k_1, k_2, k_{Qj}, \dots, k_{Qn}$ can be defined as the conditions or parameters that allow for the discrimination of alternatives and the establishment of the decision-maker's importance preferences. The criteria for making decisions about each alternative are evaluated based on the linguistic terms in Single-Valued Neutrosophic Numbers (SVNNs) according to the scales shown in Table 1.

$$L_{ij} = \frac{y_{ij} - y_{jmax}}{y_{jmax} - y_{jmin}} \tag{1}$$

Step 3: Calculate the standard deviation of each criterion.

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^{m}\left[l_{ij} - \left(\frac{\sum_{i=1}^{m} l_{ij}}{m}\right)\right]^2}{m - 1}} \tag{2}$$

Step 4: Calculate the correlation between each pair of criteria.

$$r_{jk} = \frac{cov\,(j,k)}{\sigma_j - \sigma_k} \tag{3}$$

Step 5: Calculate the weight of each criterion.

$$w_j = \sigma_j \cdot \sum_{k=1}^{n}\left(1 - r_{jk}\right) \tag{4}$$

Step 6: Weighting each criterion.

$$w_j' = \frac{w_j}{\sum_{j=1}^{n} w_j} \tag{5}$$

A criterion with greater weights means that its variance (standard deviation) is higher and that the information it provides is more different compared to other criteria (lower correlation coefficient between criteria).

2.2 Neutrosophic PROMETHEE Method.

The Neutrosophic PROMETHEE Method enriches the original PROMETHEE method by incorporating the principles of neutrosophy and offering an advanced approach to handling indeterminacy in decision-making [11]. This integration significantly improves the analysis of options against multiple criteria in complex contexts, where information can be imprecise, indeterminate, or incomplete [12,17].

The Neutrosophic PROMETHEE Method represents a significant advancement in the ability to evaluate complex decisions. Thus, it provides a more robust and versatile tool to face the challenges inherent in decision-making in uncertain and dynamic environments. Below are the steps of the method [13,18]:

Step 1: Define the decision matrix with the respective weights of each criterion (see Figure 2).

$$
\begin{array}{c}
\begin{array}{cccccc}
k_1 & k_2 & \dots & k_j & \dots & k_n \\
w_1 & w_2 & \dots & w_j & \dots & w_n
\end{array} \\
\begin{array}{c}
A_1 \\ A_2 \\ \vdots \\ A_i \\ \vdots \\ A_m
\end{array}
\begin{bmatrix}
g_{11} & g_{12} & \cdots & g_{1j} & \cdots & g_{1n} \\
g_{21} & g_{22} & \cdots & g_{2j} & \cdots & g_{2n} \\
\vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
g_{i1} & g_{i2} & \cdots & g_{ij} & \cdots & g_{in} \\
\vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
g_{m1} & g_{m2} & \cdots & g_{mj} & \cdots & g_{mn}
\end{bmatrix}
\end{array}
$$

Figure 2: Decision Matrix. Source: own elaboration.

where $A = \left[g_{ij}\right]$, where each element g_{ij} represents the relative importance of criterion i for criterion j, with $i, j = 1,2, \dots, n_{ij}$. While k_n corresponds to the established criteria.

Step 2: Define the generalized criteria associated with each k_j (see Table 3).

Generalized criterion		
Criterion maximization $P_j(a,b) = F_j\big[d_j(a,b)\big]$	+	The set of g_{ij} evaluations $i = 1, \dots, m$
Criterion minimization $P_j(a,b) = F_j\big[-d_j(a,b)\big]$		

Table 3. Generalized Criterion. Source: Own elaboration

Generalized criteria are defined based on the determination of parameters p (threshold of strict preference), q (threshold of indifference), and/or s (an intermediate value between q and p).

Step 3: Pairwise comparison of alternatives (calculation of $P_j(a,b)$ and $P_j(b,a)$).

Step 4: Calculation of the aggregated preference indices $\pi(a,b)$, $\pi(b,a)$.

$$\Pi(a,b) = \sum_{j=1}^{n} P_j(b,a)\, w_j \tag{6}$$

$$\Pi(b, a) = \sum_{j=1}^{n} P_j(b, a) \, w_j \tag{7}$$

Step 5: Calculation of the flows φ^+ (Positive), φ^- (Negative), and φ (Net).

$$\varphi^+ = \sum \pi(a, b) \tag{8}$$

$$\varphi^- = \sum \pi(b, a) \tag{9}$$

$$\varphi = \varphi^+ - \varphi^- \tag{10}$$

Step 6: Obtaining the ranking of alternatives based on φ. For this, the following conditions must be analyzed:
- aPb (a surpasses b) if $\varphi(a) > \varphi(b)$.
- aIb (a and b are indifferent) if $\varphi(a) = \varphi(b)$

3. METHODS

This study employed a mixed-methods approach, combining qualitative and quantitative techniques to analyze the challenges faced by defense attorneys in drug trafficking cases in Ambato, Ecuador. The research framework integrated expert consultations with a mathematical decision-making model, leveraging the Neutrosophic PROMETHEE method for a structured evaluation of challenges and their impact on the presumption of innocence.

3.1. Data Collection and Expert Consultation

To gain insights into the complexities of legal defense in drug trafficking cases, semi-structured interviews were conducted with a purposive sample of 20 experienced defense attorneys. These professionals, with an average of 8 years of experience, were selected based on their expertise in criminal law and their direct involvement in cases related to drug trafficking. The interviews focused on identifying key obstacles in the legal process and exploring strategies employed to preserve the presumption of innocence. The responses were categorized into eight major challenges, as outlined in Table 4 in the results section.

Additionally, secondary data was reviewed, including legal frameworks, case law, and academic literature on judicial decision-making in drug-related offenses. This background information provided a contextual foundation for the study, ensuring that the identified challenges aligned with broader legal and socio-political dynamics.

3.2. Application of Neutrosophic Multi-Criteria Decision-Making (MCDM) Methods

To systematically assess and prioritize the identified challenges, a Neutrosophic Multi-Criteria Decision-Making (MCDM) approach was applied. The methodology involved the following key steps(Figure 1):
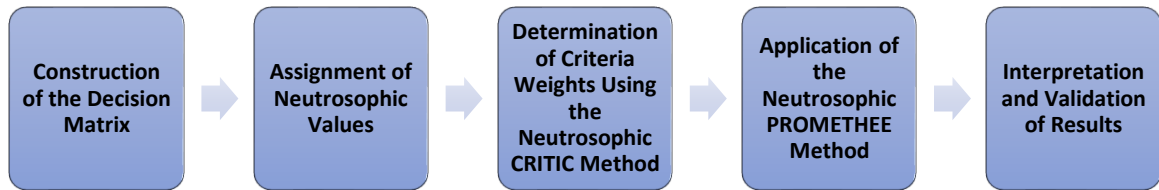

Figure 1. Neutrosophic Multi-Criteria Decision-Making approach

Step 1: Construction of the Decision Matrix

A decision matrix was formulated, incorporating the eight identified challenges as alternatives (D1 to D8) and five evaluation criteria (k1 to k5) representing critical aspects influencing legal defense (Table 5). The criteria were selected based on expert input and literature review, covering aspects such as impact on defense strategy, public perception, legal complexity, resource requirements, and case outcomes.

Step 2: Assignment of Neutrosophic Values
Each challenge was evaluated against the five criteria using Single-Valued Neutrosophic Numbers (SVNNs). These numbers captured the degrees of truth (T), indeterminacy (I), and falsity (F) associated with each evaluation, reflecting the inherent uncertainty in legal decision-making. The linguistic scale employed for the assignment of values is detailed in Tables 6 to 9.

Step 3: Determination of Criteria Weights Using the Neutrosophic CRITIC Method
The Criteria Importance Through Intercriteria Correlation (CRITIC) method was adapted to a neutrosophic environment to assign weights to the evaluation criteria. This involved:
- Standardizing the decision matrix values.
- Calculating the standard deviation of each criterion to assess its variability.
- Computing the correlation coefficients between criteria to identify dependencies.
- Determining the final weight of each criterion based on its relative importance in the decision-making process (Table 8).

Step 4: Application of the Neutrosophic PROMETHEE Method
The PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluations) method was used to rank the challenges based on their impact on legal defense. The process included:
- Pairwise comparisons of challenges using preference functions.
- Calculation of aggregated preference indices (π) to assess the dominance of each alternative.
- Computation of positive (φ^+), negative (φ^-), and net (φ) preference flows to establish the final ranking of challenges (Table 11).

Step 5: Interpretation and Validation of Results
The ranked challenges were analyzed to identify priority areas for intervention. The top-ranked challenges, including "previous reputation of the accused," "pressure for plea deals," and "difficulty in proving lack of knowledge," were highlighted as critical obstacles affecting the presumption of innocence (Figure 3). The findings were validated through expert review, ensuring alignment with real-world legal practice.

3.3. Development of Strategic Recommendations
Based on the ranking of challenges, targeted strategies were proposed to enhance the preservation of the presumption of innocence in drug trafficking cases. These strategies, outlined in Table 12, included legal reforms, ethical training for lawyers, public awareness campaigns, and enhanced investigative resources. Each recommendation was assessed for feasibility, impact, and implementation timeframe, providing a structured roadmap for legal practitioners and policymakers.

3.4. Ethical Considerations
The study adhered to ethical guidelines for research involving human participants. Informed consent was obtained from all interviewed attorneys, ensuring confidentiality and anonymity. The research focused solely on systemic challenges without discussing specific cases, safeguarding the integrity of the legal process.

3.5. Limitations
While the study provides a structured evaluation of legal defense challenges, certain limitations must be acknowledged:
- The findings are specific to Ambato, Ecuador, and may not fully generalize to other jurisdictions.
- The reliance on expert opinions introduces a degree of subjectivity, despite efforts to mitigate bias through mathematical modeling.
- The study does not account for real-time judicial decisions, as it focuses on retrospective analysis and expert perceptions.

Despite these limitations, the integration of qualitative insights with neutrosophic MCDM techniques provides a novel and robust framework for analyzing legal complexities. Future research could expand this approach to other legal contexts and incorporate real-time case data to enhance predictive accuracy.

By systematically identifying and ranking the challenges in defending drug trafficking cases, this methodological framework offers practical tools for legal professionals and policymakers seeking to uphold the principles of fairness and justice in criminal proceedings.

4. RESULTS.

The research on the experience of lawyers specializing in drug trafficking cases in Ambato, Ecuador, sheds light on the challenges and tactics employed in defending these cases. The lawyers, with an average of 8 years of experience, identify key challenges that affect the process (see Table 4).

Challenges	Challenge name	Description	Intrinsic obstacles
D1	Complexity of laws and regulations.	The difficulty arises from the constant evolution and complexity of drug trafficking laws.	The need for constant updating and understanding can overwhelm the defense's capacity, affecting the fairness of the trial.
D2	Limited resources for investigation.	The lack of resources to conduct a thorough investigation in defense.	Limits the lawyer's ability to build a strong defense, potentially compromising the presumption of innocence.
D3	Interference from external factors.	The influence of external elements unrelated to the case, such as politics or public opinion, on the trial.	Can bias the legal process and the perception of the accused's innocence by introducing factors unrelated to the evidence.
D4	Pressure for quick results.	The judicial system's urgency to resolve cases quickly.	This may lead to rushed judgments without full consideration of all evidence, affecting the justice of the process.
D5	Previous reputation of the accused.	How the accused's background can negatively influence the perception of their innocence.	Stigmatization based on history can predispose those involved in the trial against the accused, undermining the presumption of innocence.
D6	Pressure to obtain plea deals.	The tendency to resolve cases through plea deals under undue pressure.	Compromises the accused's ability to fully exercise their right to a fair trial, pushing them to accept possibly unjustified guilt.
D7	Negative publicity and media bias.	The creation of a bias in public opinion through negative media coverage.	Affects the objectivity of the judicial process by influencing the perception of judges, juries, and society, eroding the presumption of innocence.
D8	Difficulty in proving lack of knowledge.	The challenge of proving that the accused had no knowledge of the illegal activity.	Requires solid and convincing evidence, which is often difficult to obtain, affecting the ability to establish an effective defense.

Table 4: Main challenges provided by the interviewed lawyers. Source: Own elaboration.

Table 4 shows cases of the diversity and complexity of the challenges that lawyers face in preserving the presumption of innocence in drug trafficking cases. Each challenge presents unique obstacles in the legal process, highlighting the importance of adaptive and ethical strategies in legal defense (see Table 5).

Criterion	Criterion name	Description	Neutrosophic Environment
k1	Impact on Defense.	Evaluates how the challenge affects the lawyer's ability to effectively defend the accused.	Effectiveness of Legal Defense.
k2	Public Perception.	Considers the effect of the challenge on public opinion and media regarding the case and the accused.	Influence on Public Perception.

k3	Legal Complexity.	Measures the legal and technical difficulty presented by the challenge to be addressed.	Difficulty of Management within the Legal Framework.
k4	Required Resources.	Assesses the amount of resources (time, money, personnel) required to overcome the challenge.	Resource Demand.
k5	Impact on the Result.	Analyzes how the challenge may affect the outcome of the case.	Influence on the Case Verdict.

Table 5: Evaluation criteria and associated neutrosophic scales. Source: Own elaboration.

This table facilitates the implementation of the neutrosophic PROMETHEE method by providing a detailed framework for evaluating challenges in defending drug trafficking cases. The inclusion of neutrosophic scales allows for addressing the indeterminacy associated with each criterion, offering a more flexible and adaptive tool for analyzing indeterminate decisions in the legal field. By assigning these scales to the measurement ranges, the precision of the evaluation is improved, and the identification of priority areas for strategic action is facilitated. Therefore, the determination of weights is proceeded with using the Neutrosophic CRITIC method (see Tables 6 to 9).

Challenges	Impact on Defense	Public Perception	Legal Complexity	Required Resources	Impact on the Result
	k1	k2	k3	k4	k5
D1	(0.5,0.47,0.51)	(0,0.97,1)	(0.3,0.67,0.71)	(0.5,0.47,0.51)	(0.7,0.27,0.31)
D2	(0,0.97,1)	(0.5,0.47,0.51)	(0.4,0.57,0.61)	(0.5,0.47,0.51)	(0.6,0.37,0.41)
D3	(0.3,0.67,0.71)	(0.4,0.57,0.61)	(0.2,0.77,0.81)	(0.6,0.37,0.41)	(0,0.97,1)
D4	(0,0.97,1)	(0.4,0.57,0.61)	(0.3,0.67,0.71)	(0.6,0.37,0.41)	(0.5,0.47,0.51)
D5	(0.3,0.67,0.71)	(0.6,0.37,0.41)	(0.5,0.47,0.51)	(0.4,0.57,0.61)	(0.7,0.27,0.31)
D6	(0,0.97,1)	(0.4,0.57,0.61)	(0.3,0.67,0.71)	(0.2,0.77,0.81)	(0.6,0.37,0.41)
D7	(0.5,0.47,0.51)	(0.8,0.17,0.21)	(0.5,0.47,0.51)	(0,0.97,1)	(0.7,0.27,0.31)
D8	(0.4,0.57,0.61)	(0.5,0.47,0.51)	(0,0.97,1)	(0.2,0.77,0.81)	(0,0.97,1)
X_{max}	**(0.5,0.47,0.51)**	**(0.8,0.17,0.21)**	**(0.5,0.47,0.51)**	**(0.6,0.37,0.41)**	**(0.7,0.27,0.31)**
X_{min}	**(0,0.97,1)**	**(0,0.97,1)**	**(0,0.97,1)**	**(0,0.97,1)**	**(0,0.97,1)**

Table 6: Decision Matrix. Own elaboration.

Criteria	k1	k2	k3	k4	k5
k1	(1,0,0)	(0,0.97,1)	(0,0.97,1)	(0,0.97,1)	(0,0.97,1)
k2	(0,0.97,1)	(1,0,0)	(0.3,0.67,0.71)	(0,0.97,1)	(0,0.97,1)
k3	(0,0.97,1)	(0.3,0.67,0.71)	(1,0,0)	(0,0.97,1)	(0.8,0.17,0.21)
k4	(0,0.97,1)	(0,0.97,1)	(0,0.97,1)	(1,0,0)	(0,0.97,1)
k5	(0,0.97,1)	(0,0.97,1)	(0.8,0.17,0.21)	(0,0.97,1)	(1,0,0)
σ_j	**0.090**	**0.058**	**0.034**	**0.065**	**0.074**

Table 7: Calculate the standard deviation and correlation between each pair of criteria. Source: own elaboration

Criteria	k1	k2	k3	k4	k5	w_j	w'_j
σ_j	**0.090**	**0.058**	**0.034**	**0.065**	**0.074**		
Total	**(0.5,0.47,0.51)**	**(0.3,0.67,0.71)**	**(0,0.97,1)**	**(0.4,0.57,0.61)**	**(0.4,0.57,0.61)**	**1,301**	
k1	(0,0.97,1)	(1,0,0)	(1,0,0)	(1,0,0)	(1,0,0)	0.407	**(0.7,0.35,0.25)**
k2	(1,0,0)	(0,0.97,1)	(0.5,0.47,0.51)	(1,0,0)	(0.8,0.17,0.21)	0.238	**(0.25,0.7,0.75)**
k3	(1,0,0)	(0.5,0.47,0.51)	(0,0.97,1)	(1,0,0)	(0,0.97,1)	0.098	**(0,0.95,1)**
k4	(1,0,0)	(1,0,0)	(1,0,0)	(0,0.97,1)	(1,0,0)	0.324	**(0.50,0.55,0.5)**
k5	(1,0,0)	(0.8,0.17,0.21)	(0,0.97,1)	(1,0,0)	(0,0.97,1)	0.234	**(0.25,0.7,0.75)**

Table 8: Correlation matrix, standard deviations, and weightings of each criterion. Source: own elaboration.

SVNN	Linguistic term	Criteria
(0.95,0.15,0)	Extremely Important (EI)	-
(0.7,0.35,0.25)	Very Important (VI)	**k1**
(0.50,0.55,0.5)	Important (I)	**k4**
(0.25,0.7,0.75)	Not So Important (NSI)	**k2,k5**
(0,0.95,1)	Not Important (NI)	**k3**

Table 9: Linguistic terms and corresponding weight of importance for each criterion. Source: own elaboration.

The results obtained from the modeling of the neutrosophic CRITIC method represent the criterion *Impact on Defense* with a classification of *Very Important* when evaluating each challenge in the defense of drug trafficking

cases. Meanwhile, *k4* shares a classification of *Important*, and the rest of the criteria fall below the neutrosophic average. Therefore, once the neutrosophic weights are defined, the PROMETHEE model is developed using the 8 challenges and the 5 defined criteria. Consequently, a decision matrix is constructed (see Table 10). Each challenge is evaluated according to the established criteria using the provided neutrosophic scales to obtain the flows φ^+, φ^- and φ for each alternative (see Table 11).

Alternatives / Criteria	Impact on Defense	Public Perception	Legal Complexity	Required Resources	Impact on the Result
	k1	k2	k3	k4	k5
w	(0.7,0.35,0.25)	(0.25,0.7,0.75)	(0,0.95,1)	(0.50,0.55,0.5)	(0.25,0.7,0.75)
Min/Max	max	max	min	max	max
D1	(0.5,0.47,0.51)	(0.5,0.47,0.51)	(0.8,0.17,0.21)	(0.7,0.27,0.31)	(0.6,0.37,0.41)
D2	(0.3,0.67,0.71)	(0.3,0.67,0.71)	(0.5,0.47,0.51)	(0.8,0.17,0.21)	(0.4,0.57,0.61)
D3	(0.4,0.57,0.61)	(0.6,0.37,0.41)	(0.5,0.47,0.51)	(0.6,0.37,0.41)	(0.5,0.47,0.51)
D4	(0.6,0.37,0.41)	(0.6,0.37,0.41)	(0.6,0.37,0.41)	(0.5,0.47,0.51)	(0.7,0.27,0.31)
D5	(0.9,0.07,0.11)	(0.8,0.17,0.21)	(0.7,0.27,0.31)	(0.7,0.27,0.31)	(0.8,0.17,0.21)
D6	(0.8,0.17,0.21)	(0.8,0.17,0.21)	(0.7,0.27,0.31)	(0.6,0.37,0.41)	(0.8,0.17,0.21)
D7	(0.7,0.27,0.31)	(0.8,0.17,0.21)	(0.7,0.27,0.31)	(0.6,0.37,0.41)	(0.7,0.27,0.31)
D8	(0.8,0.17,0.21)	(0.7,0.27,0.31)	(0.7,0.27,0.31)	(0.6,0.37,0.41)	(0.8,0.17,0.21)

Table 10: Define the decision matrix. Source: Own elaboration.

Challenges	φ	φ^+	φ^-
D5	0.7400	0.8700	0.1300
D6	0.3800	0.6900	0.3100
D8	0.2371	0.6186	0.3814
D7	0.1029	0.5514	0.4486
D1	-0.3114	0.3443	0.6557
D4	-0.3114	0.3443	0.6557
D2	-0.3400	0.3300	0.6700
D3	-0.4971	0.2514	0.7486

Table 11: Calculation of the flows φ^+, φ^-, and φ. Source: own elaboration.

This method has enabled the prioritization of these challenges based on their neutrosophic importance. This ranking identifies "previous reputation of the accused," "pressure to secure plea deals," and "difficulty in proving lack of knowledge" as the most significant obstacles impeding the protection of the presumption of innocence (refer to Figure 3).
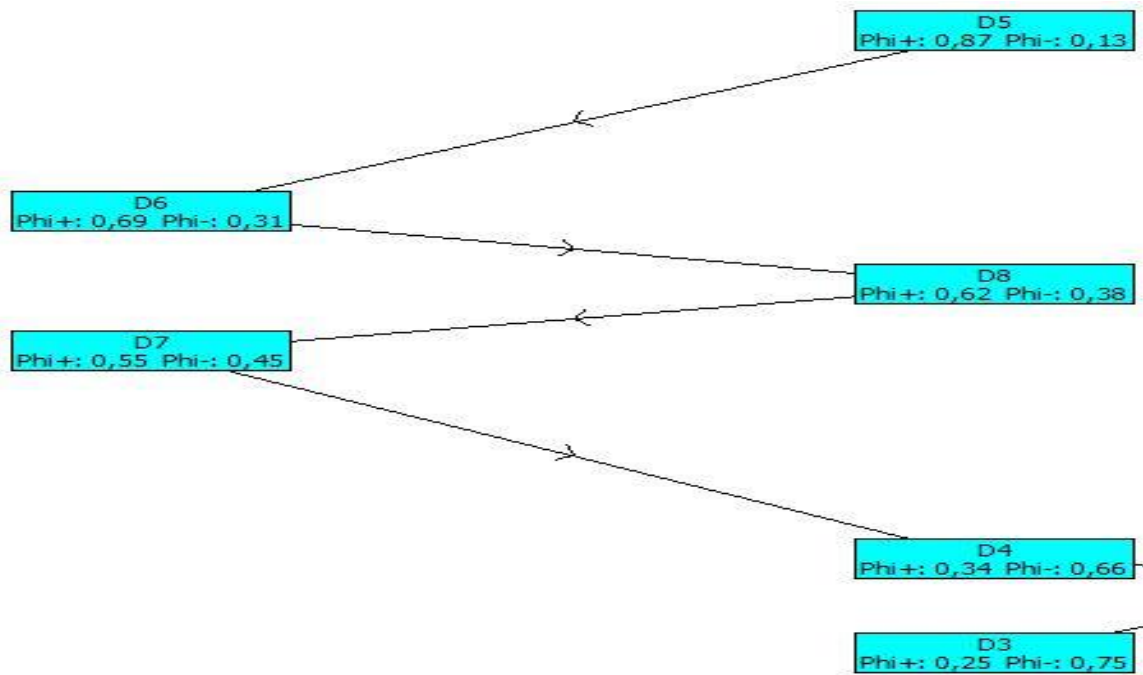
Figure 2: Ranking of alternatives based on φ. Source: Own elaboration.

This research underscores the complexity of ensuring the presumption of innocence in the current judicial context, highlighting both systemic obstacles and the need for meticulous and well-informed defense to overcome them. It also emphasizes the critical importance of the lawyer-client relationship in building tailored and effective defenses. This fact shows the need for substantial improvements in how the principle of the presumption of innocence is applied. General strategies for addressing these challenges include:

•   Legal reforms: A call for reform is highlighted to achieve fairer and more equitable procedures, reflecting a critique of current legislation or its application.

•   Strengthening of ethical training: An emphasis on the importance of ethical standards in legal practice to ensure effective defense and maintain the integrity of the judicial process.

•   Public awareness: A strategy aimed at educating society about the presumption of innocence to mitigate social and media biases.

•   Adaptation to changes in drug control policies: An acknowledgment of the need to continuously adapt to legislative and regulatory changes in the field of drug control.

However, to address the main challenges identified in neutrosophic modeling, among which the *prior reputation of the accused* stands out as dominant, it is proposed to expand strategies that adopt a comprehensive and multidimensional approach. Below, Table 12 proposes strategies for protecting the presumption of innocence in drug trafficking cases.

Challenge	Proposed Measures	Scope	Time	Benefits	Impact on the Preservation of the Presumption of Innocence
The previous reputation of the accused	Awareness campaigns on the presumption of innocence. Media training for lawyers.	National	6-12 months	Improves public perception of the accused. Equip lawyers with tools to manage the public narrative.	Reinforces the principle that everyone is innocent until proven guilty by minimizing the impact of the defendant's record.
Pressure for plea deals	Training workshops on negotiation and ethics for lawyers. Development of judicial protocols.	Judicial/ Legal	3-6 months	Strengthens lawyers' negotiation and ethical skills. Ensures fairness of plea agreements.	Ensures that plea agreements are based on informed and voluntary decisions by protecting the right to a fair trial.

| Difficulty demonstrating a lack of knowledge | Investments in investigative and forensic resources. Training in defense techniques. | Legal/ Scientific | 6-12 months | Improves the ability to present exculpatory evidence. Increases the effectiveness of defenses based on technical evidence. | Facilitates the demonstration of innocence in complex cases by improving the chances of a fair verdict. |

Table 12: Expanded strategies to mitigate challenges. Source: Own elaboration.

The scope of the measures shows their level of implementation, whether it be national, within the judicial/legal sector, or in the scientific/forensic community, indicating the required breadth. The estimated time for implementation allows for strategic planning and the allocation of appropriate resources. The expected benefits include improvements in public perception and capacity strengthening. Thus, it contributes to reinforcing the presumption of innocence in drug trafficking cases by improving defense capabilities. It also supports ensuring fair decision-making processes and facilitates the presentation of key evidence.

These recommendations highlight the need for a multifaceted approach that combines legal reforms, professional ethics, public awareness, and adaptability to changes in drug control policies. In a way that helps to improve the fairness of the legal process and strengthen the protection of the presumption of innocence in drug trafficking cases.

5. CONCLUSION

In this research, the challenges faced by lawyers in drug trafficking cases to preserve the presumption of innocence and the strategies they employ were explored. The challenges identified, such as the influence of media biases and the pressure for plea deals, highlighted the complexity of ensuring a fair trial in drug trafficking cases. These obstacles suggest that there are external factors that can compromise the presumption of innocence and fairness in the legal process. However, factors like the previous reputation of the accused are elements that can be managed in many different ways depending on professional ethics.

The application of the Neutrosophic PROMETHEE Method allowed for the ranking of challenges, placing previous reputation and pressure for plea deals in priority positions within the analyzed neutrosophic set. This provides a guide for focusing efforts and resources on mitigating the most significant obstacles. The main strategies indicate the need for legal reforms and ethical strengthening in legal defense in drug trafficking cases. These suggestions aim to address structural problems and maintain high standards of professional conduct to ensure the protection of the presumption of innocence. Solutions involving legal and ethical reforms can influence future improvements in the application of the presumption of innocence and the quality of the legal defense process in this area. These outcomes may influence future enhancements in the application of the presumption of innocence and the legal defense process in drug trafficking cases.

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