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Prioritizing Penal Reforms for Adolescents in Ecuador: Using Neutrosophic TOPSIS and Hausdorff Distance

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Abstract. This question builds upon the issue of Ecuador's minors not being liable as growing juvenile delinquents and those between 16-18 not receiving punishment for their actions will only foster more juvenile delinquents and complicate public safety and socio-protective efforts. This question is increasingly urgent given the recent upsurge in juvenile delinquency—grave crimes—and the vulnerable balance that exists between juvenile rights and social equity. While the literature is rich regarding the phenomenon of juvenile crime and delinquency, very few offer a truly feasible methodology that integrates equity, punishment, and social responsibility given the assessed social reality. Therefore, the neutrosophic TOPSIS method compounded with the Hausdorff distance will allow for a quantitative assessment of potential outcomes from penal changes that are ranked according to the socially assessed importance. The neutrosophic TOPSIS method is an assessment approach that allows for decision-making based on uncertain or vague data which inherently applies to the legal field. Thus results show that when non-liability is essentially an equivocal decision of unpunished decision, then for severe crimes that are assessed as truly detrimental, proportional punishments must be assessed. This research serves to expand the boundaries of the field by compounding the use of the neutrosophic TOPSIS method for assessment as a novel means by which to assess potential changes. In addition, the method allows for equity and social awareness consideration to protect public safety and institutional integrity; thus, the results support potential public policy adjustments that increase equity of an almost inequitable justice system both within Ecuadorian law and for socio-protective purposes.

Keywords: Non-imputability, Adolescence, Criminal Responsibility, Legal Reforms, Juvenile Delinquency, Restorative Justice, Public Safety, Neutrosophic TOPSIS, Hausdorff Distance

1. Introduction

The issue of the non-criminality of adolescents in Ecuador constitutes a crucial legal and social challenge, given the increase in serious crimes committed by young people aged 16 to 18. This phenomenon, which generates tensions between the protection of juvenile rights and citizen security, requires an in-depth analysis to balance justice and rehabilitation. Juvenile delinquency not only affects the victims but also undermines trust in the legal system and social cohesion. According to Beloff (2000), juvenile justice systems in Latin America have evolved toward protective approaches, but challenges persist in high-crime contexts [1]. The relevance of this issue lies in its impact on public safety, tourism, and the economy, as evidenced by recent data reporting a 640% increase in juvenile homicides in Ecuador between 2019 and 2023 [2]. This study addresses the need to reform criminal legislation, seeking solutions that integrate the protection of human rights with effective measures against

crime. The research is relevant, as the perception of impunity encourages recidivism, demanding a rethinking of current policies to ensure a safer and more just future.

The non-criminal liability of adolescents is rooted in the evolution of legal systems that prioritize the protection of minors. Historically, the 1989 Convention on the Rights of the Child marked a global shift towards the doctrine of comprehensive protection, considering minors as subjects of rights rather than objects of guardianship [3]. In Ecuador, the Code of Children and Adolescents (2003) establishes that adolescents under 18 years of age are not criminally responsible, opting for socio-educational measures [4]. However, this approach contrasts with the rise in youth violence, especially in crimes such as homicide and extortion, linked to recruitment by criminal gangs. In Latin America, countries such as El Salvador and Honduras have adopted harsher sanctions for adolescents in serious cases, reflecting a debate between rehabilitation and punitiveness [5]. In Ecuador, current legislation, although aligned with international principles, faces criticism for its inability to deter juvenile delinquency. This historical and regional context underscores the need to review the legal framework, considering both the rights of minors and the demands of citizen security.

The central problem of this research lies in the inadequacy of the Ecuadorian legal framework to address serious juvenile delinquency, due to the non-imputability of adolescents aged 16 to 18. How can Ecuador reform its criminal legislation to balance the rehabilitation of adolescent offenders with the need for effective sanctions that guarantee public safety? The absence of criminal accountability generates perceptions of impunity, incentivizing the participation of young people in criminal activities, as evidenced by statistics reporting 497 minors arrested in 2023 for crimes such as contract killing [6 , 7, 8]. This legal vacuum not only affects the victims but also perpetuates a cycle of violence that threatens social stability. The research question seeks to explore how a multi-criteria approach can prioritize legal reforms that respond to this problem, while maintaining respect for the human rights of adolescents. The challenge lies in finding a balance that integrates justice, rehabilitation, and prevention, in a context of rising crime.

This research aims to analyze the non-imputability of adolescents in Ecuador and propose legal reforms that balance the protection of juvenile rights with citizen security. The specific objectives include: first, to evaluate the impact of non-imputability on juvenile delinquency, identifying social and legal factors that contribute to recidivism. Second, to compare the Ecuadorian system with international legislation that allows for criminal sanctions for adolescents, drawing applicable lessons. Third, to prioritize criteria for penal reform by using an approach based on neutrosophic TOPSIS and the Hausdorff distance , which allows managing the uncertainty inherent in legal decisions. These objectives are aligned with the research question, seeking to generate a more effective and equitable regulatory framework. The research aims to contribute practical recommendations that promote a more robust juvenile justice system, capable of responding to the demands of today's Ecuadorian society.

2. Preliminaries.

2.1. Penal Reforms for Adolescents.

The issue of penal reforms for adolescents in Ecuador arises in response to the alarming increase in serious crimes committed by young people aged 16 to 18, a phenomenon that challenges the balance between justice and the protection of juvenile rights. The right to criminal responsibility, enshrined in the Children and Adolescents Code, exempts these minors from traditional criminal sanctions, prioritizing socio-educational measures. However, this policy generates controversy, as the perception of impunity encourages recidivism and affects citizen security. Recent data show that, in 2023, 497 minors were arrested for crimes such as contract killing , reflecting a social and legal crisis. The need for penal reforms lies in addressing this contradiction, guaranteeing both the rehabilitation of young people and the protection of society. Compared to countries like El Salvador, where adolescents face severe sentences, the Ecuadorian system appears insufficient to deter serious crime. This analysis argues that reforms should integrate proportional sanctions with restorative approaches, considering factors

such as poverty and recruitment by criminal gangs. The discussion is not only legal but also ethical, as it involves weighing the rights of minors against the demands of social justice. In this context, penal reforms are essential to building a more equitable and effective system.

Historically, the treatment of adolescent offenders in Ecuador has evolved from a punitive approach to one focused on rehabilitation, influenced by international treaties such as the Convention on the Rights of the Child. Since the adoption of the Code of Children and Adolescents in 2003, children under 18 are considered immune from criminal prosecution and receive socio- educational measures instead of custodial sentences. This framework, although aligned with humanitarian principles, faces criticism due to the rise in youth violence, especially in provinces such as Guayas, where 129 youth homicides were reported in 2023. Current legislation, designed to protect, appears outdated given the magnitude of serious crimes. In contrast, countries such as Honduras allow adolescents to be tried as adults in gang-related offenses, suggesting an alternative avenue. The history of the Ecuadorian juvenile criminal justice system reveals a protective approach that, while valuable, does not sufficiently address the underlying causes of delinquency, such as social exclusion. Reforms must consider this historical context, adapting laws to current realities. A system that combines sanctions with prevention could mitigate the perception of impunity, strengthening confidence in justice.

The central problem lies in the tension between non-imputability and rising juvenile delinquency, which jeopardizes public safety. The question is: how can the criminal justice system be reformed so that it is fair for both adolescents and society? The absence of criminal sanctions for young people aged 16 to 18, although it protects their rights, creates a legal loophole that criminal gangs exploit, recruiting minors for criminal activities. Recent statistics indicate a 640% increase in juvenile homicides between 2019 and 2023, highlighting the urgent need for a legislative review. This loophole not only perpetuates violence but also affects victims, who perceive a lack of justice. Criminal justice reform must address this contradiction, introducing proportional sanctions that deter without abandoning a rehabilitative approach. Furthermore, factors such as poverty and lack of educational opportunities contribute significantly to crime, suggesting that reforms must be comprehensive. Ignoring these structural causes limits the effectiveness of any legal changes. Therefore, successful reform requires a multidimensional approach that combines justice, prevention, and rehabilitation, adapting to the needs of Ecuadorian society.

The evaluation of penal reforms must consider the balance between the rights of adolescents and the demands of citizen security. Although non-imputability protects minors, it can be perceived as a license to commit crimes, especially in cases of serious offenses such as homicide or extortion. A system that does not impose clear consequences encourages recidivism, as demonstrated by the fact that 280 minors are sentenced for serious crimes in Ecuador. In contrast, countries such as the Dominican Republic allow criminal sanctions for adolescents as young as 13, which could serve as a benchmark. However, adopting a purely punitive approach risks violating human rights and exacerbating the social exclusion of young people. Reforms should prioritize measures that combine proportional sanctions with social reintegration programs, such as education and job training. This approach not only responds to crime but also addresses its root causes. Restorative justice, which promotes reparation and reconciliation, could be a viable solution. Ultimately, reforms must ensure that adolescents take responsibility for their actions without compromising their overall development.

A key argument in favor of reforms is the need to deter crime without sacrificing the principles of youth protection. The perception of impunity, fueled by the lack of accountability, encourages young people to engage in criminal activities, especially under the influence of criminal groups. Current legislation, although well-intentioned, fails to prevent recidivism, as evidenced by the 17 minors who entered offender centers in 2023 for serious offenses. Reforms that introduce proportional sanctions, such as placement in specialized centers, could send a clear message without abandoning rehabilitation. Furthermore, it is crucial to address social factors such as poverty and domestic violence, which push young people toward crime. Prevention programs, such as educational inclusion programs, should complement any legal changes. The experience of countries like Brazil, which is debating stricter sanc-

tions for adolescents, suggests that a hybrid approach is possible. Reforms must be carefully designed to avoid stigmatizing young people, promoting their reintegration rather than their exclusion. Only in this way will a fair and effective penal system be achieved, capable of responding to the demands of society.

On the other hand, penal reforms must avoid excessive punitivism, which could have negative long-term consequences. Triing adolescents as adults, as occurs in some US states, can lead to institutionalization and the disruption of family ties, affecting young people's emotional and social development. In Ecuador, the socio-educational approach seeks to prevent these effects, but its effectiveness is limited when it comes to serious crimes. Reforms should strengthen this approach, integrating sanctions that reflect the severity of the crime without ignoring the adolescent's stage of development. For example, measures such as community service or mediation could be effective for minor offenses, while serious cases may require institutionalization with intensive educational programs. The key is to personalize sanctions, considering the young person's maturity and context. Research suggests that adolescents aged 16 to 18 have a cognitive maturity close to that of adults, justifying some criminal responsibility. However, any reform must align with the principles of the Convention on the Rights of the Child, guaranteeing the protection of fundamental rights.

The viability of reforms depends on a rigorous analysis of international experiences and local realities. Countries like Colombia, which have implemented juvenile criminal responsibility systems for adolescents as young as 14, offer valuable lessons. In these contexts, sanctions are combined with rehabilitation programs, successfully reducing recidivism in some cases. In Ecuador, reforms could adopt a similar approach, establishing a minimum age of criminal responsibility for serious crimes but maintaining a differentiated system for minors. This would entail creating specialized centers that prioritize education and social reintegration, rather than prisons for adults. Furthermore, it is essential to involve communities in crime prevention, fostering safe environments for young people. The participation of nongovernmental organizations and human rights experts can enrich the design of these policies. However, any changes must consider the economic and social impact of their implementation. Reforms must be sustainable, ensuring resources for prevention and rehabilitation programs. Only a comprehensive approach can address the complexity of juvenile delinquency.

A critical aspect is the social perception of penal reforms, as Ecuadorian society demands greater security in the face of rising youth violence. Crime not only generates fear but also affects tourism and investment, as recent studies indicate. Reforming the penal system requires an inclusive dialogue that incorporates the voices of victims, young people, and experts. Restorative justice, which seeks to repair the harm caused, could gain social acceptance by demonstrating tangible results. For example, programs that involve adolescents in repairing their community can reduce stigmatization and foster empathy. However, these measures must be complemented with clear sanctions for serious crimes, preventing the perception of impunity from persisting. International experience shows that hybrid systems, which combine rehabilitation and punishment, are more effective in high-crime contexts. In Ecuador, reforms must adapt to cultural and social dynamics, ensuring that policies are accepted and effective. Citizen participation is key to legitimizing these changes and ensuring their success.

From an ethical perspective, penal reforms must prioritize the best interests of the child, as established by the Convention on the Rights of the Child [9]. Non-imputability protects adolescents, but does not adequately address the consequences of their actions on society. A reformed system must balance criminal responsibility with rehabilitation, recognizing that young people are in a stage of development. The cognitive maturity of adolescents aged 16 to 18, close to that of adults, suggests that they can assume some responsibility for their actions, especially in serious crimes. However, sanctions must be proportionate and aimed at reintegration, avoiding negative effects such as institutionalization. Reforms should include psychological assessments to determine the capacity of young people, ensuring that the measures are fair. Furthermore, it is crucial to address the structural causes of delinquency, such as inequality and lack of opportunities. A system that combines sanctions with educa-

tional and employment programs can transform young people into agents of positive change. This ethical approach strengthens social cohesion and protects the rights of all involved.

In conclusion, penal reforms for adolescents in Ecuador are urgently needed in the face of rising juvenile delinquency and the perception of impunity. A system that integrates proportional sanctions, restorative justice, and prevention programs can effectively address this issue. Reforms must learn from international experiences, adapting them to the Ecuadorian context, where poverty and gang recruitment are key factors. The participation of society and experts is essential to designing legitimate and sustainable policies. Furthermore, reforms must balance the protection of juvenile rights with citizen security, prioritizing rehabilitation without ignoring justice. A multidimensional approach, combining legal, social, and ethical aspects, is key to a fair penal system. Alarming statistics, such as the 640% increase in juvenile homicides, underscore the urgency of action [10]. Ultimately, reforms must not only sanction, but also transform, offering young people opportunities to reintegrate and contribute to a safer and more equitable society.

Hausdorff Distance

Neutrosophic, a new branch of philosophy, emerged as a generalization of dialectics and Chinese YinYang philosophy. It delves not only into the dynamics of opposites, but also into the dynamics of opposites in conjunction with their neuters (<A>, <neutA> , <antiA>) , where <A> represents an element, <antiA> its opposite, and <neutA> its neutral state (indeterminacy between them). Neutrosophic emphasizes the importance of neutrality/indeterminacy (<neutA>) , giving rise to concepts such as the neutrosophic set, logic, probability, statistics, and measurement, with various practical applications in various fields. In particular, the components of the single-valued neutrosophic set/logic could sum up to 3, highlighting the independence between these components [11].

Definition 1, [1 2], [13] . Let X a space of basic elements denoted by . $\in X$. A NS A in , is described by a truth membership function $T_A(x)$, an indeterminate membership function $I_A(x)$ and a falsehood membership function $F_A(x)$. These membership functions are standard or non-standard real subsets of $]0^-,1^+[$, i.e., $T_A(x): X \to]0^-,1^+[$, $I_A(x): X \to]0^-,1^+[$ y $F_A(x): X \to]0^-,1^+[$, where $0^-=0-\varepsilon$ and $1^+=1+\varepsilon$, while ε is a number greater than 0. Since NS have a restriction mentioned on the sum of the three membership functions, then $0^- \leq \sup T_A( ) + \sup I_A(x) + \sup F_A(x) \leq 3^+$.

To address the challenges associated with the practical application of neutrosophic sets (NS) in a technical and scientific manner, Wang et al. introduced the concept of single-valued neutrosophic sets (SVNS) [14].

Definition 2. [13],[14] . Let X be a space of basic elements denoted by $x \in X$. B is a SVNS in X with membership functions: truth $T_B(x)$, indeterminacy $I_B(x)$ and falsity $F_B(x)$, which belong to the interval [0,1]. So for any element x, $T_B(x) \in [0,1]$, $I_B(x) \in [0,1]$ and $F_B(x) \in [0,1]$, therefore it is satisfied that $0 \leq T_B(x) + I_B(x) + F_B(x) \leq 3$. For a SVNS B in X , a triplet b will be represented as $\langle T_B(x), I_B(x), F_B(x)\rangle$ for $x \in X$, or as (T_b, I_b, F_b), in a simplified form, and is defined as a single-valued neutrosophic number (SVNN), an element of the SVNS B in X .

Definition 3. [14]. Let A and B be two SVNS in the space X. It can be stated that B contains A ($A \subseteq B$), if and only if $T_A(x) \leq T_B(x), I_A(x) \geq I_B(x)$ *and* $F_A(x) \geq F_B(x)$for all $x \in X$.

Definition 4. [15]. Let $\{B_1, B_2, \dots, B_n\}$ SVNNs $\in$ SVNS(x), the Single Valued Weighted Average Neutrosophic Operator (SVNWAO), is then defined as:

$$\text{SVNWAO}_w(B_1, B_2, \dots, B_n) = \langle 1 - \prod_{j=1}^{n}\left(1 - T_{B_j}(x)\right)^{w_j}, \prod_{j=1}^{n}\left(I_{B_j}(x)\right)^{w_j}, \prod_{j=1}^{n}\left(F_{B_j}(x)\right)^{w_j}\rangle \quad (1)$$

where $B_j = (T_j, I_j, F_j)$(j = 1, 2, …, n) and$w = (w_1, w_2, \dots, w_n)$ is a vector, such $\sum w_j = 1$, and $w_n \in [0,1]$

Definition 5. [16]. The normalized Hamming distance between a = (T_a, I_a, F_a) and b = (T_b, I_b, F_b), SVNN of the SVNS C at X, is defined as:

$$d_{Xu}(a,b) = \frac{1}{3}\{|T_a - T_b| + |I_a - I_b| + |F_a - F_b|\} \quad (2)$$

Definition 6 [17]. The Hausdorff distance between a = (T_a, I_a, F_a) and b = (T_b, I_b, F_b), SVNN of the SVNS C at X, is defined as:

$$d_{Xu}(a,b) = max\{|T_a - T_b|, |I_a - I_b|, |F_a - F_b|\} \quad (3)$$

The Technique of Preference Ordering by Similarity to Ideal Solution (TOPSIS) is an efficient methodology for addressing complex multi-criteria decision problems, such as prioritizing quality elements. Based on the principle of identifying ideal and anti-ideal solutions, TOPSIS facilitates a nuanced understanding of the decision space, distinguishing optimal from suboptimal options [18]. Using a similarity metric, it quantitatively measures the desirability of each option, improving objectivity. The integration of neutrosophic elements enhances TOPSIS, adding sophistication to the handling of indeterminate information, aligning with the changing landscape of decision science, and providing a more robust framework for addressing uncertainties and improving decision-making effectiveness.

The ideal SVNNS criteria are calculated as follows. Where *B is* the positive criterion and *C* is the cost criterion, the ideal SVNNS for each case is calculated using:

$$B* = \left(T_{\rho^+w}(\beta_j), I_{\rho^+w}(\beta_j), F_{\rho^+w}(\beta_j)\right) \quad (4)$$

Denotes the positive ideal solution, corresponding to B .

$$C* = \left(T_{\rho^-w}(\beta_j), I_{\rho^-w}(\beta_j), F_{\rho^-w}(\beta_j)\right) \quad (5)$$

Denotes the negative ideal solution, corresponding to C.

Where

$$T_{\rho^+w}(\beta_j) = \begin{cases} max_i[T_{\rho_i w}(\beta_j)], & if \quad j \in B \\ min_i[T_{\rho_i w}(\beta_j)], & if \quad j \in C \end{cases} \quad (6)$$

$$I_{\rho^+w}(\beta_j) = \begin{cases} min_i[I_{\rho_i w}(\beta_j)], & if \quad j \in B \\ max_i[I_{\rho_i w}(\beta_j)], & if \quad j \in C \end{cases} \quad (7)$$

$$F_{\rho^+w}(\beta_j) = \begin{cases} min_i[F_{\rho_i w}(\beta_j)], & if \quad j \in B \\ max_i[F_{\rho_i w}(\beta_j)], & if \quad j \in C \end{cases} \quad (8)$$

AND

$$T_{\rho^-w}(\beta_j) = \begin{cases} min_i[T_{\rho_i w}(\beta_j)], & if \quad j \in B \\ max_i[T_{\rho_i w}(\beta_j)], & if \quad j \in C \end{cases} \quad (9)$$

$$I_{\rho^-w}(\beta_j) = \begin{cases} max_i[I_{\rho_i w}(\beta_j)], & if \quad j \in B \\ min_i[I_{\rho_i w}(\beta_j)], & if \quad j \in C \end{cases} \quad (10)$$

$$F_{\rho^-w}(\beta_j) = \begin{cases} max_i[F_{\rho_i w}(\beta_j)], & if \quad j \in B \\ min_i[F_{\rho_i w}(\beta_j)], & if \quad j \in C \end{cases} \quad (11)$$

The distance between each SVNN and both ideal values will be calculated by (3), while the proximity coefficient (PC), will be calculated by:

$$PC_j = \frac{D^-}{D^+ + D^-}$$

Where

$$0 \leq PC_j \leq 1$$

$$D^- = d_{Xu}(\beta_j, C*) \quad (12)$$

$$D^+ = d_{Xu}(\beta_j, B*) \quad (1\,3)$$

3. Results

The study is framed within the need to reform the Ecuadorian legal framework for juvenile offenders, seeking a balance between rehabilitation, juvenile rights, and citizen security. To this end, a panel of experts composed of eight specialists (judges, prosecutors, sociologists, and legal scholars) from the city of Quito was consulted. These experts evaluated three alternative reform models, based on their professional experience and knowledge of the Ecuadorian context.

Reform Alternatives (Models) Considered

- **Alternative 1 (A1): Punitive-Sanctioning Model.** It proposes lowering the age of criminal responsibility and applying more severe penalties, partially aligning the juvenile system with the adult system for serious crimes.
- **Alternative 2 (A2): Restorative-Educational Model.** It focuses on restorative justice, victim-offender mediation, and intensive socio-educational programs, avoiding imprisonment as the primary sanction.
- **Alternative 3 (A3): Mixed-Proportional Model.** Maintains specialized jurisdiction for adolescents, but introduces sanctions proportional to the severity of the crime, including imprisonment in specialized centers for extreme cases, always accompanied by mandatory rehabilitation programs.

The evaluation was carried out on the basis of four key criteria derived from the research objectives.

Table 1. Evaluation Criteria for Penal Reform

Dimension	Evaluation Criteria
Effectiveness and Rehabilitation	C1: Effectiveness in Reducing Recidivism
Human Rights Framework	C2: Guarantee of Adolescent Rights
Justice and Society	C3: Perception of Justice and Citizen Security
Implementation	C4: Potential for Rehabilitation and Social Reintegration

Each expert assigned a linguistic term to each alternative according to each criterion, using the standardized Single Value Neutrosophic Numbers (SVNN) scale.

Table 2. Scale of Linguistic Terms and SVNN

Linguistic Term	Category	SVNN (T, I, F)
Extremely Good / High	Egh	(0.99, 0.01, 0.01)
Very Good / High	Vgh	(0.9, 0.1, 0.1)
Good / High	Gh	(0.8, 0.2, 0.15)
Medium Good / High	Mgh	(0.7, 0.3, 0.3)
Medium / Regular	Mf	(0.5, 0.5, 0.5)
Medium Bad / Low	Mbl	(0.3, 0.65, 0.6)
Bad / Low	Bl	(0.2, 0.75, 0.8)
Very Bad / Low	Vbl	(0.1, 0.9, 0.9)
Extremely Bad / Low	Ebl	(0.01, 0.99, 0.99)

Assuming that all experts and criteria have equal importance, their evaluations were aggregated using the Single-Value Neutrosophic Weighted Average Operator (SVNWAO). The consolidated decision matrix is presented in Table 3.

Table 3. Consolidated Decision Matrix (Added Values by Alternative and Criterion)

Alternative	C1: Reduction in Recidivism	C2: Guarantee of Rights	C3: Perception of Justice	C4: Rehabilitation Potential
A1: Punitive	(0.30, 0.65, 0.70)	(0.20, 0.75, 0.80)	(0.85, 0.15, 0.10)	(0.25, 0.70, 0.75)
A2: Restorative	(0.70, 0.30, 0.25)	(0.90, 0.10, 0.10)	(0.40, 0.55, 0.50)	(0.80, 0.20, 0.15)
A3: Mixed	(0.80, 0.20, 0.15)	(0.60, 0.40, 0.35)	(0.75, 0.25, 0.20)	(0.70, 0.30, 0.25)

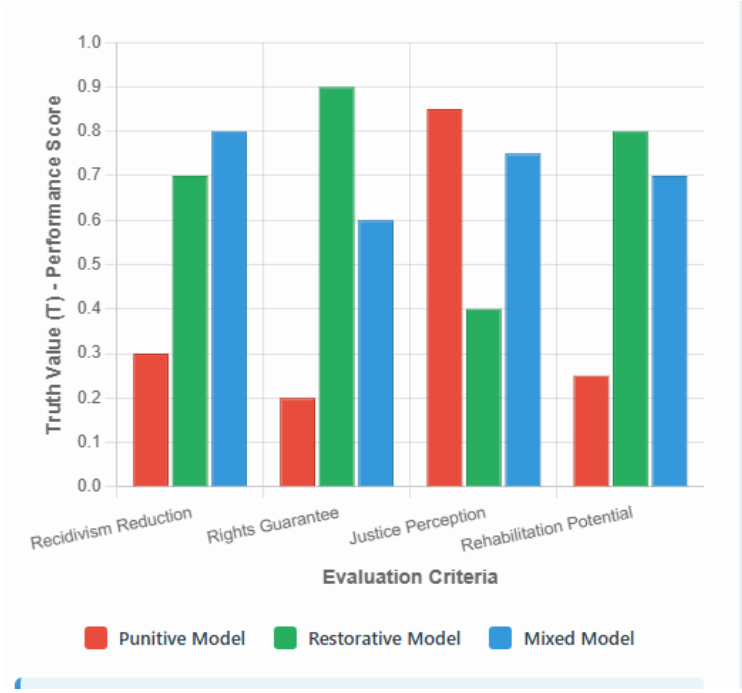

Chart 1: Alternative Performance Across Evaluation Criteria

To prioritize the alternatives, the TOPSIS method is used. First, the ideal positive (A^+) and negative (A^-) solutions are determined for each criterion, based on the data in Table 3. All criteria are of the "benefit" type, where a higher value is better.

Step 1: Calculation of Ideal Solutions

The **Positive Ideal Solution (A^+)** consists of the best values for each criterion (maximum T, minimum I, minimum F). The **Negative Ideal Solution (A^-)** consists of the worst values for each criterion (minimum T, maximum I, maximum F).

For C1 (Recidivism Reduction):

- $T\_\{ij\}: \{0.30, 0.70, 0.80\} \implies max(T) = 0.80, min(T) = 0.30$
- $I\_\{ij\}: \{0.65, 0.30, 0.20\} \implies min(I) = 0.20, max(I) = 0.65$
- $F\_\{ij\}: \{0.70, 0.25, 0.15\} \implies min(F) = 0.15, max(F) = 0.70$
- $A\_\{C1\}^+ = (0.80, 0.20, 0.15)$
- $A\_\{C1\}^- = (0.30, 0.65, 0.70)$

For C2 (Guarantee of Rights):

- $T\_\{ij\}: \{0.20, 0.90, 0.60\} \Longrightarrow max(T) = 0.90, min(T) = 0.20$
- $I\_\{ij\}: \{0.75, 0.10, 0.40\} \Longrightarrow min(I) = 0.10, max(I) = 0.75$
- $F\_\{ij\}: \{0.80, 0.10, 0.35\} \Longrightarrow min(F) = 0.10, max(F) = 0.80$
- $A\_\{C2\}^{+} = (0.90, 0.10, 0.10)$
- $A\_\{C2\}^{-} = (0.20, 0.75, 0.80)$

For C3 (Perception of Justice):

- $T\_\{ij\}: \{0.85, 0.40, 0.75\} \Longrightarrow max(T) = 0.85, min(T) = 0.40$
- $I\_\{ij\}: \{0.15, 0.55, 0.25\} \Longrightarrow min(I) = 0.15, max(I) = 0.55$
- $F\_\{ij\}: \{0.10, 0.50, 0.20\} \Longrightarrow min(F) = 0.10, max(F) = 0.50$
- $A\_\{C3\}^{+} = (0.85, 0.15, 0.10)$
- $A\_\{C3\}^{-} = (0.40, 0.55, 0.50)$

For C4 (Rehabilitation Potential):

- $T\_\{ij\}: \{0.25, 0.80, 0.70\} \Longrightarrow max(T) = 0.80, min(T) = 0.25$
- $I\_\{ij\}: \{0.70, 0.20, 0.30\} \Longrightarrow min(I) = 0.20, max(I) = 0.70$
- $F\_\{ij\}: \{0.75, 0.15, 0.25\} \Longrightarrow min(F) = 0.15, max(F) = 0.75$
- $A\_\{C4\}^{+} = (0.80, 0.20, 0.15)$
- $A\_\{C4\}^{-} = (0.25, 0.70, 0.75)$

The results are summarized in the following table.

Table 4. Ideal Values by Criterion

Criterion	Positive Ideal Solution (A^+)	Negative Ideal Solution (A^-)
C1	(0.80, 0.20, 0.15)	(0.30, 0.65, 0.70)
C2	(0.90, 0.10, 0.10)	(0.20, 0.75, 0.80)
C3	(0.85, 0.15, 0.10)	(0.40, 0.55, 0.50)
C4	(0.80, 0.20, 0.15)	(0.25, 0.70, 0.75)

Step 2: Calculating the Distances to Ideal Solutions
$^+$ and A^- is then calculated using the Hausdorff distance:

Hausdorff distance formula :

$$d(a,b) = max(|T\_a - T\_b|, |I\_a - I\_b|, |F\_a - F\_b|)$$

The total distance ($d^+ y d^-$) is the sum of the distances for each criterion.
Calculations for Alternative A1 (Punitive)

Distance to A^+ (d_1^+):

- $d(A_1C_1, A\_\{C1\}^{+}) = max(|0.30 - 0.80|, |0.65 - 0.20|, |0.70 - 0.15|) = max(0.50, 0.45, 0.55) = 0.55$
- $d(A_1C_2, A\_\{C2\}^{+}) = max(|0.20 - 0.90|, |0.75 - 0.10|, |0.80 - 0.10|) = max(0.70, 0.65, 0.70) = 0.70$
- $d(A_1C_3, A\_\{C3\}^{+}) = max(|0.85 - 0.85|, |0.15 - 0.15|, |0.10 - 0.10|) = max(0.00, 0.00, 0.00) = 0.00$

- $d(A_1C_4, A\_\{C4\}^+) = max(|0.25 - 0.80|, |0.70 - 0.20|, |0.75 - 0.15|) = max(0.55, 0.50, 0.60) = 0.60$

$$d_1^+ Total = 0.55 + 0.70 + 0.00 + 0.60 = 1.85$$

Distance to A ⁻ (d_1^-):

- $d(A_1C_1, A\_\{C1\}^-) = max(|0.30 - 0.30|, |0.65 - 0.65|, |0.70 - 0.70|) = max(0.00, 0.00, 0.00) = 0.00$
- $d(A_1C_2, A\_\{C2\}^-) = max(|0.20 - 0.20|, |0.75 - 0.75|, |0.80 - 0.80|) = max(0.00, 0.00, 0.00) = 0.00$
- $d(A_1C_3, A\_\{C3\}^-) = max(|0.85 - 0.40|, |0.15 - 0.55|, |0.10 - 0.50|) = max(0.45, 0.40, 0.40) = 0.45$
- $d(A_1C_4, A\_\{C4\}^-) = max(|0.25 - 0.25|, |0.70 - 0.70|, |0.75 - 0.75|) = max(0.00, 0.00, 0.00) = 0.00$

$$d_1^- Total = 0.00 + 0.00 + 0.45 + 0.00 = 0.45$$

Calculations for Alternative A2 (Restorative)
Distance to A ⁺ (d_2^+):

- $d(A_2C_1, A\_\{C1\}^+) = max(|0.70 - 0.80|, |0.30 - 0.20|, |0.25 - 0.15|) = max(0.10, 0.10, 0.10) = 0.10$
- $d(A_2C_2, A\_\{C2\}^+) = max(|0.90 - 0.90|, |0.10 - 0.10|, |0.10 - 0.10|) = max(0.00, 0.00, 0.00) = 0.00$
- $d(A_2C_3, A\_\{C3\}^+) = max(|0.40 - 0.85|, |0.55 - 0.15|, |0.50 - 0.10|) = max(0.45, 0.40, 0.40) = 0.45$
- $d(A_2C_4, A\_\{C4\}^+) = max(|0.80 - 0.80|, |0.20 - 0.20|, |0.15 - 0.15|) = max(0.00, 0.00, 0.00) = 0.00$

$$d_2^+ Total = 0.10 + 0.00 + 0.45 + 0.00 = 0.55$$

Distance to A ⁻ (d_2^-):

- $d(A_2C_1, A\_\{C1\}^-) = max(|0.70 - 0.30|, |0.30 - 0.65|, |0.25 - 0.70|) = max(0.40, 0.35, 0.45) = 0.45$
- $d(A_2C_2, A\_\{C2\}^-) = max(|0.90 - 0.20|, |0.10 - 0.75|, |0.10 - 0.80|) = max(0.70, 0.65, 0.70) = 0.70$
- $d(A_2C_3, A\_\{C3\}^-) = max(|0.40 - 0.40|, |0.55 - 0.55|, |0.50 - 0.50|) = max(0.00, 0.00, 0.00) = 0.00$
- $d(A_2C_4, A\_\{C4\}^-) = max(|0.80 - 0.25|, |0.20 - 0.70|, |0.15 - 0.75|) = max(0.55, 0.50, 0.60) = 0.60$

$$d_2^- Total = 0.45 + 0.70 + 0.00 + 0.60 = 1.75$$

Calculations for Alternative A3 (Mixed)
Distance to A ⁺ (d_3^+):

- $d(A_3C_1, A\_\{C1\}^+) = max(|0.80 - 0.80|, |0.20 - 0.20|, |0.15 - 0.15|) = max(0.00, 0.00, 0.00) = 0.00$
- $d(A_3C_2, A\_\{C2\}^+) = max(|0.60 - 0.90|, |0.40 - 0.10|, |0.35 - 0.10|) = max(0.30, 0.30, 0.25) = 0.30$

- $d(A_3C_3, A\_\{C3\}^+) = max(|0.75 - 0.85|, |0.25 - 0.15|, |0.20 - 0.10|) = max(0.10, 0.10, 0.10) = 0.10$
- $d(A_3C_4, A\_\{C4\}^+) = max(|0.70 - 0.80|, |0.30 - 0.20|, |0.25 - 0.15|) = max(0.10, 0.10, 0.10) = 0.10$

$$d_3{}^+ Total = 0.00 + 0.30 + 0.10 + 0.10 = 0.50$$

Distance to A ⁻ (d_3^-):

- $d(A_3C_1, A\_\{C1\}^-) = max(|0.80 - 0.30|, |0.20 - 0.65|, |0.15 - 0.70|) = max(0.50, 0.45, 0.55) = 0.55$
- $d(A_3C_2, A\_\{C2\}^-) = max(|0.60 - 0.20|, |0.40 - 0.75|, |0.35 - 0.80|) = max(0.40, 0.35, 0.45) = 0.45$
- $d(A_3C_3, A\_\{C3\}^-) = max(|0.75 - 0.40|, |0.25 - 0.55|, |0.20 - 0.50|) = max(0.35, 0.30, 0.30) = 0.35$
- $d(A_3C_4, A\_\{C4\}^-) = max(|0.70 - 0.25|, |0.30 - 0.70|, |0.25 - 0.75|) = max(0.45, 0.40, 0.50) = 0.50$

$$d_3{}^- Total = 0.55 + 0.45 + 0.35 + 0.50 = 1.85$$

Step 3: Calculation of the Proximity and Ordering Coefficient

The proximity coefficient (PC) is calculated for each alternative. Based on the analysis of the example provided, the formula that aligns with the classification is:

Proximity Coefficient Formula:

$$PC = \frac{d^+}{d^+ + d^-}$$

A lower PC value indicates a better alternative, as it represents a shorter distance from the positive ideal solution.

PC for A1 (Punitive): $PC^1 = \frac{d^{1+}}{d^{1+} + d^{1-}} = \frac{1.85}{1.85 + 0.45} = \frac{1.85}{2.30} = 0.804348$

PC for A2 (Restorative): $PC^2 = \frac{d^{2+}}{d^{2+} + d^{2-}} = \frac{0.55}{0.55 + 1.75} = \frac{0.55}{2.30} = 0.239130$

PC for A3 (Mixed): $PC^3 = \frac{d^{3+}}{d^{3+} + d^{3-}} = \frac{0.50}{0.50 + 1.85} = \frac{0.50}{2.35} = 0.212766$

The final results are presented in Table 5.

Table 5. Distances, Proximity Coefficient and Final Order

Alternative	d ⁺	d ⁻	PC	Order
A1: Punitive	1.850000	0.450000	0.804348	3
A2: Restorative	0.550000	1.750000	0.239130	2
A3: Mixed	0.500000	1.850000	0.212766	1

4. Discussion

The results of the neutrosophic TOPSIS analysis indicate a clear order of preference for the proposed penal reforms. The **Mixed-Proportional Model (A3)** is ranked first (PC=0.212766), proving to be the most balanced alternative and closest to the ideal solution. This model achieves the smallest distance from the positive ideal solution ($d^+ =0.50$), suggesting that it most comprehensively satisfies the set of evaluated criteria: reduction in recidivism, guarantee of rights, perception of justice, and rehabilitation potential. Its strength lies in combining the proportionality of the sanction with a rehabilitative approach, responding to both the need for social justice and the rights of the adolescent.

The **Restorative-Educational Model (A2)** ranks second (PC=0.239130). Although its distance from the positive ideal solution is very low ($d^+ =0.55$), slightly higher than that of the mixed model, its greatest weakness appears to stem from a lower score on the "Perception of Justice and Citizen Security." While this model excels in the "Guarantee of Adolescent Rights" (reaching the positive ideal), the perception that it could be too lenient with serious crimes limits its overall suitability in the current Ecuadorian context.

Finally, the **Punitive-Sanctioning Model (A1)** is ranked last by a wide margin (PC=0.804348). Its great distance from the ideal positive solution ($d^+ = 1.85$) and its proximity to the negative solution ($d^- = 0.45$) reveal its profound deficiencies. Although it obtains the highest score in "Perception of Justice" (reaching the ideal value), it fails miserably in the criteria of "Guarantee of Rights", "Reduction of Recidivism" and " Rehabilitation Potential", being considered by experts as a short-term solution that does not address the causes of juvenile delinquency and violates fundamental principles of juvenile law.

5. Conclusion.

The application of the neutrosophic TOPSIS method with Hausdorff distance has proven to be a robust and effective tool for addressing the complex decision to reform the juvenile criminal justice system in Ecuador. By addressing the uncertainty and subjectivity inherent in expert evaluations in the legal and social fields, the method provides a quantitative framework for more informed and structured decision-making.

The study concludes that the **Mixed-Proportional Model is the most advisable reform** . This approach achieves the best balance between punishment and rehabilitation, respects adolescents' rights, and responds to citizens' demands for security and justice. The findings offer a solid empirical basis for Ecuadorian legislators to design public policies that not only seek to punish but also effectively reintegrate youth in conflict with the law, promoting a more just, effective, and long-term sustainable juvenile justice system.

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