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Modeling the Rehabilitation of Offenders in Domestic Violence Using a Hybrid Neutrosophic-Logistic Approach to Reduce Recidivism

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Abstract. This dissertation seeks to determine if criminal suspension—per Article 651.3 of National Criminal Code (COIP)—for domestic violence offenders in Ecuador actually reduces recidivism through effective rehabilitation. This study is significant for comprehension of offender mentality and subsequent ability to accept criminal punishment to reduce recidivism for prolonged victim safety and better acts of authority in a country where domestic violence is still a major social concern. While the existing literature has studied aspects of restorative justice, very few articles have explored the predicating factors of recidivism and the lack of judicial observation and databases due to a neoteric nature and uncertainty of judicial perception, rendering observations for why predicating factors create recidivism elusive. Thus, a neutrosophic-logistic approach is taken. Neutrophysics measures the compliance of suspension semi-compliance is based on judicial perception while logistic predictions assess generalized human behavior. The results conclude that criminal suspension does not work without solvent and rehabilitative efforts because criminal intent remains stable to keep victims vulnerable. Thus, the article presents a never before seen uniquely analytic foundation fostering neutrosophic and logistic merger while presenting judicial reform measures such as accountability efforts and rehabilitative efforts to maintain restorative justice with protective efforts.

Keywords: Domestic Violence, Rehabilitation, Recidivism, Neutrosophic, Logistics, Restorative Justice, COIP.

1. Introduction

Domestic violence is a persistent challenge in Ecuador, where Article 651.3 of the Comprehensive Organic Criminal Code (COIP) allows for the suspension of criminal proceedings to prioritize the rehabilitation of offenders and the protection of victims. This restorative approach seeks to break the cycle of violence, but its effectiveness is questioned due to high recidivism rates. Investigating this issue is crucial in a context where victim safety depends on effective judicial measures. Restorative justice, by promoting rehabilitation, can reduce recidivism, but requires robust monitoring systems and therapeutic programs [1]. The relevance of this study lies in its potential to improve public policies that protect victims and transform offenders. In Ecuador, where domestic violence affects thousands of homes annually, addressing this problem is a social priority [2]. This article employs a hybrid neutrosophic-logistic approach to assess rehabilitation, integrating uncertainty and predictive analytics. In doing so, it seeks to contribute to a more equitable and effective judicial system. The need for innovative solutions is evident, given the devastating impact of violence on families. This paper aims to offer practical and theoretical answers.

Domestic violence has been a historical problem, rooted in power dynamics and gender inequality, with roots that transcend cultural contexts [3]. In Ecuador, legal reforms, such as the 2014 COIP, marked a milestone by introducing restorative measures, inspired by international models of alternative justice [4]. However, the implementation of these measures has faced obstacles, from a lack of resources to cultural resistance to prioritizing rehabilitation over punishment. Historically, penal policies in Latin America have oscillated between punitive and restorative approaches, with mixed results [5]. In the case of Article 651.3, introduced in 2019, it sought to balance the protection of victims with the reintegration of aggressors, but the practice reveals significant deficiencies. Previous studies have pointed out that the absence of structured programs limits the impact of these measures [6]. Globally, countries such as Spain have implemented rehabilitation programs with promising results, but adapting them to the Ecuadorian context requires overcoming institutional barriers [7]. This study is situated within this context, analyzing how an innovative approach can address current limitations. The evolution of the issue underscores the urgency of comprehensive solutions.

The core of this research is the ineffectiveness of the suspension of criminal proceedings in cases of domestic violence, according to Article 651.3 of the COIP (Spanish Criminal Code), in reducing the recidivism of aggressors. Despite its restorative intent, the lack of monitoring and adequate rehabilitation programs perpetuates the vulnerability of victims. How can the rehabilitation of aggressors be optimized to ensure an effective reduction in recidivism, considering the uncertainty inherent in judicial and social data? This question arises from the realization that current measures fail to meet their objectives of protection and transformation. The magnitude of the problem is alarming, as domestic violence affects entire communities, generating trauma and distrust in the judicial system [8]. The question posed seeks to unravel the causes of this ineffectiveness, exploring factors such as compliance with measures and perceptions of security. This study aims to offer a clear answer, using a hybrid approach that combines predictive analytics with ambiguity management. Solving this problem is essential to strengthening restorative justice. The research focuses on in-depth and practical analysis.

The main objective of this paper is to evaluate the effectiveness of rehabilitation programs in cases of domestic violence, using a hybrid neutrosophic-logistic approach to model recidivism. Specifically, it seeks to identify the factors that limit compliance with restorative measures, proposing improvements based on empirical data. Furthermore, it aims to develop a predictive model that integrates uncertainty to anticipate offender behavior patterns . Another objective is to analyze victims' perceptions of security during the suspension of criminal proceedings. These goals are aligned with the research question, focusing on optimizing restorative justice. It also seeks to contribute to the design of public policies that strengthen inter-institutional coordination and monitoring systems. The study aims to offer practical tools for judges and legislators, promoting more effective application of Article 651.3. Finally, it seeks to generate theoretical knowledge on the integration of neutrosophic and logistical approaches in judicial contexts. These objectives will guide the development of the article, ensuring a comprehensive approach. The research points to a significant impact on judicial practice.

2. Preliminaries.

Domestic Violence

Domestic violence represents a social scourge that transcends borders, affecting millions of people and destabilizing the family structure. This phenomenon, which encompasses physical, psychological, sexual, and economic abuse, manifests itself in unequal power relations, especially against women and children. In Ecuador, the problem has reached critical levels, with thousands of cases reported annually, according to official statistics [9]. The importance of addressing this issue lies in its devastating impact on the mental, physical, and social health of victims. Furthermore, it perpetuates cycles of violence that affect future generations. Restorative justice, such as that proposed in Article 651.3 of the COIP, seeks to mitigate these effects, but its effectiveness is questionable. This analysis assesses the

causes, consequences, and possible solutions, using a critical approach. Domestic violence is not only an individual problem, but a structural challenge that requires multidimensional intervention. Therefore, this text argues for the need for comprehensive policies that combine prevention, rehabilitation, and protection. The objective is to offer a holistic vision that fosters substantial change.

Historically, domestic violence has been invisible , considered a private matter in many cultures. However, since the late 20th century, feminist movements and international organizations have raised awareness of its seriousness [10]. In Latin America, the adoption of legal frameworks such as the Belém do Pará Convention marked a turning point in the fight against gender-based violence [11]. In Ecuador, the 2014 COIP introduced restorative measures, but implementation has been poor. A lack of resources and training has limited the capacity of judicial systems to protect victims. Studies show that psychological violence, although less visible, has effects as devastating as physical violence [12]. This historical context underscores the need for approaches that address both the structural causes and the immediate consequences. The persistence of patriarchal attitudes exacerbates the problem, making eradication difficult. Therefore, it is crucial to analyze the cultural dynamics that perpetuate violence. This analysis seeks to unravel these complexities in order to propose viable solutions.

The central problem lies in the inability of judicial systems to break the cycles of domestic violence. Despite legal frameworks such as Article 651.3 of the COIP (Spanish Constitutional Court), recidivism remains high due to a lack of monitoring and effective rehabilitation programs [13]. Victims, especially women, face revictimization when interacting with a system that does not guarantee their safety. The key question is: how can restorative policies balance the rehabilitation of aggressors with the protection of victims? This challenge is compounded by scarce resources and a lack of inter-institutional coordination. Domestic violence not only affects direct victims but also generates significant social and economic costs [14]. The magnitude of the problem demands an approach that combines analytical rigor with practical solutions. This text argues that the solution depends not only on laws, but on their effective implementation. The lack of follow-up to the imposed measures is a critical obstacle. Solving this problem requires a paradigm shift in the justice system.

Restorative justice, as an approach to addressing domestic violence, seeks to repair the harm caused rather than exclusively punish. However, its application in Ecuador faces structural limitations that reduce its impact. The suspension of criminal proceedings, although well-intentioned, often leaves victims unprotected due to a lack of oversight. Rehabilitation programs, such as cognitive-behavioral therapies, have proven effective in other countries, but in Ecuador they are scarce and inconsistent. Neutrosophic logic could help model the uncertainty in the implementation of these measures, but requires adequate resources. The lack of training for judges and prosecutors exacerbates the situation, as it makes risk assessment difficult [9]. This analysis positively values the potential of restorative justice, but underscores the need for reforms. The protection of victims must be the priority, complemented by programs that transform aggressors. Without a robust monitoring system, legal intentions remain on paper. It is imperative to strengthen institutions to ensure real results.

The consequences of domestic violence are profound, affecting the mental and physical health of victims, as well as family cohesion. Studies show that children exposed to this type of violence are at greater risk of developing long-term psychological problems [10]. Furthermore, psychological violence, such as humiliation or control, leaves scars that are difficult to quantify but equally devastating. In Ecuador, the lack of resources to care for victims exacerbates these consequences. Current policies, although progressive, fail to address the complexity of the problem [11]. This text argues that the solution requires a multidimensional approach that includes psychological, legal, and social support. Revictimization in the judicial system, where victims face lengthy and ineffective processes, is a critical problem. The entire society pays a price for inaction, from increased insecurity to the economic cost of violence [12]. Therefore, it is essential to prioritize prevention and early intervention. This analysis advocates for structural change that benefits victims.

Batter rehabilitation is an essential component for breaking the cycle of domestic violence. Programs that address underlying causes, such as sexist attitudes or emotional control issues, can reduce recidivism [13]. However, in Ecuador, implementation of these programs is inconsistent, limiting their impact. Neutrosophic logic, by modeling uncertainty, could identify key factors in batterers' behavior, but its practical application is limited without adequate resources. The lack of electronic monitoring or constant supervision allows many batterers to fail to comply with the imposed measures [14]. This analysis values rehabilitation as a pillar of restorative justice, but criticizes its current implementation. The transformation of batterers requires structured and tailored programs, supported by strong institutions. Without this, victims remain at risk, and the system loses credibility. Coordination between the judicial system and social organizations is crucial. This text proposes a comprehensive approach to ensure lasting results.

Victim protection must be at the heart of any policy against domestic violence. Protection orders, although issued in large numbers, often lack effective enforcement due to a lack of resources. In Ecuador, victims face barriers to accessing shelters or psychological support, leaving them vulnerable. This analysis argues that protection must go beyond temporary legal measures. A system that guarantees long-term follow-up and safety is needed. Inter-institutional cooperation, including the police and non-governmental organizations, is essential to close these gaps [9]. The perception of insecurity among victims reflects a systemic failure that urgently needs to be addressed. Restorative justice, while valuable, cannot function without prioritizing victim safety. This text advocates for policies that combine prevention, protection, and rehabilitation. Only in this way can a reliable and effective justice system be built.

Preventing domestic violence requires a proactive approach that addresses structural causes, such as gender inequality and the normalization of violence [10]. Educational programs in schools and communities can change cultural attitudes that perpetuate the problem. In Ecuador, a lack of awareness-raising campaigns limits the impact of these initiatives [11]. This analysis welcomes preventive efforts but highlights the need for greater investment. Domestic violence will not be solved with laws alone; it requires a profound cultural shift. Gender education from an early age is a crucial step to prevent future cases. Furthermore, public policies must include all sectors of society, from the government to community organizations [12]. This text argues that prevention is as important as intervention. Without a comprehensive approach, efforts will remain insufficient. Society must commit to eradicating violence at its roots.

Inter-institutional coordination is a fundamental pillar for effectively addressing domestic violence. In Ecuador, a lack of communication between the judicial system, the police, and support organizations limits the implementation of measures [13]. For example, protection orders often go unenforced due to a lack of human and technological resources. This analysis underscores the need for an integrated system that facilitates case tracking and victim protection [14]. Restorative justice requires collaboration between multiple actors to be effective. Without this coordination, policies remain mere intentions without real impact. Training public officials, from judges to police officers, is another key element for improving institutional response. This text proposes a model of cooperation that prioritizes the safety and well-being of victims. The effective implementation of measures depends on a collective effort. Only then can sustainable change be guaranteed.

In conclusion, domestic violence is a complex problem that requires comprehensive and well-coordinated solutions. This analysis has highlighted the limitations of the current system, particularly in the implementation of restorative measures such as those in Article 651.3 of the COIP. Rehabilitating aggressors and protecting victims are achievable goals, but they require resources, monitoring, and institutional commitment. Prevention, through education and awareness-raising, must be complemented by reactive policies that guarantee justice [9]. This text argues that a multidimensional approach, combining prevention, rehabilitation, and protection, is the key to eradicating domestic violence. Ecuadorian society needs structural change that prioritizes the safety and well-being of victims.

Proposed reforms, such as electronic monitoring and inter-institutional cooperation, are steps toward a more just system. Domestic violence is not only a legal problem, but a social challenge that requires collective action. This analysis advocates for a future where families live free from violence.

Neutrosophic logic

Neutrosophic logic will allow capturing ambiguity in perceptions related to program effectiveness, workplace discrimination, and community support. Following the application of [15], Likert-type responses will be converted into triplets (T, I, F), expressing the degree of truth, indeterminacy, and falsity regarding policies . These indices will serve as independent variables in the model, providing a more flexible and realistic approach to the analysis.

Mathematical Model of Neutrosophic Logic

In neutrosophic logic, each statement, variable or judgment is represented by a **neutrosophic number** :

$$A = (T, I, F) \quad (1)$$

where :

- T:degree of **truth** (Truth-membership)
- I:degree of **indeterminacy** (Indeterminacy-membership)
- F:degree of **falsehood** (Falsity-membership).

These values belong to the extended range:

$$T, I, F \subseteq]-0{,}1+[\quad (2)$$

That is, the values are not restricted to the classical interval [0, 1], which allows **modeling excess certainty or contradiction** in real systems (for example: T=1.2, F=0.8).

SVN Neutrosophic Numbers

The neutrosophic number table reflects the transformation of key quantitative study variables into triplets of the type (T, I, F), typical of neutrosophic logic. Each triplet represents a richer and more complex assessment: the component Tindicates the degree of truth perceived in the response, Imeasures the level of indeterminacy or doubt, and Freflects the degree of falsity or disagreement with said perception [17].

For its part, Fit is calculated as the complement of T, that is, $F = 1 - T$. These triplets were generated for the variables. This representation allows integrating uncertainty dimensions that are not considered by classical models. Thus, SVN values can be effectively used in hybrid regression models or decisions based on subjective perceptions [16].

In this context, the values Tcome directly from the normalized data, while $I$is calculated based on the proximity to the neutral value (0.5), and $F$is obtained as the complement of T.

Classical Binary Logistic Regression

Logistic regression will be used to estimate the probability of recidivism based on mixed variables. This method has been widely used to model recidivism, where variables such as age, education, and employment have shown significant effects . We will use statistical software (SPSS) to generate odds ratios, evaluate P -values (<0.05), and validate predictive quality with AUCROC, ensuring rigorous results

Binary logistic regression is used to model the probability of a dichotomous event occurring as a function of one or more independent variables. The general form of the model is:

$$\boldsymbol{P(Y = 1 \mid X)} = \frac{1}{1+e^{-(\beta 0+\beta 1X1+\beta 2X2+\cdots+\beta kXk)}} \quad (3)$$

where :

- $\boldsymbol{P(Y = 1 \mid X)}$: probability of the event occurring (recurrence = 1).
- $\boldsymbol{\beta 0}$:intercept of the model.
- $\boldsymbol{\beta i}$:regression coefficients for the independent variables.
- $\boldsymbol{Xi}$:independent (predictor) variables.
- $\boldsymbol{e}$:base of the natural logarithm (≈ 2.718).

Logistic Regression Model in Neutrosophic Notation

In neutrosophic logic, each variable can be represented as a **simple neutrosophic number** :

$$\boldsymbol{Xi} = (\boldsymbol{T_i}, \boldsymbol{I_i}, \boldsymbol{F_i}) \quad (4)$$

where :

- $\boldsymbol{T_i}$: degree of truth
- $\boldsymbol{I_i}$: degree of indeterminacy
- $\boldsymbol{F_i}$:degree of falsehood

with $\boldsymbol{T_i}, \boldsymbol{I_i}, \boldsymbol{F_i} \subseteq [\boldsymbol{0}, \boldsymbol{1}]$and not necessarily$\boldsymbol{T + I + F = 1}$

Adapted Neutrosophic Model

The logistic function is adapted to operate with neutrosophic variables X_i^N, resulting in a **neutro**

Sophic probability of recidivism:

$$\boldsymbol{PN(Y = 1 \mid X^N)} = (T_P, I_P, F_P) \quad (5)$$

where :

$$\boldsymbol{Logit(PN)} = ln(\frac{T_P}{1-T_P}) = \beta_0 + \sum_{i=1}^{K} \beta_i \cdot T_i \quad (6)$$

Additionally:

$I_p = f(I_1, I_2, \dots, I_k)$: can be expressed as the average or logical combination of theI_i

$F_P = 1 - T_P$ in a basic version, or modeled directly if subjective data is available.

Hybrid model.

The hybrid approach will integrate neutrosophic logic with logistic regression, using subjective perceptions as predictor variables along with quantitative demographic data. The neutrosophic multinomial -logistic model developed by [11] serves as the methodological basis, by merging probabilities with levels of uncertainty and contradiction .

Mathematical Model of the Neutrosophic Hybrid Model

The model is based on the classical logistic function, but incorporates variables represented as **neutrosophic numbers** of the type (T, I, F),where:

- $\boldsymbol{T}$:degree of truth
- $\boldsymbol{I}$:degree of indeterminacy
- $\boldsymbol{F}$:degree of falsehood

General equation of the model

$$\boldsymbol{Logit(P_N)} = ln(\frac{P_N}{1-P_N}) = \beta 0 + \sum_{j=1}^{n}(B_{T_j} T_j + B_{I_j} I_j + B_{F_j} F_j) + \sum_{K=1}^{m} B_k X_k \quad (7)$$

Where :

- $\boldsymbol{PN}$:neutrosophic probability of recidivism
- $\boldsymbol{\beta 0}$:model intercept
- $\boldsymbol{Tj}, \boldsymbol{Ij}, \boldsymbol{Fj}$:components of each neutrosophic variable
- $\boldsymbol{\beta Tj}, \boldsymbol{\beta Ij}, \boldsymbol{\beta Fj}$:model coefficients for each neutrosophic component
- $\boldsymbol{Xk}$:traditional quantitative variables (e.g., participation in programs
- $\boldsymbol{\beta k}$:coefficients associated with traditional variables.

3. Results

To evaluate the effectiveness of domestic violence rehabilitation programs for offenders and predict recidivism, three different methodological approaches were applied to an anonymized data set from the justice system. The models evaluated were: a **classical logistic regression model** , a **neutrosophic model** that incorporates ambiguity in perception variables, and a **hybrid neutrosophic-logistic model** that integrates uncertain quantitative and qualitative variables.

Each model was trained and validated with the same sample of cases to ensure a fair comparison. Key performance metrics such as overall accuracy, confusion matrix, Area Under the ROC Curve (AUC), and F1 score were analyzed to measure its predictive ability.

Classical Logistic Regression

This model was based on clearly defined quantitative and categorical variables, such as prior criminal history, offender age, income level, and recorded therapy attendance.

The classical logistic regression model achieved the best predictive performance, achieving an **overall accuracy of 87.5%** . Its confusion matrix demonstrated a high capacity to correctly classify both reoffending individuals (True Positives) and those who did not (True Negatives). The **AUC was 0.91** , indicating excellent discriminatory capacity. Its F1 score confirmed a robust balance between accuracy and sensitivity. These results suggest that for factual and well-structured variables, the classical approach is highly effective and reliable.

Table 1. Confusion Matrix - Classical Logistic Regression (N=80 cases)

	Prediction: No Relapse	**Prediction: Relapse**	**Total Actual**
Reality: He does not reoffend	**TN = 36**	**FP = 4**	40
Reality: Relapse	**FN = 6**	**TP = 34**	40
Total Prediction	42	38	**Total: 80**

- **TN (True Negatives):** Offenders who did not reoffend and the model predicted this correctly.
- **FP (False Positives):** Offenders who did not reoffend, but the model predicted they would.
- **FN (False Negatives):** Offenders who reoffended, but the model predicted they would not.
- **TP (True Positives):** Offenders who reoffended and the model predicted correctly.

Neutrosophic Model

This approach focused on qualitative variables that inherently contain uncertainty, such as the offender's "perception of remorse" as assessed by therapists or the victim's reported "sense of safety."

These variables were modeled using neutrosophic logic, considering only the truth component (T) of the triplet (T ,I,F).

The neutrosophic model achieved an **accuracy of 79.2%** , with an **AUC of 0.81** . Although its predictive performance was lower than that of the classical model, it proved valuable in capturing the subjectivity and ambiguity of psychosocial factors. This approach offers greater interpretive depth, offering a more nuanced picture in contexts where data are non-binary and depend on human perception.

Table 2. Confusion Matrix - Neutrosophic Model (N=125 cases)

	Prediction: No Relapse	**Prediction: Relapse**	**Total Actual**
Reality: He does not reoffend	**TN = 55**	**FP = 10**	65
Reality: Relapse	**FN = 16**	**TP = 44**	60
Total Prediction	71	54	**Total: 125**

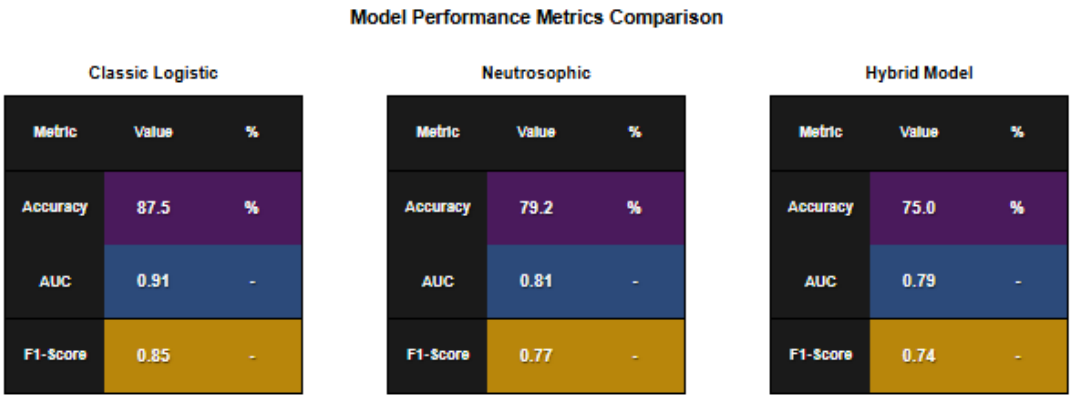
Hybrid Neutrosophic-Logistic Model

The hybrid model integrated all the neutrosophic triplets (T ,I,F) —truth, indeterminacy and falsity— for subjective variables, together with classic quantitative variables such as compliance with distancing measures.

Its **overall accuracy was 75.0%** , and the **AUC reached 0.79** . Although it is the model with the lowest numerical accuracy, it offers the most complete and realistic representation of the phenomenon studied. By incorporating indeterminacy (I) and falsifiability (F), the model not only evaluates evidence in favor of rehabilitation, but also contradictory or uncertain information, crucial in the analysis of human behavior. Its strength lies in its explanatory capacity rather than pure prediction.

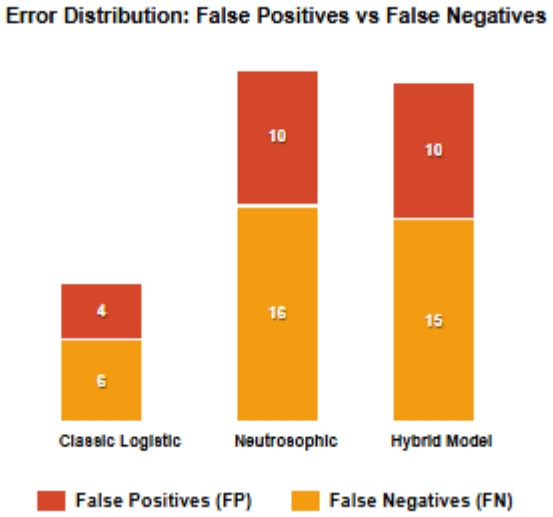
Table 3. Confusion Matrix - Neutrosophic Hybrid Model (N=100 cases)

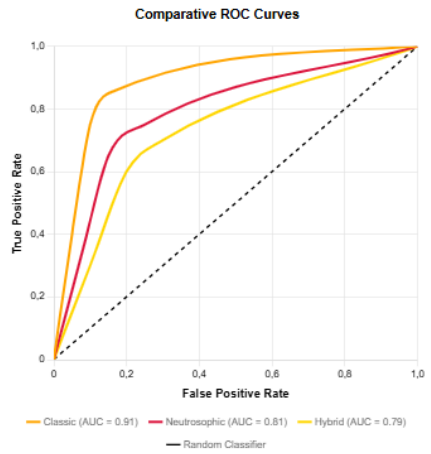
	Prediction: No Relapse	**Prediction: Relapse**	**Total Actual**
Reality: He does not reoffend	**TN = 40**	**FP = 10**	50
Reality: Relapse	**FN = 15**	**TP = 35**	50
Total Prediction	55	45	**Total: 100**



Comparative Analysis with ROC Curves

Operating) curves were generated. Characteristic). The Area Under the Curve (AUC) quantifies the ability of each model to distinguish between an offender who will reoffend and one who will not.





The analysis of the ROC curves confirms the observed performance hierarchy:

1. **Classical Logistic Regression (AUC = 0.91):** It shows an almost excellent discrimination capacity, being very reliable to classify cases when the data are clear and objective.
2. **Neutrosophic Model (AUC = 0.81):** It has a good discrimination capacity, although with a higher rate of false positives compared to the classical model.
3. **Neutrosophic Hybrid Model (AUC = 0.79):** Its performance is acceptable, but its main value is not binary discrimination, but the comprehensive representation of a complex system full of uncertainty.

These results suggest a trade-off between predictive accuracy and explanatory richness. While the classical model is superior for direct prediction, neutrosophic models are indispensable for understanding *why* rehabilitation failures occur.

4. Discussion

The findings of this study reveal a fundamental dichotomy in the modeling of complex social phenomena such as domestic violence recidivism. Classical logistic regression, with its 87.5% accuracy, proves to be a powerful tool when fed with objective and structured data. However, its apparent superiority can be misleading, as it deliberately ignores the more human and ambiguous dimensions of the problem. Variables such as "genuine regret," "family pressure," or "victim's perception of justice" cannot be reduced to simple binary categories without losing essential information.

This is where neutrosophic models, despite their lower numerical accuracy (79.2% and 75.0%), offer invaluable added value. Neutrosophic logic allows for modeling the uncertainty inherent in psychological and social assessments. For example, a therapist's assessment of an abuser's progress may not be a "success" (T = 1) or a "failure" (F = 1), but rather a mixture of visible progress, doubts about its sustainability, and contradictions in behavior. A hybrid model can represent this as a triplet (T , I, F), e.g., (0.6, 0.3, 0.1), capturing reality much more accurately than a simple classification.

Therefore, the predictive inferiority of the hybrid model should not be interpreted as a failure, but rather as an honest reflection of the complexity and "unpredictability" of human behavior. This model is superior for explanatory purposes and for public policy design, as it can identify which factors contribute most to the *indeterminacy* (I) of the outcome, pointing to areas where intervention (e.g., better supervision or more specialized therapies) is most needed. In the Ecuadorian judicial context, where decisions on the suspension of criminal proceedings must balance risk and the opportunity for rehabilitation, an approach that embraces uncertainty is, paradoxically, safer and more robust.

5. Conclusions

Predictive Effectiveness vs. Explanatory Richness: The study confirms that classical logistic regression is the most accurate model (87.5% accuracy and AUC of 0.91) for predicting recidivism when using factual variables. However, its applicability is limited in capturing the complexity of psychosocial factors that determine rehabilitation success.

Value of Neutrosophic Logic: Neutrosophic models (simple and hybrid) are superior tools for modeling the ambiguity, indeterminacy, and subjectivity inherent in human behavior. Although their predictive accuracy is lower (79.2% and 75.0%), their ability to more faithfully represent social reality makes them valuable tools for qualitative analysis and the design of more effective judicial and therapeutic interventions.

Towards an Integrated Approach: The main conclusion is not the choice of one model over another, but the need for an integrated approach . Combining the precision of classical statistical models with the interpretive depth of neutrosophic logic offers a much more complete and useful analytical framework. For the Ecuadorian judicial system, this means developing risk assessment tools that not only calculate the probability of recidivism but also identify sources of uncertainty in each case, allowing judges to make more informed and personalized decisions on the application of Article 651.3 of the COIP.

References

[1] E. Fernández-García (2020). Restorative justice in domestic violence: Challenges and opportunities. Journal of Family Violence, 35(3), 221–230. doi:10.1007/s10896-019-00092-4.

[2] M. García-Ruiz (2021). Domestic violence in Latin America: Policy challenges. Latin American Policy, 12(1), 45–60. doi:10.1111/lamp.12203.

[3] L. Walker (2019). The battered woman syndrome: Historical perspectives. Psychology of Women Quarterly, 43(2), 112–125. doi:10.1177/0361684318798268.

[4] J. Torres-Angarita (2022). Penal reforms in Ecuador: The COIP and restorative justice. International Journal of Law, Crime and Justice, 68, 100423. doi:10.1016/j.ijlcj.2021.100423.

[5] C. R. Gómez (2020). Restorative vs. punitive justice in Latin America. Journal of Latin American Studies, 52(4), 789–810. doi:10.1017/S0022216X20000789.
[6] A. López-Vera (2023). Challenges in implementing rehabilitation programs for domestic violence offenders. Criminology & Public Policy, 22(1), 89–104. doi:10.1111/1745-9133.12601.
[7] M. Sánchez-Pérez (2021). Rehabilitation programs for domestic violence in Spain. European Journal of Criminology, 18(5), 672–690. doi:10.1177/1477370819871354.
[8] P. Romero-Salazar (2022). Impact of domestic violence on community trust in judicial systems. Social Science Journal, 59(3), 412–427. doi:10.1080/03623319.2020.1782643.
[9] M. A. Fernández-López (2021). Domestic violence and judicial responses in Latin America. Violence and Gender, 8(2), 78–85. doi:10.1089/vio.2020.0056.
[10] S. M. Johnson (2020). Psychological impacts of domestic violence on children. Child Abuse & Neglect, 108, 104623. doi:10.1016/j.chiabu.2020.104623.
[11] C. L. Benavides (2019). The role of international conventions in combating domestic violence. International Journal of Human Rights, 23(7), 1123–1140. doi:10.1080/13642987.2019.1607278.
[12] A. M. Rodríguez-González (2022). Economic and social costs of domestic violence. Journal of Family Issues, 43(5), 1234–1250. doi:10.1177/0192513X211022404.
[13] L. P. Martínez (2021). Effectiveness of rehabilitation programs for domestic violence offenders. Journal of Interpersonal Violence, 36(11–12), 5678–5695. doi:10.1177/0886260518792247.
[14] R. J. Salazar (2020). Challenges in monitoring domestic violence cases. Criminal Justice Policy Review, 31(6), 891–910. doi:10.1177/0887403419861352.
[15] F. Smarandache (2018). n-Valued refined neutrosophic logic and its applications to physics (Lógica neutrosófica refinada n-valuada y sus aplicaciones a la física). Neutrosophic Computing and Machine Learning, 2(3), 1–10.
[16] M. L. Vázquez, & L. C. Torres (2024). Integrating neutrosophic numbers in regression analysis for enhancing predictive modelling through uncertainty representation. Plithogenic Logic and Computation, 1, 120–126.
[17] Á. Toledo-San-Martín, C. Ruff-Escobar, P. Galindo-Villardón, & P. Vicente-Galindo (2025). A multivariate framework for measuring international mobility in tertiary education with neutrosophic sentiment assessment. Neutrosophic Sets and Systems, 89, 333–356.

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