

EXAMINATION OF THE OBSTACLES IN ACHIEVING EFFECTIVE INTERNAL CONTROL WITHIN THE CONTEXT OF STATE GOVERNANCE: PERSPECTIVES THROUGH NEUTROSOPHIC SOFT SETS.

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ABSTRACT:

Under constitutional precepts and provisions, state governance stands as the main driver of policies aimed at addressing social needs. However, there is a lack of effective supervision of companies involved in illicit activities, which represents a threat to citizens. The purpose of this research is to examine the aspects related to state governance and its impact on the implementation of internal control, using soft neutrosophic sets, with special attention to the criminal liability of legal entities in Ecuador. The methodology used follows a qualitative approach based on a bibliographic review that includes the compilation of academic articles and the consultation of the Constitution of the Republic of Ecuador. The results reveal that in the context of governance in Ecuador, business management, both public and private, continues to be affected by acts of corruption due to the lack of clarity on the rights of citizens regarding the criminal responsibility of companies that commit crimes against society. In this sense, it is suggested that the strengthening of internal state control may be essential to guarantee the protection of citizen rights and satisfy social demands.

KEYWORDS: Soft Neutrosophic Sets, Internal Control, Governance, Constitutional Regulations

MSC: 03E72, 91B32, 90B50, 93B85, 62P25

RESUMEN

En virtud de preceptos y disposiciones constitucionales, la gobernanza estatal se erige como el principal impulsor de políticas dirigidas a atender necesidades sociales. Sin embargo, existe una falta de supervisión efectiva sobre las empresas involucradas en actividades ilícitas, lo que representa una amenaza para los ciudadanos. El propósito de esta investigación es examinar los aspectos relacionados con la gobernanza estatal y su impacto en la implementación del control interno, utilizando conjuntos neutrosóficos suaves, prestando especial atención a la responsabilidad penal de las personas jurídicas en Ecuador. La metodología empleada sigue un enfoque cualitativo basado en una revisión bibliográfica que incluye la recopilación de artículos académicos y la consulta de la Constitución de la República del Ecuador. Los resultados revelan que, en el contexto de la gobernanza en Ecuador, la gestión empresarial, tanto pública como privada, sigue viéndose afectada por actos de corrupción debido a la falta de claridad en los derechos de los ciudadanos respecto a la responsabilidad penal de las empresas que cometen delitos contra la sociedad. En este sentido, se sugiere que el fortalecimiento del control interno estatal puede ser esencial para garantizar la protección de los derechos ciudadanos y satisfacer las demandas sociales.

PALABRAS CLAVE: Conjuntos Neutrosóficos Suaves, Control Interno, Gobernanza, Regulaciones Constitucionales.

1. INTRODUCTION

In the intricate framework of state governance, achieving effective internal control stands as a pivotal challenge. Internal control mechanisms, designed to ensure transparency, accountability, and operational efficiency, are integral to the success of governance systems. Yet, the complexities and uncertainties inherent in state-level administration often render these mechanisms ineffective. This study delves into the examination of obstacles impeding effective internal control within state governance, adopting a novel perspective through neutrosophic soft sets. The neutrosophic approach, which excels in managing indeterminacy and ambiguity, provides a unique lens to address the multifaceted nature of these obstacles [1]. Historically, the evolution of internal control systems has been shaped by global efforts to combat corruption, enhance public sector efficiency, and ensure adherence to legal and ethical standards. The foundation of modern internal control frameworks can be traced back to the Committee of Sponsoring Organizations of the Treadway Commission (COSO), which established a structured approach for evaluating control effectiveness [2]. However, despite decades of refinement, state governance continues to grapple with issues such as resource misallocation, lack of transparency, and systemic inefficiencies. Recent technological advancements, including data analytics and artificial intelligence, have introduced new tools for control monitoring, yet their implementation often falls short due to institutional resistance and a lack of contextual adaptability [3,14].

The central problem addressed in this study revolves around the persistent obstacles that undermine the effectiveness of internal control systems in state governance. These obstacles range from structural limitations, such as bureaucratic inefficiencies, to subjective factors like conflicting stakeholder interests and inadequate

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accountability frameworks. The critical question emerges: how can state governance systems overcome these barriers to achieve effective internal control, particularly in contexts characterized by high levels of uncertainty and dynamic complexity? Addressing this question requires a multidimensional approach that integrates technical, organizational, and perceptual perspectives. The neutrosophic soft set framework offers a promising solution by enabling the analysis of these challenges through a model that accounts for indeterminacy, vagueness, and subjective variability [4]. Unlike traditional methods, this approach allows for the integration of conflicting or incomplete data, providing a more comprehensive understanding of the barriers to effective internal control. By leveraging the flexibility of neutrosophic logic, this study aims to bridge the gap between theoretical models and practical applications, fostering a deeper comprehension of the underlying dynamics within governance systems [7,15,17]. The objectives of this study are twofold. First, it seeks to identify and prioritize the primary obstacles that hinder effective internal control in state governance. Second, it aims to propose a methodological framework, grounded in neutrosophic soft sets, that facilitates the development of adaptive strategies for overcoming these challenges. The outcomes of this research are expected to contribute to the enhancement of governance systems by providing actionable insights and innovative tools for decision-making in uncertain environments [8,16,18]. The subsequent sections of this article outline the theoretical foundation of the study, including an in-depth exploration of neutrosophic soft set theory and its applicability to governance contexts. The methodological approach is then detailed, followed by a presentation of the findings and their implications. By situating the research within the broader discourse on governance and control, this study aims to advance the field and inspire further investigations into the application of neutrosophic models in complex organizational systems.

This research underscores the urgency of addressing the systemic challenges faced by state governance in achieving effective internal control. By examining these obstacles through the lens of neutrosophic soft sets, the study not only offers a novel analytical framework but also seeks to foster a paradigm shift in how internal control systems are designed, evaluated, and implemented. Ultimately, the findings aim to empower policymakers and administrators to navigate the complexities of governance with greater clarity and confidence.

2. PRELIMINARIES

2.1. Neutrosophic soft sets:

Consider a set U , representing a universe of scenarios, and H as a non-empty subset of U , with $P(H)$ as the power set of H . Let A be an attribute, and A be a set of values for this attribute.

A function $F: A \rightarrow P(H)$ is termed an indeterminate or smooth function if any of the following conditions are met:

- Set A exhibits some degree of uncertainty.
- $P(H)$ exhibits some degree of uncertainty.
- There exists at least one attribute value v in A such that $F(v) = \text{indeterminatae (unclear, uncertain, or not unique)}$.
- Any combination of two or all three of the above situations occurs.

The neutrosophic soft set is defined as a soft set in which maybe (indeterminate, etc.), is approximately equivalent to $F(\text{yes})$, $F(\text{not})$, $F(\text{true})$, or $F(\text{false})$, associated with a triad of values (α, β, γ) , where (α, β, γ) belongs to the interval $[0,1]^3$ representing the degrees of truth, indeterminacy, and falsity, respectively [10,16].

Based on the preceding analysis, we can characterize the following neutrosophic trinomial:

- Classical Function: This function is fully defined (internally defined) for all elements in its domain, or $(T, I, F) = (1, 0, 0)$.

- Neutrofunction (or neutrosophic function): It is a function that is partially defined (with a degree of truth T), partially indeterminate (with a degree of indeterminacy I), and partially externally defined (with a degree of falsity F) in its domain, where (T, I, F) belongs to the set $\{(1,0,0), (0,0,1)\}$.

In the mathematical context described in Definition 1, we are discussing a scenario where U represents a universe of potential scenarios, while H is a specific subset within that universe. This subset H is non-empty and has an associated power set $P(H)$. Additionally, we consider an attribute with its respective set of values, denoted as A . In this context, the pair (F, H) , where $F: A \rightarrow P(H)$, is referred to as a classical soft set over H .

Definition 1: If the function $F: A \rightarrow P(H)$, where for each $x \in A$, $f(x)$ in $P(H)$ and $f(x)$ is true and unique, it is called a Determined Function (classical).

3. METHODOLOGY

This chapter outlines the methodologies employed to collect, analyze, and validate the information necessary to address the research problem from a rigorously scientific and mathematical perspective. The selection and engagement of experts, the implementation of structured interviews, and systematic observation form the foundational pillars of a robust analytical framework. Each method has been meticulously designed to ensure the objectivity and validity of the results, integrating mathematical reasoning with critical analysis. Through these approaches, the chapter aims to unravel the complexities of the phenomenon under study and generate conclusions that not only answer the posed questions but also contribute to advancing knowledge within the field of mathematical sciences.



Figure 1. Methodological Framework

Interviews: A series of meticulously planned interviews will be conducted with carefully selected experts, who will play a pivotal role in the exploration of the subject matter. These interviews, designed with precision and rigor, aim to uncover the complexities of the problem under investigation. The ultimate goal is to derive well-founded conclusions that serve as a guiding framework for advancing knowledge in this field.

Observation: Observation will serve as a systematic and discerning tool, allowing for the detailed exploration of the environment in which the phenomenon under study unfolds. Acting as an objective observer, this method seeks to identify patterns, behaviors, and nuances within the context, unveiling critical insights that contribute to a deeper mathematical understanding of the dynamics at play.

Selection of Experts: The selection process for experts will be carried out with meticulous care, employing a rigorous methodology to identify individuals with substantial expertise. A competency validation survey will be utilized, where candidates self-assess their proficiency using a structured scale that transcends numerical evaluation. A mathematical model will then be applied to quantify each expert's rating factor, ensuring an objective balance between subjective expertise and quantitative rigor. This process will ensure that the selected panel of experts represents the highest standards of knowledge and competence [9].

The "Expert Competence Coefficient" is calculated based on the opinion expressed by the expert on his level of knowledge about the research problem, as well as the sources that allow him to support the established criterion. The coefficient is obtained by applying the following formula:

$$K = \frac{(K_c + K_a)}{2} \quad (1)$$

K_c is the «Knowledge coefficient» or information that the expert has about the topic or problem raised. It is calculated from the assessment made by the expert himself on a scale of 0 to 10, multiplied by 0.1.

K_a is the so-called «Argumentation coefficient» or foundation of the experts' criteria. This coefficient is obtained from the assignment of a series of scores to the different sources of argumentation that the expert has been able to put forward.

With the final values obtained, the experts are classified into three large groups:

- If K is greater than 0.8, greater than or less than or equal to 1, then there is a high influence from all sources.
- If K is greater than or equal to 0.7, greater than or less than or equal to 0.8, then there is a medium

influence from all sources.

- If K is greater than or equal to 0.5, greater than or less than or equal to 0.7, then there is a low influence from all sources.

It is also important to mention that experts with values lower than 0.8 are not considered in the study and are therefore rejected.

2.3 Neutrosophic Soft Set-Based Evaluation Model for Legal Statements

The model based on Neutrosophic Soft Sets begins with a collection of statements or propositions denoted by $A = \{a, a_2, \dots, a_k\}$, which are to be assessed by specialists from the selected expert group $E = \{e_1, e_2, \dots, e_l\}$. Each statement's veracity and relevance in the legal context are evaluated using a binary parameter set $C = \{\text{Yes}, \text{No}\}$, where "Yes" signifies the expert's affirmation of the statement's positivity, while "No" indicates the opposite stance.

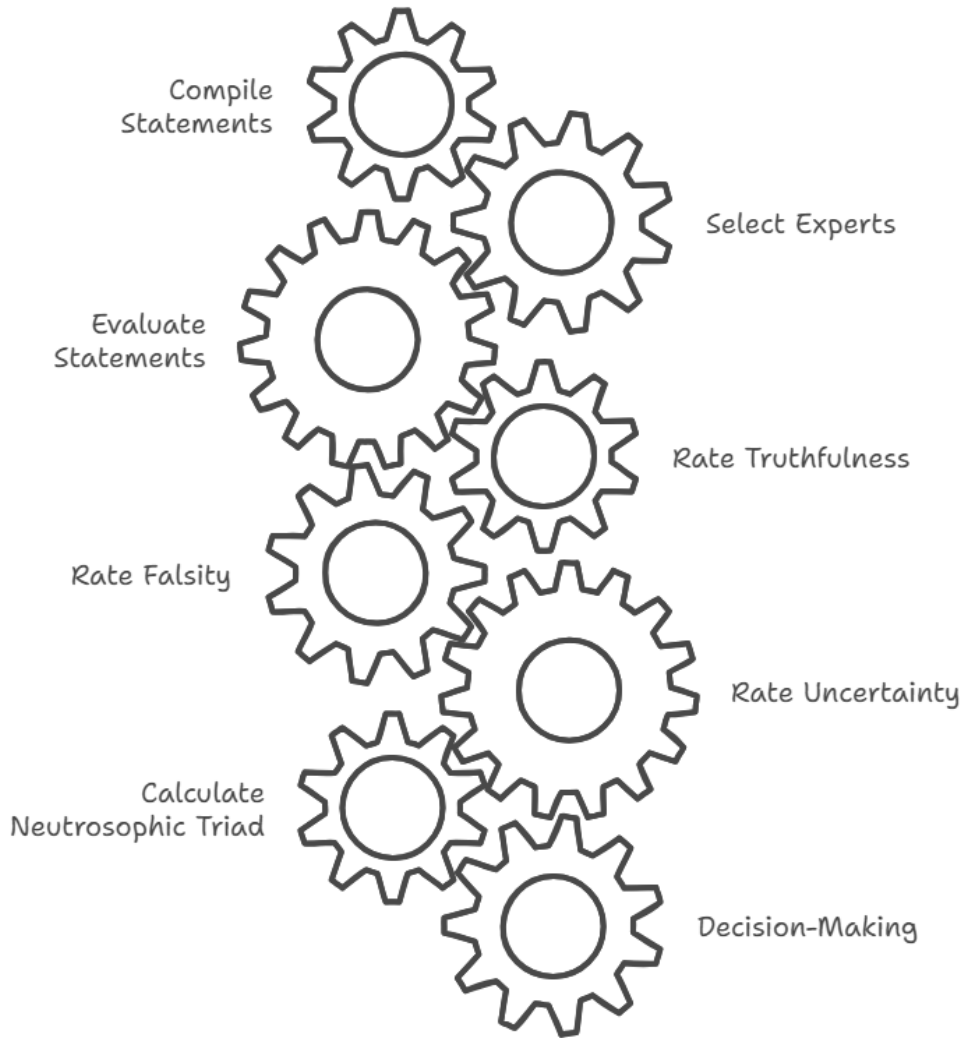


Figure 2. Neutrosophic Soft Set Framework for Decision-Making

The outlined procedure unfolds as follows:

1. Compile a set of statements to evaluate their veracity and relevance in the legal context, denoted by A , $A = \{a, a_2, \dots, a_k\}$.
2. Convene a group of experts or specialists to provide their assessments regarding the veracity or relevance of the described statements. This group is denoted as $E = \{e_1, e_2, \dots, e_l\}$
3. Each expert e_j is tasked with delivering their judgment on the statement a_i concerning its veracity and relevance.

4. Experts are requested to rate the truthfulness and relevance of the statement on a scale from 0 to 100, denoted as α_{ij}
 5. Experts are also asked to evaluate the falsity and irrelevance of the statement on the same scale, represented as γ_{ij} .
 6. Furthermore, experts are requested to assess the uncertainty and irrelevance of the situation on the same scale, denoted as β_{ij} .
 7. Consequently, a triad $R_{ij} = \langle \alpha_{ij}/100, \beta_{ij}/100, \gamma_{ij}/100 \rangle$ is obtained. This triad represents the truth values between 0 and 1, evaluating the degrees of truthfulness, indeterminacy, and falsity, respectively, of the relevance of the i -th statement according to the j -th expert.
- The Soft Set is then formed by $F: A \rightarrow P(H)$, where $P(H) = \{Yes, No\}$. Two sets of results, $F(Yes)$ and $F(No)$ are considered for tests or evidence. The final results are derived from two different sets, $G(Yes)$ and $G(No)$, [11]. The evaluation process ensures an objective ranking of statements based on their relevance and truthfulness, providing a robust foundation for informed decision-making.

4. RESULTS

To discern the primary obstacles concerning adherence to the legal framework underpinning governance policies in Ecuador and its ramifications on internal control, a series of interviews were conducted involving 25 governmental officials. To ensure the integrity of the research, a panel of 5 subject matter experts was assembled, each boasting K scores ranging from 8 to 10, indicative of their extensive expertise and experience in the field.

A structured interview guide was devised, encompassing a spectrum of assertions about internal control, for appraisal by the experts on a 0 to 100 scale concerning veracity, indeterminacy, and falsehood. These assertions delved into matters such as the imperative of securing internal control within entities and corporations, the adequacy of extant legal frameworks, the obligations incumbent upon officials and executives, and the allotment of resources to auditing systems.

The experts denoted as e_1, e_2, e_3, e_4 , and e_5 , tendered their assessments regarding these assertions, affording a more expansive and nuanced perspective on the perceptions of these issues by seasoned practitioners. This iterative process was conducted on two separate occasions to scrutinize the authenticity and significance of the assertions at distinct junctures.

Table 1 presents the derived values, offering a solid basis for understanding the challenges and areas requiring improvement in internal control within the framework of state governance in Ecuador. By integrating insights from government officials and experts, a holistic perspective of the situation is achieved, aiding in the identification of potential corrective measures or enhancements to current policies and practices.

Expert/Assertion	c_1	c_2	c_3	c_4
b_1	$\langle 64, 15, 21 \rangle$	$\langle 89, 10, 10 \rangle$	$\langle 35, 10, 60 \rangle$	$\langle 56, 10, 13 \rangle$
b_2	$\langle 76, 10, 20 \rangle$	$\langle 58, 20, 30 \rangle$	$\langle 38, 0, 52 \rangle$	$\langle 72, 8, 20 \rangle$
b_3	$\langle 85, 0, 20 \rangle$	$\langle 79, 0, 20 \rangle$	$\langle 36, 0, 45 \rangle$	$\langle 82, 12, 15 \rangle$
b_4	$\langle 68, 4, 18 \rangle$	$\langle 72, 15, 18 \rangle$	$\langle 45, 0, 58 \rangle$	$\langle 54, 15, 22 \rangle$
b_5	$\langle 81, 8, 16 \rangle$	$\langle 90, 12, 26 \rangle$	$\langle 42, 0, 36 \rangle$	$\langle 57, 9, 18 \rangle$

Table 1: Displays the outcome of the assessment regarding the accuracy of the statement as determined by the experts chosen for the study.

The previous results are divided by 100 to bring them to a scale $[0, 1]$ which is more common in neutrosophic theories.

Expert/Assertion	c_1	c_2	c_3	c_4
b_1	$\langle 0.64, 0.15, 0.21 \rangle$	$\langle 0.89, 0.1, 0.1 \rangle$	$\langle 0.35, 0.1, 0.6 \rangle$	$\langle 0.56, 0.1, 0.13 \rangle$
b_2	$\langle 0.76, 0.1, 0.2 \rangle$	$\langle 0.58, 0.2, 0.3 \rangle$	$\langle 0.38, 0, 0.52 \rangle$	$\langle 0.72, 0.08, 0.2 \rangle$
b_3	$\langle 0.85, 0, 0.2 \rangle$	$\langle 0.79, 0, 0.2 \rangle$	$\langle 0.36, 0, 0.45 \rangle$	$\langle 0.82, 0.12, 0.15 \rangle$
b_4	$\langle 0.68, 0.04, 0.18 \rangle$	$\langle 0.72, 0.2, 0.18 \rangle$	$\langle 0.45, 0, 0.58 \rangle$	$\langle 0.54, 0.15, 0.22 \rangle$
b_5	$\langle 0.81, 0.08, 0.16 \rangle$	$\langle 0.9, 0.1, 0.26 \rangle$	$\langle 0.42, 0, 0.36 \rangle$	$\langle 0.57, 0.09, 0.18 \rangle$

Table 2: Outcome of experts' assessment regarding the truthfulness of the statement, presented using neutrosophic numbers.

Upon examining the results derived from the assessment, it is evident that statements a_1 , a_2 , and a_4 have been affirmed as true by the consulted experts, whereas statement a_3 has not received such validation. Consequently, it is imperative to analyze the significance of the three statements recognized as true by the experts. This decision is supported by the comparison of the average relevance values, where $V_1 = 0.8$ is greater than F_1 and $V_2 = 0.7$ is greater than F_2 , and $V_4 = 0.7$ is greater than F_4 . Thus, it is deduced that statements a_1 , a_2 , and a_4 hold considerable importance based on their truth values and relevance assessments, indicating their pertinence in the legal context.

under scrutiny.

1. The need to guarantee internal control to entities and companies: This statement has the support of experts, which indicates a clear and urgent demand to establish effective internal control mechanisms in organizations. This aspect is crucial to ensure transparency, efficiency and responsibility in the management of resources and processes, both in the public and private spheres. The relevance of this statement lies in its strategic importance in strengthening internal control as a fundamental part of the governance and proper functioning of entities.

2. The insufficiency of the legal framework to guarantee internal control, following international standards and the national Constitution: The confirmation of this statement highlights the need to review and improve the legal framework related to internal control in the country. The lack of alignment with international standards and constitutional principles indicates a deficiency that could compromise the effectiveness of internal control. Therefore, the relevance of this statement lies in the urgency of carrying out legal reforms to strengthen the regulatory framework and guarantee internal control following international standards.

3. The limited allocation of resources to audit systems to strengthen internal control: This statement highlights the need to allocate adequate resources to audit systems as a measure to strengthen internal control. Although experts have validated this statement, its relevance lies in pointing out the importance of guaranteeing sufficient resources to carry out effective audits that allow detection and address possible deficiencies in internal control systems. This is essential to mitigate risks and promote integrity and efficiency in organizational management.

In summary, the three statements validated as true by the experts are relevant due to their impact on the effectiveness and integrity of internal control systems in the context of state governance in Ecuador. Its detailed analysis provides a solid basis to identify areas of improvement and take necessary corrective measures to strengthen internal control and promote efficient and transparent management in the country's organizations.

Expert	a_1	a_2	a_4
e_1	$\langle 86,11,12 \rangle$	$\langle 51,13,15 \rangle$	$\langle 67,24,16 \rangle$
e_2	$\langle 71,10,20 \rangle$	$\langle 63,11,17 \rangle$	$\langle 78,10,19 \rangle$
e_3	$\langle 86,6,18 \rangle$	$\langle 68,15,10 \rangle$	$\langle 73,3,15 \rangle$
e_4	$\langle 84,10,16 \rangle$	$\langle 51,12,16 \rangle$	$\langle 73,21,21 \rangle$

Table 3: Result of the evaluation of the relevance of the statements according to the experts.

The previous results are divided by 100 to bring them to a scale [0, 1] which is more common in neutrosophic theories.

Expert/Assertion	a_1	a_2	a_4
e_1	$\langle 0.86,0.11,0.12 \rangle$	$\langle 0.51,0.13,0.15 \rangle$	$\langle 0.67,0.24,0.16 \rangle$
e_2	$\langle 0.71,0.10,0.20 \rangle$	$\langle 0.63,0.11,0.17 \rangle$	$\langle 0.78,0.10,0.19 \rangle$
e_3	$\langle 0.86,0.06,0.18 \rangle$	$\langle 0.68,0.15,0.10 \rangle$	$\langle 0.73,0.03,0.15 \rangle$
e_4	$\langle 0.84,0.10,0.16 \rangle$	$\langle 0.51,0.12,0.16 \rangle$	$\langle 0.73,0.23,0.21 \rangle$
e_5	$\langle 0.73,0.09,0.20 \rangle$	$\langle 0.52,0.21,0.23 \rangle$	$\langle 0.66,0.15,0.21 \rangle$

Table 4: Result of experts' assessments

After careful examination and analysis, it is apparent that statements a_1 , a_2 , and a_3 have been deemed relevant by the experts, supported by their respective truth values. Specifically, statement a_1 holds a truth value of 0.72, indicating its significant relevance in the context under consideration. Similarly, statement a_2 is also regarded as relevant, with a truth value of 0.55, slightly less compared to a_1 . Furthermore, statement a_3 , despite its lower truth value of 0.16, still carries relevance according to the experts' evaluations. It is imperative to consider these findings seriously, as they provide valuable insights into the importance and pertinence of each statement within the legal framework being examined. Therefore, these conclusions serve as a foundation for prioritizing actions and addressing key issues to ensure effective governance and compliance with legal standards. The determination has been reached following a comparative assessment of the mean relevance scores attributed to each statement. Specifically, it is noted that the mean relevance scores for the statements are as follows: $V_1=0.80$, $V_2=0.69$, and $V_3=0.76$, while the mean irrelevance values are $F_1=0.45$, $F_2=0.49$, and $F_3=0.41$.

From the findings, it can be inferred that all statements are significant, given that the mean relevance scores surpass the mean irrelevance values for each. Moreover, a hierarchy of statement relevance is delineated as follows: a_1 emerges as the most pertinent statement, succeeded by a_3 , trailed by a_2 .

Henceforth, the hierarchy of statement relevance is delineated as follows:

1. a_1 : Ensuring internal control within entities and companies is imperative.
2. a_3 : Inadequate allocation of resources to audit systems to fortify internal control.
3. a_2 : Shortcomings in the legal framework supporting internal control, aligned with international declarations and domestic legislation.

This sequence is predicated on the extent of significance attributed to each statement by the consulted experts, furnishing a lucid roadmap to pinpoint the paramount areas and priorities concerning adherence to the legal framework and fortification of internal control within the governmental domain of Ecuador.

4. CONCLUSIONS

The findings of this study highlight the critical relevance of internal control mechanisms in the field of governance, as underlined by expert evaluations of statements A1, A2, and A3. Declaration A1, with a truth value of 0.72, emerged as the most significant, reflecting the urgent need to prioritize internal control within entities and companies. Declaration A3, although slightly lower with 0.16, indicates the insufficient allocation of resources to audit systems, a challenge that weakens the effectiveness of internal control. For its part, Declaration A2, with a truth value of 0.55, highlights the deficiencies in the legal framework that hinder its alignment with international standards and national legislation. Together, these results provide a structured basis to understand and address the main challenges in governance. From a practical perspective, the study emphasizes actionable ideas that can directly impact the design and implementation of solid internal control systems. When delineating a clear hierarchy of priorities, those responsible for decision-making have a road map to address critical areas such as the allocation of resources and the strengthening of the legal framework. These findings offer a valuable guide to improve compliance, transparency, and government efficiency in contexts such as the public sector of Ecuador. An outstanding contribution of this study is the application of neutral methods to evaluate the relevance of governance challenges under conditions of uncertainty and complexity. This innovative approach integrates mathematical rigor with practical utility, advancing theoretical understanding while offering pragmatic tools for prioritization. The hierarchy established through expert evaluations is a testimony of the usefulness of neutrosophical analysis to address multifaceted problems within the legal and administrative landscape.

However, it is important to recognize certain limitations inherent to the study. The dependence on expert judgments introduces a degree of subjectivity that, although mitigated by methodological rigor, can affect the generalization of the results. In addition, the specific nature of the context of the findings - based on the framework of governance of Ecuador - can limit its applicability to other environments without additional adaptations. Future research should focus on expanding these findings by incorporating alternative methodologies, such as Fuzzy analysis or automatic learning algorithms, to validate and improve the ideas presented. In addition, extending the study to a broader range of contexts and populations could improve the generalization of the results. It is necessary to explore more thoroughly the interaction between the legal frameworks, the allocation of resources and the internal control systems to build a more comprehensive understanding of the governance challenges. In summary, this study not only sheds light on urgent issues related to internal control mechanisms but also provides a methodological scheme to address them. By connecting mathematical theory with government practice, research offers a significant contribution to continuous efforts to strengthen institutional frameworks and guarantee compliance with legal standards.

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