An Intelligent Fusion Framework for Risk Assessment of Notarial Activities in the Digital Era: Balancing Speed and Legal Security with ICT

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Abstract

The integration of Information and Communication Technologies (ICT) into notarial activities has revolutionized the way procedures are processed by significantly enhancing speed and legal security, which are key aspects for user satisfaction. This shift responds to the growing demand for fast and secure notarial services, where efficiency and legal protection are priorities. Through the analysis conducted with the neutrosophic RAFSI method, risks derived from digitalization have been identified and classified, proposing effective solutions for their mitigation. Among these, the need to update regulations to adapt them to the digital context and the importance of training notaries in digital competencies and cyber security stand out. These measures are focused not only on streamlining notarial procedures but also on reinforcing trust in notarial services, marking a significant advance toward the modernization of notarial practice in the digital era. In conclusion, the fusion of ICT with notarial activities, supported by risk control and supervision, has effectively balanced service speed with legal security, meeting the current expectations of users.

Keywords: notarial activity; speed; legal security; technology; principle.

1. Introduction

The technological evolution, particularly in the field of Information and Communication Technologies (ICT), has profoundly transformed society and the way organizations manage their resources, driving significant changes towards digitalization in sectors such as notarization [1]. This technological advancement has generated both opportunities and challenges in terms of legal security, information integrity, and confidentiality, critical aspects in a notarial activity that demand regulatory and legislative adaptation to support the validity of digital processes [2]. Moreover, the implementation of ICT in notarization has not only improved operational efficiency but also required a careful approach to risk management, especially in the protection of personal data and information security [3] [4].

Adapting to new technological tools has allowed notarial entities to improve the speed and quality of their services while facing the ethical and regulatory challenges these technologies present [5] [6]. In

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this context, legal security in digital notarial processes has become a fundamental concern, requiring a solid legal framework that guarantees the integrity, authenticity, and non-repudiation of notarial documents in cyberspace [7].

The need for regulatory and legislative updates to support the legality of digital notarial processes is imperative to ensure a legal environment adapted to the demands of the digital age. This includes reviewing and adapting traditional notarial principles, such as publicity and document preservation, to their new digital dimension to enhance document security. Moreover, it is essential to ensure strict compliance with notarial principles to provide certainty in legal relationships and social tranquility. Thus, adapting these principles to the modernization of the documentary system and its digital transformation, which underscores the importance of legal security as an essential normative value in constitutional democracy and efficient public administration [8] [9]. Therefore, the research aims to analyze the influence of ICT in notarial activities in terms of speed, legal security, and risk assessment and management in notarial activities. The specific objectives include:

- Assess the importance of the principle of speed and legal security in notarial processes.
- Analyze the influence of ICT on notarial activity in terms of the principles of speed and legal security.
- Identify and evaluate the risks in notarial activities and propose measures to mitigate or minimize the impact on legal security.

2. Functional Mapping of Criteria for Sub-intervals in a Single Interval (RAFSI). Neutrosophic Extension.

The Functional Mapping of Criteria for Sub-intervals of a Single Interval (RAFSI) method is a technique that allows for the classification and evaluation of risks, based on a set of predetermined criteria. This methodology can be applied to quantify legal security risks in notarial activities by assigning to each risk a position within a unique neutrosophic interval, as it consolidates how it aligns with each criterion.

The method of Ranking Alternatives through Functional Mapping of Criteria for Sub-intervals in a Single Interval (RAFSI) is an innovative technique in the field of Multi-Criteria Decision Making (MCDM) [10]. It is designed to solve the problem of rank reversal, where the order of preference for alternatives may change by adding new alternatives to the system or removing an existing one. This method is distinguished by its unique approach to data normalization and its specific mathematical formulation that directly addresses the problem of rank reversal, a significant challenge in existing MCDM methods [11].

For this study, an extension to the RAFSI method is carried out, where it converts multiple criteria with different units or scales into a common neutrosophic single interval. This facilitates direct comparison and ranking of alternatives within the neutrosophic set. This process is done through the functional mapping of sub-interval criteria into a single neutrosophic interval, allowing for a more coherent and fair evaluation of the alternatives. Therefore, it is defined as the neutrosophic RAFSI method or neutrosophic extension [12].

The neutrosophic RAFSI method involves the application of specific formulas, primarily during data normalization and the calculation of global scores for each alternative. Although the exact details of the formulas may vary depending on the specific implementation of the method, the following steps are generally followed, with key formulas applied at each stage:

Step 1: Construction of the initial decision matrix as established by equation (1)

$$\mathrm{x} = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & \mathrm{x_{mn}} \end{bmatrix} \quad (1)$$

Given that, in constructing the matrix within the neutrosophic set, it must be determined that X_{mn} represents a neutrosophic number defined for the study, determined as $X = (v, i, f)$, where $v, i, f \in$

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$\{0,1\}$ and satisfy the following condition: $0 \leq v + i + f \leq 3$. This is as established in the neutrosophic methodology [13] [14].

Step 2: Data Normalization:
Normalization is carried out to transform the various criteria, which may have different units and scales, into a common neutrosophic interval. This allows for direct comparison between criteria, alternatives, factors, and risks (see Tables 1 and 2).

Table 1: Linguistic terms to represent the neutrosophic importance weight of the criteria.

Linguistic scale	**SVNN**
Very Very Important (MMI)	(0.93,0.15,0.15)
Very Important (MI)	(0.73,0.3,0.25)
Important (I)	(0.5,0.55,0.45)
Least Important (NI)	(0.2,0.75,0.75)
Very Not Important (MNI)	(0.05,0.9,0.95)

Table 2: Linguistic terms used to determine and evaluate the proposed risks and their neutrosophic equivalence.

Criterion	**SVNN**	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**
Extremely	(1,0,0)	High	Frequent	High	High	Greater	High
Very very	(0.96,0.1,0.11)						
Very good	(0.86,0.2,0.21)						
Good	(0.76,0.3,0.31)						
Moderately	(0.66,0.4,0.41)						
	(0.56,0.5,0.51)	Medium	Occasional	Moderate	Medium	Moderate	Medium
Moderately	(0.46,0.6,0.61)	Low	Rare	Low	Low	Lesser	Low
Slightly	(0.36,0.7,0.72)						
Very	(0.26,0.8,0.81)						
Very very	(0.16,0.9,0.91)						
Extremely	(0.06,1,1)						

Once the criteria are defined, they are classified to determine the normalization formula to be used. For benefit criteria (where the higher value is better), the following formula is proposed:

$$n_{ij} = \frac{(x_{ij} - \min(x_{.j}))}{(\max(x_{.j}) - \min(x_{.j}))} \quad (2)$$

Whereas for cost criteria (where the lower value is better), the following formula is used:

$$n_{ij} = \frac{(\max(x_{.j}) - x_{ij})}{(\max(x_{.j}) - \min(x_{.j}))} \quad (3)$$

Where:

- n_{ij} is the normalized value of alternative i under criterion j.
- x_{ij} is the original value of alternative i under criterion j.
- $\max(x_{.j})$ is the maximum value of criterion j in all alternatives.
- $\min(x_{.j})$ is the minimum value of criterion j in all alternatives.

Step 3: Calculation of Global Scores

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Once the data are normalized, a global score for each alternative is calculated. This can be done by the weighted sum of the normalized values, applying formula (4):

$$S_i = \sum_{j=1}^{n} w_j \cdot n_{ij} \quad (4)$$

Where S_i is the global score of alternative i and w_j is the weight of criterion j (indicating the relative importance of the criterion), and n_{ij} is the normalized value of alternative i under criterion j.

Step 4: Ranking of Alternatives

In this step, alternatives are ordered based on their global scores S_i, from highest to lowest, to determine the most preferable ones. These formulas are crucial for the neutrosophic RAFSI method, allowing for a fair and coherent comparison between alternatives by taking into account multiple evaluation criteria. The correct application of these formulas ensures that the method effectively addresses the problem of rank reversal, by providing a reliable and consistent ranking of the alternatives or any other element to be measured.

Results.

To synthesize and analyze the results presented in the surveys efficiently, the information is organized into a table that details the findings and their implications in notarial practice. Table 3 condenses how the implementation of Information and Communication Technologies (ICT) has impacted the speed, case processing, staff skills, client satisfaction, and legal security in notarial activities.

Table 3: Findings in Notarial Practice.

No.	Main finding	Implication in notarial practice
1	Planned organization for the survey application.	Demonstrates a rigorous methodological approach in gathering data on the impact of ICT in notaries.
2	Improved speed in service thanks to ICT.	ICT has facilitated faster service to users by optimizing the processing time and resolution of notarial cases.
3	Facilitation in document search and information cross-referencing through ICT.	The use of ICT has simplified processes that were traditionally long and complex, improving efficiency in case handling.
4	Significant advancement in the processing of notarial activities following the application of ICT.	Although the need for more ICT training is recognized, its implementation has significantly improved the management of notarial processes.
5	Varied levels of ICT skills among notaries.	Emphasizes the importance of ICT training to optimize its use in notarial practice.
6	Improved quality of case handling with the use of ICT.	Despite difficulties, some notaries manage to operate efficiently.
7	Reduction in case processing delays over time thanks to ICT.	Clients notice faster and more effective attention in their procedures, suggesting a positive impact of ICT on customer satisfaction.
8	Increased perceived legal security in processes with the use of ICT.	ICT has contributed to a notable decrease in waiting and processing times, increasing the speed of notarial services.

The table summarizes the positive impact of ICT on notarial activities, highlighting improvements in efficiency, time management, legal security, and client satisfaction. Despite the challenges identified in terms of ICT skills among notaries, the overall balance indicates a favorable evolution towards a more modern and efficient notarial practice. However, potential risks that notarial activities may currently face must be envisioned (see Table 4).

Table 4: Risks Identified in Notarial Activities.

No.	Risk Name	Risk Description

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R1	Digitalization errors.	Incorrect conversion of physical documents to digital, potentially causing information loss.
R2	Document forgery.	Manipulation or alteration of documents to compromise their legality.
R3	Unauthorized access.	Potential for unauthorized individuals to access personal or sensitive data.
R4	Software vulnerabilities.	Failures or external attacks on notarial systems compromise data integrity.
R5	Cloud storage risks.	Dependence on external services for data storage increases security risks.
R6	Misuse of electronic signature.	Fraudulent use of electronic signatures that may invalidate notarial documents.
R7	Lack of ICT regulation knowledge.	Lack of training in ICT tools and regulations can lead to errors in legal security.
R8	System incompatibility.	Differences between document management systems can cause problems in document preservation.
R9	Interference in data transmission.	Interception or manipulation of data during its transfer, compromising confidentiality.
R10	Data protection non-compliance.	Improper management of personal data results in violations of data protection laws.
R11	Loss of digital documents.	Irrecoverable loss of documents due to failures in storage or document management systems.
R12	Natural or human disasters.	Loss of notarial documents due to fires, floods, or attacks on facilities.

This table provides an overview of the legal security risks in notarial activities, offering a foundation for the development of suitable mitigation strategies. Therefore, it proceeds to determine the criteria for evaluating the risks and identifying the most significant ones (see Table 5).

Table 5: Evaluation Criteria with Measurement Ranges.

Code	Criterion name	Description of the criterion	Measuring ranges	w
C1	Impact on legal security	Evaluates how risk affects the certainty and reliability of notarial acts and documents.	Low Medium High	**(0.73,0.3,0.25)**
C2	Probability of occurrence	Determines the expected frequency of the risk's occurrence.	Rare Occasional Frequent	**(0.5,0.55,0.45)**
C3	Mitigation cost	Estimates the expenditure required to prevent or mitigate the risk.	Low Moderate High	**(0.05,0.9,0.95)**
C4	Impact on confidentiality	Measures the risk of unauthorized exposure of sensitive information.	Low Medium High	**(0.05,0.9,0.95)**
C5	Effect on institutional image	Considers the effect of the risk on public perception and trust in the notarial institution.	Lesser Moderate Greater	**(0.2,0.75,0.75)**
C6	Legal and compliance requirements	Assesses the risk of non-compliance with applicable regulations and norms.	Low Medium High	**(0.2,0.75,0.75)**

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The linguistic and numerical scale for the measurement ranges allows for an intuitive and detailed assessment of each risk according to the established criteria. The assignment of neutrosophic weights reflects the relative importance of each criterion in the overall risk assessment. A greater emphasis is placed on the impact on legal security and the probability of occurrence, given their critical relevance in the notarial context as indicated by experts.

With the 6 defined criteria and the 12 identified risks, a matrix is proposed as established by the RAFSI method. The construction of the matrix is determined by the measurement ranges and the corresponding neutrosophic linguistic value (see Tables 6 and 7). Subsequently, the global Score S_i of the identified risks is determined (see Figure 1).

Table 6: Initial Decision Matrix.

Risk	C1	C2	C3	C4	C5	C6
	Legal security	**Probability**	**Cost Mitigation**	**Confidentiality**	**Institutional Image**	**Legal compliance**
R1	Medium	Frequent	Moderate	High	Moderate	High
R2	High	Occasional	Low	Medium	Greater	Medium
R3	Low	Rare	High	Low	Lesser	High
R4	Medium	Occasional	Moderate	Medium	Moderate	Medium
R5	High	Frequent	High	High	Greater	High
R6	Low	Occasional	Low	Medium	Moderate	Low
R7	Medium	Rare	Moderate	Low	Greater	Medium
R8	High	Occasional	Low	High	Moderate	High
R9	Low	Frequent	Moderate	Medium	Lesser	Low
R10	Medium	Rare	High	High	Greater	Medium
R11	High	Frequent	Moderate	Medium	Moderate	Low
R12	Low	Occasional	Low	Low	Minor	Medium

Table 7: Neutrosophic Normalized Matrix.

Risk	C1	C2	C3	C4	C5	C6
	Legal security	**Probability**	**Cost Mitigation**	**Confidentiality**	**Institutional Image**	**Legal compliance**
w	**(0.73,0.3,0.25)**	**(0.5,0.55,0.45)**	**(0.05,0.9,0.95)**	**(0.05,0.9,0.95)**	**(0.2,0.75,0.75)**	**(0.2,0.75,0.75)**
R1	(0.06,1,1)	(0.86,0.2,0.21)	(0.06,1,1)	(0.26,0.8,0.81)	(0.86,0.2,0.21)	(0.26,0.8,0.81)
R2	(0.46,0.6,0.61)	(0.76,0.3,0.31)	(0.66,0.4,0.41)	(0.06,1,1)	(0.06,1,1)	(0.46,0.6,0.61)
R3	(0.26,0.8,0.81)	(0.06,1,1)	(0.26,0.8,0.81)	(0.36,0.7,0.72)	(0.56,0.5,0.51)	(0.56,0.5,0.51)
R4	(0.36,0.7,0.72)	(0.46,0.6,0.61)	(0.36,0.7,0.72)	(0.06,1,1)	(0.86,0.2,0.21)	(0.56,0.5,0.51)
R5	(0.46,0.6,0.61)	(0.76,0.3,0.31)	(0.76,0.3,0.31)	(0.76,0.3,0.31)	(0.46,0.6,0.61)	(0.06,1,1)
R6	(0.66,0.4,0.41)	(0.46,0.6,0.61)	(0.06,1,1)	(0.26,0.8,0.81)	(0.76,0.3,0.31)	(0.36,0.7,0.72)
R7	(0.66,0.4,0.41)	(0.56,0.5,0.51)	(0.36,0.7,0.72)	(0.56,0.5,0.51)	(0.86,0.2,0.21)	(0.26,0.8,0.81)
R8	(0.76,0.3,0.31)	(0.36,0.7,0.72)	(0.06,1,1)	(0.06,1,1)	(0.46,0.6,0.61)	(0.46,0.6,0.61)
R9	(0.06,1,1)	(0.46,0.6,0.61)	(0.66,0.4,0.41)	(0.66,0.4,0.41)	(0.76,0.3,0.31)	(0.56,0.5,0.51)
R10	(0.66,0.4,0.41)	(0.36,0.7,0.72)	(0.56,0.5,0.51)	(0.06,1,1)	(0.06,1,1)	(0.56,0.5,0.51)
R11	(0.06,1,1)	(0.46,0.6,0.61)	(0.46,0.6,0.61)	(0.26,0.8,0.81)	(0.76,0.3,0.31)	(0.06,1,1)
R12	(0.46,0.6,0.61)	(0.26,0.8,0.81)	(0.76,0.3,0.31)	(0.56,0.5,0.51)	(0.26,0.8,0.81)	(0.36,0.7,0.72)

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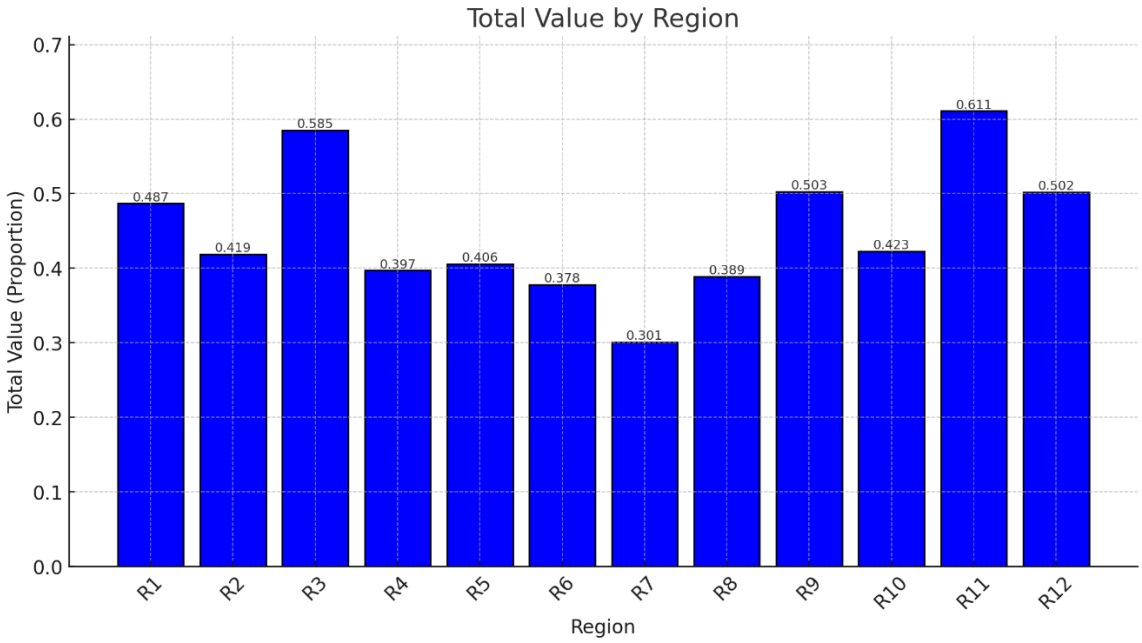

Figure 1: Global Score S_i of the risks.

In Figure 1, it is observed that the risk:

- R11: This risk stands out as the most significant due to its high potential impact on legal compliance. Additionally, it requires considerable investment for its mitigation. It is identified as a priority for risk management.
- R3 and R9 (High in critical criteria): These risks are also significant, especially due to their high impact on legal security (R9) and the probability of occurrence (R3). Both require special attention given their capacity to negatively affect fundamental aspects of notarial activity.

After identifying the most significant risks in the previous neutrosophic linguistic evaluation (R11, R3, and R9), a detailed action plan is proposed to mitigate or minimize them (see Table 8). Each action is specifically directed at the aspects that make these risks considered significant.

Table 8: Action Plan to Mitigate Significant Risks. Source: Own elaboration.

Risk	Action plan	Responsible	Term	Success Indicators
R3	Implementation of a robust authentication and access control system to protect the confidentiality of documents.	IT Department	3 months	90% reduction in incidents of unauthorized access.
	Mandatory training for staff on data protection regulations and secure information handling.	HR Department	2 months	100% of staff trained; assessments with at least 80% approval.
R9	Update and strengthen security policies, including specific protocols for legal compliance.	Legal Department	3 months	Policy updates completed; 100% compliance in external audits.
	Establishment of a monitoring unit for constant review of security standards and legal compliance.	Legal Department	4 months	Monitoring unit established; quarterly reports with no major incidents.
R11	Development and implementation of a comprehensive risk	General Management	6 months	Risk management system established; 50% reduction in incident response time.

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	management system that includes continuous threat assessment.			
	Investment in encryption technologies and data backups to ensure the integrity and availability of information.	IT Department	4 months	Data encryption implemented; daily backups conducted without failures.

This action plan is designed to address both the technical and organizational aspects of the identified risks, involving different departments within the organization and establishing clear and measurable goals. The successful implementation of this plan should result in a significant reduction of the most significant risks and contribute to a safer and more reliable notarial environment.

6. Conclusion

The integration of Information and Communication Technologies (ICT) in notarial activities has revolutionized case processing, optimizing both efficiency and legal security in the service offered. The adoption of ICT has significantly accelerated notarial procedures, responding more quickly and effectively to user needs, which has increased their overall satisfaction.

The implementation of specific regulations and adherence to digital security standards have been fundamental in ensuring the protection of information and the integrity of legal processes. The application of the RAFSI method has enabled a detailed assessment of the risks associated with digital notarial practices, allowing for the efficient identification and classification of threats, and the implementation of appropriate mitigation or minimization measures.

Among the proposed solutions, the updating of legislation to address digital challenges, and the strengthening of ICT and cyber security competencies among notaries stand out. The implementation of a document management platform based on blockchain to ensure document authenticity, and the launch of a digital signature and biometric authentication system to reinforce identity verification. These initiatives have contributed not only to improving the effectiveness and security of notarial procedures but also to elevating the perception of quality and trust in digital notarial services.

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