Proposal of a neutrosophic index to evaluate the management of internal control

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Abstract. Corporate auditing is part of the necessary mechanisms to evaluate and monitor the practices being carried out in enterprises. It also allows for the timely correction of future trends that will damage the company. Internal control is part of these audits, where the company is internally analyzed, and is a highly recommended practice for both state and private companies. Evaluation of internal control presents some challenges, such as the presence of incomplete or contradictory information, as well as the importance of properly understanding and communicating what it is wished to study. This is why in this paper we propose an index to evaluate the internal control of a company, based on Single-Valued Neutrosophic Numbers (SVNN) and natural language. The advantage of this tool is that linguistic terms can be more easily used for assessing and better understood by the evaluated; also the indeterminacy that exists in any evaluation can be incorporated. To illustrate the use of this index, a case study is carried out in the internal control of the municipal public water company of Tulcán, Ecuador.

Keywords: Internal control, audit, neutrosophy, Single-Valued Neutrosophic Number.

1 Introduction

The audit is a monitoring and control tool that contributes to the creation of a culture of discipline in the organization and allows discovering failures in the existing structures or vulnerabilities in the organization. The audit is the evolution or upper stage of accounting that is practiced by public accountants and is defined as a systematic process to obtain and evaluate evidence objectively with respect to claims regarding acts or facts to determine the degree of compliance and to communicate the results to interested third parties, see [1].

Audit activity must be effective and efficient to generate added value to the organization in order to meet the risk hedging objectives to which that review is exposed, see [2].

The importance of having a good internal control system in organizations has increased in recent years, due to it is a practice where efficiency and productivity are measured at the time of planting them; especially if it focuses on the basic activities that are carried out, because it depends on maintaining reliable accounting, see [3].

Government internal control for public sector entities, recommended by the Ecuadorian governing body, is based on the integrated internal control framework issued by the Committee of Organizations Sponsored by the Treadway Commission (COSO), which sets out five interrelated and integrated components of the administration process, with the aim of helping entities achieving their objectives, see [4][1].

Internal control is a key factor in the achievement of the objectives of public or private organizations, whose responsibility in its application goes from the highest authority and it is related to all human talent. Internal control system, as quoted by Rivas in the paper "contemporary models of internal control" by Mantilla and Blanco, states that there are three generators ([5]): the first one is based on empirical actions of trial and error procedures; the second one is it has a legal bias that imposes structures and practices of internal control, especially in the public sector, there exists a distortion because it operates in the line compliance (formal) and far from the levels of quality (technical); the third is the current one that focuses efforts on the quality derived from positioning at the highest strategic and managerial levels, as a requirement that guarantees the efficiency of internal control ([5]).

Internal control is a useful tool by which the administration manages to ensure the orderly and efficient management of the company's activities, see [6]. It is important to note that the audit carried out by an auditor must be performed on the basis of selective tests and random sampling of the accounting and documentation records supporting those records, as well as of the important decisions (in his or her opinion) taken by management. The

extent and scope of such tests shall be determined by the nature of the process and by the strength or weakness of the internal control system, see [7].

This paper aims to propose an index to measure internal control. To do this we select the Single-Valued Neutrosophic Number (SVNN) as measurement tools, because of three characteristics of neutrosophy ([8-9]), the first ones is the modeling of the uncertainty, which it shares with other theories such as fuzzy sets of Zadeh ([10]), the second one is the explicit inclusion of the indeterminacy, and thirdly the possibility that provides for modeling with linguistic terms. The internal control measurement is performed by auditors who do not necessarily manage well numeric evaluation terms, however the use of linguistic terms would allow them to evaluate more easily, in addition they will better be understood by the evaluated personnel. Moreover, each evaluation has a certain degree of indeterminacy that is inevitable, due to contradictions, ignorance, inconsistencies among other characteristics; therefore the use of neutrosophic tools is justified in this research.

The paper has the following structure, a section where some criteria of internal control and the basic concepts of neutrosophy, which are used throughout this document are explained, as well as the proposed index is defined. The next section illustrates with a Case Study the application of this index in the internal control to the Municipal Public Water Company of Tulcán, Ecuador. The last section is devoted to conclusions.

2 Basic Concepts

This section describes the main concepts needed in this article. Subsection 2.1 contains the basic elements on internal control. Subsection 2.2 contains the definitions of Single-Valued Neutrosophic Numbers, the proposed index to measure internal control, among others.

2.1 Internal Control

Audit has three stages, viz., firstly the information collection phase, secondly, the analysis phase, and thirdly the decision-making phase ([11]). The Ecuadorian Government Auditing Standards set out three phases, namely, (1) planning, which has two processes, preliminary planning, which aims to determine the strategy to be followed based on the knowledge of the process that was audited, also that obtained from the audited department, its obligations and responsibility assigned by the management of the company in its statutes, and (2) the specific planning that is to define the strategy by determining the procedures to be carried out in (3) the execution phase of the audit., where, on the basis of compliance and substantive tests, evidence can be obtained that will be the basis of findings that are reported in the reporting and audit results phase.

The author in [12][2, 3] lists the responsibilities of the internal controls of the administration and the auditor. The administration is responsible for establishing and maintaining the internal controls that the entity requires and that the administration publicly reports on the effectiveness of the operation of those controls. In contrast, the auditor is responsible for understanding and verifying the effectiveness and efficiency of the internal control system, and the auditor should therefore prepare an audit report on the evaluation of the internal controls of the administration, including the auditor's opinion on the operational effectiveness of those controls.

The internal control audit under the management audit makes it possible to analyze efficiency and effectiveness, and in the investigated case is to determine compliance with previous recommendations and to assess how these were implemented in order to give a professional judgment to the enterprise departments as its own management.

The internal control audit before expressing an opinion must comply with the planning, control tests and results communication phases; where the planning consists of understanding the audited entity or process, its environment; the control components are necessary to investigate the administration, its procedures to observe and inspect and logically follow up the recommendations resulting from previous audits; the control tests must identify the procedures applicable in the circumstances to form an opinion and obtain sufficient and competent evidence regarding the controls that were operating during the audit period; and finally, the communication of results, which is the third phase that the auditor should report to manage any weaknesses detected in the internal control, in addition, to ensure that those responsible for this management are properly informed of the weaknesses found, the main goal of that report is to induce the entity to take necessary measures for the correction of the deficiencies and strengthen internal control.

The main criteria that should be evaluated in the internal control, according to COSO, are the following five:

1. Control Environment,
2. Risk Assessment,
3. Control Activities,
4. Information and Communication,
5. Monitoring Controls.

These criteria are defined as follows:

Control Environment: these are the criteria that set the pattern of the organization's functioning and its sensitivity to control.

Risk Assessment: processes developed by the company to identify, measure and manage the risks related to achieving the objectives.

Control Activities: policies, procedures, and control mechanisms aimed at the fulfillment of the objectives.

Information and Communication: these are the mechanisms that make it possible to have the appropriate information, in time and form, for the development of the responsibilities of the managers.

Monitoring Controls: it is the process of evaluating the quality of the internal control system by means of the evaluation monitoring activities.

It is appropriate to break down these five criteria into sub-criteria to be measured, because the evaluation is easier to perform, in this paper we propose the following sub-criteria ([13]):

1. Control Environment.
   - 1.1. Integrity and ethical values,
   - 1.2. Commitment to competition,
   - 1.3. Board of directors or audit committee,
   - 1.4. Philosophy and operating style of management,
   - 1.5. Organizational structure,
   - 1.6. Allocation of authority and responsibilities,
   - 1.7. Human resources policies and procedures.
2. Risk Assessment.
   - 2.1 Mission, objectives and policies,
   - 2.2. Process or activity level objectives,
   - 2.3. Risk identification,
   - 2.4. Risk estimation,
   - 2.5. Change management.
3. Control Activities.
   - 3.1. Identification of control procedures,
   - 3.2. Opposition of interests,
   - 3.3. Coordination of areas,
   - 3.4. Documentation,
   - 3.5. Defined levels of authorization,
   - 3.6. Adequate recording of transactions,
   - 3.7. Restricted access to resources, assets and records,
   - 3.8. Staff relationship in sensitive areas,
   - 3.9. Control of the information system,
   - 3.10. Information Technology Control,
   - 3.11. Performance indicators,
   - 3.12. Manual of procedures.
4. Information and Communication.
   - 4.1. Information and responsibility,
   - 4.2. Information flow,
   - 4.3. Integrated Information Systems,
   - 4.4. Flexibility to change,
   - 4.5. Commitment of the higher authority,
   - 4.6. Communication channels.
5. Monitoring Controls.
   - 5.1. Evaluation of the internal control system,
   - 5.2. Effectiveness of the internal control system,
   - 5.3. Validation of assumptions,
   - 5.4. Deficiencies detected.

2.2 Neutrosophic Approach

Definition 1. ([8-9, 14]) Let U be a space of points (objects), with a generic element in U denoted by x. A *neutrosophic set* A in U is characterized by a truth-membership function T_A, an indeterminacy-membership function I_A and a falsity-membership function F_A. $T_A(x)$, $I_A(x)$ and $F_A(x)$ are real standard or nonstandard subsets of $]^-0, 1^+[$. It can be written as $A = \{< x, (T_A(x), I_A(x), F_A(x)) >: x \in U; T_A(x), I_A(x), F_A(x) \subseteq]^-0, 1^+[\}$. There is no restriction on the sum of $T_A(x)$, $I_A(x)$ and $F_A(x)$, thus, $^-0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3^+$.

Neutrosophic sets are useful in their nonstandard form only in philosophy, but not in technical applications, thus the *Single-Valued Neutrosophic Sets* are defined.

Definition 2. ([8-9, 14][4]) Let U be a space of points (objects), with a generic element in U denoted by x. A *Single-Valued Neutrosophic Set* (SVNS) A in U is characterized by a truth-membership function T_A, an indeterminacy-membership function I_A and a falsity-membership function F_A. $T_A(x)$, $I_A(x)$ and $F_A(x) \in [0,1]$. It can be written as $A = \{< x, (T_A(x), I_A(x), F_A(x)) >: x \in U; T_A(x), I_A(x), F_A(x) \in [0, 1]\}$.

There is no restriction on the sum of $T_A(x)$, $I_A(x)$ and $F_A(x)$, thus, $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$.

For convenience, a *Single-Valued Neutrosophic Number* (SVNN) is represented by (a, b, c), where a, b, c $\in$ [0, 1] and $0 \leq a + b + c \leq 3$.

A linguistic scale can be associated with SVNN, here we propose the scale summarized in Table 1.

Linguistic term	SVNN
Extremely good (EG)	(1,0,0)
Very very good (VVG)	(0.9, 0.1, 0.1)
Very good (VG)	(0.8,0.15,0.20)
Good(G)	(0.70,0.25,0.30)
Medium good (MDG)	(0.60,0.35,0.40)
Medium(M)	(0.50,0.50,0.50)
Medium bad (MDB)	(0.40,0.65,0.60)
Bad (B)	(0.30,0.75,0.70)
Very bad (VB)	(0.20,0.85,0.80)
Very very bad (VVB)	(0.10,0.90,0.90)
Extremely bad (EB)	(0,1,1)

Table 1: Linguistic terms proposed in [9, 15] associated with SVNNs.

Definition 3. Let U be a universe of discourse, a space of points (objects) and *x* denotes a generic element of U. $\boldsymbol{A}$ is a *Single Valued Neutrosophic Aggregation Operator* (SVNAO) if it is a mapping $\boldsymbol{A}$: $\cup_{n\in\mathbb{N}} ([0,1]^3)^n \rightarrow [0,1]^3$.

One example of SVNAO is the *Weighted Average* operator (WA), see [16-17], which is shown in Equation 1.

$$WA(a_1, a_2, \cdots, a_n) = \sum_{i=1}^{n} w_i a_i \quad (1)$$

Where, $a_i = (T_i, I_i, F_i)$ are SVNNs and $w_i \in [0, 1]$ for every i = 1, 2, …, n; which satisfy the condition $\sum_{i=1}^{n} w_i = 1$. The a_is are the values obtained for the i^{th} alternative assessment, and w_i denotes the weight which represents the importance given to the alternative a_i or the expertise level who evaluates the alternative.

The index we propose here is based on a combination between WA and the evaluators ' assessment on the linguistic scale shown in Table 1, as detailed below:

1. The managers of the company, trained to carry out the evaluation are selected for each one of the five criteria. Let us denote them by $K = \{k_{11}, k_{12},\ldots,k_{1m1}; k_{21}, k_{22},\ldots,k_{2m2}; k_{31}, k_{32},\ldots,k_{3m3}; k_{41}, k_{42},\ldots,k_{4m4}; k_{51}, k_{52},\ldots,k_{5m5}\}$, where k_{ij} denotes the evaluator selected to evaluate the i-th criterion (i = 1, 2, …, 5) and the j-th rater (j = 1, 2, …, m_i). Two different notations can denote the same evaluator, when a specialist evaluates two different criteria for which he or she is trained.
2. It is denoted by $W = \{w_{11}, w_{12},\ldots, w_{1m1}; w_{21}, w_{22},\ldots, w_{2m2}; w_{31}, w_{32},\ldots,w_{3m3}; w_{41}, w_{42},\ldots,w_{4m4}; w_{51}, w_{52},\ldots, w_{5m5}\}$ the set of weights that are assigned to each evaluator with respect to each criterion, so that $\sum_{j=1}^{m_i} w_{ij} = 1$, for i = 1, 2, …, 5.
3. Each evaluator in K evaluates the internal control criterion assigned to him or her using the linguistic terms in Table 1. The procedure is the following:
    - If the i-th criterion is assigned to the j-th evaluator, he (she) evaluates each of the sub-criteria corresponding to i. Next, he (she) aggregates his (her) evaluations according to Equation 1, using identical weights for every sub-criterion. This will be the final evaluation of criterion i by the evaluator j.
    - The total assessment of criterion i is obtained by aggregating, using Formula 1 and weights w_{i1}, $w_{i2},\ldots, w_{imi}$ of all evaluations obtained for i in the previous point. This evaluation allows determining the state of the i-th criterion and itself is useful for internal control.
4. The final index is obtained by aggregating the indices calculated in the previous point and constitutes the final evaluation of internal control of the company. Again Equation 1 is used for this.
5. Each of the previous assessments are compared with the SVNNs in Table 1 by using Formula 2 as follows ([18]):

$$d(a,b) = \sqrt{\frac{1}{3}((T_a - T_b)^2 + (I_a - I_b)^2 + (F_a - F_b)^2)} \quad (2)$$

Where $a = <T_a, I_a, F_a>$ and $b = <T_b, I_b, F_b>$ are two SVNNs.

The linguistic term associated with the SVNN having the minimum distance in formula 2 is selected as the natural language evaluation of the criterion.

In case there is a tie between two values of Table 1, the worst of the two possible linguistic values in the table is selected.

3 Case Study

This research was carried out in the Company, Public Municipal Water and Sewer utilities of the city of Tulcán, Ecuador, in order to verify the compliance of the internal control standards that are of mandatory compliance in the public sector of Ecuador, norm 100-01 of the State General Controllership 2009 ([4]). It defines an integral process applied by the highest authority, management and personnel that provides reasonable security for the achievement of institutional objectives and the protection of public resources. It is oriented to comply with the legal, technical and administrative order, promote efficiency and effectiveness of the operations of the entity and guarantees the reliability and timeliness of the information, for this, it is essential to evaluate the reliability of internal control.

One evaluator per criterion was selected to evaluate the internal control. Thus, we have $K = \{k_{11}; k_{21}; k_{31}; k_{41}; k_{51}\}$ and $W = \{w_{11}; w_{21}; w_{31}; w_{41}; w_{51}\}$, where $w_{i1} = 1$, for i = 1, 2, 3, 4, and 5.

The obtained results of evaluation by every one of experts respect to every sub-criterion is summarized in Table 2, see that we denote the sub-criterion with the number used in the previous subsection, also, it can be seen the linguistic term and its associated SVNN, according to Table 1. Let us observe that the evaluation of the criteria are obtained aggregating the SVNNs of sub-criteria, according to Equation 1, whereas its associated linguistic term is selected with the criterion proposed in the fifth point of the method.

Sub-Criterion		Evaluation in form of linguistic term	Associated SVNN
1.	Control Environment	**MDG** (dist = 0.02369)	**(0.58571,0.38571,0.41429)**
	1.1.	MDG	(0.60,0.35,0.40)
	1.2	MDG	(0.60,0.35,0.40)
	1.3	M	(0.50,0.50,0.50)
	1.4	M	(0.50,0.50,0.50)
	1.5	G	(0.70,0.25,0.30)
	1.6	G	(0.70,0.25,0.30)
	1.7	M	(0.50,0.50,0.50)
2.	Risk Assessment	**M** (dist = 0.028284)	**(0.48,0.54,0.52)**
	2.1.	VVG	(0.9, 0.1, 0.1)
	2.2	G	(0.70,0.25,0.30)
	2.3	B	(0.30,0.75,0.70)
	2.4	B	(0.30,0.75,0.70)
	2.5	VB	(0.20,0.85,0.80)
3.	Control Activities.	**MDB** (dist = 0.035358)	**(0.35833,0.66667,0.64167)**
	3.1.	VB	(0.20,0.85,0.80)
	3.2	VB	(0.20,0.85,0.80)
	3.3	VB	(0.20,0.85,0.80)
	3.4	VB	(0.20,0.85,0.80)
	3.5	G	(0.70,0.25,0.30)
	3.6.	G	(0.70,0.25,0.30)
	3.7	B	(0.30,0.75,0.70)
	3.8	G	(0.70,0.25,0.30)
	3.9	B	(0.30,0.75,0.70)
	3.10	B	(0.30,0.75,0.70)
	3.11	B	(0.30,0.75,0.70)
	3.12	VB	(0.20,0.85,0.80)
4.	Information and	**G** (dist = 0.028868)	**(0.7,0.3,0.3)**

	Communication		
	4.1.	VVG	(0.9, 0.1, 0.1)
	4.2	VVG	(0.9, 0.1, 0.1)
	4.3	G	(0.70,0.25,0.30)
	4.4	B	(0.30,0.75,0.70)
	4.5	M	(0.50,0.50,0.50)
	4.6.	VVG	(0.9, 0.1, 0.1)
5.	Monitoring Controls.	**M** (dist = 0.059512)	**(0.55,0.425,0.45)**
	5.1.	G	(0.70,0.25,0.30)
	5.2	G	(0.70,0.25,0.30)
	5.3	MDG	(0.60,0.35,0.40)
	5.4	VB	(0.20,0.85,0.80)

Table 2: Experts' evaluation of the criteria and sub-criteria, using linguistic terms and SVNNs, *dist* represents the minimum distance between SVNN of the criteria and the SVNN associated with the linguistic terms in Table 1.

The final index of the internal control is obtained by means of Equation 1, aggregating the indexes of the five criteria; it is (0.53481, 0.46348, 0.46519). Thus, the internal control is evaluated as Medium (M) with dist = 0.035389.

Conclusion

This paper was dedicated to define a new neutrosophic index to measure the internal control of an enterprise. Moreover, we proposed a group decision method for Internal Control assessment. The advantage of the index is that inputs and outputs are linguistic terms, which is the most convenient way to measure by human beings, and also it is more comprehensible for the evaluated directives, thus, the reception of the evaluation is more natural. Additionally, to use the neutrosophy permits joining the indeterminacy that is typical in decision making. We illustrated the application of the index in the case study of the Company, Public Municipal Water and Sewer utilities of the city of Tulcán, Ecuador. We propose to code this method for being applied in real life internal controls.

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