University of New Mexico

A neutrosophic linguistic model for internal control evaluation to an Ecuadorian Company

Víctor Martin Parrales Carvajal[1], Mishelly Teresa Macías Valverde[2], and Roberto Aguas Pután[3]

[1]Professor, Universidad Autónoma de Los Andes, Ecuador. E-mail: martinparrales21@hotmail.com
[2] Professor, Universidad Autónoma de Los Andes, Ecuador. E-mail: ub.mishellymacias@uniandes.edu.ec
[3] Professor, Universidad Regional Autónoma de Los Andes, Ecuador. E-mail: raguas.00@hotmail.com

Abstract. The internal control of a company is essential to evaluate the performance of the institution during a certain period of time, which allows taking the necessary measures to correct in advance the mistakes that are being made or to enhance the positive practices within the company. In this paper we propose to evaluate the Commercial Company Manolo's located in the city of Babahoyo, Ecuador, regarding the aspects measured in the internal control. For this, we use the neutrosophic 2-tuples method. This method is a part of the Computing with Word (CWW) that is distinguished by performing calculations on words rather than numbers and is an easier and more natural way to evaluate by experts. The inclusion of neutrosophy allows for greater accuracy of the results, since the calculations incorporate indeterminacy. Three experts evaluated the internal control for this investigation.

Keywords: internal control, computing with words, linguistic model, 2-tuple method.

1 Introduction

There exist several concepts and theories of control, for Munch: "control is the phase of the administrative process through which the standards are established to measure the results obtained in order to correct deviations, prevent them and continuously improve the performance of the company", see [1, 2].

Also he explains: "The control is of vital importance as it serves to verify the effectiveness of the management, promotes quality assurance, allows the protection of the assets of the company, guarantees the fulfillment of the plans, set out measures to prevent errors and reduce cost and time. With this, the causes of deviations are detected and analyzed, in order to avoid repeating them, is the foundation for the planning process", see [2].

According to Estupiñán ([3]): "internal control is a process carried out by the board of directors, management and staff of the entity, designed to provide reasonable security with a view to achieving objectives in the area of internal control."

Internal control has as its purposes the following:

1. Effectiveness and efficiency of operations.- Supports the basic objectives of the company, including performance goals profitability and resource safeguarding.
2. Reliability of financial information.- Relates to the preparation and publication of trustworthy financial statements, including interim and summary financial statements and financial information derived from statements such as publicly reported distribution gains.
3. Compliance with applicable laws and regulations.- Ensures compliance with the laws and regulations to which the company is subject. Internal control includes the organizational plan and all coordinated methods and measures taken within an enterprise to safeguard its assets, to verify the accuracy and veracity of accounting data.

Paz in [4], details that the internal control system are appropriate policies and procedures that generate the administration of a company to help achieving one of the objectives of each company to affirm, as much as possible, as the person in charge of carrying out everything about its business, including all kinds of administration policies, asset protection, as well as to avoid fraud and error, the accuracy of most accounting records, and a timely preparation of accounting information.

Some authors emphasize that internal control in companies is of vital importance for the optimization and growth of the business, both in the administrative and in the operation; thus benefiting from the shareholders to the client itself, since it will have a degree of confidence over the company and will prevail over time generating profits and internal growth in the entity, see [5].

Reyes in ([6]) also indicates that one of the most obvious reasons for the importance of control is because even the best of plans can be derived. The control is used to:

- Create better quality: process failures are detected and process.
- Remove errors.
- Facing change, this is an inescapable part of the environment of any organization.

The contribution of this research project is to inform to the manager of the commercial Manolo's on the knowledge of the activities and operations of its business, through the evaluation of the internal control and application of the COSO II method with their respective components, which are, viz., control environment, risk assessment, control activities, information and communication, monitoring controls, to obtain the complete, timely information and knowledge of the current situation of the company, see [1].

To meet this objective, a neutrosophic linguistic model is used, in particular the 2-tuples linguistic model ([7, 8]). This model is part of the Computing with Word (CWW), see [9-12], which allows calculation based on linguistic rather than numerical terms ([13]), which is a more natural way to evaluate by experts. The inclusion of neutrosophy ([14-16]) brings more accuracy to the model, because it also takes into account the indeterminacy of the evaluations, see [17]. In addition, as part of the method there exists a numerical term in the range [-0.5, 0.5) that measures the accuracy of the indexes of the linguistic values defined in the scale.

After conducting a search on the application of neutrosophic methods to measure the state of internal control in a company, the authors of this paper did not find any approach in this regard. For this reason, this paper could be considered the first neutrosophic measurement of internal control.

Within the review carried out by us it was found that there exist mathematical methods and techniques to measure the state of the internal control. In [18] a methodology is designed to guide the internal control of small companies with respect to risks, for this end they define some economic indices that allow measuring them by decision makers. In [19] a method is proposed to perform internal control based on statistics, specifically linear regression. Ge and Koester in [20] also use statistical and econometric methods for this purpose.

In [21] a reference is made to the Chinese Internal Control Index *IC_INDEX*, which is used to measure the quality of internal control in the Chinese companies, which is constructed using the Analytic Hierarchy Process (AHP) technique. That article studies the relationship between the internal control of the company and the risk of a crash in the stock market, where statistical methods are applied. A similar method for the same purpose can be found in [22].

In general, the AHP technique is recurrent to resolve this problem, to obtain weights that measure the importance of the criteria used in internal control. Wu in [23] proposes an internal control measurement system in manufacturing companies, where the AHP-fuzzy method is applied, with the intention of trapping the uncertainty using fuzzy logic, specifically for this type of company. Also Zhang in [24] uses this technique applied in administrative institutions.In [25] the uncertainty is also captured by measuring in the fuzzy frame, using the fuzzy stratified evaluation method.

In [26] mathematical programming is utilized for the validation of internal control mechanisms in local governments. In [27] the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is proposed as part of a Decision Support System in internal control to select the best employees of the company. On the other hand, Petridis et al. in [28] select internal auditors based on the hybridization of TOPSIS with non-linear programming.

All these techniques and methods could be generalized to the neutrosophic environment, where not only uncertainty is considered, but also the indeterminacy, which is typical of decision-making, achieving a modeling more in line with reality. In [29] a method is proposed to solve linear programming problems in a neutrosophic environment. Neutrosophic AHP was designed in [30]. The neutrosophic TOPSIS study can be found in [31]. In [32] a combination of AHP and TOPSIS is applied for solving a real-life problem. Giri et al. in [33] design a TOPSIS method to solve multicriteria decision problems based on trapezoidal interval neutrosophic numbers. Additionally, these methods can be automated with the support of toolboxes developed in Matlab ([34]) or the python programming language ([35]).

Apart from the fact that the measurement proposed in this research is based on neutrosophic theory and therefore carries its characteristics, it also has the advantage that it is based on CWW, which is why specialists can assess using linguistic terms and not numerical ones, which is more understandable for both, the evaluators and the evaluated employees.

This paper is divided as follows, the section of materials and methods describes the main definitions of the 2-tuples method, and in addition to define the method we will follow in this paper to perform calculations. The section of Results is dedicated to describe the evaluation of the three experts on the internal control aspects of Manolo's company located in Babahoyo, Ecuador. Finally we give the conclusions.

2 Materials and Methods

Here we describe the main concepts related to linguistic models, especially 2-tuple linguistic representation.

2-tuple linguistic representation model aims to compute processes with words without loss of information. It is based on the concept of symbolic translation.

Let $S = \{s_0, s_1, \dots, s_g\}$ be a set of linguistic terms and $\beta \epsilon [0, g]$ a value in the granularity interval of S.

Definition 1. ([8, 9])The *Symbolic Translation* of a linguistic terms$_i$ is a number valued in the interval [-0.5, 0.5) which expresses the difference of information between a quantity of information expressed by the value $\beta \epsilon$ [0, g], obtained in a symbolic operation and the nearest integer value, $i \in \{0, \dots, g\}$ which indicates the index of the nearest linguistic label (s_i) in S.

Based on this concept, a model for the representation of linguistic information is developed, which makes use of a pair of values or 2-tuples. This representation model defines a set of functions that facilitate operations on 2-tuples.

Definition 2. ([8, 9]) Let $S = \{s_0, s_1, \dots, s_g\}$ be a set of linguistic terms and $\beta \epsilon [0, g]$ a value that represents the result of a symbolic operation, then the linguistic 2-tuple that expresses the information equivalent to β, is obtained using the following function:

$\Delta: [0, g] \to S \times [-0.5, 0.5)$

$$\Delta(\beta) = (s_i, \alpha), \text{ such that } \begin{cases} s_i, & i = \text{round}(\beta) \\ \alpha = \beta - i, & \alpha \in [-0.5, 0.5) \end{cases} \quad (1)$$

Where "round" is the usual rounding operator, s_i is the index label closest to β and α is the value of the symbolic translation.

It should be noted that $\Delta^{-1}: \langle S \rangle \to [0, g]$ is defined as $\Delta^{-1}(s_i, \alpha) = i + \alpha$. Thus, a linguistic 2-tuple $\langle S \rangle$is identified with its numeric value in $[0, g]$.

In [17] the concept of 2-Tuple Linguistic Neutrosophic Number (2TLNN) is proposed to solve problems based on Single-Valued Neutrosophic Sets and 2-tuples linguistic sets (2TLSs).

A 2TLNN is defined as follows [17]:

Suppose that $S = \{s_0, \dots, s_g\}$ is a 2TLSs with odd cardinality t+1. It is defined for $(s_T, a), (s_I, b), (s_F, c) \in L$ and a, b, c $\in$[0, t], where $(s_T, a), (s_I, b), (s_F, c) \in L$ independently express the degree of truthfulness, indeterminacy, and falsehood by 2TLSs, then 2TLNN is defined as follows:

$$l_j = \left\{(s_{T_j}, a), (s_{I_j}, b), (s_{F_j}, c)\right\} \quad (2)$$

Where $0 \le \Delta^{-1}(s_{T_j}, a) \le t$, $0 \le \Delta^{-1}(s_{I_j}, b) \le t$,$0 \le \Delta^{-1}(s_{F_j}, c) \le t$, and$0 \le \Delta^{-1}\left(s_{T_j}, a\right) + \Delta^{-1}\left(s_{I_j}, b\right) + \Delta^{-1}(s_{F_j}, c) \le 3t$.

The score and accuracy functions allow us to rank 2TLNN [17]. Let$l_1 = \{(s_{T_1}, a), (s_{I_1}, b), (s_{F_1}, c)\}$be a 2TLNN in L, the score and accuracy functions in $l_1$are defined as follows, respectively:

$$S(l_1) = \Delta\left\{\frac{2t + \Delta^{-1}(s_{T_1}, a) - \Delta^{-1}(s_{I_1}, b) - \Delta^{-1}(s_{F_1}, c)}{3}\right\},\ \Delta^{-1}(S(l_1)) \in [0, t] \quad (3)$$

$$H(l_1) = \Delta\left\{\frac{t + \Delta^{-1}(s_{T_1}, a) - \Delta^{-1}(s_{F_1}, c)}{2}\right\},\ \Delta^{-1}(H(l_1)) \in [0, t] \quad (4)$$

Definition 3. Given a 2TLNN, $l_j = \langle (s_{T_j}, a_j), (s_{I_j}, b_j), (s_{F_j}, c_j) \rangle$ (j = 1, 2,…, n) with vector of weights $w_i = (w_1, w_2, \dots, w_n)^T$ which satisfies the conditions $w_i \in [0, 1]$ and $\sum_{i=1}^{n} w_i = 1$, then the following two aggregation operators are defined, which are the Linguistic Neutrosophic Number-weighted arithmetic averaging (LNNWAA) and the Linguistic Neutrosophic Number-weighted geometric averaging (LNNWGA), respectively, [36]:

$$\text{LNNWAA}(l_1, l_2, \dots, l_n) = \sum_{j=1}^{n} w_j l_j = \langle s_{t - t\prod_{j=1}^{n}\left(1 - \frac{T_j}{t}\right)^{w_j}}, s_{t\prod_{j=1}^{n}\left(\frac{I_j}{t}\right)^{w_j}}, s_{t\prod_{j=1}^{n}\left(\frac{F_j}{t}\right)^{w_j}} \rangle \quad (5)$$

$$\text{LNNWGA}(l_1, l_2, \dots, l_n) = \prod_{j=1}^{n} l_j^{w_j} = \langle s_{t\prod_{j=1}^{n}\left(\frac{T_j}{t}\right)^{w_j}}, s_{t - t\prod_{j=1}^{n}\left(1 - \frac{F_j}{t}\right)^{w_j}}, s_{t - t\prod_{j=1}^{n}\left(1 - \frac{F_j}{t}\right)^{w_j}} \rangle \quad (6)$$

$$\text{WAO}(l_1, l_2, \dots, l_n) = \langle s_{\sum_{j=1}^{n} w_j T_j}, s_{\sum_{j=1}^{n} w_j I_j}, s_{\sum_{j=1}^{n} w_j F_j} \rangle \quad (7)$$

Given $C = \{c_1, c_2, \dots, c_m\}$ ($m \ge 2$), a number of criteria and $K = \{k_1, k_2, \dots, k_n\}$ ($n \ge 2$) denoting n experts, then a decision-making problem is defined as follows:

1. Experts $K = \{k_1, k_2, \dots, k_n\}$ ($n \ge 2$) are selected to assess internal control in Manolo's company.
2. Specify the scale of linguistic terms that will be used for evaluating.
3. Aggregate the result for each criterion for all experts, using Equation 7 with weights fixed as 1/n.
4. Aggregate the precedent results for all criteria, using Equation 7 with weights fixed as 1/m.
5. Either the score or the accuracy functions are applied to evaluate the results, obtaining a unique 2-tuple value.

3 Results

This section is devoted to expose experts' evaluations and calculations about the internal control in the commercial Manolo's. We use the criteria recommended in the Committee of Sponsoring Organizations of the Treadway Commission (COSO), see [37]. These are five agencies initiative to improve internal control within organizations.

According to the COSO framework, internal control consists of five interrelated components; these will derive from the way in which the directorate manages the enterprise and will be integrated into the management process. The components are the same for all organizations (public or private) and the implementation of each of them depends on its size.

The components are the following:

6. Control Environment.
7. Risk Assessment.
8. Control Activities.
9. Information and Communication.
10. Monitoring Controls.

A brief explanation of every one of them is the following:

Control Environment: The control environment or environment is the basis of the internal control pyramid, providing discipline to the structure. It supports the remaining components, so it is essential to establish the foundations of an effective and efficient internal control system. It sets the standard for the operation of the enterprise and influences the awareness of its managers.

The factors to be considered within the Control Environment are: Integrity and Ethical Values, Capacity of the managers, Management Style, the Assignment of Authority and Responsibility, the Organizational Structure and, Policies and Practices used by the personnel.

Risk Assessment: Each enterprise faces various internal and external risks that must be evaluated. A precondition to the Risk Assessment is the identification of the objectives at the different levels, which must be linked to each other.

The Risk Assessment consists of the identification and analysis of the risks, which are relevant to the achievement of the objectives, and serves as a basis to determine how they should be managed. In turn, given the permanent changes in the environment, it will be necessary for the enterprise to have mechanisms to identify and address the risks associated with the change.

The evaluation should analyze which objectives in the area have been appropriately defined, if they are consistent with the institutional objectives, if they were duly communicated, if the risks were detected and analyzed properly, and if they have been classified according to the relevance and probability of occurrence.

Control Activities: The control activities are the policies, procedures, techniques, practices and mechanisms that allow management to manage (mitigate) the risks identified during the Risk Assessment process and ensure that the guidelines established by it are carried out.

The Control Activities are carried out at all levels of the enterprise and at each stage of the management, based on the development of a Risk Map, as indicated in the previous point.

In the evaluation of the Internal Control System, it should not only be considered if the activities relevant to the identified risks were established, but also if they are applied in real life and if the results obtained were as expected.

Information and communication: The relevant information must be identified, collected and disseminated in a timely manner that allows each manager to fulfil his or her responsibilities in charge. There must be effective communication - in a broad sense - that flows in all directions across all areas of the enterprise, in descending and ascending ways.

Management must clearly communicate the responsibilities of each manager within the Internal Control System implemented. Managers have to understand their role in the Internal Control System and how individual activities are related to the work of the rest.

Monitoring Controls: Internal Control Systems require - mainly - Supervision, that is, a process that verifies the validity of the Control System over time. This is achieved through continuous monitoring activities, periodic evaluations or a combination of both.

In our investigation for evaluating the five precedent aspects, three experts were hired for assessing the commercial Manolo´s, they are identified with the notation k_i for i = 1, 2, 3. The linguistic scale used for evaluating is S = {s_0 = "Very bad", s_1 = "Bad", s_2 = "More or less", s_3 = "Good", s_4 = "Very good"}, and the criteria are denoted as follows:

C_1: Control Environment.
C_2: Risk Assessment.
C_3: Control Activities.
C_4: Information and Communication.

C_5: Monitoring Controls.

We asked experts for both, how they evaluate and how they do not evaluate that Commercial Manolo´s satisfies C_1, C_2, C_3, C_4, and C_5, as well as what is the linguistic term in S they cannot determine to evaluate this company. The answers can be seen in Table 1.

Criterion/Expert	E_1	E_2	E_3
C_1	(s_1, s_0, s_3)	(s_1, s_2, s_3)	(s_1, s_0, s_2)
C_2	(s_1, s_2, s_3)	(s_1, s_2, s_3)	(s_1, s_0, s_2)
C_3	(s_2, s_3, s_0)	(s_2, s_1, s_3)	(s_2, s_3, s_0)
C_4	(s_0, s_1, s_2)	(s_1, s_0, s_2)	(s_1, s_0, s_3)
C_5	(s_1, s_0, s_2)	(s_1, s_0, s_3)	(s_0, s_1, s_2)

Table 1: Triple of evaluations by each expert on every criterion of the internal control. Each triple is composed by the truth member, the indeterminacy member and the false member, respectively.

Let us note that $\alpha = 0$ for each linguistic value in each triple of Table 1.

The values of each criterion in Table 1 are aggregated using Equation 7, also we aggregate the linguistic values for all criteria; see Table 2.

Criterion	WAM
C_1	($\langle s_1, 0\rangle$, $\langle s_1, -0.333\rangle$, $\langle s_3, -0.333\rangle$)
C_2	($\langle s_1, 0\rangle$, $\langle s_1, 0.333\rangle$, $\langle s_3, -0.333\rangle$)
C_3	($\langle s_2, 0\rangle$, $\langle s_2, 0.333\rangle$, $\langle s_1, 0\rangle$)
C_4	($\langle s_1, -0.333\rangle$, $\langle s_0, 0.333\rangle$, $\langle s_2, 0.333\rangle$)
C_5	($\langle s_1, -0.333\rangle$, $\langle s_0, 0.333\rangle$, $\langle s_2, 0.333\rangle$)
Total	($\langle s_1, 0.2\rangle$, $\langle s_1, -0.2\rangle$, $\langle s_2, 0.2\rangle$)

Table 2: Aggregation of the values in Table 1 according to Equation 7. Total results of aggregating the linguistic values for all criteria.

Table 3 contains the results of applying the score function to linguistic values and the linguistic terms in S associated with them, applied to the values in Table 2.

Criterion	*s*	Linguistic term
C_1	$\langle s_2, -0.11130\rangle$	"More or less"
C_2	$\langle s_2, -0.33330\rangle$	"More or less"
C_3	$\langle s_2, 0.22230\rangle$	"More or less"
C_4	$\langle s_2, 0.0003\rangle$	"More or less"
C_5	$\langle s_2, 0.0003\rangle$	"More or less"
Total	$\langle s_2, 0.0667\rangle$	"More or less"

Table 3: Score function evaluating the linguistic values in Table 2 and the linguistic terms associated with them.

According to Table 3 the evaluation of the enterprise is "More or less", for each criterion and in the general assessment.

Despite the fact that the situation of the company is not bad, in general in the face of these evaluations any company would take measures to improve the evaluations and to prevent them from getting worse, [38]. As all the criteria have the same evaluation, one way to improve them all would be by reinforcing the Control Environment, which is the base of all the others. It is necessary to identify the strengths and weaknesses of the management style that is being carried out.

Firstly, the strengths and weaknesses of the formal organization of the company must be identified, which is the space where the duties and rights of each worker are defined, as well as the object of their work. We have to investigate what is the managers and their subordinates' behavior in the workplace, if each of them ethically complies with what they should do from their job.

A deeper approach takes place when analyzing informal relationships between workers who work together, when we analyze what are the personal relationships among the subordinates, and among the subordinates with their bosses, if it is necessary to create more communication or on the contrary, if it is necessary for the manager to be more authoritative and determined with its subordinates. The top managers of the company must be able to carry out this study at all hierarchical levels of the enterprise. For this purpose, they can use surveys applied to workers and managers.

A second phase consists on determining what changes should be made to improve management within the company, determining where to relocate each worker, preferably considering more than one possibility for each one of them, with the idea of avoiding impositions.

The third phase would be the implementation of those changes. First of all, it is necessary to create conscience among workers about the need for change and the proposals studied would be suggested to them. In multiple organized assemblies, the opinions of workers and managers on the change proposed for each of them would be collected. With the studied ideas and opinions a final decision is made, which would be communicated to the workers and a change plan would be made for each one of them.

It is imperative that once this process begins, when hiring a new worker or changing the job to one already hired, including managers, that they go through a probationary period of proficiency in the job, where the skills shown are measured about their performances in the workplace, its comprehensiveness, its adaptability to changing conditions, and its relationship with the other members of the organization, both formally and informally.

All these steps will result in a management style that, if successful, will positively influence other aspects. An important point to keep in mind is that this process must be understood as dynamic and changing over time, in no way it should be rigid and immovable. It must be possible to change what does not work for the good of the organization, and at the same time it must maintain and reinforce what empowers the organization.

These changes must be considered in an integral way within the company, from the material working conditions as the subjective attitudes of the workers within the organization. A more effective way is to train managers in management techniques.

Let us emphasize that each company in the real-life may solve this situation in a different way, the strategy we outlined above corresponds to an ideal and applicable way of improving the management style.

Conclusion

This paper was dedicated to evaluate the internal control in the commercial Manolo's situated in Babahoyo, Ecuador. Three experts were hired to give their opinion according to the five criteria recommended by COSO. We used linguistic terms because it is an easier way to evaluate, particularly the linguistic scale S = {"Very bad", "Bad", "More or less", "Good", "Very good"} is used. The results was processed utilizing the neutrosophic linguistic model of 2-tuple, which provides the results of accuracy and a linguistic approach. We conclude that each criterion is evaluated as "More or less", and the conjoint evaluation is "More or less" as well, which is a not satisfactory result; therefore, executives of the enterprise must improve the performance in every one of these aspects.

Although this paper met the stated goal of solving a real-life practical problem, it also demonstrates that the used method is effective. We based on the fact that the administration of the company received the evaluation result in an understandable way, which would have been less clear if some traditional method such as TOPSIS, AHP or another one based on numerical results had been used and not based on linguistic terms such as the one applied in this paper. However, future research does not rule out combining the traditional methods mentioned above with linguistic ones. More specifically, to study the result of the measurements taken at Manolo's for improving its performance, it is proposed to apply this method another time, where the weighted average weights are calculated using the AHP technique.

References

[1] Macías-Valverde, M. T. (2019). *The internal control of the financial information and its incidence in the profitability of the commercial Manolo's of Babahoyo (El control interno de la información financiera y su incidencia en la rentabilidad del Comercial Manolo's de Babahoyo)(In Spanish).*Bachelor Thesis, Regional Autonomous University of Los Andes, Babahoyo, Ecuador.

[2] Munch, L. (2012). *Organizational Management, focuses and Management Process (Administración Gestión Organizacional, enfoques y Proceso Administrativo)(In Spanish)*. Mexico: Pearson.

[3] Estupiñán, G. (2013). *Internal Control and Frauds (Control Interno y Fraudes)(In Spanish)* (Second Edition ed.). Bogotá, Colombia: Ecoe Ediciones.

[4] Paz, R. (2011). *Internal Control and Frauds (Control Interno y Fraudes)(In Spanish)* (First Edition ed.). Bogotá, Colombia: Ecoe Ediciones.

[5] Aguirre-Choix, R. (2012). Importance of internal control in the small and medium enterprises in Mexico (La importancia del control interno en las pequeñas y medianas empresas en México)(In Spanish). *Revista El Buzón de Pacioli, 12*(76), 1-17.

[6] Reyes-Ponce, A. (1978). *Management of enterprises: theory and practice (Administración de empresas: Teoría y Práctica)(In Spanish)*. Mexico: Limusa S.A. de C.V. Grupo Noriega.

[7] Herrera, F., and Martínez, L. (2000). A 2-tuple fuzzy linguistic representation model for computing with words. *IEEE Transactions on Fuzzy Systems, 8*, 746-752.

[8] Herrera, F. and Martínez, L. (2000). An approach for combining linguistic and numerical information based on the 2-tuple fuzzy linguistic representation model in decision-making. *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems, 8*, 539-562.
[9] Herrera, F., Alonso, S., Chiclana, F. and Herrera-Viedma, E. (2009). Computing with words in decision making: foundations, trends and prospects. *Fuzzy Optimization and Decision Making, 8*(4), 337-364.
[10]A Martinez, L., Ruan, D. and Herrera, F. (2010). Computing with words in decision support systems: an overview on models and applications. *International Journal of Computational Intelligence Systems, 3*(4), 382-395.
[11]Rubin, S. H. (1999). Computing with words. *IEEE Transactions on Systems, Man, and Cybernetics, Part B (Cybernetics), 29*(4), 518-524.
[12]AWang, P. P. (2001). *Computing with words*: John Wiley & Sons, Inc..
[13]Zadeh, L. A. (1999). From computing with numbers to computing with words. From manipulation of measurements to manipulation of perceptions. *IEEE Transactions on circuits and systems I: fundamental theory and applications, 46*(1), 105-119.
[14]Leyva-Vázquez, M. and Smarandache, F. (2018). *Neutrosophy: new advances in the treatment of uncertainty (Neutrosofía: Nuevos avances en el tratamiento de la incertidumbre)(In Spanish)*. Brussels: Pons.
[15]Smarandache, F. (2002). *Neutrosophy, a new Branch of Philosophy*: Infinite Study.
[16]Smarandache, F. (2005). *A Unifying Field in Logics: Neutrosophic Logic. Neutrosophy, Neutrosophic Set, Neutrosophic Probability: Neutrsophic Logic. Neutrosophy, Neutrosophic Set, Neutrosophic Probability*: Infinite Study.
[17]Wang, J., Wei, G. and Yu, W. (2018). Models for Green Supplier Selection with Some 2-Tuple Linguistic Neutrosophic Number Bonferroni Mean Operators. *Symmetry, 10*(5), 131.
[18]Piskunov, V. A., Manyayeva, V. A., Tatarovskaya, T. E., and Bychkova, E. Y. (2016). Risk-Oriented Internal Control: the Essence, Management Methods at Small Enterprises. *IEJME — Mathematics Education, 11*(7), 2710-2731.
[19]Harisova, F. I., and Mukhametzyanova, L. Z. (2018). Construction of a model for internal audit via economic and mathematical methods. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies, 9*(5), 385-392.
[20]Ge, W., Koester, A., and McVay, S. (2017). Benefits and costs of Sarbanes-Oxley Section 404(b) exemption: Evidence from small firms' internal control disclosures. *Journal of Accounting and Economics, 63*(2-3), 358-384.
[21]Chen, J., Chan, K. C., Dong, W., and Zhang, F. (2016). Internal Control and Stock Price Crash Risk: Evidence from China. *European Accounting Review, 26*(1), 125-152.
[22]Chen, H., Dong, W., Han, H., and Zhou, N. (2017). A comprehensive and quantitative internal control index: construction, validation, and impact. *Review of Quantitative Finance and Accounting, 49*(2), 337-377.
[23]Wu, B. (2016). Internal Control Evaluation System of Manufacturing Enterprises *Revista Técnica de Ingeniería de la Universidad de Zulia 39*(2), 358 - 363.
[24]Zhang, C.-C. (2018). *Internal Control Measure of Administrative Institutions based on AHP and Fuzzy Comprehensive Evaluation*. Paper presented at the 2018 14th International Conference on Computational Intelligence and Security (CIS).
[25]Cheng, F. (2018). *Internal Control of Modern Management Accounting Information System under IT Environment*. Paper presented at the 2018 International Conference on Educational Research, Economics, Management and Social Sciences (EREMS 2018).
[26]Petridis, G. D. K., Petridis, N. E., and Zografidou, E. (2020). Valuation of the internal audit mechanisms in the decision support department of the local government organizations using mathematical programming [Online Version]. *Annals of Operations Research*, 1-14.
[27]Rahim, R., Supiyandi, S., Siahaan, A.-P.-U., Listyorini, T., Utomo, A. P., Triyanto, W. A., Irawan, Y., Aisyah, S., Khairani, M., Sundari, S., and Khairunnisa, K. (2018). *TOPSIS Method Application for Decision Support System in Internal Control for Selecting Best Employees*. Paper presented at the 2nd International Conference on Statistics, Mathematics, Teaching, and Research.
[28]Konstantinos Petridis, Georgios Drogalas, and Eleni Zografidou. (2019). Internal auditor selection using a TOPSIS/non-linear programming model. *Annals of Operations Research*, 1-27. doi:10.1007/s10479-019-03307-x.
[29] Abdel-Basset, M., Mohamed, M., and Smarandache, F. (2020). Comment on "A Novel Method for Solving the Fully Neutrosophic Linear Programming Problems: Suggested Modifications". *Neutrosophic Sets and Systems, 31*, 305-309.
[30] Abdel-Basset, M., Mohamed, M., Zhou, Y., and Hezam, I. (2017). Multi-criteria group decision making based on neutrosophic analytic hierarchy process. *Journal of Intelligent & Fuzzy Systems, 33*(6), 4055-4066.
[31] Elhassouny, A., Idbrahim, S., and Smarandache, F. (2019). Machine learning in Neutrosophic Environment: A Survey *Neutrosophic Sets and Systems, 28*, 58-68.
[32] Gonzalez-Ortega, R., Leyva-Vazquez, M., Sganderla-Figueiredo, J. A., and Guijarro-Rodriguez, A. (2018). Sinos river basin social-environmental prospective assessment of water quality management using fuzzy cognitive maps and neutrosophic AHP-TOPSIS. *Neutrosophic Sets and Systems, 23*, 160-171.
[33]Giri, B. C., Molla, M. U., and Biswas, P. (2018). TOPSIS Method for MADM based on Interval Trapezoidal Neutrosophic Number. *Neutrosophic Sets and Systems, 22*, 151-167.
[34]Broumi, S., Son, L. H., Bakali, A., Talea, M., Smarandache, F., & Selvachandran, G. (2017). Computing Operational Matrices in Neutrosophic Environments: A Matlab Toolbox. *Neutrosophic Sets and Systems, 18*, 58-66.
[35]El-Ghareeb, H. A. (2019). Novel Open Source Python Neutrosophic Package. *Neutrosophic Sets and Systems, 25*, 136-160.
[36]Fang, Z., and Ye, J. (2017) Multiple Attribute Group Decision-Making Method Based on Linguistic Neutrosophic Numbers, *Symmetry*, *9*, 111.

[37]Geiger, M. A., Cooper, S. M. and Boyle, E. J. (2004). Internal control components: did COSO get it right? *The CPA Journal, 74*(1), 28-31.

[38]Grandío-Botella, A. (1997). Total Quality, Strategic Management and Intelligent Organization: Proposal for an Integrative Theoretical Framework (Calidad Total, Dirección Estratégica y Organización Inteligente: Propuesta de un Marco Teórico Integrador)(In Spanish). In *Company and territory strategy: presentations and communications (Estrategia de la empresa y territorio: ponencias y comunicaciones)*: Asociación Científica de Economía y Dirección de la Empresa, ACEDE.

Received: October 01st, 2019. Accepted: February 25rd, 2020