Evaluation of actions to implement quality management and institutional projects in UNIANDES-Quevedo University a neutrosophic approach

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Abstract: The processes of quality management and human vocational training constitute an important element to be measured in higher education organizations. Quantifying its impact makes it possible to project the organization to improve this indicator. However, consolidating the processes of quality management and institutional development for the achievement of professional human development of excellence at the UNIANDES-Quevedo University represents an unresolved task. The present investigation proposes a solution to the problem posed from the development of a method to measure the implementation of quality management in institutional projects. The method bases its operation by neutrosophic numbers and uses a multicriteria approach. The proposal is applied as a case study at the UNIANDES-Quevedo University, from which it was possible to quantify its implementation rate.

Keywords: Method; neutrosophic; multicriteria; quality management

1Introduction

The institutional training management in universities has been framed in a strong theoretical and methodological debate that can cover different issues. Given the various epistemological and methodological positions that exist today in this field, a cultural, political and institutional debate arises. The above leads to recognize in the discussion environments about university reality, the issues associated with university social responsibility [1], [2], [3], university management processes, quality systems, final academic achievements and the scope of quality indices in graduates [4], [5], [6].

As part of the strategy to improve higher education in Ecuador, the consolidation of quality management processes and institutional development represents a line of work for the achievement of professional human development of excellence [7], [8]. At the University of UNIANDES-Quevedo in recent years, the subject has been given vital importance.

Based on the aforementioned analysis, the objective of this research is to develop a method to measure the implementation of quality management in institutional projects.

During the investigation diverse methods of science were used, among them the synthetic analytical, the logical historical, the one of the modeling and the systemic one. This allowed: to carry out a conceptual historical analysis, on quality management and its impact on training in universities, as well as structuring ideas on how to model the training of professionals as managers of culture in the 21st century, in the recognition of human and professional development as guiding categories thereof. Through interviews and observation guides, the investigated problem was corroborated.

From the theoretical references used for the development of this research, there was no evidence of the existence of a method to measure the implementation of project quality management. The fundamental contribution of the research developed is specified in the realization of a comprehensive institutional management project that enables work with various institutional projects perfected for the various substantive functions carried out at the UNIANDES-Quevedo University.

2 Preliminaries

This section introduces the main elements that help to understand the proposed solution. Quality management is described for the context of the present investigation. The problem regarding the management of university institutional quality is presented and finally the use of Neutrosophics Cognitive Maps is described as a proposal for the evaluation of quality management.

2.1 Quality management

In order to implement an integrated institutional management system in any university, it is necessary to recognize concepts such as: quality, systems, quality systems, processes and results; This coincides with the pretense of considering the training of true competent professionals committed to their being, their knowledge, their work and living together, in the context of a transformative and socially relevant university[9], [10]. Therefore, the assessment of aspects such as career evaluation, accreditation and development rates achieved[11], [12]. These are criteria to take into account in this field, because universities need an academic evaluation and accreditation system [13], [14].

The process of university quality and excellence is important within the functions of higher education institutions, with an Academic, Research, Extensionist and management perspective. Highlighting ontological elements that have a preponderance in these processes as [11], [15] :

1. Governance, degree of effectiveness and legitimacy in the exercise of the function of university government; capacity of direction and coordination of the development between the personnel and organizational units, of whose contribution and synergy the institutional efficiency will depend.

2. The normative regulation set of legal instruments to establish the obligations, processes and procedures that the members of the university community must fulfill to exercise a right or benefit. Culture of planning and programming of financial resources, level of modernization of the legal framework that regulates programming and financing linked to the Institutional Development Plan and the Annual Operational Plans of the higher education institution.

3. The responsible University Autonomy, legal capacity to carry out its purposes with the widest freedom and organize its own government. Decentralized management, action to empower the University Centers so that they can execute the training, research, cultural dissemination and extension of services, which favor the development of their environment.

4. Rationality of expenditure, establishment of practices and lines of conduct of austerity and rationalization of operational and administrative expenses, as well as the compaction of occupational structures of campuses, centers, institutes and university units.

5. Technological systemic assurance, adoption of an operation model with a systemic and automated approach, of which all the actors of the university community that contribute to the execution of institutional expenditure are oriented to specific results and goals.

2.2 Issue around quality management

In the management and training dynamics of UNIANDES University, Quevedo Extension, practices are observed in the framework of institutional management and academic, research, extensionist and support processes, which do not make it possible to achieve the aspirations that senior management has raised, from the mission and vision that this university has; These practices constitute weaknesses at the systemic level, and encompass both students, managers, teachers and support staff or services involved in institutional life[1], [2].

When assessing the institutional reality in relation to the quality standards in university management that are established in the country and internationally, it is important to consider as in the context of this university, logic of an extension prevails, as it does not have a fully existing existence autonomous since many essential processes need the control, evaluation and addressing of the matrix, or headquarters [1], [2]. The preliminary studies carried out, which relied on triangulation as a method of determining factual manifestations of the problem, were developed from the analysis of the results of institutional evaluations, the observation of university processes and the application of instruments to measure the satisfaction of the members of the university community, throwing the following elements [1], [2]:

a) The university community of UNIANDES-Quevedo University is unaware of the theories and practices of university institutional excellence recognized in the world. This is expressed in the fact that in the university community of UNIANDES-Quevedo there is a generalized practice of process management from the operational logic, but not of a process management that leads to institutional excellence, highlights the fact that teachers do not participate in the logic or paradigms of university excellence recorded by international organizations.

b) The existing capacities, both of infrastructure, as well as technological or human, are moderately used in the socio-educational context of the UNIANDES-Quevedo University; In this sense, managers, teachers and administrative staff do not have an awareness of management and institutional excellence.

c) Students in training do not achieve excellence in their integral and professional development; because the same in the process of vocational training do not recognize institutional excellence, as they do not handle terms such as relevance, institutional significance in society, quality and impact of graduates.

d) The institutional climate is favorable but fails to be optimal. Institutional communication processes can still be directed to perfect the institutional climate. There is no communication program for students in vocational training that prepares them to understand institutional excellence.

2.3 Neutrosophic Cognitive Map for quality assessment

Causal models: there are different types of causality that are expressed in the form of graphs, where each causal model that can be represented by a graph is a representation of causality between concepts. Causal models allow modeling the cause or effect of a given event [16], [17], [18]. Figure 1 shows a scheme with the different causal relationships.

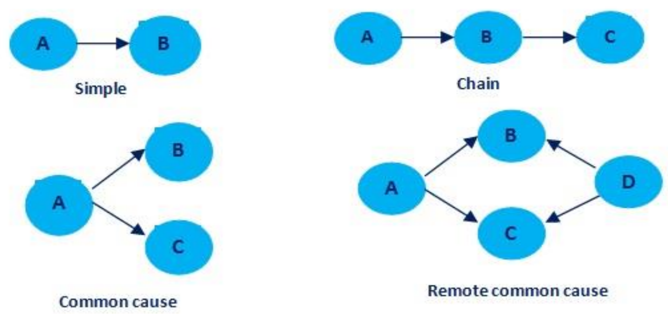

Figure 1: Example of causal graphs.

Neutrophic numbers are defined as: be $N = \{(T, I, F) : T, I, F \subseteq [0,1]1n$, a neutrosophic valuation is a mapping of a group of formulas proportional to N, this is that for every sentence p have:

$$v\ (p) = (T, I, F) \quad (1)$$

With the purpose of facilitating the practical application to decision-making and engineering problems, the proposal of the Single Valued Neutrosophic Numbers was made (SVN) [19], [20], [21] which allow the use of linguistic variables [22], [23], [24] which increases the way of interpreting the recommendation models and the use of indeterminacy.

Let X be a universe of speech. An SVN over X is an object of the form.

$$A = \{\langle x, u_A(x), r_A(x), v_A(x)\rangle : x \in X\}d \quad (2)$$

Neutrosophic Cognitive Map (NCM): it is a technique that allows the representation of the causal relationships of different concepts[25], [26], [23]. It is an extension of mental models using diffuse values in a range of [-1,1] [27],[28], [29]. NCM are represented by diffuse models with feedback to represent causality[30, 31].

In general terms, a cognitive map can be characterized by a set of concepts and causal relationships between nodes[32], [33]. The concepts represent variables, entities or states that usually describe the system that is intended to be modeled in a given domain. On the other hand, causal relationships denote connections between concepts. Each relationship has an associated sign to express the direction of causation. More explicitly, it is true that[34,35:

• If the sign of the connection is positive, then a variation in the concept of cause (initial concept) will cause a variation in the concept of effect in the same direction.
• If the sign of the relationship is negative, then a variation in the concept of cause will cause a variation in the concept of effect in the opposite direction.

3 Design of the method to measure the implementation of quality management in institutional projects

This section describes the operation of the method to measure the implementation of quality management in institutional projects through the Neutrosophics Cognitive Map. The fundamental elements that characterize the proposal are presented to facilitate its understanding.

The method designed to infer the quality management implementation rate is expressed through three basic activities: input, inference and results. Figure 2 shows a general scheme of the proposed method.

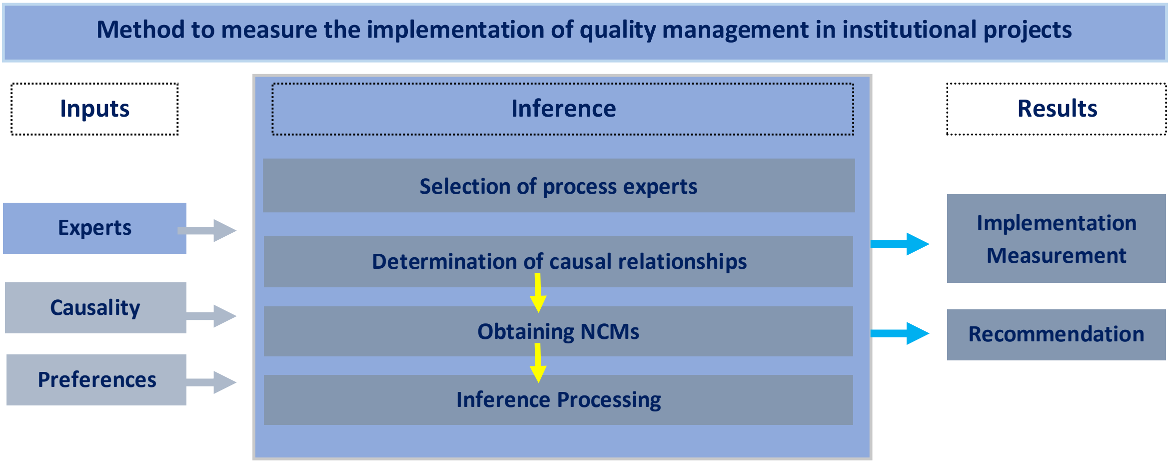

Figure 2: Structure of the proposed method.

The proposed method is structured to support workflow management on the implementation of quality in institutional projects. It employs a multi-expert multicriteria approach. It uses a set of evaluative indicators that represent the basis on which the method makes the inference.
The inference process describes the reasoning from the implementation of the Neutrosophics Cognitive Map technique. Figure 3 shows the activities that describe the workflow of the method.

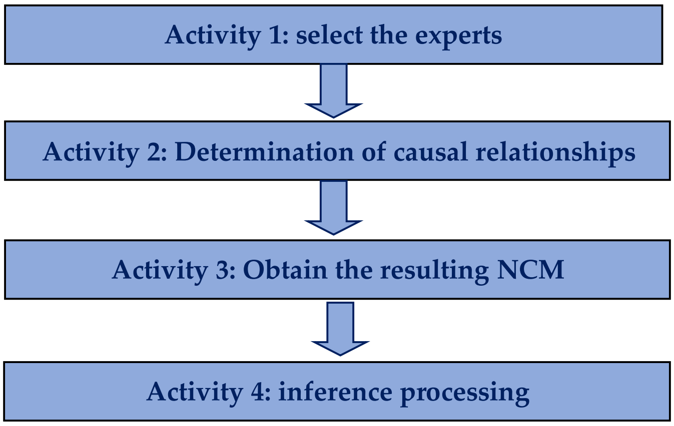

Figure 3: Workflow activities of the method.

A description of the proposed activities follows:

Activity 1 select the experts and determine the indicators:

The activity consists in determining the group of experts involved in the process. A multi-expert approach is used so that:

The number of experts involved in the process $E = \{e_1, \ldots e_m\},\ m \geq 2$,

The number of process evaluation indicators $I = \{i_1, \ldots i_n\},\ n \geq 2$,

Activity 2 determinations of causal relationships:

The determination of the causal relationships consists in establishing the relation of the map concepts. They are represented by diffuse variables expressed as linguistic terms. More explicitly, during the knowledge engineering stage each expert expresses the relationship between each pair of concepts C_i yC_j of the map. Then, for each causal relationship, K rules are obtained with the following structure: If C_i is A THEN C_j is B and weight $W_{ij}$is C.

The Centroid method and the Mamdani inference mechanism are then used to add the k rules, and the defuzified value is the value of the relationship. Figure 4 shows the membership functions used for the domain.

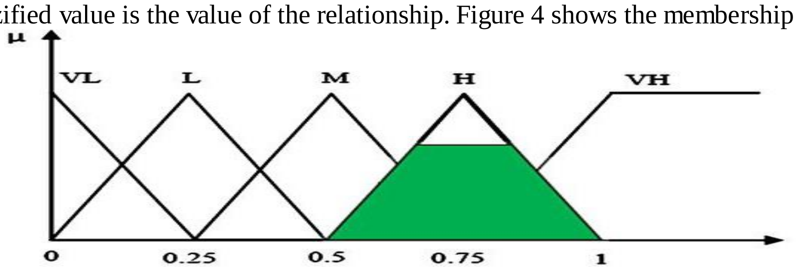

Figure 4: Membership function.

Activity 3 obtaining the resulting NCM:

From the results of activity 2 where the causal relationships are obtained, they are expressed by the adjacency matrix [34]. The aggregate values issued by the grouped experts, make up the relationships with the weights of the nodes, through which the resulting Neutrosophics Cognitive Map is generated [35]. By means of a static analysis of the result of the values obtained in the adjacency matrix, the degree of output can be calculated using equation (3) where the weights attributed to each manifestation are obtained [36].

$$id_i = \sum_{i=1}^{n} \left\| I_{ji} \right\| \tag{3}$$

Activity 4 inference processing:

The degree of activation of a neuron is an indicator of the level of presence of the concept in the system[37]. This feature is a key aspect in the interpretability and usability of NCMs, especially if the threshold function is continuous. Figure 5 shows the appearance of an NCM and the semantics in the activation of a neuron.

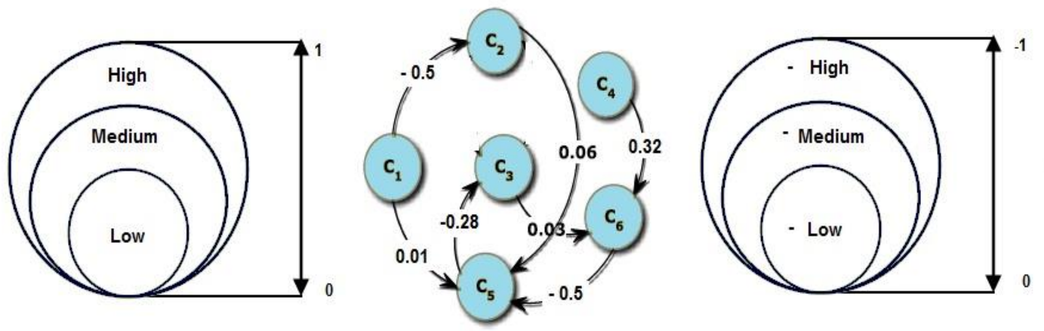

Figure 5: Level of activation of a concept.

From equation (4) the processing is carried out, which consists in calculating the state vector A over time, for an initial condition A^0. Similarly to other neuronal systems, the activation of$C_i$the neurons that directly affect the concept will depend on the activation$C_i$and of the causal weights associated with said concept [38, 39, 40].

$$A_i^{(K+1)} = f\left(A_i^{(K)} \sum_{i=1;\, j\neq i}^{n} A_i^{(K)} * W_{ji}\right) \tag{4}$$

Where:

$A_i^{(K+1)}$: is the value of the concept C_i in step k+1 of the simulation,

$A_i^{(K)}$: is the value of the concept C_j in step k of the simulation,

W_{ji}: is the weight of the connection that goes from the concept C_j to the concept C_i y f (x) It is the activation function.

4. Introduction of the method to measure the implementation of quality management

This section describes the implementation of the proposed method. A case study is carried out where it is possible to determine the behavior of the different alternatives based on determining the implementation of quality management in institutional projects.

For the proposed method, a support system for decision-making is implemented that allows the quality implementation to be measured through quality indicators. The proposal used the institutional projects at the UNIANDES-Quevedo University as the implementation scenario. The results of the study are described below:

Activity 1 select the experts and determine the indicators:

For the development of the study, 3 experts were consulted who represented the basis for the identification of causal relationships. The knowledge about the generation of the Project of innovation in the socio-institutional university management of the UNIANDES-Quevedo University was taken into account. The interactive circular and spiral logical structure. The dynamic generation in responses to institutional evaluation indicators.

From the work with the experts, 6 evaluation indicators were identified, which are related in Table 1.

Number.	Indicator
1	Management dynamics of Technical-Economic Cultural Reproduction
2	Dynamics of Creative Interpretation - Transgressive of Professional Human Development
3	Formation Dynamics of Integrative Human Capabilities
4	Orientation Dynamics of Professional Intentionality
5	Elective Freedom Dynamics responsible for Vocational training
6	Management dynamics Contextual Praxis Professional Partner

Table 1: Evaluative indicators.

Activity 2 determine causal relationships:

For the process of identifying causal relationships, 3 adjacency matrices were obtained corresponding to the 3 experts involved in the process for which they were added in the resulting matrix. Table 2 shows the adjacency matrix resulting from the process.

	C1T, I, F	**C2 T, I, F**	**C3 T, I, F**	**C4 T, I, F**	**C5 T, I, F**	**C6 T, I, F**
C1 T, I, F	[0, 0,0]	[0.7, 0.5,0.2]	[0.5, 0.25,0]	[0.5, 0.2,0]	[0.5, 0.2,0]	[0.5, 0.2,0]
C2 T, I, F	[0.7, 0.5,0.2]	[0, 0,0]	[0.7, 0.5,0.2]	[0.7, 0.5,0.2]	[0.7, 0.5,0.2]	[0, 0,0]
C3 T, I, F	[0, 0,0]	[0.7, 0.5,0.2]	[0, 0,0]	[0.5, 0.2,0]	[0, 0,0]	[0.5, 0.2,0]
C4 T, I, F	[0.7, 0.5,0.2]	[0.5, 0.25,0]	[0.5, 0.2,0]	[0, 0,0]	[0.5, 0.2,0]	[0, 0,0]
C5 T, I, F	[0.5, 0.2,0]	[0.5, 0.25,0]	[0.5, 0.2,0]	[0.5, 0.2,0]	[0, 0,0]	[0.5, 0.2,0]
C6 T, I, F	[0.5, 0.2,0]	[0.5, 0.25,0]	[0.5, 0.2,0]	[0.5, 0.2,0]	[0.5, 0.25,0]	[0, 0,0]

Table 2: Adjacency matrix evaluative indicators.

Activity 3 results of the resulting NCM:

From the resulting adjacency matrix, the Neutrosophic Cognitive Map of the method to measure the implementation of quality management is obtained. Figure 6 shows the resulting Neutrosophic Cognitive Map.

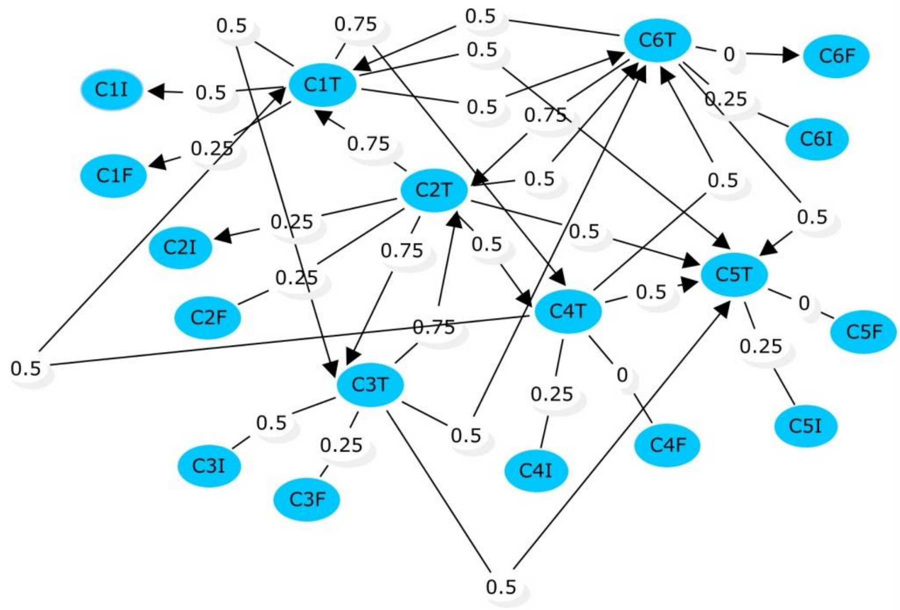

Figure 6: Neutrosophic Cognitive Map resulting.

Activity 4 inference processing:

From the adjacency matrix, the weights attributed to the evaluation indicators were identified by solving equation (3). Table 3 shows the results obtained from the weights.

Number	Evaluative Indicators	Peso
C_1	Management dynamics of Technical-Economic Cultural Reproduction	0,1875
C_2	Dynamics of Creative Interpretation - Transgressive of Professional Human Development	0,1944
C_3	Formation Dynamics of Integrative Human Capabilities	0,1181
C_4	Orientation Dynamics of Professional Intentionality	0,1528
C_5	Elective Freedom Dynamics responsible for Vocational training	0,1736
C_6	Management dynamics Contextual Praxis Professional Partner	0,1736

Table 3: Weight attributed to the evaluation indicators.

Based on the behavior of the weights attributed to the indicators and the behavior in the organization of the evaluation indicators, an information aggregation process is carried out with the objective of estimating the implementation rate. Table 4 shows the result of the calculation performed.

Criteria	Weights	Preferences	Aggregation
C_1	0,1875	0,75	0,140625
C_2	0,1944	1	0,1944
C_3	0,1181	1	0,1181
C_4	0,1528	0,5	0,0764
C_5	0,1736	0,75	0,1302
C_6	0,1736	0,75	0,1302
Index			0,79

Table 4: Weight and preferences attributed to the development of the method.

Once the implementation index is obtained, an analysis of the value obtained is performed where an index of quality management implementation of an I = 79 is evidenced. From the determined value, it can be concluded that the project quality management Institutions at Universidad UNIANDES-Quevedo is at an appropriate level.

Conclusions

From the development of the proposed research, a method is obtained to determine the implementation rate of quality in institutional projects. The proposed method based its operation through a multi-expert multicriteria approach.

From the implementation of the method, the aggregated Neutrosophic Cognitve Map is obtained with the representation of the causal relationships in the evaluation criteria. This element represents the basis for the inference of the operation of the proposed method. A limitation to be address in future work in the inclusion of machine learning mechanism to improve the dynamic behavior con NCM.

From the application of the method in the case study, it is possible to demonstrate the applicability of the method that allowed measuring the quality management implementation index based on the set of evaluation criteria.

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