

Neutrosophic Sets and Systems

Volume 34 *Special Issue: Social Neutrosophy in Latin America*

Article 8

6-1-2020

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Recommended Citation

Galarza Villalba, Miguel Francisco; Marielisa Stefanía Serrano Viteri; Inés Ramos Castro; and Felipe Vera Díaz. "Critical success factors modelling in operational management and the recovery of overdue portfolio of the Babahoyo GAD in The Municipal Market May 4." *Neutrosophic Sets and Systems* 34, 1 (2020). https://digitalrepository.unm.edu/nss_journal/vol34/iss1/8

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Critical success factors modelling in operational management and the recovery of overdue portfolio of the Babahoyo GAD in The Municipal Market May 4

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Abstract. This paper aims to study the situation of the recovery of the overdue portfolio of the Babahoyo Municipal Decentralized Autonomous Government (MDAG) in the municipal market "4 de Mayo". The problem consists in the difficulties arose in tax collection by the municipal government's employees to this market. In the present investigation neutrosophic cognitive maps are applied to assess the relationship between every pair of causes of this problem. For the evaluation, we count on five experts' criteria. Because there exist some pairs of causes whose relationship are unknown, neutrosophic cognitive maps are used instead of the fuzzy ones, where symbol I denotes indeterminate relationships among them. Additionally, the Ishikawa Diagram is applied, which is a simple graphical way to represent the causes and effects of problems.

Keywords: neutrosophic cognitive map, recovery of overdue portfolio, neutrosophic graph, neutrosophic number, Ishikawa diagram.

1 Introduction

All Decentralized Autonomous Governments obtain liquidity from two ways of income, firstly by the collection of direct taxes and secondly by budgetary appropriation from the State. Thus, at the moment that the MDAG has a high index of past due portfolio of taxes, either for property, for occupancy rates of the municipal markets modules, or for different concepts collected by the municipality, its liquidity decreases and also falls into dependence on the State to make payments for current expenses such as remuneration.

Municipality is an institution that is in charge of meeting the requirements that come from the community, and the collection of public resources aims to sponsor the continuous improvement in order to meet the needs of citizens. Its attention focuses on the timely collection of municipal taxes, carried out by the Municipal Treasury Department.

The municipal tax collection procedure is directly responsible for the compilation of public resources that will be invested for the community works benefit. It is essential that the collection process for the modules of the municipal market "4 de Mayo", which the Treasury Department of the Babahoyo MDAG is in charge, made some optimal and strategic changes.

Therefore, the level of municipality's commitment to address central problems that are related to the community and promote the development of Ecuador is highly compromising because they depend on the community's welfare in all its aspects.

Also, this project was aligned with the National Development Plan of Ecuador, since it is the direct duty of the municipalities to reorder the territory and redistribute the power, the money to solve the population's essential problems, as well as the merchants whom they sell their products in the different municipal markets, for which the municipality must have the necessary tools to chronologically describe all the processes for the modules collection of the municipal markets and thus avoid increasing the value of the past due portfolio value.

The recovery of the State, because of it acts in accordance with the general interests of the population, allows us to deepen the improvement in quality and warmth in the provision of public services. This improvement must be the result of a transparent, participatory, inclusive public management that articulates its management with the non-state, private and community public sphere. At present, the country has an institutionalized State with roles and competences assigned to each government level, whose public management during the last ten years has

contributed to the structural transformations in favour of the society. There exist considerable achievements in management, which must be strengthened, but there is always space to improve and, in some cases, amend courses of action taken.

This intervention includes, among others, the following actions:

- Efficient and effective public resources administration.
- Transparency of information and accountability.
- Decentralized management.
- Quality of public services from supply and demand.
- Provision of services with warmth.

Therefore, the collection procedures of the municipal markets should be improved, taking into account this emblematic intervention to renew these processes and thus provide a warmth service to the merchants when they immediately approach to cancel their securities due with the municipality, then these values will be used in the improvement of the municipal market.

The Babahoyo MDAG is in charge of executing the different steps for local development together with the State to improve the living conditions of the community including the merchants, for this end, it must collect the market tax values of 4 de Mayo's in a timely manner, to invest them in works to improve such market.

Given the fundamental need of the Babahoyo municipality to improve the processes that are carried out in the treasury area for the collection of the modules of the municipal market "4 de Mayo", the need arises to implement an operational management that details the processes to follow at the time of making the collection to the merchants of such market, which will reduce the level of overdue portfolio for this concept.

Briefly, our goal is to increase the level of recovery of the past due portfolio of the Babahoyo MDAG related to the municipal market "4 de Mayo". For this, we realize a study based on the Serrano's Bachelor thesis, see [1]. This kind of difficulties has aroused the interest of several researchers in Ecuador; see [2-7].

The technique used in this paper is the Neutrosophic Cognitive Maps. Cognitive maps were introduced by Axelrod, consisting in a directed graph; where each vertex represents a concept and every edge represents the causal relationship between two concepts, see [8][1]. Additionally, the edges are weighted with a value in the set $\{-1, 0, 1\}$, where 0 means there is not any relationship between the concepts; whereas, -1 represents that there exists an inverse relationship between them, and +1 that the relationship between them is direct. Later Kosko introduced the notion of Fuzzy Cognitive Maps, see [9], where the three precedent values of the weights are extended to the interval $[-1, 1]$, to model the strength of the causal relationships.

The most recent approach to this subject are the Neutrosophic Cognitive Maps, which basically are fuzzy cognitive maps where symbol I is added to denote the representation of indeterminate relationships between the concepts, see [10-12]. Because experts cannot establish a relationship between some pair of concepts related to the studied problem, then, neutrosophic cognitive maps are used instead of fuzzy cognitive maps. The uncertainty is modeled aided by the values in $[-1, 1]$.

We also include an Ishikawa Diagram, which is a simple graphical representation of the causes and the effect in the studied problem; see [13-15][2].

This paper is divided as follows; first the section of Materials and Methods contains the concepts of Neutrosophic Cognitive Maps and Ishikawa Diagram. The Results section is devoted to expose the solution of the problem here posed. Finally, we draw the Conclusions.

2 Materials and Methods

This section contains the main theories and methods used in this paper. The first subsection is dedicated to the Neutrosophic Cognitive Maps, whereas the second subsection is devoted to expose the definition of the Ishikawa Diagrams.

2.1 Neutrosophic Cognitive Maps

Neutrosophic logic extends the notion of fuzzy logic, where the semantic of a proposition P is described by a three-tuple $\langle T, I, F \rangle$, each element representing truthfulness, indeterminacy and falseness, respectively.

A neutrosophic matrix is a matrix $A = (a_{ij})$, whose elements have been replaced by elements in $\langle R \cup I \rangle$, where $\langle R \cup I \rangle$ is the neutrosophic integer ring, i.e., the usual integer ring where it is added the symbol I and operations with it, see [16-17][3].

On the other hand, a neutrosophic graph is a graph in which at least one edge or one vertex is neutrosophic. If indeterminacy is introduced in cognitive mapping it is called a Neutrosophic Cognitive Map (NCM).

NCM are based on neutrosophic logic to represent uncertainty and indeterminacy in cognitive maps. A NCM is a directed graph in which at least one edge is an indeterminacy denoted by dotted lines. The static analysis methods in NCM can be read in [12]. The static analysis of NCM is based on neutrosophic numbers, see [16-17], where neutrosophic numbers has the form $a+bI$, where a and b are real numbers, and I = indeterminate.

A de-neutrosophication process was introduced by Salmeron and Smarandache in [18], where a neutrosophic number is associated with a real number. In the following we summarize the main measures used in the NCM adjacency matrix:

1. Outdegree ($od(v_i)$): is the row sum of absolute values of a variable in the neutrosophic adjacency matrix. It shows the cumulative strengths of connections (a_{ij}) exiting the variable.

2. Indegree ($id(v_i)$) is the column sum of absolute values of a variable. It shows the cumulative strength of variables entering the variable.

3. The centrality or total degree ($td(v_i)$), of a variable is the summation of its indegree (in-arrows) and outdegree (out-arrows), see Equation 1.

$$td(v_i) = od(v_i) + id(v_i) \quad (1)$$

The variables can be classified according to their values of Outdegree, Indegree and Total degree, as it is shown:

- a) Transmitter variables have a positive or indeterminacy outdegree $od(v_i)$, and zero indegree $id(v_i)$.
- b) Receiver variables have a positive indegree or indeterminacy $id(v_i)$, and zero outdegree $od(v_i)$.
- c) Ordinary variables have both a nonzero indegree and outdegree. Ordinary variables can be more or less receiver or transmitter variables, based on the ratio of their indegrees and outdegrees.

A de-neutrosophication process gives an interval number for centrality. Finally the nodes are ordered.

The contribution of a variable in a cognitive map can be calculated by its degree of centrality, which shows how connected the variable is to other variables and what the cumulative strength of these connections are. The median of the extreme values is used, see Equation 2:

$$\lambda([a_1, a_2]) = \frac{a_1 + a_2}{2} \quad (2)$$

We can rank the variables by the using Equation 3.

$$\text{Then } A > B \Leftrightarrow \frac{a_1 + a_2}{2} > \frac{b_1 + b_2}{2} \quad (3)$$

2.2 Ishikawa Diagrams

Ishikawa diagrams are due to the Japanese Professor Kaoru Ishikawa, and they were created as part of a group of techniques used to measure quality, see [13][4]. This graphic is also known fishbone diagram because of its shape. This diagram is still used in many fields to graphically represent an effect, its causes and their sub-causes.

Ishikawa diagram consists in a central line, divided in two sections. On the right the problem or the effect is represented, whereas, on the left, some transversal line point to the central line, each of them contains horizontal lines where a cause of the problem is written. At the same time, others lines can point to the line of causes representing sub-causes and so on.

This diagram permits a schematic visual representation of cause-effect representation. It is used in fields like to assist memory and retrieval of relevant medical cases from the medical literature, or for reducing radiator rejection, and in general to represent causes which produce a negative problem, see [14-15][5].

3 Results

To study the causes of the present problem we applied a poll to the population of 40 members of the staff of the Municipal Decentralized Autonomous Government of Babahoyo. Then, we identified the causes of the recovery of overdue portfolio, which are summarized in Table 1.

Cause			Effect
Internal and Financial	Internal and Managerial	External	Low level of recovery of Past Due Portfolio in the municipal market "4 de Mayo"
1. Inefficiency of collection process.	4. Lack of documentation control.	9. Disagreement of merchants for operational management.	
2. Receipts collected and not discounted in the collection system.	5. Lack of collection policies.	10. Merchants do not go to the treasury department to update their data if required.	
3. Late accounts receivable.	6. Lack of procedures.	11. Little interest on the part of the merchants for the fulfillment of the payment obligations of the modules of the municipal market "4 de Mayo" of Babahoyo.	

- 7. Lack of merchant classification.
- 8. They do not have an Operational Management that adequately performs the approval process for municipal market “4 de Mayo” of Babahoyo, amnesties, incentives.

Table 1: Causes and effect in the recovery of overdue portfolio of the Municipal Decentralized Autonomous Government of Babahoyo in the market “4 de Mayo”.

In Table 1, on the left we can see the causes classified in viz., “Internal and Financial”, “Internal and Managerial” and External. The “Internal and Financial” factors consist in the causes related to internal deficiencies of the government having a financial nature, whereas the “Internal and Managerial” are also internal associated with organizational deficiencies. The External ones are negatives effects coming from the workers of the market “4 de Mayo”, which is not directly controlled by the government. See that every cause is numbered from 1 to 11 and we use this numeration in the Ishikawa Diagram of Figure 1.

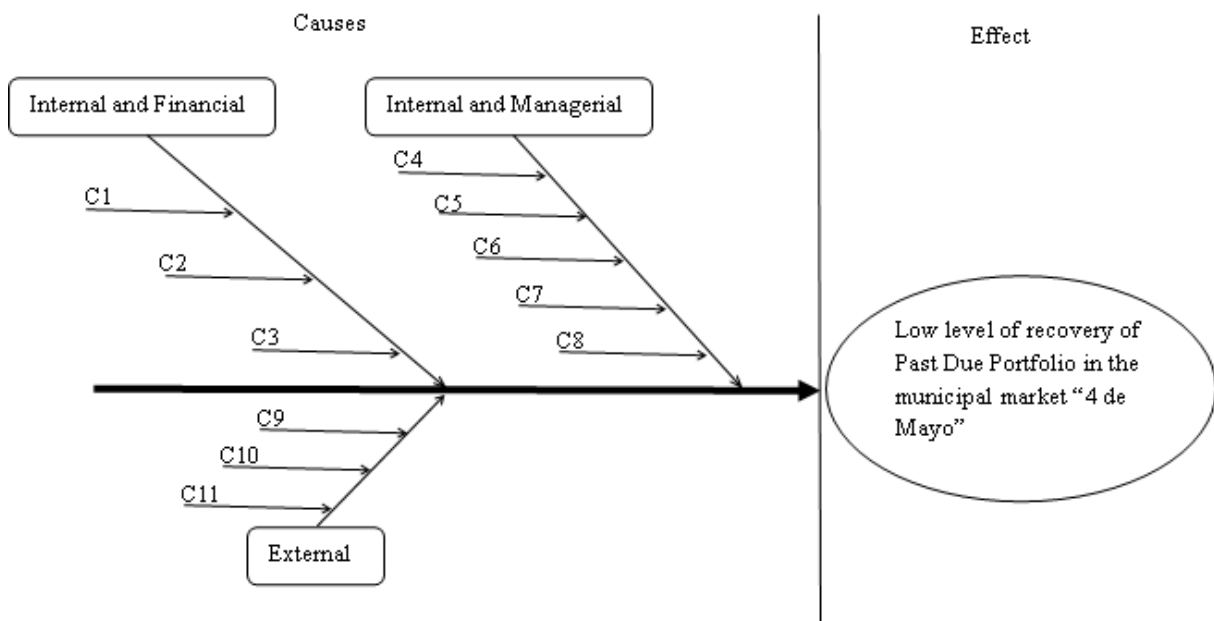


Figure 1: Ishikawa Diagram of the recovery of overdue portfolio of the Municipal Decentralized Autonomous Government of Babahoyo in the market “4 de Mayo”. The number of the represented cause is taken from Table 1.

We considered that the Ishikawa Diagram is not sufficient to determine the nature of the problem. Thus, we studied the relationship among the causes by using Neutrosophic Cognitive Maps. For this, we count on five experts’ assessment on the causal relationships for every pair of causes. In the following we detail the criteria of that assessment:

1. To establish a scale from 0 to 10 to assess the causal relationship between C_i and C_j , $b_{ij} = 0$ when “ C_i does not implies C_j at all”, $b_{ij} = 10$ when “ C_i implies C_j for sure”, and the others values in 1, 2, ..., 9 represents intermediate degrees of causal relationships. Also, $b_{ij} = I$ symbolizes that the causal relationship is indeterminate.
2. Every expert emits his (her) criterion for every $C_i C_j$ edge, according to the scale described in point 1.
3. For every b_{ij} , we calculate the median of them respect to the five experts. When at least one expert evaluates $b_{ij} = I$, then the obtained median is substituted by I.
4. For every median obtained in the point 3, we calculate $a_{ij} = b_{ij}/10$. Moreover, $a_{ij} = I$ if $b_{ij} = I$.

The results for applying the precedent algorithm can be seen in Table 2, where the adjacency matrix of the obtained neutrosophic cognitive map is summarized.

Vertex (v_i)	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	C ₇	C ₈	C ₉	C ₁₀	C ₁₁
C ₁	0	0	0	0	0	0	0	0	0.7	0	0
C ₂	0.6	0	0	0	0	0	0	0	0	0	0
C ₃	0.7	I	0	0	0	0	0	0	0	0	0
C ₄	0.3	0.6	I	0	0	0	0.8	0	0	0	0
C ₅	0.9	0.9	0.9	0.6	0	0	0	0	0.6	0	0
C ₆	0.1	0.9	0.9	0.6	0.8	0	0	0	0.6	0.6	0
C ₇	0.4	0.9	0.6	0	0.6	0.8	0	0	0.6	0	0
C ₈	I	0	I	I	0	0.6	0	0	0.8	I	0
C ₉	0	0	0	I	0	0	0	0	0	0.6	0
C ₁₀	0.6	0	0.8	0	0.8	0	0.6	0	0	0	0
C ₁₁	0.7	0	0.8	0	0.8	I	0	0	0	I	0

Table 2: Adjacency matrix of the Neutrosophic Cognitive Map.

The indegree, outdegree, total degree indexes, and also $\lambda(td(v_i))$ are calculated and they can be seen in Table 3. Additionally, the rank of every one the causes are situated in the last column.

Cause	$id(v_i)$	$od(v_i)$	$td(v_i)$	$\lambda(td(v_i))$	Ranking
C ₁	0.7	4.3+ I	5.0+I	5.5	4
C ₂	0.6	3.3+ I	3.9+I	4.4	7
C ₃	0.7+I	4.0+2.0I	4.7+ 3.0I	6.2	3
C ₄	1.7+I	1.2+ 2.0I	2.9+3.0I	4.4	7
C ₅	3.9	3.0	6.9	6.9	1
C ₆	4.5	1.4+I	5.9+I	6.4	2
C ₇	3.9	1.4	5.3	5.3	5
C ₈	1.4+4.0I	0.0	1.4+4.0I	3.4	10
C ₉	0.6+I	3.3	3.9+I	4.4	7
C ₁₀	2.8	1.2+2.0I	4.0+2.0I	5.0	6
C ₁₁	2.3+2.0I	0.0	2.3+ 2.0I	3.3	11

Table 3: Indegree, Outdegree, Total Degree and Ranking results of every cause.

According to Table 3, variables 8 and 11, representing “They do not have an Operational Management that adequately performs the approval process for municipal market ‘4 de Mayo’ of Babahoyo, amnesties, incentives” and “Little interest on the part of the merchants for the fulfillment of the payment obligations of the modules of the municipal market ‘4 de Mayo’ of Babahoyo” respectively, are receivers, i.e., they are inferred from the other causes and they do not infer others. The rest of the variables are ordinary.

On the other hand, according to the ranking, C₅, C₆ and C₃ are the three most influential variables in this order, thus, the most important strategy to follow is to improve the procedures and collection methods by the functionaries of the municipal government.

Conclusion

The present investigation was dedicated to the study of the problems of collection by the municipal government of Babahoyo on the taxes coming from the municipal market “4 de Mayo”. For this end, the Ishikawa Diagram of causes-effect was obtained. The technique of neutrosophic cognitive maps was also applied to determine the variables that most influence the problem. We yielded that the three variables to which more attention should be paid are: “Lack of collection policies”, “Lack of procedures” and “Late payment of accounts receivable”, in that order. The authorities were informed about these results so that they can take the appropriate measures.

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Received: October 1st, 2019

Accepted: January 22nd, 2020