Neutrosophic Sets and Systems

Volume 52 Article 23

12-1-2022

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Neutrosophic Sets and Systems
{Special Issue: Neutrosophic in Latin America, progress and perspectives}, Vol. 52, 2022
University of New Mexico

Application of Neutrosophy to the Analysis of Open Government, its Implementation and Contribution to the Ecuadorian Judicial System

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Abstract. The implementation of open governments is a trend in recent years in democratic countries, of which Ecuador is a part. Reaching its correct development and operation represents a challenge and an opportunity for the sectors that make up society, including the judicial system. The present investigation is based on the analysis of open government and how it can be brought to reality in the Ecuadorian judicial system, taking into account that like any phenomenon of practical life, it presents a certain degree of indeterminacy in the information analyzed. Methods such as PESTEL analysis, cognitive maps, and neutrosophic soft sets were used. The conditions that must be guaranteed for the application of an open government in Ecuador and the interrelationships between them were determined which were plotted through a neutrosophic cognitive map. Then, the neutrosophic soft sets were applied for the hierarchy of these conditions, determining that in the first place the judicial system should be strengthened through an increase in the mechanisms of citizen participation.

Keywords: open government, neutrosophy, neutrosophic soft set, neutrosophic cognitive maps.

1 Introduction

Having effective spaces for participation is a necessity for countries and democratic systems to maintain citizen trust. The assumed model of public governance must take into account the great persistent inequalities in terms of access and use of information, which is accentuated in the Latin American region. If not managed properly, these inequalities make the implementation of the government much more complex [1].

Open Government is born as a new prototype and way of interacting between the government, society, and administrations. This is a transparent, collaborative, and multidirectional approach to citizen participation, both in monitoring and in public decision-making, from whose stage or space of action it is possible to create public value beyond the borders of state procedures. It is a new way of communicating, organizing, and managing innovation inside and outside the public service. Actively interact with everyone, mainly with citizens; decentralize resources that were constrained, and benefit from massive collaboration. It is characterized by transparency in its operations and does not behave as an isolated department or jurisdiction [2].

Multiple studies have been carried out in this area of knowledge, which is largely subject to the forms of action and perception of people, which makes it difficult to carry out and interpret since a portion of indeterminacy and uncertainty is introduced in information, as happens in most cases of practical life, making it uncertain and not unique, but hesitant or alternative [3]. To include qualitative research, this quantitative character of uncertainty, the discipline known as Neutrosophy arises. There are numerous applications of neutrosophy to real life and specifically, the soft set, among which are the legal and social sciences.

Neutrosophy deals with decision-making problems that involve human knowledge, which frequently presents uncertainty, indeterminacy, and inconsistency in information, this is a tool to represent those inconsistencies and contradictions that undoubtedly exist in the processing of evidence within the social sciences and everyday life [4].

The Neutrosophic set is a novel tool to characterize uncertain information in a more sufficient and precise way, as well as allowing the information to be represented in a more complete and real way, which allows covering not only truth or falsehood but also ambiguity. ignorance, contradiction, neutrality, and saturation [5].

Neutrosophic sets are characterized by a truth membership function (t), an indeterminacy membership function (i), and a falsehood membership function (f) independently, which lie within the standard real unit interval $[-0, 1+]$ standard or not standard [6]. There is not always total certainty in the information that is worked on, since there may be several points of view that sometimes may even be contrary, lack of information, or that it is

incomplete due to various causes, the lack of witnesses, the hesitant opinion of one of the factors involved in the process, among other reasons [7].

When triads of truth values are assigned to the possible values of the obtained sets, meaning membership, non-membership, and indeterminacy, soft set theory is combined with that of neutrosophic sets to obtain greater precision in the results [8]. This situation can be modeled by operators that have some degree of indeterminacy due to the imprecision that exists in the world.

2 Materials and methods

2.1 Strategic Analysis PESTEL

It is a strategic analysis technique to determine the external environment that affects the following factors, namely political, economic, sociocultural, technological, ecological, and legal. It consists of determining the forces that affect the specific environment: sector, employment market, target groups, and competition, among others. It is a technique to analyze businesses that allows and determines the context in which it operates, in turn, allows the design of strategies to defend themselves, take advantage of or adapt to anything that affects the sector. The categories contemplated are the following: internal policies, economics, human resources, technology, social, and legal [9, 10].

2.2 Neutrosophic Cognitive Maps

Starting from the previous elements, in this particular work, the use of Neutrosophic Cognitive Maps (NCMs) is proposed considering the advantages that this technique offers compared to other soft-computing techniques, in terms of interpretability, scalability, aggregation of knowledge, dynamism, and its ability to represent feedback and indeterminacy relationships. NCMs are an integration of the Fuzzy Cognitive Maps (FCMs) introduced by Kosko in 1986 and the Neutrosophic Sets (NSs) introduced by Smarandache in 1995.

This technique overcomes the inability of traditional FCMs to represent indeterminacy. The inclusion of indeterminacy establishes that neutrality and ignorance are also forms of uncertainty. NCMs constitute a technique that has received increasing attention due to their possibilities for representing causality. The following is a set of definitions necessary for working with NCMs.

Definition 1. Let $N = \{(T, I, F): T, I, F \in [0,1]\}$be a neutrosophic set of evaluation v: is a mapping of a group of propositional formulas into N, i.e., each sentence p is associated with a value in N, as it is exposed in Equation 1, meaning that P is T% true, I% indeterminate, and F% false.

$$\mathrm{v}(\mathrm{p}) = (\mathrm{T}, \mathrm{I}, \mathrm{F}) \tag{1}$$

Hence, neutrosophic logic is a generalization of fuzzy logic, based on the concept of neutrosophy according to [11].

Definition 2. (See [12]) Let K be the ring of real numbers. The ring generated by $K \cup I$ is called a neutrosophic ring if it involves the indeterminacy factor in it, where I satisfies $\mathrm{I}2 = \mathrm{I}, \mathrm{I} + \mathrm{I} = 2\mathrm{I}$ and in general, $I + I + \ldots + I = nI$, if $k \in$, then $k.I = kI, 0I = 0$. The neutrosophic ring is denoted by $K(I)$, which is generated by $K \cup I, i.e., K(I) = < K \cup I >$, where $< K \cup \mathrm{I} >$ denotes the ring generated by K and I.

Definition 3. A neutrosophic matrix is a matrix $A = [c]_{ij} = 1, 2, \ldots, m$ and $j = 1, 2, \ldots, n;\ m, n \geq 1$, such that each$a_{ij} \in K(I)$, where $K(I)$ is a neutrosophic ring.

An element of the matrix can have the form $a + bI$, where "a" and "b" are real numbers, whereas I is the indeterminacy factor. The usual operations of neutrosophic matrices can be extended from the classical matrix operations.

For example, $\begin{pmatrix} -1 & \mathrm{I} & 5\mathrm{I} \\ \mathrm{I} & 4 & 7 \end{pmatrix} \begin{pmatrix} \mathrm{I} & 9\mathrm{I} & 6 \\ 0 & \mathrm{I} & 0 \\ -4 & 7 & 5 \end{pmatrix} = \begin{pmatrix} -21\mathrm{I} & 27\mathrm{I} & -6 + 25\mathrm{I} \\ -28 + \mathrm{I} & 49 + 13\mathrm{I} & 35 + 6\mathrm{I} \end{pmatrix}$

Additionally, a neutrosophic graph is a graph that has at least one indeterminate edge or one indeterminate node. The neutrosophic adjacency matrix is an extension of the adjacency matrix in classical graph theory. $a_{ij} = 0$ means nodes i and j are not connected, $a_{ij} = 1$ means that these nodes are connected and $a_{ij} = I$, which means the connection is indeterminate (unknown if it is or if not). Fuzzy set theory does not use such notions. On the other hand, if the indetermination is introduced in a cognitive map, as it is referred to, then this cognitive map is called a neutrosophic cognitive map, which is especially useful in the representation of causal knowledge. It is formally described in Definition 4.

Definition 4. A Neutrosophic Cognitive Map (NCM) is a neutrosophic directed graph with concepts like policies, and events, among others, as nodes and causalities or indeterminates as edges. It represents the causal relationship between concepts. The measures described below are used in the proposed model, they are based on the absolute values of the adjacency matrix [13]:

Outdegree(v_i) is the sum of the row elements in the neutrosophic adjacency matrix. It reflects the strength of outgoing relationships (c_{ij}) of the variable:

$$od(v_i) = \sum_{}^{n} c_{ij} \tag{2}$$

Indegree(v_i) is the sum of the column elements. It reflects the strength of outgoing relationships (c_{ij}) from the variable:

$$id(v_i) = \sum_{}^{n} c_{ji} \tag{3}$$

Total centrality (total degree (v_i)), is the sum of the indegree and the outdegree of the variable:

$$td(v_i) = od(v_i) + id(v_i) \tag{4}$$

The variables are classified according to the following criteria:

- Transmitting variables are those with $od(v_j) > 0\ e\ id(v_i) = 0$
- The receiving variables are those with $od(v_j) = 0\ e\ id(v_i) > 0$
- Ordinary variables satisfy both $od(v_j) \neq 0\ e\ id(v_i) \neq 0$

The static analysis is applied using the adjacency matrix, taking into consideration the absolute value of the weights. Static analysis in Neutrosophic Cognitive Maps (NCM), initially contains the neutrosophic number of the form $(a\ +\ bI)$, where I = indetermination. It requires a process of de-neutrosophication as proposed in [12], where $I\ \in\ [0, 1]$ and it is replaced by their values maximum and minimum. Finally, the average of the extreme values are processed, which is useful to obtain a single value. This value contributes to the identification of the characteristics to be attended, according to the factors obtained, for our case study.

$$\lambda([a_1, a_2]) = \frac{a_1 + a_2}{2} \tag{5}$$

Then,

$$A \succ B \Leftrightarrow \frac{a_1 + a_2}{2} > \frac{b_1 + b_2}{2} \tag{6}$$

2.3 Neutrosophic Soft Set

Let U, be a universe of situations, H a non-empty subset of U, and $P(H)$ the power function of H. Let a be an attribute and A a set of these attribute values.
A function F: $A \rightarrow P(H)$ is called an indeterminate or soft function if:

i. The set A has some indeterminacy;

ii. or $P(H)$ has some indeterminacy;

iii. or there exists at least one attribute value $v \in A$, such that F(v) = *indeterminate* (unclear, uncertain, or not unique);

iv. or two or the three previous situations.

The neutrosophic soft set is defined as the soft set where F (perhaps) or F (indeterminate), etc, is roughly equivalent to F (yes), F (no), F (true), or F (false), associated with a triad of values (α, β, γ), where $(\alpha, \beta, \gamma) \in [0, 1]^3$ mean the degrees of truth, indeterminacy, and falsehood, respectively [14].

From the previously discussed, the following neutrosophic triplet can be formed [14]:

i. (Classical) function, which is a well-defined (inner-defined) function for all elements in its domain of definition, or (T, I, F) = (1,0,0).

ii. Neutrofunction (or neutrosophic function), is a function that is partially well defined (degree of truth T), partially indeterminate (degree of indeterminacy I), and partially externally defined (degree of falsehood F) in its domain of definition, where (T, I, F)ϵ{(1,0,0), (0,0,1)}.

Definition 5. [14]: let U be a universe of situations, H is a non-empty subset of U, with $P(H)$ the power set of H, and an attribute, with its set of attribute values, is denoted by A. Then the pair (F, H), where $F: A \to P(H)$, is called classic soft set on H.

Definition 6. [14]: If the function $F: A \to P(H)$, where for each $x \in A, f(x) \in P(H)$ and $f(x)$ is true and unique, it is called a determinate (classical) function.

2.4 Model based on neutrosophic soft sets

Starting from a group of statements or sentences that will be denoted by $A = \{a_1, a_2, \cdots, a_k\}$, which must be classified or evaluated by the specialists that belong to the group of experts $E = \{e_1, e, \cdots, e_l\}$ chosen for the study. The set of parameters to be measured is given by C={Yes, No}, where "yes" means that for the expert, the statement is positive, while "no" means the opposite.
The algorithm to follow is:

1. A group of statements is compiled whose veracity and relevance in the legal context are to be determined. These will be denoted by $A = \{a_1, a_2, \cdots, a_k\}$.

A group of experts or specialists is convened to issue a criterion regarding the veracity or relevance of the statements described. This is understood as a set.

2. The expert (e_j) is asked to give its opinion on the statement a_i about truthfulness and relevance Expert (e_j) is asked to rate the truth of the statement and its relevance on a scale of 0 to 100. This value is called α_{ij}.

   2.2. Expert (e_j) is asked to give an on-scale evaluation of the falsehood and irrelevance of the statement on a scale of 0 to 100. This value is called γ_{ij}.

   2.3. Expert (e_j) is asked to give an on-scale assessment of the uncertainty relevance of the situation on a scale of 0 to 100. This value is called β_{ij}.

As a result, the following triad is obtained:

$$R\_ij = \langle \alpha\_ij/100, \beta\_ij/100, \gamma\_ij/100 \rangle \quad (7)$$

This is the triad of truth values between 0 and 1, to evaluate the degrees of truth, indeterminacy, and falsehood, respectively, of the relevance of the i-th test according to the j-th expert.

3. The Soft Set is formed by $F: A \to P(H)$, where $A = \{yes, no\}$, being as follows:

$$F(yes) = \{(a_i, e_j, R_{ij}), where\ R_{ij} \neq \langle 0, \tau, 1 \rangle, \tau \geq 0\}, \quad (8)$$

while:

$$F(no) = \{(a_i, e_j, R_{ij}), where\ R_{ij} \neq \langle 1,0,0 \rangle\} \quad (9)$$

4. The final results for tests or evidence are obtained from:

$$G(yes) = \{(a_i, \wedge_j R_{ij}) : j \in \{1,2, \cdots, l\}\ such\ that\ (a_i, e_j, R_{ij}) \in F(si)\} \quad (10)$$

Where, (11) $[\![\wedge\_j\ R]\!]\_ij = \langle \min\_j \{\alpha\_ij/100\}, \max\_j \{\beta\_ij/100\}, \max\_j \{\gamma\_ij/100\} \rangle$

$$G(no) = \{(a_i, \wedge_j NOT(R_{ij})) : j \in \{1,2, \cdots, l\}\ such\ that\ (a_i, e_j, R_{ij}) \in F(no)\} \quad (12)$$

Where, $[\![NOT(R)]\!]\_ij) = \langle \gamma\_ij/100, \beta\_ij/100, \alpha\_ij/100 \rangle$

5. For each proof or evidence s_i, select between $G(yes)$ and $G(no)$ the triad that meets the following requirements.

   5.1 If a_i is in $G(yes)$ and is not in $G(no)$, then this statement is determined to be true or relevant, with a truth value determined by $\overline{R}_i = \wedge_j R_{ij}$.

5.2 If a_i is in $G(no)$ and is not in $G(yes)$, then this statement is determined to be true or relevant, with a truth value determined by $\tilde{R}_i = \wedge_j NOT(R_{ij})$.

5.3 If a_i is in both sets, the following criteria are followed:

A single value $V\_i = (2 + R\_i1 - R\_i2 - R\_i3)/3$ is calculated, where $\bar{R}_i = \langle \bar{R}_{i1}, \bar{R}_{i2}, \bar{R}_{i3} \rangle$, while $F\_i = (2 + R\_i1 - R\_i2 - R\_i3)/3$, where $\tilde{R}_i = \langle \tilde{R}_{i1}, \tilde{R}_{i2}, \tilde{R}_{i3} \rangle$.

5.3.1 If $\bar{V}_i > \bar{F}_i$ then the i-th statement is relevant with a truth value of $\bar{R}_i$.

5.3.2 If $\bar{V}_i < \bar{F}_i$ then the i-th test is not relevant with a value of truth $\tilde{R}_i$.

5.3.4 If $\bar{V}_i = \bar{F}_i$ then it is determined that the i-th test is not relevant enough with a truth value of $\bar{R}_i = \langle \bar{R}_{i1}, \bar{R}_{i2}, \bar{R}_{i3} \rangle$.

6. The statements that were classified as relevant are issued, in order from highest to lowest, where $e_m \succ e_n$ if and only if $\bar{V}_m > \bar{V}_n$.

3 Results

3.1 Results of the bibliographic review

In 2015, the Agenda for 2030 was established by the United Nations Organization, which consists of 17 Sustainable Development Goals, in which a guide is proposed for the coming years to achieve, among other goals, societies with greater and better levels of access to justice instances. According to the Charter of Rights of Persons before Justice in the Ibero-American Judicial Environment adopted in 2017, it is stated that the Judicial Power must act more openly and transparently, the Summit defends a new model of justice that makes it more transparent, understandable, attentive to all people, responsible to the citizen, agile and technologically advanced, and that protects the weakest [15].

One of the models based on public governance that has been proposed in recent years is that of the "Open State", which was dealt with for the first time in 2013 by Oscar Oszlak, according this author, the change in the terminology of "Open Government " to “Open State” involves the fact of taking into account the inherent complexities that are intrinsic within it, since it is made up of public companies, universities, mixed public entities and all kinds of decentralized organizations, both state and non-state [16].

Among the principles of Open Government in the executive branch are transparency, the foundation of democracy. One strategy to achieve it is access to government information. Government action using technology should be made known to citizens in a clear and didactic way, which allows for meeting the needs of social information, improving the image, and regaining confidence in the government, in addition to generating growth and good governance results, fighting corruption, and promoting citizen participation.

Participation is another key element in achieving democracy, it is understood as a serious commitment of citizens to government affairs. The cooperation of citizens in the design of programs and through debates, assessments, criticisms, and complements of laws, decrees, measures, or other decisions made by governments through the opinions of citizens. Collaboration is another of the principles and this can occur between organizations and within them between employees, independent individuals, levels of government, and companies or between all. Its success depends on the achievement of the interaction between communication, trust, commitment, understanding, and results, of the participating actors.

The opening of data makes cooperation possible between the public administration and third parties that want to collaborate with it, so information must be treated as a resource and, therefore, managed properly to identify useful information that must be disclosed, such as documents of consultation, policies, plans, laws, regulations, programs, statistics and the one that the government must supply, such as results indicators, accounts and respond to the required requests.

The information generated by the Judiciary must be available as a whole, at a reasonable reproduction cost, and preferably available for download from the Internet. There must be no discrimination in terms of effort, individuals or groups to use, reuse, and redistribute the information. Access to information should not be restricted to certain uses or subject to copyright. The data must be in formats that allow its reuse, redistribution, and integration with other data, to facilitate the interactive use of the information. Sustainability is particularly relevant to consider whether the benefits of an activity or program can continue over time, regardless of who implements them. The data on the web pages must be kept up to date [17].

3.2 Application of the PESTEL method to identify the conditions to guarantee the application of open government in Ecuador based on the bibliographic review carried out.

Dimension	Condition
Political	Strengthen the judicial system through an increase in citizen participation mechanisms.
Economic	Allocate resources to face the high cost of massive popular consultation and citizen participation processes
Social	Carry out communication and information campaigns for communities on open government
Technological	Use of ICT and dissemination of how to use it
Ecological	No
Legal	Increase official feedback spaces

Table 1: PESTEL. Source: own elaboration. Note: based on the bibliographic review carried out.

Based on the conditions identified by the PESTEL method, the map shown in Figure1 was created.

1) Political
2) Economic
3) Social
4) Technological
5) Legal

A group of experts composed of jurists and law professors was selected. As an inclusion criterion, it was taken into account that the experts had a minimum of five years of professional experience, both as teachers and in practice, associated with the Autonomous University of the Andes.

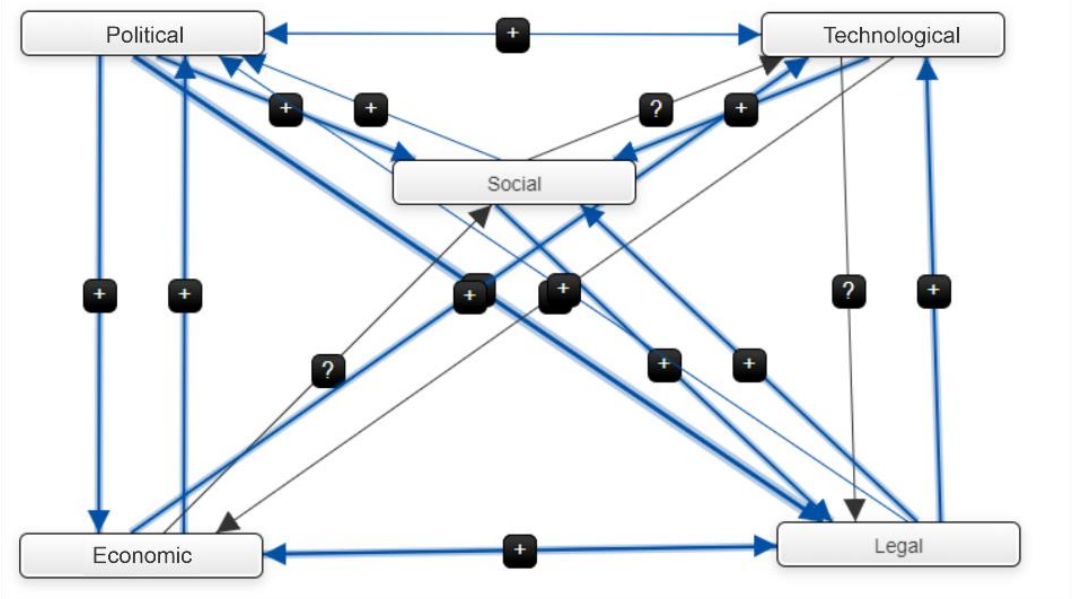

Figure 1: Neutrosophic Cognitive Map. Source: own elaboration.

	Political	Economic	Social	Technological	Legal
Political	0	0.32	0.24	0.16	0.62
Economic	0.21	0	0	0.44	0.13
Social	0.11	I	0	I	0.17
Technological	0.09	I	0.24	0	I
Legal	0.15	0.2	0.22	0.17	0

Table 2: Adjacency matrix. Source: own elaboration.

Component	Indegree	Outdegree	Centrality	Preferred State	Type
Political	0.56	1.34	1.9000000000000001		ordinary
Economic	0.52	0.78	1.3		ordinary
Social	0.7	0.28	0.98		ordinary
Technological	0.77	0.32999999999999996	1.1		ordinary
Legal	0.92	0.74	1.6600000000000001		ordinary

Figure 2: Static Analysis. Source: own elaboration.

3.3 Application of the neutrosophic model.

To carry out the neutrosophic analysis of the difficulties encountered, 4 experts were chosen, from those previously selected, for this purpose those who had at least 2 publications in scientific journals on the subject matter were chosen. The 4 experts consulted (e_1, e_2, e_3, e_4) issue their criteria regarding the conditions identified $(c_1, c_2, c_3, c_4, c_5)$, in triads of values from 0 to 100, to standardize truthfulness, negative and indeterminate answers, where the first score represents the certainty or relevance of the assertion raised, the second value indicates doubt or indeterminacy regarding the assertion described and the third value indicates the falsehood of that assertion.

Conditions:

- c_1: Strengthen the judicial system through an increase in citizen participation mechanisms.
- c_2: Allocate resources to face the high cost of massive popular consultation and citizen participation processes
- c_3: Carry out communication and information campaigns for communities on open government
- c_4 : Use of ICT and dissemination of how to use it
- c_5: Increase official feedback spaces

Expert/Condition	c1	c2	c3	c4	c5
e1	⟨86,12,14⟩	⟨68,16,7⟩	⟨74,7,9⟩	⟨90,5,11⟩	⟨69,11,9⟩
e2	⟨95,8,10⟩	⟨73,2,10⟩	⟨73,12,10⟩	⟨63,10,9⟩	⟨78,12,10⟩
e3	⟨88,9,12⟩	⟨62,18,12⟩	⟨88,10,6⟩	⟨59,8,12⟩	⟨66,16,12⟩
e4	⟨93,0,9⟩	⟨68,12,9⟩	⟨89,11,14⟩	⟨52,11,13⟩	⟨83,14,11⟩

Table 3: Result of the evaluation of the conditions according to the experts.

The above results are divided by 100 to bring them to a [0, 1] scale which is more common in neutrosophic theories.

Expert/Condition	c1	c2	c3	c4	c5
e1	⟨0.86,0.12,0.14⟩	⟨0.68,0.16,0.7⟩	⟨0.74,0.7,0.9⟩	⟨0.90,0.5,0.11⟩	⟨0.69,0.11,0.9⟩
e2	⟨0.95,0.8,0.10⟩	⟨0.73,0.2,0.10⟩	⟨0.73,0.12,0.10⟩	⟨0.63,0.10,0.9⟩	⟨0.78,0.12,0.10⟩
e3	⟨0.88,0.9,0.12⟩	⟨0.62,0.18,0.12⟩	⟨0.88,0.10,0.6⟩	⟨0.59,0.8,0.12⟩	⟨0.66,0.16,0.12⟩
e4	⟨0.93,0,0.9⟩	⟨0.68,0.12,0.9⟩	⟨0.89,0.11,0.14⟩	⟨0.52,0.11,0.13⟩	⟨0.83,0.14,0.11⟩

Table 4: Result of the evaluation of the conditions according to the experts, expressed in the form of neutrosophic numbers.

Soft sets are defined as:

$$F(yes) = \left\{ \begin{array}{c} (e_1, c_1, \langle 0.86,0.12,0.14\rangle), (e_1, c_2, \langle 0.68,0.16,0.7\rangle), (e_1, c_3, \langle 0.74,0.7,0.9\rangle), \\ (e_1, c_4, \langle 0.90,0.5,0.11\rangle), (e_1, c_5, \langle 0.69,0.11,0.9\rangle) \\ (e_2, c_1, \langle 0.65,0.8,0.10\rangle), (e_2, c_2, \langle 0.73,0.2,0.10\rangle), \\ (e_2, c_3, \langle 0.53,0.12,0.10\rangle), (e_2, c_4, \langle 0.63,0.10,0.9\rangle), (e_2, c_5, \langle 0.63,0.10,0.9\rangle) \\ (e_3, c_1, \langle 0.78,0.9,0.12\rangle), (e_3, c_2, \langle 0.62,0.18,0.12\rangle), \\ (e_3, c_3, \langle 0.68,0.10,0.6\rangle), (e_3, c_4, \langle 0.59,0.8,0.12\rangle), \\ (e_3, c_5, \langle 0.66,0.16,0.12\rangle)(e_4, c_1, \langle 0.73,0,0.9\rangle), \\ (e_4, c_2, \langle 0.68,0.12,0.9\rangle), (e_4, c_3, \langle 0.89,0.11,0.14\rangle), \\ (e_4, c_4, \langle 0.52,0.11,0.13\rangle), (e_4, c_5, \langle 0.83,0.14,0.11\rangle) \end{array} \right\}$$

$$F(No) = \left\{ \begin{array}{c} (e_1, c_1, \langle 0.86,0.12,0.14\rangle), (e_1, c_2, \langle 0.68,0.16,0.7\rangle), (e_1, c_3, \langle 0.74,0.7,0.9\rangle), \\ (e_1, c_4, \langle 0.90,0.5,0.11\rangle), (e_1, c_5, \langle 0.69,0.11,0.9\rangle) \\ (e_2, c_1, \langle 0.65,0.8,0.10\rangle), (e_2, c_2, \langle 0.73,0.2,0.10\rangle), \\ (e_2, c_3, \langle 0.53,0.12,0.10\rangle), (e_2, c_4, \langle 0.63,0.10,0.9\rangle), (e_2, c_5, \langle 0.63,0.10,0.9\rangle) \\ (e_3, c_1, \langle 0.78,0.9,0.12\rangle), (e_3, c_2, \langle 0.62,0.18,0.12\rangle), \\ (e_3, c_3, \langle 0.68,0.10,0.6\rangle), (e_3, c_4, \langle 0.59,0.8,0.12\rangle), \\ (e_3, c_5, \langle 0.66,0.16,0.12\rangle)(e_4, c_1, \langle 0.73,0,0.9\rangle), \\ (e_4, c_2, \langle 0.68,0.12,0.9\rangle), (e_4, c_3, \langle 0.89,0.11,0.14\rangle), \\ (e_4, c_4, \langle 0.52,0.11,0.13\rangle), (e_4, c_5, \langle 0.83,0.14,0.11\rangle) \end{array} \right\}$$

$G(yes) = \{(c_1, \langle 0.86,0.12,0.14\rangle), (c_2, \langle 0.62,0.18,0.12\rangle), (c_3, \langle 0.53,0.12,0.10\rangle), (c_4, \langle 0.52,0.11,0.13\rangle), (c_5, \langle 0.66,0.16,0.12\rangle)\}$

$G(no) = \{(c_1, \langle 0.14,0.12,0.86\rangle), (c_2, \langle 0.12,0.18,0.62\rangle), (c_3, \langle 0.10,0.12,0.53\rangle), (c_4, \langle 0.13,0.11,0.52\rangle), (c_5, \langle 0.66,0.16,0.12\rangle)\}$

From $G(yes)$ and $G(no)$ it is concluded that c_1 is relevant with a truth value of $\langle 0.56,0.12,0.14\rangle$, c_2 is relevant with a truth value of $\langle 0.62,0.18,0.12\rangle$, c_3 is relevant with a truth value of $\langle 0.53,0.12,0.10\rangle$, c_4 is relevant with a truth value of $\langle 0.52,0.11,0.13\rangle$, and c_5 is also relevant with a truth value of $\langle 0.66,0.16,0.12\rangle$.

This decision is made since $\overline{V}_1 = 0.87 > \overline{F}_1 = 0.39$; $\overline{V}_2 = 0.77 > \overline{F}_2 = 0.44$; $\overline{V}_3 = 0.84 > \overline{F}_3 = 0.48$; $\overline{V}_4 = 0.76 > \overline{F}_4 = 0.50$; $\overline{V}_5 = 0.79 > \overline{F}_5 = 0.43$.

The difficulties identified are ranked as follows: $c_1 \succ c_3 \succ c_5 \succ c_2 \succ c_4$, where all are relevant or important according to the results obtained.

Finally, the order of relevance of the identified difficulties is as follows:

1- c_1: Strengthen the judicial system through an increase in citizen participation mechanisms.
2- c_3: Carry out communication and information campaigns for communities on open government
3- c_5: Increase official feedback spaces

4- c_2: Allocate resources to face the high cost of massive popular consultation and citizen participation processes

5- c_4 : Use of ICT and dissemination of how to use it

Conclusions

The adoption of an open government is a need and aspiration of democratic countries. Its adoption is not exempt from challenges that must be overcome to achieve adequate performance in this regard. Taking into account the literature consulted, the regulatory framework that supports this type of government, its principles, and its main characteristics were identified. From this and using the PESTEL analysis, the conditions that must be guaranteed for the application of an open government in Ecuador are specified. In order to know the interrelationships between these conditions, neutrosophic cognitive maps were applied, a tool that allowed us to represent the relationships between each one, including those that by their nature were indeterminate.

Neutrosophic soft sets were then applied to rank these conditions, determining that in the first place the judicial system must be strengthened through an increase in citizen participation mechanisms. Then carry out communication and information campaigns to the communities about open government, increase official feedback spaces, allocate resources to deal with the high cost of massive popular consultation and citizen participation processes, and, finally, guarantee the use of ICTs and the dissemination of how to use them.

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Received: August 18, 2022. **Accepted:** October 15, 2022