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Design of a Model for the Evaluation of Social Projects Using Neutrosophic AHP and TOPSIS

Bayron Pinda Guanolema[1], Luis German Castro Morales[2], Dailin Peña Suárez[3] and Mario Javier Cabezas Arellano[4]

[1] Universidad Regional Autónoma de los Andes (UNIANDES). Km 5 ½ vía a Baños. Ambato. Tungurahua. Ecuador. Email: dir.contabilidad@uniandes.edu.ec
[2] Universidad Regional Autónoma de los Andes (UNIANDES). Juan de Salinas 612-500, Ibarra. Imbabura. Ecuador. Email: ui.luiscastro@uniandes.edu.ec
[3] Universidad Regional Autónoma de los Andes (UNIANDES). Calle Teniente Hugo Ortiz, Puyo. Pastaza. Ecuador. Email: up.dailinpena@uniandes.edu.ec
[4] Universidad Regional Autónoma de los Andes (UNIANDES). Avenida La Lorena, Santo Domingo. Ecuador. Email: us.mariocabezas@uniandes.edu.ec

Abstract. Projects are responses to identified problems. So a thorough analysis to detect the problem is extremely important in project management. There are countless types of projects depending on their purpose, content among other issues. Among these, those related to content and social development stand out due to the current context. In the development of this research, the characteristics of a project in a general sense are detailed and it is specified in those related to social programs, taking into account the current situation in the world, mainly influenced by the economic crisis and the Covid 19 pandemic. The foundations for the design and development of a procedure for the evaluation of social projects will be established. A series of principles and premises related to these will be analyzed using the AHP and TOPSIS multicriteria methods in their neutrosophic version. The result is a decision support tool for all the people involved in the process.

Keywords: projects, procedure, principles, premises, Neutrosophy

1. Introduction

The vast majority of human decisions (if not all) can be classified as projects. However, of the thousands or millions of decisions that are adopted and carried out daily, many are relatively simple. In contrast, others require a careful analysis of their probable outcome and, therefore, it is advisable to take a certain time to ensure, as far as possible, that given the prevailing circumstances, the results obtained are the most convenient.

A project is an organized set of actions, carried out in an orderly manner during a determined period, that respond to a demand or problem to offer a solution [1]. In this sense, it is good to point out that the project becomes a tool that has an established deadline, it will be carried out in the future, generating specific products or solutions. There is an infinity of types, depending on their purpose, content, financing, projects can be of one type or another.

Depending on financing:

- Private
- Public
- Mixed or subsidized.

Depending on its content:

- Building
- Business
- Production of goods or services
- Computer scientist.

Depending on the complexity:

- Simple
- Complex

Depending on its purpose:

- Production
- Educational
- Community
- Research or academics
- Social.

The most critical phases of the projects are formulation and evaluation. The formulation is the stage focused on designing the different options of the project, which means systematizing a set of technically feasible possibilities, to achieve the objectives and solve the problem that motivated its initiation. Through the formulation of projects, producing and regulating the most appropriate information is guided, which allows efficient progress in its execution. Furthermore, it implies adapting to a presentation or format that is required for this purpose, containing all the necessary information for its subsequent management or execution.

Evaluation is a process of estimation, assessment and detailed review of the achievements based on the proposed objectives. It allows organizing activities systematically, consolidating the participation of those involved, and reflecting on the need to make changes, to make decisions that lead to its improvement and subsequent implementation. Thus, formulation and evaluation are two interdependent processes, in which one serves as a frame of reference for the other.

There are two types of evaluation depending on when it is carried out and the objectives set:

- The ex-ante evaluation, which is carried out before the operation. Its objective is to estimate costs, impact, scope of objectives, viability and feasibility of the project, ultimately to diagnose the context.
- The ex-post evaluation is carried out in the execution and completion stage of the project. Its objective is to decide whether to continue with the process, establish similar formulations, guide the process, adapt and change conditions, reprogram.

Monitoring is a type of administrative management, which is carried out periodically and at different levels, to monitor and know the inputs, activities, processes, products related to time, quantity, quality, and costs. It allows verifying the development of scheduled activities, measuring management results and optimizing processes.

Just as the ex-post evaluation is carried out during the operation, they differ in that the monitoring is concerned with the analysis of the different components of internal management, in terms of effectiveness, efficiency, and focalization, while the ex-ante evaluation, focuses on the relationship between the products and the achievement of the objectives, that is, externally, (effects, impact, objectives).

From the foregoing, it can be concluded that the evaluation makes it possible to establish a feedback process, which seeks to improve the processes based on future actions and promote the well-being of the participants.[2]. In summary, a project can be defined as "a proposal for action that involves the use of a specific set of resources to achieve expected results." Projects are responses to identified problems, and the analysis to identify the problem is extremely important in project management. Finally, the evaluation process (of identifying, quantifying and evaluating costs and benefits) constitutes a very powerful tool to help define society's priorities.

Social is an adjective related to society (the community formed by individuals who share a culture and who interact with each other). A social project, therefore, has the objective of modifying the living conditions of the people. The intention is that the project improves the daily life of society as a whole or, at least, of the most disadvantaged social groups. Typically, a social project aims to satisfy a basic need of people. Most of these projects, in this way, seek to promote improvements in the fields of education, housing, health, or employment. The social project concept seeks to maintain the balance between three fundamental points that give meaning to its existence: the fragility of the individual, which can lead to a lack, which must be resolved through the responsibility of the social worker. As one of its extremes increases, the other decreases.

At a time marked by the rapid advance of scientific and technological progress, especially visible in the industrialization processes and the concomitant changes in our cultures and societies. Experience teaches that the success of any development attempt depends on the goodness of the knowledge of the economic, sociological, and cultural factors specific to each country or region. From an understanding of these objective conditions and the available means of action, the coherence, relevance, and effectiveness of the development of adopted strategies.

The evaluation of benefits and costs corresponding to investment projects has advanced extraordinarily in the course of the last three decades until it has become a discipline widely used by financing organizations, although it still arouses controversies related not so much to its basic methodological content, but mainly with differences of emphasis with respect to the objectives pursued, the parameters of economic policy, the instruments of action and the interpretation of the elements and relationships of the economic structure of the countries. The same does not happen in the field of social programs. Decisions in this area are usually made with the best intentions to meet the needs of a certain population [3-8].

For this, it is important that in the social field too, the establishment of techniques for evaluating policies, programs and projects is sought. The ex-post evaluation will make it possible to learn from experience and, based on it, to design new projects more appropriately.

The ex-ante evaluation, in turn, will ensure that various ways to achieve the objectives are taken into account and, likewise, that the one that represents the most efficient solution in the use of these resources has been chosen.

The Autonomous University of the Andes has the subject of social development in the Faculty of Mercantile Systems in the Systems Engineering degree where it sets out in its objective to design technological projects oriented to the social sphere and structured under the so-called logical framework scheme. The reason for the present contribution to that institution responds to an attempt to clarify in a general way, the elaboration of intervention projects in social problems to contribute to the development of such processes. Therefore, based on the antecedents above, it is derived as a scientific problem to be solved: how to develop a procedure for the evaluation of social projects for UNIANDES?

The research object is to analyze the basis of a procedure for the evaluation of social projects. Therefore, its field of action is part of the development of UNIANDES social projects. To comply with it, the following specific objectives are proposed:

1. Develop a theoretical framework of reference
2. Establish the basis to design a procedure for the evaluation of social projects at UNIANDES.

The research hypothesis states that, if a procedure is developed for the evaluation of social projects, it will contribute to improving the procurement of preventive and correct information for precise decision-making and selection of projects to guarantee the adequate registration of the activities derived from it.

2. Case Study

The current situation of Latin American social development is far from promising. The economic crisis in the region has affected the living conditions of important segments of the population. In addition to this, the appearance of the Covid-19 shows a not very encouraging picture and requires social assistance of all kinds. Faced with this situation, technicians and professionals from all branches have the responsibility of facilitating political decisions by proposing alternatives that go beyond the merely declarative and pessimistic diagnoses, outlining theoretically based solutions that are supported by the analysis of successes and failures of the past.

In this line, it is especially important to focus on developing adequate methodologies and procedures for the formulation and evaluation of social projects since, in a situation where there is a shortage of resources and the needs have increased, the task of comparing, choosing, and discard alternative projects, while seeking to increase the rationality of the options adopted, would be even more pressing.

The evaluation of social projects plays a central role in this rationalization process and is a basic element of planning. These cannot be effective and efficient if the results of their application are not evaluated. For this reason, having ex-post evaluations of projects in progress or already carried out is essential to improve their design. Likewise, the ex-ante evaluation allows you to choose the best option of the programs and projects in which the political actions are specified.

The existing experience in the field of evaluating social projects has large gaps. On the one hand, there is the tradition of social evaluation linked to the ex-ante stage of those projects that comply with all the "states" of the conventional cycle: pre-investment, investment, and operation, which means that social projects imply the design and execution of physical work (investment) so that they can operate. But there are various types of social projects that do not require any physical work, or where it has a marginal magnitude, for which these projects would remain without the possibility of being evaluated.

On the other hand, there is no doubt that cost-benefit analysis is a useful tool for evaluating social projects. It is also equally undeniable that there are strong restrictions derived from the methodology used to analyze projects whose products are not translatable into benefits expressed in monetary units.

Due to the above, the need to develop a procedure for the evaluation of social projects is considered. To achieve this procedure, certain fundamentals must be followed to guarantee coherence and correct implementation. At the beginning of this first stage, a bibliographic review was carried out that allowed defining some principles and premises related to these procedures for their correct design.

Principles:

1. Practicality or Utility: This principle must be understood in a double aspect. The evaluation must be practical, in the sense that an evaluation with very sophisticated instruments is of little use when what is intended can be achieved by simpler procedures. The "practicality" of an evaluation is given by the adequacy of the design used with the intended purpose of the conclusions and recommendations. And it is called *useful* because the evaluation should serve to improve the program, project, activities, or service that is being evaluated; its results must be applicable and usable in decision-making by those who have administration and management responsibility; They must respond clearly and concisely to the interests of the multiple hierarchical levels (funder, politicians, executing units, counterparts or beneficiaries)
2. Credibility: depends on the specialization, independence, and transparency of the process. Transparency must be a characteristic throughout the evaluation process, from selecting, executing, and disseminating reports at different levels.

3. Impartiality: contributes to the credibility of the evaluation and the elimination of prejudices in the results, analysis, and conclusions
4. Objectivity. The programs will be oriented to eradicate the structural causes of poverty, extreme poverty, marginality, and prevention and reduction of vulnerability in all its manifestations.
5. Timeliness: a key point that influences the ability to use the results promptly; it must be carried out at a time when it is possible to introduce corrections or modifications in the process of management and/or implementation of a program or project or to introduce them quickly enough when dealing with very dynamic processes; that it is done with the full acceptance of the political, technical and administrative officials who have the power to make decisions and introduce corrections
6. Independence: provides legitimacy to the evaluation and reduces the potential conflict of interest that could arise if policymakers and managers are solely responsible for evaluating their activities
7. Validity: It is understood that the evaluation meets this requirement when it is capable of revealing, in a demonstrable and controllable way, that the evaluations and judgments that have been made are valid. The principle of validity involves the possibility of rigorously estimating what is to be verified, excluding all kinds of systematic distortions, and that the data collected can be used for evaluation.
8. Reliability: an evaluation is reliable or safe when, applied repeatedly and in the same situation to the same individual or group, or at the same time by different researchers, it provides the same or similar results

These principles [9] were subjected to multicriteria analysis, using neutrosophic AHP for the versatility in decision-making to determine the relevance related to the evaluation of social projects. To ensure that the principles are met during the development of the procedure, a group of UNIANDES experts brainstormed a series of premises related to them.

Premises:

1. There are conditions and an appropriate environment for the assessment task to be possible
2. The evaluation must be useful, feasible, ethical, and accurate
3. The political and administrative leaders of the project are fully convinced that the evaluation is necessary; they must agree on its purposes, thus they are fully committed to the decision to include the evaluation as part of their program.
4. There are the resources required to carry out an evaluation
5. Who will be responsible for conducting the evaluation is defined and responsibilities are distributed
6. The personnel participating in the evaluation have the appropriate knowledge about the techniques and tools for its realization
7. The effective participation and the willingness to cooperate of the users or beneficiaries who will take part in the evaluation are ensured, for which they are defined with which criteria are selected
8. The information that is expected to be obtained, as well as the objectives of the evaluation, must be clarified and defined.
9. The evaluation must generate sufficient information to arrive at valid, systematic, and reliable results, on time, in such a way that its conclusions can be applied within a reasonable space of time and in the life cycle of the project or planning.
10. It must be clearly known how the processes associated with the implementation of the project are organized and how the flows and interrelationships between the different components of the system are manifested, to identify the sources of value creation.

Taking into consideration the amount of premises obtained, to select the best ones that allow determining a path to follow, the technique called TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) was used. This technique is characterized by its effectiveness and the simplicity of its principle in solving multicriteria decision problems.

3. Methods

After studying the case, it is convenient to define the methods used for this research.

- Analysis and synthesis: for the development of the theoretical framework and bibliographic analysis, the determination of the common thread of the evaluation model of social projects and the elaboration of the conclusions.
- Hypothetical - Deductive: for the formulation of hypotheses, it was also used in all stages of the research in the analysis of the research problem, which allowed the extraction of the necessary information to support both the theory and also reach the conclusions.

- Logical history for the background analysis of the process both in the state of the art and in practice in the country.
- Surveys: they are developed and applied to the experts who will intervene in decision-making.

Experts' selection:

The competencies of potential experts are checked. For this, a competency validation survey was applied, tested by [10] where it is carried out through self-assessments, on a scale from 1 to 10 the degree of knowledge that said potential expert possesses about the subject and the degree of influence that each of the sources of argumentation has. The processing of the form was based on the calculation of the rating factor of the experts through the following mathematical expression:

$$K = ((FA + GC)) /= [((SI + EP + IR + FB)) / 4 + GC]/2 \qquad (1)$$

Where:

YI = your intuition

EP = practical experience	IR = Investigations carried out by you	FB = Consultation of bibliographic sources	CG: degree of knowledge (1-10)
K-value	Classification		
8-10	High		
5-7	Half		
1-4	Under		

Neutrosophic AHP:

Analytic Hierarchy Process (AHP): it was proposed by Thomas Saaty in 1980 [11]. It is one of the most widespread methods for solving multicriteria decision-making problems. This technique models the problem that leads to the formation of a representative hierarchy of the associated decision-making scheme. This hierarchy presents in the upper level the objective that is pursued in the solution of the problem and in the lower level the different alternatives are included from which a decision must be made. The intermediate levels detail the set of criteria and attributes considered [12-25]. For the description of the method it is necessary to present the following definitions:

Definition 1: ([26, 27]) The Neutrosophic set N is characterized by three membership functions, which are the truth-membership function TA, indeterminacy-membership function IA, and falsehood-membership function FA, where U is the Universe of Discourse and ∀x∈U, TA (x), IA (x), FA (x) ⊆] -0, 1+ [, and -0≤inf TA (x) + inf IA (x) + inf FA (x) ≤sup TA (x) + sup IA (x) + sup FA (x)≤3+. Notice that, according to the definition, TA (x), IA (x) and FA (x) are real standard or non-standard subsets of] -0, 1+ [and hence, TA (x), IA (x) and FA (x) can be subintervals of [0, 1].

Definition 2: ([26, 27]) The Single-Valued Neutrosophic Set (SVNS) N over U is A = {<x; TA (x), IA (x), FA (x)>: x∈U}, where TA: U→[0, 1], IA: U→[0, 1], and FA: U→[0, 1], 0 ≤TA (x) + IA (x) + FA (x)≤ 3. The Single-Valued Neutrosophic Number (SVNN) is represented by N = (t, I, f), such that 0 ≤t, I, f ≤ 1 and 0 ≤t + I + f≤ 3.

Definition 3: ([26-29]) the single-valued trapezoidal neutrosophic number $\tilde{a} = \langle (a_1, a_2. a_3, a_4); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \rangle$, is a neutrosophic set on ℝ, whose truth, indeterminacy, and falsehood membership functions are defined as follows, respectively:

$$T_{\tilde{a}}(x) = \begin{cases} \alpha_{\tilde{a}\left(\frac{x-a_1}{a_2-a_1}\right)}, & a_1 \leq x \leq a_2 \\ \alpha_{\tilde{a}}, & a_2 \leq x \leq a_3 \\ \alpha_{\tilde{a}\left(\frac{a_3-x}{a_3-a_2}\right)}, & a_3 \leq x \leq a_4 \\ 0, \text{ otherwise} \end{cases} \qquad (2)$$

$$I_{\tilde{a}}(x) = \begin{cases} \frac{(a_2 - x + \beta_{\tilde{a}}(x-a_1))}{a_2-a_1}, & a_1 \leq x \leq a_2 \\ \beta_{\tilde{a}}, & a_2 \leq x \leq a_3 \\ \frac{(x-a_2+\beta_{\tilde{a}}(a_3-x))}{a_3-a_2}, & a_3 \leq x \leq a_4 \\ 1, & \text{otherwise} \end{cases} \qquad (3)$$

$$F_{\tilde{a}}(x) = \begin{cases} \frac{(a_2 - x + \gamma_{\tilde{a}}(x - a_1))}{a_2 - a_1}, & a_1 \le x \le a_2 \\ \gamma_{\tilde{a}}, & a_2 \le x \le a_3 \\ \frac{(x - a_2 + \gamma_{\tilde{a}}(a_3 - x))}{a_3 - a_2}, & a_3 \le x \le a_4 \\ 1, & \text{otherwise} \end{cases} \quad (4)$$

Where, and. $\alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \in [0, 1]$ $a_1, a_2, a_3, a_4 \in \mathbb{R} a_1 \le a_2 \le a_3 \le a_4$

Definition 4: ([26-29]) given and two single-valued trapezoidal neutrosophic numbers and $\tilde{a} = \langle (a_1, a_2, a_3, a_4); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \rangle \tilde{b} = \langle (b_1, b_2, b_3, b_4); \alpha_{\tilde{b}}, \beta_{\tilde{b}}, \gamma_{\tilde{b}} \rangle$ λany non-null number in the real line. Then, the following operations are defined:

Addition: $\tilde{a} + \tilde{b} = \langle (a_1 + b_1, a_2 + b_2, a_3 + b_3, a_4 + b_4); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle$

Subtraction: (4)$\tilde{a} - \tilde{b} = \langle (a_1 - b_4, a_2 - b_3, a_3 - b_2, a_4 - b_1); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle$

Investment: where.$\tilde{a}^{-1} = \langle ({a_4}^{-1}, {a_3}^{-1}, {a_2}^{-1}, {a_1}^{-1}); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \rangle a_1, a_2, a_3, a_4 \neq 0$

Multiplication by a scalar number:

$$\lambda\tilde{a} = \begin{cases} \langle (\lambda a_1, \lambda a_2, \lambda a_3, \lambda a_4); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \rangle, & \lambda > 0 \\ \langle (\lambda a_4, \lambda a_3, \lambda a_2, \lambda a_1); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \rangle, & \lambda < 0 \end{cases} \quad (5)$$

Definitions 3 and 4 refer to single-valued triangular neutrosophic number when the condition a2 = a3, [30-32]. For simplicity, we use the linguistic scale of triangular neutrosophic numbers, see Table 1 and also compare it with the scale defined in[33]. The analytic hierarchy process was proposed by Thomas Saaty in 1980 [11]. This technique models the problem that leads to the formation of a hierarchy representative of the associated decision-making scheme [12, 13]. The formulation of the decision-making problem in a hierarchical structure is the first and main stage. This stage is where the decision-maker must break down the problem into its relevant components [34], [35, 36]. The hierarchy is constructed so that the elements are of the same order of magnitude and can be related to some of the next levels. In a typical hierarchy, the highest level locates the problem of decision-making. The elements that affect decision-making are represented at the intermediate level, the criteria occupying the intermediate levels. At the lowest level, the decision options are understood [37]. The levels of importance or weighting of the criteria are estimated using paired comparisons between them. This comparison is carried out using a scale, as expressed in equation (6) [38].

$$S = \left\{\frac{1}{9}, \frac{1}{7}, \frac{1}{5}, \frac{1}{3}, 1,3,5,7,9\right\} \quad (6)$$

We can find in [33]the theory of the AHP technique in a neutrosophic framework. Thus, we can model the indeterminacy of decision-making by applying neutrosophic AHP or NAHP for short. Equation 7 contains a generic neutrosophic pair-wise comparison matrix for NAHP.

$$\tilde{A} = \begin{bmatrix} \tilde{1} & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ \vdots & & \ddots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \cdots & \tilde{1} \end{bmatrix} \quad (7)$$

The matrix must satisfy the condition, based on the inversion operator of Definition 4. $\tilde{A}$ $\tilde{a}_{ji} = \tilde{a}_{ij}^{-1}$

To convert neutrosophic triangular numbers into crisp numbers, there are two indexes defined in [33]. They are the so-called score and accuracy indexes, respectively, see Equations 8 and 9:

$$S(\tilde{a}) = \frac{1}{8}[a_1 + a_2 + a_3](2 + \alpha_{\tilde{a}} - \beta_{\tilde{a}} - \gamma_{\tilde{a}}) \quad (8)$$

$$A(\tilde{a}) = \frac{1}{8}[a_1 + a_2 + a_3](2 + \alpha_{\tilde{a}} - \beta_{\tilde{a}} + \gamma_{\tilde{a}}) \quad (9)$$

Saaty's scale	Definition	Neutrosophic Triangular Scale
1	Equally influential	$\tilde{1} = \langle(1,1,1); 0.50, 0.50, 0.50\rangle$
3	Slightly influential	$\tilde{3} = \langle(2,3,4); 0.30, 0.75, 0.70\rangle$
5	Strongly influential	$\tilde{5} = \langle(4,5,6); 0.80, 0.15, 0.20\rangle$
7	Very strongly influential	$\tilde{7} = \langle(6,7,8); 0.90, 0.10, 0.10\rangle$
9	Absolutely influential	$\tilde{9} = \langle(9,9,9); 1.00, 1.00, 1.00\rangle$
2, 4, 6, 8	Sporadic values between two close scales	$\tilde{2} = \langle(1,2,3); 0.40, 0.65, 0.60\rangle$
		$\tilde{4} = \langle(3,4,5); 0.60, 0.35, 0.40\rangle$
		$\tilde{6} = \langle(5,6,7); 0.70, 0.25, 0.30\rangle$
		$\tilde{8} = \langle(7,8,9); 0.85, 0.10, 0.15\rangle$

Table 1. Saaty's scale translated to a neutrosophic triangular scale.

Step 1 Select a group of experts.

Step 2 Structure the neutrosophic pair-wise comparison matrix of factors, sub-factors, and strategies, through the linguistic terms shown in Table 1.

The neutrosophic scale is attained according to expert opinions[39]. The neutrosophic pair-wise comparison matrix of factors, sub-factors, and strategies are as described in Equation 6.

Step 3 Check the consistency of experts' judgments.

If the pair-wise comparison matrix has a transitive relation, ie, aik = aijajk for all i, j, and k, then the comparison matrix is consistent, focusing only on the lower, median, and upper values of the triangular neutrosophic number of the comparison matrix.

Step 4 Calculate the weight of the factors from the neutrosophic pair-wise comparison matrix, by transforming it to a deterministic matrix using Equations 9 and 10. To get the score and the accuracy degree of the following equations are used:$\tilde{a}_{ji}$

$$S(\tilde{a}_{ji}) = 1/S(\tilde{a}_{ij}) \quad (10)$$

$$A(\tilde{a}_{ji}) = 1/A(\tilde{a}_{ij}) \quad (11)$$

With compensation by accuracy degree of each triangular neutrosophic number in the neutrosophic pair-wise comparison matrix, we derive the following deterministic matrix:

$$A = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ \vdots & & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & 1 \end{bmatrix} \quad (12)$$

Determine the ranking of priorities, namely the Eigen Vector X, from the previous matrix:

1. Normalize the column entries by dividing each entry by the sum of the column.
2. Take the total of the row averages.

Note that Step 3 refers to consider the use of the calculus of the Consistency Index (CI) when applying this technique, which is a function depending on λ_{max}, the maximum eigenvalue of the matrix. Saaty establishes that consistency of the evaluations can be determined by the equation:

$$CI = \frac{\lambda_{max} - n}{n-1} \text{ [40]}, \quad (13)$$

where n is the order of the matrix, in addition, the Consistency Ratio (CR) is defined by the equation:

$$CR = \frac{CI}{RI} \quad (14)$$

RI is given in Table 2.

Order (n)	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

Table 2. RI associated with every order.

If CR≤0.1 we can consider that experts' evaluation is sufficiently consistent, we can use NAHP. We apply this procedure to matrix "A" in Equation 12.

TOPSIS

In the case of TOPSIS, the selection is based on finding the alternative that is closest to the ideal solution and, in turn, moves further away to the worst solution. It was developed by Hwang and Yoon in 1981 and is based on the concept that a given alternative should be located at the shortest distance from an ideal alternative that represents the best (positive ideal or simply ideal), and at the greatest distance from an ideal alternative that represents the worst (negative ideal or anti-ideal) [41, 42]. This method had its evolution towards Neutrosophy. In this paper, linguistic terms will be associated with Single-Valued Neutrosophic Numbers (S), so that experts can carry out their assessments in linguistic terms, which is more natural [16, 22, 43-49]. Therefore, the scales shown in Table 3 will be taken into account.

Linguistic term	NNVU
Highly related (AR)	(0.9, 0.1, 0.1)
Related (R)	(0.75,0.25,0.20)
Medically related (MR)	(0.50,0.50,0.50)
Little related (PR)	(0.35,0.75,0.80)
Very little related (MPR)	(0.10,0.90,0.90)

Table 3. Linguistic terms that represent the evaluation of the criteria in the alternatives.

The TOPSIS method for SVNN consists of the following, assuming it is a set of alternatives and it is a set of criteria, where the following steps will be carried out: $A = \{\rho_1, \rho_2, \dots, \rho_m\} G = \{\beta_1, \beta_2, \dots, \beta_n\}$

Step 1: Establish a performance matrix

In this step, we proceed to the construction of the neutrosophic decision matrix of aggregated single values. Which is used to aggregate all individual evaluations. Each dij is calculated as the aggregation of the evaluations given by each expert using the weights of the AHP of each criterion with the help of equations 7 and 8 and tables 1 and 2. In this way, a matrix D = (dij) ij is obtained, where each dij is a SVNN (i = 1,2, .., m; j = 1,2,…, n).$(u_{ij}^t, r_{ij}^t, v_{ij}^t)$

Step 2: Normalize the decision matrix

Suppose that the weight of each criterion is given by W = (w1, w2,…, wn), where wj denotes the relative importance of the criterion wj. If it is the evaluation of criterion wj by the t-th expert. Then Equation 13 is used to add those with the weights. The construction of the normalized matrix will be as follows:$w_j^t = (a_j^t, b_j^t, c_j^t) w_j^t$

$$w_{ij} = \frac{f_{ij}}{\sqrt{\sum_{j=1}^{n} f_{ij}^2}} \tag{15}$$

Where: w_{ij} is the normalized value for the qualification of alternative i against criterion j and fij is the indicator of each alternative i against each indicator j.

Step 3: Calculate the weight normalized decision matrix

We proceed to constructing the neutrosophic decision matrix of the weighted average of single values with respect to the criteria.

$$D^* = D^*W, \text{ where } d_{ij}^* = w_j * d_{ij} = (a_{ij}, b_{ij}, c_{ij}) \tag{16}$$

Step 4: Determine the positive ideal and negative ideal solutions

$$s^{+} = (x_1^{+}, x_2^{+}, \dots x_{j+l}^{+}) \text{ namely, } s_i^{+} = \left(\frac{1}{3}\sum_{j=1}^{n}\left\{\left(a_{ij} - a_j^{+}\right)^2 + \left(b_{ij} - b_j^{+}\right)^2 + \left(c_{ij} - c_j^{+}\right)^2\right\}\right)^{\frac{1}{2}} \quad (17)$$

$$s^{-} = (x_1^{-}, x_2^{-}, \dots x_{j+l}^{-}) \text{ namely, } s_i^{-} = \left(\frac{1}{3}\sum_{j=1}^{n}\left\{\left(a_{ij} - a_j^{-}\right)^2 + \left(b_{ij} - b_j^{-}\right)^2 + \left(c_{ij} - c_j^{-}\right)^2\right\}\right)^{\frac{1}{2}} \quad (18)$$

Step 5: *Calculation of the distances to the ideal positive and negative SVNN solutions.* With the help of Equation 6, the following Equations are calculated:

$$\rho(A^k, A^{+}) = \|w * (TA^k - TA^{+})\| \quad (19)$$

$$\rho(A^k, A^{-}) = \|w * (TA^k - TA^{-})\| \quad (20)$$

Step 6: Calculate the relative closeness to the ideal solution

To calculate the Relative Proximity Index (Ri), it is done as follows. The proximity coefficient of each alternative is calculated with respect to the positive and negative ideal solutions.

$$Ri(A^k, A^i) = \frac{\rho(A^k, A^{+})}{\rho(A^k, A^{+}) + \rho(A^k, A^{-})} \quad (21)$$

Step 7: Rank the preference order
The alternatives are ordered from highest to lowest, under the condition that Ri1 is the optimal solution.→

4. Results and discussion

Once the different previous approaches have been analyzed, the techniques described above will be applied: with the Neutrosophic AHP method, the weights of the principles on which the procedure for evaluating social projects will be based are based on the following determined.

Principles	P1	P2	P3	P4	P5	P6	P7	P8
P1	1	⟨(6,7,8);0.90,0.10,0.10⟩	⟨(6,7,8);0.90,0.10,0.10⟩	⟨(6,7,8);0.90,0.10,0.10⟩	⟨(7,8,9);0.85,0.10,0.15⟩	⟨(5,6,7);0.70,0.25,0.30⟩	⟨(5,6,7);0.70,0.25,0.30⟩	⟨(5,6,7);0.70,0.25,0.30⟩
P2	⟨(6,7,8);0.90,0.10,0.10⟩	1	⟨(2,3,4);0.30,0.75,0.70⟩	⟨(4,5,6);0.80,0.15,0.20⟩	⟨(3,4,5);0.60,0.35,0.40⟩	⟨(6,7,8);0.90,0.10,0.10⟩	⟨(6,7,8);0.90,0.10,0.10⟩	⟨(6,7,8);0.90,0.10,0.10⟩
P3	⟨(6,7,8);0.90,0.10,0.10⟩	⟨(2,3,4);0.30,0.75,0.70⟩	1	⟨(2,3,4);0.30,0.75,0.70⟩	⟨(2,3,4);0.30,0.75,0.70⟩	⟨(2,3,4);0.30,0.75,0.70⟩	⟨(2,3,4);0.30,0.75,0.70⟩	⟨(2,3,4);0.30,0.75,0.70⟩
P4	⟨(6,7,8);0.90,0.10,0.10⟩	⟨(4,5,6);0.80,0.15,0.20⟩	⟨(2,3,4);0.30,0.75,0.70⟩	1	⟨(1,1,1);0.50,0.50,0.50⟩	⟨(2,3,4);0.30,0.75,0.70⟩	⟨(2,3,4);0.30,0.75,0.70⟩	⟨(2,3,4);0.30,0.75,0.70⟩
P5	⟨(7,8,9);0.85,0.10,0.15⟩	⟨(3,4,5);0.60,0.35,0.40⟩	⟨(2,3,4);0.30,0.75,0.70⟩	⟨(1,1,1);0.50,0.50,0.50⟩	1	⟨(1,1,1);0.50,0.50,0.50⟩	⟨(1,1,1);0.50,0.50,0.50⟩	⟨(1,1,1);0.50,0.50,0.50⟩
P6	⟨(5,6,7);0.70,0.25,0.30⟩	⟨(6,7,8);0.90,0.10,0.10⟩	⟨(2,3,4);0.30,0.75,0.70⟩	⟨(2,3,4);0.30,0.75,0.70⟩	⟨(1,1,1);0.50,0.50,0.50⟩	1	⟨(1,1,1);0.50,0.50,0.50⟩	⟨(1,1,1);0.50,0.50,0.50⟩
P7	⟨(5,6,7);0.70,0.25,0.30⟩	⟨(6,7,8);0.90,0.10,0.10⟩	⟨(2,3,4);0.30,0.75,0.70⟩	⟨(2,3,4);0.30,0.75,0.70⟩	⟨(1,1,1);0.50,0.50,0.50⟩	⟨(1,1,1);0.50,0.50,0.50⟩	1	⟨(1,1,1);0.50,0.50,0.50⟩
P8	⟨(5,6,7);0.70,0.25,0.30⟩	⟨(6,7,8);0.90,0.10,0.10⟩	⟨(2,3,4);0.30,0.75,0.70⟩	⟨(2,3,4);0.30,0.75,0.70⟩	⟨(1,1,1);0.50,0.50,0.50⟩	⟨(1,1,1);0.50,0.50,0.50⟩	⟨(1,1,1);0.50,0.50,0.50⟩	1
Sum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 1. Paired Matrix AHP Neutrosophic

Principles	P1	P2	P3	P4	P5	P6	P7	P8	Weight
P1	0.52	0.77	0.58	0.40	0.38	0.23	0.27	0.27	0.43
P2	0.07	0.11	0.25	0.28	0.27	0.23	0.19	0.19	0.20
P3	0.07	0.04	0.08	0.17	0.16	0.23	0.19	0.19	0.14
P4	0.07	0.02	0.03	0.06	0.05	0.14	0.12	0.12	0.08
P5	0.07	0.02	0.03	0.06	0.05	0.05	0.12	0.12	0.06
P6	0.10	0.02	0.02	0.02	0.05	0.05	0.04	0.04	0.04
P7	0.07	0.02	0.02	0.02	0.02	0.05	0.04	0.05	0.03
P8	0.07	0.02	0.02	0.02	0.02	0.05	0.04	0.04	0.03

Table 2. Determination of criteria weights applying the Neutrosophic AHP method

Criteria	A x Weight	Approximate eigenvalues
1	4.48	10.52939754
2	1.94	9.7130298
3	1.24	8.743880449
4	0.62	8.253215035
5	0.54	8.399642628

6	0.35	8.371912999
7	0.29	8.212070304
8	0.29	8.42304258
	8.830773916 Eigenvalue	

Table 2. Analysis of the consistency of the paired matrix

The analysis of the consistency of the method showed that its eigenvalue is 8.83, IC = 0.12, and RC = 0.08, so it is confirmed that the exercise was correct.

Neutrosophic TOPSIS

To identify in a simpler way the elements to be analyzed, the principles will be identified with P and the premises (Pr):

Principles/ Premises	P1	P2	P3	P4	P5	P6	P7	P8
Pr1	(0.9, 0.1, 0.1)	(0.75,0.25,0.20)	(0.9, 0.1, 0.1)	(0.9, 0.1, 0.1)	(0.75,0.25,0.20)	(0.9, 0.1, 0.1)	(0.9, 0.1, 0.1)	(0.9, 0.1, 0.1)
Pr2	(0.9, 0.1, 0.1)	(0.9, 0.1, 0.1)	(0.9, 0.1, 0.1)	(0.9, 0.1, 0.1)	(0.9, 0.1, 0.1)	(0.9, 0.1, 0.1)	(0.75,0.25,0.20)	(0.9, 0.1, 0.1)
Pr3	(0.35,0.75,0.80)	(0.35,0.75,0.80)	(0.35,0.75,0.80)	(0.10,0.90,0.90)	(0.10,0.90,0.90)	(0.10,0.90,0.90)	(0.35,0.75,0.80)	(0.10,0.90,0.90)
Pr4	(0.75,0.25,0.20)	(0.75,0.25,0.20)	(0.75,0.25,0.20)	(0.75,0.25,0.20)	(0.75,0.25,0.20)	(0.9, 0.1, 0.1)	(0.9, 0.1, 0.1)	(0.9, 0.1, 0.1)
Pr5	(0.50,0.50,0.50)	(0.75,0.25,0.20)	(0.75,0.25,0.20)	(0.75,0.25,0.20)	(0.75,0.25,0.20)	(0.75,0.25,0.20)	(0.75,0.25,0.20)	(0.75,0.25,0.20)
Pr6	(0.50,0.50,0.50)	(0.50,0.50,0.50)	(0.50,0.50,0.50)	(0.50,0.50,0.50)	(0.75,0.25,0.20)	(0.50,0.50,0.50)	(0.50,0.50,0.50)	(0.50,0.50,0.50)
Pr7	(0.35,0.75,0.80)	(0.50,0.50,0.50)	(0.35,0.75,0.80)	(0.50,0.50,0.50)	(0.50,0.50,0.50)	(0.50,0.50,0.50)	(0.35,0.75,0.80)	(0.50,0.50,0.50)
Pr8	(0.35,0.75,0.80)	(0.35,0.75,0.80)	(0.75,0.25,0.20)	(0.35,0.75,0.80)	(0.75,0.25,0.20)	(0.35,0.75,0.80)	(0.35,0.75,0.80)	(0.35,0.75,0.80)

Table 3. Performance Matrix

Principles/ Premises	P1	P2	P3	P4	P5	P6	P7	P8	D+	D-	Ri	Hierarchy Order
Pr1	0.21943346	0.10050378	0.06527534	0.039036	0.02797514	0.01873172	0.01477994	0.01404879	0.21943346	0.08777338	1	1
Pr2	0.21943346	0.08040303	0.06527534	0.039036	0.02238012	0.01873172	0.01182395	0.01404879	0.10050378	0.04020151	0.87258786	2
Pr3	0.08777338	0.04020151	0.02611013	0.0078072	0.00559503	0.00374634	0.00591198	0.00280976	0.06527534	0.02611013	0	7
Pr4	0.17554676	0.08040303	0.05222027	0.0312288	0.02238012	0.01873172	0.01477994	0.01404879	0.039036	0.0078072	0.66666667	3
Pr5	0.13166007	0.08040303	0.05222027	0.0312288	0.02238012	0.01498537	0.01182395	0.01123903	0.02797514	0.00559503	0.39793807	4
Pr6	0.13166007	0.06030227	0.0391652	0.0234216	0.02238012	0.01123903	0.00886796	0.00842927	0.01873172	0.00374634	0.33333333	5
Pr7	0.08777338	0.06030227	0.02611013	0.0234216	0.01678509	0.01123903	0.00591198	0.00842927	0.01477994	0.00591198	0.12741214	6
Pr8	0.08777338	0.04020151	0.05222027	0.0156144	0.02238012	0.00749269	0.00591198	0.00561951	0.01404879	0.00280976	0	8

Table 4. Weighted normalized matrix, Proximity calculation relative to the ideal solution, and hierarchical order

In the first stage of the study, a consensus is achieved among the experts by identifying 7 fundamental principles that the evaluation procedure must comply with and the weighting of weights allows determining the level of relevance of each one. The need to find the best alternative to facilitate decision-making made it possible to determine that the greatest weight in the assessment corresponds to the principle related to credibility.

This decision is supported by the analysis carried out on the consistency of the paired matrix, according to which, when determining the ratio between the consistency index and the random index, a value of $0.08 \leq 0.10$ is obtained, which leads to conclude that the analysis carried out is consistent.

Once the weights have been calculated, it is decided to apply the TOPSIS technique for the evaluation of the premises, on the aforementioned principles, using the weights resulting from the AHP. Moreover, all the resulting results can be summarized in a table like the following one that relates the principles that best fit a procedure for the evaluation of social projects with the premises that must be met for their establishment.

Principle	Related premise
Practicality or utility	2; 3; 10
Credibility	6; 8; 9
Impartiality	1; 5; 6
Objectivity	2; 4; 6; 8
Timeliness	3; 7; 9
Independence	1; 5
Validity	1; 4; 5; 9
Reliability	9

Table 5. Relationship of principles and premises

The procedure for the evaluation of social projects must then comply with the following principles.

Figure 1. Procedure design.

Conclusion

After conducting the investigation, we have reached the following conclusions:

a. Projects require a careful analysis of their likely outcome and, therefore, it is advisable to take some time for their formulation and evaluation.
b. The evaluation of investment projects has progressed extraordinarily. This is not the case in the field of social programs.
c. The existing experience in the field of evaluating social projects has large gaps. On one hand, there is the tradition of social evaluation linked to the ex-ante stage. On the other hand, there is no doubt that cost-benefit analysis can and often is a useful tool
d. The need to develop a procedure for the evaluation of social projects is considered. To achieve this procedure, certain fundamentals must be followed to guarantee coherence and correct implementation.
e. The development of a procedure for evaluating social projects will contribute to obtaining preventive and correct information for precise decision-making and selection of projects.
f. The development of the research allowed defining some principles and premises that the procedure must comply with for its correct design and it will become a tool that can unify criteria and allow decisions to be made in a short period.

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