



Neutrosophic Plithogenic AHP Model for Inclusive Higher Education Program Selection

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Abstract

One of the achievements of Peruvian higher education is that it has recognized the need for this type of education to be inclusive. That is, certain vulnerable social sectors also can study for a university degree. Within this group are individuals with special abilities, such as the blind, people with motor problems, among others of this type, although people with economic problems and others who are discriminated against for having suffered prison regimes, because of their gender, race, among others can also be included. To make a reality this idea of inclusion, inclusive teaching programs are needed, which also comprise several programs, from which to choose one. The purpose of this paper is to design a technique that allows decision makers to select among several proposed programs the one that is the most suitable for this type of teaching. To this end, we propose a method to evaluate five dimensions of inclusive education, hybridizing the Analytic Hierarchy Process (AHP) technique with plithogenic sets. The Plithogenic AHP method allows us making the most appropriate decision, with the degree of complexity proper of decision making in education, considering the various components that are part of the training of the university students.

Keywords: Neutrosophic Plithogenic AHP; Plithogenic set; Plithogenic AHP; higher education; inclusive education

1. Introduction

Inclusion in higher education has undergone a general evolution. Initially, it was understood as the restitution of opportunities for students with special needs. Then, it gained access to different social strata that have been excluded due to poverty, gender, culture, and social adaptation problems. At present, it aims to close the gaps of inequality, marginality, and domination to build an educational system for all, based on equality, participation, and non-discrimination, in a social rule of law.

Admission and access to university education under conditions of equal opportunities is an aspiration of Peruvian higher education and a commitment that must be assumed by the State so that governments and public and private institutions materialize gradually and systematically.

Inclusive higher education calls for the construction of proactive and sustainable strategies. The right of citizens to have a better society in the future depends on the ability of the current actors to realize this aspiration.

Law 3020 "University Law" states as a principle of university education, Article 5, that of Pluralism, tolerance, intercultural dialogue, and inclusion. In the Article 129 of the body, the integration of persons with disabilities in the university community does not fully develop the principle,

constituting in the authors' opinion a substantial omission, despite recognizing that other legal bodies of the Peruvian legal system analyze and regulate this component.

Inclusion has as its foundation the value of human dignity as an inseparable condition for the free development of the personality, inclusive education then builds a cardinal right, because without the correct protection and promotion of the right of access to education, the sense of human decency and the rights directly instituted in it, becomes weakened and ineffective realizations, which generates the absence of personal fulfillment.

The right to education implies the following dimensions, manifested in the General Observation of the Committee of the International Covenant on Economic, Social, and Cultural Rights and accepted by researchers as pillars of inclusion in Peruvian higher education for the coming years:

1. **Availability:** There must be enough educational institutions and programs within the State party. The conditions for them to function depend on numerous factors, like the development context in which they operate; infrastructure that integrates the existence of basic services, working conditions and incentives for teachers, libraries, quality internet, technological services, knowledge of other disruptive ways of educating and deploying metacognitions, among others.
2. **Accessibility.** Institutions and educational programs must be accessible to all, without discrimination. Compliance with this principle is a way to minimize the emerging problems of the socioeconomic context of communities and inclusion mechanisms. Accessibility consists of three components that interact as a system:
 - a. **Non-discrimination.** Higher education must be accessible to all, with a preponderance of *de facto* and *de jure* vulnerable groups, without discrimination based on any associated condition.
 - b. **Real accessibility.** Education must be materially accessible, using the progress of new technologies and the obligation to comply with constitutional norms and mandates.
 - c. **Economic accessibility.** Education must be within everyone's reach. It is an approach that addresses the existence of educational needs with a focus on attention to diversity and opportunity, regardless of the condition and availability of resources.
3. **Acceptability:** The form and teleology of higher education, which includes the curriculum, didactics, and learning environments, must be accepted by the learner. This dimension assumes that training cannot be assigned but implies that it must be accepted by the students themselves, thus recognizing a greater protagonism of the recipient. There must be an active appropriation and collaboration of the students in the educational teaching process.
4. **Adaptability.** Education must have the flexibility for adapting to the needs of changing societies and communities and to respond to the demands of learners in multiple socio-cultural spaces.
5. **Quality:** The transformation of times, spaces, didactics, educational hierarchies, roles, making research the substantive transversal process, and internationalization of the curriculum, are inclusive demands that urge universities to make permanent changes, adaptations, and continuous improvements as philosophy of management and performance improvement.

It is evident that simply identifying these dimensions or recognizing the need to apply inclusive educational policies is not enough for this to take place. A transcendental step is the proposal of concrete educational programs that make it possible to carry out this type of education. The other important step is the evaluation of these programs once they have been developed, including the selection of an educational program from among several proposals, where we select the one that best meets the objectives proposed above. This constitutes a multi-criteria decision-making process.

This decision-making is not simple, it is known that education, in general, is a science interrelated with other sciences that are part of the individual, not only pedagogy but also psychology, sociology, politics, and economics. It is necessary to manage minimum material conditions for the individual to be educated, which is why economic management is supreme, in addition, the individual must have sufficient economic guarantees to be able to study without having to worry about ensuring their livelihood in a way that occupies all their time. Also socially, the individual must have the support of his (her) community and his (her) family, his (her) educational development is enhanced by policies that encourage him (her) to study, in addition to the fact that his (her) skills and psychological strengths are also enhancers of his (her) development.

This complexity is not free of contradictions among its components and, in addition to the fact that it changes over time because it is dynamic; it requires tools that capture these peculiarities. We chose

as a tool the Plithogenic Analytic Hierarchy Process or Plithogenic AHP ([1]). AHP is a technique from mathematics and psychology created by T. Saaty to support the decision-maker to find the solution that best fits his (her) needs and his (her) understanding of the problem ([2]). It is a structured technique for dealing with complex decisions. Plithogeny “is the genesis or origination, creation, formation, development, and evolution of new entities from dynamics and organic fusions of contradictory and/or neutral and/or non-contradictory multiple old entities. Plithogeny pleads for the connections and unification of theories and ideas in any field.” From the logical point of view, Plithogenic sets generalize fuzzy sets, intuitionistic fuzzy sets, neutrosophic sets, among others ([3,4]). There are many generalizations of classical AHP to uncertainty frameworks, [5-12]. Also, there are many uses of Neutrosophy applied in Education, [11,13,14].

The present article is divided into the following structure, a section on Materials and Methods that contains the basic notions of the AHP technique and Plithogenic Sets. Next, we present a section, where the proposed technique is introduced with an illustrative example. The last section contains the conclusions.

2. Materials and methods

This section is devoted to recalling the main notions of the AHP technique and plithogenic sets.

A. Notions on AHP technique

Criteria, sub-criteria, and alternatives in Analytic Hierarchy Process (AHP) are represented in form of a hierarchical structure which graphically is a tree. There is an upper unique leaf representing the goal, such that this leaf is the parent of other leaves of criteria, which are equally the parents of the leaves of sub-criteria, and so on. The bottom level contains the leaves of alternatives, Figure 1 ([2]).

The graphical representation is used by a group of decision makers or experts for assessing the alternatives based on pair-wise comparison matrices according to a certain scale. Originally Saaty proposed the scale that he considered to be the better to evaluate decisions; see Table 1.

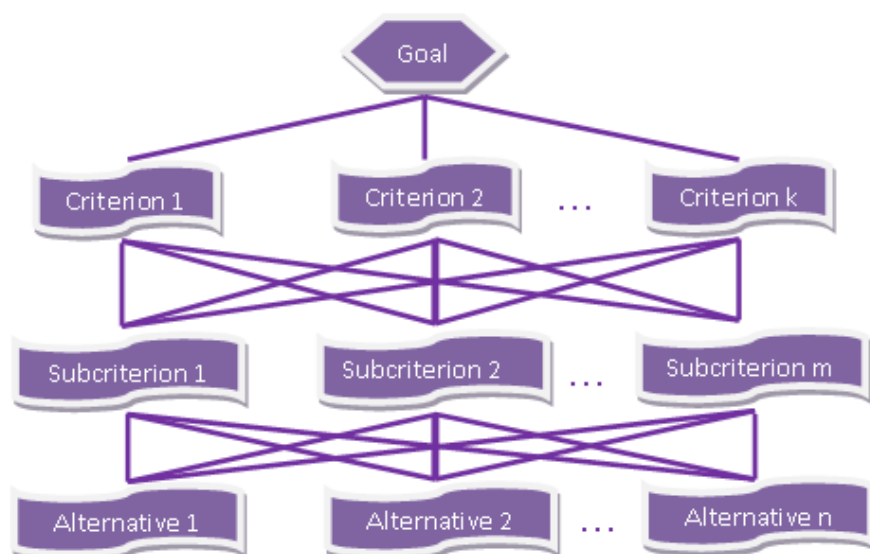


Figure 1: Generic tree representing an AHP problem.

Table 1: Intensity of importance according to the classical AHP

Intensity of importance on an absolute scale	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment strongly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Very strong importance	An activity is strongly favored and its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgments.	When compromise is needed
Reciprocals	If activity i has one of the above numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i.	

Then we must calculate the Consistency Index (CI) which is a function depending on λ_{\max} , the maximum eigenvalue of the matrix. Saaty proposed $CI = \frac{\lambda_{\max} - n}{n - 1}$ like the equation of this index, where n is the order of the matrix. Also, the Consistency Ratio (CR) is defined by the equation $CR = CI/RI$, where RI is given in Table. 2.

Table 2: RI associated with every order.

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

If $CR \leq 0.1$ we can consider that the experts' evaluation is sufficiently consistent and hence we can proceed to use AHP.

AHP aims to score criteria, sub-criteria, and alternatives, and to rank every alternative according to these scores. This technique can also be used in group assessment. In such a case, the final value is calculated by the weighted geometric mean according to Equations 1 and 2. The weights measure

the importance of each expert's criteria, where some factors are considered like the expert's authority, knowledge, effort, among others.

$$\bar{x} = \left(\prod_{i=1}^n x_i^{w_i} \right)^{1/\sum_{i=1}^n w_i} \quad (1)$$

When the expert's weights sum up one ($\sum_{i=1}^n w_i = 1$), Equation 1 converts to Equation 2,

$$\bar{x} = \prod_{i=1}^n x_i^{w_i} \quad (2)$$

B. Plithogenic sets

Definition 1. ([6, 8]) Let X be a universe of discourse. A *Neutrosophic Set* (NS) is characterized by three membership functions, $u_A(x), r_A(x), v_A(x) : X \rightarrow]-0, 1^+[$, which satisfy the condition $-0 \leq \inf u_A(x) + \inf r_A(x) + \inf v_A(x) \leq \sup u_A(x) + \sup r_A(x) + \sup v_A(x) \leq 3^+$ for all $x \in X$. $u_A(x), r_A(x)$ and $v_A(x)$ are the membership functions of truthfulness, indeterminacy and falseness of x in A , respectively, and their images are standard or non-standard subsets of $] - 0, 1^+[$.

Definition 2. ([6, 8]). Let X be a universe of discourse. A *Single-Valued Neutrosophic Set* (SVNS) A on X is a set of the form:

$$A = \{ \langle x, u_A(x), r_A(x), v_A(x) \rangle : x \in X \} \quad (3)$$

Where $u_A, r_A, v_A : X \rightarrow [0,1]$, satisfy the condition $0 \leq u_A(x) + r_A(x) + v_A(x) \leq 3$ for all $x \in X$. $u_A(x), r_A(x)$ and $v_A(x)$ denote the membership functions of truthfulness, indeterminate and falseness of x in A , respectively. For convenience a *Single-Valued Neutrosophic Number* (SVNN) will be expressed as $A = (a, b, c)$, where $a, b, c \in [0,1]$ and satisfy $0 \leq a + b + c \leq 3$.

Given A and B two SVNSs, they satisfy the following relationships:

1. $A \subseteq B$ if and only if $T_A(x) \leq T_B(x)$, $I_A(x) \geq I_B(x)$ and $F_A(x) \geq F_B(x)$. Particularly, $A = B$ if and only if $A \subseteq B$ and $B \subseteq A$.
2. $A \cup B = \langle \max(T_A(x), T_B(x)), \min(I_A(x), I_B(x)), \min(F_A(x), F_B(x)) \rangle$, for every $x \in X$.
3. $A \cap B = \langle \min(T_A(x), T_B(x)), \max(I_A(x), I_B(x)), \max(F_A(x), F_B(x)) \rangle$, for every $x \in X$.

Definition 3. The *Neutrosophic Logic* (NL) is the generalization of the fuzzy logic, where a logical proposition P is characterized by three components:

$$NL(P) = (T, I, F) \quad (4)$$

Where the neutrosophic component T is the degree of truthfulness, F is the degree of falsehood, and I is the degree of indeterminacy.

Definition 4. Let (T_1, I_1, F_1) and (T_2, I_2, F_2) be elements of NL where the sum of the elements of the triplet is 1. The logical connectives of $\{ \neg, \wedge, \vee \}$ can be defined in the following way:

1. $\neg(T_1, I_1, F_1) = (F_1, I_1, T_1)$,
2. $(T_1, I_1, F_1) \wedge (T_2, I_2, F_2) = (T = \min\{T_1, T_2\}, I = 1 - (T + F), F = \max\{F_1, F_2\})$,
3. $(T_1, I_1, F_1) \vee (T_2, I_2, F_2) = (T = \max\{T_1, T_2\}, I = 1 - (T + F), F = \min\{F_1, F_2\})$.

This *Neutrosophic Logic* is denoted by NL1.

To analyse the result, a scoring function is established to order alternatives:

$$S(V) = T - F - I \quad (5)$$

Definition 5. Let X be a universe of discourse, a space of points (objects) and x denotes a generic element of X . A is a Single Valued Neutrosophic Aggregation Operator (SVNAO) if it is a mapping $A: \cup_{n \in \mathbb{N}} ([0, 1]^3)^n \rightarrow [0, 1]^3$.

One example of SVNAO is the Weighted Average operator (WA), which is shown in Equation 6.

$$WA(a_1, a_2, \dots, a_n) = \sum_{i=1}^n w_i a_i \quad (6)$$

Where, $a_i = (T_i, I_i, F_i)$ are SVNNS and $w_i \in [0, 1]$ for every $i = 1, 2, \dots, n$; which satisfy the condition $\sum_{i=1}^n w_i = 1$. The a_i s are the values obtained for the i th alternative assessment, and w_i denote the weight which represents the importance given to the alternative a_i .

Definition 6. ([3,15]) A plithogenic set (P, A, V, d, c) is a set P that includes numerous elements described by several attributes $A = \{\alpha_1, \alpha_2, \dots, \alpha_m\}$, $m \geq 1$, which has values $V = \{v_1, v_2, \dots, v_n\}$, for $n \geq 1$. For V there exist two main features attributes values, they are the *appurtenance degree function* $d(x, v)$ of the element x , concerning some given criteria, and the contradiction (dissimilarity) degree function $c(v, D)$ which is the one realized between each attribute value and the most important (dominant) one.

Given A a non-empty set of uni-dimensional attributes $A = \{\alpha_1, \alpha_2, \dots, \alpha_m\}$, $m \geq 1$, and let $\alpha \in A$ be an attribute with its value spectrum is the set S , where S can be defined as a finite discrete set, $S = \{s_1, s_2, \dots, s_l\} \mid l \in [1, \infty)$, or infinitely countable set $S = \{s_1, s_2, \dots\}$, or infinitely uncountable (continuum) set $S = (a, b)$, $S = (a, b]$, $S = [a, b)$, or $S = [a, b]$.

Definition 7. ([3,15]) The *degree of appurtenance* is defined as fuzzy, intuitionistic fuzzy, or neutrosophic degree of appurtenance to the plithogenic set. It is defined as follows:

$$\forall x \in P, d: P \times V \rightarrow \mathcal{P}([0, 1]^z) \quad (7)$$

$d(x, v)$ is a subset of $[0, 1]^z$, $\mathcal{P}([0, 1]^z)$ is the power set of $[0, 1]^z$, where $z = 1, 2, 3$, for fuzzy, intuitionistic fuzzy, and neutrosophic degrees of appurtenance, respectively.

Definition 8. ([3]) The attribute value contradiction degree function is defined as follows:

$$c: V \times V \rightarrow [0, 1] \quad (8)$$

Such that $c(v_1, v_2)$ represents the dissimilarity between two attribute values v_1 and v_2 , and satisfies the following axioms:

$c(v_1, v_1) = 0$, which means the contradiction degree between the attribute value and itself is zero,

$$c(v_1, v_2) = c(v_2, v_1).$$

Definition 9. ([3]) Given a plithogenic set (P, A, V, d, c) a *Plithogenic Neutrosophic Aggregation Operator* is defined as in Equation 9:

$$(a_1, a_2, a_3) \text{AND}_p(b_1, b_2, b_3) = \left((1 - \bar{c})(a_1 \wedge_F b_1) + \bar{c}(a_1 \vee_F b_1), \frac{1}{2}[a_1 \wedge_F b_1 + a_1 \vee_F b_1], (1 - \bar{c})(a_1 \vee_F b_1) + \bar{c}(a_1 \wedge_F b_1) \right) \quad (9)$$

Where $\bar{c} \in [0, 1]$, \wedge_F is a t-norm and \vee_F is a t-conorm, see [16].

It is a Plithogenic Neutrosophic Intersection when $\bar{c} = 0$ and it is a Plithogenic Neutrosophic Union when $\bar{c} = 1$, [3]. This aggregator is more accurate than both the n-norms and n-conorms between neutrosophic sets, [3].

A plithogenic neutrosophic set can be converted into a crisp value using the following formula, [3]:

$$S(T, I, F) = \frac{1}{3}(2 + T - I - F) \quad (10)$$

There are many applications of plithogeny in real-life situations, see ([14, 17-19]).

3. The proposed plithogenic AHP technique for inclusive higher education

In this section, we describe the proposed model for the selection of inclusive higher education programs. First, Table 3 summarizes the linguistic scale associated with a plithogenic number to be used by the experts to perform the evaluations of the criteria, sub-criteria, and alternatives.

Table 3: Linguistic values associated with plithogenic numbers for expert evaluation.

Linguistic Expression	Plithogenic number (T, I, F)
Very poor (VP)	(0.10, 0.75, 0.85)
Poor (P)	(0.25, 0.60, 0.80)
Moderately poor (MP)	(0.40, 0.70, 0.50)
Medium (M)	(0.50, 0.40, 0.60)
Moderately good (MG)	(0.65, 0.30, 0.45)
Good (G)	(0.80, 0.10, 0.30)
Very good (VG)	(0.95, 0.05, 0.05)

Table 4 contains the linguistic scale of importance and its corresponding plithogenic numbers, which are used to determine the weight of each expert's opinion.

Table 4: Linguistic values associated with plithogenic numbers for expert weight evaluation.

Linguistic Expression	Plithogenic number (T, I, F)
Low significance (LS)	(0.10, 0.70, 0.80)
Equal significance (ES)	(0.30, 0.40, 0.80)
Robust significance (RS)	(0.50, 0.40, 0.60)
Very robust significance (VRS)	(0.70, 0.30, 0.10)
Absolute significance (AS)	(0.90, 0.10, 0.10)

The proposed algorithm is as follows:

1. The committee of experts that will participate in the evaluation of educational programs is selected. Among them should be a variety of professions of origin, such as teachers, educational managers, university economic managers, among others. Let us denote it by the set $E = \{e_1, e_2, \dots, e_k\}$.
2. The tree with the hierarchical structure is designed to apply the AHP method. In this paper, we propose the tree represented in Figure 2.
3. Each expert of the set E evaluates the criteria, sub-criteria, and alternatives within the tree, according to his (her) opinion, using the linguistic scale in Table 3. The plithogenic number in the right column is taken as a reference for evaluation. The alternatives to be evaluated are the different pedagogical programs.
4. On the other hand, a moderator associates a linguistic value to each expert on the scale proposed in Table 4, according to their degree of expertise. Let $\mathbf{W} = (w_1, w_2, \dots, w_k)$ be the vector of all values.

Let us aggregate all values in similar positions by Equation 11 with the elements of W . That is, we aggregate the B_j which is a plithogenic number for a certain element of the AHP corresponding to the experts with $j = 1, 2, \dots, k$, so that we obtain a single aggregated value equal to:

$$B = \bigwedge_{p,j=1}^k (w_j \wedge_p B_j) \tag{11}$$

From this, we obtain a single value with plithogenic numbers for the AHP method. See that \wedge_p denotes the plithogenic conjunction.

5. All B 's are converted to crisp numbers by applying formula 10. These values are not yet in form of the Saaty's scale, see Table 1.
6. Equation 12 of rescaling into Saaty's scale is applied to the matrix values $\max(B_{ij}, B_{ji})$:

$$\left\{ \begin{array}{l} \tilde{B}_{ij} = \left\lfloor \frac{B_{ij}}{B_{ji}} \right\rfloor, \text{ if } B_{ij} = \max(B_{ij}, B_{ji}) \text{ and } \left\lfloor \frac{B_{ij}}{B_{ji}} \right\rfloor \in [1, 9] \\ \tilde{B}_{ji} = \left\lfloor \frac{B_{ji}}{B_{ij}} \right\rfloor, \text{ if } B_{ji} = \max(B_{ij}, B_{ji}) \text{ and } \left\lfloor \frac{B_{ji}}{B_{ij}} \right\rfloor \in [1, 9] \\ \qquad \qquad \qquad 1, \text{ if } B_{ij} = B_{ji} \\ \qquad \qquad \qquad \tilde{B}_{ij} = 9, \text{ if } \left\lfloor \frac{B_{ij}}{B_{ji}} \right\rfloor > 9 \\ \qquad \qquad \qquad \tilde{B}_{ji} = 9, \text{ if } \left\lfloor \frac{B_{ji}}{B_{ij}} \right\rfloor > 9 \end{array} \right. \tag{12}$$

Equation 13 applies to the values $\min(B_{ij}, B_{ji})$:

$$\left\{ \begin{array}{l} \tilde{B}_{ij} = \frac{1}{\tilde{B}_{ji}}, \text{ if } B_{ij} = \min(B_{ij}, B_{ji}) \\ \tilde{B}_{ji} = \frac{1}{\tilde{B}_{ij}}, \text{ if } B_{ji} = \min(B_{ij}, B_{ji}) \\ \qquad \qquad \qquad 1, \text{ otherwise} \end{array} \right. \tag{13}$$

7. The AHP crisp method is applied as proposed by T. Saaty.
8. The alternative with the highest value according to the classical AHP method is selected. See Figure 3.

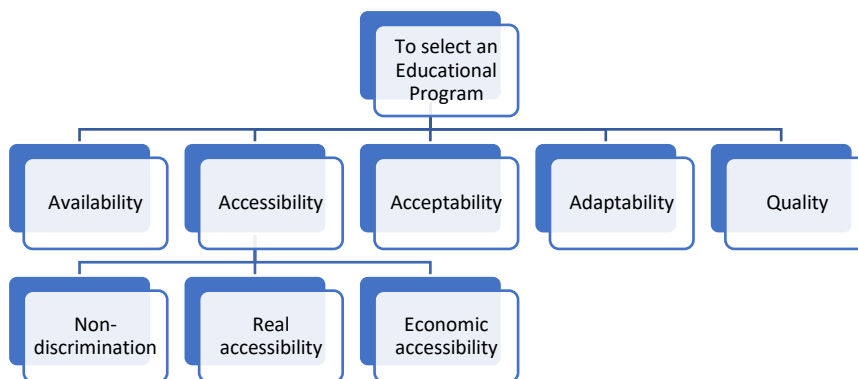


Figure 2: The proposed tree of hierarchies for inclusive higher education. See the goal, criteria, and subcriteria.

The use of the proposed Plithogenic AHP is illustrated with an example below.

Example: Let us suppose for simplicity that two experts are chosen, the first one is considered to have "very robust significance", while the second one has "absolute significance" according to Table 4. Then $E = \{e_1, e_2\}$ with $W = (w_1, w_2)$ such that $w_1 = (0.70, 0.30, 0.10)$ and $w_2 =$

(0.90, 0.10, 0.10).

Suppose that two inclusive higher education programs are denoted by P_1 and P_2 , which for simplicity will be called "non-face-to-face program" and "Face-to-face program", respectively.

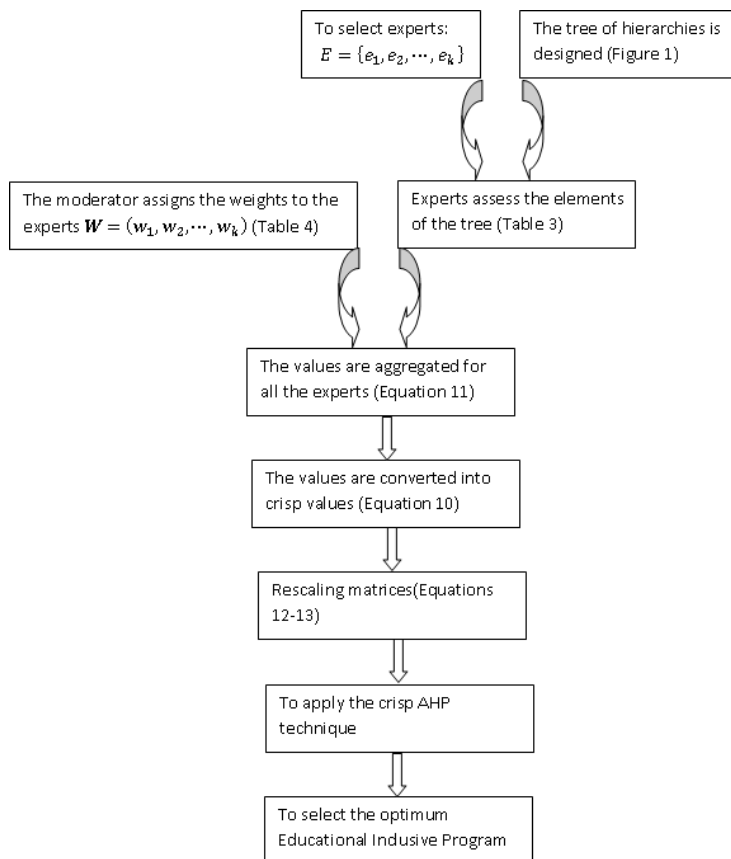


Figure 3: Algorithm of Plithogenic AHP for Inclusive Educational Programs.

Table 5 contains the results of each expert's evaluation of the importance of each criterion where C_1 denotes Availability, C_2 denotes Accessibility, C_3 denotes Acceptability, C_4 denotes Adaptability and C_5 denotes Quality.

Table 5: Results of the evaluation of the criteria according to both experts.

Criteria	Evaluation of the criteria according to e_1	Evaluation of the criteria according to e_2
C_1	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)
C_2	(0.80, 0.10, 0.30)	(0.80, 0.10, 0.30)
C_3	(0.95, 0.05, 0.05)	(0.95, 0.05, 0.05)
C_4	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)
C_5	(0.80, 0.10, 0.30)	(0.80, 0.10, 0.30)

Table 6. contains the evaluations of each of the experts on the sub-criteria of criterion C_2 . Note that C_{21} denotes Non-discrimination, C_{22} denotes Real accessibility, and C_{23} denotes Economic accessibility.

Table 6: Results of the evaluation of the criteria according to both experts for the three sub-criteria corresponding to Accessibility.

Sub-criteria	Evaluation of the sub-criteria according to e_1	Evaluation of the sub-criteria according to e_2
C_{21}	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)
C_{22}	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)
C_{23}	(0.95, 0.05, 0.05)	(0.95, 0.05, 0.05)

Table 7: Results of the evaluation of the two programs according to both experts for the criteria and sub-criteria.

Criterion or Sub-criterion	Assessment of P_1 according to e_1	Assessment of P_1 according to e_2	Assessment of P_2 according to e_1	Assessment of P_2 according to e_2
C_1	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.95, 0.05, 0.05)	(0.95, 0.05, 0.05)
C_{21}	(0.40, 0.70, 0.50)	(0.40, 0.70, 0.50)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)
C_{22}	(0.25, 0.60, 0.80)	(0.25, 0.60, 0.80)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)
C_{23}	(0.65, 0.30, 0.45)	(0.65, 0.30, 0.45)	(0.95, 0.05, 0.05)	(0.95, 0.05, 0.05)
C_3	(0.40, 0.70, 0.50)	(0.80, 0.10, 0.30)	(0.10, 0.75, 0.85)	(0.10, 0.75, 0.85)
C_4	(0.80, 0.10, 0.30)	(0.80, 0.10, 0.30)	(0.10, 0.75, 0.85)	(0.10, 0.75, 0.85)
C_5	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.40, 0.70, 0.50)	(0.40, 0.70, 0.50)

Table 8: Results of the aggregated evaluation of the criteria and crisp value.

Criteria	Aggregated evaluation of the criteria	Crisp value of the aggregated evaluation of the criteria
C_1	(0.76250, 0.20000, 0.23750)	0.77500
C_2	(0.80000, 0.15000, 0.20000)	0.81667
C_3	(0.875000, 0.125000, 0.075000)	0.89167
C_4	(0.83750, 0.13750, 0.13750)	0.85417

C₅ (0.80000, 0.15000, 0.20000) 0.81667

Table 9 contains the results of the aggregation of the sub-criteria of the second criterion and their crisp value, according to Table 6.

Table 9: Results of the aggregated evaluation of the sub-criteria and crisp value.

Sub-criteria	Aggregated evaluation of the sub-criteria	Crisp aggregated evaluation of the sub-criteria
C ₂₁	(0.83750, 0.13750, 0.13750)	0.85417
C ₂₂	(0.83750, 0.13750, 0.13750)	0.85417
C ₂₃	(0.875000, 0.125000, 0.075000)	0.89167

Table 10: Results of the aggregated evaluation of the programs for the sub-criteria, criteria, and crisp values.

Criterion or Sub-criterion	Aggregated evaluation of P ₁	Crisp value of the aggregated evaluation of P ₁	Aggregated evaluation of P ₂	Crisp value of the aggregated evaluation of P ₂
C ₁	(0.5625, 0.425, 0.375)	0.5875	(0.875, 0.125, 0.075)	0.89167
C ₂₁	(0.40, 0.70, 0.50)	0.61667	(0.8375, 0.1375, 0.1375)	0.85417
C ₂₂	(0.6125, 0.3625, 0.325)	0.64167	(0.8375, 0.1375, 0.1375)	0.85417
C ₂₃	(0.725, 0.25, 0.275)	0.73333	(0.875, 0.125, 0.075)	0.89167
C ₃	(0.7, 0.3, 0.25)	0.71667	(0.45, 0.475, 0.475)	0.5
C ₄	(0.8, 0.15, 0.2)	0.81667	(0.45, 0.475, 0.475)	0.5
C ₅	(0.8375, 0.1375, 0.1375)	0.85417	(0.6, 0.45, 0.3)	0.61667

Tables 11 and 12 contain the application of Equations 12-13 for the criteria and sub-criteria of C₂, respectively.

Table 11: Table AHP for comparing the criteria.

Criteria	C ₁	C ₂	C ₃	C ₄	C ₅
C ₁	1	0.5	0.5	0.5	0.5
C ₂	2	1	0.5	0.5	1
C ₃	2	2	1	2	2
C ₄	2	2	0.5	1	2
C ₅	2	1	0.5	0.5	1

Table 12: Table AHP for comparing the sub-criteria of C₂.

Sub-criteria	C ₂₁	C ₂₂	C ₂₃

C₂₁	1	1	0.5
C₂₂	1	1	0.5
C₂₃	2	2	1

The following tables contain the comparisons between the two programs for each of the criteria and sub-criteria.

Table 13: Table AHP for comparing the programs for criterion C₁.

Program	P₁	P₂
P₁	1	0.5
P₂	2	1

Table 14: Table AHP for comparing the programs for sub-criterion C₂₁.

Program	P₁	P₂
P₁	1	0.5
P₂	2	1

Table 15: Table AHP for comparing the programs for sub-criterion C₂₂.

Program	P₁	P₂
P₁	1	0.5
P₂	2	1

Table 16: Table AHP for comparing the programs for sub-criterion C₂₃.

Program	P₁	P₂
P₁	1	0.5
P₂	2	1

Table 17: Table AHP for comparing the programs for criterion C₃.

Program	P₁	P₂
P₁	1	2
P₂	0.5	1

Table 18: Table AHP for comparing the programs for criterion C₄.

Program	P₁	P₂
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P₁	1	2
P₂	0.5	1

Table 19: Table AHP for comparing the programs for criterion C₅.

Program	P₁	P₂
P₁	1	2
P₂	0.5	1

For the matrix in Table 11, we have $CI = 0.034090$ and $CR = 0.030712 < 0.1$; the matrix in Table 12 satisfies $CI = CR = 0 < 0.1$; the matrix in Table 13 satisfies $CI = 0.058148$ and $CR = 0.043073 < 0.1$, the rest of them satisfies $CI = 0$. This is why it can be assured that there is consistency among the experts' evaluations and the classical AHP method of T. Saaty could be applied.

The result of applying the AHP technique to the data in Tables 11-19 is as follows:

P₁: 0.57739

P₂: 0.42261

So, program 1 is preferred over program 2.

6. Conclusion

Inclusion within Peruvian higher education is part of today's governmental and social policy. However, it is necessary to convene concrete educational programs where this inclusion is made evident. It is possible to carry out calls for proposals for such programs. In this article, we proposed a technique to select and evaluate possible inclusive programs convened by the Ministry of Higher Education of Peru. The selected technique is plithogenic AHP, which has as advantage that it helps to make complex decisions in this case, the evaluative scales are understandable by the evaluators, and the plithogenic sets allow us associating elements that are part of what is being evaluated but correspond to different scientific subjects, the method contains the evaluation by one or more experts and is based on five educational dimensions established as government policy.

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