



Effectiveness of the Legal Rules that Protect Disabled People through Neutrosophic Techniques

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Abstract. Multi-criteria decision problems are present in all branches of life and present a high degree of complexity to determine a feasible solution. When it comes to individual rights, decisions are even more delicate, especially when it comes to people with disabilities. The Ecuadorian State has created insertion policies for these people within society. However, this vulnerable group is constantly the victim of discrimination, even though they are within the priority attention group. This study presents the application of multi-criteria evaluation techniques as a method for assessing the effectiveness of legal regulations regarding people with disabilities, according to certain pre-established parameters of interest. For this, the combination of the TODIM and PROMETHEE methods was used to obtain the results. In addition, single-valued neutrosophic sets based on neutrosophic logic are used. In such a way that the indeterminate and inconsistent information typical of the real world can be adequately handled. The use of the employed method demonstrates the efficiency of these methods in solving complex problems in real life and different fields of society.

Keywords: multi-criteria decisions, neutrosophic logic, neutrosophic sets, legal norms, rights.

1 Introduction

The Ecuadorian State has created Labor Insertion Policies for people within society, including disabled people. However, this vulnerable group is the victim of constant discrimination even though they are within the priority attention group. According to the National Council for Equality of Disabilities (Conadis) in Ecuador, there are 471,205 people with accredited disabilities. That is, they have an evaluation by the Ministry of Public Health. It is the most up-to-date figure and is cut to January 2022. Of these people, 215,205 have a physical disability; 108,957 intellectual; 66,538 auditory; 54,397 visual; and 26,157 psychosocial.

The place achieved by Ecuador in terms of disabilities is due in large part to the policies and legal regulations created to serve this sector of society. For years, care for people with disabilities has been relegated, and several governments only treated it as social assistance. Today it is a State policy to give priority attention to people with disabilities. Backed by the requirements of international standards and the execution of national standards, it is shown in the large projects of direct assistance to the disabled. This new regime has made Ecuador a model of assistance work and clear policies around disability, becoming a model in Latin America and achieving international recognition at the UN.

To respond to international standards, the actions of the Ecuadorian State in this regard must be considered. So much so, that the International Convention on the Rights of Persons with Disabilities was signed by Ecuador and published in Official Gazette 329 on May 5, 2008. It is a supranational norm, which means that its provisions prevail even on domestic law. The international standard that makes direct reference to the issue of labor inclusion of people with disabilities is reflected in the following statement:

The States Parties shall adopt effective and pertinent measures, including through the support of persons in the same circumstances so that persons with disabilities can achieve and maintain maximum independence, physical, mental, social, and vocational capacity, and inclusion... full participation in all aspects of life. To this end, the States Parties shall organize, intensify and expand general rehabilitation and rehabilitation services and programs, in particular in the fields of health, employment, education, and social services. (Article 26)

The State adopts actions to ensure a better quality of life for the disabled. Social inclusion, obtaining credits, and scholarships, and the development of programs and policies to promote recreation and rest. Political participation, the promotion of their autonomy, and the reduction of dependency, among others.

With the measures adopted by the State in favor of people with disabilities, it is ensured that there is social inclusion, with state and private investment, so that they can participate in the political, social, cultural, educational, and economic spheres. In each of these social spheres, serious policies must be established so that people with disabilities are taken into account, not as a means of propaganda or social assistance, but rather that their condition is respected.

Currently, there is no active participation of people with disabilities in politics. In other areas, the margin of social assistance is kept and has been left in the hands of NGOs or foundations to take over the responsibility that the State must assume. Despite establishing a policy of entrepreneurship and support for local production, this policy is not very decisive when granting loans or providing facilities to people with disabilities. At least, what is personal loans is not better known and many banking entities do not accept a person with a disability as the main debtor.

Regarding the achievement of scholarships at all levels, it is fulfilled as people are aware of this measure and it can be generated. In this sense, clear conditions are established that favor people with disabilities and may in the future generate an acceptable social space for their realization. The development of programs that include specialized adaptation is the responsibility of the state. These must attend and lead to personal fulfillment in their emotional growth and determination to instill their independence from the people who care for them. They must correspond to the disability they have, be they severe or profound, which is why it has been demanded that full compliance be given to the provisions.

The current Constitution mentions the labor insertion of which the person with a disability must be a part. In it, requirements are determined so that services, help, and facilities are implemented in the activity that the person favored with a job must carry out. At the same time, it is determined that the remuneration cannot be reduced, much worse if the person's disability is conditioned. Therefore, it must be understood that as it is a constitutional right it is applicable in the public and private sectors.

For this reason, the objective of this study is to determine, through neutrosophic methods, the effectiveness of Ecuadorian national standards regarding people with disabilities. So that, according to the results obtained, they can be given a better opportunity to be active subjects of society, under the principle of constitutional equality.

2 Methodology

This study presents the application of multi-criteria evaluation techniques as a method for the best evaluation of Ecuadorian laws for the protection of disabled people. In this sense, certain pre-established parameters of interest were taken into account. To develop the proposed objective, the study is based on the use of multi-criteria decision methods (MCDM). The MCDMs allow taking very complex real-life situations and developing actions to achieve decision-making under certain conditions. In this way, the problems initially raised reach a decisive state [1], [2].

Many are the MCDM developed for the resolution of problems in various areas of life and society [3]–[9], however, in traditional methods, the alternatives are usually evaluated with neat values in general. Due to the complexity of the environment and the subjectivity of the human being, MCDM problems are often accompanied by uncertainty, so the decision information provided is often confusing or linguistic.

This article introduces the TODIM and PROMETHEE methods [10], through the use of single-valued neutrosophic sets (SVNS). Neutrosophy, as part of philosophy, analyzes the nature of neutralities and everything related to it. Regarding neutrosophic logic and neutrosophic sets, indeterminacy membership functions are included for the first time. Indeterminacy is caused by a lack of information, by contradictory, inconsistent, and paradoxical information, among others. For this study, neutrosophic sets are used in order to eliminate the impossibility of traditional methods to handle the indeterminate and inconsistent information of the real world [11], [25].

For greater clarity of the information used, the preliminary aspects of the neutrosophic theory are first introduced, as well as the methodology. Subsequently, the methodology is applied, and finally, the results achieved and the conclusions derived from the study are presented.

Definition 1. Let X be a space of points (objects) with generic elements in X denoted by x . A single-valued neutrosophic set (SVNS) A in X is characterized by the truth-membership function $TA(x)$, indeterminacy-membership function $IA(x)$, and falsehood membership function $FA(x)$. Then, an SVNS A can be denoted by $A = \{x, TA(x), IA(x), FA(x) \mid x \in X\}$, where $TA(x), IA(x), FA(x) \in [0, 1]$ for each point x in X . Therefore, the sum of $TA(x), IA(x)$ and $FA(x)$ satisfies the condition $0 \leq TA(x) + IA(x) + FA(x) \leq 3$ [12], [23].

Decision-making normally involves human language or linguistic variables. A linguistic variable simply represents words or terms used in human language. Therefore, this linguistic variable approach is a convenient way for decision-makers to express their assessments. Ratings of criteria can be expressed by using linguistic variables. Linguistic variables can be transformed into SVNSs as shown in Table 1.

Definition	SVNS
Extremely Preferred (EXP)	(1,0,0)
Very Very Preferred (VVP)	(0.9, 0.1, 0.1)
Very Preferred (VP)	(0.8,0,15,0.20)
Preferred (P)	(0.70,0.25,0.30)
Equally Preferred (EP)	(0.50,0.50,0.50)
Not Preferred (NP)	(0.35,0.75,0.80)
Very Not Preferred (VNP)	(0.20,0.85,0.80)
Very Very Not Preferred (VVNP)	(0.10,0.90,0.90)
Extremely Not Preferred (ENP)	(0,1,1)

Table1: Linguistic variable and Single Valued Neutrosophic Numbers (SVNNs). Source: [13].

Definition 2. Let $E_k = (T_k, I_k, F_k)$ be a neutrosophic number defined for the rating of k-th decision maker. Then, the weight of the k-th decision maker can be written as [7]:

$$\psi_k = \frac{1 - \sqrt{[(1 - T_k(x))^2 + (I_k(x))^2 + (F_k(x))^2] / 3}}{\sum_{k=1}^p \sqrt{[(1 - T_k(x))^2 + (I_k(x))^2 + (F_k(x))^2] / 3}} \tag{1}$$

Further, in achieving a favorable solution, group decision-making is important in any decision-making process. In the group decision-making process, all the individual decision-maker assessments need to be aggregated into one aggregated neutrosophic decision matrix. This can be done by employing a single valued neutrosophic weighted averaging (SVNWA) aggregation operator proposed by Ye [14], [26].

Definition 3. ([14]) Let $D^{(k)} = (d_{ij}^{(k)})_{m \times n}$ be the single-valued neutrosophic decision matrix of the k-th decision-maker and $\psi = (\psi_1, \psi_2, \dots, \psi_p)^T$ be the weight vector of decision-maker such that each $\psi_k \in [0, 1]$, $D = (d_{ij})_{m \times n}$ where

$$d_{ij} = \langle 1 - \prod_{k=1}^p (1 - T_{ij}^{(p)})^{\psi_k}, \prod_{k=1}^p (I_{ij}^{(p)})^{\psi_k}, \prod_{k=1}^p (F_{ij}^{(p)})^{\psi_k} \rangle \tag{2}$$

Definition 4. Let A and B be two single-valued neutrosophic numbers (SVNNs), then the normalized Hamming distance between them is:

$$d(A, B) = \frac{|TA - TB| + |IA - IB| + |FA - FB|}{3} \tag{3}$$

Definition 5. Let $A = (TA, IA, FA)$ be a SVNN, the complement of SVNN A is:

$$AC = (FA, 1 - IA, TA). \tag{4}$$

2.1 Method

Let $A = (A_1, \dots, A_m)$ be the alternatives, and $G = (G_1, G_2, \dots, G_n)$ the attributes. Let the weights of the attributes be $W = (w_1, w_2, \dots, w_n)$, where $0 \leq w_j \leq 1, \sum_{j=1}^n w_j = 1$. Let $a_{ij}, i = 1, 2, \dots, m, j = 1, 2, \dots, n$, be the attribute value of the alternative A_i with attribute G_j , the $A = (a_{ij})_{m \times n} = \langle (T_{ij}, I_{ij}, F_{ij}) \rangle_{m \times n}$ is a SVNNs matrix, where T_{ij}, I_{ij} and F_{ij} are membership degree, indeterminacy-membership degree and non-membership degree, the procedure followed to perform the analysis is as shown bellow [15], [27].

Step 1: Identify the decision alternatives to be evaluated.

Step 2: Determine the weights of the decision-makers. Due to the logic of the method, each decision-maker can have a unique and different evaluation from the rest of the decision-makers, since each evaluation is granted according to the level of knowledge of each expert regarding the decision issue addressed. The relative weight of each decision maker is considered as linguistic variables and is transmitted in SVNN to later be identified using equation (1).

Step 3: Convert the linguistic evaluations given by the experts into SVNN. From the individual neat integer matrices obtained from the experts' evaluations, the individual neutrosophic matrices of the decision-makers are constructed, as indicated in Table 1.

Step 4: Obtain the initial relationship matrix of alternatives $A = (A_1, \dots, A_m)$ and attributes $G = (G_1, G_2, \dots, G_n)$, where each $a_{ij}, i = 1, 2, \dots, m, j = 1, 2, \dots, n$, is the value of the attribute of the alternative A_i with the attribute G. The

$A = (a_{ij})_{m \times n} = \langle (T_{ij}, I_{ij}, F_{ij}) \rangle_{m \times n}$ is an SVNNs matrix, where T_{ij} , I_{ij} and F_{ij} are the degree of membership, degree of indeterminacy- membership, and degree of non-membership, using equation (2) [16], [17], [28].

Step 5: Standardize decision information. That is, normalize $A = (a_{ij})_{m \times n}$ into $B = (b_{ij})_{m \times n}$. If the decision is a cost factor, the decision information should be changed to its complementary set using equation (3), while if it is an efficiency factor, it should not be changed.

Step 6: Construct a preference function $P_j(B_i, B_r)$ of the alternative B_i relative to B_r under the attribute G_j using (5).

$$P_j(B_i, B_r) = \begin{cases} 0, & d \leq p \\ \frac{d-p}{q-p}, & p < d < q \\ 1, & d \geq q \end{cases} \quad (5)$$

Step 7: Calculate the relative weight of the attributes w_{jr} , which is the relative weight of G_j to G_r , where

$$w_{jr} = \frac{w_j}{w_r} = (j, r = 1, 2, \dots, n) \quad (6)$$

Step 8: Define the priority index $\pi(B_i, B_r)$ of scheme B_i relative to B_r by

$$[1] \quad \pi(B_i, B_r) = \frac{\sum_{j=1}^n w_{jr} P_j(B_i, B_r)}{\sum_{j=1}^n w_{jr}} \quad (7)$$

Step 9: Calculate input flow $\Phi^+(B_i)$, the outflow $\Phi^-(B_i)$ and the net flow $\Phi(B_i)$ as follows

$$\Phi^+(B_i) = \frac{\sum_{r=1}^m \pi(B_i, B_r) - \min_{1 \leq l \leq m} \{\sum_{r=1}^m \pi(B_i, B_r)\}}{\max_{1 \leq l \leq m} \{\sum_{r=1}^m \pi(B_i, B_r)\} - \min_{1 \leq l \leq m} \{\sum_{r=1}^m \pi(B_i, B_r)\}} \quad (8)$$

$$\Phi^-(B_i) = \frac{\sum_{r=1}^m \pi(B_r, B_i) - \min_{1 \leq l \leq m} \{\sum_{r=1}^m \pi(B_r, B_i)\}}{\max_{1 \leq l \leq m} \{\sum_{r=1}^m \pi(B_r, B_i)\} - \min_{1 \leq l \leq m} \{\sum_{r=1}^m \pi(B_r, B_i)\}} \quad (9)$$

$$\Phi(B_i) = \Phi^+(B_i) - \Phi^-(B_i) \quad (10)$$

Step 10: Rank all alternatives according to the value of $\Phi(B_i)$. The higher the value of $\Phi(B_i)$, the better the alternative.

Methodological process

The place achieved by Ecuador in terms of disabilities is due in large part to the policies and legal regulations created to serve a sector of society that has been relegated for years and by several governments that only served as social assistance, today it is a State policy to give priority attention to people with disabilities, in accordance with the requirements of international standards and the implementation of national standards reflected in the large projects of direct assistance to the disabled; this new regime has made Ecuador a model of work in assistance and clear policies around disability, becoming a model in Latin America and international recognition at the UN [18], [19], [20].

For the definition of the alternatives to be evaluated, the regulations in force in the country were studied, in order to identify and know the main legislations that include the protection of disabled people:

- Constitution of the Republic of Ecuador (CRE)
- Ecuadorian Labor Code (ELC)
- Organic Law on Disabilities (OLD)
- Social Security Law (SSL)
- Comprehensive Criminal Organic Code (CCOC)

The criteria for the evaluation of the alternatives represent the guidelines to be used in the decision-making process, using them as a source of principles for the evaluation of the regulations. In this way, the alternatives to the problem can be analyzed from the same perspectives. This study was structured with 4 evaluation criteria, which were presented to the decision-makers for validation. For the analysis carried out, the analysts agreed to give the same weight of importance to each criterion (value of each weight, $w = 0.25$).

For this research, the following criteria will be used:

- **Accessibility:** the general principle and right that the pertinent measures be adopted to ensure that persons with disabilities can move, orient themselves or communicate naturally in any setting or activity. [21], [24]

- **Employment stability:** Despite the existing legislation, the pressure to which people with disabilities are subjected often forces them to end their working lives. In many cases, the disability also implies underlying diseases. With them, the absences and interruption of working hours, finally ends up bothering the bosses or other personnel, thus motivating dismissals. Even when the laws provide benefits in this regard.
- **Equal opportunities:** it is a legal principle, based on the idea that a fair society can only be achieved if any person has the same possibilities of access to minimum levels of social welfare, and their rights are not inferior to those of other groups. To this end, regulatory mechanisms are established that prohibit discrimination for reasons of various kinds.
- **Reasonable adjustments:** Necessary modifications and adaptations in infrastructure and services. These are applied according to particular cases, to guarantee that people with disabilities enjoy or exercise their rights on equal terms with others. [22], [23], [29], [30], [31], [32]

3 Results

Table 2 shows the evaluations given to decision-makers according to their relative importance in terms of the topic discussed.

Decision-makers	Linguistic evaluation	SVNN	Numerical value
Decision-maker 1	Very Important	(0.9;0.1;0.1)	0.21
Decision-maker 2	Moderately Important	(0.5;0.5;0.5)	0.17
Decision-maker 3	Very Important	(0.9;0.1;0.1)	0.21
Decision-maker 4	Very Important	(0.9;0.1;0.1)	0.21
Decision-maker 5	Important	(0.75;0.25;0.20)	0.2

Table 2: Evaluations given to decision-makers according to their importance. Source: own elaboration.

Once the decision-makers individually evaluate the alternatives indicated based on each of the criteria or attributes chosen for the evaluation, using equation (2) they are transformed to obtain the normal decision matrix of alternatives, which is shown in table 3.

	Accessibility	Employment stability	Equal opportunity	Reasonable adjustments
CCOC	(0.61424;0.38576;0.35486)	(0.67429;0.32571;0.28374)	(0.7626;0.2374;0.2081)	(0.7257;0.2743;0.2519)
OLD	(0.55653;0.44347;0.42667)	(0.5;0.5;0.5)	(0.56731;0.43269;0.41301)	(0.5;0.5;0.5)
CRE	(0.68696;0.31304;0.2988)	(0.54297;0.47088;0.45555)	(0.47187;0.54413;0.5515)	(0.6024;0.4096;0.3789)
SSL	(0.69071;0.30929;0.29523)	(0.61623;0.38377;0.35244)	(0.47187;0.54413;0.5515)	(0.5673;0.4327;0.413)
ELC	(0.5;0.5;0.5)	(0.55653;0.44347;0.42667)	(0.5;0.5;0.5)	(0.7445;0.2555;0.2555)

Table 3: Decision normal matrix of alternatives Note. Source: own elaboration.

All the selected criteria are considered as benefit criteria, that is, they should be maximized, except for criterion 4, so the normalized matrix obtained coincides with the normal matrix shown in Table 3. From it, the degrees of preference $P_j (B_i, B_r)$ with respect to G_j . This calculation can be carried out using the linear function proposed in (4). For this case, it is assumed that $q = 1, p = 0$, obtaining the matrices from P_1 a P_4 .

$$P_1 = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & B_5 \\ \begin{matrix} B_1 \\ B_2 \\ B_3 \\ B_4 \\ B_5 \end{matrix} & \begin{pmatrix} 0.0000 & 0.0000 & 0.0187 & 0.0199 & 0.0000 \\ 0.0239 & 0.0000 & 0.0426 & 0.0438 & 0.0000 \\ 0.0000 & 0.0000 & 0.0000 & 0.0012 & 0.0000 \\ 0.0000 & 0.0000 & 0.0000 & 0.0000 & 0.0000 \\ 0.0484 & 0.0245 & 0.0671 & 0.0683 & 0.0000 \end{pmatrix} \end{matrix}$$

$$P_2 = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & B_5 \\ B_1 & 0.0000 & 0.0000 & 0.0000 & 0.0000 & 0.0000 \\ B_2 & 0.0721 & 0.0000 & 0.0102 & 0.0492 & 0.0244 \\ B_3 & 0.0619 & 0.0000 & 0.0000 & 0.0390 & 0.0142 \\ B_4 & 0.0229 & 0.0000 & 0.0000 & 0.0000 & 0.0000 \\ B_5 & 0.0476 & 0.0000 & 0.0000 & 0.0247 & 0.0000 \end{matrix}$$

$$P_3 = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & B_5 \\ B_1 & \mathbf{0.0000} & \mathbf{0.0000} & \mathbf{0.0000} & \mathbf{0.0000} & \mathbf{0.0000} \\ B_2 & \mathbf{0.0683} & \mathbf{0.0000} & \mathbf{0.0000} & \mathbf{0.0000} & \mathbf{0.0000} \\ B_3 & \mathbf{0.1198} & \mathbf{0.0515} & \mathbf{0.0000} & \mathbf{0.0000} & \mathbf{0.0225} \\ B_4 & \mathbf{0.1198} & \mathbf{0.0515} & \mathbf{0.0000} & \mathbf{0.0000} & \mathbf{0.0225} \\ B_5 & \mathbf{0.0973} & \mathbf{0.0290} & \mathbf{0.0000} & \mathbf{0.0000} & \mathbf{0.0000} \end{matrix}$$

$$P_4 = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & B_5 \\ B_1 & \mathbf{0.0000} & \mathbf{0.0000} & \mathbf{0.0000} & \mathbf{0.0000} & \mathbf{0.0000} \\ B_2 & \mathbf{0.0827} & \mathbf{0.0000} & \mathbf{0.0364} & \mathbf{0.0290} & \mathbf{0.0815} \\ B_3 & \mathbf{0.0463} & \mathbf{0.0000} & \mathbf{0.0000} & \mathbf{0.0000} & \mathbf{0.0451} \\ B_4 & \mathbf{0.0537} & \mathbf{0.0000} & \mathbf{0.0074} & \mathbf{0.0000} & \mathbf{0.0525} \\ B_5 & \mathbf{0.0012} & \mathbf{0.0000} & \mathbf{0.0000} & \mathbf{0.0000} & \mathbf{0.0000} \end{matrix}$$

By using equation (6), the integral priority index is obtained, as shown in the matrix Π , from which the input, output, and net flow of each alternative are obtained, as shown in table 4.

$$\Pi = \begin{matrix} & B_1 & B_2 & B_3 & B_4 & B_5 \\ B_1 & 0.000 & 0.000 & 0.005 & 0.005 & 0.000 \\ B_2 & 0.062 & 0.000 & 0.022 & 0.030 & 0.026 \\ B_3 & 0.057 & 0.013 & 0.000 & 0.010 & 0.020 \\ B_4 & 0.049 & 0.013 & 0.002 & 0.000 & 0.019 \\ B_5 & 0.049 & 0.013 & 0.017 & 0.023 & 0.000 \end{matrix}$$

	$\Phi+$	$\Phi-$	Φ
CCOC	0	1,000	-1,000
OLD	1	0.000	1,000
CRE	0.691	0.036	0.654
SSL	0.555	0.167	0.388
ELC	0.703	0.150	0.553

Table 4: Input, output, and net flow of the alternatives. Note: Source: Own elaboration

The positive and negative flows in this type of analysis indicate the degrees of preference and non-preference against other alternatives. In this sense, from the results achieved by the analysis carried out, the Organic Law on Disabilities has a higher level of preference with respect to the other regulations. Closely followed by the Constitution and the Labor Code, being the one that has the least preference over the rest, the Comprehensive Criminal Organic Code. On the other hand, when analyzing the negative flows obtained, it can be seen that the CCOC is the one with the highest degree of non-preference with respect to the other laws. In this case, all regulations present similar levels of non-preference, except for the Organic Law on Disabilities, which in this case is the lowest of the values.

Conclusions

The use of the employed neutrosophic method demonstrates the efficiency of these methods in solving complex problems in real life, and different fields of society; in this particular case, the Law. Through the use of single value neutrosophic sets, it was possible to solve the proposed problem, eliminating the indeterminacies and vagueness of reality.

When analyzing the entire legal and regulatory framework, both in national and international regulations, it can be concluded that there is more than enough legislation to specify the rights of people with disabilities. The study shows that the most important are the rights to health, education, and employment. Gradually, an effective social and economic integration of people with disabilities is being achieved in the face of social issues, but there is still work to be done to guarantee compliance with all the rights that assist them.

The net flows confirm the data given by the negative and positive flows and show that the preferred regulation by the analysts in charge of decision-making was the Organic Law on Disabilities, placing the Constitution and the Labor Code in second and third place. It is pointed out that, in this case, the Comprehensive Criminal Organic Code was the least preferred by the analysts.

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