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Neutrosophic Case-Based Reasoning Method to Determine the Profitability of the Tourism Sector in the City of Riobamba

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Abstract: The tourism sector represents an area of vital importance for the economic growth of developing countries. The City of Riobamba in Ecuador, constitutes a reference tourist destination for the region. Quantifying the profitability of the tourism sector allows enhancing the places that represent economic objectives. This investigation proposes a case-based reasoning method to determine the profitability of the tourism sector. It bases its operation on Neutrosophy to represent uncertainty. The proposed method has been implemented to determine the profitability of the tourism sector in the City of Riobamba. After applying the method we reached to the conclusion that it constitutes a highly profitable area.

Keywords: case-based reasoning; Neutrosophy; Cost effectiveness; Tourism sector, SVNN

1. Introduction

Nowadays, tourism sector represents one of the highest income areas for the economies. In countries such as Ecuador, its growth has been enhanced, located in third place in non-oil exports [1], [2]. Each region has touristic destinations that characterize it [3], [4]. Riobamba is known as a passing city that has several places and tourist areas that make of it an interesting city [5], [6].

The existing parishes in Riobamba contribute positively to economic profitability due to the performance of the tourist activity [7], [8]. However, the little publicity given about the tourist offers puts tourists in a clear position of absolute confusion [9].

Economically, the classic modalities of tourism generate multiplier effects on the incomes and the native wealth of the tourist zones[10]. In the case of rural tourism, the effect is no different and it also stimulates the growth of other economic sectors through the creation of direct and indirect sources of employment [11], [12].

Although tourism can be considered as a heterogeneous product, the tourism sector is largely price sensitive, due to the great competition that exists between destinations. The consumer has a considerable range of choice where to choose from. Quantifying the profitability of the tourism sector allows enhancing the places that represent key economic objectives.

Based on the situation described above, the objective of this research is to develop case-based reasoning method to determine the profitability of the tourism sector.

2. Preliminaries

This section introduces the main theoretical references on the object of study and the different concepts that facilitate the understanding of the research. We also present a description of tourism in the city of Riobamba, located in Chimborazo province. SVN numbers are used to represent uncertainty in decision-making problems and, finally, a modeling of the uncertainty is carried out using a case-based reasoning method.

2.1. Tourism in the city of Riobamba, Chimborazo province

Riobamba is a wonderful city that has very beautiful touristic places and a wide culture, history and tradition. It has superimposed natural disasters like earthquakes. Riobamba is declared as "the railway capital" of Ecuador,

it is one of the first heritage cities, considered the first city for having the first Catholic church and the first Olympic stadium [13], [14]. It represents a historical destination for being the city where the first Constitution of Ecuador was signed [15], [16].

In the communities of San Juan, they believe that their livelihood continues to come from the sowing of agricultural products and the management and grazing of sheep and cattle. The income from milk is low, less than half of a minimum wage. However, thanks to different support programs, both from the State and NGOs, there is a variety of additional income, the main one is the Socio Bosque program [17], which generally provides more income at the family level than agriculture itself. Additionally, there is income from handicrafts and tourism [18], [19], the latter being the object of analysis of this research.

2.1. Neutrosphic case-based reasoning

The profitability of the tourism sector can be modeled as a multi-criteria decision-making problem [20], so that it complies with [21]:

A set of profitability criteria $R = \{R_1, \dots R_n\}, n \geq 2$;

So that they are evaluated to the set of alternatives that represent the tourist sectors

$I = \{I_1, \dots I_m\}, m \geq 2$

The profitability is made up of the group of criteria that determine the profitability of the tourism sector [22] strongly influenced by hotel impact on the community [23].

The case-based reasoning methodology consists of solving new problems by reusing past experience using a similarity function to retrieve close cases [24]. Case-based reasoning is one of the preferred method for uncertain decision in complex and dynamic situations. In this paper, we apply this method to multi-criteria evaluation of profitability with an indeterminacy environment.

Indeterminacy could be modeled by neutrosophic theory proposed by Smarandache [25].

Definition 1. ([26, 27]) Let U be a space of points (objects), with a generic element in U denoted by x. A Single-Valued Neutrosophic Set (SVNS) A in U is characterized by a truth-membership function TA, an indeterminacy-membership function IA and a falsehood-membership function FA. TA(x), IA(x) and FA(x)∈[0,1]. It can be written as A = {< x, (TA(x), IA(x), FA(x)) >: x ∈ U; TA(x), IA(x), FA(x)∈[0, 1]}.

There is no restriction on the sum of TA(x), IA(x) and FA(x), thus, 0≤TA(x) +IA(x)+FA(x) ≤3.

For convenience, a Single-Valued Neutrosophic Number (SVNN) is represented by (a, b, c), where a, b, c ∈ [0, 1] and 0≤a+b+c ≤3. In this paper, a linguistic scale is associated with SVNN and used to give assessment in a more natural way; similarity metrics are used for neutrosophic case-based reasoning[28] .

3. Materials and Methods

This section describes the operation of the method to determine the profitability of the tourism sector. The fundamental elements that characterize the proposal are presented to facilitate its understanding.

The method to determine the profitability of the tourism sector is designed to assess its behavior, it is expressed through three basic activities: input, management and information output. Figure 1 shows a general scheme of the proposed method.

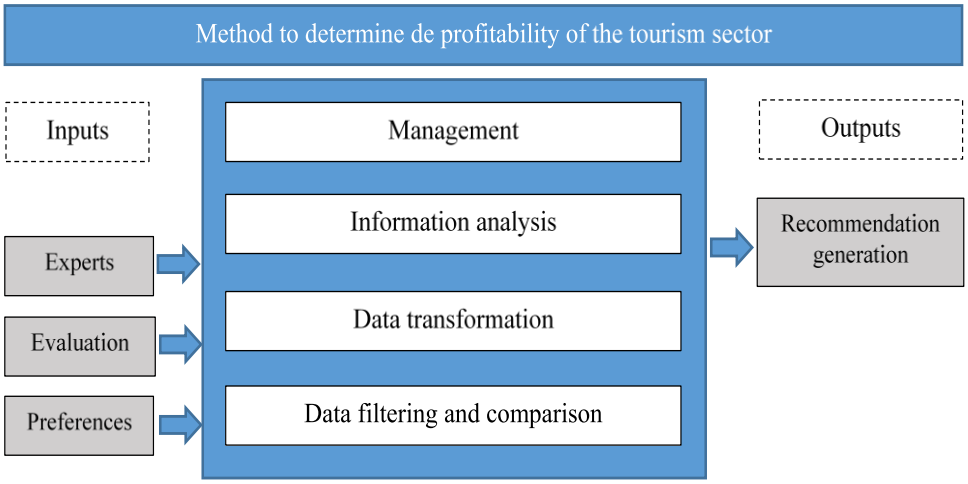

Figure 1. Scheme with the workflow of the proposed method.

The method to determine the profitability of the tourism sector was designed through a workflow composed of three activities that in its integration determine the proposed inference. Below is a description of the proposed activities.

Activity 1 information analysis

To nourish the operation of the proposed method, the sources of information are identified and subsequently stored in databases for further transformation and analysis. This activity uses the empirical organizational knowledge base. It consists of the collection of historical information on the behavior of the tourism sector.

Supported by Neutrosophy, an interpretability of the data is obtained, SVNS sets are used because they allow the use of linguistic variables [29] [30]. The evaluation criteria are expressed through a universe of discourse that is denoted as (X) [31, 32]. Where the Single Valued Neutrosophic Set is defined as A over X, which is an object of the form shown in equation 2.

$$A = \{\langle x, uA(x), rA(x), vA(x)\rangle:\ x \in X\}d \quad (2)$$

Where: (x)X $\rightarrow$ [0,1], rA(x) $\rightarrow$ [0,1], vA(x) $\rightarrow$ [0,1]; with 0 $\leq$uA(x)+ rA(x)+ vA(x): $\leq$ 3 for all x $\in$ X. The interval (x), rA (x) and vA (x) denotes the membership to true, indeterminate and false of x in A, successively. The value of the Neutrosophic set A is expressed as shown in equation 3.

$$A = (a, b, c) \quad (3)$$

Where: a, b, c $\in$ [0,1], a+b+c $\leq$ 3

Activity 2 data transformation

Each data describes the characteristics of the sector from Neutrosophic numbers [33], [34],[35],[29] . It has $A^* = (A_1^*, A_2^*, .., A_n^*)$ a vector of SVN numbers, such that: $A_j^* = (a_j^*, b_j^*, c_j^*)$, j=(1,2, … , n), $B_i = (B_{i1}, B_{i2}, \dots, B_{im})$ (i = 1,2, … , m), it has m vectors of n SVN numbers.

Such that that $B_{ij} = (a_{ij}, b_{ij}, c_{ij})$($i$ = 1,2, … , m), (j = 1,2, … , n), B_i and A^* obtained by equation 4:

$$d_i = \left(\frac{1}{2}\sum_{i=1}^{n}\left\{\left(|a_{ij}-a_i^*|\right)^2+\left(|b_{ij}-b_i^*|\right)^2+\left(|c_{ij}-c_i^*|\right)^2\right\}\right)^2 \quad (4)$$

(i = 1,2,3… , m)

The similarity average is used to obtain the Euclidean distance as expressed in equation 5.

$$F_{a_i} = \{v_1^j, \dots, v_k^j, \dots v_l^j\}, j = 1, \dots n \quad (5)$$

Calculation allows to obtain the measure of the alternative A_i, from the similarity, the method must look for which of the data are closest to the solution set S_i, through the neighborhood you get an order of the alternatives. The smaller the neighborhood the greater the similarity will be [36] ,[34] ,[37].

Activity 3 Data filtering and comparison

The activity consists in evaluating the behavior of the indicators for a given activity. The linguistic scale S, $V_k^j \in S$. is used for this purpose

Where: $S = \{S_1, , S_g\}$ representing the set of linguistic labels to evaluate the characteristics of the C_k sectors.

The evaluation is considered the preference of the process from which they are obtained:

$$P = \{P_1, \dots P_e\},$$

The values obtained are compared with the previously stored data, a comparison process is carried out using the Euclidean distance as expressed in equation (6).

$$S=1-\left(\frac{1}{2}\sum_{i=1}^{n}\left\{\left(|a_{ij}-a_i^*|\right)^2+\left(|b_{ij}-b_i^*|\right)^2+\left(|c_{ij}-c_i^*|\right)^2\right\}\right)^2 \quad (6)$$

The S function determines the similarity between the values of the stored data and the preferences obtained by comparing the entire existing neighborhood [30, 35].

Information output: Generation of recommendations

After obtaining the similarity, the process of recommendations is executed. Recommendations are made from stored data. It consists of generating an order on the similarity neighborhood.

The best result will be the one that meets the needs that characterize the indicator.

4. Application of the Neutrosophic Method to determine the profitability of the tourism sector

The proposed method was tested to determine the profitability of the tourism sector in the City of Riobamba. An evaluation of two other alternatives was carried out, which were compared with the City of Riobamba. The objective was to make an evaluation and comparison of the indicators to determine the profitability of the tourism sector. Results are represented by alternatives *I*, so that:

$I = \{i_1, i_2, i_3\}$

i_1: Canton of Babahoyo.

i_2: Canton of Quevedo.

i_3: Canton of Riobamba.

Valued from the set of characteristics C that describe the profitability according to [38], such that: $C = \{c_1, c_2, c_3, c_4, c_5, c_6, c_7, c_8\}$,

Where:

C_1: Index of income and expenses for the hotel service.
C_2: Economic impact of the hotel service in the locality.
C_3: Customer satisfaction index with hotel service.
C_4: Representativeness index of the hotel service in the locality.
C_5: Index of water consumption by rooms occupied days.
C_6: Index of energy consumption by rooms occupied days.
C_7: Number of complaints and claims.
C_8: Hotel competitiveness index in the tourist destination.

From the set of linguistic labels presented in table 1 [33], defined as:

Linguistic term	**SVN numbers**
Extremely good (EG)	(1,0,0)
Very very good (VVG)	(0.9, 0.1, 0.1)
Very good (VG)	(0.8,0,15,0.20)
Good (G)	(0.70,0.25,0.30)
Moderate good (MG)	(0.60,0.35,0.40)
Medium (M)	(0.50,0.50,0.50)
Moderate bad (MB)	(0.40,0.65,0.60)
Bad (B)	(0.30,0.75,0.70)
Very bad (VB)	(0.20,0.85,0.80)
Very Very bad (VVB)	(0.10,0.90,0.90)
Extremely bad (EB)	(0,1,1)

Table 1. Language terms used.

The comparison expression shown in (7) is obtained from the application of the method, this data is stored in the case base for further analysis.

$$P_e = \{VVG, G, MG, VG, VVG, G, MG, VG\} \quad (7)$$

After processing the data, its filtering provides a systematic mapping for each alternative object of analysis. Figures 2, 3 and 4 present distances to each criterion in a bar graph.

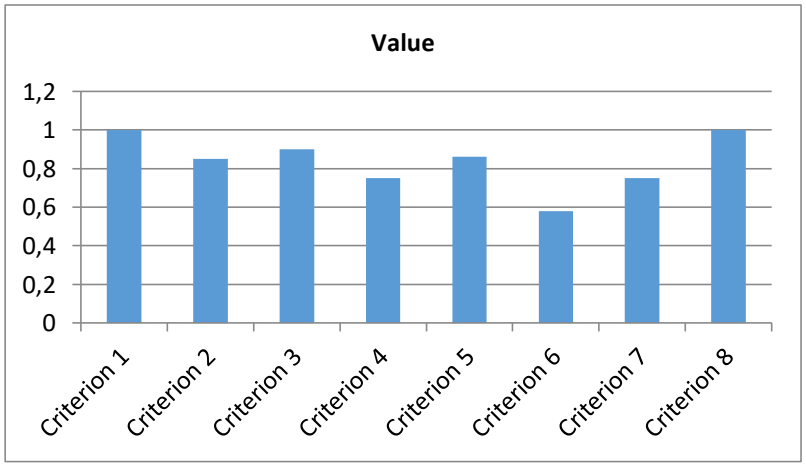

Figure 2. Individual criterion distances for Babahoyo Canton.

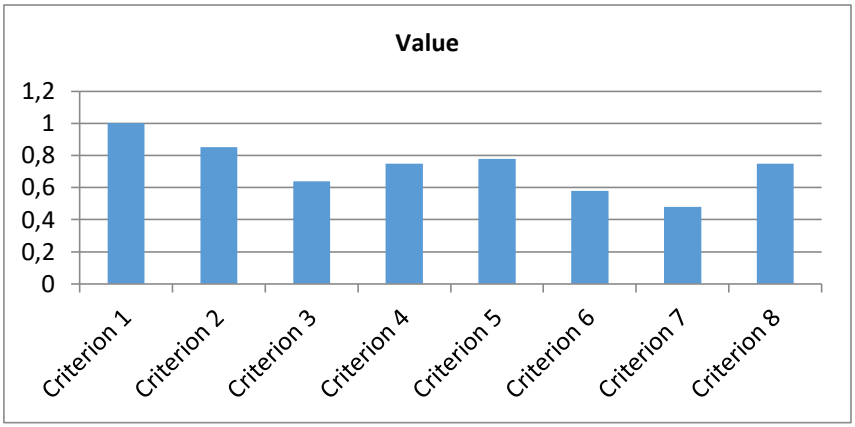

Figure 3. Individual criterion distances for Quevedo Canton .

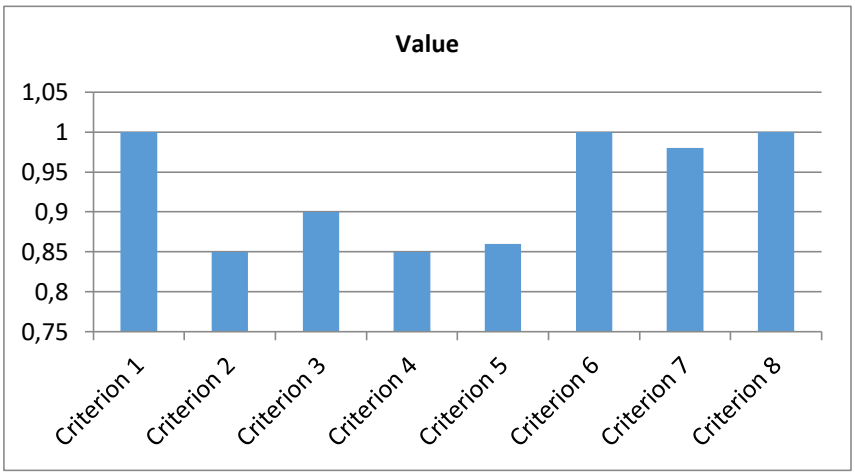

Figure 4. Individual criterion distances for Riobamba Canton.

Once the map of the alternatives was obtained, we proceeded to calculate the similarity. Results are shown in Table 2.

a_1	a_2	a_3
0.45	0.85	0.72

Table 2. Similarity between the characteristics and the profile of the tourism sector.

Based on the analysis of the results, the alternative ordering process is carried out. From that process, the alternative object of attention is visualized. Expression 8 shows the result of the resulting ordering.

$$\{a_2, a_3, a_1\} \quad (8)$$

After ordering, the method recommends the alternative (a_3) which correspond to the City of Riobamba. The recommended alternative has in the case base an evaluation of the profitability valued as "Very good". The analyzed case goes on to take part in the base of cases with a ¨Very good¨ assessment for similarity. Processing lead us to determine that the case under study constitutes a feasible result for its strengthening.

Conclusions

The contribution presented to determine the profitability of the tourism sector was based on the use of Single Valued Neutrosophic Set Numbers through expressions of linguistic terms. The method developed follows a workflow through 3 activities that make up its integral management using case-based reasoning theory.

In order to test of the proposed method, we made an assessment of three cantons to evaluate and determine the touristic profitability in order to enhance their attention. The inference of the method was obtained through the criteria that characterize the profitability and they populated the knowledge base that improves learning for later functioning.

As a general result, we concluded that the City of Riobamba is quantified with a profitability index valued as Very good. Future work will concentrate on extending the model with more historical data and new similarity metrics.

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