Fuzzy multicriteria decision making method applied to selection of the best touristic destinations

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***Abstract*—**We adapt a recent method in fuzzy multicriteria decision making to find the best tourist destinations from the point of view of the possible future customers. We obtain a hierarchy of the destinations, so that the travel agency has the possibility to virtually contract the most desired destinations. The theoretical development is completed by a real numerical example. The list of attributes considered the most important are obtained using a focus group and the levels of importance of different attributes after applying a questionnaire in a sample of 400 individuals from the target group.

***Keywords*—**fuzzy number, multicriteria decision making, tourist destinations, travel agent

I. Introduction

FUZZY mathematics is often applied to objectively reflect the ambiguity in human judgement, to represent uncertain and incomplete information, to incorporate unquantifiable and partial facts in decision making, linguistic controllers, biotechnological systems, expert systems, data mining, pattern recognition, etc. (see, e.g., [1]-[7]). Fuzzy set theory seems to be a suitable tool in the evaluation of services quality especially ([8]-[16], etc.).

The fuzzy numbers were already used for evaluating tourist service quality with very fine results in [17] and [18]. The fuzzy multicriteria decision making method elaborated in [19] was adapted in [20] to hierarchy the available tourist destinations/locations of a tourist agency from the customer's perspective. Proposed method in the present paper is based on the mathematical development in [19] too, and its aim is to offer the possibility of a travel agency to buy the best destinations for its customers, taking into account the relative importance of each destination attribute given by every customer. The attributes are assessed by using semantic differentials. The major advantage of modeling by fuzzy numbers is the capacity to consider the performance of attributes and the weights of importance of attributes in a more natural way.

On the other hand, the tourist market is a very dynamic one, requiring a difficult symbiosis between the classical values and the modern ones. The perennial classical values that have to characterise a tourist offer are the correct relation quality-price, comfort and safety. The modern values are given by freedom, diversity and the possibility of choice: of the type of accommodation, the component of the menu, the structure of the programme.

The tourist market is extremely segmented, with firm, precise and specific needs. The condition to satisfy the needs of different segments of consumers is the mediation of the encounter between the demand and supply, by knowing the needs, of the demand wishes and the configuration of the offer in accordance to it.

The ranking of destinations in accordance with certain attributes, appropriately chosen from the perspective of the target market, presents utility for the tourism intermediaries. The suppliers of tourist services follow a good specialization on the segments of consumers. The tourism intermediaries annually conceive their offer in accordance with the experience of the previous years but also in accordance with the needs manifested on the market and noticed in the research performed.

In this paper we suggest a method meant to help the travel agencies to contract the most suitable locations from the potential client's perspective.

Echtner and Ritchie [21] have done an excellent inventory of the most used assessment attributes of a destination, analysing 14 studies. They obtained 34 attributes, to which we add a number of 12 extracted Jenkins [22] from 6 international studies investigating the image.

We intentionally use the focus group method to discover whether the attributes resulted after the discussions correspond to those provided by the speciality literature. For the importance given to attributes is different according to the target public considered, a questionnaire which should clarify this aspect must be applied. Taking into account the importance of attributes and the extent to which these are satisfied for each destination, we can obtain a value synthesising the quality of the destination from the potential client's perspective.

Organizing the values found, we obtain a hierarchy of tourist destinations had in view in order to be contracted. The instruments used to process the data and to obtain as accurate as possible results belong to fuzzy mathematics.

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II. Fuzzy Numbers

A. Triangular Fuzzy Numbers

A fuzzy set μ on the universe of discourse U is described by a mapping $\mu: U \to [0,1]$, where $\mu(x)$ is the membership degree of x.

A triangular fuzzy number is a fuzzy set on the real line $\mathbb{R}$ with the membership function given by

$$\mu(x) = \begin{cases} \dfrac{x-a}{b-a}, & if\ a \le x \le b \\ \dfrac{c-x}{c-b}, & if\ b \le x \le c \\ 0, & otherwise \end{cases} \tag{1}$$

where $a, b, c \in \mathbb{R}, a < b < c$ (see Fig. 1). We denote by (a, b, c) a triangular fuzzy number. The parameter b gives the most possible value of the evaluated data and a, c are the lower and upper bounds of the available area for the evaluated data.

If $a = b$ or $b = c$ then, by convention, (a, b, c) denotes the triangular fuzzy numbers in Fig. 2, respectively. Any real number a can be represented as the triangular fuzzy number (a, a, a).

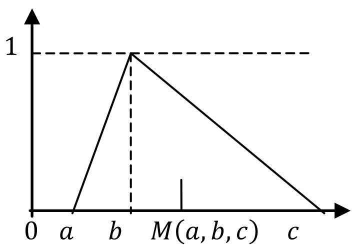

Fig.1 Triangular fuzzy number (a, b, c).

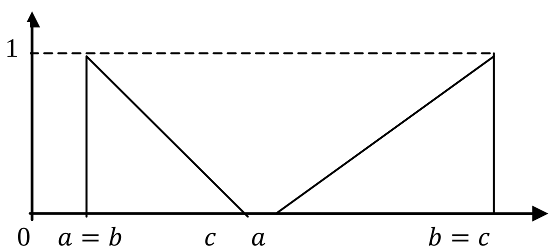

Fig.2 Triangular fuzzy numbers (a, a, c) and (a, c, c)

B. Fuzzy Numbers

A fuzzy number is a fuzzy set on the real line $\mathbb{R}$ with the membership function given by (see e.g. [23])

$$u(x) = \begin{cases} 0, & if\ a_1 > x \\ f(x), & if\ a_1 \le x < a_2 \\ 1, & if\ a_2 \le x \le a_3 \\ g(x), & if\ a_3 < x \le a_4 \\ 0, & if\ x > a_4, \end{cases} \tag{2}$$

where $a_1, a_2, a_3, a_4 \in \mathbb{R}$, f is a nondecreasing function and g is a nonincreasing function.

An useful tool for dealing with fuzzy numbers are the level sets. The α-level set u_α of a fuzzy number u is the set

$$u_\alpha = \{x \in \mathbb{R}: \mu(x) \ge \alpha\}$$

if $\alpha \in (0, 1]$ and

$$u_0 = \overline{\{x \in R: \mu(x) > 0\}},$$

where $^{-}$ denotes the closure operator. In fact,

$$u_\alpha = [u_L(\alpha), u_R(\alpha)] = [f^{-1}(\alpha), g^{-1}(\alpha)],$$

where

$$f^{-1}(\alpha) = inf\{x: u(x) \ge \alpha\},$$
$$g^{-1}(\alpha) = sup\{x: u(x) \ge \alpha\},$$

for every $\alpha \in (0, 1]$.

If $u = (a, b, c)$ is a triangular fuzzy number then

$$u_L(\alpha) = a + (b-a)\alpha$$

and

$$u_R(\alpha) = c + (b-c)\alpha,$$

for every $\alpha \in [0,1]$.

Given fuzzy numbers u and v such that $u_0, v_0 \subset (0, +\infty)$ and $\lambda \in (0, +\infty)$ the main operations of u and v can be expressed as follows (see [24])

$$(u \oplus v)_\alpha = [u_L(\alpha) + v_L(\alpha), u_R(\alpha) + v_R(\alpha)],$$
$$(u \otimes v)_\alpha = [u_L(\alpha) \cdot v_L(\alpha), u_R(\alpha) \cdot v_R(\alpha)]$$
$$(\lambda \cdot u)_\alpha = [\lambda \cdot u_L(\alpha), \lambda \cdot u_R(\alpha)].$$

For example, if u and v are triangular fuzzy numbers, $u = (a_1, b_1, c_1), v = (a_2, b_2, c_2), a_1 > 0, a_2 > 0$ and $\lambda > 0$ then

$$(u \oplus v)_L(\alpha) = a_1 + a_2 + (b_1 + b_2 - a_1 - a_2)\alpha,$$
$$(u \oplus v)_R(\alpha) = c_1 + c_2 + (b_1 + b_2 - c_1 - c_2)\alpha,$$

that is

$$(a_1, b_1, c_1) \oplus (a_2, b_2, c_2) = (a_1 + a_2, b_1 + b_2, c_1 + c_2).$$

In an obvious way we get

$$(u \otimes v)_L(\alpha) = a_1a_2 + \big(a_1(b_2 - a_2) + a_2(b_1 - a_1)\big)\alpha + (b_1 - a_1)(b_2 - a_2)\alpha^2,$$
$$(u \otimes v)_R(\alpha) = c_1c_2 + \big(c_1(b_2 - c_2) + c_2(b_1 - c_1)\big)\alpha + (b_1 - c_1)(b_2 - c_2)\alpha^2$$

and

$$(\lambda \cdot u)_L(\alpha) = \lambda a_1 + (\lambda b_1 - \lambda a_1)\alpha,$$
$$(\lambda \cdot u)_R(\alpha) = \lambda c_1 + (\lambda b_1 - \lambda c_1)\alpha,$$

that is

$$\lambda \cdot (a_1, b_1, c_1) = (\lambda a_1, \lambda b_1, \lambda c_1).$$

C. Expected Value, Correlation Coefficient and Rankings of Fuzzy Numbers

To capture the relevant information, to simplify the task of representing and handling of fuzzy numbers, different parameters associated with fuzzy numbers were introduced.

The expected value M of a fuzzy number u was defined in [25] and [26] as follows:

$$M(u) = \frac{1}{2}\big(M_L(u) + M_R(u)\big), \tag{3}$$

where

$$M_L(u) = a_2 - \int_{a_1}^{a_2} f(x)dx$$

and

$$M_R(u) = a_3 + \int_{a_3}^{a_4} g(x)dx.$$

The expected value of a triangular fuzzy number (a, b, c) (see Fig. 1) becomes

$$M\big((a,b,c)\big) = \frac{a+2b+c}{4}. \quad (4)$$

The correlation coefficient between two fuzzy numbers u and v was introduced in [27] by

$$\rho(u,v) = \frac{M_L(u)M_L(v) + M_R(u)M_R(v)}{\sqrt{M_L^2(u)+M_L^2(v)}\sqrt{M_R^2(u)+M_R^2(v)}}. \quad (5)$$

If $u = (a_1, b_1, c_1)$ and $v = (a_2, b_2, c_2)$ are two triangular fuzzy numbers then

$$\rho(u,v) = \frac{(a_1+b_1)(a_2+b_2)+(b_1+c_1)(b_2+c_2)}{\sqrt{(a_1+b_1)^2+(a_2+b_2)^2}\sqrt{(b_1+c_1)^2+(b_2+c_2)^2}}.$$

Many fuzzy number ranking methods have been proposed. A theoretical approach can be found in [28].
Due to its simplicity, the following procedure of ranking is often used:

$$u \le v$$

if and only if (6)

$$M(u) \le M(v).$$

In the case of triangular fuzzy numbers,

$$(a_1, b_1, c_1) \le (a_2, b_2, c_2)$$

if and only if (7)

$$a_1 - a_2 + 2(b_1 - b_2) + c_1 - c_2 \le 0.$$

III. Fuzzy Multiple Criteria Decision Making

A. General Problem

The aim of a multicriteria decision making method is to hierarchy some alternatives $A_1, \dots, A_m$ taking into account the opinions of decision makers with respect to a set of criteria and weights of these criteria. In the case of data expressed by linguistic values, or, equivalently, by fuzzy sets we must elaborate fuzzy multicriteria decision making methods.

Let us assume that k decision makers $D_1, \dots, D_k$ evaluate alternatives $A_1, \dots, A_m$ under n criteria $C_1, \dots, C_n$. The criteria can be classified to be subjective $(C_1, \dots, C_h)$ and objective $(C_{h+1}, \dots, C_n)$, where $1 \le h \le n$. Objective criteria are benefit criteria $(C_{h+1}, \dots, C_l)$ and cost criteria $(C_{l+1}, \dots, C_n)$, where $h+1 \le l \le n$.

Let $r_{ijt} = \big(e_{ijt}, f_{ijt}, g_{ijt}\big), i \in \{1, \dots, m\}, j \in \{1, \dots, h\}, t \in \{1, \dots, k\}$ the triangular fuzzy number which represents the linguistic value assigned by decision maker $D_t, t \in \{1, \dots, k\}$ to alternative $A_i, i \in \{1, \dots, m\}$, for subjective criterion $C_j, j \in \{1, \dots, h\}$.

Let $x_{ij} = \big(a_{ij}, b_{ij}, c_{ij}\big), i \in \{1, \dots, m\}, j \in \{h+1, \dots, n\}$ the performance of alternative $A_i, i \in \{1, \dots, m\}$ with respect to objective criterion $C_j, j \in \{h+1, \dots, n\}$ and $w_{jt} = \big(o_{jt}, p_{jt}, q_{jt}\big), j \in \{1, \dots, n\}, t \in \{1, \dots, k\}$ the triangular fuzzy number which represents the weight assigned by decision maker $D_t, t \in \{1, \dots, k\}$ to criterion $C_j, j \in \{1, \dots, n\}$, expressed by a linguistic value. The characteristics "the larger the better" and "the smaller the better" are valid for benefit criteria and cost criteria respectively. Because the objective criteria may have different units they must be normalized into a comparable scale.

B. Chu and Lin's method

A procedure to solve a problem as above was elaborated in [chu]. It uses the arithmetic mean to aggregate triangular fuzzy numbers and the expected value in the final fuzzy evaluation process to rank the triangular fuzzy numbers corresponding to alternatives $A_1, \dots, A_m$.

The averaged rating of $A_i, i \in \{1, \dots, m\}$ under subjective criteria $C_j, j \in \{1, \dots, h\}$ is calculated by

$$r_{ij} = \big(e_{ij}, f_{ij}, g_{ij}\big) = \left(\frac{1}{k}\sum_{t=1}^{k} e_{ijt}, \frac{1}{k}\sum_{t=1}^{k} f_{ijt}, \frac{1}{k}\sum_{t=1}^{k} g_{ijt}\right).$$

The triangular fuzzy number $r_{ij}, i \in \{1, \dots, m\}, j \in \{h+1, \dots, l\}$ corresponding to the benefit type objective criterion $C_j, j \in \{h+1, \dots, l\}$ is obtained by normalizing the performance $x_{ij} = \big(a_{ij}, b_{ij}, c_{ij}\big), i \in \{1, \dots, m\}, j \in \{h+1, \dots, l\}$ of the alternative $A_i, i \in \{1, \dots, m\}$ through normalization, using the formula

$$r_{ij} = \big(e_{ij}, f_{ij}, g_{ij}\big) = \left(\frac{a_{ij} - a_j^*}{d_j^*}, \frac{b_{ij} - a_j^*}{d_j^*}, \frac{c_{ij} - a_j^*}{d_j^*}\right) \quad (8)$$

and the triangular fuzzy number $r_{ij}, \forall i \in \{1, \dots, m\}, j \in \{l+1, \dots, n\}$ corresponding to the cost type objective criterion $C_j, j \in \{l+1, \dots, n\}$ is obtained by normalizing the performance $x_{ij} = \big(a_{ij}, b_{ij}, c_{ij}\big), i \in \{1, \dots, m\}, j \in \{l+1, \dots, n\}$ of the alternative $A_i, i \in \{1, \dots, m\}$ through normalization, using the formula

$$r_{ij} = \big(e_{ij}, f_{ij}, g_{ij}\big) = \left(\frac{c_j^* - c_{ij}}{d_j^*}, \frac{c_j^* - b_{ij}}{d_j^*}, \frac{c_j^* - a_{ij}}{d_j^*}\right) \quad (9)$$

where,

$$a_j^* = min_{i \in \{1, \dots, m\}} a_{ij},$$

$$c_j^* = max_{i \in \{1, \dots, m\}} c_{ij},$$

$$d_j^* = c_j^* - a_j^*.$$

The averaged weight of C_j assessed by decision makers is given by

$$w_j = \big(o_j, p_j, q_j\big) = \left(\frac{1}{k}\sum_{t=1}^{k} o_{jt}, \frac{1}{k}\sum_{t=1}^{k} p_{jt}, \frac{1}{k}\sum_{t=1}^{k} q_{jt}\right).$$

The aggregation of weighted ratings, denoted by G_i, is calculated as

$$G_i = \frac{1}{n} \cdot (r_{i1} \otimes w_1 \oplus \dots \oplus r_{in} \otimes w_n),$$

that is, the final fuzzy evaluation value of alternative A_i is given by fuzzy number G_i, $i \in \{1, \dots, m\}$, where

$$(G_i)_L(\alpha) = \frac{1}{n}\sum_{j=1}^{n} e_{ij}o_j + \left(\frac{1}{n}\sum_{j=1}^{n} e_{ij}(p_j - o_j) + \frac{1}{n}\sum_{j=1}^{n} o_j(f_{ij} - e_{ij})\right)\alpha + \frac{1}{n}\sum_{j=1}^{n}(f_{ij} - e_{ij})(p_j - o_j)\alpha^2$$

$$(G_i)_R(\alpha) = \frac{1}{n}\sum_{j=1}^{n} g_{ij}q_j + \left(\frac{1}{n}\sum_{j=1}^{n} g_{ij}(p_j - q_j) + \frac{1}{n}\sum_{j=1}^{n} q_j(f_{ij} - g_{ij})\right)\alpha + \frac{1}{n}\sum_{j=1}^{n}(f_{ij} - g_{ij})(p_j - q_j)\alpha^2.$$

For each of the m alternatives $A_1, \dots, A_m$, the final fuzzy evaluation value, that is the fuzzy number G_i is defuzzified according with the expected value (see (3)). In other words, the following value is calculated (see [19])

$$M(G_i) = Y_i + U_i + R_i, \tag{10}$$

where,

$$Y_i = \frac{1}{n}\sum_{j=1}^{n} f_{ij}p_j \tag{11}$$

$$U_i = \frac{6I_{i1}J_{i1}(Y_i - Q_i) - [J_{i1}^2 + 4I_{i1}(Y_i - Q_i)]^{\frac{3}{2}} + J_{i1}^3}{24I_{i1}^2} \tag{12}$$

$$R_i = \frac{-6I_{i2}J_{i2}(Z_i - Y_i) + [J_{i2}^2 + 4I_{i2}(Y_i - Z_i)]^{\frac{3}{2}} - J_{i2}^3}{24I_{i2}^2} \tag{13}$$

$$I_{i1} = \frac{1}{n}\sum_{j=1}^{n}(f_{ij} - e_{ij})(p_j - o_j) \tag{14}$$

$$I_{i2} = \frac{1}{n}\sum_{j=1}^{n}(f_{ij} - g_{ij})(p_j - q_j) \tag{15}$$

$$J_{i1} = \frac{1}{n}\sum_{j=1}^{n}\left[e_{ij}(p_j - o_j) + o_j(f_{ij} - e_{ij})\right] \tag{16}$$

$$J_{i2} = \frac{1}{n}\sum_{j=1}^{n}\left[g_{ij}(p_j - q_j) + q_j(f_{ij} - g_{ij})\right] \tag{17}$$

$$Q_i = \frac{1}{n}\sum_{j=1}^{n} e_{ij}o_j, \tag{18}$$

$$Z_i = \frac{1}{n}\sum_{j=1}^{n} g_{ij}q_j. \tag{19}$$

According to the ranking procedure (6), the descending order of the numbers $M(G_1), \dots, M(G_m)$ give us the order of alternatives $A_1, \dots, A_m$, that is if $M(G_i) > M(G_j)$ then alternative A_i is preferred to alternative A_j.

IV. Application to the Contracting the most suitable tourist destinations

A. Linguistic Terms

In the present paper, as in [29] two sets of linguistic terms {not important (NI), somewhat important (SI), important (I), very important (VI), extremely important (EI)} and ({very poor (VP), poor (P), fair (F), good (G), very good (VG} are used for assessing attribute weights and performance ratings, respectively. Of course, finer linguistic scales lead to more exact results, but the application of questionnaires may become difficult.

Let us assume that each linguistic term is characterized by a triangular fuzzy number defined in Table I and represented in Fig. 3.

Table I: Triangular fuzzy numbers associated to linguistic variables

NI/VP	(0,0,0.3)
SI/P	(0.1,0.3,0.5)
I/F	(0.3,0.5,0.7)
VI/G	(0.5,0.7,0.9)
EI/VG	(0.7,1,1)

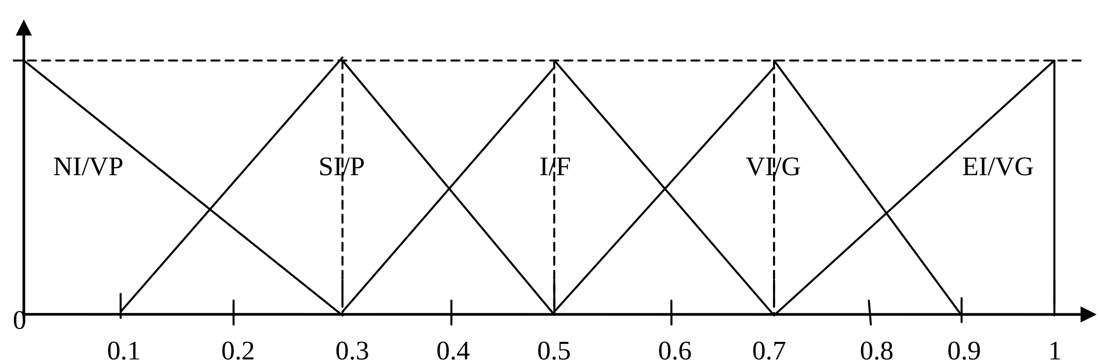

Fig. 3 Triangular fuzzy numbers associated to linguistic variables

B. Determining the Attributes Using the Focus-Group Method

The methods and techniques generating the attributes characterizing the tourist destination are divided into: structured and unstructured, those structured being predominant. Echtner and Ritchie [21] made a synthesis of the methods and techniques used to generate the attributes as they are found in the specialty literature. The structured methods are predominant.

In our research we used a combination of structured and unstructured methods. We organized a focus group in April 2010 among the young people of 18-25 years old. The purpose of the focus group was to identify some criteria, attributes which are the basis of choosing a tourist destination at the seaside. The attributes resulted were compared with those provided by the specialty literature [21], [22]. Subsequently, we made a survey through questionnaire by choosing only 14 attributes, a questionnaire which was applied to 400 individuals in this age category.

On the other side, the social-professional category of the target group hallmarks the attributes characterizing the destination. Synthesizing the attributes provided by Echtner and Ritchie [21] there is no attribute resulted from the focus group organized by us, that is: the type of consumers attending the destination (let it be a destination for young people). This attribute could come undone from the combination of 2 attributes given by Echtner and Ritchie [21] and that is ″Fame/Reputation″ and ″Family or Adult Oriented″. Within the focus group, there has been the opinion that the destination must have the reputation of being attended by young people. Such destinations are Costineşti (Romania) or Ibiza (Spain). Also, certain generic attributes of the accommodation type require an itemization of the type: comfort, flexibility, closeness to the beach.

The attributes resulting from the study, $C_1 - C_{14}$, are presented in Table 2. Of these, $C_1 - C_9$ are subjective criteria, $C_{10} - C_{13}$ are objective criteria of benefit type, and C_{14} is an objective criterion of cost type.

C. The calculus of the levels of importance of the attributes

The attributes selected will be re-evaluated in order to determine the importance given from the perspective of the target market.

The question is whether the attributes characterizing a destination are different in according to the type of tourist destination and/or the category of respondents. For the first part of the question the answer is given by Y. Hu and J.R.B. Ritchie [30] who show that two models stood out. The first model suggests that certain attributes have a universal importance in choosing a destination, such as: scenery, price and climate. The second model indicates the fact that 2 or 3 attributes are general but there are others specific to the destination.

We believe that there is a set of generally available attributes for any tourist destination, to which we add attributes specific to the type of destination: seaside, mountain, cultural, balneary. The set of attributes, general and specific, are given importance according to each consumer, according to its psychological-social-demographic characteristics. The experience is another factor influencing the importance given to attributes. It can change the individual hierarchy of the attributes, the percentage in general. We assume that each of the k persons considered $D_1, \dots, D_k$, answers a questionnaire made to find out the importance of the given criterion $C_j, j \in \{1, \dots, n\}$. The answers will be considered, obtaining thus the triangular fuzzy numbers $w_{jt} = (o_{jt}, p_{jt}, q_{jt}), j \in \{1, \dots, n\}, t \in \{1, \dots, k\}$. The weight assigned by the group of decision makers $\{D_1, \dots, D_k\}$ to criterion $C_j, j \in \{1, \dots, n\}$, is calculates as the arithmetic mean of the individual answers, that is

$$w_j = (o_j, p_j, q_j) = \left(\frac{1}{k}\sum_{t=1}^{k} o_{jt}, \frac{1}{k}\sum_{t=1}^{k} p_{jt}, \frac{1}{k}\sum_{t=1}^{k} q_{jt}\right). \quad (20)$$

In this paper we consider the linguistic scale $\{NI, SI, I, VI, EI\}$ in Table I and the answers obtained after applying a questionnaire to 400 persons. The application of formula (20) leads to the results in Table II.

Table II: Attributes and weights as triangular fuzzy numbers

Attribute	Weight
C_1 (kind of consumers)	(0.36775,0.56875,0.74800)
C_2 (accommodation flexibility)	(0.40125,0.60575,0.78175)
C_3 (rich and diverse cuisine)	(0.50375,0.73200,0.87175)
C_4 (nightlife and entertainment)	(0.47125,0.69750,0.83675)
C_5 (sports facilities/activities)	(0.38575,0.59050,0.76000)
C_6 (shopping facilities)	(0.40225,0.60575,0.77400)
C_7 (crowdedness)	(0.34900,0.54175,0.72625)
C_8 (local infrastructure/transportation)	(0.40175,0.60725,0.77450)
C_9 (beaches and sea water)	(0.61775,0.88675,0.94800)
C_{10} (comfortable accommodation)	(0.41725,0.62875,0.79675)
C_{11} (sea proximity)	(0.48050,0.70675,0.84675)
C_{12} (sea orientation)	(0.34750,0.54300,0.72200)
C_{13} (pool)	(0.28250,0.46675,0.65775)
C_{14} (cost)	(0.54825,0.79675,0.89750)

D. Ranking the levels of importance of the attributes

To rank the weights of attributes $C_1 - C_{14}$ in Table II, we use the order generates by expected value, that is (6) and (7). We obtain the results in Table III and some conclusions are immediate:

- The least important attribute is C_{13}, regarding the existence/non existence of a pool. This is a very interesting result because of respondents characteristics. We presume that, for a young people, the pool is a entertaining place.

Attribute	$M(C_i)$
C_1	0.56331
C_2	0.59863
C_3	0.70988
C_4	0.67575
C_5	0.58169
C_6	0.59694
C_7	0.53969
C_8	0.59769
C_9	0.83481
C_{10}	0.61788
C_{11}	0.68519
C_{12}	0.53888
C_{13}	0.46844
C_{14}	0.75981

Table III Expected values of attributes

- The most important attribute is C_9, regarding the quality of beaches and sea water, then cost (C_{14}) and C_3, the existence of a rich and diverse cuisine. This result is a congruent one relate to first one, because explain why the existence of a pool is not a key problem.

E. Correlations of the levels of importance

The correlation coefficients between weights of attributes is interesting too and it give us some important informations. Applying (5) we obtain the results in Table IV for correlation between any two weights (to emphasize the differences, the values calculated by (5) are multiplied by 10^5 and only the last three digits are considered). It furnish us at least the following conclusions:

- The lowest correlation is between the quality of beaches and sea water and the existence/non existence of pool
- The highest correlation is between the cost and the existence of a rich and diverse cuisine

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}
C_1	-	995	927	946	997	992	998	992	765	989	941	999	954	861
C_2	995	-	959	973	1000	1000	988	1000	826	999	941	990	920	907
C_3	927	959	-	998	953	967	903	967	954	972	999	907	764	990
C_4	946	973	998	-	969	980	926	979	936	984	1000	929	800	980
C_5	997	1000	953	969	-	999	991	999	815	997	965	992	927	898
C_6	992	1000	967	980	999	-	983	1000	844	1000	977	985	907	920
C_7	998	988	903	926	991	983	-	983	723	979	919	1000	970	828
C_8	992	1000	967	979	999	1000	983	-	843	1000	976	985	908	919
C_9	765	826	954	936	815	844	723	843	-	855	941	730	510	987
C_{10}	989	999	972	984	997	1000	979	1000	855	-	981	981	897	928
C_{11}	941	941	999	1000	965	977	919	976	941	981	-	923	790	983
C_{12}	999	990	907	929	992	985	1000	985	730	981	923	-	967	834
C_{13}	954	920	764	800	927	907	970	908	510	897	790	967	-	654
C_{14}	861	907	990	980	898	920	828	919	987	928	983	834	654	-

Table IV: Correlations of the levels of importance

F. Performances of locations and preliminary preparation

Let us assume that a travel agency has possibility to contract m locations $A_1, \dots, A_m$. We have in view to provide a method to hierarchy these locations from the point of view of the virtual customers, the respondents to the questionnaire. In this way, the agency will have the possibility to choose the most suitable destinations for its clients.

It is natural to assume that the performances of each location relatively to each attribute are known by the agency.

We can use the procedure proposed in [19] and presented in Section III, B. We consider that the decision will be made based on the performance of the attribute criteria, taking also into account the importance given to them by the client.

In what follows we consider a list of eight destinations $A_1, \dots, A_8$, possible to be contracted by a travel agency in a fixed country and the attribute criteria determined using the focus group method (see Table II). From the information the agency has, result the levels of attribute satisfaction in Table V.

Table V: Attributes and linguistic variables associated to destination

	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8
C_1	F	G	F	G	VG	P	VG	G
C_2	VG	G	G	VG	G	G	G	P
C_3	G	VG	F	F	VG	VP	G	VG
C_4	G	G	G	G	G	VG	VG	F
C_5	VG	G	VG	F	VG	G	G	G
C_6	VG	G	F	G	F	P	VG	G
C_7	G	F	VG	G	F	VG	G	F
C_8	G	VG	F	VG	P	P	F	VG
C_9	G	VG	VG	G	G	VG	P	G
C_{10}	5*	4*	5*	5*	3*	5*	3*	4*
C_{11}	150 m	50 m	10 m	60 m	300 m	200 m	50 m	400 m
C_{12}	N	Y	N	Y	N	Y	N	Y
C_{13}	Y	N	Y	Y	N	Y	N	Y
C_{14}	600 E	500 E	800 E	900 E	400 E	1000 E	350 E	600 E

Criteria 1-9 are subjective, criteria 10-13 are benefit criteria and attribute 14 is a cost criterion (see Table II).

Because the entire information is offered by agency, we consider here $k = 1$. The triangular fuzzy number $r_{ij} = (e_{ij}, f_{ij}, g_{ij}), i \in \{1, \dots ,8\}, j \in \{1, \dots ,9\}$ are representations of the linguistic variables $\{VP, P, F, G, VG\}$ (see Table I) attached to performance of the alternative $A_i, i \in \{1, \dots ,8\}$ for the subjective criteria $C_j, j \in \{1, \dots ,9\}$. With respect to objective criteria $C_j, j \in \{10, \dots ,14\}$ we apply (8) and (9) to calculate $r_{ij} = (e_{ij}, f_{ij}, g_{ij}), i \in \{1, \dots ,8\}, j \in \{10, \dots ,14\}$. All the triangular fuzzy numbers $r_{ij}, i \in \{1, \dots ,8\}, j \in \{1, \dots ,14\}$ are in Table VI.

The triangular fuzzy numbers $w_j = (o_j, p_j, q_j), j \in \{1, \dots , n\}$, expressing the weight criteria are already calculated according to formula (20) in Table II.

Table VI Triangular fuzzy numbers corresponding to objective attributes and destinations

r_{ij}	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8
C_1	(0.3,0.5,0.7)	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.5,0.7,0.9)	(0.7,1,1)	(0.1,0.3,0.5)	(0.7,1,1)	(0.5,0.7,0.9)
C_2	(0.7,1,1)	(0.5,0.7,0.9)	(0.5,0.7,0.9)	(0.7,1,1)	(0.5,0.7,0.9)	(0.5,0.7,0.9)	(0.5,0.7,0.9)	(0.1,0.3,0.5)
C_3	(0.5,0.7,0.9)	(0.7,1,1)	(0.3,0.5,0.7)	(0.3,0.5,0.7)	(0.7,1,1)	(0,0,0.3)	(0.5,0.7,0.9)	(0.7,1,1)
C_4	(0.5,0.7,0.9)	(0.5,0.7,0.9)	(0.5,0.7,0.9)	(0.5,0.7,0.9)	(0.5,0.7,0.9)	(0.7,1,1)	(0.7,1,1)	(0.3,0.5,0.7)
C_5	(0.7,1,1)	(0.5,0.7,0.9)	(0.7,1,1)	(0.3,0.5,0.7)	(0.7,1,1)	(0.5,0.7,0.9)	(0.5,0.7,0.9)	(0.5,0.7,0.9)
C_6	(0.7,1,1)	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.1,0.3,0.5)	(0.7,1,1)	(0.5,0.7,0.9)
C_7	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.7,1,1)	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.7,1,1)	(0.5,0.7,0.9)	(0.3,0.5,0.7)
C_8	(0.5,0.7,0.9)	(0.7,1,1)	(0.3,0.5,0.7)	(0.7,1,1)	(0.1,0.3,0.5)	(0.1,0.3,0.5)	(0.3,0.5,0.7)	(0.7,1,1)
C_9	(0.5,0.7,0.9)	(0.7,1,1)	(0.7,1,1)	(0.5,0.7,0.9)	(0.5,0.7,0.9)	(0.7,1,1)	(0.1,0.3,0.5)	(0.5,0.7,0.9)
C_{10}	(1,1,1)	(0.5,0.5,0.5)	(1,1,1)	(1,1,1)	(0,0,0)	(1,1,1)	(0,0,0)	(0.5,0.5,0.5)
C_{11}	(0.64,0.64,0.64)	(0.9,0.9,0.9)	(1,1,1)	(0.87,0.87, 0.87)	(0.26,0.26, 0.26)	(0.51,0.51, 0.51)	(0.9,0.9,0.9)	(0,0,0)
C_{12}	(0,0,0)	(1,1,1)	(0,0,0)	(1,1,1)	(0,0,0)	(1,1,1)	(0,0,0)	(1,1,1)
C_{13}	(1,1,1)	(0,0,0)	(1,1,1)	(1,1,1)	(0,0,0)	(1,1,1)	(0,0,0)	(1,1,1)
C_{14}	(0.62,0.62,0.62)	(0.77,0.77, 0.77)	(0.31,0.31, 0.31)	(0.15,0.15, 0.15)	(0.92,0.92, 0.92)	(0,0,0)	(1,1,1)	(0.62,0.62, 0.62)

G. *Determining the most desired tourist destinations by Chu and Lin's method*

After complicate calculus by using (11)-(19), formula (10) leads to the following values $M(G_i)$:

	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8
$M(G_i)$	5.09	2.75	3.34	3.69	2.91	2.26	3.51	2.27

therefore the destination A_1 is the first which must be contracted, then destinations A_4, A_7, A_3, A_5, A_2 and, at the end, destinations A_8 and A_6.

V. CONCLUSION

The advantages of this method are the following:

- choosing destinations which follow to be contracted is proper; the level of customer satisfaction will increase because the chance to find an adequate destination will increase
- determining the attributes using the focus group method and the evaluating their importance is not necessary anymore as long as the structure of the target public does not change
- any travel agency can implement it, with minimum effort

In the numerical example, the weights assigned to criteria and the level of performance of each attribute, with respect to a destination, were measured on a five linguistic scale. To obtain refined results in applications, smoother scales can be employed. As example, in [13] the importance is presented in terms of a nine linguistic scale (extra low, very low, low, slightly low, middle, slightly high, high, very high, extra high).

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