Travel Agent Destinations Selection based on a Fuzzy Multicriteria Decision Making Method

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Abstract: We suggest a rigorous method to determine the most appropriate tourist destinations to be purchased by a travel agency from the perspective of a target public. First, we obtain the list of attributes considered the most important, using a focus group, chosen from the target group. Then, we determine the levels of importance of different attributes, in terms of linguistic variables, after applying a questionnaire in a sample of 400 individuals from the target group. The last step is to use a recent method in fuzzy multicriteria decision making to find the best tourist destinations from the point of view of the possible future customers. In fact, we obtain a hierarchy of the destinations, so that the travel agency has the possibility to virtually contract the most desired destinations. The method is easy implementable and it is sufficient to apply the last step if the structure of customers is unchanged and the structure of the tourist destinations is changed. The theoretical development is completed by a real numerical example, the questionnaire being applied.

Key-Words: fuzzy number, tourist destinations, multicriteria decision making, travel agent, offer, survey

1 Introduction

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 [9] 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 [12] 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.

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. Fuzzy set theory seems to be a suitable tool in the evaluation of services quality especially [4]-[6], [13]-[17], [19].

The fuzzy numbers were already used for evaluating tourist service quality with very fine results in [1] and [2]. The fuzzy multicriteria decision making method elaborated in [7] was adapted in [3] 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 [7] 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 fuzzy number using is the capacity to considering every level of attribute importance.

2 Triangular fuzzy numbers and fuzzy multiple criteria decision making methods

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

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

\[
f_A(x) = \begin{cases} 
\frac{x-a}{b-a}, & \text{if } a \leq x \leq b \\
\frac{c-x}{c-b}, & \text{if } b \leq x \leq c \\
0, & \text{otherwise}
\end{cases}
\]  (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 \((a, a, a)\)

\[
M((a, b, c)) = \frac{a+2b+c}{4}
\]  (2)

Many fuzzy number ranking methods have been studied. A theoretical approach can be found in [18]. Due to its simplicity, the following procedure is used to rank the triangular fuzzy numbers

\[
(a_1, b_1, c_1) \leq (a_2, b_2, c_2)
\]

if and only if

\[
M((a_1, b_1, c_1)) \leq M((a_2, b_2, c_2))
\]

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

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

Let \( x_{ij} = (a_{ij}, b_{ij}, c_{ij}), i \in \{1, \ldots, m\}, j \in \{h+1, \ldots, n\} \) the performance of alternative \( A_i, i \in \{1, \ldots, m\} \) with respect to objective criterion \( C_j, j \in \{h+1, \ldots, n\} \) and \( w_{jt} = (q_{jt}, p_{jt}, q_{jt}), j \in \{1, \ldots, n\}, t \in \{1, \ldots, k\} \) the triangular fuzzy number which represents the weight assigned by decision maker \( D_t, t \in \{1, \ldots, k\} \) to criterion \( C_j, j \in \{1, \ldots, n\} \), 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.

The aim of a fuzzy multicriteria decision making method is to hierarchy the alternatives \( A_1, \ldots, A_m \) taking into account the above data. In this sense, a procedure was elaborated in [7]. 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 \( A_1, \ldots, A_m \).

3 Linguistic terms
As in [20] 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 1.

Table 1 Triangular fuzzy numbers associated to linguistic variables

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NI/VP</td>
<td>(0,0,0.3)</td>
</tr>
<tr>
<td>SI/P</td>
<td>(0.1,0.3,0.5)</td>
</tr>
<tr>
<td>I/F</td>
<td>(0.3,0.5,0.7)</td>
</tr>
<tr>
<td>VI/G</td>
<td>(0.5,0.7,0.9)</td>
</tr>
<tr>
<td>EI/VG</td>
<td>(0.7,1,1)</td>
</tr>
</tbody>
</table>

4 Contracting the most suitable tourist destinations

4.1 Determining the attributes using the focus-group methods
The methods and techniques generating the attributes characterizing the tourist destination are divided into: structured and unstructured, those structured being predominant. Echtner and Ritchie [4] 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 [9], [12]. 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 [4] 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 [4] 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 Costinești (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.

4.2 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 [11] 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 $D_1, ..., D_k$, answers a questionnaire made to find out the importance of the criterion $c_j$, $j \in \{1, ..., n\}$. The answers will be considered, obtaining thus the triangular fuzzy numbers $w_{ij} = (o_j, p_j, q_j), j \in \{1, ..., n\}, t \in \{1, ..., k\}$. The weight assigned by the group of decision makers $\{D_1, ..., D_k\}$ to criterion $c_j, j \in \{1, ..., n\}$, is calculated as the arithmetic mean of the individual answers, that is

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

(4)

In this paper we consider the linguistic scale from Section 3 and the answers obtained after applying a questionnaire to 400 persons. The application of formula (4) leads to the results in Table 2.

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

Table 2 Attributes and weights as triangular fuzzy numbers

4.3 Determining the most desired tourist destinations

Let us assume that a travel agency has possibility to contract $m$ locations $A_1, ..., A_m$. 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 suggested in [7] and 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.

The triangular fuzzy number $r_{ij} = (e_{ij}, f_{ij}, g_{ij}), i \in \{1, ..., m\}, j \in \{1, ..., h\}$ is obtained by normalizing the performance $x_{ij} = (a_{ij}, b_{ij}, c_{ij}), i \in \{1, ..., m\}, j \in \{1, ..., h\}$ of the alternative $A_i, i \in \{1, ..., m\}$ through normalization, using the formula

$$r_{ij} = \left( e_{ij}, f_{ij}, g_{ij} \right) = \left( \frac{c_{ij} - a_{ij}}{d_{ij} - d_{ij}}, \frac{c_{ij} - a_{ij}}{d_{ij} - d_{ij}} \right)$$

(5)

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

$$r_{ij} = \left( e_{ij}, f_{ij}, g_{ij} \right) = \left( c_j - c_i, c_j - c_i, c_j - c_i \right)$$

(6)

where,

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

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

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

The triangular fuzzy numbers $w_j = (o_j, p_j, q_j), j \in \{1, ..., n\}$, expressing the weight criteria are already calculated according to formula (4) in Table 2. For each of the $m$ locations $A_1, ..., A_m$ considered, the following value is calculated (see [7])

$$M(A_j) = Y_i + \frac{6t_{11}I_{11}(Y_i - Q_i) - [f_{12}^2 + 4t_{11}(Y_i - Q_i)]^{3/2}}{24t_{11}} + \frac{-6t_{12}I_{12}(Z_i - Y_i) + [f_{12}^2 + 4t_{12}(Y_i - Q_i)]^{3/2}}{24t_{12}}$$

(7)
where,
\[
I_{11} = \frac{1}{n} \sum_{j=1}^{n} (f_{ij} - e_{ij})(p_j - o_j) \tag{8}
\]
\[
I_{12} = \frac{1}{n} \sum_{j=1}^{n} (f_{ij} - g_{ij})(p_j - q_j) \tag{9}
\]
\[
J_{11} = \frac{1}{n} \sum_{j=1}^{n} [e_{ij}(p_j - o_j) + q_j(f_{ij} - e_{ij})] \tag{10}
\]
\[
J_{12} = \frac{1}{n} \sum_{j=1}^{n} [g_{ij}(p_j - q_j) + q_j(f_{ij} - g_{ij})] \tag{11}
\]
\[
Q_i = \frac{1}{n} \sum_{j=1}^{n} e_{ij} o_j \tag{12}
\]
\[
Y_i = \frac{1}{n} \sum_{j=1}^{n} f_{ij} p_j \tag{13}
\]
\[
Z_i = \frac{1}{n} \sum_{j=1}^{n} g_{ij} q_j \tag{14}
\]

The descending order of the numbers \(M(A_1), \ldots, M(A_m)\) give us the order of the client’s preferences regarding the considered destinations, that is if \(M(A_i) > M(A_j)\) then destination \(A_i\) is preferred to destination \(A_j\), for a future vacation.

To exemplify the above theoretical development, we give an application.

We consider a list of eight destinations \(A_1, \ldots, A_8\), possible to be contracted by a travel agency in a fixed country. From the information the agency has, result the levels of attribute satisfaction in Table 3.

| Table 3: Attributes and linguistic variables associated to destinations |
|----------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| \(A_1\) | \(A_2\) | \(A_3\) | \(A_4\) | \(A_5\) | \(A_6\) | \(A_7\) | \(A_8\) |
| \(C_1\) | 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 | 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 |
| \(C_{12}\) | Y | N | Y | N | Y | N | N | Y |
| \(C_{13}\) | Y | N | Y | Y | N | Y | N | Y |

Criteria 1-9 are subjective, criteria 10-13 are benefit criteria and attribute 14 is the cost criterion. Using the representations of the linguistic variables from Table 1 for subjective criteria \(C_1 - C_9\) we obtain the associated triangular fuzzy numbers in an easy way. The normalization formulae (5) and (6), applied for the calculation of the performances of the objective attributes \(C_{10} - C_{14}\) lead to the triangular fuzzy numbers corresponding to the attributes and destinations in Table 4.

| Table 4 Triangular fuzzy numbers corresponding to objective attributes and destinations |
|----------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| \(C_{14}\) | \(A_1\) | \(A_2\) | \(A_3\) | \(A_4\) | \(A_5\) | \(A_6\) | \(A_7\) | \(A_8\) |
| \((400,0,0,0,0,0,0,0\)) | \((500,0,0,0,0,0,0,0\)) | \((600,0,0,0,0,0,0,0\)) | \((700,0,0,0,0,0,0,0\)) | \((800,0,0,0,0,0,0,0\)) | \((900,0,0,0,0,0,0,0\)) | \((1000,0,0,0,0,0,0,0\)) | \((1100,0,0,0,0,0,0,0\)) |

Formula (7) leads to: \(M(A_1) = 5.09 > M(A_4) = 3.69 > M(A_7) = 3.51 > M(A_3) = 3.34 > M(A_5) = 2.91 > M(A_2) = 2.75 > M(A_9) = 2.27 > M(A_6) = 2.26\), 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 \(A_6\).
5 Conclusions

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 [15] 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).

References: