PERFORMANCE INDICATORS FOR MEASURING TOURISM DESTINATION COMPETITIVENESS WITH A FUZZY METHOD

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Abstract

The destination image is an important aspect of successful tourism management and destination marketing. The purpose of this paper is to identify those destination features which contribute to build a positive destination attractiveness and to analyze the relationship between those features and the choice of destination by tourists. Accordingly, this study is based on previous research on the impact of tourist information sources in destination promotion. This article is an attempt to prepare a decision by the use of the fuzzy method of ordering alternatives (i.e. aims), and to set priorities among some alternatives and criteria, in the decision-making situations where there are multiple decision-makers, multiple criteria. Under the existing circumstances containing fuzzy characteristics, there is a wish to achieve radical improvements in the production management and decision making. Factors influencing the attractiveness of the destination and its tourism offer can be used to build a methodology for ranking of tourist destinations.

Key Words: *digital transformation of tourism, multiple attribute decision making, destination competitiveness*
JEL classification: *Z32, C61, M31*

Introduction

Tourism has reached world importance in the economy. The competition in tourism has intensified between destinations, whether the destinations are cities, regions or countries (Tovmasyan, 2016). In this sense, the evaluation of the tourism competitiveness of these destinations may be helpful in planning and prioritizing actions that will benefit the industry.

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This article discusses the concept of competitiveness by the multidimensional view of performance, efficiency and unit analysis.

The classical decision making operates with a set of alternatives over the space of decision, a set of states off affairs over the space of the state of affairs, relation pointing to states or outcomes expected from each of the alternative actions, and finally, the utility or the goal function, which arranges these outcomes in accordance with the desired outcome. Decision making is said to be performed under conditions of certainty, when the outcomes of any action can be precisely determined and arranged. In such cases, alternatives are chosen that lead to outcomes with maximum utility. On the other hand, a decision is made under conditions of risk, when the only knowledge available regarding the state of outcomes is their probability distribution. Based on the previous theoretical discussion regarding image, an empirical research was conducted to test the relationship proposed here. The subject of the decision making discipline is the study of how decisions are really made, and how they can be made better and more successful. The predominant focus of this discipline was in the area of business decision making, where the decision-making process is of key importance for functions such as investment, new product development, resource allocation, and many others.

In any real-life situation, including the decision making and management fields – whether it is about setting goals and formulating strategies, or selecting, implementing and monitoring the selected strategy – many processes are unfit for mathematical modeling. In normal real-life situations in various areas of human activity, very often we do not know the equations for most non-linear processes and systems and therefore resort to approximation.

Fuzzy systems approximate those equations. Fuzzy systems enable us to make optimum approximations of the non-linear universe. If it is possible to build a mathematical model, we shall use it. There is always a question: how can we know that mathematical approximation corresponds to a process in reality? Fuzzy systems enable us to model the universe in linguistic terms, rather than forcing us to write a mathematical model of the universe. The technical term for it is *model-free function approximation* (Sedlak et al., 2013). Here is important to emphasize that for many knowledge-intensive applications, it is important to develop an environment that permits flexible modeling and fuzzy querying of complex data and knowledge including uncertainty (Koyuncu & Yazici, 2005).

In practice, we often find models where multiple attributes take part in decision making simultaneously. This paper is an attempt to prepare a decision by the use of the fuzzy method of ordering alternatives (i.e. aims), and to set priorities among some alternatives and criteria, in the decision-making situations where there are multiple decision-makers, multiple attribute and multiple periods.

Problem description

The sense, value, manner and process of decision-making problems are determined by the cultural, social, temporal, value, as well as logical context. Fuzzy logic was developed more than five decades ago. The characteristics of fuzzy logic include operating by fuzzy notions, imprecise authentication tables, and fuzzy inference rules. All these characteristics of fuzzy logic are highly important, especially if we try to exchange or supplement the long-dominating approach of strategic decision making with the descriptive one.

The fuzzy set theory and various mathematical reviews, the measures of uncertainty and information have an unlimited possibility of application in all the fields of sciences using a lot of information and data, like for instance, in decision-making. The contexts of strategic management are under the conditions of uncertainty and indefiniteness (Dubois & Prade, 1980).

The criteria, limitations and performances of measures of alternatives bear in themselves some aspects of indefiniteness: in determinativeness, multiple aspects of meaning, incompleteness and fuzziness.

Fuzzy Linear Programming

Operational research offers optimization models aimed at finding an activity programme that will yield the best possible results. The models use precisely determined and known data. Constraints are also precisely determined, and the goal function is clearly defined, so that it can be formulated easily and simply.

The reality, however, is different: very often we lack precise information on the value of individual input parameters, or the values of coefficients in constraint and goal functions, and imprecise formulation of limitations themselves is possible as well (Maier, 2008).

Fuzzy sets can be introduced into the existing decision-making models in several ways (Sedlak et al., 2010). As an economic institution, a company bases its existence on the environment, both from the aspect of providing input and from the aspect of achieving and valorising input.

Miscellaneous knowledge and experience, and also decision making in the areas of investment, market operations, financial function, production function or research and development, can be considered more fully and exactly applying fuzzy sets. Under the existing circumstances containing fuzzy characteristics, there is a wish to achieve radical improvements of the production management and decision making.

The need arises for choosing an appropriate corporate goal out of the available possible alternative goals. When accomplishing and executing the alternatives, the company achieves different levels of increase in sales (because, although the subject issue is decision making on production, one must bear in mind that the ultimate goal of production is a sale of the produced commodities).

In addition to many constraints under the given conditions, one must particularly bear in mind limitations, i.e. constraints such as:

- that the selected alternative (goal) is to be accomplished in the shortest possible period;
- that investment in accomplishing the selected alternative should not be excessive.

The goal of decision making is a large number of sold products. The decision must best meet the goal and constraints of the given problem.

The nature of the problem displays the characteristics of uncertainty and vagueness. The need for fuzzification, i.e. fuzzy decision-making systems from the fact that the decision maker is faced with a large number of scenarios and sub-scenarios out of which the optimum must be chosen, and the imprecision of input data results from a subjective approach in interpreting *per se* vague information.

The Mark Giving Method

The basic prerequisite to apply fuzzification for obtaining more effective instruments for using different kinds of uncertainty, as well as for using the natural language in modelling decision-making, in the field of business decision-making of hierarchical level, faces a whole range of problems which cannot be solved by the methods of classical quantitative analysis.

Above all, we would point to the following problems:
- ambivalence of aims,
- variability of factors,
- subjectivity of sight,
- linguistic description of variables.

In practice, we often meet models where multiple criteria take part in decision-making simultaneously. This article is an attempt to prepare a decision by the use of the fuzzy method of ordering alternatives (i.e. aims), and to set priorities among some alternatives and criteria, in the decision-making situations where there are multiple decision-makers, multiple criteria, and in the multiple time periods (Ćirić et al., 2015). The applied method of evaluating in this article is based on the usual assessment, i.e. marking method used in education.

The mark-giving method, very similar to R. Jain's ordering method, is based on the weighted aggregation of marks (Jain, 1997). As mark processing can be described by many rules, the method forms a fuzzy set of extra marks by the aggregation on the basis of rules, and it can also be programmed as a fuzzy system. The values of criteria, which describe alternatives, are given as marks. An extra mark is assigned to every alternative, aggregating fuzzy sets of marks which describe alternatives. Alternatives are ordered on the basis of extra marks. The mark-giving method based on examples can be generally applied for ordering (Sedlak et al., 2013).

The method is applicable if the values of criteria can be treated as marks (or if they can be transformed into them).

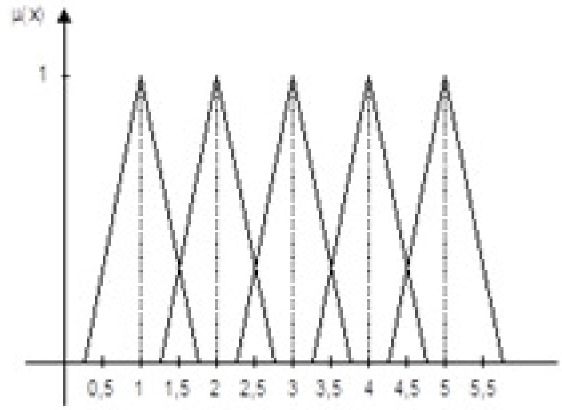
Let us assume $x=\{a_1,a_2,...,a_n\}$ is the final set of alternatives, and then take $K=\{k_1,k_2,...,km\}$ as the final set of fuzzy criteria. Let $g_1,g_2,...g_m$ be the weights belonging to criteria, where the maximal value of the weight is 1.

Let every K_j fuzzy criteria be over x a linguistic variable ($1 \leq j \leq m$), also letting $K_1=\{S_1,S_2,...,S_{p1}\}$ where S_1, S_2,…, S_{p1} are the values of the linguistic variable. The functions of belonging (μ) $S_1,S_2...,S_{p1}$ to fuzzy sets are determined on the basis of marks:

$$\mu S1(x) \qquad supp\ S1 = [0,4;1,6]$$
$$\mu S2(x) \qquad supp\ S2 = [1,4;2,6]$$
$$\vdots \qquad\qquad \vdots$$
$$\mu Sp_j(x) \qquad suppSp_j\ [p_j\text{-}0,6;p_j\text{+}0,6].$$

Let every function of belonging be over the sets of the same form of a triangular fuzzy set. The degree of marking (p) can be any whole number, but the exactness and possibilities of expression differ from case to case (Figure 1 represents the fuzzy sets of the criteria K, in the case p=5). The alternative a_1(IS i S_n) with S_1,S_2,... S_{p1} fuzzy sets of criteria can be evaluated.

Figure 1: *Triangular fuzzy set (Kosko, 1992)*



The mark-giving method assigns every alternative a_1 one fuzzy set R_i, i.e. extra marks, which will appear in one E fuzzy set of results. The set E will enable the set R_i to be compared, as well as the set R not to be defined. The set E is a fuzzy set identical with the set of criteria:

$$E = \{S_1,S_2,...,S_p\}$$

where K = max P_j (j=1,2,…m), and every R set will be formed on the basis of partly activated subsets of the E set.

Copying and aggregations of fuzzy sets are necessary for forming R_1 sets. In the program package of fuzzy logic, which is applicable, these operations can be performed only with the help of such program blocks which the program package treats as Kosko's FAM (fuzzy associative memories) (Kosko, 1992).

One simple FAM system copies n dimensional fuzzy sets into m dimensional with K parallel FAM rules and their simultaneous use (A_1, B_1), (A_2, B_2),..., (A_k, B_k). Every A-input information activates rule of the FAM system in a way every. (A_i, B_i) is FAM rule and has the form:

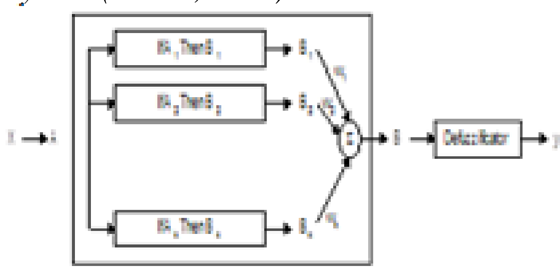
$$\text{IF } C = A_i \text{ THEN } D = B_i$$

(where C, D are linguistic variables, and A_i, B_i are their possible values). Input information A is copied into the part of B_1 set, which is partly activated into B_i. The B set is produced from the whole FAM system, which is the weighted sum of partly activated B_1, B_2, … B_k fuzzy sets:

$$B = w_1 \cdot B_1 + w_2 \cdot B_2 + \ldots w_k \cdot B$$

where W_i values in the interval (0,1) designates the weights of FAM rules. One procedure of defuzzification is directly connected to the FAM system, which assigns one sole number to the B fuzzy set (Table 2). The focus point in the B set is given by the COG (Centre of Gravity) Method.

Figure 2: *FAM system (Kosko, 1992)*



Input data of the program block are the marks of the criteria: o_1, o_2,… o_m. Any o_j mark of the given values of the criteria S_1, S_2,…, S_p. partly activates one or two neighbouring ones, and FAM rules copy these partly activated sets into the E set. The R_i set is a weighted sum, even more times, of partly activated S_1, S_2,… S_{pi} sets.

In the course of functioning, the FAM system, one series of marks o_1, o_2…o_m, belonging to one a_i alternative, partly activates S_1, S_2,…, S_{pj} sets, which are located in the part of the conditions of the FAM system. In the same way, the rule activates the same set in the part of consequences. With every copying into the set E, the given triangular number is multiplied with the CF value.

CF (Certainty factor) gives the degree of rule security by which the FAM system automatically multiplies the result of the rules. This CF value is determined by the square of criteria weights. After copying, the sets partly activated by the operator of the algebraic sum are aggregated and added, and finally, the centre of gravity of the aggregated set is formed by defuzzification.

Kosko uses the term "fuzzy associative memory” to describe how a fuzzy system works. The system activates all the rules in parallel and to a degree. Computers use direct memory. Associative memory searches the entire memory. (Kosko, 1992)

The mark-giving method, Jain's method and Yager's method

The formal similarities between Jain's method and the mark-giving method are used for comparing (formerly applied signs are used in comparing).

Steps of Jain's method:
1. One R_1 fuzzy set is formed for every a_i alternative in the form:

$$R_i = \sum_{j=1}^{m} g_j \cdot r_{ij}$$

where g_i is the fuzzy set of weights, r_{ij} is the fuzzy value K_i of criteria in case of a: alternative (signed operations mean the multiplication and addition of fuzzy sets).
2. A union of multiples of R_i sets is formed:

$$S = \bigcup_{i=1}^{n} \sup \mathrm{R_i}$$

and one 'maximized' M fuzzy set is defined in the set S:

$$\mu_M(r) = [r / r_{\max}]^{\beta}$$

with the function of belonging, where r_{max}=sup S and β is a natural number (the set M gives the upper limit for the values $\mu_{R_i}(r)$.

3. A fuzzy set R_{io} is formed from M and R_i sets with the functions belonging to:

$$\mu_{R_{i0}}(r) = \min\{\mu_{R_i}(r), \mu_M(r)\}, (r \in S)$$

4. One Y_i value is assigned to every alternative:

$$y_i = \max \mu_{R_{io}}(r), (r \in S)$$

Many have criticized Jain's method as it does not give any help in forming the set M (choice β), and Yi, which is assigned the alternative ai, represents only one maximum value (the other ones are not taken into consideration in ordering).

Comparing to Jain's method, the steps of this method are the following:

1. Like in Jain's method, one R_i fuzzy set is formed for every a_i alternative in the form:

$$R_i = \sum_{j=1}^{m} g_j \cdot r_{ij}$$

where the values of the weight g_j can range within the interval (0,1) of real numbers, the values r_{ij} are special, and the fuzzy sets of marks are the same for every criterion (the degree of marks can be different depending on the criteria).

2-3. The method does not limit the values of functions of belonging to the sets R_i, it is not necessary to define M, nor form R_{io} sets. Instead, the sets R_i are compared in the mutual E set.

4. The value y_i, which joins the alternative a_i, representing the centre of gravity, is formed taking into consideration all the values of criteria. The value y_i, shows the ordinal number of alternatives.

We can conclude that the mark-giving method, compared to Jain's method, represents a different principle of problem solving.

Taking into consideration every value of the "possibility of realization", Yager's method assigns the value Y_i to the alternative a_i (Philips, 1995).

$$y_i = \max \min (\mu_{k_j}(a_i)t_j)$$

It also orders every $K_j(\leq j \leq m)$, as well as alternatives on the basis of the value Y_i.

Yager's method does not always differentiate between alternatives with approximately the same weight, so it assigns the same numerical values to the groups of alternatives (Yager, 2005). With the mark-giving method we notice quite the opposite: it assigns a different numerical value to almost every alternative. According to this, the mark-giving method points more to the difference between alternatives than Yager's method.

Ranking of Tourist Destinations

Consideration of the application of fuzzy logic in solving some problems in tourism is related to the name of Lozada (Lozada et al., 2011). In the work fuzzy logic is used to measure the results achieved in the tourism industry caused by the application of innovation management. Stojanovic in his work (Stojanović, 2011) has tried to find and to define the indicators of tourist destinations, which affect the sustainable development of the same. Comparative indicators presented as fuzzy sets, and the value of output variable, economic effects determined by previously defined fuzzy logic rules.

In his work, Bowman (Bowman, 2011) wants to explore the state of sustainable tourism in developing countries and to present methodological and practical criticisms and improvements. The conclusion underlines that a sustainable tourism program should be designed in the region, largely based on performance, and the concept should be built using the logic stage, taking into account the many attributes of sustainable tourism.

Ranking should serve as an incentive to the further development the competitiveness of the destination, to improve the existing criteria, to discover new criteria, or to contribute to the better fulfilment of the criteria (Crouch & Ritchie, 1999). Cities or tourist places have to have different offers, which require multiple demands and multiple attributes.

The model of the competitiveness of the destinations with four basic components (basic resources and attractiveness, factors and resources for support, destination management and factors contributing to the quality of the destination) and their weights are equally represented in the model. The weights of the criteria are such as to favor certain components of group 4 and groups 3.

This is proof that the basic resources and attractiveness and COMPETITIVENESS (Group 1) are significant components for the desirability of the destination (, but are not sufficient to reach the leading position in the attractiveness of the tourist destination. Factors contributing to the quality of the destination (group 4) prove to be a very important factor in the overall assessment result and were omitted and neglected in most of the previous studies. A similar conclusion may also be made for the components classified in Group 3 and Group 2.

For ranking, the main cities in Europe are the largest number of overnight stays in 2016. Criteria were selected from a set of many attributes of sustainable urban tourism (Pulido-Fernández et al., 2015).

The main criteria and weights were used for editing, which were chosen based on previous statistical analysis of the opinion of tourists who visited the destinations in the organization of one of the leading travel agencies in Serbia in 2016. Table 1. contains 14 criteria and their weights.

Table 1: *Criteria and their weights*

Criteria	Weights
1. Safety	1.00
2. Climate	0.70
3. Sights	0.50
4. Visual appeal	0.31
5. Special events	0.30
6. Interesting architecture	0.26
7. Kitchen	0.25
8. Nightlife	0.24
9. Interesting festivals	0.21
10. Transportation	0.20
11. Exotic culture	0.16
12. Historical significance	0.15
13. Museums and galleries	0.14
14. Music events	0.10

Table 2: Description of tourist destinations based on the criterion rating in 2016.

		Tourist destination													
		1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**	**11.**	**12.**	**13.**	**14.**
Criteria	**1.**	1	3	3	3	5	4	5	1	3	5	3	3	5	5
	2.	5	1	1	5	5	5	5	5	1	5	5	5	5	5
	3.	5	5	5	3	5	5	5	3	0	2	5	5	5	5
	4.	3	4	3	2	3	4	4	4	2	3	0	0	0	0
	5.	0	0	0	0	2	2	1	0	4	0	0	0	5	5
	6.	5	5	5	5	5	5	5	5	5	5	5	1	5	5
	7.	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	8.	2	3	4	0	3	4	0	3	5	5	1	0	1	1
	9.	3	2	2	2	1	4	5	1	1	5	4	4	5	3
	10.	3	3	3	3	3	3	3	3	3	3	3	5	3	3
	11.	3	3	3	3	3	3	3	1	3	3	3	5	3	3
	12.	0	1	0	0	0	0	3	0	0	3	0	0	3	3
	13.	3	3	3	3	1	3	3	3	3	3	3	3	3	3
	14.	0	5	5	5	0	0	5	1	1	5	1	0	1	5

To compare editing, the same was done with the Yager's method. The Yager's method, taking into account every value of "possibility of achievement" t_j, alternatives a_i and joins y_i value

$$y_i = \max\min\left(\mu_{k_j}(a_i), t_j\right)$$

For k_j ($1 \le j \le m$), and alternatives based on the y_i value.

Results of ranking are shown in Table 3.

Table 3: Editing results[3]

Tourist destination	Number of overnight stays in 2016 (in 10^6)*	Marks from 1-5 per night	Yager's metod	Mark giving method
Brisel	7.62	0.635	1.00	2.53
Budapest	7.82	0.652	1.50	2.73
Dublin	9.92	8.27	1.50	2.79
Stocholm	11.85	0.99	3.00	3.49

[3] Leading European city tourism destinations in 2016, by number of bednights, (https://www.statista.com/statistics/314340/leading-european-city-tourism-destinations-by-number-of-bednights/)

Amsterdam	12.57	1.05	3.45	3.84
Wien	14.38	1.20	3.50	4.18
Pragh	14.75	1.23	3.50	4.42
Istambul	16.02	1.33	1.00	2.31
Madrid	16.51	1.38	1.50	2.54
Barcelona	17.09	1.42	2.50	4.06
Roma	25.38	2.11	3.00	3.68
Berlin	28.69	2.38	3.00	3.68
Paris	36.03	3.00	3.45	4.25
London	56.98	4.75	3.45	4.71

Conclusion

The ratings obtained by the Yager's method correctly determine the significance of the destination. In a few cases, the method associates the same values to different but the following cities: for example, there is no difference between the cities of Rome and Berlin.

The mark giving method assigns a different value to almost every destination, and the ratings are appropriately redesigned. Only Barcelona, Paris and London have a different order in relation to the Yager's method. However, in these cases, the mark giving method is more precise.

Both methods correctly rank the destinations, which proves that tourist destinations can be edited with fuzzy methods. Yager's method does not always make the difference between destinations with approximately equal weight, so the group of cases associates the same numerical values. The mark giving method is quite the opposite: almost every destination joins a different numerical value. The mark giving method more emphasizes the difference between the cases compared to the Yager's method.

The demonstrated fuzzy ordering method, which is based on marking, enables the ordering such alternatives where fuzzy criteria can be described by marks or where the values of criteria can be considered to be marks. The results are similar to the results achieved by other ordering methods.

The mark-giving-method treats criteria as a fuzzy system with the rules of aggregation. It can be easy programmed by fuzzy logic software. The method is, in some points, similar to Jain's method of alternative ordering, but an ordering on the basis of weights, to assigned alternatives is a different principle in relation to Yager's method.

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