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STRATEGIC PROJECTS FOR DEVELOPMENT OF GAMZIGRAD SPA

Abstract

Choosing and ranking projects are complex tasks in business operations. Ranking of projects considers Multiple-Criteria Decision Making as a very popular way to support decision makers. This paper deals with proposed projects for development of the tourist resort of Gamzigrad spa in Eastern Serbia and its thermo-mineral wells. The projects are ranked by application of the ELECTRE method and by application of the AHP method, as ancillary method to determine the weights of criteria.

Key words: *project ranking, MCDM, ELECTRE I method, AHP method, Gamzigrad spa.*

JEL Classification: Q00

СТАРТЕГИЈСКИ ПРАВЦИ РАЗВОЈА ГАМЗИГРАДСКЕ БАЊЕ

Апстракт

Рангирање пројеката, односно развојних праваца представља комплексан задатак пословних подухвата и операција. Методе Вишекритеријумског Одлучивања (MCDM) се често користе као подршка доносиоцу одлука. У раду је акценат стављен на рангирање стратегијских пројеката за развој Гамзиградске бање, места у Источној Србији. Пројекти су рангирани ELECTRE методом, као главном и AHP методом приликом одређивања тежине критеријума, као помоћном методом Вишекритеријумског Одлучивања.

Кључне речи: *рангирање пројеката, MCDM, ELECTRE, AHP, Гамзиградска бања.*

Introduction

Tha Gamzigrad spa is one of the important Serbian marketing destination. Marketing is the sum of the activities that are used to direct the flow of goods and services from producers to consumers (users, customers, clients).[2] Great potential for development

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[2] Simonović Z., Miletić S., Miletić V., Uloga i značaj marketinga u svremenom poslovanju, Ekonomika časopis 3/2012, 93-101 str., Niš, 2012

of both marketing and protection of natural values lies in using up renewable energy resources [3]. The paper presents the possibility of finding adequate solutions for strategic selection between several projects for development strategies, applying the ELECTRE method, as major and AHP method as ancillary method to determine the weights of criteria. The concept of the paper was done as follows: in the part of introduction it is given a brief overview of the problem of decision-making, then in the second part of paper it is explained Multiple-Criteria Decision Making and it is theoretical presented the ELECTRE method. After that, it is explained application of selected method that is used for ranking optimal projects of Gamzigrad. Finally in the section of conclusion, it is given recommendation for the final selection of projects.

Multi-Criteria Decision Making - ELECTRE method

Multi Criteria Decision Making (MCDM) is one of the most well known branches of decision making. According to many authors, such as Zimmerman, MCDM is divided into Multi-Objective Decision Making (MODM) and Multi-Attribute Decision Making (MADM) [4]. MODM studies decision problems in which the decision space is continuous. MADM concentrates on problems with the discrete decision spaces. The concept of MCDM refers to situations when there is making a number of conflicting criteria. However, MCDM has its bad side, that is the need to use much more complex mathematical models for solving multi-criteria problems[5]. The ELECTRE method (**EL**imination and **E**T **C**hoice **T**ranslation **RE**ality) was made up by Bernard Roy, 1971. There are a few versions of this method [6]. ELECTRE I is used for determining partial order of alternatives, while the ELECTRE II method is used for complete arrangement of the assembly of alternatives. The ELECTRE III and IV are the methods of higher rank. To select the ELECTRE I method for evaluating the projects for development of Gamzigrad spa, a number of specific factors were influental. For the start, preferences in ELECTRE methods are modelled by using binary outranking relations, S, whose meaning is "at least as good as". Considering two actions a *and* b, four situations may occur (Salminen, Hokkanen, Lahdelma, 1998):

1. aSb and not bSa, i.e., aPb (a is strictly preferred to b).
2. bSa and not aSb, i.e., bPa (b is strictly preferred to a).
3. aSb and not bSa, i.e., aIb (a is indifferent to b).
4. Not aSb and not bSa, i.e., aRb (a is incomparable to b).

At the very begining of a process of ELECTRE method, it is necessary to define the initial decision matrix. The general form of the initial decision matrix is shown on

[3] Magdalinović N. (2007), *Upravljanje prirodnim resursima,* Inorog, Bor, 2007

[4] Zimmermann, Niklaus E. Kienast, Felix, Predictive mapping of alpine grasslands in Switzerland:Species versus community approach, *Journal of Vegetation Science 10: 469-482, 199 © IAVS; Sweden*

[5] Nikolić M (2009), *Metode odlučivanja,* Univerzitet u Novom Sadu, Tehnički fakultet „MihajloPupin, Zrenjanin

[6] Roy B. (1968), Classement et choix en présence de critères multiples (la méthode ELECTRE), *RIRO*, 8, 57-75.

table 1. Beyond that, it should be quantified matrix via the linear scale. The linear scale usually has values ranging from 0 to 10 for estimating the importance of criteria. In the paper, the following grades of criteria are used: 1- very low , 3 – low, 5 – average, 7 -high and 9 –very high.

Table 1 - General form of the initial matrix

Criteria	C_1	C_2	...	C_n
Alternative				
A_1	X_{11}	X_{12}	...	X_{1n}
A_2	X_{21}	X_{22}	...	X_{2n}
A_3	X_{31}	X_{32}	...	X_{3n}
...	...	...	...	...
A_n	X_{n1}	X_{n2}	...	X_{mn}

The first step involves calculating normalized decision matrix via adequate formulas (3, 4) by which normalized elements are calculated. The formula 3 is applied to the attribute of type max, while the formula 4 is applied to the attribut of type min. Each element of a vector columns from the normalized decision matrix, is divided by its norm[5].

$$n_{ij} = \frac{x_j}{\sqrt{\sum_{j=1}^{m} x_j^2}} \tag{3}$$

$$n_{ij} = 1 - \frac{x_j}{\sqrt{\sum_{j=1}^{m} x^2{}_j}} \tag{4}$$

The general form of normalized decision matrix is shown in table 1.1.

Table 1.1- General form of normalized decision matrix

n_{11}	n_{12}	...	n_{1n}
n_{21}	n_{22}	...	n_{2n}
...	...	...	...
n_{m1}	n_{m2}	...	n_{mn}

The second step involves calculated weighted normalized matrix, where the decision-maker actively participates in the procedure of solving the problem by determining the preference, that is the weight of user's criterion (formula 5)[7]. The general form of weighted normalized matrix is shown on table 2.

$$N = T \bullet N \tag{5}$$

[7] Mitevska N. (2005), *Terija odlučivanja*, Tehnički fakultet, Bor 59-69.

Table 2 - General form of weighted normalized matrix -TN

$t_1 n_{11}$	$t_1 n_{12}$	...	$t_1 n_{1n}$
$t_1 n_{21}$	$t_1 n_{22}$	...	$t_1 n_{2n}$
...	...	...	...
$t_1 n_{m1}$	$t\, n_{m2}$	...	$t_1 n_{mn}$

In the paper, it is the section where the Analytical Hierarchical Process (AHP) method is applied, so that by comparing in pairs, on the basis of opinion of three experts, it is possible to get more exact determination of criteria weights. The AHP method was developed at the start of the 1970's, by Thomas Saaty (Saaty, 1980). It is a useful tool in decision-making analyses at solving problems in which a pretty large number of decision-makers participate [8]. The third step of the ELECTRE method, there are determined the assemblies of agreement and disagreement. This step compares all pairs of the analyzed actions on the basis of value of elements from weighted normalized matrix[6]. There, we compare the pairs of actions *p* and *r*. Firstly, it is determined the assembly of agreement *Spr* for the actions a_p and a_r (actions mark the alternatives), made up of all criteria, for which the action, or alternative a_p is more desirable than the alternative, or action a_r, that is shown in formula[6].

$$S_{pr} = \{j \mid xpj \geq xrj\} \tag{6}$$

Then, it is formed the complementary assembly of disagreement – NS_{pr}, by using the following formula 7 [6]:

$$NS_{pr} = J - S_p = \{j \mid xpj < xrj\} \tag{7}$$

In the fourth step, it is defined the matrix of agreement on the basis of the assembly of agreements. The elements of the matrix of consent are the indices of agreement, and they are calculated as a sum of weights of criteria belonging to certain assemblies of agreement. Based on the assembly of agreement, it is determined the matrix of agreement MS. For calculating the values of the matrix, it is used the formula 8 [6].

$$S_{pr} = \sum_{j \in Spr} t_j \tag{8}$$

The fifth step refers to determining the disagreement matrix on the basis of the assembly of disagreements. The elements of the matrix are the indices of disagreement, determined by the formula 9 [6]. The element of weight normalized matrix in the formula is marked as

$$ns_{pr} = \frac{\max\limits_{j \in NSpr} \left| tn_{pj} - tn_{rj} \right|}{\max\limits_{j \in J} \left| tn_{pj} - tn_{rj} \right|} \tag{9}$$

In the sixth step it is determined the matrix of agreement domination, on the basis of the value of so-called threshold of agreement index (the average index of consent) -

[8] Cupic M., Tummala R. (1997), *Savremeno odlučivanje: metode i primena*, Fakultet Organizacionih nauka, Beograd

which can be also defined as average index of agreement - **PIS** (10)[4].

$$PIS = \sum_{p=1}^{m} \sum_{r=1}^{m} \frac{s_p}{m(m-1)} \quad where \quad p \neq r \tag{10}$$

The matrix of disagreement domination (step seven) is calculated on the basis of the average index of disagreement, as it is analogous to the matrix of agreement domination[9]. First, it is calculated the average index of disagreement – PINS (11) [4].

$$PINS = \sum_{p=1}^{m} \sum_{r=1}^{m} \frac{\boldsymbol{\mathcal{R}}_p}{m(m-1)} \quad where \quad p \neq r \tag{11}$$

The step eighth determines the matrix of aggregate domination. The elements of this matrix are equal to the product of the elements on definite position in matrices of agreement and disagreement domination (12) (Mitevska, 2005).

$$mad_{pr} = msd_{pr} \bullet mnsd_{pr} \tag{12}$$

Finally, in the ninth step, less desirable actions are eliminated, while one or more alternatives is/are sorted out as most desirable. The matrix of aggregate domination gives partial preferred order of actions. Therefore, the ELECTRE method I provides a partial order of actions [10].

Ranking projects of Gamzigrad applying the ELECTRE method

Gamzigrad spa is the little village of termomineral well, settled in Eastern Serbia. Taking into consideration degree of utilization of the existing facilities, we should point the fact that business operations of Gamzigrad spa is based on relatively modest capacities of a hotel „Kastrum“. This paper emphasizes the choice of the best alternatives at making adequate decisions for the development of the geo-thermal well, as a renewable energy resource. To make good possibilities for future development of the Gamzigrad spa, a group of experts made up a list of projects, that could be acceptable relating to financial and other criteria. The following five development projects have been defined and accepted: Health tourism, Sport tourism, Recreational tourism,Rural tourism,Congress tourism. Each project or the alternative for future development strategy, was defined by its attributes, that is, appropriate criteria. After talk with the Management team, the following five criteria (with some attributes shown in brackets) were defined for evaluation of the projects:

1. FI financial investments (investments in Euros – 200,000)
2. EN (the environment)- (the influence on resources and approach to resources) – maximum care for the environment.

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[9] Cupic M., Tummala R., Suknovic M. (2001), *Odlučivanje : formalni pristup*, Fakultet organizacionih nauka, Beograd

[10] (Adamovic et al, 2008)

3. SD (solution delivery) – relating to subsequent appropriate solutions if initial ones are not adequate (proof of technology, uncertainess, if benefits are measurable)- expressed in Euros – 250,000.
4. SC (strategic contribution) (the contribution of the business plan for Gamzigradska Banja and its surroundings) – it was estimated that maximum is necessary.
5. RM (risk management) it is necessary to lessen risk to its minimum.

Table 1.2 - Values of criteria and project

Criterias	**F**	**SD**	**SC**	**RM**	**EN**
Project	min	min	max	min	max
Healthy (P_1)	200,000	250,000	high	average	v. high
Sports (P_2)	70,000	90,000	v. high	average	high
Recreative (P_3)	60,000	70,000	v. high	low	v. high
Country (P_4)	120,000	140,000	high	low	high
Congress (P_5)	40,000	60,000	high	low	v. high

The table 1.2 shows the values of five projects and five criteria that were using for selecting optimum development project of Gamzigrad. Majority of criteria were divided into simpler measures of well-defined attributes, combined in the way that a result for each project and each criterion could be obtained. On the basis of the table 1.2, it was created the initial decision matrix, shown on table 1.3.

Table 1.3 - Initial decision matrix

Criterias	**F**	**SD**	**SC**	**RM**	**EN**
Project	min	min	max	min	max
P_1	200,000	250,000	7	5	9
P_2	70,000	90,000	9	5	7
P_3	60,000	70,000	9	3	9
P_4	120,000	140,000	7	3	7
P_5	40,000	60,000	7	3	9

Applying the formulas 3 and 4 (Mitevska, 2005) using the data from the table 1.3, it was obtained the normalized decision matrix, shown on table 1.4.

Table 1.4 - Normalized decision matrix

	F	SD	SC	RM	EN
P_1	0.790	0.800	0.398	0.570	0.487
P_2	0.275	0.286	0.511	0.570	0.380
P_3	0.236	0.222	0.511	0.341	0.487
P_4	0.472	0.445	0.398	0.341	0.380
P_5	0.157	0.190	0.398	0.341	0.487

Applying the formula 5, it is calculated the weighted normalized matrix -TN. In this part the decision maker determines the weights of criteria. In the case of the Gamzigrad, three experts (ecologist, sociologist, economist) were consulted to calculate the weights of criteria.

Table 2.1 - Weights of criteria – Expert 1

	F	EN	RM	SC	SD	Cr	Wt
F	1	1/7	1/3	1	1	F	0.072
EN	7	1	5	7	7	EN	0.580
RM	3	0.200	1	3	3	RM	0.188
SC	1	0.143	0.333	1	0.333	SC	0.061
SD	1	0.143	0.333	3	1	SD	0.099

Consistency Ratio (CR) =7,39%

Table 2.2 - Weights of criteria– Expert 2

	F	EN	RM	SC	SD	Cr	Wt
F	1	1/7	1	5	1	F	0.136
EN	7	1	3	7	7	EN	0.539
RM	1	0.333	1	5	3	RM	0.190
SC	0.200	0.143	0.200	1	0.333	SC	0.042
SD	1	0.143	0.333	3	1	SD	0.093

Consistency Ratio (CR) =9,30%

Table 2.3.- Weights of criteria – Expert 3

	F	EN	RM	SC	SD	Cr	Wt
F	1	1/7	1/3	3	1	F	0.091
EN	7	1	5	7	7	EN	0.569
RM	3	0.200	1	5	3	RM	0.204
SC	0.333	0.143	0.200	1	0.333	SC	0.045
SD	1	0.143	0.333	3	1	SD	0.091

Consistency Ratio (CR) =9,50 %

By using of arithmetic mean for the final weights, the mean values of criteria were found, and the same are shown in tables 2.1, 2.2, and 2.3. The final values of criteria weights, obtained by calculating the arithmetic mean for each criterion, are shown in table 2.4.

Table 2.4 - Arithmetic mean - weights of criteria

Cr	Wt
F	0.100
SD	0.094
SC	0.049
RM	0.194
EN	0.563
Σ	1

The weighted normalized matrix –TN, is shown on the table 2.5.

Table 2.5 - Weighted normalized matrix - TN

	F	SD	SC	RM	EN
P_1	0.078	0.074	0.020	0.110	0.274
P_2	0.028	0.026	0.025	0.110	0.213
P_3	0.024	0.021	0.025	0.066	0.274
P_4	0.047	0.042	0.020	0.066	0.213
P_5	0.016	0.018	0.020	0.066	0.274
$\mathbf{W}_{Cr}$	0.100	0.094	0.049	0.194	0.563

Having calculated the before mentioned, also applying the formulas 6 and 7 it the is determining the assemblies of agreement **- S** and disagreement **- NS** (table 3).

Table 3 - Assemblies of agreement (S) and disagreement (NS)

Assemblies of agreement S	Assemblies of disagreement NS
S_{12} = 1,2,4,5	NS_{12} = 3
S_{13} = 1,2,4,5	NS_{13} = 3
S_{14} = 1,2,3,4,5	NS_{14} = -
S_{15} = 1,2,3	NS_{15} = 4, 5
S_{21} = 3,4	NS_{21} = 1,2,5
S_{23} = 1,2,3,4	NS_{23} = 5
S_{24} = 3,4,5	NS_{24} = 1,2
S_{25} = 1,2,3,4	NS_{25} = 5
S_{31} = 3,5	NS_{31} = 1,2,4
S_{32} = 3,5	NS_{32} = 1,2,4
S_{34} = 3,4,5	NS_{34} = 1,2
S_{35} = 1,2,3,4,5	NS_{35} = -
S_{41} = 3	NS_{41} = 1,2,4,5
S_{42} = 1,2,5	NS_{42} = 3,4
S_{43} = 1,2,4	NS_{43} = 3,5
S_{45} = 1,2,3,4	NS_{45} = 5
S_{51} = 3,5	NS_{51} = 1,2,4
S_{52} = 5	NS_{52} = 1,2,3,4
S_{53} = 4,5	NS_{53} = 1,2,3
S_{54} = 3,4,5	NS_{54} = 1,2

Matrix of agreement – MS, for definite values of index is calculated applying formula 8 and it is shown on table 4.

Table 4 - Matrix of agreement - MS

0	0.757	0.563	0.612	0.612
0.437	0	0.049	0.806	0.049
1	1	0	1	0.806
0.437	0.757	0.194	0	0.243
1	0.951	0.951	1	0

Table 5 - Matrix of disagreement - MNS

0	0.840	1	0.725	1
1	0	1	1	1
0	0	0	0	1
1	0.045	1	0	1
0	0.092	0.708	0	0

The matrix of disagreement –MNS is calculated applying formula 9. It is shown on table 5. Matrix of agreed domination - MSD is shown on table 6. It is calculated applying formula 10.

Table 6 - Matrix of agreed domination - MSD

0	1	0	0	0
0	0	0	1	0
1	1	0	1	1
0	1	0	0	0
1	1	1	1	0

The matrix of disagreed domination – MNSD is shown on the table 7. The elements of the matrix are calculated applying formula 11.

Table 7 - Matrix of disagreed domination - MNSD

0	0	0	0	0
0	0	0	0	0
1	1	0	1	0
0	1	0	0	0
1	1	0	1	0

Table 8 - Matrix of aggregate domination - MAD

P_1	0	0	0	0
0	P_2	0	0	0
1	1	P_3	1	0
0	1	0	P_4	0
1	1	0	1	P_5

The next step is determining the aggregate domination matrix – MAD (matrix of aggregate domination). In this case, the matrix has the values, shown on table 8. It is calculated applying formula 12. The last step, step nine, of the ELECTRE method, by eliminating less desirable projects, led us to the following reccommended projects (Mitevska, 2005).

Table 9 - Final ranks of projects

$P_3 \longrightarrow P_1, P_2, P_4$	**Dominate under P_1, P_2, P_4**
$P_5 \longrightarrow P_1, P_2, P_4$	**Dominate under P_1, P_2, P_4**
P_2	Do not dominate
$P_4 \longrightarrow P_2$	Dominate under P_2
P_1	Do not dominate

Conclusion

Approach of the ELECTRE method, described in this paper, besides the ranking projects, also separates objective components from subjective ones. In the case of ranking projects of Gamzigrad, it has been allocated that the projects P_1 and P_2 do not dominate, while the project P_4 dominates under the project P_2. However, projects P_3 and P_5, dominate under the projects P_1, P_2 and P_4, which means that these two projects, P_3 and P_5, are the approepriate. The further question can be defined on the next way: between the two projects that have applied in the ELECTRE method as acceptable, which one is better? If we take into account the Financial criterion, then the development strategy of Gamzigrad should be based on Congress tourism, because the investments in this project are lower than the investment of the project Recreative tourism. Therefore, the project of Congress tourism is economically better than the others. In the experts' opinion and on its rank in the selected method, beside the least investment, this project, requires the shortest time of realization.

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