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ПРЕГЛЕДНИ РАД
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STRATEGY OF REGIONAL ECONOMIC AND ENVIRONMENTAL DEVELOPMENT OF THE TOURISM POTENTIAL OF GAMZIGRAD SPA

Abstract

Tourism is integral part of modern business, and also part of green economy. Tourism spas must be seen as a major part of the tourism in the countries that are rich in spas. In this case it must be considered as tool of achieving important economic goals. The paper proposes an evaluation model based on TOPSIS, and ELECTRE mathematical methods to help the decision makers in selection of the optimal strategy for Gamzigrad spa development. AHP method is used as ancillary method to determine the weights of criteria. A real case study is used for determination of the development strategies, towards green economy.

Key words: modern society, economic goals, green economy, TOPSIS, ELECTRE

JEL Classification: Q00

СТРАТЕГИЈСКИ ПРАВЦИ РЕГИОНАЛНОГ ЕКОНОМСКОГ И ЕКОЛОШКОГ РАЗВОЈА ТУРИСТИЧКОГ ПОТЕНЦИЈАЛА ГАМЗИГРАДСКЕ БАЊЕ

Апстракт

Туризам представља саставни део савременог пословања, а самим тим и пословање везано за “зелену економију“. Бањски туризам се треба посматрати као главни део туристичке понуде у земљама које су богате у бањама. Такође се може сматрати средством за постизање важних економских циљева. У раду је изложен модел евалуације на основу решења TOPSIS и ELECTRE математичких метода, које служе као помоћ доносиоцима одлука у избору оптималне стратегије за развој Гамзиградске бање. AHP се користи као помоћни метод за одређивање тежине критеријума. На студији случаја Гамзиградске бање могу се одредити развојне стратегије, у складу са циљевима зелене економије.

Кључне речи: модерно друштво, економски циљеви, зелена економија, TOPSIS, ELECTRE.

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Introduction

In the last few years, there have been more and more proofs pointing to the fact that doing tourism means being highly concerned with sustainability of natural resources. Green economy as a new branch of economics, encompasses the achievement of economic goals, but with maximum consideration of environmental objectives, too. The development complies with the requirements and limitations of nature, involves correlation of economic and environmental policy at all levels of society and its integration with modern international trends.[2] The paper is based on finding the adequate development of spa tourism strategies, in case studies of Gamzirad spa, using the appropriate mathematical methods to help decision makers in the selection of appropriate solutions. But choosing the appropriate strategy is not easy task. It could be obtained by using MCDM (Multi-Criteria Decision-Making) methods. Many authors have discussed MCDM methods in the papers and example of that are reviews[2-3].

Determining the weights of criteria - AHP method

AHP was proposed by Saaty to model subjective decision-making processes based on multiple criteria in a hierarchical system[4]. This method is very convenient for determining the relative criteria weights. Three of the most used methods for determining the weights in AHP are: average of normalized columns (ANC), normalization of row average (NRA), and normalization of the geometric mean of the rows (NGM)[5]. The AHP method includes following steps: **Step 1.** Construct a pairwise comparison matrix using the fundamental scale of the AHP (Table 1).

Table 1 Fundamental scale of AHP

The evaluation scale	Definition
1	Equally important
3	Slightly more importance

[2] D. Mihajlović, B. Ilić, Z. Simonović „Razvoj održive ekonomije prirodnih resursa u skladu sa ekološkim zahtevima“ *Ekonomika,* broj 4, 2013. YUISSN 0350-137X, UDK: 338 (497,1), str. 10-22, Niš, 2013.

[3] Chen F-H., Hsu T-S., Tzeng G-H, A balanced scorecard approach to establish a performance evaluation and relationship model for hot spring hotels based on a hybrid MCDM model combining DEMATEL and ANP, *International Journal of Hospitality Management*, Vol. 30, No. 4, 2011, pp. 908-932.
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5	Strongly more importance
7	Demonstrably more importance
9	Absolutely more importance
2, 4, 6, 8	The medium value of the adjacent scale

In the pairwase comparison matrix where a_{ij} denotes the comparative importance of criterion $Ц_u$ with respect to criterion $Ц_j$. In the matrix $a_{ij} = 1$, when $a_{ju} = a_{ju}$ and $a_{ju} = a_{ju}$.

Table 2 Pairwase comparison matrix

	$Ц_1$	$Ц_2$	$Ц_j$	$\cdots$	$Ц_j$
$Ц_1$	a_{11}	a_{12}	a_{13}	$\cdots$	a_{1j}
$Ц_2$	a_{21}	a_{22}	a_{23}	$\cdots$	a_{2j}
$Ц_j$	a_{j1}	a_{j2}	a_{j3}	$\cdots$	a_{jj}

Step 2. Calculate relative normalized weight $њ_j$ of each criterion by using the following formulae:

$$GM_i = \left(\prod_{i=1}^{n} a_{ij} \right)^{1/n}, \tag{1}$$

$$w_j = GM_i / \sum_{i=1}^{n} GM_i, \tag{2}$$

where *GM* is geometric mean.

Step 3. Determine the maximum eigenvalue $\lambda_{\max}$ and calculate the consistency index CI : $CI = (\lambda_{\max} - n)/(n-1)$. (3)

Step 4. Obtain the random index *RI* for the number of criteria used in the decision making (Table 3).

Table 3 Random index details

Number of cr.	1	2	3	4	5	6	7	8	9
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

Step 5. Calculate the consistency ratio *CR* by using following formula:

CR = CR / RI (4)

Judgment is appropriate when the value of *CR* is 0.1. Three experts in the field of tourism resources management are consulted in order to determine the relative importance of all possible pairs of criteria with respect to the overall goal. Their judgments are arranged into the matrixes and presented in Tables 4, 5 and 6. The relative normalized weight *wj* of each criterion *j* is calculated by using formulae (1) and (2). The consistency ratio *CR* is checked by formulae (3) and (4). Three different judgments and therefore, different weights, are reduced to a common weight by using formula (1).

Table 4 Pairwise matrix - Expert 1

	C_1	C_2	C_3	C_4	C_5	w_j
C_1	1	1/7	1	5	1	0.136
C_2	7	1	3	7	7	0.539
C_3	1	1/3	1	5	3	0.190
C_4	1/5	1/7	1/5	1	1/3	0.042
C_5	1	1/7	1/3	3	1	0.093

CR = 9.30%

Table 5 Pairwise matrix - Expert 2

	C_1	C_2	C_3	C_4	C_5	w_j
C_1	1	1/7	1/3	1	1	0.072
C_2	7	1	5	7	7	0.580
C_3	3	1/2	1	3	3	0.188
C_4	1	1/7	1/3	1	1/3	0.061
C_5	1	1/7	1/3	3	1	0.099

CR = 7.39%

Table 6 Pairwise matrix - Expert 3

	C_1	C_2	C_3	C_4	C_5	w_j
C_1	1	1/7	1/3	3	1	0.091
C_2	7	1	5	7	7	0.569
C_3	3	1/2	1	5	3	0.204
C_4	1/3	1/7	1/2	1	1/3	0.045
C_5	1	1/7	1/3	3	1	0.091

CR = 9.50%

Final weights of criteria calculated by formula (1), are: $C_{1=}$0.100; $C_{2=}$0.094; $C_{3=}$0.049; C_4 =0.194; $C_{5=}$0.563 (Σ=1)

Intorduction of TOPSIS Method

The TOPSIS was first introduced by Hwang and Yoon 1981 [6]. According to this method the most suitable alternative would have the shortest distance from the ideal solution and largest distance from the anti-ideal solution. There are a lot of examples of using TOPSIS for improving the decision making process in many different fields and one example of that is paper of Dağdeviren et al. [7] The TOPSIS method consists of following steps: **Step 1.** Establish decision matrix. Criteria shown as qualitative values need to be changed into quantitative values. A numerical scale, which is using for that purpose, is shown in Table 8:

Table 8 Transformation of linguistic scales into quantitative values

Linguistic scale	**Quantitative value**	
	Benefit - max	**Cost - min**
Very high	9	1
High	7	3
Average	5	5
Low	3	7
Very low	1	9

Step 2. Calculate the normalized decision matrix. The normalized value p_{ij} is calculated as:

$$r_{ij} = x_{ij} / \sqrt{\sum_{i=1}^{m} x_{ij}^2} \qquad (5)$$

where $ц_{ij}$ is the rating of alternative *Cj* with respect to the criteria $Ц_j$, $њ_j$ is the weight of the criteria *Cj*, $и = 1,\ldots,м$, m is number of alternatives, and $j = 1,\ldots,n$, *n* is number of criteria. **Step 3.** Create the weighted normalized decision matrix. The weighted normalized value $в_{ij}$ is calculated as:

$$в_{ij} = њ_j p_{ji} \,. \qquad (6)$$

Step 4. Determine ideal solution A^+ and anti-ideal solution A^- using formulae:

$$A^+ = \left\{в_1^+,\ldots,в_н^+\right\} = \left\{\left(\underset{и}{\text{мац}}\, в_{ji} \mid и \in И\right), \left(\underset{и}{\text{мин}}\, в_{ji} \mid и \in И'\right)\right\} \qquad (7)$$

$$A^- = \left\{в_1^-,\ldots,в_н^-\right\} = \left\{\left(\underset{и}{\text{мин}}\, в_{ji} \mid и \in И\right), \left(\underset{и}{\text{мац}}\, в_{ji} \mid и \in И'\right)\right\} \qquad (8)$$

[6] Hwang C.L., Yoon K., Multiple attribute decision making: Methods and applications, A State of the Art Survey, New York: Springer-Verlag, 1981.

[7] Dağdeviren M., Yavuz S., Kılınç N., Weapon selection using the AHP and TOPSIS methods under fuzzy environment, *Expert Systems with Application*, Vol. 36, 2009, pp. 8143-8151.

where $И$ is associated with set of benefit criteria, and $И'$ is associated with set of cost criteria. **Step 5.** Calculate the separation of each alternative from ideal solution $Д_u^-$, and anti-ideal solution $Д_u^-$ using the n-dimensional Euclidean distance using formulae:

$$Д_u^+ = \sqrt{\sum_{j=1}^{н} \left(в_{ju} - в_j^+ \right)}, \qquad (9)$$

$$Д_u^- = \sqrt{\sum_{j=1}^{н} \left(в_{ju} - в_j^- \right)}. \qquad (10)$$

Step 6. Calculate the relative closeness to the ideal solution as follows:

$$Ц_u^+ = Д_u^- / \left(Д_u^+ + Д_u^- \right), \qquad (11)$$

where $0 \le Ц^+ \le 1$. Rank the alternatives according to descending order of C_i.

Intorduction of The ELECTRE Method

The ELECTRE method was developed by Roy 1968 as response to the existing decision making methods[8]. This method could be viewed as a philosophy of a decision aid. The main steps of the ELECTRE method include: **Step 1, 2** and **3** are equal to the TOPSIS methodology.**Step 4.** Determine concordance *Cpr* and discordance *Dpr* sets by using follows formulae:

$$Ц_{pr} = \{ j | \; џūj \ge џpj \}, \qquad (12)$$

$$Д_{pr} = J - C_{\bar{p}} = \{ j | \; џūj < џpj \}. \qquad (13)$$

Step 5. Define the concordance matrix c_{pr} on the basis of the concordance sets. The elements of this matrix are the concordance indices and it is calculated as:

$$ц_{pr} = \sum_{j \in Ц\bar{u}p} њ_j . \qquad (14)$$

Step 6. Determine the discordance matrix d_{pr} on the basis of the discordance sets. The elements of the matrix are the discordance indices determined by the following formula:

$$gpr = \frac{\underset{j \in Д\bar{u}p}{\text{маџ}} \left[њ_{ju} - њ_{jp} \right]}{\underset{j \in J}{\text{маџ}} \left[њ_{ju} - њ_{jp} \right]} . \qquad (15)$$

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[8] Roy B., Classement et choix en présence de points de vue multiples (la méthode ELECTRE), *La Revue d'Informatique et de Recherche Opérationelle (RIRO)*, Vol. 8, 1968, pp. 57–75.

Step 7. Determine the matrix of concordance domination, on the basis of the average index of concordance - *AIC* by using formula:

$$АИЦ = \sum_{\bar{u}=1}^{м} \sum_{p=1}^{м} \frac{ц_{\bar{p}}}{м(м-1)}, \tag{16}$$

where $\bar{u} \neq p$. **Step 8**. Analogously to the matrix of concordance domination, there is a need for determination of the matrix of discordance domination on the basis of the average index of discordance - *AID*, as follows:

$$АИД = \sum_{\bar{u}=1}^{м} \sum_{p=1}^{м} \frac{g_{\bar{p}}}{м(м-1)}, \tag{17}$$

where $\bar{u} \neq p$. **Step 9.** Determine the matrix of aggregate domination – mad_{pr} whose elements are equal to the product of the elements on a certain position in matrices of agreement and disagreement domination:

$$mad_{pr} = msd_{pr} \cdot mnsd_{pr}. \tag{18}$$

Step 10. Less desirable actions are eliminated, while one or more alternatives are separated as most desirable. Therefore, the ELECTRE I method provides a partial order of actions.

Numerical application of proposed methods

Future development of Gamzigrad spa requires realization of suitable projects which could promote different tourism capacities of this area. TOPSIS and ELECTRE are used in ranking of the development strategies in order to improve the presence position of this spa and East Serbia region as well. The available alternative projects, defined by management team of the spa, are: A_1 **– health tourism;** A_2 **– sports tourism;** A_3 **– recreation tourism;** A_4 **– country tourism;** A_5 **– congress tourism.** The following five criteria were defined for evaluation of the projects: C_1 **– financial investments (€).** Project that requires less investments are more desirable; C_2 **– solution delivery (€).** Second best investment solution for the observed projects. As previous, project that requires less investment has the advantage; C_3 **- strategic contribution.** Project with higher contribution to the development of the Gamzigrad spa is desirable; C_4 **- risk management**. The project with the least risk has the advantage; C_5 **– environment.** Project that more relies on the environment potentials is more desirable.

Ranking strategies by TOPSIS Method

Table 9 presents the raw data which are base for decision making process.

Table 9 Raw data

	Financial invest. (€)	**Solution delivery (€)**	**Strategic contribut.**	**Risk managem.**	**Environ.**
	min	**min**	**max**	**min**	**max**
Health tourism	**200.000**	**250.000**	**High**	**Average**	**Very High**

Sports tourism	**70.000**	**90.000**	**Very high**	**Average**	**High**
Recreation tourism	**60.000**	**70.000**	**Very high**	**Low**	**Very high**
Country tourism	**120.000**	**140.000**	**High**	**Low**	**High**
Congress tourism	**40.000**	**60.000**	**High**	**Low**	**Very high**

Qualitative data is changed into quantitative by using numerical scale shown in the Table 8 (see Table 10).

Table 10 Initial decision matrix

Alternatives	Criteria				
	C_1	C_2	C_3	C_4	C_5
	min	min	max	min	max
A_1	200.000	250.000	7	5	9
A_2	70.000	90.000	9	5	7
A_3	60.000	70.000	9	3	9
A_4	120.000	140.000	7	3	7
A_5	40.000	60.000	7	3	9

Normalized decision matrix (Table 11) is calculated by using formula (5).

Table 11 Normalized decision matrix

Alternatives	Criteria				
	C_1	C_2	C_3	C_4	C_5
	min	min	max	min	max
A_1	0.7875	0.7958	0.3982	0.5698	0.4874
A_2	0.2756	0.2865	0.5120	0.5698	0.3791
A_3	0.2362	0.2228	0.5120	0.3419	0.4874
A_4	0.4725	0.4456	0.3982	0.3419	0.3791
A_5	0.1575	0.1910	0.3982	0.3419	0.4874

Steps 1 and **2** are done. **Step 3.** The weighted normalized decision matrix is calculated by formula (6) and shown in Table 12.

Table 12 Weighted normalized decision matrix

	Criteria				
	C_1	C_2	C_3	C_4	C_5
Weights	0.100	0.094	0.049	0.194	0.563
Alternatives	min	min	max	min	max
A_1	0.0787	0.0748	0.0195	0.1105	0.2744
A_2	0.0276	0.0269	0.0251	0.1105	0.2134
A_3	0.0236	0.0209	0.0251	0.0663	0.2744
A_4	0.0472	0.0419	0.0195	0.0663	0.2134
A_5	0.0157	0.0180	0.0195	0.0663	0.2744

Step 4. The ideal A^{+} and anti-ideal solutions A^{-} are determined by formulae (7) and (8), and they are as in Table 13.

Table 13 The ideal A^{-} and anti-ideal solutions A^{-}

A^{+}	0.0157	0.0180	0.0251	0.0663	0.2744
A^{-}	0.0787	0.0748	0.0195	0.1105	0.2134

Step 5. The separation measures $Д_u^{+}$ and $Д_u^{-}$ are determined by using the formulae (9) and (10). The results are shown in Table 14.

Table 14 The separation measures and relative closeness to the ideal solution

Alternative	$Д_u^{+}$	$Д_u^{-}$
	I	II
A_1	0.0958	0.0610
A_2	0.0768	0.0703
A_3	0.0084	0.1079
A_4	0.0729	0.0635
A_5	0.0056	0.1135

Step 6. Relative closeness of a particular solution to the ideal solution $Ц_u$ is calculated by using formula (11), and it is given in Table 15. According to the results, the rank is followed:

Table 15 Ranking results

Alternative	$Ц_u$	**Rank**
A_1	0.3888	5
A_2	0.4780	3
A_3	0.9276	2
A_4	0.4655	4
A_5	0.9532	1

Ranking by ELECTRE Method

Available alternatives for improving the conditions in the Gamzigrad spa are ranked by using ELECTRE method. **Step 1**, **2** and **3** of this method are the same as in TOPSIS. **Step 4.** Concordance C_{pr} and discordance sets D_{pr} are determined by applying the formulae (12) and (13). **Step 5.** Concordance matrix c_{pr} is calculated by using formula (14) and data from Table 8 and it is as in Table 16.

Table 16 Concordance matrix

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

Step 6. Discordance matrix d_{pr} is calculated by using formula (15) and it is presented in Table 17.

Table 17 Discordance matrix

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

Step 7. The matrix of concordance domination is calculated by using formula (16) and presented in Table 18.

Table 18 Matrix of concordance domination

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

Step 8. The matrix of discordance domination is obtained by using formula (17) and it is presented in Table 19.

Table 19 Matrix of discordance domination

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

Step 9. Matrix of aggregate domination mad_{pr} is determined by using formula (18) and values of the matrix are follows (Table 20):

Table 20. Matrix of aggregate domination

A_1	0	0	0	0
0	A_2	0	0	0
1	1	A_3	1	0
0	1	0	A_4	0
1	1	0	1	A_5

Step 10. shows recommended projects that are obtained by eliminating less desirable alternatives. Ranking results are: $A_3 \rightarrow A_1$, A_2, A_4 dominate under A_1, A_2, $A_{4;}$ A_5 $\rightarrow A_1$, A_2, A_4 dominate under A_1, A_2, $A_{4;}$ A_2 not dominant; $A_4 \rightarrow A_2$ dominate under $A_{2;}$ A_1 not dominant.

Conclusion

The obtained results are not completely identical. TOPSIS shows alternative A_5 – congress tourism as the most appropriate choice for the present conditions and alternative

A_3 – recreation tourism is in the second place. Application of the ELECTRE method was relative successful because precise ranking was not determined. But, solution gained by the TOPSIS is more accurate and elegant because it gives the precision ranks of observed alternatives. Efficiency of the strategy selection is significantly increased by using the proposed methods. These methods could consider any number of different criteria and offers a more objective, simple and reliable strategy selection approach. Proposed methods could be combined with different mathematical models for improving the decision making quality.

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