

MULTICRITERIA ANALYSIS OF THE LEVEL OF SUSTAINABLE DEVELOPMENT OF THE TOPLICA DISTRICT USING THE ELECTRE METHOD

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Abstract

Multicriteria analysis and optimization is applied as a procedure in situations when there are a large number of criteria and variants for defining the solution of the problem. Multi-criteria evaluation can be applied in various activities. In this paper, it was applied in order to rank the municipalities of the Toplica district (Kursumlija, Prokuplje, Blace and Zitoradje) in order to determine which of them is the most developed. The ranking of municipalities according to a number of criteria at the same time, contributes to determining the real situation regarding the factors of sustainable development. Common to all methods of multicriteria analysis is that they solve a given problem on the basis of quantitative analyzes between several alternatives with a larger number of criteria. The procedure for selecting criteria and their weights is very important for their application, which is why these methods mostly differ. All used mathematical models proved to be useful, and the paper presents the results obtained by the method of multicriteria analysis ELECTRE (Elimination and (Et) Choice Translating Reality).

Keywords: Multicriteria analysis, sustainable development, ELECTRE, Toplica district.

1. INTRODUCTION

An integrated approach to the strategy and policy of regional development enables, in addition to defining the degree of regional development and considering its development possibilities, the connection of factors and development goals, so that in the end the result of development is in the function of population interest and general well-being [1-3].

According to the available theoretical and practical knowledge, the integral approach in the analysis of the situation and decision-making on regional development is mainly reduced to the application of some of the methods based on factor, branch-regional or analysis that monitors the basic determinants of economic and sustainable development.

The factor approach is the closest to a complete systemic approach, which analyzes the impact of all relevant factors on the development of the region. By introducing the methods of multicriteria analysis and optimization, the factor approach also gained the status of a suitable integrated model for research and planning of regional sustainable development [4-8].

Having in mind the complexity of the problem of regional development, it is necessary to, in addition to modern theoretical and practical knowledge, establish a more active relationship between local, regional and state institutions in mutual coordination in the process of implementing strategic development plans. Only in this way can the concept of regional sustainable development meet the set goals and objectives [9-17].

The paper takes the Toplica district as an example, which was chosen as a demo region due to poor development, long-term trend of population depopulation, modest qualification structure of

the active population, agriculture as the leading industry, and the area whose natural boundaries are defined by the Toplica river basin. they coincide with the administrative borders, within which there are significant, but untapped natural potentials, which are the key factors for the future sustainable development of this region. Based on this example, it can be concluded that multicriteria analysis can be successfully applied to identify inequalities in the degree of sustainable regional development.

2. METHODOLOGY

2.1 Multicriteria analysis of sustainable development of Toplica district

Planning the development of the Toplica district, based on the principles of sustainability, implies the simultaneous monitoring of the development of its municipalities under the influence of selected economic, social and environmental factors of development. The number and value of these factors and its influences on the development of municipalities in the Toplica district have conditioned the need to use mathematical models, which are based on their multi-criteria analysis, offering a sequence of alternative solutions (position of municipalities in sustainable development). For the selected influencing development factors, the initial quantification matrix was formed, as a starting point for the application of multicriteria analysis using the ELECTRE method [11,12]. Consideration of this method for multi-criteria analysis aims to verify the obtained solutions, their compatibility and reliability in determining the final solution on the position of the municipalities of Toplica district in the field of sustainable development.

3. RESULTS

3.1 Multicriteria analysis - ELECTRE method

The ELECTRE method is one of the methods of multicriteria analysis that are often used when solving problems with several alternatives and influencing factors of different origins and units of measure. From the initial matrix for ranking the municipalities of the Toplica district, all the complexity and diversity of development factors can be seen, which justifies the choice of this method for further analysis. By forming a normalized matrix from the initial decision matrix by applying the norm of decision criteria ($\sum_{i,j} X_{ij}^2$ where X_{ij} is one of the development criteria), the problem of dimensional discrepancy between development factors was eliminated and conditions were created for conducting multicriteria analysis for obtaining solutions in quantitative form and its evaluation.

The ELECTRE method bases its analysis on the comparison of alternative solutions in pairs (each with each alternative), with the aim of obtaining first the degree of agreement between their weights, and then the degree of disagreement according to which the analyzed alternatives differ in weight.

The procedure of applying the method itself is iterative and consists of the following steps:

1. Calculation of the normalized decision matrix (N)
2. Calculation of weight normalized matrix (TN) (two variants of weight criteria)
3. Determining sets of agreement and disagreement (S_{ij} , N_{ij})
4. Determining the compliance matrix (MS)
5. Determining the non-compliance matrix (MNS)
6. Determination of matrix aggregate dominance (MAD)
7. Ranking of alternative solutions and conclusion

An overview of the practical application of this method with its procedures on the problem of defining the state of sustainable development of the municipalities of the Toplica district is given in Table 1.

Table 1. Initial matrix for decision-making on sustainable development of Toplica district - ELECTRE method

Alternative-municipality		Kuršumlija a1	Blace a2	Prokuplje a3	Žitorođa a4	Normof decision criteria $\sum_{j=1}^n \lambda_j^2$
I Population						
f ₁ - Age index	min	1.284	1.890	1.230	1.383	8.646 = 2.9400
f ₂ - Coefficient of working capacity of the population	min	0.284	0.416	0.283	0.350	0.4563 = 0.6375
f _j - Degree of education	max	2.510	2.480	2.630	2.260	$\sum_{j=1}^n \lambda_j^2 = 4.9472$
II Economy - activity of the population						
f _p -Economic Sustainability Index I	min	1.135	1.004	1.452	0.729	$\sum_{j=1}^n \lambda_j^2 = 2.2217$
f _j -Economic Sustainability Index II	max	1.720	2.040	1.766	1.347	$\sum_{j=1}^n \lambda_j^2 = 3.4718$
f _f ,- Sustainability ratio	max	0.85	0.74	0.88	0.89	$\sum_{j=1}^n \lambda_j^2 = 1.6742$
III Social standard						
f _y -Education-density of primary and secondary schools	max	0.1777	0.5000	0.3364	0.700	$\sum_{j=1}^n \lambda_j^2 = 0.9406$
f _g - Health care standard	max	0.0018	0.0016	0.0037	0.0010	$\sum_{j=1}^n \lambda_j^2 = 0.0045$
f ₉ - Degree of road construction (km/h)	max	0.0290	0.0170	0.0080	0.0060	$\sum_{j=1}^n \lambda_j^2 = 0.0351$
IV Ecology and environment						
f ₁₀ - Available land per household	max.	3.37	3.12	3.17	2.44	$\sum_{j=1}^n \lambda_j^2 = 6.2970$
f ₁₁ - Degree of forest exploitation	min	1.26%	1.66%	1.40%	0.70%	$\sum_{j=1}^n \lambda_j^2 = 2.6063$
f ₁₂ - Degree of water utilization for water supply	min	35%	44%	55%	121%	$\sum_{j=1}^n \lambda_j^2 = 144.32$

Based on the data of the aggregate dominance matrix (MAD) for variant (1), the following follows: Alternative a3 (municipality of Prokuplje) dominates in the field of sustainable development over other alternatives (municipalities): a1, a2, a4 (Kuršumlija, Blace, Žitorođa), respectively; Alternative a1 (Kuršumlija) and a2 (Blace), dominate in sustainable development over alternative (municipality) a4 (Žitorođa); Alternative a4 (Žitorođa) does not dominate any alternative (municipality); Alternative a1 (Kuršumlija) and a2 (Blace) have equal dominance in sustainable development.

Based on the data obtained from the analysis conducted by the ELECTRE method with the application of two, variant proposals of weight criteria, it can be concluded that for both variants: Alternative a3 (Prokuplje municipality) dominates in the field of sustainable development over other alternatives a1, a2, a4 and Žitorođa), respectively; Alternative a4 (Žitorođa) does not dominate any alternative (municipality of Toplica district); Alternatives a1, a2 (municipalities of

Kuršumlja, Blace), respectively, dominate over alternative a4 (municipality of Žitorođa) and Alternative a1 (Kuršumlja) because they have a slight advantage of sustainable development compared to alternative a2 (municipality of Blace).

4. CONCLUSIONS

Economic development is one of the changing factors of development, relying primarily on the available natural and human resources of the region and its municipalities. As these potentials also differ between municipalities within the region, this is consequently transferred to their economic and overall development. The methodological approach for the analysis of their condition and status within the region is completely equivalent to the new concept, which is defined in this paper, and refers to sustainable regional development, starting from the process of preparing and defining research programs to the final solution on the state and directions, further economic and overall sustainable development of the municipalities of the Toplica region.

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