



## DEVELOPMENT OF THE MULTI-CRITERIA MODEL FOR THE QUALITY OF LIFE ASSESSMENT IN LOCAL GOVERNMENTS

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**Abstract:** The perception of satisfaction with the quality of life by an individual in urban and rural areas includes a number of objective and subjective indicators, based on the analysis that could be performed. Measuring the preferences of individuals living in different environments, in terms of life goals, needs, moods, expectations, as well as personal satisfaction with the quality of life, requires more criteria to be included for its evaluation. The research was conducted on the basis of twenty indicators for measuring the quality of life in local governments depending on the preferences of individuals, and of different age, gender, education, social status, and satisfaction motives. The subject of this paper is the selection of criteria in a multi-criteria model for assessing the quality of life in local governments, using adequate statistical tools. In addition to descriptive statistics and testing the significance of differences, the authors of the paper used a modified PROMETHEE multi-criteria method for ranking local governments.

**Keywords:** quality of life assessment, local governments, multi-criteria model, quality of life indicators, preferences of individuals, Promethee method

**JEL classification:** C44, C82, R58

### 1. Introduction

The quality of life can be viewed as a result of individual fulfillment of individual desires in urban and rural areas. However, improving the quality of life is a prerequisite for social development, as well as a basic goal of state policies in many countries, regardless of their economic development. More precisely, the

quality of life determines the social position, and, on the other hand, represents the goal of social development (Arsovski, 2006). In addition to the individual and social dimensions, the quality of life includes the value system of the individual and objective evaluation. However, finding an adequate way to measure and evaluate the quality of life is one of the more difficult tasks.

Monitoring the quality of life determines differences in the population of different social groups, status, culture and historical heritage. By comparing these differences with other countries, priority areas for improving the quality of life can be identified. As it is a question of the multidimensional definition of the quality of life, the solution to the problem must be viewed from the aspect of human development and the well-being of society. The function of social welfare ( $W$ ) can be presented in general form (Begović, 2010):

$$W = f(w_1, w_2, w_3, \dots, w_n) \quad (2)$$

where  $w_i$  represents the individual well-being of the individual and ( $i = 1, \dots, n$ ), and society consists of  $n$  individuals. The term represents the general form of the function of social welfare, as well as the distribution of well-being between individuals. Therefore, it is necessary to pay attention to the equal specific weights of each individual and his individual well-being. If the individual well-being of each individual is joined by an equal specific weight, then the function of social well-being is reduced to the sum of individual well-being (Kahneman et al., 1997):

$$w = \sum w_i \quad (i = 1, \dots, n) \quad (3)$$

this form is called the utilitarian function of social welfare and is a standard form in economic theory. According to Jeremy Bentham (1748–1832), who is considered the father of utilitarianism, social welfare for economics is the sum of individual well-being (Kahneman et al., 1997). However, research on subjective well-being has been conducted for the last 30 years, i.e. a set of new techniques and data for measuring well-being and satisfaction in the economy known as the economics of happiness.

The economics of happiness represents a new direction, relying on the expansion of the notion of utility and well-being, including interdependent utility functions, procedural utility, and the interaction between rational and irrational influences in determining economic behavior (Graham, 2005). The study on the economics of happiness was conducted by the European Organization for Economic Cooperation and Development (OECD) in 34 member countries in 2014. Respondents in the study rated happiness based on the following factors: housing, income, jobs, education, environment, civic engagement, and health (OECD, 2014). The aim of the study is to propose activities to improve the living standards of the population in the member states and to assist governments in designing

better public policies. The results of the study indicated that not only the economic component, but also the other dimensions of life, such as health, career satisfaction, quality of interpersonal relationships, social interaction, political rights and freedom of speech, are crucial for subjective well-being (Frey & Stutzer, 2002).

The value of the gross domestic product (GDP) is most often treated as an indicator of economic well-being, i.e. it measures the market production of all final goods and services produced in one year period, within one economy as a whole. More precisely, there is a clear link between the value of GDP per capita and quality of life, i.e. The residents of richer countries live longer on average, go to school longer, live in a healthier environment, and have access to better health care. Also, GDP is useful for measuring market production and providing an indicative picture of the economy at a given time, but it does not provide comprehensive data on the living standard of the most citizens of society (Fitoussi et al., 2018). According to Fitoussa (2018), the growth of average GDP does not automatically mean a better standard of living for most of its citizens, i.e. the benefit of growth is noticeable in a small part of society, leaving many groups at the same level or worse than before, in terms of their wealth. Development models, which are based only on economic indicators, do not show a realistic picture of the overall progress of societies. Thus, a society cannot see progress if, in addition to the indicators of economic growth and development, it does not include measurements and indicators of social progress, as well as a special emphasis on measuring outcomes (Porter et al. 2017).

The aim of this paper is to propose objective and subjective indicators, which would comprehensively describe the quality of life of the population in local governments. As the assessment is performed on the basis of twenty indicators, the methods of selection are multi-criteria analysis for the assessment and analysis of the quality of life in local governments. In this paper, a modified Promethee method (MODIPROM) was applied to rank local governments, according to satisfaction with the quality of life of individuals involved in the research. In accordance with the goal and the above description of the problem, the structure of the paper, in addition to the introductory part and literature review, includes parts describing the quality of life indicators, research methodology and hypotheses, discussion of statistical analysis results, and formation and development of the multi-criteria model.

## **2. Quality of life indicators**

The quality of life research is a multidisciplinary concept, which provides different interpretations and indicates that there are tools and methods that can be used to measure it. Also, the quality of life is a complex concept that implies the possibilities that people have, the meaning and significance they attach to their lives, and the way they enjoy what they have (Stiglitz et al., 2010). In addition to

significant differences in defining the concept of the quality of life, there are common characteristics agreed by most experts that: health, emotional well-being, material well-being, close relationships with other people, community productivity and security are important factors (Vuletić & Misajon, 2011). More specifically, the domains represent areas where each has an impact on the quality of life (Burgess & Gutstein, 2007). Eight domains of quality of life stand out in the literature, namely: emotional well-being, physical health, determination, interpersonal relationships, social inclusion, personal rights, personal development and material well-being (Schalock et al., 2016). These domains are universal, but their predictive significance differs depending on the age of the respondents. Also, regardless of the individual importance of the domain, it is emphasized that they should be viewed through two dimensions - as an objective and a subjective approach to the quality of life (Burgess & Gutstein, 2007). However, numerous studies have shown that the connection between the objective indicators and subjective assessments of an individual about their own quality of life is complex.

The domains of the quality of life can be assessed through subjective and objective indicators. The quality of life indicators represent the outcomes of perception, behavioral manifestations, and the characteristics of the conditions underlying each of the quality of life domains (Schalock et al., 2010). Subjective indicators of the quality of life are the indicators of personal evaluation of the life of each individual, which includes measuring the real conditions and the attitude that a person has towards those conditions. Objective indicators of the quality of life are quantitative indicators of the quality of life that are related to social factors - economic, social, and demographic indicators that affect the conditions and lifestyle of the individual (Kolenikov, 1998). However, these indicators do not provide an insight into the subjective experience of an individual's life.

The subjective approach to the study of the quality of life starts from the assumption that it is important to have an insight into individuals' thinking about their own life as a whole, but also about certain aspects of life, such as health, society, work (Diener & Suh, 1997). The problems of subjective indicators in the assessment of the quality of life are focused on their definition of individuals who value their lives as a whole, as well as on the individuals who affect their quality (Veehoven, 1996). Differences in the way of thinking, culture, and historical heritage of the population have an impact on the subjective assessment of satisfaction with the quality of life. As the quality of life contains both objective and subjective elements, the former is measured by objective indicators of well-being, while the latter is measured by issues related to the degree of satisfaction (Major, 2014). The research of subjective satisfaction with the quality of life in this paper is considered according to the methodological framework and target variable "subjective well-being" based on the Survey on Income and Living Conditions (EU - SILC), which is used in the analyses of the EU countries, as well as in Serbia.

The development of European statistics plans to integrate the quality of life issues into the regular EU-SILC questionnaire from 2023 (Eurostat, 2020). According to the EU-SILC methodological framework, life satisfaction is defined as a reflex assessment that an individual gives about his or her life as a whole (Eurostat, 2020). Also, the term "life" means all areas of human existence. Therefore, the variable refers to the opinion of each individual about the degree of satisfaction with their life.

The questions in the EU-SILC questionnaire are focused on how people feel at the moment, instead of stating a longer or shorter period of time, i.e. to get a reflexive judgment about their level of satisfaction. The term "meaning of life" represents the *eudaimon* aspect of well-being, which is not related to any specific area of life, but focuses on life in general. The frequency of positive emotions (happiness) in the last four weeks is a dimension of well-being effect. Eight domains are included as a comprehensive framework for measuring the well-being of individuals, according to EU-SILC. Each of the domains has a specific aspect, which is considered simultaneously: material living conditions (income, consumption, and material conditions), productive or main activity, health and education, leisure and social interactions, economic and physical security, governance and fundamental rights, natural and living environment, overall life experience. The EU-SILC questionnaire is designed to reflect a multidimensional approach to the quality of life.

A simple questionnaire according to EU-SILC was created for the purposes of this paper, which has 7 questions and relates to objective indicators and 13 questions to subjective indicators within these domains, which can be considered criteria for comparing local governments. As the evaluation and analysis of the quality of life satisfaction were considered from the aspect of several criteria, the application of multi-criteria analysis methods is imposed as a solution to the problem.

### 3. Literature review

The analysis of the content of the available literature highlights the method of analytical hierarchical processes (Analytical Hierarchy Process - AHP), as a decision support system (SPO) in the assessment of the quality of life. AHP and RAHP (Rough Analytical Hierarchy Process) methods are used in determining weights, as a special approach to the criteria of physical health, psychological, social relations, and the environment (Rădulescu et al., 2019). The result of the analysis shows that the order of importance of the criteria is the same for both methods from the most important to the least important: physical health, mental, social relations, and the environment. Also, the determination of weight coefficients in the multi-criteria model for the analysis of local economic development based on the preferences of a group of experts, using the multi-criteria method SAW (Simple Additive Weighting) (Stanković et al., 2016). The

results of the ranking of local governments included in the study show that the best ranking is in the city of Nis, followed by Belgrade and Kragujevac. However, the established rank shows the subjective preferences of the expert group and is not in line with certain real indicators of economic activity in these cities.

The application of multi-criteria decision-making in environmental projects is involved in selecting appropriate strategies to repair and reduce the pollution of contaminated sites, land use planning, and regulatory processes often include multiple additional criteria such as cost-benefit allocation, environmental impacts for different populations, safety, environmental risk or human values (Kiker et al., 2005). In the case of food quality domains, the Promethee family of methods is used to rank wheat lots in terms of their overall quality intended for sale and processors (Mastilović et al., 2016). Also, the application of multi-criteria methods and models for the analysis of methodological quality of health technology (HTA) is current. In the case study, aggregation methods were used to analyze the quality of systematic reviews (Oliveira et al., 2019).

#### **4. Research methodology, definition of hypotheses and data analysis**

A sample of 300 respondents was randomly selected for the needs of this research from the population living in the city of Kragujevac, the smaller town of Sopot, and the rural area of Popović in Serbia. The research was conducted using the method of interviews through a questionnaire, where 100 respondents were surveyed in each of the mentioned local governments in 2019. The questionnaire consists of two parts, and contains 20 indicators (7 objective indicators and 13 subjective indicators), which are criteria for assessing and analyzing the quality of life, according to EU-SILC.

The questions in the questionnaire were formulated as statements, to which the respondents expressed a certain degree of satisfaction with the quality of life on a scale from 1 to 10 (1 - very dissatisfied, 10 - extremely satisfied). The results were evaluated by the Likert scale, which consists of five levels, where 1 indicates the lowest level, and level 5 represents the highest level of satisfaction with the quality of life. To test the differences depending on the levels of satisfaction with the quality of life in local governments, the t-test of the significance of the difference and the ANOVA analysis is used. Then, the selected criteria are used in a multi-criteria model to assess the quality of life depending on the preferences of individuals in local governments. The following hypotheses will be verified and tested in the research:

*H1: There is a statistically significant difference in the perception of individual satisfaction with the quality of life in local governments depending on objective and subjective indicators.*

*H2: The combination of objective and subjective indicators describes the quality of life in local governments as much as possible.*

The analysis of all research results in the paper is systematized into two groups:

I: Statistical analysis of results;

II: The formation of a multi-criteria model and the ranking of local governments depending on the perception of satisfaction with the quality of life by individuals are presented in two steps:

Step I: ranking local governments based on objective or subjective indicators of quality of life;

Step II: ranking local governments based on the results obtained in Step I.

#### **4.1. Data analysis**

The data were collected on the basis of the Questionnaire, which was created for the purpose of measuring, evaluating, and monitoring the satisfaction with the quality of life of individuals, in order to improve the quality of life of the population in local governments. Analysis of the collected data based on counting the responses of individuals individually using the method of logical reasoning indicates the following characteristics of the selected sample:

- gender structure of respondents: 57% women and 43% men;
- age of respondents: 18 to 25 years - 18%; 26 to 45 years -38%, 46 to 60 years - 32%, over 60 years - 11%;
- educational structure of respondents: four-year high school 63% of respondents, college 25% of respondents, college (faculty) 36% of respondents;
- employment status: employed 35% of respondents, unemployed 24% of respondents, temporarily employed 21% of respondents, inactive (retired or incapable of work) 20% of respondents;
- monthly income per household member: up to 20,000 dinars 13%, from 20,000 to 40,000 dinars 55%, from 40,000 to 60,000 dinars 22%, more than 60,000 dinars 5%;
- Number of family members: up to 2 members - 25%, 3-5 members - 71%, more than 6 members - 4%.
- Respondents who are educated along with work are about 59%, while 40% of respondents do not practice. Out-of-work education is practiced by 22% of respondents, while 78% of respondents do not study out of work.

The collected data from local governments are shown in Table 1. Based on the data from Table 1, the difference in the structure of the population by gender can be seen. The majority of respondents are women, who dominate in Popović (64%), Kragujevac (55%), and Sopot (52%). The age structure of the respondents is dominant from 26 to 40 years in all three local governments. Also, the secondary education of the respondents is the most represented, as well as employees in all three local self-governments. The number of households whose monthly income per household is up to 30,000 dinars dominates in Sopot and Popović, and over 50,000 in Kragujevac. It is represented by a predominance of four members, and at least six

households in all three local governments. In Kragujevac and Sopot, more than 50% of respondents are educated at work, while in Popović it is not represented at all. The perception of vocational education outside work is much more practiced in Kragujevac (32%) and Sopot (25%), while in Popović it is represented by only 9%.

**Table 1. Criteria for evaluation of objective indicators of quality of life in local self-governments in Serbia according to EU-SILC (number of respondents)**

Criteria / name indicator				
<b>GENDER</b>				
K1	Male	45	48	36
	Female	55	52	64
<b>AGE</b>				
K2	18-25	21	18	15
	26-45	38	40	37
	46-60	27	32	38
	> 60	14	10	10
<b>EDUCATION LEVEL</b>				
K3	Higher education (graduated)	18	10	8
	Higher education (completed higher school)	38	24	12
	High school (four-year high school)	44	66	80
<b>EMPLOYMENT STATUS</b>				
	Employed	42	39	25
	Unemployed	23	22	28
	Temporarily employed	15	17	29
	Inactive (retired or disabled)	20	22	18
<b>MONTHLY INCOME PER HOUSEHOLD</b>				
K5	to 30.000	10	15	15
	30.000-40.000	50	55	60
	40.000-50.000	25	20	20
	> 50.000	15	10	5
<b>NUMBER OF HOUSEHOLDS</b>				
K6	to 2	25	28	24
	3-5	71	67	74
	> 6	4	5	2
<b>EDUCATION AT WORK OR OUTSIDE OF WORK</b>				
K7	Attending educational programs at work:	58	51	44
		42	49	-
	Attending educational programs outside of work: Yes	32	25	9
		68	75	91

Source: Systematized by authors, according to EU-SILC data (<https://ec.europa.eu/eurostat/web/income-and-living-conditions/methodology/main-concepts-definitions>)

The perceptions of satisfaction with the quality of life by individuals depending on subjective indicators were expressed on a scale from 1 - extremely dissatisfied, to 10 - extremely satisfied, and then the results were evaluated by the Likert scale, which consists of five levels (1 - lowest level of satisfaction, 5 - highest level satisfied), which is used to calculate the average score for each subjective indicator (Table 2).



**Table 2. Criteria for assessing subjective indicators of quality of life in local governments in Serbia according to EU-SILC**

Name of the indicator / criterion	Local government			
	Kragujevac	Sopot	Popović	
<b>K11 - LEVEL OF DEPRIATION</b> (meeting all types of needs) (on a scale from 0 to 10)				
1. Extremely satisfied	36	30	25	
2. Satisfied	25	20	18	
3. Partially satisfied	16	18	20	
4. Dissatisfied	10	16	20	
5. Extremely dissatisfied	13	16	17	
<i>Average</i>	<b>6,7</b>	<b>5,4</b>	<b>4,8</b>	
<b>K2 - SATISFACTION WITH FAMILY LIFE</b> (on a scale from 0 to 10)				
1. Extremely satisfied	28	32	22	
2. Satisfied	26	28	18	
3. Partially satisfied	20	20	25	
4. Dissatisfied	11	10	18	
5. Extremely dissatisfied	15	10	17	
<i>Average</i>	<b>5,2</b>	<b>5,4</b>	<b>4,9</b>	
<b>K3 - DIFFICULTIES WITH RECONCILING FAMILY LIFE AND WORK</b>				
Too tired to perform household chores	Yes	74	78	70
	Not	26	22	30
Having difficulties in meeting obligations due to time spent at work	Yes	32	31	25
	Not	68	69	75
<b>K4 - HEALTH STATUS</b>				
1. Very good	30	29	30	
2. Very bad	54	53	53	
3. Bad	16	18	17	
<b>K5 - SATISFACTION WITH LIFE AND HAPPINESS</b> (on a scale from 0 to 10)				
1. Extremely satisfied	22	35	25	
2. Satisfied	30	25	28	
3. Partially satisfied	25	22	20	
4. Dissatisfied	12	10	15	
5. Extremely dissatisfied	11	8	12	
	<b>4,9</b>	<b>5,6</b>	<b>5,4</b>	
<b>K6 - LEVEL STRESS</b> (on a scale from 0 to 10)				
1. Physical exercise while listening to music	20	13	10	
2. Walk	18	15	18	
3. Healthy food	15	19	20	
4. Enough sleep	12	13	14	
5. Inerlocutor for life issues	9	13	8	
6. Relations with other people	9	15	17	
7. Enjoyment at work	9	6	7	
8. Free time	8	6	5	
<i>Average</i>	<b>5,6</b>	<b>5,3</b>	<b>5,7</b>	
<b>K7 - THE PLEASURE FREE TIME</b> (on a scale from 0 to 10)				
1. Extremely satisfied	19	18	15	
2. Satisfied	38	40	37	

3. Partially satisfied	23	24	28
4. Dissatisfied	11	12	10
5. Extremely dissatisfied	8	6	9
	<b>4,2</b>	<b>4,0</b>	<b>3,9</b>
<b>K8 - GENERAL SATISFACTION WITH THE QUALITY OF LIFE</b> (on a scale from 0 to 10)			
1. Extremely satisfied	16	15	12
2. Satisfied	39	30	38
3. Partially satisfied	40	35	35
4. Dissatisfied	10	11	10
5. Extremely dissatisfied	4	9	5
<i>Average</i>	<b>4,6</b>	<b>5,4</b>	<b>5,5</b>
<b>K9 - JOB SATISFACTION</b> (on a scale from 0 to 10)			
1. Extremely satisfied	13	10	10
2. Satisfied	38	28	26
3. Partially satisfied	14	40	39
4. Dissatisfied	10	13	15
5. Extremely dissatisfied	10	8	10
<i>Average</i>	<b>4,6</b>	<b>5,4</b>	<b>5,5</b>
<b>K10 - SATISFACTION WITH ACCOMPLISHED EDUCATION</b> (on a scale from 0 to 10)			
1. Extremely satisfied	20	20	17
2. Satisfied	38	40	40
3. Partially satisfied	27	28	29
4. Dissatisfied	10	7	9
5. Extremely dissatisfied	3	5	4
	<b>5,9</b>	<b>5,8</b>	<b>5,7</b>
<b>K11 - SELF SATISFACTION</b> (on a scale from 0 to 10)			
1. Extremely satisfied	29	24	26
2. Satisfied	40	41	40
3. Partially satisfied	20	23	25
4. Dissatisfied	8	9	8
5. Extremely dissatisfied	3	3	2
<i>Average</i>	<b>6,1</b>	<b>6,2</b>	<b>5,9</b>
<b>K12 - RELATIONSHIP WITH OTHER PEOPLE</b> (on a scale from 0 to 10)			
1. Extremely satisfied	40	39	40
2. Satisfied	50	52	52
3. Partially satisfied	7	6	6
4. Dissatisfied	2	2	1
5. Extremely dissatisfied	1	2	1
<i>Average</i>	<b>6,9</b>	<b>6,8</b>	<b>6,7</b>
<b>K13 - SATISFACTION ENERGY NEEDED FOR DAILY LIFE</b> (on a scale from 0 to 10)			
1. Extremely satisfied	18	16	14
2. Satisfied	23	24	26
3. Partially satisfied	38	40	40
4. Dissatisfied	12	12	11
5. Extremely dissatisfied	10	8	11
	<b>3,9</b>	<b>4,1</b>	<b>4,2</b>
Source: Systematized by authors, according to EU-SILC data ( <a href="https://ec.europa.eu/eurostat/web/income-and-living-conditions/methodology/main-concepts-definitions">https://ec.europa.eu/eurostat/web/income-and-living-conditions/methodology/main-concepts-definitions</a> )			

The average assessment of satisfaction with the fulfillment of all types of needs (level of deprivation) is the highest among respondents in Kragujevac (6.7), then in Sopot (5.4), and the lowest in Popović (4.5). However, the average assessment of satisfaction with family life is higher in Sopot (5.4), than in Kragujevac (5.2) and Popović (4.9). The majority of respondents do not reconcile family obligations and work, while difficulties in fulfilling family obligations are somewhat higher in Kragujevac (32%), than in Sopot (31%) and Popović (25%). Satisfaction with the health of most respondents is good in all three local governments. The average assessment of life satisfaction and the feeling of happiness is higher among citizens in Sopot (5.6) and Popović (5.4), than in Kragujevac (4.9). However, respondents in Popović (5.5) had a higher average score for general satisfaction with the quality of life, than in Sopot (5.4) and Kragujevac (4.6). Respondents with the lowest stress levels are in Sopot (5.3), followed by Kragujevac (5.6) and Popović (5.7). However, activities that are a source of stress for respondents, most often represent a significant potential for local government to invest and create a better business environment for the satisfaction of each individual.

#### ***4.2. Statistical Analysis of the Results***

The first phase of the statistical processing of collected data is the analysis of the frequency of the occurrence of individual scores - descriptive statistics. Table 3 shows the descriptive statistics of the preferences of individuals on the importance of these criteria for assessing the quality of life in local governments. To examine the statistical significance of differences in criteria for assessing the quality of life depending on the level of satisfaction of individuals was done by t-test (Table 3).

By analyzing the results from Table 3, we can conclude, depending on the level of satisfaction of individuals with the quality of life, that the most important criteria are K1, K7 and K10 with an average score of 50, then criterion K7 with an average score of 45 and criteria K3, K6 and K11 with a score of 33, rated criterion K13 with the lowest average score of 12.46. Also, all criteria are statistically significant differences depending on the level of satisfaction of individuals with the quality of life based on objective and subjective indicators. To test the significance of differences in the perception of individuals' satisfaction with the quality of life, based on subjective indicators in the three local governments, the analysis of the variance ANOVA is used (Table 4). Specifically, the variance analysis is an analytical model for testing a significant difference between the mean values of a dependent variable when there are more than two groups.

**Table 3 Results of t-test and significance of score differences for the significance of the observed criteria depending on the level of satisfaction of individuals with the quality of life**

Criterion	Mean value	Std. deviation	Std. error	95% Confidence interval of difference		t	Df	Sig.
				Lower	Higher			
<i>K1</i>	50,00	9,487	3,873	40,04	59,06	12,910	5	<b>0,000</b>
<i>K2</i>	25,00	11,662	3,367	17,59	32,41	7,426	11	<b>0,000</b>
<i>K3</i>	33,33	25,848	8,615	13,478	53,20	3,869	8	<b>0,005</b>
<i>K4</i>	25,00	8,367	2,415	19,68	30,32	10,351	11	<b>0,000</b>
<i>K5</i>	25,00	18,950	5,470	12,96	37,04	4,570	11	<b>0,001</b>
<i>K6</i>	33,33	29,871	9,957	10,37	56,29	3,348	8	<b>0,010</b>
<i>K7</i>	45,33	26,32	7,620	28,562	62,11	5,949	11	<b>0,000</b>
<i>K8</i>	20,00	6,655	1,718	16,31	23,69	11,640	14	<b>0,000</b>
<i>K9</i>	20,00	6,866	1,773	16,20	23,80	11,282	14	<b>0,000</b>
<i>K10</i>	50,00	23,626	6,820	34,99	65,01	7,301	11	<b>0,000</b>
<i>K11</i>	33,33	15,984	5,328	21,05	45,62	6,256	8	<b>0,000</b>
<i>K12</i>	20,00	8,238	2,127	15,44	24,56	9,403	14	<b>0,000</b>
<i>K13</i>	12,46	4,718	0,963	10,47	14,45	12,936	23	<b>0,000</b>
<i>K14</i>	19,87	11,457	2,958	13,52	26,21	6,716	14	<b>0,000</b>
<i>K15</i>	20,60	13,674	3,531	13,03	28,17	5,835	14	<b>0,010</b>
<i>K16</i>	18,93	11,865	3,064	12,36	25,50	6,180	14	<b>0,010</b>
<i>K17</i>	19,80	13,327	3,441	12,42	27,18	5,754	14	<b>0,000</b>
<i>K18</i>	20,07	13,936	3,598	12,35	27,38	5,577	14	<b>0,000</b>
<i>K19</i>	20,07	21,97	5,659	7,93	32,20	3,543	14	<b>0,003</b>
<i>K20</i>	20,20	11,258	2,907	13,97	26,43	6,949	14	<b>0,000</b>

Source: Authors' calculations in SPSS

Based on the results shown in Table 4, when observing the significance of the criteria depending on the level of satisfaction of individuals with the quality of life in local governments, all criteria are statistically significant differences (Sig value  $\leq 0,05$ ). Having in mind the results of the t-test and ANOVA, we can conclude that hypothesis H1 is proven, i.e. there are differences in significance in all criteria depending on the level of satisfaction of respondents based on objective and subjective indicators. The result of testing the differences in the significance of the criteria, based on objective and subjective indicators depending on the place of work and residence of the respondents, does not have statistically significant differences in any of the criteria. More precisely, the perception of satisfaction with the quality of life does not depend on the place of work and residence of the respondents.

**Table 4. Testing the significance of the difference in the assessment of the significance of the criteria depending on the satisfaction of individuals with the quality of life in local governments**

		The sum of squares	Df	The mean value of the square	F	Significance
<i>K1</i>	Among the (Combined) groups	312.000	4	78.000	3.391	0.053
	In the group	230.000	10	23.000		
	In total	542.000	14			
<i>K2</i>	Among the (Combined) groups	472.667	4		6.308	<b>0.008</b>
	In the group	187.333	118.167			
	In total	660.000	10	18.333		
			14			
<i>K3</i>	Among the (Combined) groups	6018.667	3	2006.222	132.278	<b>0.000</b>
	In the group	121.333	8	15.167		
	In total	6140.000	11			
<i>K4</i>	Among the (Combined) groups	2040.667	2	1020.333	1836.600	<b>0.000</b>
	In the group	3.333	6	0.556		
	In total	2044.000	8			
<i>K5</i>	Among the (Combined) groups	810.667	4	202.667	14.545	<b>0.000</b>
	In the group	139.333	10	13.933		
	In total	950.000	14			
<i>K6</i>	Among the (Combined) groups	379.292	7	54.185	6.535	<b>0.001</b>
	In the group	1327.667	16	8,292		
	In total	511.958	23			
<i>K7</i>	Among the (Combined) groups	1932.400	4	783.100	111.485	<b>0.000</b>
	In the group	43.333	10	4.9333		
	In total	1975.733	14			
		733				
<i>K8</i>	Among the (Combined) groups	2528.933	4	632.233	71.305	<b>0.000</b>
	In the group	88.667	10	8.867		
	In total	2617.600	14			
<i>K9</i>	Among the (Combined) groups	1432.933	4	358.233	6.659	<b>0.007</b>
	In the group	538.000	10	53.800		
	In total	1970.933	14			
<i>K10</i>	Among the (Combined) groups	2469.067	4	617.267	356.115	<b>0.000</b>
	In the group	17.333	10	1.733		
	In total	2486.400	14			

K11	Among the (Combined) groups	2691.600	4	672.900	246.183	<b>0.000</b>
	In the group	27.33	10	2.733		
	In total	2718.933	14			
K12	Among the (Combined) groups	6719.600	4	1679.900	3149.813	<b>0.000</b>
	In the group	5.333	10	0.533		
	In total	6724.933	14			
K13	Among the (Combined) groups	1753.733	4	438.433	212.145	<b>0.000</b>
	In the group	20.667	10	2.067		
	In total	1774.400	14			

Source: Authors' calculations in SPSS

### 4.3. The Formation of Multi-Criteria Model and Ranking of Local Governments

Having in mind the obtained results of descriptive statistics, the multi-criteria model was formed so that the preferences of individuals were generated in weighting coefficients of equal importance, i.e. they were evaluated with 1 for all criteria, thus minimizing the subjectivity of respondents. The empirical data from Table 1 form a multi-criteria decision matrix for objective indicators. The calculated average scores on the respondents' satisfaction with the quality of life in local self-governments are the input data for the multi-criteria decision-making matrix for subjective indicators. However, a special multi-criteria decision-making matrix was formed, where the input data for criteria K3 and K4 are expressed by the number of respondents involved in the research. The formed multi-criteria decision matrices are further used as input data for testing the modified method for multi-criteria Promethee ranking.

Improved family method for multi-criteria ranking (preference ranking organization method for enrichment evaluation), Promethee, is used for ranking alternatives based on criteria. Authors of Promethee methods (Brans and Viske, 1985) developed six variants of these methods, and three of them were applied in the paper: (Brans and Mareschal, 1992)

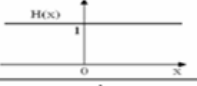
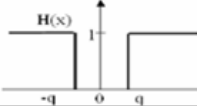
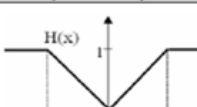
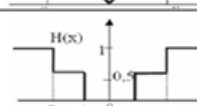
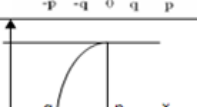
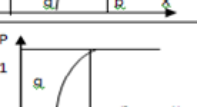
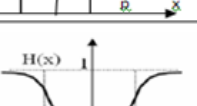
- Promethee I to determine the partial order of the alternatives,
- Promethee II to determine the complete order of the alternatives and
- Promethee III to determine the interval order of the alternatives.

Input data were tested using a modified version of the method Promethee, MODIPROM (Modified PROMETHEE method), designed on the Faculty of Mechanical Engineering in Kraljevo (Kolarević, 2004). The advantage of using a modified method MODIPROM is as follows:

- simplicity in the calculation parameters,
- input data are tested for all types of generalized functions,
- the results of the tested parameters have an economic explanation and
- the possibility of completely eliminating the following negative effects of the rankings.

In comparison to the group of methods for Promethee multi-criteria ranking, enhancements introduced in MODIPROM methods relate primarily to the change of the type of generalized criteria used. Criteria for the basic version of the *Promethee* method were retained (simple criterion, a quasi criterion, criterion with linear preference, stepped criteria, and Gauss criterion) while instead of the criterion with linear preference and an area of indifference, a square, and a cubic criterion were introduced (Figure 1).

Figure 1 Type of generalized criteria

Type of generalized criteria			Parameters	$P_j(x)$
Type	Name	Form		
I	Plain criterion		-	$P_j(x) = 1$ $P_j(x) = 1$
II	Criteria quasi		q	$P_j(x) = \begin{cases} 0, & x < q \\ 1, & x \geq q \end{cases}$
III	Criterion with linear preference		q, p $b_0$ , $b_1$	$P_j(x) = \begin{cases} 0, & x < q \\ b_0 + b_1 x, & q \leq x < p \\ 1, & \end{cases}$
IV	Stepped criterion		q, p	$P_j(x) = \begin{cases} 0, & x < q \\ 0,5, & q \leq x < p \\ 1, & \end{cases}$
V	Quadratic criterion		q, p $b_0$ , $b_1$ , $b_2$	$P_j(x) = \begin{cases} 0, & x < q \\ b_0 + b_1 x + b_2 x^2, & q \leq x < p \\ 1, & \end{cases}$
VI	Cubic criterion		q, p $b_0$ , $b_1$ , $b_2$ , $b_3$	$P_j(x) = \begin{cases} 0, & x < q \\ b_0 + b_1 x + b_2 x^2 + b_3 x^3, & q \leq x < p \\ 1, & \end{cases}$
VII	Gauss criterion		$\sigma$	$P_j(x) = \begin{cases} 0, & x \leq 0 \\ 1 - e^{-\frac{x^2}{2\sigma^2}}, & \end{cases}$

Source: (Kolarević, 2004, p.63)

The choice of generalized criteria is not left to decision maker's experience and subjective assessment, but it is realized based on the smallest squares' method. The choice of the type of generalized criteria solves the problem of the normalization of the criterion values because the preferences by individual criteria are distributed in the interval  $[0,1]$ , thus avoiding the influence of the difference in measuring units of certain criteria. According to the *MODIPROM* method, the type of generalized criterion, in which the sum of the smallest square deviation of the points from the theoretical curve is the smallest of the criteria for the comparison, functions/criteria are different and reflect different units of measurement (Figure 1).

The *MODIPROM* method provides the possibility of solving a specific problem of ranking alternatives/sub-criteria within certain criteria. This aspect of the analysis was solved by the introduction of sub-criteria functions, where several levels of dividing the function into sections can be applied. Additionally, the ranking of the significance of the selected criteria and sub-criteria, depending on the nature of the decision-making, is also enabled, due to which the multi-criteria analysis is applied. The general mathematical formulation of a structured model with multiple levels of criteria is described by a mathematical model (Nikolić & Borović, 1996) :

$$\max \min [f_1(x), f_2(x), \dots, f_p(x)], p \geq 2, \quad (4.1)$$

at the limit:  $g_i(x) \leq 0, \quad i = \overline{1, m} \quad x_j \geq 0, \quad j = \overline{1, n}$  where:  $n$  – the number of variables,  $p$  – the number of criterial functions,  $m$  – the number of constraints,  $X$  –  $n$  dimensional vector of variables  $x_j, \quad j = \overline{1, n}$ ;  $f_k$  – the criteria (goals) of the criteria,  $k = \overline{1, p}$  and  $g_i(x)$  – the set of constraints,  $i = \overline{1, m}$ . Then the minimization criteria are translated into the maximization criteria, which maximizes the target function vector with the set limits, according to the expression (Kolarević, 2004):

$$\max f_r(x) = - \min [-f_r(x)], r \in (1, p) \quad (4.2)$$

By solving this model, a set of permissible solutions is obtained, a vector  $X$  that belongs to a set of natural numbers  $X \in R^n$ , which holds:  $X = [x | g_i(x) \leq 0, \quad i = \overline{1, m}, \quad x_j \geq 0, \quad j = \overline{1, n}]$ . The set of solutions  $X$ , corresponds to the set of the value of the function of the criterion  $f(x)$ , so that the set of permissible solutions  $X$  can be mapped to the criterion set  $S$ . (Kolarević, 2004)

$$S: f(x) = [f_1(x), f_2(x), \dots, f_p(x)] ; S = [f(x) | x \in X] \quad (4.3)$$

In a further analysis, using the medium values of pure flow  $\Phi$  solves the problem of having multiple decision criteria and multiple alternatives for selecting the most acceptable action. The problem is solved in the following way: the actual values of the criterion functions are only used at the last  $r$ -th level, at other ranking



levels, as the values of the sub-criterion functions, the transformed values of the pure flux  $\Phi$  from the  $k$ -th level to  $(k-1)$  the level of ranking, with the repetition of the process to the 1<sup>st</sup> level (basic), the transformation of the mean value of the pure current is carried out according to the form:  $e_i = \frac{\bar{\phi}(a_i) - \min \bar{\phi}}{R}$  where

$R = \max \bar{\phi} - \min \bar{\phi}$  and represents a "range", i.e. the difference between the highest and lowest values for pure flux. The values of  $e_i$  represent the transformed values of the mean values of the pure flux  $\Phi$ , which for further analysis are formed in the interval  $[0, 1]$ , with the best alternative having a value of 1, and the weakest 0. The calculated values of the quality of life indicators for all three local self-governments are included in the summary table, as a multi-criteria input data matrix for applying the method for multi-criteria ranking of Promethee (Tables 3,4 and 5). Formed multi-criteria decision matrices are used to apply the multi-criteria modified Promethee method for ranking the local governments.

#### 4.4. Discussion of results

The analysis of the results obtained by testing a multi-criteria model for assessing the quality of life in local governments was considered in two phases. The first phase is the analysis of the results obtained by testing a multi-criteria model for assessing the quality of life depending on gender, age, level of education, employment status, monthly income, number of household members, and attending a course or other type of education at work or outside (Table 5). The result of ranked alternatives using the MODIPROM v1.0 method, based on objective indicators, shows, on average, that the respondents in Kragujevac have the highest level of satisfaction with the quality of life (1.0000), then in Sopot 77.20% (0.7720), and the lowest level of pleasures respondents express in Popović (0.0000). The test results are presented as an input vector, which is used for further research (Report 1). The result of the ranking of alternatives based on the criteria for assessing subjective indicators, shows that on average the highest level of satisfaction with the quality of life has the surveyed population in Kragujevac (1.0000) and Sopot (1.0000), and the lowest level of satisfaction in Popović (Report 2). The result of the ranking of alternatives based on the criteria for assessing the compliance of family life with work (K3) and health status (K4) indicates that on average the most satisfied surveyed population is in Kragujevac (1.0000), followed by 9.40% in Sopotu (0.09399) and the least satisfied are in Popović (0.0000). The test results are presented as the input vector, which is used for further research (Report 3).

**Table 5. Multi-criteria matrix of decision making - objective indicators**

Criteria/ subcriteria	Alternatives			Weight coeff. $w_j$	max/ min	
	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>			
$K_1$	$I_{01/1}$	65	48	46	1	max
	$I_{01/2}$	55	52	64	1	max
$K_2$	$I_{02/1}$	22	17	15	1	max
	$I_{02/2}$	39	40	37	1	max
	$I_{02/3}$	28	32	38	1	min
	$I_{02/4}$	11	11	10	1	min
$K_3$	$I_{03/1}$	18	10	8	1	max
	$I_{03/2}$	38	24	12	1	max
	$I_{03/3}$	44	60	80	1	min
$K_4$	$I_{04/1}$	39	22	22	1	max
	$I_{04/2}$	62	78	59	1	min
	$I_{04/3}$	22	22	39	1	min
	$I_{04/4}$	58	59	61	1	min
$K_5$	$I_{05/1}$	40	35	30	1	min
	$I_{05/2}$	35	55	50	1	min
	$I_{05/3}$	15	5	12	1	max
	$I_{05/4}$	10	5	8	1	max
$K_6$	$I_{06/1}$	25	28	24	1	min
	$I_{06/2}$	71	67	74	1	max
	$I_{06/3}$	4	5	2	1	max
$K_7$	$I_{07/1}$	58	51	44	1	max
	$I_{07/2}$	42	49	0	1	min
	$I_{07/3}$	32	25	9	1	max
	$I_{07/4}$	68	79	91	1	min

**Table 6. Multi-criteria matrix of decision making - subjective indicators**

Cri.	Alternatives			Weight coeff. $w_j$	max/ min
	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>		
$K_1$	6,7	5,4	4,8	1	max
$K_2$	5,2	5,4	4,9	1	max
$K_3$	4,9	5,6	5,4	1	min
$K_6$	5,6	5,3	5,7	1	max
$K_7$	4,2	4,0	3,9	1	max
$K_8$	4,6	5,4	5,5	1	max
$K_9$	4,6	5,4	5,5	1	max
$K_{10}$	5,9	5,8	5,7	1	max
$K_{11}$	6,4	6,2	5,9	1	max
$K_{12}$	6,9	6,8	6,7	1	max
$K_{13}$	3,9	4,1	4,2	1	max

**Table 7. Multicriteria matrix of decision-making subjective indicators**

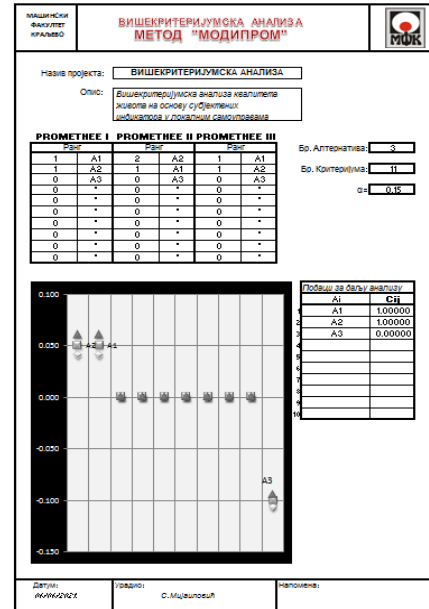
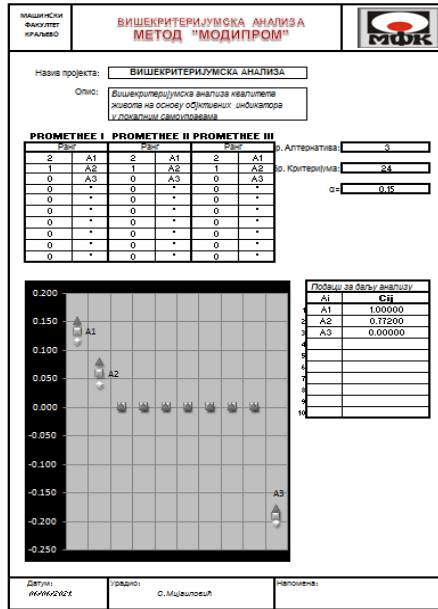
$K_3$	$I_{S3/1}$	74	78	70	1	max
	$I_{S3/2}$	26	22	30	1	min
	$I_{S3/3}$	32	31	25	1	max
	$I_{S3/4}$	68	69	75	1	min
$K_4$	$I_{S4/1}$	30	29	30	1	max
	$I_{S4/2}$	54	53	53	1	max
	$I_{S4/3}$	16	18	17	1	min

Source: Authors' calculations

The second phase is the analysis of the results obtained by testing the multi-criteria model based on the results obtained in the first phase. The analysis of the results of ranked alternatives based on the combination of objective and subjective indicators shows that on average the highest level of satisfaction of individuals with the quality of life is in Sopot (1.0000), then in Kragujevac 66,67% (0.66667), while the lowest level of satisfaction on average is in Popović (Report 4). Thus, the analysis of the results indicated that the combination of objective and subjective indicators of the quality of life reflects the quality of life of individuals in local governments as much as possible, which is the proof of hypothesis H2.

**Report 1. Results of MODIPROM testing based on objective indicators**

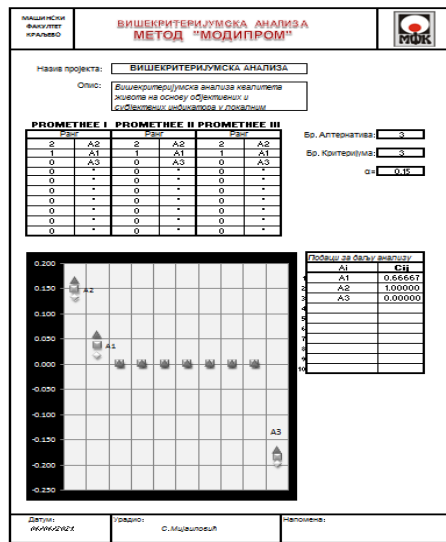
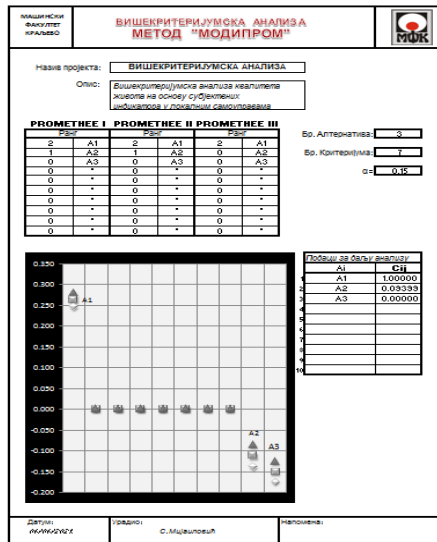
**Report 2. Results of MODIPROM testing based on subjective indicators**



Source: Authors' calculations in MODIPROM

**Report 3 Results of MODIPROM testing based on subjective indicators K3 and K4**

**Report 4 Results of MODIPROM testing based on the results obtained from phase I.**



Source: Authors' calculations in MODIPROM

## 5. Conclusion

The quality of life is a complex multidisciplinary area and encompasses all segments of the development of local self-governments, as well as the wider community. The vital interest for a region and its population is the achievement of the quality of life levels, as well as monitoring the future trend. Improving the quality of life of the population is primarily the main task of every local community. However, the task is difficult precisely because it requires the selection of such a system of indicators that will describe the quality of life of the population as much as possible. As the quality of life of the population depends on a number of different economic, and social factors, but also the methodological framework includes a multi-criteria approach, there is a need to apply the methods of multi-criteria analysis to solve the problems. One of the key elements in the formation of a multi-criteria model is the determination of adequate criteria for comparing alternatives.

The paper discusses objective and subjective indicators for measuring satisfaction with the quality of life by individuals, as criteria for comparing local governments. However, the task becomes particularly complicated in cases where the decision-maker is an individual, which requires overcoming the problem by including multi-criteria decision-making. Therefore, the direction of further research is the integration of individual preferences into one that would express a collective opinion, i.e. group preference.

A multi-criteria model has been developed for the analysis of the quality of life, according to the target variable subjective well-being of the EU-SILK, which may be a limitation. More specifically, the described model is limited in terms of including several criteria for assessing the quality of life in local governments, which are not defined by EU-SILK. By analyzing the preferences of individuals, according to the degree of satisfaction with the quality of life in three local governments in Serbia, it was concluded that there is a statistically significant difference for all criteria included in the model, which confirms the adequacy of selected criteria. Also, there is a statistically significant difference in the perception of individuals about the achieved level of satisfaction, which is a proposal to improve the quality of life in local governments. The direction of further research will primarily focus on the integration of the Expert choice method for determining the weighting coefficients and the methods of the analytical process hierarchy, VIKOR and Topsis.

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### RAZVOJ VIŠEKRITERIJUMSKOG MODELA ZA PROCENU KVALITETA ŽIVOTA U LOKALNIM SAMOUPRAVAMA

**Rezime:** Percepcija zadovoljstva kvalitetom života od strane pojedinca u urbanim i ruralnim sredinama obuhvata niz objektivnih i subjektivnih indikatora, na osnovu kojih se može izvršiti analiza. Merenje preferencija pojedinaca, koji žive u različitim sredinama, po pitanju životnih ciljeva, potreba, raspoloženja, očekivanja, kao i ličnog zadovoljstva kvalitetom života, zahteva da se uključi više kriterijuma za njegovu evaluaciju. Istraživanje je sprovedeno na osnovu dvadeset indikatora za merenje kvaliteta života u lokalnim samoupravama u zavisnosti od preferencija pojedinaca, koji se razlikuju po starosti, polu, obrazovanju, socijalnom statusu i motivima zadovoljstva. Predmet ovog rada je izbor kriterijuma u višekriterijumskom modelu za procenu kvaliteta života u lokalnim samoupravama, primenom adekvatnih statističkih alata. Pored deskriptivne statistike i testiranja značajnosti razlika, u radu je primenjena modifikovana višekriterijumska metoda Promethee za rangiranje lokalnih samouprava.

**Ključne reči:** procena kvaliteta života, višekriterijumski model, indikatori kvaliteta života, preferencije pojedinaca, Promethee metoda

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