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COMPARATIVE ANALYSIS AND SELECTION OF THE BEST METHOD HIGHWAY ROUTE

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SUMMARY

The main objective of this study was to review the methods used in the process of selecting the optimal route of the highway, the way in which these methods are used, highlighting the advantages and disadvantages of each method, and comparing the particular case make the favored one of the offered methods. In addition to mutual comparison criteria optimization work are detailed methods and presents a concrete example, which can be very useful to researchers in this field.

Comparison of the already complex valuation methods with a large number of influential factors is a particular challenge to the author. It is extremely difficult to make a comparison method which the authors used a completely different mathematical approach. Some of the criteria optimization are incurred in order to concrete problems (air transport of passengers, the annual prediction of accidents, etc.) and as such are not primarily been designed for the selection of the optimal route of the highway.

After much thought and research criteria optimization, this paper applied the mathematical approach in comparison method, as follows: Spearman's and Pearson's correlation coefficient and Kendall's coefficient of correlation.

Keywords: *road, highway, multidisciplinary optimization, comparison, methods*

INTRODUCTION

Road Design is a complex research process which is considering a large number of parameters to find an optimal solution. It involves analysis of a large number of parameters, finding the weight of these parameters and applying appropriate methods in order to reach an objective assessment of project solutions.

Since many elements influence the selection of the route times require access to a maximum fund information and objective analysis of all the input parameters.

It is clear that when selecting the optimal route of the highway involved a large number of criteria and the relative weight of these criteria is not the same (for example, the price of building the highway and ride comfort). In addition, certain criteria are mutually conflicting (cost of road construction should be as small as possible, but at the same time aiming for the greater stability of the highway or driving comfort). To all of these criteria and weight of each criteria considered necessary the application of appropriate methods that are called multicriteria method or methods of multi-criteria optimization (MCA- multi criteria analysis, MCDA - multi-criteria decision analysis) [1,2,3,4].

MCA is a formal approach used to assist in the process of complex decision-making the last few decades (Anand Raj and Kumar, 1996; Choi and Park, 2001; David and Duckstein, 1976; Flug and others, 2000; Hajeeh and Al-Othman, 2005; Hobbs et al, 1992; and Mohsen Jaber, 2001; and Fahmy Kheireldin, 2001; and Rijsberman Ridgley, 1994). MCA is widely used because it facilitates the participation of a large number of participants and joint decision-making, does not require the assignment of a monetary value to environmental or social criteria and to consider a number of criteria with incommensurable units (eg. A combination of quantitative and qualitative criteria) (Hajkowicz, 2000) [3,4,5].

METHOD MULTI-CRITERIA OPTIMIZATION - THEORETICAL BASIS

Choosing among several variants highway route represents part of the overall problem of managing the construction of transport networks. The selection represents a scientific analysis of the solutions with the help of subjective methods (intuition), and with the help of exact methods. Administration methods for multi-criteria analysis represent one of the methods that are used in the selection of the optimal route of the highway.

Results obtained using the method of multi-criteria analysis of the ranks who often give a different order. Reducing the difference between the output result of the method can be achieved using the same linear normalization, other than the AHP method forming its matrix and making it not require normalization [6,7,8].

You can use two categories of weights that will help in the analysis of the same methods and determine the impact of weight coefficients in the final rankings.

Differences discrepancies between the different methods are the basis for a comparative analysis and selection of the most suitable method for ranking.

INTERCONNECTION RESULTS METHODS OF MULTI-CRITERIA ANALYSIS

The results of other methods ranked alternatives or optimal alignment of the highway, and there is the problem of so-called. conflict ranks. In order to statistically analyze the conflicts must be good enough sample different evaluation of alternatives, as in practice hard to accomplish.

One possibility is the use of Spearman's coefficient, which is on a smaller sample reported correlation of ranks obtained by different methods.

Another way is to use Kendall's coefficient consent. Using these statistical methods can demonstrate the interconnection results methods of multi-criteria analysis, and the dependence of certain methods of weight coefficients.

This will be used and Pearson's correlation that is normally applied to the results of the method, not on their ranking.

SPEARMAN'S CORRELATION COEFFICIENT

"Spearman rank correlation coefficient measures the degree and direction of association between two events presented doubles ranking variables" [9].

In this correlation coefficient if the variables NUMERICAL need to be transformed into variable shapes rank. The basics of this coefficient couples modalities ranking variables and with the help of them to account correlation. Spearman's correlation coefficient is [3,5].

$$r_s = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n^3 - n};\ d_i = r(x_i) - r(y_i)$$

where is:

- d_i difference between the two sets which are compared
- n total number of units sets that are compared

The value of the results of this ratio can vary between theoretical value of -1 and 1. When approaching 1, an indication that the ranks of similar or the same, when the value is less than zero and is approaching -1, ranks are reversed or negatively correlated.

With the help of Spearman correlation coefficient will be calculated degree of correlation between the ranking list of the optimal route of the highway for a variety of methods. Calculating this ratio can be done with the help of SPSS Inc. Statistics in. 17.0.

KENDALL'S COEFFICIENT OF CORRELATION

Besides Spearman's rank correlation coefficient is very often used and Kendall rank correlation coefficient. The method of calculating the correlation coefficient is different from calculating the Spearman correlation coefficient.

In its application, it is assumed that each variable ranking takes the value from the set of the first n natural numbers. In the performance of this ratio is based first on the assumption that there is a coincidence in the ranking. Kendall's coefficient of correlation takes values from 0 to 1. The minimum value of the coefficient represents the total disagreement variations variable ranking and it is 0, and 1 represents the largest total agreement rankings variables rank [3,9].

The form for calculating Kendall's coefficient of correlation is:

$$\rho^m = \frac{m}{12} \cdot \frac{n\sum S_i^2 - n\sum S_i^2 - (\sum S_i)^2}{n^4 - n}$$

where is:

- m Number of observed phenomena;
- n Number of data occurs;
- S_i The sum of the values of ranks by type

Kendall's coefficient of correlation has the advantage of using it can be counted and partial correlation. With the help of the same parameters as the Spearman-ovkoeficijent consent calculated Kendall's correlation coefficient with the help of SPSS INC. Statistics 17.0.

THE SELECTION OF THE MOST SUITABLE METHOD FOR RANKING THE HIGHWAY ROUTE

By using Spearman's and Kendall's correlation coefficient are comparable rankings optimal highway route obtained using the multi-criteria analysis. In order for the analysis to be complete except rankings route by individual multiobjective it is necessary to calculate the deviation of the results of these methods. This is done by using Pearson's correlation coefficient. Pearson's correlation coefficient is used in cases where a model variables observed a linear relationship and continuous normal distribution. He calculates the correlation between the two variables. Its results can range from 1 (perfect positive correlation) to-1 (perfect negative correlation) [1,9].

The coefficient us to the direction of correlation - whether positive or negative, but we are not suggesting the strength of correlation. Pearson correlation coefficient based on a comparison of the actual impact of the observed variables to one another in relation to the maximum possible impact of two variables. Indicates the small Latin letters r. To calculate the orrelation coefficient requires three different sums of squares (SS): sum of squared variables, sum of squares and the sum of the products of variables and variables.

The sum of squares of variables equal to the sum of the squares of the value of the variable from its average value:

$$SS_{xx} = \sum_{i=1}^{n}(x_i - \overline{x})^2 \,, \overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

The sum of squares of variables equal to the sum of the squares of the value of the variable from its average value:

$$SS_{yy} = \sum_{i=1}^{n}(y_i - \overline{y})^2 \,, \overline{y} = \frac{1}{n}\sum_{i=1}^{n} y_i$$

The sum of the products of variables and equal to the sum of the products of deviations from the values of variables and their average:

$$SS_{xy} = \sum (x_i - \overline{x})(y_i - \overline{y})$$

The correlation coefficient equal to the ratio:

$$r = \frac{SS_{xy}}{\sqrt{SS_{xx} \cdot SS_{yy}}}$$

In the case of the variables of a linear relationship, can perform the appropriate transformation of the values of the variables which are reduced to the linear model. Pearson's correlation coefficient is calculated only under the following conditions: data both studied variables following an interval or ratio scale, data for at least one variable are normal, ie. symmetrically distributed, it is preferred that the test sample is high (N> 35) satisfies the condition of linear connection.

It should be noted that VIKOR method ranks the value of the worst to the best, while other methods value ranked vice versa, and the result of the correlation is necessary to multiply by "-1" to make uniform results [10]

COMPARATIVE ANALYSIS

By applying the methods of multi-criteria optimization received the same order for all methods. The question is whether all methods are good enough for use in selection of the optimal route of the highway or need certain methods to avoid. On the other hand, it is necessary to look further specific criteria and the possibility of giving preference to certain subjective criteria. If the decision maker make a subjective preference for a particular criterion (such as, for example, the price of building the highway) then this criterion can be a cause to which the application of the methods of multi-criteria optimization certain routes has an advantage over other more expensive route. To compare specific criteria and thus analyze applied methods used are different correlation coefficients. In the first place it is the Pearson correlation coefficient, then Spearman coefficient of correlation [5].

DATA NORMALIZATION

To be used any correlation coefficient it is necessary to normalize the initial decision matrix. Normalization of data is done to make the data uniform and comparable.

One process of normalization of the initial decision matrix is shown as part of the AHP method and requires normalization before the final budget-level variants. This method of normalization is recommended Saaty, one of the authors of this method. Meaning recommended normalization is that the value of each criterion divided by the sum of the values for each criterion. Belton and Gear have suggested that the normalization of the matrix is performed so that certain criteria to share with the highest value-for certain criteria.

Methods Vikor, electre and Topsis require that the normalization of the initial decision matrix done using the following equation [3,5,10].

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{k=1}^{n} x_{kj}^2}}$$

In Promethee method is not necessary to normalize the initial value because of the method by adopting the tool preferences gives the corresponding values for the final decision-making matrix. Given that there are more functions preferences, this method provides the most possibility of the decision-maker to choose a particular function preferences. In addition, the decision maker can choose different functions preferences for different criteria when it considered the correct decision [7].

No matter which way the normalization that is used most often to obtain a value of criteria between 0:01 or possibly between -1 and 1 to simpler decision there.

Below is the first analysis, used way of normalization that recommended Belton and Gear, and normalization is done so that each criterion is divided by the highest value for that criterion. In this way, all the values of the initial decision matrix given a value between 0 and 1. The maximum value for each criterion is given a value of 1, and minimum values for each criterion obtain the closest value is 0.

In the second reading adopted the way of normalization that is commonly used in the method Vikor, Electre and Topsis, and that is that the value of each criterion is divided by the square root of the sum of squares value for this criterion [3,5,12].

For both normalized matrix being calculated and Spearman and Pearson correlation coefficient between all decision-making criteria.

The following are criteria that are considered previous methods, and in the case of designing the route of the highway Tuzla-Orasje (Table 1). [13].

- K1 Investment value (€)
- K2 length of the route (km)
- K3 length of bridges and viaducts (km)
- K4 tunnel length (km)
- K5 bend characteristics (city / km)
- K6 middle longitudinal inclination (%)
- K7 hilly (% / km)
- K8 wave (m / km)

- K9 total length parts of the route with a slope of more than 3% if they are longer than 500 meters (yards)
- K10 length of the route with an altitude of more than 300 meters (yards)
- K11 mark the route with a geological point of view in relation to the exploitation and maintenance
- K12 rating impact on creating opportunities for the development of the area
- K13 length of the route on which there is a possibility of endangering (km)
- K14 length of the route on which appears the possibility of conflict (km)

Table 1. Home stencil making

criteria	section /variant				Objective function	Weight aim
	A	B	C	D		
K_1	937.342.502	768.236.810	763.950.409	1.004.767.323	min	**0,286**
K_2	49,256	46,562	47,461	49,326	min	**0,043**
K_3	2,48	1,421	1,431	7,167	min	**0,042**
K_4	5,99	3,67	3,67	10,34	min	**0,063**
K_5	26,476	31,147	33,068	22,879	min	**0,027**
K_6	1,831	1,967	1,931	1,080	min	**0,028**
K_7	0,603	0,683	0,640	0,369	min	**0,023**
K_8	10,222	10,962	10,719	10,042	min	**0,023**
K_9	13,471	15,307	15,373	15,407	min	**0,018**
K_{10}	19,566	15,703	15,703	20,068	min	**0,042**
K_{11}	3,311	3,597	3,623	2,000	max	**0,077**
K_{12}	2,467	3,525	4,281	3,408	max	**0,116**
K_{13}	18,00	17,50	13,00	11,50	min	**0,116**
K_{14}	18,00	15,60	11,10	19,00	min	**0,097**

SPEARMAN AND PEARSON'S COEFFICIENT

The first step is to calculate the Spearman and Pearson correlation coefficient normalized matrix is derived from the value of each criterion is divided by the maximum value for this criterion (Table 2).

In the right part of the table provides a ranking of variants according to individual criteria. Where the same value criteria and could not be executed ranking each variant are given the arithmetic mean. Such a case is seen with criteria K4 and K10 where there is 1:02 place than the variants B and C give the mean value, or the value of 1.5 [13].

In order to determine the connectivity ranking shall be applied Spearman and Pearson correlation coefficient. The value of the results of the correlation coefficient can range between -1 and 1.

Looking at the table above it can be concluded that the Spearman and Pearson correlation coefficient behave similarly when it comes to relations between the criteria. Where there is a strong link certain criteria both coefficients have high value and vice versa. (Table 3).

Looking Spearman and Pearson correlation coefficient was applied to the previous normalization can be concluded that there is a strong or medium strong correlation for most of the observed criteria, except for the criterion K9 and K13.

For criterion K9 (total length parts of the route with a slope of more than 3% if they are longer than 500 m, expressed in km) absolute value of the correlation coefficient is the mostly moving from 0.20 to 0.40, while the absolute value of the Pearson coefficient ranges from 0, from 02 to 0.85 [13].

Table 2. Matrix normalized with the maximum values for each criterion, ranking list for each criterion separately

criteria	Section/ variant				Objective function	Ranked according to certain criteria			
	A	B	C	D		A	B	C	D
K_1	0,9329	0,7646	0,7603	1,0000	min	3	2	1	4
K_2	0,9986	0,9440	0,9622	1,0000	min	3	1	2	4
K_3	0,3460	0,1983	0,1997	1,0000	min	3	1	2	4
K_4	0,5793	0,3549	0,3549	1,0000	min	3	1,5	1,5	4
K_5	0,8007	0,9419	1,0000	0,6919	min	2	3	4	1
K_6	0,9309	1,0000	0,9817	0,5491	min	2	4	3	1
K_7	0,8829	1,0000	0,9370	0,5403	min	2	4	3	1
K_8	0,9325	1,0000	0,9778	0,9161	min	2	4	3	1
K_9	0,8743	0,9935	0,9978	1,0000	min	1	2	3	4
K_{10}	0,9750	0,7825	0,7825	1,0000	min	3	1,5	1,5	4
K_{11}	0,9139	0,9928	1,0000	0,5520	max	3	2	1	4
K_{12}	0,5763	0,8234	1,0000	0,7961	max	4	2	1	3
K_{13}	1,0000	0,9722	0,7222	0,6389	min	4	3	2	1
K_{14}	0,9474	0,8211	0,5842	1,0000	min	3	2	1	4

Table 3. Values of Spearman coefficient (above) and the Pearson coefficient (below)

	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	K_{12}	K_{13}	K_{14}
K_1	1,00	0,80	0,80	0,95	-1,00	-0,80	-0,80	-0,80	0,20	0,95	1,00	0,80	-0,20	1,00
K_2	0,94	1,00	1,00	0,95	-0,80	-1,00	-0,90	-0,90	0,40	0,95	0,80	0,60	-0,40	0,80
K_3	0,86	0,70	1,00	0,95	-0,80	-1,00	-1,00	-1,00	0,40	0,95	0,80	1,00	-0,40	0,80
K_4	0,93	0,81	0,99	1,00	-0,85	-0,85	-0,85	-0,85	0,35	1,00	0,95	0,75	-0,25	0,95
K_5	-0,98	-0,86	-0,89	-0,95	1,00	0,80	0,80	0,80	-0,20	-0,85	-1,00	-0,80	0,20	-1,00
K_6	-0,83	-0,68	-1,00	-0,97	0,86	1,00	1,00	1,00	-0,40	-0,85	-0,80	-0,60	0,40	-0,80
K_7	-0,86	-0,74	-0,99	-0,98	0,87	0,99	1,00	1,00	-0,40	-0,85	-0,80	-0,60	0,40	-0,80
K_8	-0,97	-0,99	-0,81	-0,89	0,91	0,79	0,84	1,00	-0,40	-0,85	-0,80	-0,60	0,40	-0,80
K_9	-0,35	-0,50	0,19	0,02	0,38	-0,24	-0,18	0,38	1,00	0,35	0,20	-0,40	-1,00	0,20
K_{10}	0,99	0,96	0,77	0,87	-0,96	-0,74	-0,78	-0,97	-0,48	1,00	0,95	0,75	-0,25	0,95
K_{11}	-0,86	-0,70	-1,00	-0,99	0,89	1,00	0,99	0,80	-0,19	-0,77	1,00	0,80	-0,20	1,00
K_{12}	-0,62	-0,60	-0,18	-0,33	0,60	0,12	0,14	0,53	0,85	-0,70	0,18	1,00	0,40	0,80
K_{13}	-0,26	-0,25	-0,64	-0,54	0,25	0,68	0,69	0,36	-0,65	-0,16	0,63	-0,59	1,00	-0,20
K_{14}	0,86	0,68	0,68	0,76	-0,91	-0,64	-0,62	-0,71	-0,38	0,85	-0,69	-0,79	0,13	1,00

For criterion K13 (length of the route on which there is a possibility of endangering (km)) absolute value Spearman correlation coefficients are predominantly moving from 0.20 to 0.40, while the absolute value of Pearson coefficient ranges from 0.13 to 0.69.

In addition to these two criteria, we can extract the criterion K12 (rating impact on creating opportunities for the development of the area) whose coefficients consent milder correlation with certain criteria but also a slight correlation with the four criteria (Pearson coefficients less than 0.20). What is also interesting in the above table (Table 4). is the fact that the criteria that have little correlation with other criteria, milder or strong correlation between them (correlation coefficient between criteria K9 and K13 is -1.0 - Spearman, or -0.65 - Pearson) [13].

Table 4. Table showing the strength of correlation between variables

The absolute value of the correlation coefficient	The strength of the association between variables
$\lvert r \rvert = 1$	full correlation
$0.80 \le \lvert r \rvert < 1$	strong correlation
$0.50 \le \lvert r \rvert < 0.80$	Medium strong correlation
$0.20 \le \lvert r \rvert < 0.50$	Relatively low correlation
$0.00 \le \lvert r \rvert < 0.20$	insignificant correlation
$\lvert r \rvert = 0$	The complete absence of correlation

Given the fact that there are different forms of normalization initial decision matrix below will apply normalization which is commonly used in the method Vikor, Electre and Topsis recommending that the normalization of the initial decision matrix done using the following equation (Table 5). [10,12].

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{k=1}^{n} x_{kj}^2}}$$

Table 5. Matrix normalized by the root sum of squares for each criterion, ranking list for each criterion separately

criteria	Section/variant				Objective function	Ranked according to certain criteria			
	A	**B**	**C**	**D**		**A**	**B**	**C**	**D**
K$_1$	0,195	0,6871	0,6996	0,0000	min	2	3	4	1
K$_2$	0,020	0,8287	0,5592	0,0000	min	2	4	3	1
K$_3$	0,499	0,6129	0,0000	0,0000	min	3	4	1	1
K$_4$	0,418	0,6421	0,6421	0,0000	min	2	3,5	3,5	1
K$_5$	0,536	0,1563	0,0000	0,8298	min	3	2	1	4
K$_6$	0,151	0,0000	0,0400	0,9876	min	3	1	2	4
K$_7$	0,244	0,0000	0,1315	0,9606	min	3	1	2	4
K$_8$	0,613	0,0000	0,2015	0,7632	min	3	1	2	4
K$_9$	0,998	0,0515	0,0175	0,0000	min	4	3	2	1
K$_{10}$	0,081	0,7047	0,7047	0,0000	min	2	3,5	3,5	1
K$_{11}$	0,516	0,5615	0,5656	0,3122	max	3	2	1	4
K$_{12}$	0,354	0,5064	0,6150	0,4896	max	4	2	1	3
K$_{13}$	0,654	0,0000	0,4534	0,6045	min	4	1	2	3
K$_{14}$	0,115	0,3926	0,9124	0,0000	min	2	3	4	1

Table 6. Values of Spearman coefficient (above) and the Pearson coefficient (below)

	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	K_{12}	K_{13}	K_{14}
K_1	**1,00**	0,80	-0,10	0,95	-1,00	-0,80	-0,80	-0,80	0,20	0,95	-1,00	-0,80	-0,60	1,00
K_2	0,94	**1,00**	0,50	0,95	-0,80	-1,00	-0,90	-0,90	0,40	0,95	-0,80	-0,60	-0,80	0,80
K_3	0,23	0,32	**1,00**	0,25	-0,30	-0,90	-0,90	-0,90	0,70	0,25	-0,30	1,00	-0,50	-0,10
K_4	0,93	0,81	0,44	**1,00**	-0,85	-0,85	-0,85	-0,85	0,35	1,00	-0,85	-0,65	-0,65	0,95
K_5	-0,98	-0,86	-0,16	-0,95	**1,00**	0,80	0,80	0,80	-0,20	-0,85	1,00	0,80	0,60	-1,00
K_6	-0,83	-0,68	-0,56	-0,97	0,86	**1,00**	1,00	1,00	-0,40	-0,85	0,80	0,60	0,80	-0,80
K_7	-0,86	-0,74	-0,60	-0,98	0,87	0,99	**1,00**	1,00	-0,40	-0,85	0,80	0,60	0,80	-0,80
K_8	-0,97	-0,99	-0,38	-0,89	0,91	0,79	0,84	**1,00**	-0,40	-0,85	0,80	0,60	0,80	-0,80
K_9	-0,35	-0,50	0,49	0,02	0,38	-0,24	-0,18	0,38	**1,00**	0,35	-0,20	0,40	0,20	0,20
K_{10}	0,99	0,96	0,15	0,87	-0,96	-0,74	-0,78	-0,97	-0,48	**1,00**	-0,85	-0,65	-0,65	0,95
K_{11}	0,86	0,70	0,50	0,99	-0,89	-1,00	-0,99	-0,80	0,19	0,77	**1,00**	0,80	0,60	-1,00
K_{12}	0,62	0,60	-0,57	0,33	-0,60	-0,12	-0,14	-0,53	-0,85	0,70	0,18	**1,00**	0,80	-0,80
K_{13}	-0,74	-0,92	-0,51	-0,61	0,60	0,50	0,59	0,88	0,47	-0,77	-0,50	-0,36	**1,00**	-0,60
K_{14}	0,86	0,68	-0,24	0,76	-0,91	-0,64	-0,62	-0,71	-0,38	0,85	0,69	0,79	-0,33	**1,00**

Looking Spearman and Pearson correlation coefficient was applied to the previous normalization can be concluded that there is a strong or medium strong correlation for most of the observed criteria, except for the criterion K9, K13, and this time the criteria K3 (Table 6)..

For criterion K9 (total length parts of the route with a slope of more than 3% if they are longer than 500 m, expressed in km) absolute value of the correlation coefficient is the mostly moving from 0.20 to 0.40, while the absolute value of the Pearson coefficient ranges from 0, from 02 to 0.85 [13].
For criterion K13 (length of the route on which there is a possibility of endangering (km)) absolute value Spearman correlation coefficients are predominantly moving from 0.20 to 0.80, while the absolute value of Pearson coefficient ranges from 0.33 to 0.92.

For criterion K3 (length of bridges and viaducts (km)) absolute value Spearman correlation coefficients are predominantly moving from 0.10 to 0.90, while the absolute value of Pearson oefficient ranges from 0.15 to 0.60.

In addition to these two criteria, we can extract the criterion K12 (rating impact on creating opportunities for the development of the area) whose coefficients consent milder correlation with certain criteria but also a slight correlation with the three criteria (Pearson coefficients less than 0.20) [13]

The above analysis leads to the conclusion that in both ways used normalization correlation coefficients between certain criteria are minor or negligible. It is essentially the same criteria for both normalization.

CONCLUSION

Choosing among several variants highway route represents part of the overall problem of managing the construction of transport networks. Results obtained using the method of multi-criteria analysis of the ranks who often give a different order. Reducing the difference between the output method may be achieved by using the same linear normalization, other than the AHP method forming its matrix and making it not require normalization.

One possibility is the use of Spearman's coefficient, which is on a smaller sample reported correlation of ranks obtained by different methods. Another way is to use Kendall's coefficient consent. Using these statistical methods can demonstrate the interconnection results methods of multi-criteria analysis, and the dependence of certain methods of weight coefficients.

By using Spearman's and Kendall's correlation coefficient are comparable rankings optimal highway route obtained using the multi-criteria analysis. In order for the analysis to be complete except rankings route by individual multiobjective it is necessary to calculate the deviation of the results of these methods. This is done by using Pearson's correlation coefficient. To be used any correlation coefficient it is necessary to normalize the initial decision matrix. Normalization of data is done to make the data uniform and comparable.

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