Application of Correlation Test to Criteria Selection for Multi Criteria Decision Making Problems in Domain of Logistics Systems

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Generally, at considering any selection problem in domain of logistics and logistics systems there is a great number of technically feasible alternatives, and the task of designer is to choose from the set of possible solutions the one that best meets the technical and economic conditions defined by the terms of reference. Multi criteria decision making (MCDM) models are widely used in selection problems in the literature. Starting base at criteria defining is the fact that at solving each problem we can adopt various number and kind of criteria depending on corresponding decisions and information available. Also, an unique set of criteria of considered problem usually is not available to a decision maker. In this work the correlation test was used for getting the set of independent criteria and reducing their number to operating and acceptable level. It has been shown in the paper that the obtained set of independent criteria still fully represents the characteristics of the considered selection problem.

Keywords: criterion, rank, correlation test, Spearman's correlation test, multi criteria decision making

1. INTRODUCTION

Key part of every logistics strategy or part of a supply chain that connects the manufacturers, deliverers and customers represents the transport – storage system. Modern transport engineering is characterized by constant development of devices for transport and manipulation and MCDM methods are the most common approach type applied for selection of material handling equipment. MCMD models try to answer the question of "what is the best alternative?" given a set of selection criteria and a set of alternatives. A model ranks the alternatives and the highest ranked one is recommended as the best alternative to the decision maker. At solving any problem we can adopt different number and kinds of criteria depending on corresponding decisions and information available. So, within the application of MCDM model, mostly the carrying out of the following steps is required [12]:

- defining relevant criteria and alternatives,
- giving numerical values for relative importance (weights), as well as alternatives influence on these criteria,
- getting numerical values that determine final result of alternatives ranking.

Decision maker, in great number of such real problems/situations, must meet one or more goals as well as the numerous conflict criteria. Final order of a problem's alternatives thus depends on applied technique of multicriteria decision-making, and especially on the procedure of defining the evaluation criteria, transformation (normalization) of criteria and determination of their relative importance. In application of multicriteria decision-making approaches, the selection criteria are directly taken without specific tests of checking their independency or other characteristics [12]. Because of the independent nature of criteria it is very important to limit their number to have a model which is sensitive to to changes in criteria weights, as well as the easier determination of their relative importance. From survey of literature [8,9], notable is the fact that generally the selection of criteria requires application of formal procedures to obtain an set of approximately seven plus or minus two independent criteria.

The research in this study is directed to the possibility of correlation test application for comparing the independent criteria and reduction of their number to operational and acceptable level. Correlation analysis are used to measure reletionship between two variables. Based on outcome of the correlation test, are analized the statistically significant differences between the initial and the reduced set of criteria to final ranking and it has been shown that the obtained set of independent criteria still fully represents the characteristics of the selection problem. Application of correlational test is illustrated on multicriteria decision-making problem of material handling equipment selection (forklift).

2. STATISTICAL HYPOTHESIS TESTING – MATHEMATICAL BACKGROUND

A statistical hypothesis test is a method of statistical inference using data from a scientific study. In statistics, a result is called statistically significant if it has been predicted as unlikely to have occurred by chance alone, according to a pre-determined threshold probability, the significance level.

These tests are used in determining what outcomes of a study would lead to a rejection of the null hypothesis for a pre-specified level of significance; this can help to decide whether results contain enough information to cast doubt on conventional wisdom, given that conventional wisdom has been used to establish the null hypothesis. The task of hypothesis testing in statistics theory is to quantify the degree of doubt in some hypothesis.

The critical region of a hypothesis test is the set of all outcomes which cause the null hypothesis to be rejected in favor of the alternative hypothesis (Figure 1).

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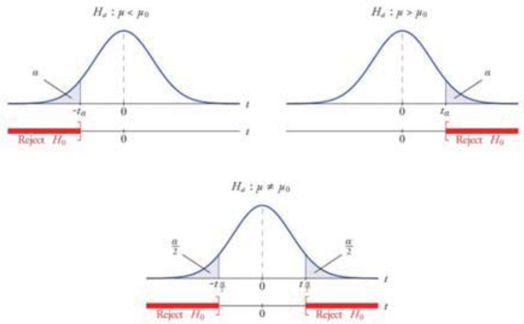

Figure 1: Rules of accepting the hypothesis [6]

In statistics, dependence is any statistical relationship between two random variables or two sets of data. Correlations are useful because they can indicate a predictive relationship that can be exploited in practice. The first step of testing is to state the relevant null and alternative hypotheses. The two hypotheses, namely H_0: there is no linear correlation between two variables and H_1: there is linear correlation between two variables are tested with correlation test. In the correlation test, correlation coefficient is used to test the hypothesis. There are several correlation coefficients, often denoted ρ or r, measuring the degree of correlation. The most common of these is the Pearson correlation coefficient, which is sensitive only to a linear relationship between two variables (which may exist even if one is a nonlinear function of the other). Simple linear correrlation coefficient can take values only in the interval -1 and 1, ie. $-1 \leq r \leq 1$. The correlation coefficient never has the values 1 or -1, because it would mean that between the phenomena there is a mathematical, not statistical connection.

Let (X,Y) be a random vector. From two-dimensional distribution of vectors (X,Y) we take a circumference sample n: (X_1,Y_1), (X_2,Y_2),…, (X_n,Y_n). Here the pairs (X_i,Y_i) are independent, while the random values from the same pair have specified common distribution and can be dependent, with correlation coefficient r:

$$r = \frac{\sum_{i=1}^{n}\left(X_i - \overline{X}\right)\cdot\left(Y_i - \overline{Y}\right)}{\sqrt{\left(\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2\right)\cdot\left(\sum_{i=1}^{n}\left(Y_i - \overline{Y}\right)^2\right)}} \quad (1)$$

For hypotheses testing, as for finding the confidence interval, of use is the following theoreme:

Theoreme 1: If random vector (X,Y) has two-dimensional normal distribution with ρ=0, then the statistics

$$t = r\sqrt{\frac{n-2}{1-r^2}} \quad (2)$$

has t (n-2) distribution.

Testing of hypothesis about simple linear equation coefficient on the basic set ρ, on the ground of its estimate from random sample r is based on the assumption about normality of common distribution for variables X and Y. Most commonly used parametric test of significance for testing the zero hypothesis is the Student's t-test. It is used for testing the significance of differences between two arithmetic means.

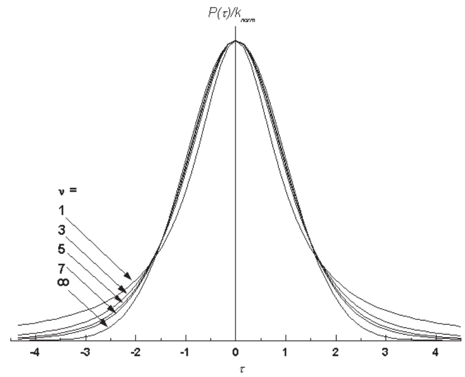

Figure 2: Student's t – distribution with ν degrees of freedom [6]

If the observed t-value is less than border table value for appropriate number ν and threshold (level) of significance, zero hypothesis is accepted as correct, and the alternative hypothesis is rejected. Reversely, if the observed t-value is equal or greater than the border table value, for corresponding number ν and threshold of significance, zero hypothesis is rejected as incorrect, and the alternative hypothesis is accepted. An alternative process is commonly used:

1. Compute from the observations the observed value *t* obs of the test statistic *t*.
2. Calculate the p-value. This is the probability, under the null hypothesis, of sampling a test statistic at least as extreme as that which was observed.
3. Reject the null hypothesis, in favor of the alternative hypothesis, if and only if the p-value is less than the significance level (the selected probability) threshold. Common values are 5% and 1%.

To analize the statistically significant differences between the original and the reduced set of criteria to final ranking Spearman's rank-correlation test is used. Spearman's rank correlation test, which is a special form of correlation test, is used when the actual values of paried data are substituted with the ranks which the values occupy in the respective samples [12]. In this study, Spearman's rank correlation test evaluates the similarity of the outcomes (rankings a set of forklift alternatives). To test the null hypothesis in Spearman's correlation test, test statistic Z is calculated using eqs. (3) and (4) and compared with a pre-determined level of significance α value. In eqs. (3) and (4), d_j represents the ranking difference between j results, K is the number of alternatives to be compared and r_s represents the Spearman's rank correlation coefficient.

$$r_s = 1 - \left[\frac{6 \cdot \sum_{j=1}^{K} (d_j)^2}{K(K^2-1)}\right] \quad (3)$$

$$Z = r_s\sqrt{(K-1)} \quad (4)$$

3. ILLUSTRATION OF THE CORRELATION TEST

Generally, for the needs of multicriteria problems in selection of material handling equipment, different approaches have been developed [2,3,4,5,7,11]. Namely, at solving the multicriteria decision-making problem, and especially when it comes to the selection of material handling equipment, there is a variant when the criteria for choice of the most acceptable alternative are taken directly from manufacturers'catalogues. In that case, by applying the correlational test we expect to get the reduced and independent a set of criteria. The reason for test application lies in the already mentioned fact that in literature there is no clearly defined procedure of criteria selection.

For numerical illustration of correlational test in further works there will be considered a selection of three wheel electro forklift unit for warehouse operation [6]. It is a MCDM problem and for ranking a set of alternatives of forklifts that satisfy in advance required parameters, the initial set of 20 characteristics was observed (Table 1) as a initial set of selection criteria. Starting sample that is considered consists of 25 forklifts of different manufacturers. Their initial values are collected from appropriate catalogs. The task is to, from sample of 25 different values that takes 20 variables, using the correlational test, determine the intensity of connection between two variables and in this way reduce the initial number of independent criteria for evaluation of alternative solutions.

Table 1: Forklifts characteristical values for 20 criteria

Model	*Capacity (kg)*	*Max. lift height (mm)*	*Travel speed with the load (km/h)*	*Travel speed without the load (km/h)*	*Lift speed with the load (m/s)*	*Lift speed without the load (m/s)*	*Turning radius (mm)*	*Length to fork face (mm)*	*Engine power (kW)*	*Wheelbase (mm)*
7FBEST10	1000	3310	12	12.5	0.32	0.52	1230	1565	7.5	985
7FBEST13	1250	3310	12	12.5	0.31	0.52	1400	1725	7.5	1145
7FBEST15	1500	3310	12	12.5	0.3	0.52	1450	1780	7.5	1200
2ET2500	1300	3000	16	16	0.48	0.6	1440	1774	11.5	1249
2ETC3000	1600	3000	16	16	0.49	0.6	1548	1887	11.5	1357
2ETC3500	1800	3000	16	16	0.44	0.55	1548	1887	11.5	1357
2ETC4000	2000	3000	16	16	0.4	0.55	1655	1995	11.5	1465
J30XNT	1361	3032	15.7	15.7	0.39	0.65	1481	1808	4.8	1290
J35XNT	1588	3032	15.7	15.7	0.36	0.65	1577	1903	4.8	1386
J40XNT	1814	3032	15.7	15.7	0.34	0.65	1577	1903	4.8	1386
TX30N	1350	3300	14.5	14.5	0.34	0.515	1525	1895	10.7	1300
TX35N	1600	3300	14.5	14.5	0.31	0.515	1525	1895	10.7	1300
TX40N	1800	3300	16	16	0.32	0.6	1635	2005	14.6	1410
ERP13VC	1250	3320	12	12.5	0.3	0.51	1398	1724	6	1168
ERP15VC	1500	3320	12	12.5	0.3	0.51	1452	1778	6	1222
ERP15VT	1500	3320	16	16	0.43	0.59	1476	1805	12	1290
ERP16VT	1600	3320	16	16	0.43	0.59	1476	1805	12	1290
ERP18VT	1800	3390	16	16	0.41	0.58	1676	1896	12	1494
ERP20VT	2000	3390	16	16	0.4	0.58	1676	1999	12	1494
EFG110	1000	3000	12	12.5	0.29	0.5	1293	1623	6	1038
EFG113	1250	300	12	12.5	0.25	0.5	1401	1731	6	1146
EFG115	1500	3000	12	12.5	0.24	0.5	1455	1785	6	1200
EFG213	1300	3000	10	16	0.48	0.6	1440	1774	11.5	1249
EFG218	1800	3000	10	16	0.44	0.55	1655	1995	11.5	1465
EFG220	2000	3000	10	16	0.4	0.55	1655	1995	11.5	1465

Model	*Total width (mm)*	*Level of noise (dB)*	*Voltage (V)*	*Battery capacity (Ah)*	*Tilt (°)*	*Forklift mass (kg)*	*Forks length (mm)*	*Installation pressure (bar)*	*Battery weight (kg)*	*Total height to top of overhead guard (mm)*
7FBEST10	990	62.4	24	400	5	2550	800	140	372	2055
7FBEST13	990	62.4	24	700	5	2820	800	140	600	2055
7FBEST15	990	62.4	24	800	5	2930	800	140	676	2055
2ET2500	1060	66	24	400	7	2698	1150	200	679	2040
2ETC3000	1060	66	24	500	7	2957	1150	200	812	2040
2ETC3500	1120	66	24	500	7	3213	1150	200	812	2040
2ETC4000	1120	66	24	600	7	3331	1150	200	974	2040
J30XNT	1050	69	36	750	5	2313	1067	155	670	2070
J35XNT	1050	69	36	800	5	2372	1067	155	670	2070
J40XNT	1116	69	36	1000	5	2390	1067	155	700	2070
TX30N	1105	61	36	680	4	2955	1070	140	700	2110
TX35N	1105	61	36	680	4	3155	1070	140	700	2110
TX40N	1105	61	48	750	4	3365	1070	140	1050	2110
ERP13VC	996	59	24	735	5	2700	1000	155	570	1980
ERP15VC	996	59	24	840	5	2905	1000	155	642	1980
ERP15VT	1050	65	48	500	5	2990	1000	180	673	2070
ERP16VT	1050	65	48	500	5	2990	1000	180	673	2070
ERP18VT	1116	65	48	750	5	3280	1000	180	962	2070
ERP20VT	1116	65	48	750	5	3290	1000	180	962	2070
EFG110	990	63	24	625	5	2570	1150	160	481	2090
EFG113	990	63	24	875	5	2760	1150	185	648	2090
EFG115	990	63	24	1000	5	2870	1150	210	730	2090
EFG213	1060	66	24	400	7	2698	1100	200	679	2040
EFG218	1120	66	24	600	7	3156	1100	200	974	2040
EFG220	1120	66	24	600	7	3331	1100	200	974	2040

In the use of equation (1), n corresponds to the sample value of 25 forklifts, (X_i ,Y_i) represent the criteria pairs for which we calculate the correlation coefficient, and $\overline{X}$ and $\overline{Y}$ their average values.

$$r = \frac{\sum_{i=1}^{25}\left(X_i - \overline{X}\right)\cdot\left(Y_i - \overline{Y}\right)}{\sqrt{\left(\sum_{i=1}^{25}\left(X_i - \overline{X}\right)^2\right)\cdot\left(\sum_{i=1}^{25}\left(Y_i - \overline{Y}\right)^2\right)}} \qquad (5)$$

After the calculated value of correlation coefficient for every pair of criteria, further testing of linear correlation coefficient is based on already mentioned Student’s distribution with n-2 degrees of freedom. Statistic test p-value is compared to predefined significance level α which is a proof of positive relation between two criteria. In this research α=0.01 was chosen as critical value. In case that p-value is less than 0.01, we conclude that there is a proof of positive relation between two criteria and one of them can be eliminated.

For the needs of this work, because of easier carrying out the extensive calculations when getting the values of correlation coefficient and statistic test p-value, the shown procedure is automatized by development of program tools in the environment of Microsoft Excel. Given program tools have restrictions regarding the number of criteria (maximum 25). For arbitrary criteria pair (eg. Criterion A: Capacity and G: Turning radius) the program tool calculates the value of t-statistic of the two-tailed t-distribution with 23 (n-2) degrees of freedom, by using the eqs. (2). For this arbitrary criteria par, corresponding valies as t=12,263 and r=0.935. The program then determines, one-tailed and two-tailed p – value in t – distribution (Table 2).

Table 2: Correlation coefficient and p-values for criteria pairs: A – to G; B – to G, C – to G D – to G; E – to G, F – to G

r	0.179	0.345	0.657	0.344	0.339	0.935
t_p	0.871	1.763	4.176	1.759	1.729	12.683
p	0.804	0.954	1.000	0.954	0.951	1.000
p-1	0.196	0.046	0.000	0.046	0.049	0.000
p-2	0.393	0.091	0.000	0.092	0.097	0.000

r	0.196	0.203	0.242	0.172	0.157
t_p	0.956	0.995	1.194	0.838	0.763
p	0.826	0.835	0.878	0.795	0.773
p-1	0.174	0.165	0.122	0.205	0.227
p-2	0.349	0.330	0.245	0.411	0.453

When p-value for every criteria pair is calculated, two-tailed p-value is entered into the matrix under the main diagonal (Table 3), whereby the pairs, whose p-values are less than previously defined value 0.01, are marked above the main diagonal by the sign “X”.

The elimination procedure itself, or reduction of criteria number (variables) that are in mutual correlation, from the shown table, could be presented through the following steps:

1. check if there are criteria which are not correlated to any other criteria (both by rows and columns of given table), and if this is the case, they should be chosen for independent criteria;
2. check the correlation of every criteria (by rows) with other members, and if there is such criterion, choose it as independent one, other criteria in corelation discard;
3. If there are undeleted criteria left, go back to step 1, otherwise the process of correlation analysis is finished.

Table 3: Criteria pairs correlation(pairs in correlation marked with "X")

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
A				X			X	X		X	X					X			X	
B	0.393																			
C	0.091	0.349		X		X							X							
D	0.000	0.330	0.005		X	X	X	X	X	X	X	X							X	
E	0.092	0.245	0.108	0.000		X			X	X	X	X		X	X			X		
F	0.097	0.411	0.003	0.000	0.002					X		X								
G	0.000	0.453	0.068	0.000	0.049	0.037		X	X	X	X					X			X	
H	0.000	0.479	0.088	0.000	0.068	0.057	0.000		X	X	X					X			X	
I	0.013	0.219	0.184	0.001	0.001	0.543	0.009	0.005		X	X			X		X			X	
J	0.000	0.377	0.038	0.000	0.009	0.009	0.000	0.000	0.006		X					X			X	
K	0.000	0.299	0.035	0.000	0.004	0.028	0.000	0.000	0.001	0.000						X			X	
L	0.081	0.716	0.094	0.000	0.002	0.000	0.060	0.105	0.970	0.018	0.033									
M	0.079	0.162	0.001	0.014	0.465	0.016	0.034	0.064	0.066	0.025	0.042	0.533			X					
N	0.408	0.317	0.910	0.079	0.000	0.682	0.383	0.482	0.003	0.685	0.496	0.555	0.601		X					
O	0.200	0.640	0.437	0.035	0.000	0.417	0.301	0.320	0.137	0.173	0.185	0.015	0.008	0.006				X		X
P	0.000	0.443	0.643	0.113	0.314	0.230	0.001	0.001	0.000	0.003	0.005	0.241	0.256	0.499	0.414				X	
Q	0.217	0.064	0.405	0.039	0.205	0.400	0.109	0.067	0.434	0.089	0.051	0.113	0.629	0.969	0.049	0.625		X		
R	0.079	0.203	0.862	0.031	0.004	0.602	0.128	0.188	0.083	0.075	0.190	0.029	0.286	0.172	0.000	0.139	0.001			
S	0.000	0.713	0.229	0.000	0.065	0.197	0.000	0.000	0.000	0.000	0.000	0.234	0.119	0.667	0.142	0.000	0.075	0.034		
T	0.993	0.442	0.158	0.625	0.248	0.736	0.669	0.520	0.518	0.836	0.354	0.682	0.015	0.347	0.009	0.808	0.536	0.276	0.676	

By using the listed rules of elimination procedure, the number of rules in this particular case is reduced from the initial 20 to the following six independent criteria: A-Capacity (kg), B-Maximum lift height (mm), C- Travel speed with the load (km/h), E-Lift speed with the load (m/s), Q-Forks length (mm) and T-Total height to top of overhead guard (mm).Thus obtained, the set of independent criteria satisfies the suggested number (seven plus or minus two) and it is possible to use it further in the following stage of solving the multicriteria decision-making problems, i.e. in the procedure of determining their relative weights and later also in the final ranking of suggested alternatives of the considered multicriteria problem [6].

3.1 Spearman's rank correlation test

In order to analyze statistical significances of the differences between the initial and the reduced number of criteria are developed the program tools in the environment of Microsoft Excel, that uses a special type of correlation test - Spearman's rank correlation test (Figure 3). Developed tool, it's possible for a given level of significance to compare the results of ranking the reduced and the initial set of criteria, and also compare outputs the ranking obtained using a different multiple criteria analysis approach. Testing the null hypothesis Ho, i.e. the Spearman's test statistic Z value is determined by using the expression (3) and (4) and compares it with a value that corresponds to a given significance level α. In this study, Z = 1.645 is selected as the critical value at the level of significance α = 0.05. If the calculated value of Z obtained by test exceeds the critical value the null hypothesis is rejected and it is concluded that there is evidence of a positive relationship - agreement between the two sets of rankings.

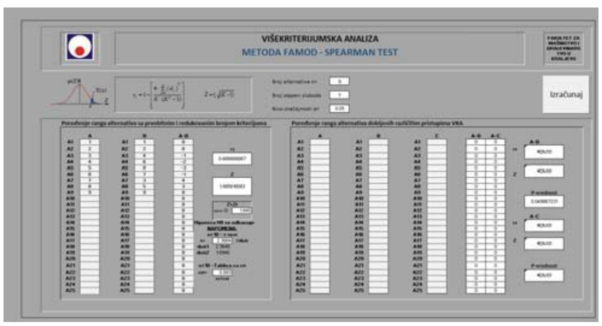

Figure 3: Spearman's rank correlation test program tool

A different MCDM approaches, FAMOD (Fuzzy Analytic Hierarchical process + MODification Promethee Methods), TOPSIS and Promethee methods, are used to obtain ranking scores and rank the forklift alternatives accordingly. Steps and application details of the methods are provided in literature [7,11,14].

Table 4: Two different weight sets used for MCDM approaches

Weight sets of initial 20 criteria			Weight sets of 6 independent criteria		
Criteria	W1	W2	Criteria	W1	W2
A	0.15	0.05	A	0.2	0.16666
B	0.15	0.05	B	0.2	0.16666
C	0.15	0.05	C	0.2	0.16666
D	0.02	0.05	E	0.15	0.16666
E	0.12	0.05	Q	0.15	0.16666
F	0.02	0.05	T	0.1	0.16666
G	0.02	0.05			
H	0.02	0.05			
I	0.02	0.05			
J	0.02	0.05			
K	0.02	0.05			
L	0.02	0.05			
M	0.02	0.05			
N	0.02	0.05			
O	0.02	0.05			
P	0.02	0.05			
Q	0.02	0.05			
R	0.02	0.05			
S	0.08	0.05			
T	0.05	0.05			

In order to compare the results of ranking with the initial set of criteria and a reduced number of criteria (in the present case the number was reduced from 20 to a set of 6 independent criteria), it is necessary for further calculations to determine a decision matrix and weights of criteria as inputs (Table 4).

Forklift alternatives
ERP15VT
ERP16VT
ERP18VT
7FBEST15
TX35N
TX40N
ERP15VC

Figure 4: Output screen of FAMOD elimination module for case study

Results of the final ranking of the seven alternatives (Figure 4.) considered problem obtained by FAMOD are shown in Table 5. The alternative with the highest rank is indicated by 1, while the alternative with the lowest rank indicated by 7. The MCDM methods calculations are performed with two different weight sets (W1 and W2) for the two separate criteria (20 initial criteria and 6 independent criteria). Firstly, in the analysis of results, the statistical signifance of the difference between the 20 and the 6 criteria for different weight sets (set W1 and W2) is tested. The Spearman's correlation test results indicate that the differences between rankings are not statistically significant (Z values respectively 2.362 and 2,187 are above the critical value of 1.645).

Table 5: Analysis of differences using Spearman's rank correlationn test

Alternatives	Ranking score				Analysis of differences using Spearmann's rank correlation test			
	(A) Initial set of 20 criteria		(B) Reduce set of 6 criteria		A-B		A	B
	W1	W2	W1	W2	W1	W2	W1-W2	W1-W2
ERP15VT	3	2	4	3	-1	-1	1	1
ERP16VT	2	1	2	2	0	-1	1	0
ERP18VT	1	3	1	1	0	2	-2	0
7FBEST15	7	7	7	7	0	0	0	0
TX35N	5	5	5	5	0	0	0	0
TX40N	4	4	3	4	1	0	0	-1
ERP15VC	6	6	6	6	0	0	0	0
Spearman's correlation coefficient r_s					0,96428	0,8928	0,8928	0,9642
Statistical signifance value Z					2,362	2,187	2,1870	2,362

A further analysis of the differeces among the rankings within each criteria set is needed to determine whether or not the sensitivity of the rankings to the changes in the criteria weights depends on the number of criteria.

Results for the values of correlation coefficient in this case for a set of seven alternatives are greater in the case of the six criteria than the 20, and shows on one side a great similarity ranking, but does not indicate a change in the sensitivity of the model to the change of criteria. It is expected that the increasing number of considered alternatives i.e. differences in the ranking are such that the value of the correlation coefficient in the case of the reduced number of criteria of lower value than the value of the original dataset, which would indicate less similarity ranking, and hence the conclusion that the reduces the number of criteria increases the sensitivity of a given multi-criteria model. Also, in this study to test the validity of outcomes obtained with different MCDM approaches, the ranking results are compared and presented in Table 6.

Table 6: Comparasion of forklift ranking approaches

Alternatives	Ranking score			Analysis of differences using Spearmann's rank correlation test	
	(A) FAMOD	(B) TOPSIS	(C) PROMETHEE	A-B	A-C
ERP15VT	3	3	4	0	-1
ERP16VT	2	2	2	0	0
ERP18VT	1	1	1	0	0
7FBEST15	7	7	7	0	0
TX35N	5	5	5	0	0
TX40N	4	4	3	0	1
ERP15VC	6	6	6	0	0
Spearman's correlation coefficient r_s				1	0.9642
Statistical signifance value Z				2.449	2.362

As the outcome of the test, the statistical signifance rates of the differences in the rankings (Z) are illustrated in the last row of Table 6. It is evident that in all cases the value of Z exceeds the critical significance level of 0.05, and it can be concluded that the results of the ranking obtained with new approach FAMOD are statistically similar to the results obtained by other traditional approaches.

4. CONCLUSION

In this study, the fact was pointed out that solving the problem of decision-making requires firstly defining the criteria system, and then determining their relative significance before final ranking of the considered multicriteria problem alternatives. Also, the fact was pointed out that a unique set of criteria of considered problem most often is not available to decision-maker. Correlation test was used for getting a set of independent criteria, more precisely reduction of their number to operative and acceptable level for determining the relative weights and later on the procedure of ranking the alternatives. A key results in this analysis, are that when the number of criteria is reduced, the model clearly becomes more sensitive to the changes in criteria weights But, correlation test determines only the level of correlation for every criteria pair, and as it is determined there is not a unique way of obtaining the set of independent criteria (seven plus or minus two).

Set of independent criteria can be different for the same value of correlation coefficient, but also by changing the values of significance level, the number of pairs in correlation changes. In this way the pairs in correlation become the pairs without correlation and vice resa. It becomes clear that defining the set of independent criteria requires, in that case, repetition and check of procedure for choosing the set of seven plus or minus two independent criteria. However, the result of such approach can lead to a situation where the available criteria, i.e. the most commonly used ones in previous researches, can become preferential to the less significant criteria, and as such be used for solving the equipment choice problem.

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