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APPLICATION OF MARCOS METHOD IN EVALUATION OF EFFICIENCY OF TRADE COMPANIES IN SERBIA

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Abstract: *The problem of measuring the efficiency of trade companies using methods is continuously relevant, significant and complex. With this in mind, this paper investigates the efficiency of trade companies in Serbia on the basis of the MARCOS method in order to consider the most realistic situation and improve in the future by taking relevant measures. According to the results of the MARCOS method, the top five trade companies in Serbia are in the following order: NELT CO. DOO BELGRADE, KNEZ PETROL DOO ZEMUN, DELHAIZE SERBIA DOO BELGRADE, LIDL SERBIA KD NOVA PAZOVA, and MERCATOR-S DOO NOVI SAD. Trade companies in Serbia that sell food products are well ranked. Factors that influenced this ranking of trade companies in Serbia are: general business conditions, interest rate, exchange rate, inflation, sustainable development, inflow of foreign direct investment, employment, living standards, digitalization of business, Covid-19. Also, the application of modern concepts of cost management, customer management, product category management, multi-channel sales, etc.Conducted similar research in other countries provides additional renewal to assess the efficiency of trade enterprises in Serbia and improve in the future by taking relevant measures.*
Key words*: efficiency, factors, MARCOS method, Serbian trade*

INTRODUCTION

As is well known, research on the efficiency of trade companies based on multi-criteria decision making methods is increasingly being applied. It provides a better understanding of the impact of key factors on the efficiency of trade companies. With this in mind, the subject of research in this paper is the analysis of efficiency factors of trade companies in Serbia using the MARCOS method. The purpose and goal of this is to look as realistically as possible at the situation regarding the efficiency of trade companies in Serbia in order to improve in the future by taking adequate measures.

In recent times, the literature is increasingly using individual or integrated methods of multi-criteria decision making to measure the efficiency of trade companies (Ersoy, 2017). This is also the case with literature in Serbia (Lalic et al., 2021; Lukic and Hadrovic, 2019; Lukic et al.,2020a, b;Lukic, 2020c; Lukic, 2021a, b, c, d;Lukic and

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Hadrovic,2021e). However, in this paper, for the first time, the MARCOS method is used when measuring the efficiency of trade companies in Serbia. This, among other things, reflects the scientific and professional contribution of this paper.

Permanent evaluation of the efficiency of trade companies in Serbia using the MARCOS method enables the assessment of the real situation and improvement in the future by taking relevant measures. Also, comparing with the results of other methods of multi-criteria decision making. This reflects the basic research hypothesis in this paper.

In addition to the MARCOS method, the AHP (Analytical Hierarchical Process**)** method is used in this paper to determine the weighting coefficients of the criteria.

The research of the treated problem in this paper is based on empirical data of the Agency for Business Registers of the Republic of Serbia. There are no restrictions on international comparability as they are "manufactured" in accordance with relevant international standards.

1. MATERIALS AND METHODS

The **MARCOS method** is based on defining the relationship between alternatives and reference values (ideal and anti-ideal alternative) **(** Đalić et al., 2020; Kovač et al., 2021; Miškić et al., 2021; Nedeljković et al., 2021; Puška et al., 2021; Stević et al., 2020a,b; Stanković et al., 2020; Trung, 2021). Based on the defined relationships, the utility functions of the alternatives are determined and a compromise ranking is made in relation to the ideal and anti-ideal solutions. Decision making preferences are defined based on the utility function. Utility functions represent the position of an alternative to ideal and anti-ideal solutions. The best alternative is the one that is closest to the ideal and at the same time the farthest from the anti-deal reference point. The MARCOS method takes place through the following steps (Stević et al., 2020a, b):

Step 1: Establish an initial decision matrix. The multi-criteria model includes defining a set of *n* criteria and *m* alternatives. In the case of group decision making, a set of experts is formed who evaluate the alternatives in relation to the criteria. In this case, the expert evaluation matrices are aggregated into the initial group decision matrices.

Step 2: Forming an extended initial matrix. In this step, the initial matrix extensions are defined with ideal (*AI*) and anti-ideal (*AAI*) solutions.

$$X = \begin{array}{c} \\ AAI \\ A_1 \\ A_2 \\ \cdots \\ A_m \\ AI \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} x_{aa1} & x_{aa2} & \cdots & x_{aan} \\ x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \\ x_{ai1} & x_{ai2} & \cdots & x_{ain} \end{bmatrix} \end{array} \qquad (1)$$

Anti-ideal solution (*AAI*) is the worst alternative. The ideal solution (*AI*) is, in contrast, an alternative with the best characteristics. Depending on the nature of the criteria, *AAI* and *AI* are defined using the following equations:

$$AAI = \min_i x_{ij} \ if \ j \in B \ and \ \max_i x_{ij} \ if \ j \in C \qquad (2)$$

$$AI = \max_i x_{ij} \ if \ j \in B \ and \ \min_i x_{ij} \ if \ j \in C \qquad (3)$$

where *B* represents the benefit and *C* the cost group of criteria.

Step 3: Normalize the extended initial matrix (*X*). The elements of the normalized matrix $N = \left[n_{ij}\right]_{mxn}$ were obtained using the following equations:

$$n_{ij} = \frac{x_{ai}}{x_{ij}} \ if \ j \in C \qquad (4)$$

$$n_{ij} = \frac{x_{ij}}{x_{ai}} \ if \ j \in B \qquad (5)$$

where the elements x_{ij} and x_{ai} represent the elements of the matrix *X*.

Step 4: Defining the weight matrix $V = \left[v_{ij}\right]_{mxn}$. The weight matrix *V* is obtained by multiplying the normalized matrix *N* by the weight coefficients of the criterion w_j using the following equation:

$$v_{ij} = n_{ij} x v_j \qquad (6)$$

Step 5: Determining the degree of usefulness of alternatives K_i. The degree of usefulness of alternatives in relation to anti-ideal and ideal solutions is determined using the following equations:

$$K_i^- = \frac{S_i}{S_{aai}} \qquad (7)$$

$$K_i^+ = \frac{S_i}{S_{ai}} \qquad (8)$$

where $S_i (i = 1,2, .., m)$ represents the sum of the elements of the weight matrix V, shown in the following equation:

$$S_i = \sum_{i=1}^{n} v_{ij} \qquad (9)$$

Step 6: Determining the utility function of alternatives $f(K_i)$. The utility function is a compromise of the observed alternative in relation to ideal and anti-ideal solutions. The utility function of alternatives is defined by the following equation:

$$f(K_i) = \frac{K_i^+ + K_i^-}{1 + \frac{1-f(K_i^+)}{f(K_i^+)} + \frac{1-f(K_i^-)}{f(K_i^-)}} \qquad (10)$$

where it$f(K_i^-)$represents the utility function in relation to the anti-ideal solution and $f(K_i^+)$represents the utility function in relation to the ideal solution.

The utility functions in relation to ideal and anti-deal solutions are determined using the following equations:

$$f(K_i^-) = \frac{K_i^+}{K_i^+ + K_i^-} \qquad (11)$$

$$f(K_i^+) = \frac{K_i^-}{K_i^+ + K_i^-} \qquad (12)$$

Step 7: Ranking the alternatives. The ranking of alternatives is based on the final value of the utility function. The alternative that has the highest possible value of the utility function is preferred.

Considering that the weights of criterion in the application of the MARCOS method are determined using the **AHP (Analytical Hierarchical Process) method**, we will briefly look at its theoretical and methodological characteristics.

The Analytical Hierarchical Process (AHP) method takes place through the following steps (Saaty, 2008):

Step 1: Forming a matrix of comparison pairs

$$A = [a_{ij}] = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{bmatrix} \quad (13)$$

Step 2: Normalize the matrix of comparison pairs

$$a_{ij}^{*} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}, i, j = 1, \ldots, n \quad (14)$$

Step 3: Determining the relative importance, i.e. vector weight

$$w_i = \frac{\sum_{i=1}^{n} a_{ij}^{*}}{n}, i, j = 1, \ldots, n \quad (15)$$

Consistency index - CI (consistency index) is a measure of deviation *n* from λ_{max} and can be represented by the following formula:

$$CI = \frac{\lambda_{max} - n}{n} \quad (16)$$

If CI <0.1 is the estimated value of the coefficient $a_{ij}$are consistent, and the deviation of λ_{max} from *n* is negligible. This means, in other words, that the AHP method accepts an inconsistency of less than 10%.

The consistency index can be used to calculate the CR = CI / RI consistency ratio, where RI is a random index.

2. RESULTS AND DISCUSSION

When measuring the efficiency of trade enterprises in Serbia on the basis of the MARCOS method, the following criteria were used: C1 - number of employees, C2 - business assets, C3 - equity, C4 – business income and C5 - net result. The selected criteria adequately measure the efficiency of resource use and financial performance of trade enterprises. They are key factors that affect the efficiency of trading companies. Adequate control of them can significantly affect the achievement of target efficiency of trade companies in Serbia. Alternatives were observed trade companies: A1 - Nelt Co., A2 - Phoenix Pharma, A3 - Mecata VT, A4 - Knez Petrol, A5 - Agroglobe, A6 - Delhaize Serbia, A7 - Mercator-S, A8 - Lidl Serbia, A9 - Mol Serbia, and A10 - Lukoil Serbia. *Table 1* shows the

initial data for measuring the efficiency of trade enterprises in Serbia for 2020 using the MARCOS method.

Table 1. Initial data

		Number of employees	Business assets	Equity	Business income	Net result
		C1	**C2**	**C3**	**C4**	**C5**
A1	NELT CO. DOO BELGRADE	2.037	26.799	13.326	77.376	783
A2	PHOENIX PHARMA DOO BELGRADE	512	25.082	5.928	55.983	1.004
A3	MERCATA VT DOO NOVI SAD	754	9.605	1.015	55.487	650
A4	KNEZ PETROL DOO ZEMUN	1.129	8.467	2.809	39.351	791
A5	AGROGLOBE DOO NOVI SAD	286	24.481	6.390	32.380	50
A6	DELHAIZE SERBIA DOO BELGRADE	12.889	72.196	42.305	111.485	3.931
A7	MERCATOR-S DOO NOVI SAD	8.031	55.477	0.000	79.966	-5.478
A8	LIDL SERBIA KD NOVA PAZOVA	2.483	53.999	28.806	57.014	1.138
A9	MOL SERBIA DOO BELGRADE	98	16.040	13.215	44.691	1.381
A10	LUKOIL SERBIA AD BELGRADE	150	6.271	3.027	29.200	1.036

Note: Data are expressed in millions of dinars. The number of employees is expressed in whole numbers. The first five companies are from the wholesale sector, and the rest are from the retail sector.

Source: Agency for Business Registers of the Republic of Serbia

The weighting coefficients of the criteria were determined using the AHP method (Saaty, 2008). They are shown in *Table 2* (The calculation was performed using AHPSSoftware-Excel software).

Table 2. Criteria weighting coefficients

AHP With Arirthmetic Mean Method					
Initial Comparisons Matrix					
	C1	**C2**	**C3**	**C4**	**C5**
C1	1	2.5	1	2	1
C2	0.4	1	2	1.25	1
C3	1	0.5	1	0.5	1
C4	0.5	0.8	2	1	1
C5	1	1	1	1	1
SUM	3.9	5.8	7	5.75	5

Normalized Matrix						
	C1	**C2**	**C3**	**C4**	**C5**	**Weights of Criteria**
C1	0.2564	0.4310	0.1429	0.3478	0.2000	0.2756
C2	0.1026	0.1724	0.2857	0.2174	0.2000	0.1956
C3	0.2564	0.0862	0.1429	0.0870	0.2000	0.1545
C4	0.1282	0.1379	0.2857	0.1739	0.2000	0.1852
C5	0.2564	0.1724	0.1429	0.1739	0.2000	0.1891
					SUM	**1**
Consistency Ratio	**0.0654**	**COMPARE WITH 0.1; IT SHOULD BE LESS THAN 0.1.**				

Note: Author's calculation

Table 3 shows the initial matrix.

Table 3. Initial matrix

Initial Matrix					
weights of criteria	0.2756	0.1956	0.1545	0.1852	0.1891
kind of criteria	-1	1	1	1	1
	C1	**C2**	**C3**	**C4**	**C5**
A1	2.037	26.799	13.326	77.376	783
A2	512	25.082	5.928	55.983	1.004
A3	754	9.605	1.015	55.487	650
A4	1.129	8.467	2.809	39.351	791
A5	286	24.481	6.39	32.38	50

A6	12.889	72.196	42.305	111.485	3.931
A7	8.031	55.477	0	79.966	-5.478
A8	2.483	53.999	28.806	57.014	1.138
A9	98	16.04	13.215	44.691	1.381
A10	150	6.271	3.027	29.2	1.036
MAX	754	72.196	42.305	111.485	791
MIN	1.129	6.271	0	29.2	-5.478

Note: Author's calculation

Table 4 shows the extended initial matrix.

Table 4. Extended initial matrix

Extended Initial Matrix					
weights of criteria	0.2756	0.1956	0.1545	0.1852	0.1891
kind of criteria	-1	1	1	1	1
	C1	**C2**	**C3**	**C4**	**C5**
AAI	754	6.271	0	29.2	-5.478
A1	2.037	26.799	13.326	77.376	783
A2	512	25.082	5.928	55.983	1.004
A3	754	9.605	1.015	55.487	650
A4	1.129	8.467	2.809	39.351	791
A5	286	24.481	6.39	32.38	50
A6	12.889	72.196	42.305	111.485	3.931
A7	8.031	55.477	0	79.966	-5.478
A8	2.483	53.999	28.806	57.014	1.138
A9	98	16.04	13.215	44.691	1.381
A10	150	6.271	3.027	29.2	1.036
AI	1.129	72.196	42.305	111.485	791

Note: Author's calculation

Table 5 shows the normalized matrix.

Table 5. Normalized matrix

NormalizedMatrix					
weights of criteria	0.2756	0.1956	0.1545	0.1852	0.1891
kind of criteria	-1	1	1	1	1
	C1	**C2**	**C3**	**C4**	**C5**
AAI	0.001497	0.086861	0	0.261919	-0.00693
A1	0.5542	0.3712	0.3150	0.6940	0.9899
A2	0.0022	0.3474	0.1401	0.5022	0.0013
A3	0.0015	0.1330	0.0240	0.4977	0.8217
A4	1.0000	0.1173	0.0664	0.3530	1.0000
A5	0.0039	0.3391	0.1510	0.2904	0.0632
A6	0.0876	1.0000	1.0000	1.0000	0.0050
A7	0.1406	0.7684	0.0000	0.7173	0.0000
A8	0.4547	0.7480	0.6809	0.5114	0.0014
A9	0.0115	0.2222	0.3124	0.4009	0.0017
A10	0.0075	0.0869	0.0716	0.2619	0.0013
AI	1	1	1	1	1

Note: Author's calculation

Table 6 shows the weight-normalized matrix.

Table 6. Weight-normalized matrix

Weighted NormalizedMatrix					
	C1	**C2**	**C3**	**C4**	**C5**
AAI	0.000413	0.01699	0	0.048507	0
A1	0.1528	0.0726	0.0487	0.1285	0.1872
A2	0.0006	0.0680	0.0216	0.0930	0.0002
A3	0.0004	0.0260	0.0037	0.0922	0.1554
A4	0.2756	0.0229	0.0103	0.0654	0.1891
A5	0.0011	0.0663	0.0233	0.0538	0.0120
A6	0.0241	0.1956	0.1545	0.1852	0.0009
A7	0.0387	0.1503	0.0000	0.1328	0.0000
A8	0.1253	0.1463	0.1052	0.0947	0.0003
A9	0.0032	0.0435	0.0483	0.0742	0.0003
A10	0.0021	0.0170	0.0111	0.0485	0.0002
AI	0.2756	0.1956	0.1545	0.1852	0.1891

Note: Author's calculation

Table 7 shows the results of the MARCOS method

Table 7. Results of the MARCOS method

	Results of MARCOS Method								
		Yes	**Ki-**	**Ki +**	**f (K-)**	**f (K +)**	**f (K)**		**Ranking**
	AAI	0.0659							
NELT CO. DOO BELGRADE	**A1**	0.5897	8.9478	0.5897	0.0618	0.9382	0.5874	0.5874	**1**
PHOENIX PHARMA DOO BELGRADE	**A2**	0.1835	2.7834	0.1835	0.0618	0.9382	0.1827	0.1827	**7**
MERCATA VT DOO NOVI SAD	**A3**	0.2777	4.2135	0.2777	0.0618	0.9382	0.2766	0.2766	**6**
KNEZ PETROL DOO ZEMUN	**A4**	0.5633	8.5460	0.5633	0.0618	0.9382	0.5610	0.5610	**2**
AGROGLOBE DOO NOVI SAD	**A5**	0.1565	2.3744	0.1565	0.0618	0.9382	0.1559	0.1559	**9**
DELHAIZE SERBIA DOO BELGRADE	**A6**	0.5604	8.5022	0.5604	0.0618	0.9382	0.5581	0.5581	**3**
MERCATOR-S DOO NOVI SAD	**A7**	0.3219	4.8837	0.3219	0.0618	0.9382	0.3206	0.3206	**5**
LIDL SERBIA KD NOVA PAZOVA	**A8**	0.4718	7.1582	0.4718	0.0618	0.9382	0.4699	0.4699	**4**
MOL SERBIA DOO BELGRADE	**A9**	0.1695	2.5712	0.1695	0.0618	0.9382	0.1688	0.1688	**8**
LUKOIL SERBIA AD BELGRADE	**A10**	0.0789	1.1967	0.0789	0.0618	0.9382	0.0786	0.0786	**10**
	AI	1.0000							

Note: Author's calculation

So, in the top five trade companies in Serbia, according to the results of the MARCOS method, they fall in the order: NELT CO. DOO BELGRADE, KNEZ PETROL DOO ZEMUN, DELHAIZE SERBIA DOO BELGRADE, LIDL SERBIA KD NOVA PAZOVA, and MERCATOR-S DOO NOVI SAD. Trade companies in Serbia that sell food products are well ranked.

Factors that influenced the ranking of trade companies in Serbia are: general business conditions, interest rate, exchange rate, inflation,

sustainable development, inflow of foreign direct investment, employment, living standards, digitalization of business, Covid-19. The application of modern cost management concepts also plays an important role in this, customer management, product category management, multichannel sales, etc.

In order to improve the efficiency of trade companies in Serbia in the future, it is necessary to manage human resources, assets, capital, sales and profits as efficiently as possible. In modern business conditions, the significant digitalization of the entire business has a significant role in that.

For the purpose of international comparison, it is necessary to conduct similar research in other countries. In that way, the efficiency of trade companies in Serbia can be better seen in relation to similar ones abroad.

In relation to the ratio analysis, the MARCOS method gives more accurate results on the efficiency of trading companies. For these reasons, it is recommended especially in combination with other methods of multi-criteria decision-making.

CONCLUSION

Based on the conducted empirical research on the efficiency of trade companies in Serbia, the following can be concluded:

1.In the top five trade companies in Serbia, according to the results of the MARCOS method, they fall in the order: NELT CO. DOO BELGRADE, KNEZ PETROL DOO ZEMUN, DELHAIZE SERBIA DOO BELGRADE, LIDL SERBIA KD NOVA PAZOVA, and MERCATOR-S DOO NOVI SAD. Trade companies in Serbia that sell food products are well ranked;

2. This ranking of trade companies in Serbia was influenced by numerous factors of macroeconomic and microeconomic nature. These are: general business conditions, interest rate, exchange rate, inflation, sustainable development, inflow of foreign direct investment, employment, living standards, business digitalization, the application of modern concepts of cost management, customer management, product category management, multichannel sales, Covid-19, etc.;

3. The comparative use of several methods of multi-criteria decision-making provides a realistic basis for reviewing the efficiency of trade companies in Serbia and improving in the future by taking relevant measures.

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