EFFICIENCY ANALYSIS OF TRADE COMPANIES IN SERBIA USING THE ARAS METHOD

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Abstract

The research of company efficiency can be quite challenging when using different methods of multicriteria decision-making. This paper looks into the efficiency of trade companies in Serbia using the ARAS method, with the aim to achieve improvements in the future. The empirical results of efficiency evaluation of trade companies in Serbia for 2020 using the ARAS method reveal that the most efficient company is MERCATA VT. It is followed by DELHAIZE SERBIA, NELT CO., PHOENIX PHARMA, LIDL SRBIJA, KNEZ PETROL, AGROGLOBE, MERCATOR-S, MOL SERBIA, and LUKOIL SRBIJA. This ranking of trade companies in Serbia was influenced by economic climate, but even more significantly by management efficiency as regards human resources, assets, capital, sales and profits. Obviously, this efficiency differs in these companies, depending on the skills and competences displayed by their management. Another important aspect is full digitalisation of operations. Those who had embarked on e-commerce early enough were able to avoid some of the negative consequences of COVID-19 pandemic. As is the case elsewhere in the world, e-commerce has significantly alleviated the negative impact of the pandemic on the performance of trade companies in Serbia.

Keywords: efficiency, factors, ARAS method, trade, Serbia

1. INTRODUCTION

In recent years, various multi-criteria decision-making methods or combinations thereof are fast becoming a key instrument for measuring the efficiency of trade companies (Nguyen, 2020; Karcıoğlu, 2022; Görçün, 2022). Against this background, the paper seeks to perform a complex analysis of the efficiency of trade companies in Serbia using the ARAS method aimed at determining, as close as possible, the

efficiency of trade companies in Serbia and making suggestions for improvements in the future (through application of effective relevant measures).

Recent years have seen a proliferation of studies on efficiency evaluation of trade companies using multi-criteria analyses (Saaty, 2008; Ersoy, 2017; Gaur, 2020; Lukic, 2011, 2019, 2020a, b, c, d, 2021a, b, c, d, e, f, g, h, i, j; Lalic, 2021; Berman, 2018; Levy, 2019; Lovreta, 2021; Tsai, 2021). In particular, the ARAS method appears to be gaining in popularity. However, when reviewing the available literature, we could not find a comprehensive work dedicated to evaluating the efficiency of trade companies in Serbia using this particular method, especially for 2020. The paper addresses this gap thereby adding to the existing scientific and professional research in the field.

The hypothesis that will be tested in this paper is that a careful analysis of the efficiency factors of trade companies is a key prerequisite for future improvements through timely implementation of effective relevant measures. This can be easily achieved by using various methods of multi-criteria decision-making or combinations thereof, including the ARAS method as well as DEA models (Banker, 1984; Lukic, 2019).

The empirical data needed for the research presented in this paper were collected from the Serbian Business Registers Agency (SBRA). The data are internationally comparable as they are produced in accordance with relevant international standards.

The paper has been organised in the following way: in addition to the introduction and conclusion, it contains sections describing the basic characteristics of the AHP and ARAS methods, and an analysis of empirical results of efficiency evaluation of trade companies in Serbia using the ARAS method. The authors acknowledge the limitations of the research and make recommendations for improving the efficiency of trade companies in Serbia in the future.

2. ARAS METHOD

The ARAS (Additive Ratio Assessment System) method is a multi-criteria analysis technique developed by Zavadskas and Turskis (Zavadskas and Turskis, 2010). Unlike other multi-criteria decision-making methods, the alternatives are ranked based on the utility function value (Chatterjee and Chakraborty, 2013; Sliogene et al. 2013; Rostamzadeh, 2017; Koc, 2017; Dahooie, 2019; Jovčić, 2020). The ARAS method procedure includes several steps (Zavadskas et. al., 2010):

Step 1: Create a decision-making matrix (DMM) The decision-making matrix is created as follows:

$$X = \begin{bmatrix} x_{01} & \dots & x_{0j} & \dots & x_{0n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{i1} & \dots & x_{ij} & \dots & x_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{m1} & \dots & x_{mj} & \dots & x_{mn} \end{bmatrix}; i = \overline{0, m}; j = \overline{1, n}$$
(1)

where m – the number of alternatives, n – the number of criteria describing each alternative, x_{ij} –the value representing the performance value of the *i*-th alternative in terms of the *j*-th criterion, x_{0l} – the optimal value of the *j*-th criterion.

(2)

If the optimal value of the *j*-th criterion is unknown, then $x_{0j} = \max_{i} x_{ij}$, *if* $\max_{i} x_{ij}$ *is preferable*;

 $x_{0j} = \min_{i} x_{ij}^*$, if $\min_{i} x_{ij}^*$ is preferable

Step 2: Normalise the values of the criteria

In this stage, the initial values of the criteria are normalised - by defining the values \bar{x}_{ii} of the normalised decision-making matrix - \bar{X} .

$$\bar{X} = \begin{bmatrix} \bar{x}_{01} & \cdots & \bar{x}_{0j} & \cdots & \bar{x}_{0n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \bar{x}_{i1} & \cdots & \bar{x}_{ij} & \cdots & \bar{x}_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \bar{x}_{m1} & \cdots & \bar{x}_{mj} & \cdots & \bar{x}_{mn} \end{bmatrix}; i = \overline{0, m}; j = \overline{1, n}$$
(3)

If a maximum value is preferable, normalisation is done as follows:

$$\bar{x}_{ij} = \frac{x_{ij}}{\sum_{i=0}^{m} x_{ij}} \tag{4}$$

If a minimum value is preferable, the procedure consists of two phases:

$$x_{ij} = \frac{1}{x_{ij}^*}; \ \bar{x}_{ij} = \frac{x_{ij}}{\sum_{i=0}^m x_{ij}}$$
(5)

Step 3: Define the normalised-weighted matrix - \hat{X}

Weights are usually determined by the expert evaluation method. One should use only well-founded weights because they are always subjective and affect the solution. The sum of weights is limited (i.e. equal to 1):

$$\sum_{j=1}^{n} w_{j} = 1$$

$$\hat{X} = \begin{bmatrix} \hat{x}_{01} & \cdots & \hat{x}x_{0j} & \cdots & \hat{x}_{0n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \hat{x}_{i1} & \cdots & \hat{x}_{ij} & \cdots & \hat{x}_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \hat{x}x_{m1} & \cdots & \hat{x}_{mj} & \cdots & \hat{x}_{mn} \end{bmatrix}; i = \overline{0, m}; j = \overline{1, n}$$
(6)
(7)

The normalised-weighted values of the criteria are calculated as follows:

$$\hat{x}_{ij} = \bar{x}_{ij} w_j; i = \overline{0, m}$$
(8)

where w_j is the weight (importance) of the *j*-th criterion and \bar{x}_{ij} j is the normalised rating of the *j*-th criterion.

Determining values of optimality function:

$$S_i = \sum_{j=1}^n \hat{x}_{ij}; \ i = \overline{0, m}$$
(9)

where S_i is the value of optimality function of the *i*-th alternative. If S_i is the largest, the criterion is the best.

The utility degree (K_i) of an alternative a_i is calculated (using the previous equation) as follows:

$$K_i = \frac{S_i}{S_0}, \qquad i = \overline{0, m} \tag{10}$$

where S_i and S_0 are the optimality criterion values.

The value of K_i is in the interval [0, 1]. The relative efficiency (position, rank) of an alternative is determined according to the utility function values. The best alternative is the one with the greatest value.

3. ANALYTICAL HIERARCHICAL PROCESS (AHP) METHOD

Considering that, when applying the ARAS method, the weights of criteria are determined using the AHP method, we will briefly look at its theoretical and methodological characteristics.

The Analytical Hierarchical Process (AHP) involves the following steps (Saaty, 2008):

Step 1: Construct a pairwise comparison matrix

$$A = \begin{bmatrix} a_{ij} \end{bmatrix} = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{bmatrix}$$
(11)

Step 2: Normalise the pairwise comparison matrix

$$a_{ij}^* = \frac{a_{ij}}{\sum_{i=1}^n a_{ij}}, i, j = 1, \dots, n$$
(12)

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

$$w_i = \frac{\sum_{i=1}^{n} a_{ij}^*}{n}, i, j = 1, \dots, n$$
(13)

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

$$CI = \frac{\lambda_{max} - n}{n} \tag{14}$$

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

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

4. MEASURING THE EFFICIENCY OF TRADE COMPANIES IN SERBIA USING THE ARAS METHOD

The following criteria were used to measure the efficiency of trade companies in Serbia based on the ARAS method: C1 - number of employees, C2 - assets, C3 capital, C4 – operating income (sales) and C5 - net income. The selected criteria adequately measure the efficiency of resource use and financial performance of trade companies which are key factors in the efficiency of trade companies (Lukic, 2011, 2020a,b,c,d, 2021a-j). Adequate control over these factors can enable trade companies in Serbia to achieve their target efficiency (Lalic, 2021). These variables fully correspond to the nature of business operations of trading companies, i.e. of using resources in order to achieve the target profit (Berman, 2018; Levy, 2019; Lovreta, 2021). Based on them, a strategic model can be constructed (Berman, 2018; Levy, 2019):

$$Return \ on \ assets = \frac{Net \ profit}{Sales} \ x \ \frac{Sales}{Assets}$$
(15)

relation

$$Return on net worth = \frac{Net \ profit}{Sales} \ x \ \frac{Sales}{Assets} \ x \ \frac{Assets}{Net \ worth} \ (16)$$

By effectively controlling the return on sales and asset turnover, the target return on assets can be achieved. Likewise, effective control of the return on assets (that is, the return on the sale and turnover of assets) and financial indebtedness (financial leverage) can achieve the target return on net worth.

For these reasons, among other things, the mentioned variables are used in the literature when evaluating the financial performance and efficiency of trading companies.

The trade companies whose efficiency was analysed are the alternatives: A1 – Nelt Co., A2 – Phoenix Pharma, A3 – Mercata VT, A4 – Knez Petrol, A5 – Agroglobe, A6 – Delhaize Serbia, A7 – Mercator-S, A8 – Lidl Srbija, A9 – Mol Serbia, and A10 – Lukoil Srbija.

Table 1 shows the initial data for measuring the efficiency of trade companies in Serbia for 2020 using the ARAS method.

		Number of	Assets	Capital	Operating	Net income
		employees			income	
		C1	C2	C3	C4	C5
A1	NELT CO. DOO	2,037	26,799	13,326	77,376	783
	BEOGRAD					
A2	PHOENIX PHARMA	512	25,082	5,928	55,983	1,004
	DOO BEOGRAD					
A3	MERCATA VT DOO	754	9,605	1,015	55,487	650
	NOVI SAD					
A4	KNEZ PETROL	1,129	8,467	2,809	39,351	791
	DOO ZEMUN					
A5	AGROGLOBE DOO	286	24,481	6,390	32,380	50
	NOVI SAD					

Table 1. Initial data

A6	DELHAIZE SERBIA	12,889	72,196	42,305	111,485	3,931
	DOO BEOGRAD					
A7	MERCATOR-S DOO	8,031	55,477	0,000	79,966	-5,478
	NOVI SAD					
A8	LIDL SRBIJA KD	2,483	53,999	28,806	57,014	1,138
	NOVA PAZOVA					
A9	MOL SERBIA DOO	98	16,040	13,215	44,691	1,381
	BEOGRAD					
A10	LUKOIL SRBIJA	150	6,271	3,027	29,200	1,036
	AD BEOGRAD					

Note: The 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. Capital = Net worth. Net worth = Total assets – Total liabilities. It is noted that the company A7 MERCATOR-S DOO NOVI SAD has no capital and is operating with a loss above the capital.

Source: Serbian Business Registers Agency

The influence of the wholesale and retail trade companies on the performance of the Serbian economy is significant. More specifically, wholesale companies (21 in total) accounted for 4,7% (Nelt Co., 0.7%, Phoenix Pharma 0.5%, Mercata VA 0.5% Knez Petrol 0.3% and other companies 2.0%) and retail trade companies (14 in total, including Delhaize Serbia 1.0%, Mercator-S 0.7%, Lidl Serbia 0.5% and other companies 2.0%) accounted for 4,1% of the total operating revenues of the 100 largest companies in Serbia in 2020 (source: Serbian Business Registers Agency). Thus, it is essential to continuously investigate the efficiency factors of trade companies in Serbia using various multi-criteria decision making methods or a combination thereof, including the ARAS method, with the aim to achieve improvements in the future by taking effective relevant measures and through effective control of their implementation.

The criteria weights shown in Table 2 and Figure 1 were determined using the AHP method. (The calculation was done using AHP Software for Excel)

AHP With Arithmetic Mean Method									
Initial Comparisons Matrix									
		C1	C2	2		C3	C4	C5	
C	1	1	2.5	5		1	2	1	
C	2	0.4	1			2	1.25	1	
C	3	1	0.5	5		1	0.5	1	
C	4	0.5	0.8	3		2	1	1	
C	5	1	1			1	1	1	
SU	М	3.9	5.8	3		7	5.75	5	
Normalise	d Matrix								
	C1	C2		С	3	C4	C5	Weights of Criteria	
C1	0.2564	0.4310)	0.14	129	0.3478	0.2000	0.2756	

 Table 2. Criteria weights

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Consistency Ratio	0.0654	COMPARE WITH 0.1; IT SHOULD			SUM	
C5	0.2564	0.1724	0.1429	0.1739	0.2000	0.1891
C4	0.1282	0.1379	0.2857	0.1739	0.2000	0.1852
C3	0.2564	0.0862	0.1429	0.0870	0.2000	0.1545
C2	0.1026	0.1724	0.2857	0.2174	0.2000	0.1956

Note: Authors' calculation

Figure 1. Weights of criteria



Source: Authors

In terms of their importance, the selected criteria are ranked as follows based on the results of evaluation using the AHP method: The most important criterion is C1 number of employees. It is followed by: C2 - assets, C5 - net income, C4 - operating income, and C3 - capital. These results suggest that by improving human resource management (through training, flexible working hours, flexible employment, career advancement, and rewards), the efficiency of trade companies in Serbia can be significantly improved. In addition, there is a need to improve the efficiency of financial capital management (by increasing sales revenues, reducing costs, and increasing profit). Furthermore, full digitalisation of operations plays an important role in achieving higher efficiency.

The empirical results of the research into the efficiency of trade companies in Serbia using the ARAS method are shown in Tables 3, 4, 5, 6, and Figure 2. (The calculation was done using ARAS Software for Excel)

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

Table 3. Initial matrix

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
0-Optimal					
Value	754	72.196	42.305	111.485	791

Note: Authors' calculation

Table 4. Normalised matrix

Normalized 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
0-Optimal Value	0.2922	0.1948	0.2659	0.1605	0.2574
A1	0.0008	0.0723	0.0837	0.1114	0.2548
A2	0.1984	0.0677	0.0373	0.0806	0.0003
A3	0.2922	0.0259	0.0064	0.0799	0.2115
A4	0.0004	0.0228	0.0177	0.0567	0.2574
A5	0.1108	0.0661	0.0402	0.0466	0.0163
A6	0.0050	0.1948	0.2659	0.1605	0.0013
A7	0.0031	0.1497	0.0000	0.1152	0.0000
A8	0.0010	0.1457	0.1810	0.0821	0.0004
A9	0.0380	0.0433	0.0830	0.0644	0.0004
A10	0.0581	0.0169	0.0190	0.0420	0.0003

Note: Authors' calculation

Table 5. Normalised weighted matrix

Normalised Weight	Normalised Weighted Matrix				
	C1	C2	C3	C4	C5
0-Optimal Value	0.0805	0.0381	0.0411	0.0297	0.0487
A1	0.0002	0.0141	0.0129	0.0206	0.0482
A2	0.0547	0.0132	0.0058	0.0149	0.0001
A3	0.0805	0.0051	0.0010	0.0148	0.0400
A4	0.0001	0.0045	0.0027	0.0105	0.0487
A5	0.0305	0.0129	0.0062	0.0086	0.0031
A6	0.0014	0.0381	0.0411	0.0297	0.0002
A7	0.0009	0.0293	0.0000	0.0213	0.0000
A8	0.0003	0.0285	0.0280	0.0152	0.0001
A9	0.0105	0.0085	0.0128	0.0119	0.0001
A10	0.0160	0.0033	0.0029	0.0078	0.0001

Note: Authors' calculation

		S	K	K	Ranking
	0-Optimal Value	0.2381	1.0000	1.0000	
NELT CO. DOO BEOGRAD	A1	0.0961	0.4037	0.4037	3
PHOENIX PHARMA DOO BEOGRAD	A2	0.0887	0.3724	0.3724	4
MERCATA VT DOO NOVI SAD	A3	0.1414	0.5937	0.5937	1
KNEZ PETROL DOO ZEMUN	A4	0.0665	0.2792	0.2792	6
AGROGLOBE DOO NOVI SAD	A5	0.0614	0.2578	0.2578	7
DELHAIZE SERBIA DOO BEOGRAD	A6	0.1105	0.4642	0.4642	2
MERCATOR-S DOO NOVI SAD	A7	0.0515	0.2161	0.2161	8
LIDL SRBIJA KD NOVA PAZOVA	A8	0.0720	0.3024	0.3024	5
MOL SERBIA DOO BEOGRAD	A9	0.0438	0.1838	0.1838	9
LUKOIL SRBIJA AD BEOGRAD	A10	0.0301	0.1265	0.1265	10

Table 6. Ranking of alternatives

Note: Authors' calculation



Figure 2. Ranking of trade companies in Serbia

Source: Authors

As can be seen from the results of efficiency evaluation using the ARAS method, the company MERCATA VT is ranked first. It is followed by: DELHAIZE SERBIA, NELT CO., PHOENIX PHARMA, LIDL SERBIA, KNEZ PETROL, AGROGLOBE, MERCATOR-S, MOL SERBIA, and LUKOIL SERBIA.

The ranking of trade companies in Serbia was influenced by favourable economic climate, but even more significantly by management efficiency as regards human resources, assets, capital, operating income and profits, which depends on the skills and competencies of trade company management. Another important factor is the application of new business models (multi-channel sales – online and offline, organic product sales, private label, etc.). Full digitalisation of operations also plays an important role. As is the case elsewhere, e-commerce has significantly mitigated the negative impact of the COVID-19 pandemic on the performance of Serbian trade companies.

To obtain a better insight into the efficiency of trade companies in Serbia with the aim to improve it in the future through effective relevant measures, it is essential to use other methods of multi-criteria decision making (TOPSIS, DEMATEL, WASPAS, etc.) and DEA models (Banker, 1984; Lukic, 2019) in addition to the ARAS method (Banker, 1984; Lukic, 2019).

To our knowledge, similar empirical research has not been conducted elsewhere in the world. It would be desirable to undertake similar research in other countries in the future. The results would enable international comparison and thus shed light on the position of trade companies in Serbia in terms of efficiency relative to trade companies in other countries.

5. CONCLUSION

Based on the results of the empirical research into the efficiency of trade companies in Serbia using the ARAS method, the following conclusions have been reached.

According to the AHP method, the importance of the selected criteria is as follows: (1) the most important criterion is C1 - the number of employees. (2) It is followed by: C2 - assets, C5 - net income, C4 - operating income, and C3 - capital. By improving human resource management (through training, flexible working hours, flexible employment, career advancement, rewards), the efficiency of trade companies in Serbia could be significantly enhanced. Moreover, the efficiency of financial capital management should be significantly increased (by increasing sales revenues, reducing costs, and increasing profits). Full digitalisation is also an important contributing factor.

The ARAS method has revealed that the most efficient company in the trade sector (both wholesale and retail) is MERCATA VT. It is followed by: DELHAIZE SERBIA, NELT CO., PHOENIX PHARMA, LIDL SERBIA, KNEZ PETROL, AGROGLOBE, MERCATOR-S, MOL SERBIA, and LUKOIL SERBIA.

The ranking of trade companies was significantly influenced by the favourable economic climate in Serbia, but even more significantly by management efficiency as regards human resources, assets, capital, operating income and profits, which depends on management skills and competencies in individual trade companies. Full digitalisation of operations also plays an important role in this respect as does the application of new business models (multi-channel sales – online and offline, organic product sales, private label, etc.). As is the case elsewhere in the world, e-commerce has significantly alleviated the negative impact of the COVID-19 pandemic on the performance of trade companies in Serbia.

To provide a better insight into the efficiency of trade companies in Serbia with the aim to improve it in the future by implementing effective relevant measures, other methods of multi-criteria decision making (TOPSIS, DEMATEL, WASPAS, etc.) and DEA models should be used, in addition to the ARAS method. A comparative international analysis is also needed.

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