EVALUATION OF TRANSPORTATION AND STORAGE EFFICIENCY IN SERBIA BASED ON RATIO ANALYSIS AND THE OCRA METHOD

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Abstract

Over the recent years, multi-criteria analysis has been increasingly used in addition to ratios to measure a company's performance and efficiency. With this in mind, the paper analyzes the efficiency of transportation and storage sector in Serbia using ratio analysis and, in particular, the OCRA method. Adequate measures are proposed to improve the efficiency of this sector in the future. The results of empirical research using this methodology indicate that the efficiency of transportation and storage sector in Serbia has significantly improved recently. The highest efficiency was recorded in 2018. In order to increase the efficiency of the transport and storage sector in Serbia in the future, it is necessary to manage human capital, assets, capital, sales and profits as efficiently as possible. The "green economy", the application of the concept of sustainable development and the digitalization of the entire business play a significant role in this.

Key words: efficiency, transportation and storage, Serbia, determinants, ratio analysis, OCRA method

1. INTRODUCTION

Retailer performance measurement is a very current, complex and major subject of scholarly discussion (Evans, 2005; Berman, 2018; Levy, 2020). The same could be said of the transportation and storage sector performance measurement using ratios and multi-criteria decision making. Considering the above, this paper focuses on analysing the efficiency of transportation and storage sector in Serbia using the OCRA method. The authors seek to address this complex issue with the aim of proposing adequate measures for enhancing the efficiency of transportation and storage sector in Serbia in the future, thereby contributing to the existing scientific and professional literature.

Recently, there has been a growing scholarly interest in assessing the performance of companies from different economic sectors using the OCRA method. However, in contrast to the AHP and TOPSIS methods, very few works focus on performance measurement in the retail sector (Velasquez, 2013; Cagri, 2013; Ersoy, 2017; Lukić, 2019, Lukić & Hadrović Zekić, 2019; Lukić et al. 2020a; Lukić et al 2020b, Lukic 2020c, 2021), and the transportation and storage sector. To the authors' knowledge, no publications are available in the Serbian literature that address the subject of transportation and storage efficiency using the OCRA method. Thus, the purpose of this study is to evaluate the performance of the transportation and storage sector in Serbia using the OCRA method.

A literature review was conducted that provides a theoretical, methodological and empirical framework for an analysis of the transportation and storage sector efficiency in Serbia using the OCRA method. The purpose is to design adequate measures for future efficiency improvements.

The main research hypothesis is that continuous monitoring of the impact of key factors on the efficiency of companies in the transportation and storage sector in Serbia is necessary to enhance its efficiency as it allows the identification of measures that should be taken to achieve this objective. The method used in this paper is called the OCRA method.

The transport sector plays a significant role in the sustainable development of the national economy in Serbia. In 2019, the transport and storage sector participated in the total number of employees in the Serbian economy with 8.50%, in the total number of companies with 6.42% and in total revenues with 6.02% (Calculated on the basis of the Agency for Business Registers of the Republic of Serbia). For these reasons, it is important to investigate the efficiency of the transport and storage sector by applying different methods of multi-criteria decision-making, which means OCRA methods.

The necessary empirical data were drawn from the Serbian Business Directory. They are internationally comparable since they are produced in accordance with relevant international standards. In terms of international comparability, there are no restrictions in this regard. The research included all companies from the transport and storage sector (6810) that officially submit annual financial reports to the Business Registers Agency of the Republic of Serbia.

The research structure of the treated problem in this paper is composed so that, in addition to the Introduction and Conclusion, it includes (1) characteristics of the OCRA method, (2) ratio analysis of traffic and storage efficiency in Serbia and (3) assessment of traffic and storage efficiency in Serbia.

2. OCRA METHOD

The Operational Competitiveness Rating (OCRA) method was proposed by Parkan (Parkan, 1994) and further developed by Parkan and Wu (Parkan, 1997, 1999, 2000). Originally, this method was developed to measure the relative performance of a set of production units where resources are used to create value-added outputs (Chatterjee, 2012). It was later used to solve various multi-criteria decision making

problems. The OCRA method is based on the intuitive approach that takes into account decision maker's preferences regarding the relative importance of criteria (Parkan, 1997). The main advantage of the OCRA method is that it can be applied in multi-criteria decision making (MCDM) situations where the relative weights of individual criteria depend on the alternatives, and different weights are given to criteria for different alternatives, given that some of the criteria are not applicable to all alternatives, etc. (Chatterjee, 2012). The main idea behind the OCRA method is to perform an independent evaluation of the alternative considering the benefit and cost criteria and, finally, to combine the two aggregate ratings to obtain a competitive rating, which helps the decision maker not to lose information during the decision-making process (Madić, 2015). The procedure of the improved OCRA method is as follows (Parkan, 2000; Chatterjee, 2012; Liu, 2013; Stanujkić, 2017):

Step 1: Calculate the aggregate performance ratings for the cost criterion as follows:

$$\overline{I}_i = \sum_{j \in \Omega_{min}} w_j \frac{max_j x_{ij} - x_{ij}}{min_j x_{ij}} \in [-1,1], \qquad (1)$$

where $\overline{I}_i$ denotes the aggregate performance rating of the alternative *i* obtained based on the cost (input) criterion, x_{ij} denotes the performance rating of the alternative *i* with respect to the j[th], and Ω_{min} is a set of cost (minimization) criteria.

Based on Louis et al. (2013), the previous equation can be replaced with the following:

$$\overline{I}_i = \sum_{j \in \Omega_{min}} w_j \frac{max_j x_{ij} - x_{ij}}{max_j x_{ij} - min_j x_{ij}} \in [-1,1]. \qquad (2)$$

Step 2: Calculate the linear performance rating for the cost criterion as follows:

$$\overline{\overline{I}}_i = \overline{I}_i - min_i \overline{I}_i, \qquad (3)$$

where $\overline{\overline{I}}_i$ denotes the linear performance rating of the alternative *i* obtained based on the cost criterion.

The linear scaling in the OCRA method was performed with the aim of assigning a score of zero as the least preferred alternative.

Step 3: Calculate the aggregate performance rating with respect to the benefit criterion as follows:

$$\overline{O}_i = \sum_{j \in \Omega_{max}} w_j \frac{x_{ij} - min_j x_{ij}}{min_j x_{ij}} \in [-1,1], \qquad (4)$$

where $\overline{O}_i$ denotes the aggregate performance rating of the alternative i obtained based on the benefit (output) criterion, and Ω_{max} is a set of benefit (maximization) criteria.

Based on Louis et al. (2013), the previous equation can be replaced by the following equation:

$$\overline{O}_i = \sum_{j \in \Omega_{max}} w_j \frac{x_{ij} - min_j x_{ij}}{max_j x_{ij} - min_j x_{ij}} \in [-1,1], \qquad (5)$$

Step 4: Calculate the linear performance rating for the benefit criterion as follows:

$$\overline{\overline{O}}_i = \overline{O}_i - min_i \overline{O}_i, \qquad (6)$$

where $\bar{\bar{O}}_i$ denotes the linear performance rating of the alternative *i* obtained based on the benefit criterion.

Step 5: Calculate the global performance rating as follows:

$$P_i = \bar{\bar{I}}_i + \bar{\bar{O}}_i - \min\left(\bar{\bar{I}}_i + \bar{\bar{O}}_i\right), \quad (7)$$

where *Pi* denotes the global performance rating of the alternative *i*.

Step 6: Select the most preferred alternative. Based on the OCRA method, the alternative with the highest value of P_i is the most preferred alternative.

The calculation procedure in the OCRA method is based on the use of the distance from the least preferred performance criteria, i.e. $max_j\ x_{ij} - x_{ij}$ for the cost criteria and $x_{ij} - min_j\ x_{ij}$ for the benefit criteria. In this respect, the OCRA method is similar to the TOPSIS and VIKOR methods. However, the OCRA method has some specific characteristics, e.g. the normalization procedure shown in equations (1) and (3). Compared to conventional normalization procedures, the traditional OCRA method normalization procedure does not allow the values of the normalized performance rating to always belong to the interval [0,1], i.e. in some cases they may be greater than one. The OCRA method was improved by replacing equations (1) and (4) with equations (2) and (5). This allows normalized performance ratings to always belong to the interval [0,1].

3. RATIO ANALYSIS OF THE TRANSPORTATION AND STORAGE SECTOR EFFICIENCY IN SERBIA

Ratio analysis can be used to assess the efficiency of the transportation and storage sector. Table 1 shows the initial data for measuring the efficiency of transportation and storage in Serbia using ratio analysis.

Table 1. Initial data for measuring the transportation and storage sector efficiency in Serbia (in millions of dinars)

	Employee earnings	Assets	Capital	Sales	Net profit
2013	93,152	817,605	386,360	465,439	16,075
2014	95,291	852,616	407,742	196,067	20,959
2015	88,876	743,104	467,980	149,028	24,564
2016	104,223	791,564	475,628	134,497	27,140
2017	107,881	831,863	498,248	143,176	29,439
2018	115,218	1,068,997	607,640	154,746	75,645
2019	117,487	816,974	343,528	179,106	26,813

Source: Serbian Business Registers Agency (SBRA)

Table 2 shows the ratio analysis (indicators) of traffic and storage efficiency in Serbia for the period 2013 - 2019.

Table 2. Ratio analysis of traffic and storage efficiency in Serbia

	Asset turnover ratio (Sales/ Assets)	Return on assets (Profit/ Assets), (%)	Return on equity (Profit/ Equity), (%)	Return on sales (Profit/ Sales), (%)	Employee earnings in sales (Employee earnings / Sales) (%)	Net profit to employee earnings (Profit/ Employee earnings)
2013	0.569271	1.97	4.16	3.45	20.01	0.172567
2014	0.229959	2.46	5.14	10.69	48.60	0.219947
2015	0.200548	3.31	5.25	16.48	59.64	0.276385
2016	0.169913	3.43	5.71	20.18	77.49	0.260403
2017	0.172115	3.54	5.91	20.56	75.35	0.272884
2018	0.144758	7.08	12.45	48.88	74.46	0.656538
2019	0.219231	3.28	7.81	14.97	65.60	0.228221

Note: Authors' calculation

Table 3 shows the descriptive statistics of the transportation and storage sector performance ratios in Serbia.

Table 3. Descriptive statistics of transportation and storage performance ratios in Serbia

Descriptive Statistics							
		1 Asset turnover ratio	2 Return on assets	3 Return on equity	4 Return on sales	5 Sales to employee earnings	6 Employee earnings in sales
N	Valid	7	7	7	7	7	7
	Missing	0	0	0	0	0	0
Mean		0.2437	3.5814	6.6329	19.3157	60.1643	0.2981
Std. Error of Mean		0.05542	0.62266	1.05622	5.41029	7.73224	0.06129
Median		0.2005	3.3100	5.7100	16.4800	65.6000	0.2604
Std. Deviation		0.14663	1.64740	2.79449	14.31429	20.45758	0.16215
Skewness		2.419	1.940	1.884	1.679	-1.485	2.362
Std. Error of Skewness		0.794	0.794	0.794	0.794	0.794	0.794
Kurtosis		6.101	4.621	3.737	3.862	2.070	5.949
Std. Error of Kurtosis		1.587	1.587	1.587	1.587	1.587	1.587
Minimum		0.14	1.97	4.16	3.45	20.01	0.17
Maximum		0.57	7.08	12.45	48.88	77.49	0.66

Note: Authors' calculation using the SPSS software

Table 4 shows the correlation matrix of performance ratios for the transportation and storage sector in Serbia.

Table 4. Correlation matrix of performance ratios for the transportation and storage sector in Serbia

		1	2	3	4	5	6
1 Asset turnover ratio	Pearson Correlation	1	-0.567	-0.492	-0.627	-0.934**	-0.477
	Sig. (2-tailed)		0.184	0.262	0.132	0.002	0.279
	N	7	7	7	7	7	7
2 Return on assets	Pearson Correlation	-0.567	1	0.949**	0.994**	0.608	0.984**
	Sig. (2-tailed)	0.184		0.001	0.000	0.148	0.000
	N	7	7	7	7	7	7
3 Return on equity	Pearson Correlation	-0.492	0.949**	1	0.922**	0.524	0.924**
	Sig. (2-tailed)	0.262	0.001		0.003	0.227	0.003
	N	7	7	7	7	7	7
4 Return on sales	Pearson Correlation	-0.627	0.994**	0.922**	1	0.667	0.974**
	Sig. (2-tailed)	0.132	0.000	0.003		0.102	0.000
	N	7	7	7	7	7	7
5 Employee earnings in sales	Pearson Correlation	-0.934**	0.608	0.524	0.667	1	0.486
	Sig. (2-tailed)	0.002	0.148	0.227	0.102		0.269
	N	7	7	7	7	7	7
6 Net profit to employee earnings	Pearson Correlation	-0.477	0.984**	0.924**	0.974**	0.486	1
	Sig. (2-tailed)	0.279	0.000	0.003	0.000	0.269	
	N	7	7	7	7	7	7
**. Correlation is significant at the 0.01 level (2-tailed).							

Note: Authors' calculation using the SPSS software

Correlation analysis shows that the asset turnover ratio significantly affects the relationship between sales and employee earnings (i.e. sales per employee). Likewise, the ratio between net profit and employee earnings (i.e., profit per employee) significantly affects return on assets, return on equity, and return on sales. Therefore, in order to increase the efficiency of transportation and storage in Serbia, it is necessary to manage assets, human capital and profit as efficiently as possible

The results of ratio analysis show that the efficiency of transportation and storage in Serbia was highest in 2018. The values of all indicators for this year are significantly above the average (Table 2), and similarly for 2017, 2016 and 2015. In 2019, the sector efficiency was lower than in 2018, 2017, 2016 and 2015, but higher than in 2014 and 2013. The reason for that is partly a decrease in net profit and an increase in employee costs in 2019 compared to 2018. Overall, it can be concluded that the efficiency of transportation and storage in Serbia has been increasing lately.

4. ESTIMATION OF TRANSPORTATION AND STORAGE EFFICIENCY IN SERBIA USING THE OCRA METHOD

In measuring the efficiency of transportation and storage in Serbia using the OCRA method, the following criteria were considered: C1 – employee earnings, C2 - assets, C3 - capital, C4 - sales and C5 - net profit. Alternatives were the observed years: A1 - 2013, A2 - 2014, A3 - 2015, A4 - 2016, A5 - 2017, A6 - 2018 and A7 - 2019. (Calculation of the efficiency of companies in the transportation and storage sector in Serbia was performed using OCRASoftware-Excel). The obtained results are shown in the tables below, as well as in Figure 1. The weight coefficients of the criteria were determined using the fuzzy DEMATEL method (Gaur et al., 2020).

Table 5 shows the initial data for measuring the efficiency of transportation and storage in Serbia for the period 2013 - 2019 using the OCRA method.

Table 5. Initial matrix

Initial Matrix					
weights of criteria	0.17	0.17	0.192	0.193	0.275
kind of criteria	-1	1	1	1	1
	C1	C2	C3	C4	C5
A1	93152	817605	386360	465439	16075
A2	95291	852616	407742	196067	20959
A3	88876	743104	467980	149028	24564
A4	104223	791564	475628	134497	27140
A5	107881	831863	498248	143176	29439
A6	115218	1068997	607640	154746	75645
A7	117487	816974	343528	179106	26813
MAX	117487	1068997	607640	465439	75645
MIN	88876	743104	343528	134497	16075

Note: Authors' calculation using the SPSS software

Table 6 shows preference ratings for non-benefit (cost) criteria.

Table 6. Preference ratings for non-benefit criteria

Preference ratings with respect to non-beneficial criteria	C1	C2	C3	C4	C5	Measure of relative performance $\bar{I}$	Linear preference rating $\bar{\bar{I}}$
A1	0.0465	0.0000	0.0000	0.0000	0.0000	0.0465	0.0465
A2	0.0425	0.0000	0.0000	0.0000	0.0000	0.0425	0.0425
A3	0.0547	0.0000	0.0000	0.0000	0.0000	0.0547	0.0547
A4	0.0254	0.0000	0.0000	0.0000	0.0000	0.0254	0.0254
A5	0.0184	0.0000	0.0000	0.0000	0.0000	0.0184	0.0184
A6	0.0043	0.0000	0.0000	0.0000	0.0000	0.0043	0.0043
A7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Preference ratings with respect to non-beneficial criteria	C1	C2	C3	C4	C5	Measure of relative performance $\bar{I}$	Linear preference rating $\bar{\bar{I}}$
						0.0000	
						MIN	

Note: Authors' calculation using the SPSS software

Table 7 shows preference ratings for benefit (income) criteria.

Table 7. Preference ratings for benefit criteria

Preference ratings with respect to beneficial criteria	C1	C2	C3	C4	C5	Measure of relative performance $\bar{O}$	Linear preference rating $\bar{\bar{O}}$
	0.0000	0.0170	0.0239	0.4749	0.0000	0.5159	0.2830
A1	0.0000	0.0251	0.0359	0.0884	0.0836	0.2328	0.0000
A2	0.0000	0.0000	0.0696	0.0209	0.1452	0.2356	0.0028
A3	0.0000	0.0111	0.0738	0.0000	0.1893	0.2742	0.0414
A4	0.0000	0.0203	0.0865	0.0125	0.2286	0.3479	0.1150
A5	0.0000	0.0746	0.1476	0.0291	1.0191	1.2703	1.0375
A6	0.0000	0.0169	0.0000	0.0640	0.1837	0.2646	0.0318
A7	0.0000	0.0170	0.0239	0.4749	0.0000	0.5159	0.2830
						0.2328	
						MIN	

Note: Authors' calculation using the SPSS software

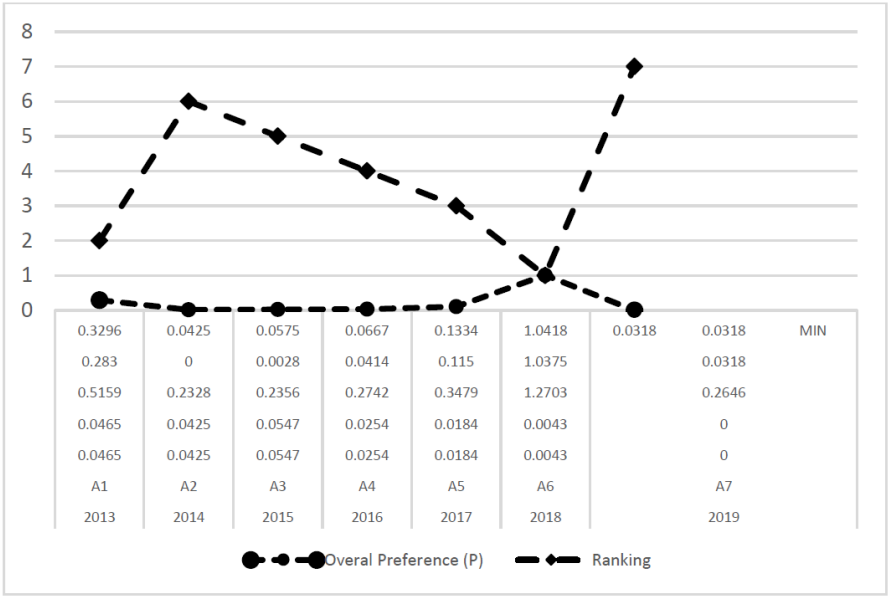
Table 8 and Figure 1 show the overall preference (P) and alternative rankings.

Table 8. Overall preference and alternative rankings

	Alterna-tives	$\bar{I}$	$\bar{\bar{I}}$	$\bar{O}$	$\bar{\bar{O}}$	$\bar{\bar{I}} + \bar{\bar{O}}$	Overall Preference (P)	Rank
2013	A1	0.0465	0.0465	0.5159	0.2830	0.3296	0.2978	2
2014	A2	0.0425	0.0425	0.2328	0.0000	0.0425	0.0107	6
2015	A3	0.0547	0.0547	0.2356	0.0028	0.0575	0.0257	5
2016	A4	0.0254	0.0254	0.2742	0.0414	0.0667	0.0350	4
2017	A5	0.0184	0.0184	0.3479	0.1150	0.1334	0.1016	3
2018	A6	0.0043	0.0043	1.2703	1.0375	1.0418	1.0100	1
2019	A7	0.0000	0.0000	0.2646	0.0318	0.0318	0.0000	7
						0.0318		
						MIN		

Note: Authors' calculation using the SPSS software

Figure 1. Overall preference and alternative rankings



Note: Authors' calculation using the SPSS software

The results of research using the OCRA method indicate that the efficiency of transportation and storage in Serbia was highest in 2018. This concurs with the results of ratio analysis. 2018 is followed by 2013, 2017, 2016, 2015, 2014 and 2019, ranked in order of decreasing efficiency. This was partly influenced by the increase in the salary of employees in 2019 compared to 2018. The efficiency was lowest in 2019 due to the drastic reduction of net profit compared to the previous year. With the exception of 2019, overall, the efficiency of transportation and storage in Serbia has been increasing lately.

To increase the efficiency of transportation and storage in Serbia in the future, it is necessary to manage human capital, assets, capital, sales and profit more efficiently. New logistics business models, the concept of green economy and the digitalization of the entire transportation and storage process have a significant role in this.

In 2020, a significant negative impact of the Covid-19 virus coronary pandemic on the efficiency of the transport and storage sector in Serbia was recorded. This is not the case with trade, however. The impact of the Covid-19 coronary virus pandemic on trade efficiency in Serbia has been mitigated with increased electronic sales, as is the case in other countries (Lukic, 2021).

In order to gain a more complete picture of the efficiency of traffic and storage in Serbia, it is necessary, for comparison, to perform an analysis using other methods of multi-criteria decision-making, such as: TOPSIS, WASPAS, VIKOR, AHP and others. Also, by applying the DEA model.

5. CONCLUSION

The results of the research obtained using ratio analysis show that the efficiency of transportation and storage in Serbia was highest in 2018. According to all indicators, it is significantly above average. It is followed by 2017, 2016 and 2015. In 2019, the efficiency of this sector was lower than in 2018, 2017, 2016 and 2015, but higher than in 2014 and 2013. Overall, it can be concluded that the efficiency of transportation and storage in Serbia has been increasing recently.

Correlation analysis shows that the asset turnover ratio significantly affects the relationship between sales and employee earnings (i.e. sales per employee). Likewise, the ratio between net profit and employee earnings (i.e. profit per employee) significantly affects return on assets, return on equity, and return on sales. Therefore, in order to increase the efficiency of transportation and storage in Serbia, it is necessary to enhance the efficiency of the management of assets and human capital.

The research results obtained using the OCRA method are consistent with those obtained through ratio analysis, indicating that the efficiency of transportation and storage in Serbia was highest in 2018. 2018 is followed by 2013, 2017, 2016, 2015, 2014 and 2019, ranked in order of sector efficiency from highest to lowest. The lowest efficiency was recorded for 2019 due to the drastic reduction of net profit and increased employee salary costs compared to the previous year. With the exception of 2019, as a whole, the efficiency of transportation and storage in Serbia has recently increased year on year (under the positive influence of numerous macro and micro factors).

To enhance the efficiency of transportation and storage in Serbia in the future, it is necessary to manage human capital, assets, capital, sales and profits as efficiently as possible. The concepts of integrated logistics and green economy could play an important role in achieving that. Moreover, the digitalization of the entire process of transportation and storage is essential.

It should be emphasized that the possibility of comparing the obtained results of research on the efficiency of the transport and storage sector in Serbia using the OCRA method at the international level is limited. Due to the fact that in the literature there are, as far as we know, similar empirical research for other countries. Therefore, it is necessary to analyze the efficiency of the transport and storage sector in other countries using the OCRA method.

In relation to the ratio analysis, the OCRA method gives more precise results of research on traffic and storage efficiency in Serbia. Therefore, it is recommended, especially in combination with other methods of multi-criteria decision-making (TOPSIS, ARAS, AHP and others).

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