Analysis of food retail efficiency in Serbia

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Abstract

As it is known, the issue of analysing the efficiency of all companies, which means trade companies, is very current, significant and complex. In this context, mathematical methods and models are increasingly being applied. Having this insight, this paper investigates the efficiency of food retailers in Serbia using AHP (Analytical Hierarchy Process) and DEA (Data envelopment analysis) methods. The aim and purpose of this paper is to examine the current efficiency of food retailers in Serbia in order to improve it in the future by taking appropriate measures. Of all the observed optimization criteria (purchase value of sold goods, operating costs, gross margin and net profit), the most significant is the purchase value of sold goods. The most efficient food retailer in Serbia is Delhaize Serbia. According to the DEA analysis, Mercator-S is inefficient. In order to improve the efficiency of food retailers in Serbia, it is necessary to apply new business models (private label, multi-channel sales, organic food sales, etc.), the concepts of strategic management accounting and strengthen the digitalization of business.

Key words: *efficiency, food retail, Serbia, AHP, DEA*

Introduction

Given the importance, the subject of research in this paper is to measure the efficiency of food retailers in Serbia. The aim and purpose of the given research is to determine the factual situation and, on that basis to propose adequate measures for improvement in the future.

As is well known, there is a very rich literature devoted to the general issue of applying DEA analysis in evaluating the efficiency of companies (Hwang, 1981; Hwang, 1995; Andersen, 1993; Yousefi, 2010; Li, 2014, 2017; Tsolas, 2015). It is getting richer when it comes to application in the retail sector (Bhargava, 1998; Karan, 2008; Keener, 2013; Kingyens, 2012; Konuk, 2018; Lau, 2013; Manini, 2018; Martini 2017; Pang, 2013; Paradi, 2014; Rogova, 2018; Simbolon, 2017; Trejo, 2017; Zaernyuk, 2016; Üçüncü, 2018; Urbonavičiūtė, 2019; Saaty, 1970; Saaty 1980; Saaty, 2001; Saaty, 2008; Harker, 1987; Hanie, 2016; Stojanović, 2016). Recently, the AHP method has been increasingly used, individually or integrally with DEA methods (Chang, 1996; Saaty, 1986; Harker, 1987; Alphonce, 1997; Saaty, 2001; Saaty, 2008; Hanie, 2016; Stojanovic, 2016). As far as the literature in Serbia is concerned, it is very poor in this respect, only in some papers the AHP (Analytical Hierarchy Process) and DEA (Data envelopment analysis) methods are partially applied (Lukic, 2011; 2018, 2019; Lukic, 2018), and this reflects, among other things, his scientific and professional contribution. The analytical hierarchical process belongs to the class of methods for soft optimization. It is basically specific a tool for forming and analyzing decision-making hierarchies.

Analytical Hierarchy Process - AHP first enables interactive hierarchy creation problems as preparation of decision scenarios, and then evaluation in pairs of elements of the hierarchy (goals, criteria and alternatives) in a top-down direction. In the end, the synthesis of all evaluations is performed according to the strictly established the mathematical model is determined by the weight coefficients of all elements of the hierarchy. Sum of weighting coefficients elements at each level of the hierarchy is equal to 1 which allows the decision maker to rank all the elements in horizontal and vertical sense.

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The DEA (*Data envelopment analysis*) method is a mathematical programming technique that allows to determine whether each of the units, based on data on its input and output variables, is relatively efficient or not in relation to the other units included in the analysis. In order to create a summary synthetic indicator that will take into account all significant multiple outcomes and all resources used for them the following efficiency measure is defined:

Efficiency = weight sum of inputs / weight sum of output

Definition allows the aggregation of the observed inputs (outputs) into one virtual input (output) which represent the sum of the products of weight coefficients and the values of inputs or outputs to whom they are assigned. Calculation of efficiency index as a quotient of virtual output and virtual input meant solving a problem related to the expression of input and output data in ranges of values that are comparable to each other (scaling problem). Next the problem relates to determining the relative importance of individual inputs or outputs (weighting or weighting).

From the very nature of the problem treated in this paper, the basic hypothesis of the research arises: knowledge of the current situation is a prerequisite for improving the efficiency of food retailers in the future. This can be achieved by taking adequate measures.

Material and methods

The research of the given hypothesis in this paper is based on the application of AHP and DEA methods. To some extent, ratio analysis and statistical analysis are used as a whole.

For the purposes of researching the problem treated in this paper, empirical data were taken from the Business Registers Agency of the Republic of Serbia. They are "manufactured" in accordance with relevant international standards and there are no restrictions on their comparability. This fully applies to the obtained research results.

Results and discussion

Table 1 shows, as a whole, due to the treated problem in this paper, some performance indicators of selective food retailers in Serbia for 2018.

Table 1. Some performance indicators of selective food retailers in Serbia, 2018

	Gross Margin / Sales (%)	Operating expenses / Sales (%)	Net profit / Sales (%)
Delhaize Serbia	30 %	27 %	3 %
Mercator-S	21 %	23 %	-2 %
DIS shop	10 %	9 %	1 %
Aman	17 %	14 %	3 %
Univerexport	23 %	23 %	0 %

Note: Author's calculation
Source: Agency for Business Registers of the Republic of Serbia

There are therefore significant differences in the gross margin rate between the observed food retailers in Serbia. They range from 10% (DIS shop) to 30% (Delhaize Serbia). These differences in their own way reflect on their efficiency, given that the gross margin (as the difference between sales and purchase value of goods sold) covers operating costs (operating costs) and the rest is net profit.

Table 2 shows the statistics of input / output data used to assess the efficiency of selective food retailers in Serbia for 2018 using AHP and DEA methods.

Table 2. Data input / output statistics

		(I) Cost of goods sold (in millions of dinars)	(I) Operating costs (in millions of dinars)	(O) Gross margin (in millions of dinars)	(O) Net profit (in millions of dinars)
Delhaize Serbia		70666	27157	29822	2665
Mercator-S		65054	19376	17714	-1662
DIS shop		17490	1840	1879	39
Aman		14256	2451	2871	420
Univerexport		14236	4309	4339	30
Statistics on Input / Output Data					
Max		70666	27157	29822	2665
Min		14236	1840	1879	-1662
Average		36340.4	11026.6	11325	298.4
SD		25823.9	10324.4	10885.4	1385.5
Correlations					
Cost of goods sold	Pearson Correlation	1	.979 **	.952 *	.185
	Sig. (2-tailed)		.004	.013	.766
	N	5	5	5	5
Operating costs	Pearson Correlation	.979 **	1	.993 **	.349
	Sig. (2-tailed)	.004		.001	.565
	N	5	5	5	5
Gross margin	Pearson Correlation	.952 *	.993 **	1	.458
	Sig. (2-tailed)	.013	.001		.438
	N	5	5	5	5
Net profit	Pearson Correlation	.185	.349	.458	1
	Sig. (2-tailed)	.766	.565	.438	
	N	5	5	5	5

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).
Note: Author ‘s calculation of input / output data statistics using the software program DEA - Solver and SPSS
Source: Agency for Business Registers of the Republic of Serbia.

In further presentations of the treated issues, we will examine the efficiency of selective food retailers in Serbia for 2018 using the AHP method, in relation to the criteria and attributes. In Table 3. the initial matrix, decision matrix and priorities are shown. (Data processing was performed using the AHP Online System - AHP-OS.)

Therefore, in the order of importance of the selected optimization criteria, the situation is as follows: cost of goods sold, operating costs, gross margin and net profit. This is quite understandable given the fact that the cost of goods sold is the most important investment in the trade sector. Operating costs are also very significant in trade and most of them relate to employee salaries. Employee earnings affect the motivation of employees to achieve as much sales as possible, with maximum satisfaction of consumer needs. The yield of gross margin on inventories is a significant indicator of trade performance. Likewise, the return on net sales profit is a significant indicator of trade performance.

Table 3. Priorities

Priorities					
		Priority	Rank	(+)	(-)
1	Cost of goods sold	53.3%	1	9.6%	9.6%
2	Operating costs	32.1%	2	4.7%	4.7%
3	Gross margin	8.2%	3	1.7%	1.7%
4	Net profit	6.4%	4	1.2%	1.2%

Note: Number of comparisons = 6 CR = 1.9% OK. Author’s calculation using AHP Online System - AHP-OS

Table 4a,b,c show in the context of measuring the efficiency and retailers of food in Serbia a matrix of the importance of criteria, attributes and evaluation of choices. Data processing was performed using AHP Example (xls).

Table 4a. Matrix of significance of selection criteria, attributes and evaluation- Summary

Summary	Delhaize Serbia # 1		Mercator-s # 2		DIS shop # 3		Aman # 4		Univerexport # 5		Final Score	
	Weighting	Score	Weighting	Score	Weighting	Score	Weighting	Score	Weighting	Score		
Cost of goods sold # 1	0.407	0.518	0.260	0.517	0.145	0.581	0.099	0.541	0.089	0.564	0.533	
Operating Costs # 2	0.407	0.136	0.260	0.247	0.145	0.250	0.099	0.260	0.089	0.255	0.204	
Gross Margin # 3	0.407	0.213	0.260	0.140	0.145	0.125	0.099	0.140	0.089	0.131	0.167	Check
Net profit # 4	0.407	0.133	0.260	0.096	0.145	0.043	0.099	0.059	0.089	0.050	0.096	1,000

Table 4b. Prioritization Matrix

Prioritization Matrix	Delhai ze Serbia # 1	Mercator-s # 2	DIS shop # 3	Aman # 4	Univerexport # 5	Delhaize Serbia # 1	Mercator-s # 2	DIS # 3	Aman # 4	Univerexport # 5	
Delhaize Serbia # 1	1	2	3	7	2	0.4038	0.4762	0.4286	0.56	0.1667	0.407
Mercator-s # 2	0.5	1	2	2	5	0.2019	0.2381	0.2857	0.16	0.4167	0.260
DIS shop # 3	0.3333	0.5	1	2	2	0.1346	0.119	0.1429	0.16	0.1667	0.145
Aman # 4	0.1429	0.5	0.5	1	2	0.0577	0.119	0.0714	0.08	0.1667	0.099
Univerexport # 5	0.5	0.2	0.5	0.5	1	0.2019	0.0476	0.0714	0.04	0.0833	0.089
	2.4762	4.2	7	12.5	12	1.000	1.000	1.000	1.000	1.000	1.000

Table 4c. Five Most Important Attributes:

Attribute #1										
Delhaize Serbia # 1	Cost of goods sold # 1	Operating Costs # 2	Gross Margin # 3	Net profit # 4		Cost of goods sold # 1	Operating Costs # 2	Gross Margin # 3	Net profit # 4	
Cost of goods sold # 1	1	5	5	2		0.5263	0.5263	0.7317	0.2857	0.518
Operating Costs # 2	0.2	1	0.3333	2		0.1053	0.1053	0.0488	0.2857	0.136
Gross Margin # 3	0.2	3	1	2		0.1053	0.3158	0.1463	0.2857	0.213
Net profit # 4	0.5	0.5	0.5	1		0.2632	0.0526	0.0732	0.1429	0.133
	1.9	9.5	6.8333	7		1.000	1.000	1.000	1.000	1.000

Attribute #2

Mercator-s # 2	Purchase value of sold goods # 1	Operating Costs # 2	Gross Margin # 3	Net profit # 4	Cost of goods sold # 1	Operating Costs # 2	Gross Margin # 3	Net profit # 4	
Cost of goods sold # 1	1	36	3	0.5455	0.6429	0.5806	0.3	0.517	
Operating Costs # 2	0.3333	13	3	0.1818	0.2143	0.2903	0.3	0.247	
Gross Margin # 3	0.1667	0.3333	1	3	0.0909	0.0714	0.0968	0.3	0.140
Net profit # 4	0.3333	0.3333	0.3333	1	0.1818	0.0714	0.0323	0.1	0.096
	1.8333	4.6667	10.333	10	1.000	1.000	1.000	1.000	1.000
			the most common						

Attribute #3

DIS # 3	Cost of goods sold # 1	Operating Costs # 2	Gross Margin # 3	Net profit # 4	Cost of goods sold # 1	Operating Costs # 2	Gross Margin # 3	Net profit # 4	
Cost of goods sold # 1	1	7	7	7	0.7	0.8448	0.4623	0.3182	0.581
Operating Costs # 2	0.1429	1	7	7	0.1	0.1207	0.4623	0.3182	0.250
Gross Margin # 3	0.1429	0.1429	1	7	0.1	0.0172	0.066	0.3182	0.125
Net profit # 4	0.1429	0.1429	0.1429	1	0.1	0.0172	0.0094	0.0455	0.043
	1.4286	8.2857	15,143	22	1.000	1.000	1.000	1.000	1.000
			the most common						

Attribute #4

Aman # 4	Cost of goods sold # 1	Operating Costs # 2	Gross Margin # 3	Net profit # 4	Cost of goods sold # 1	Operating Costs # 2	Gross Margin # 3	Net profit # 4	
Cost of goods sold # 1	1	5	5	5	0.625	0.7813	0.4464	0.3125	0.541
Operating Costs # 2	0.2	1	5	5	0.125	0.1563	0.4464	0.3125	0.260
Gross Margin # 3	0.2	0.2	1	5	0.125	0.0313	0.0893	0.3125	0.140
Net profit # 4	0.2	0.2	0.2	1	0.125	0.0313	0.0179	0.0625	0.059
	1.6	6.4	11.2	16	1.000	1.000	1.000	1.000	1.000

Attribute #5

Univerexport # 5	Cost of goods sold # 1	Operating Costs # 2	Gross Margin # 3	Net profit # 4	Cost of goods sold # 1	Operating Costs # 2	Gross Margin # 3	Net profit # 4	
Cost of goods sold # 1	1	6	6	6	0.6667	0.8182	0.4557	0.3158	0.564
Operating Costs # 2	0.1667	1	6	6	0.1111	0.1364	0.4557	0.3158	0.255
Gross Margin # 3	0.1667	0.1667	1	6	0.1111	0.0227	0.0759	0.3158	0.131
Net profit # 4	0.1667	0.1667	0.1667	1	0.1111	0.0227	0.0127	0.0526	0.050
	1.5	7.3333	13.167	19	1.000	1.000	1.000	1.000	1.000
			the most common						

Note: Author's calculation using AHP Example (xls)

Therefore, in this particular case, the significance of individual criteria in the order is as follows: Cost of goods sold, operating costs, gross margin and net profit. The cost of goods sold and operating costs are inputs, and gross margin and net profit are outputs (yields). The goal is to achieve the highest possible yields with the given resources. The order of efficiency of the observed companies is: Delhaize Serbia, Mercator-S, DIS shop, Aman and Univerexport.

The evaluation of the selection of Delhaize Serbia's criteria in the order is as follows: cost of goods sold, gross margin, operating costs and net profit. For the other observed companies (Mercator-S, DIS shop, Aman and Univerexport), the order of evaluation of the selection criteria is the same: cost of goods sold, operating costs, gross margin and net profit.

In further presentations of the treated issues, we will evaluate the business efficiency of selective food retailers in Serbia and using the DEA method. We will use Model = BCC-O. Inputs are: cost of goods sold and operating costs. Outputs are: gross margin and net profit. Table 5 shows the correlation matrix of input / output data.

Table 5. Data input / output correlation matrix

	Cost of goods sold	Operating costs	Gross margin	Net profit
Cost of goods sold	1	0.97854	0.95164	0.18492
Operating costs	0.97854	1	0.99286	0.34883
Gross margin	0.95164	0.99286	1	0.45813
Net profit	0.18492	0.34883	0.45813	1

Note: Author's calculation using the DEA software program - Solver, Model = BCC-O

The data in the given table show that there is a positive strong correlation between the cost of goods sold, operating costs and gross margin. There is a weak correlation between them and net profit.

Table 6 and Fig. 1 show the efficiency of selective food retailers in Serbia determined using the BCC-O model.

Table 6. Efficiency of food retailers in Serbia

Model = BCC-O							
No.	DMU	Score	Rank	References (Lambda)			RTS of Projected DMU
1	Delhaize Serbia	1	1	1			Constant
2	Mercator-S	0.8303	5	0.685	Aman	0.315	Constant
3	DIS shop	1	1	1			Increasing
4	Aman	1	1	1			Constant
5	Univerexport	1	1	1			Increasing
		No. of Efficient DMUs = 4					No. of Increasing RTS = 2
							No. of Constant RTS = 3
		No. of Inefficient DMUs = 1					No. Decreasing of RTS = 0
	Average	0.9661					
	Max	1					
	Min	0.8303					
	St Dev	0.0759					

Note: Author's calculation using the DEA software program - Solver, Model = BCC-O

Table 7. Projection of input / output data

Model = BCC-O				Cost of goods sold			Operating costs			Gross margin			Net profit		
No.	DMU	Score	Rank	Data	Projection	Diff. (%)	Data	Projection	Diff. (%)	Data	Projection	Diff. (%)	Data	Projection	Diff. (%)
1	Delhaize Serbia	1	1	70666	70666	0	27157	27157	0	29822	29822	0	2665	2665	0
2	Mercator-S	0.8303	5	65054	52900.1	-18,683 the most common	19376	19376	0	17714	21334	20,436 the most common	-1662	-43,718 the most common	-97.37
3	DIS shop	1	1	17490	17489.7	-0.002	1840	1840	0	1879	1879.01	0.001	39	39.0111	0.028
4	Aman	1	1	14256	14256	0	2451	2451	0	2871	2871	0	420	420	0
5	Univerexport	1	1	14236	14236	0	4309	4309	0	4339	4339.01	0	30	30.0094	0.031
	Average	0.9661	1.8	36340.4	33909.6	-3,737 the most common	11026.6	11026.6	0	11325	12049	4.0874	298.4	622,061	-19,462 the most common
	Max	1	5	70666	70666	0	27157	27157	0	29822	29822	20,436 the most common	2665	2665	0.031
	Min	0.8303	1	14236	14236	-18,683 the most common	1840	1840	0	1879	1879.01	0	-1662	-43,718 the most common	-97.37
	St Dev	0.0759	1.7889	28872	26242.1	8.3551	11543	11543	0	12170.2	12739.7	9.1391	1549.04	1156.3	43.5518

Note: Author's calculation using the DEA software program - Solver, Model = BCC-O

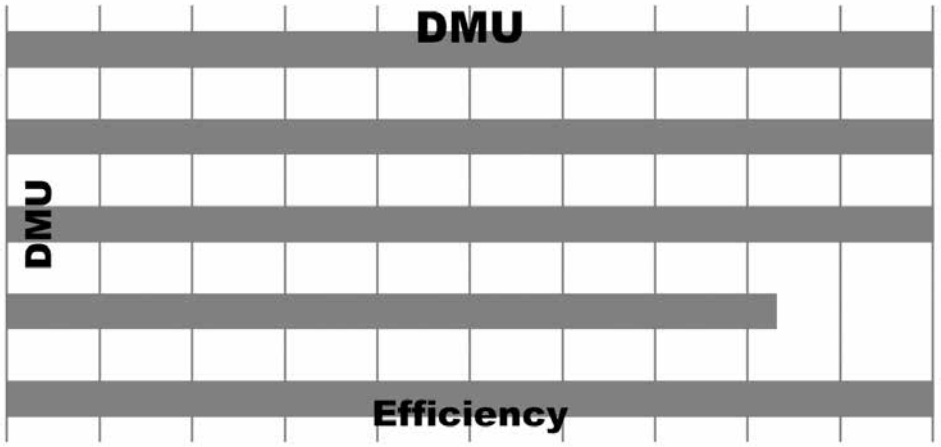

Fig. 1. Efficiency of food retailers in Serbia

Therefore, in this particular case, four food retailers are efficient (Delhaize Serbia, DIS shop, Aman and Univerexport), and only one is inefficient (Mercator-S). In relation to the planned values, Mercator-S exceeded the purchase value of sold goods by 18.683%, lower gross margin by 20.436% and lower net profit by 97.37%, which in its own way reflected on its efficiency (Table 7). In order to improve the efficiency of the company Mercator-S, it is necessary to reduce the purchase value of sold goods by 12,153.9 million dinars and increase the profit by 1957.92 million dinars (Table 8).

Table 8. Slack data input / output

Model = BCC-O				Slack	Slack	Slack	Slack
No.	DMU	Score	Rank	Cost of goods sold	Operating costs	Gross margin	Net profit
1	Delhaize Serbia	1	1	0	0	0	0
2	Mercator-S	0.8303	5	12153.9	0	0	1957.92
3	DIS shop	1	1	0.272	0	0	0.011
4	Aman	1	1	0	0	0	0
5	Univerexport	1	1	0	0	0	0.009
	Average	0.9661	1.8	2430.83	0	0	391,588
	Max	1	5	12153.9	0	0	1957.92
	Min	0.8303	1	0	0	0	0
	St Dev	0.0759	1.7889	5435.35	0	0	875,607

Note: Author's calculation using the DEA software program - Solver, Model = BCC-O

Conclusion

The research conducted in this paper in the context of measuring the efficiency of food retailers in Serbia using the AHP method showed that the importance of certain criteria in the order is as follows: purchase value of goods sold, operating costs, gross margin and net profit. The cost of goods sold and operating costs represent inputs and the gross margin and net profit are outputs. The goal is to achieve the highest possible yields with the given resources. The order of efficiency of the observed companies is as follows: Delhaize Serbia, Mercator-S, DIS shop, Aman and Univerexpor

The evaluation of the selection of Delhaize Serbia›s criteria is as follows: cost of goods sold, gross margin, operating expenses and net profit. For the other observed companies (Mercator-S, DIS shop, Aman and Univerexport), the order of evaluation of the selection criteria is the same: purchase value of sold goods, operating costs, gross margin and net profit.

Measuring the efficiency of food retailers in Serbia using the DEA method showed that four retailers (Delhaize Serbia, DIS shop, Aman and Univerexport) are efficient, and only one is inefficient (Mercator-S). In relation to the planned values, the company Mercator-S exceeded the purchase value of sold goods by 18.683%, lower gross margin by 20.436% and lower net profit by 97.37%. In order to improve the efficiency of the company Mercator-S, it is necessary to reduce the purchase value of sold goods by 12,153.9 million dinars and increase the profit by 1,957.92 million dinars.

In order to increase the efficiency of food retailers in Serbia in the future, it is necessary, in principle, to apply new business models (private label, multi-channel sales, organic food sales, etc.), and the concepts of strategic management accounting, following the example of Western ones. It is also necessary to improve the digitalization of business.

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