ANALYZING FINANCIAL PERFORMANCES AND EFFICIENCY OF THE RETAIL FOOD IN SERBIA BY USING THE AHP – TOPSIS METHOD

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ABSTRACT

The aim and purpose of this paper is to point out to the quality of financial performance and efficiency of food retailers in Serbia, as well as measures for improvement in the future, based on theoretical knowledge and empirical analysis using AHP-TOPSIS methods. The problem of analyzing the financial performance of all companies, which includes trading companies, is very topical, significant and complex. Consequently, mathematical methods and models have lately been increasingly used. With this insight in mind, this paper investigates the financial performance and efficiency of food retailers in Serbia using AHP and TOPSIS methods. Of all the observed optimization criteria (cost of goods sold, operating costs, gross margin and net profit), the most significant was the cost of goods sold. The most efficient food retailer in Serbia is Aman. The Mercator-S Company is inefficient. In order to improve the efficiency of food retailers in Serbia, it is necessary to apply the Western business models (private brand, multichannel sales, organic food sales and others), the concepts of strategic management accounting and to strengthen the digitalization of business.

Introduction

Given its importance, this paper's research subject is to measure the efficacy of food retailers in Serbia, such as analysis in Western literature (Danielle at el., 2019; Jacob at el.,

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2019; Jian at el., 2019; Kalpana at el., 2019; Yonggan at el., 2019). The aim and purpose of this research is to determine the factual state based on which adequate measures for improvement in the future will be suggested.

As is well known, a very rich body of literature is devoted to the general issue of applying the DEA analysis in evaluating company performance (Hwang, 1981; Hwang, 1995; Andersen, 1993; Yousefi, 2010; Li, 2014, 2017; Tsolas, 2015). It is also richer in terms of application in the retail sector (Bhargava, 1998; Karan, 2008; Keener, 2013; Kingyens, 2012; Konuk, 2018; Lau, 2013; Manini, 2018; Martini 2017; Pang, 2013; Parades , 2014; Rogova, 2018; Simbolon, 2017; Trejo, 2017; Zaernyuk, 2016; Üçüncü, 2018; Urbonavičiūtė, 2019). Recently, in the Western literature, in addition to the DEA methods, AHP methods have been used (Chang, 1996) as well as the TOPSIS method. As far as literature in Serbia is concerned, it is, to our knowledge, very poor in this regard, only in some works the AHP and DEA methods are partially applied (Lukic, 2011a, b; 2018, 2019; Lukic, 2018; Popovic, 2018) , which is not the case with the TOPSIS method. This void should be filled to a certain extent by this work, which should reflect its scientific and professional contribution among other things.

From the very nature of the problem addressed in this paper, the basic hypothesis of the research itself arises: knowledge of the current financial situation of food retailers in Serbia is a prerequisite for improvement in the future. This can be easily achieved by taking adequate measures.

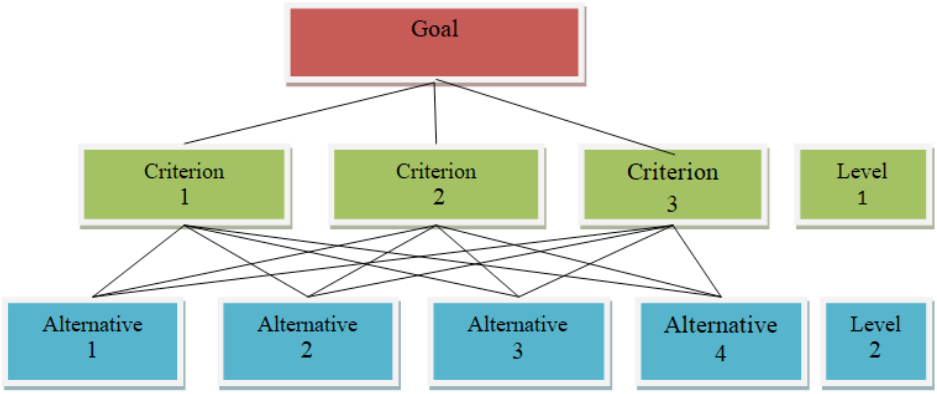
The research of the given hypothesis in this paper is based on the application of the AHP and TOPSIS methods. For the sake of comprehensiveness, ratio analysis and statistical analysis are here used to a certain extent.

For the purpose of investigating the treated problem 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 global comparability. This completely refers to the data obtained in this research.

Materials and methods

The Analytical Hierarchy Process Method (AHP) is a multi-criteria decision making recommended by Thomas Saaty in the 1970s (Saaty, 1970; Saaty 1980; Saaty, 2001; Saaty, 2008). It is used to solve complex structural hierarchical problems of decision-making and weighting coefficients (ponders) for each criterion (Harker, 1987; Hanie, 2016; Stojanovic, 2016). Figure 1 shows an example of a hierarchy in AHP.

Figure 1. An example of hierarchy in the AHP



The analytical hierarchical process method is based on the following axioms (Saaty, 1986; Harker, 1987; Alphonce, 1997):

The reciprocity axiom: If element A is *n* times more significant than element B, then element B is *1/n* times more significant than element A.

The homogeneity axiom: Comparison makes sense only if the elements are comparable.

The dependency Axiom: It is allowed to compare between a group of elements of one level with respect to higher elements, i.e. lower-level comparisons depend on higher-level elements.

The expectations axiom: Any change in the structure of the hierarchy requires an estimate of priorities in the new hierarchy.

Each comparison of the two elements of the hierarchy (model) is made using the Saaty's value scale (*Table 1.*).

Table 1. Saaty's value scale

Importance intensity	Definition	Explanation
1	Equal importance	The two elements are of identical importance with respect to the goal.
3	Weak dominance	Experience or reasoning slightly favors one element over another.
5	Strong dominance	Experience or reasoning favors one element a lot more than the other.
7	Demonstrated dominance	The dominance of one element is confirmed in practice.
9	Absolute dominance	The highest degree dominance
2,4,6,8	Intermediate values	A compromise or further division is needed.

Source: Saaty, 2008

The analytically hierarchical process (AHP) method proceeds through the following steps (Saaty, 2001; Saaty, 2008; Hanie, 2016; Stojanovic, 2016):

Step 1: Forming a pairwise comparison matrix

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

Step 2: Normalization of the pairwise comparison matrix

$$a_{ij}^{*} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}, i, j = 1, \ldots, n \quad (2)$$

Step 3: Determining relative importance, i.e. weight vectors

$$w_i = \frac{\sum_{i=1}^{n} a_{ij}^{*}}{n}, i, j = 1, \ldots, n \quad (3)$$

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

$$CI = \frac{\lambda_{max} - n}{n} \quad (4)$$

If CI <0.1, the estimated values of the coefficients 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%.

Using the consistency index, the consistency ratio CR = CI / RI can be calculated, with RI being a random index. *Table 2* gives random consistency indices.

Table 2. Random consistency indices

Matrix size (a number of criteria) (n)	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Source: Hanie, 2016

The TOPSIS *(Technique for Order Preference by Similarity to Ideal Solution)* method has been used very successfully in evaluating companies' financial performance (Üçüncü et al., 2018). It is a multi-criteria decision-making technique first developed and applied by Hwang and Yoon (1981). (Hwang, 1981; Hwang, 1995). According to this method, alternatives are determined by their distances from the ideal solution. The goal is to choose the optimal alternative that is closest to the ideal solution, i.e., farthest from the negative ideal solution (Young, 1994). A positive ideal solution maximizes utility, that is, minimizes costs (in relation to a given problem). In contrast, a negative ideal solution maximizes costs, i.e. minimizes utility (Yousefi 2010; Wang 2007).

The TOPSIS method consists of 6 steps (Üçüncü et al., 2018).

Step 1: Create an Initial Matrix

The initial matrix A_{ij} shown with *"m"* denotes the alternative number and with *"n"* the number of criteria:

$$A_{ij} = \begin{vmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{vmatrix}$$

Step 2: Formation of the Weighted Normalized Decision Matrix

The normalized decision matrix (R_{ij}; i = 1,…, m; j = 1,…, n) is determined by the equation (14) with the elements of the matrix A_{ij}:

$$r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{i=1}^{m} a_{ij}^2}} \qquad (5)$$

$$t = 1,2,3,\dots,m \qquad j = 1,2,3,\dots,n$$

$$R_{ij} = \begin{vmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{vmatrix}$$

In the equation (6) the weight measure *"j"* is represented by W_{ij}. The weighted normalized decision matrix *(V_{ij}; i = 1,..., m; j = 1,..., n)* was determined using the equation (6) with the elements of the normalized matrix:

$$V_{ij} = W_{ij} * r_{ij} \qquad (6)$$

$$i = 1,2,3,\dots,m \qquad j = 1,2,3,\dots,n$$

Step 3: Determine the Positive and Negative Ideal Solution

The value of the positive-ideal solution *(A^+)* and negative-ideal solution *(A^-)* is determined from the value of the weighted normalized matrix *(V_{ij})*. A^+ is better and A^- is a worse performance score.

The value of the positive-ideal solution *(A^+)* and the negative-ideal solution *(A^-)* is determined as follows (equation (7) and (8) respectively)

$$A^+ = \{v_i^+,\dots,v_n^+\} = \left\{\left(\max_i v_{ij}, j \in j\right)\left(\min_i v_{ij}, j \in j'\right)\right\}\ i = 1,2,\dots,m \qquad (7)$$

$$A^- = \{v_i^-,\dots,v_n^-\} = \left\{\left(\min_i v_{ij}, j \in j\right)\left(\max_i v_{ij}, j \in j'\right)\right\}\ i = 1,2,\dots,m \qquad (8)$$

where *j* is related to the benefit criterion, and *j'* is related to the cost criterion.

Step 4: Determine special measures (i.e. distance of alternatives from the ideal and negative-ideal solution)

The distance from the positive-ideal solution (S_i^+) and the negative-ideal solution (S_i^-) for each alternative according to the given criterion is determined using equations (9) and (10).

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2} \qquad (9)$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2} \qquad (10)$$

$$i = 1,2,3,\dots,m \qquad j = 1,2,3,\dots,n$$

Step 5: Determine the coefficient of relative closeness to the ideal solution

Specific measures of positive-ideal solution (S_i^+) and negative-ideal solution (S_i^-) were used to determine the relative closeness to the ideal solution (C_i^+) for each decision point. C_i^+ represents the relative closeness to the ideal solution and takes a value in the range $0 \leq C_i + \leq 1$. "C_i^+" = 1 indicates the relative closeness to the positive-ideal solution. "C_i^+" = 0 indicates relative closeness to the negative-ideal solution.

The relative closeness to the ideal solution (C_i^+; i = 1,…, m; j = 1,…, *n*) was determined using the equation (11):

$$C_i^+ = \frac{S_i^-}{S_i^- + S_i^+} \qquad (11)$$

$$i = 1,2,3,\dots,m$$

Step 6: Sort the alternatives according to relative superiority

Determining the relative superiority of the score represents the company's realized performance. High scores correlate with better performance. The results can be used to determine company's rankings within the industry (Üçüncü et al., 2018).

Results and discussion

Table 3 shows some financial indicators of the performance of selective major food retailers in Serbia for 2018.

Table 3. Some indicators of financial performance of selective food retailers in Serbia, 2018

	Gross margin/Sales (%)	Operating costs/Sales (%)	Net profit/Sales (%)
Delhaize Serbia	30%	27%	3%
Mercator-S	21%	23%	-2%

	Gross margin/Sales (%)	Operating costs/Sales (%)	Net profit/Sales (%)
DIS trade	10%	9%	1%
Aman	17%	14%	2%
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 observed food retailers. They range from 10% (DIS stores) to 30% (Delhaize Serbia). These differences are in their own way reflected in their efficiency, since operating expenses (business expenses) are covered by gross margin as the difference between the sale and the purchase value of goods sold and the rest is net profit. *Table 4* presents the statistics of input / output data as criteria used to evaluate the effectiveness of selective food retailers in Serbia for 2018 using the AHP and TOPSIS methods.

Table 4. Data input / output statistics

		(I) Purchase value of goods sold (in millions of RSD)	(I) Operating costs (in millions of RSD)	(O) Gross margin (in millions of RSD)	(O) Net profit (in millions of RSD)
Delhaize Serbia		70666	27157	29822	2665
Mercator-S		65054	19376	17714	-1662
DIS trade		17490	1840	1879	39
Aman		14256	2451	2871	420
Univerexport		14236	4309	4339	30
Statistics of 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					
Purchase value of goods sold	Pearson Correlation	1	.979**	.952*	.185
	Sig. (2-tailed)		.004	.013	.766
	N	5	5	5	5

		(I) Purchase value of goods sold (in millions of RSD)	(I) Operating costs (in millions of RSD)	(O) Gross margin (in millions of RSD)	(O) Net profit (in millions of RSD)
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).					

Source: Agency for Business Registers of the Republic of Serbia. Author's calculation of input / output statistics using DEA - Solver and SPSS software

In the further presentations of the problem, we will examine the effectiveness of selective food retailers in Serbia for 2018 using the AHP/TOPSIS method (*Table 5*). Weighting criteria were determined using the AHP method (CR =1.9%). In this particular case, therefore, in the order of importance of the criteria, the situation is as follows: purchase value of goods sold, operating expenses, gross margin and net profit. This is quite understandable given the fact that the cost of goods sold represents the most important investment in the trade sector. Operating costs are very significant in commerce and most of them relate to employee earnings. Employee earnings affect employees' motivation to achieve the best possible sales. Gross margin yield from inventories is a significant indicator of trade performance. And the return on net sales is also a significant indicator of trade performance. For these reasons, the relevant optimization criteria were chosen in this paper. The optimization criteria in this case are designated as: C1 - cost of goods sold, C2 - operating costs, C3 - gross margin and C4 - net profit. The alternatives are: A1 - Delhaize Serbia, A2 - Mercator-S, A3 - DIS store, A1 - Aman and A5 - Univerexport. (Data was processed using AHP Online System - AHP-OS, and ARASSoftware.xlsx.)

Table 5 shows the initial decision matrix.

Table 5. The initial decision matrix

weights of criteria	0.533	0.321	0.082	0.064
kind of criteria	-1	-1	1	1
	C1	C2	C3	C4
Delhaize Serbia	70666	27157	29822	2665
Mercator-S	65054	19376	17714	-1662
DIS trade	17490	1840	1879	39
Aman	14256	2451	2871	420
Univerexport	14236	4309	4339	30
MAX	70666	27157	29822	2665
MIN	14236	1840	1879	-1662
0-Optimal Value	14236	1840	29822	2665

Table 6 shows the normalized decision matrix.

Table 6. The normalized decision matrix

weights of criteria	0.533	0.321	0.082	0.064
kind of criteria	-1	-1	1	1
	C1	C2	C3	C4
0-Optimal Value	0.2362	0.2994	0.3450	0.4580
Delhaize Serbia	0.0476	0.0203	0.3450	0.4580
Mercator-S	0.0517	0.0284	0.2049	0
DIS trade	0.1923	0.2994	0.0217	0.0067
Aman	0.2359	0.2247	0.0332	0.0722
Univerexport	0.2362	0.1278	0.0502	0.0052

Table 7 shows the weighted normalized decision matrix.

Table 7. Weighted normalized decision matrix

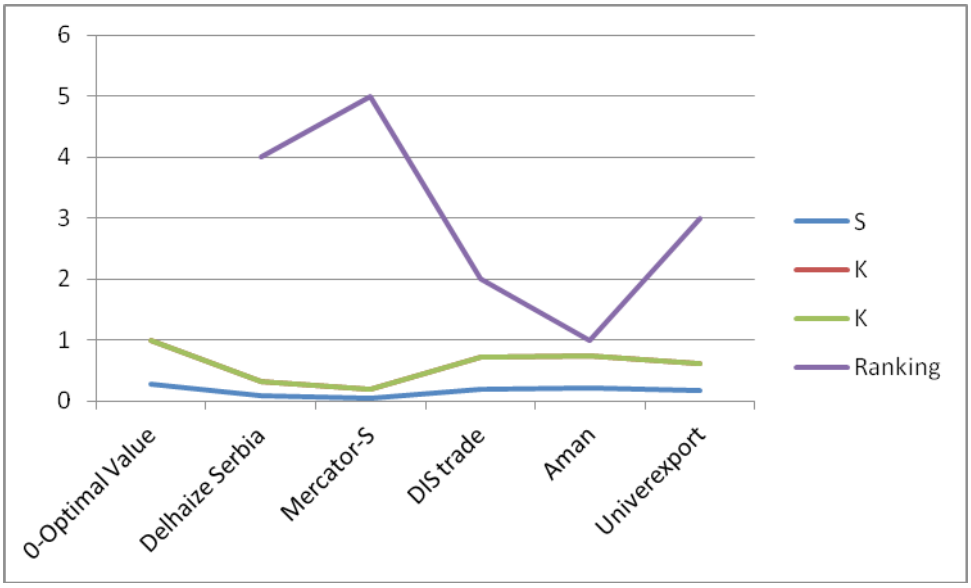
	C1	C2	C3	C4
0-Optimal Value	0.1259	0.0961	0.0283	0.0293
Delhaize Serbia	0.0254	0.0065	0.0283	0.0293
Mercator-S	0.0276	0.0091	0.0168	0
DIS trade	0.1025	0.0961	0.0018	0.0004
Aman	0.1257	0.0721	0.0027	0.0046
Univerexport	0.1259	0.0410	0.0041	0.0003

Table 8 and *Figure 2* show the ranked decision matrix.

Table 8. Ranked decision matrix

	S	K	K	Ranking
0-Optimal Value	0.2796	1	1	
Delhaize Serbia	0.0895	0.3200	0.3200	4
Mercator-S	0.0535	0.1913	0.1913	5
DIS trade	0.2008	0.7181	0.7181	2
Aman	0.2052	0.7340	0.7340	1
Univerexport	0.1714	0.6130	0.6130	3

Figure 2. Ranked decision matrix



We can therefore conclude that Aman is an efficient food retailer in Serbia. It is followed by the following companies respectively: DIS store, Univerexport, and Delhaize Serbia. Inefficient is, understood broadly, the Mercator-S Company.

Conclusions

The research conducted in this paper in the context of measuring the efficiency of food retailers in Serbia using the AHP method has shown that the importance of certain criteria is as follows: purchase value of goods sold, operating costs, gross margin and net profit. The cost of goods sold and operating expenses are inputs and gross margin and net profit are outputs. The goal is to maximize yields with given resources. In our opinion, the given optimization criteria, given the nature of the business of food retailers, are very significant.

The results of the research in this paper that used the TOPSIS method show that an efficient food retailer in Serbia is Aman which is followed by the following companies respectively: DIS store, Univerexport, and Delhaize Serbia. An inefficient food retailer in Serbia is the Mercator-S Company.

In order to increase the efficiency of food retailers in Serbia in the future, it is necessary, in principle, to apply new business models which are in line with the Western model (private brand, multichannel sales, organic food sales and others), and concepts of modern strategic management accounting. Likewise, business digitalization needs to be improved.

Conflict of interests

The authors declare no conflict of interest.

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