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INNOVATIVE METHODS OF EVALUATING BUSINESS EFFICIENCY: A COMPARATIVE STUDY

Abstract. *This paper evaluates the efficiency level of medical spa businesses operating in Slovakia. The research aims to compile an efficiency ranking of these specific healthcare facilities to apply both methods and analyze their alternative use within the efficiency level measurement. The object of research is the Slovak spa businesses over the years 2014-2018. The study involved the Simplex Method of Linear Programming and the selected Data Envelopment Analysis model. In the study frame, the authors quantified the efficiency of medical spa businesses as the optimization task of SMPL and BCC input-oriented DEA model to identify prosperous businesses from non-prosperous ones. The study applied the Spearman rank correlation to reveal a potential degree of association of business rankings. The calculations were provided by the MS Excel, MS Excel Solver package, and the statistical program Gretl. The findings indicated that the business efficiency measured by SMPL provided similar results to the DEA model. These methods could be considered equivalent. Therefore, their alternative use was confirmed. The obtained results showed that both methods almost equally divided the businesses into two groups: 1) with efficiency score above (10 DMUs) and 2) below the overall achieved average (11 DMUs). According to the average results of both applied methods, the most efficient DMUs were DMU09 (Spa Lúcky, j.s.c.) and DMU03 (Spa Bojnice, j.s.c.), vice versa, the lowest efficiency score was achieved by DMU04 (Spa Brusno, j.s.c.). This research could be considered an important opportunity to identify new gaps in the prior literature and present the need for further development in these specific healthcare facilities, not only in Slovakia. The presented research findings are also beneficial for practice as they may lead to the formulation of recommendations for improvement of the current state of Slovak spa tourism and the spa businesses themselves.*
Keywords: data envelopment analysis, efficiency, inputs, linear programming, medical spa businesses, outputs.

Introduction. Medical tourism has been changing the healthcare scene, especially in developing countries offering a combination of low costs for medical services and experienced medical personnel. It gives them the potential to become a target of choice for medical tourists (Lubowiecki-Vikuk and Dryglas, 2019). In the Slovak Republic, spa therapy is an integral part of the public health system, but medical facilities providing these services also act as tourist establishments. Spa facilities primarily provide health care benefits based on the therapeutic effects of climate and the natural resources of the environment (Derco, 2014; Dryglas and Salamaga, 2017; Kuzysin et al., 2021). They are not specific for the treatment of concrete diseases. In turn, their prices reflect actual costs. The financial stability of these medical spas rests on the balance between medical products covered by public health insurance, medical and wellness

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products reimbursed by patients (Derco and Pavlisinova, 2016). In this regard, this study considers spa tourism as an inherent part of Slovak tourism, which is getting more and more attention as people started to prefer a healthy lifestyle. Demographic trends in population aging have put increasing pressure on health care costs, so spa resorts are considered serious medicine and the main product line of tourism in Slovakia. However, they do not represent a different economic sector as it interferes with all economic and social life spheres. Many publications discuss the efficiency level of businesses in different sectors, but only a few of them are carried out within the tourism sector. For this reason, this study focuses on the technical efficiency evaluation of Slovak spa businesses by applying the Simplex Method of Linear Programming and appropriate Data Envelopment Analysis model over the years 2014-2018. The paper aimed to reveal the degree of resulting rank compliance of spa businesses in applying both selected methods of business efficiency quantification and help managers of these spa businesses identify their competitive position, strengths, and strengths potential risk areas.

The structure of the paper is as follows. The first section (Literature review) explains business efficiency and discusses methods of its evaluation. The following section (Methodology and research methods) describes the data and methodology used, including the description of input/output variables. The third section (Results) presents the results of provided efficiency analyses, their mutual comparison and revealing the potential interconnection in their alternative use. The last section (Conclusion) is ended with a summary of key findings, limitations, and future research direction.

Literature Review. In general, the current competitive struggle is won only by businesses adequately dedicated to measuring, evaluating, and managing their efficiency and using suitable approaches and measuring tools. However, the business environment is evolving faster, and it constantly comes to social, technological, and other changes. Thus, it is important to react to these changes promptly and predict them ideally (Benkova et al., 2019). Evaluation of the efficiency of production units is widely used in the private and public sectors. Measuring efficiency (especially identifying sources of potential inefficiency) is a significant step to improve the company's competitive position and overall behavior in a competitive environment. Efficiency is one of the main categories of the economy. It is directly linked to achieving the company's results. Perez-Gomez et al. (2018); Zarutska et al. (2020) stated that the efficiency estimation allowed companies to know their effectiveness in achieving the objectives (outputs) and managing the resources (inputs). Cyrek (2017) defined efficiency as the relationship between outputs and inputs, often analyzed in terms of goals. According to Grmanova and Strunz (2017), efficiency is a relative indicator that reflects a particular entity's results by comparing them with the results of other similar entities. As Mihalcova et al. (2017) reported, Gallo et al. (2019), the main factor to company success is monitoring the actual market situation. Therefore, a competitive struggle is won only by businesses adequately dedicated to evaluating efficiency and using the right approaches and measuring tools. According to Poldrugovac et al. (2016), efficiency is one of the key management control factors and a prerequisite for improving.

Carstina et al. (2015) emphasized that efficiency was closely interdependent to effectiveness. Thus, the ineffective business could exist short period since it leads to unfavorable results. Herewith, Popova (2018) analyzed the efficiency evaluation of businesses. The study dealt with the problems of Quality Management System (QMS) effectiveness evaluation in companies. The assessment of QMS effectiveness rested on achieving its objectives, comparison with benchmark indicators, and previous achievements of its QMS. In turn, Ermolina et al. (2018) examined the strategic effectiveness of business to determine the role of human capital. Thus, these authors concluded that human capital is a source of maximization of a business's profit. It occupies the central role among the indicators of strategic effectiveness of business. The researcher Shyfrina et al. (2019) expressed a similar attitude to business efficiency. As reported by authors, under the current economic conditions, the economic efficiency and competitiveness of the business depend not only on labor productivity and product quality. The authors established two significant motivation factors such as financial and free time stimulation in business efficiency measurement. Technical efficiency from the managerial perspective was investigated by Herrera-Restrepo and Triantis (2019). Authors studied managerial policies that affect the coordination among the members of business networks and the subsequent effect on technical efficiency at the individual member business and network levels. Experimental results informed when and how managerial policies enhance the coordination among network members concerning achieving technical efficiency. According to Lee et al. (2019), relatively few studies have analyzed the efficiency relative to the effort made, such as through R&D investments. Thus, they explored the innovation efficiency of small and medium-sized businesses. According to Kocisova (2015), the earliest techniques used to measure efficiency through the ratio analysis examined the financial statements of the evaluated units and compared them with a benchmark. However, the productivity or profitability ratios could not identify term efficiency. Productivity represents the ratio of output produced by the capacity of inputs used. In turn, profitability rests on the amount of profit and focuses on the connection between revenues and expenditures. Dougherty et al. (2017) suggested a method for technical efficiency measurement of the business network regarding its resource allocations, namely the Complex Adaptive Productive Efficiency Method (CAPEM) in the context of complex adaptive systems. They analyzed the aggregate technical efficiency as the outcome of the relationships between individual decision-making and collective influences. Panayides and Lambertides (2011) differentiated two types of efficiency – operational and market efficiency. The authors applied both types of efficiency within the analysis of 18 international companies. According to them, in operational efficiency analysis, the input variables included total assets, capital expenditure, and the number of employees. In turn, the outputs included revenue and profit (EBIT or EBITDA). For market efficiency, the firm's market value was used as the output, while EBIT, cash flow from operations, and the book value of equity were used as the inputs. Several studies (Balios et al., 2015; Barchue and Aikaeli, 2016) focused on estimating cost efficiency, which measures how close the company's costs are to the costs of a best-practices company producings the same output under the same conditions. However, the concept of cost efficiency as a potential source of cost reduction is important. It has two significant limitations: a) cost efficiency evaluates the efficiency for a given output level, which usually does not correspond to the optimal scale of production; b) cost efficiency does not capture differences in the output quality of companies. Fitzpatrick and McQuinn (2008) reported these limitations, combined with managers' interest in both cost minimization and revenue maximization goals, make profit efficiency the concept that best combines these important economic objectives. Thus, the concept of profit efficiency is better than that of cost efficiency for evaluating overall performance because it collects errors from both outputs and inputs.

Grell and Hyranek (2012) emphasized that the latest business efficiency and performance approaches aim to evaluate production system functioning. Besides, it is necessary to measure the effectiveness of the transformation process and implement financial indicators and the indicators of efficiency and effectiveness. The authors developed an innovative approach based on the matrix system of indicators, solved by the Simplex Method by applying linear programming (SMLP). The authors mentioned above consider the matrix system as an open, variable, and adaptable complex that can be dynamically modified depending on the business conditions, which is undoubtedly a great advantage. The goal of the matrix mentioned above system is to eliminate the subjectivity of evaluation by measuring outputs concerning the inputs. Kocisova (2015) stated that methods for efficiency measurement could be divided into several other groups. However, parametric and nonparametric methods represent the most widespread classification. Notably, parametric methods, including the Stochastic Frontier Approach (SFA), the Thick Frontier Approach (TFA), and the Distribution Free Approach (DFA), are used to measure economic efficiency. Nonparametric methods, including Free Disposal Hull (FDH) and Data Envelopment Analysis (DEA), measure technical efficiency. The difference between deterministic and stochastic methods is their attitude to the random component. Deterministic approaches assume that any deviation from the border is caused only by inefficiency.

On the other hand, stochastic approaches attach weight to the deviation from the border of inefficiency and the existence of randomness. It stands to note that both approaches are characterized by measuring the efficiency of the transformation of inputs to outputs using reference production boundaries. The results should be comparable when applying both approaches.

Methodology and research methods. This paper addressed the efficiency assessment of Slovak spa businesses during the years 2014-2018. It provided a comparative analysis of results through both methods to reveal the degree of resulting rank compliance. The following hypotheses were set to support the main aim of the paper:

H0: There is no statistically significant relationship between the business efficiency evaluation quantified as the optimization task of SMLP and the DEA model.

H1: There is a statistically significant relationship between the business efficiency evaluation quantified as the optimization task of SMLP and the DEA model.

Natural health spas in Slovakia are a significant phenomenon of the national economic development due to the rich representation of natural healing resources throughout the country. Nowadays, there are 21 spa towns and 28 spa businesses with official permission from the Ministry of Health of the Slovak Republic to operate the natural health spas and spa medical institutions in Slovakia. According to the statistical classification of economic activities (SK NACE Rev. 2), Slovak spa businesses belong to section Q – Health and social assistance. The financing particularities and the legal framework analysis did not include spa businesses having the legal form of non-profit organizations, government-subsidized organizations, or state-owned companies. Therefore, the final research sample consisted of 21 spa businesses, namely: Spa Bardejov, j.s.c. (DMU01), Spa Horezza, j.s.c. (DMU02), Spa Bojnice, j.s.c. (DMU03), Spa Brusno, j.s.c. (DMU04), Spa Dudince, j.s.c. (DMU05), Spa Horny Smokovec, l.l.c. (DMU06), Spa Kovacova, l.l.c. (DMU07), Spa Lucivna, j.s.c. (DMU08), Spa Lúcky, j.s.c. (DMU09), Spa Nimnica, j.s.c. (DMU10), Spa Novy Smokovec, j.s.c. (DMU11), Spa Sliac, j.s.c. (DMU12), Spa Stos, j.s.c. (DMU13), Spa Trencianske Teplice, j.s.c. (DMU14), Spa Vysne Ružbachy, j.s.c. (DMU15), Medical Thermal spa, j.s.c. (DMU16), Spa Číž, j.s.c. (DMU17), Spa Piesťany, j.s.c. (DMU18), Spa Rajecke Teplice, j.s.c. (DMU19), Spa Turcianske Teplice, j.s.c. (DMU20), Spa Pieniny Resort, l.l.c. (DMU21).

The financial statements of the analyzed spas were drawn from a publicly available internet portal managed by the company DataSpot, Ltd. Input/output variables within the selected DEA model were obtained from the statistical database of the National Health Information Centre of the Slovak Republic over the analyzed period of 2014–2018. To process all the calculations and implement basic DEA algorithms, MS Excel Solver was used. Notably, it could perform the optimization required despite whether nonlinear or linear programming formulations were used. Other calculations needed were processed by MS Excel and the statistical program Gretl. For identifing prosperous businesses from non-prosperous ones, the efficiency of spa businesses was quantified as the optimization task of SMLP. As reported by Grell and Hyranek (2012), the matrix model is made up of absolute indicators divided into indicators of inputs and outputs of the entrepreneurial activity. In the practical solution of this issue it is necessary to start from its simplification, while minimizing the deviations between the indicators of efficiency and effectiveness. The ui vectors and tr vectors were obtained as a solution of:

– the basic equation:

$$min\ \Sigma j\ wj\ =\ 0; \tag{1}$$

– under the conditions:

$$\Sigma i\ uiSJM, ij\ -\Sigma r\ tr\ crj\ -wj\ =\ 0 \tag{2}$$

$$\Sigma\, tr \;=\; 1 \tag{3}$$

$$uitrwj \;\geq\; 0 \tag{4}$$

– therefore, the order of transformation process efficiency was calculated by:

$$Ej \;=\; \Sigma r\; tr\; crj \;\;/\; \Sigma i\; uiSJM, ij \tag{5}$$

where w_j – deviations in individual years; u_i –weights for inputs value, $S^J_{M,ij}$ – inputs needed for linear programming; t_r – weights for outputs value; c_{rj} – outputs needed for linear programming; E_j – efficiency score.

The chosen input variables are total costs, personnel costs, and material costs (in case of application of both methods). In turn, total revenues, net profit, and value-added present output variables. It is suggested that the variables mentioned above belong to the most significant determinants of business efficiency at all. Thus, the cost of returns, wage efficiency, and material efficiency was quantified by applying the modified matrix system. The adequacy of selecting the above inputs and outputs was confirmed after comparing scientific studies focused on applying DEA models in the context of evaluating business effectiveness (Fenyves et al., 2015; Buyukkeklik et al., 2016; Gandhi and Sharma, 2018). The correlation analysis for each combination of variables confirmed that selected input and output variables for efficiency evaluations are appropriate since neither high nor low correlation rates were found. In the case of DEA application, efficiency is measured by the distance of a DMU from an envelopment frontier constructed as a set of linear combinations of the input and output measurements of DMUs belonging to the production possibility set (PPS) (Seiford and Thrall, 1990). As reported by Paleckova (2017), DEA begins with a fractional programming formulation. It is assumed that there are n DMUs to be evaluated. DMU_j consumes x_{ij} amounts of input to produce y_{rj} amounts of output. It is assumed that these inputs, x_{ij}, and outputs, y_{rj}, are non-negative, and each DMU has at least one positive input and output value. The productivity of a DMU can be formulated as follows:

$$h_j = \frac{\sum_{r=1}^{s} u_r\, y_{rj}}{\sum_{i=1}^{m} v_i\, x_{ij}} \tag{6}$$

In this equation, *u* and *v* are the weights assigned to each input and output. By using mathematical programming techniques, DEA optimally assigns the weights subject to the following constraints. The weights for each DMU are assigned subject to the constraint that no other DMU has efficiency greater than 1 if it uses the same weights, implying that efficient DMUs will have a ratio value of 1. The objective function of DMU is the ratio of the total weighted output divided by the total weighted input:

$$\max h_0(u,v) = \frac{\sum_{r=1}^{s} u_r\, y_{r0}}{\sum_{i=1}^{m} v_i\, x_{i0}} \tag{7}$$

subject to

$$\frac{\sum_{r=1}^{s} u_r\, y_{rj}}{\sum_{i=1}^{m} v_i\, x_{ij}} \;\leq\; 1,\ j = 1,2,\ldots,j_0,\ldots,n \tag{8}$$

$$ur \;\geq\; 0, r \;=\; 1, 2, \ldots, s \tag{9}$$

$$vi \;\geq\; 0, i \;=\; 1, 2, \ldots, m \tag{10}$$

where h_0 – the technical efficiency of DMU0 to be estimated, u_r and v_i – weights to be optimized; y_{rj} – the observed amount of output of the r_{th} type for the j_{th} DMU; x_{ij} – the observed amount of input of the i_{th} type for the j_{th} DMU, r indicates the s different outputs; I - denotes m different inputs and j indicates the n different DMUs.

Jablonsky (2007) outlinded the CCR and BCC model conditions. The selection of a suitable DEA model is influenced by many factors, e.g., the characteristics and size of the DMUs, the nature of available data, the evaluation criteria, the purpose of performing DEA, etc. Evaluating the effectiveness of DMUs by several DEA models may be useful but does not always capture the essence of the research problem (Canto and Lopez, 2018). Therefore, it is essential to consider the following characteristics when choosing a suitable DEA model:

– tracking of returns to scale (CCR or BCC model);
– the relationship between inputs and outputs (input or output-oriented model).

Within the health care sector (which is the most similar to the medical spas), Samut and Cafri (2016); Lo Storto and Goncharuk (2017) preferred the CCR DEA model. According to their studies on hospitals' efficiency, the CCR model provides better results as there is no restricting scale or effect on inputs and outputs. One common aim of all health care organizations is to provide high-quality services using their resources, such as beds, personnel, etc., most minimally. On the other hand, Sendek (2014); Sendek et al. (2015) used the BCC DEA model. The authors noted that the basic CCR DEA model could not be used in health care services since there is, generally, no constant economies of scale in hospitals in terms of a linear increase of outputs when increasing the inputs and vice-versa. Szabo et al. (2018) decided to apply both approaches (CCR and BCC model) in their research studies and compare the results achieved through both types of model. If the objective is to minimize the number of inputs without changing output values, then the input-oriented models should be applied. The minimal level of inputs needed to produce a given level of outputs was found in these models. Within the health care sector, Samut and Cafri (2016); Buchner et al. (2016) preferred the input-oriented DEA model. As reported by these authors, since the hospital has a social responsibility to provide medical treatment and care to the public, hospitals' operational efficiency should follow, especially the input-oriented DEA model, which focuses on minimizing inputs with fixed outputs. Oikonomou et al. (2016), Karagiannis (2015), Denes et al. (2017) presented the output-oriented DEA model in their studies. According to authors who prefer the output-oriented DEA model, lowering inputs in health service provision is undesirable, while increasing outputs is feasible. The primary objective in health care is human health, so the demand for primary health care services tends to expand and not decrease. This study applied the BCC input-oriented DEA model based on research studies conducted in a similar sector (health care facilities). For revealing a potential degree of association of business rankings according to the achieved efficiency regardless of their size, the Spearman rank correlation was used:

$$r_s = 1 - \frac{6\sum_{i=1}^{n}\left(x_i^* - y_i^*\right)^2}{n\left(n^2 - 1\right)} \tag{11}$$

where r_s – Spearman rank correlation; $(x_i^* – y_i^*)^2$ – the difference between the ranks of corresponding variables; n – number of observations.

The Spearman rank correlation could range from –1 to +1. The resulting value indicates:

- r_s = 1 → perfect degree of the positive association between the two variables;
- r_s = –1 → perfect degree of the negative association between the two variables;
- r_s = 0 → no association between the two variables (Sharma, 2007).

Results. The following partial analyses firstly focused on evaluating the efficiency of the analyzed Slovak spa businesses by both methods. Subsequently, the conformity of SMLP and DEA results was examined by comparing the resulting average order of the spa businesses from 2014 to 2018 by applying the Spearman rank correlation. For quantifying the efficiency of the Slovak spa businesses for 2014–2018, the study applied linear programming apparatus solved by the Simplex Method using a matrix mapping of three selected input (cost) and output (revenue) items. The inputs consisted of total average costs, personnel costs, and material costs. Total revenues, net profit, and added value formed the group of output items. The metrics mentioned above were selected so that inputs/outputs included the total value of costs/revenues, their selected aggregate items (personnel costs and value-added), and their specific items (material costs, net profit). Thus, all cost/revenue levels were represented.

The efficiency solution using linear programming consisted of input weights (u_i), output weights (t_r), and deviations (w_j) of selected indicators, the sum of which had to be minimized. Table 1 presents a sample of the initial input and output values surveyed during the analyzed period, whereas the individual values represented the average of whole spa businesses. In terms of inputs, the cost of returns, wage efficiency, and material efficiency was quantified. The outputs were quantified concerning the total revenues (index). After compiling the initial table with input data, it is possible to quantify spa businesses' efficiency and use the Solver package in MS Excel.

Table 1. Input data needed for the application of SMLP

Business	**Total costs (n_1)**	**Personnel costs (n_2)**	**Material costs (n_3)**	**Total revenues (v_1)**	**Net profit (v_2)**	**Added value (v_3)**
	Cost of returns	Wage efficiency	Material efficiency	In relation to total revenues	In relation to total revenues	In relation to total revenues
DMU01	€ 10,976,866	€ 3,344,376	€ 2,370,141	€ 11,640,143	€ 663,277	€ 6,203,864
	0.9430	*0.2873*	*0.2036*	*1.0000*	*0.0570*	*0.5330*
DMU02	€ 6,900,187	€ 3,031,145	€ 1,869,825	€ 6,684,498	€ -215,689	€ 3,233,538
	1.0323	*0.4535*	*0.2797*	*1.0000*	*-0.0323*	*0.4837*
DMU03	€ 7,782,315	€ 2,688,153	€ 1,909,591	€ 9,844,503	€ 2,062,188	€ 6,758,699
	0.7905	*0.2731*	*0.1940*	*1.0000*	*0.2095*	*0.6865*
…….	…….	…….	…….	…….	…….	…….
DMU19	€ 9,187,789	€ 2,356,583	€ 2,366,679	€ 9,771,980	€ 584,191	€ 4,418,411
	0.9402	*0.2412*	*0.2422*	*1.0000*	*0.0598*	*0.4522*
DMU20	€ 11,900,423	€ 3,114,920	€ 2,546,575	€ 12,131,274	€ 230,851	€ 5,343,892
	0.9810	*0.2568*	*0.2099*	*1.0000*	*0.0190*	*0.4405*
DMU21	€ 501,661	€ 199,979	€ 29,960	€ 442,508	€ -59,154	€ 155,034
	1.1337	*0.4519*	*0.0677*	*1.0000*	*-0.1337*	*0.3504*

Sources: developed by the authors.

The obtained results proved the highest weight of the selected inputs in the case of the *Material efficiency* indicator (u_3 = 2.0624). In this regard, the most important efficiency determinant of the Slovak spa businesses was considered. The highest weight was assigned to the *Net profit* (v_2 = 0.7589). Subsequently, based on calculated weights, the efficiency scores of the selected sample of businesses were quantified (Figure 1). However, due to the limited extent of the paper, the average value of the efficiency score is present for the years 2014-2018.

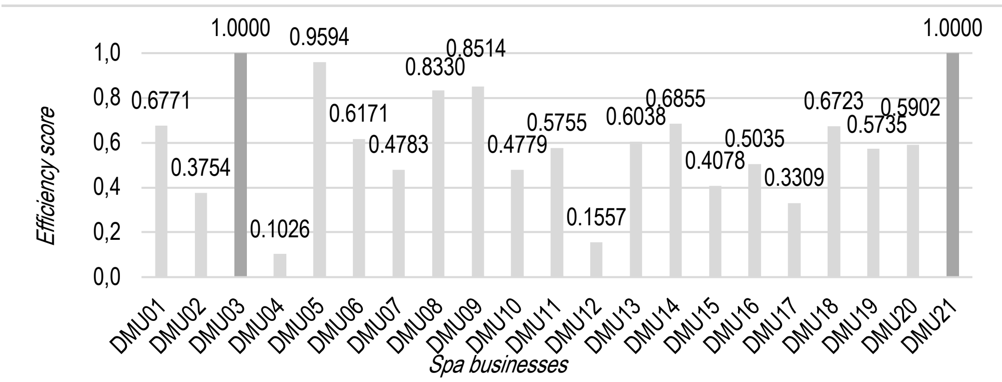

Figure 1. Average efficiency scores of the Slovak spa businesses calculated by SMLP (2014-2018)

Sources: developed by the authors.

Based on the results, it can be stated that only two DMUs reached the maximum efficiency score (on average) at the level of 1.0000 (DMU03 – Spa Bojnice, j.s.c. and DMU21 – Spa Pieniny Resort, l.l.c.). The efficiency of all other businesses during the monitored period ranged from 0.1026 to 0.9594. Under the other partial results, DMU03 reached the overall highest value of Net profit (€ 2,062,188), created the second-highest Added value (€ 6,758,699), and the material intensity indicator was maintained at the stable level (0.1940). Therefore, DMU03 can be considered the most effective business. Despite generated Added Value at the level of € 1,338,087 (on average) and the second-highest value of the material intensity (0.2814), DMU04 – Spa Brusno, j.s.c. as the only one achieved insufficient efficiency score at the level of 0.1026. This fact was undoubtedly affected by the highest average loss within the entire spa sector (€ 2,142,123 on average). Overall, the Slovak spa businesses could be ranked to a moderate efficiency level, as the average value of all analyzed DMUs was around 0.5939.

Even though various software can perform the DEA analysis, the DEA Solver is the most recent and popular DEA analysis software, an MS Excel plugin. If the efficiency score is equal to 1 (or 100%), it implies that the DMU is efficient, while if it is less than 1 (or 100%), the DMU is inefficient. Figure 2 illustrates the results of the applied BCC input-oriented DEA model. Thus, the influence of inputs in the analyzed group of companies is more permissible and more realistic than outputs (although reducing inputs in the provision of health care is in principle undesirable, and the demand for health care services tends to increase, not decrease). However, it is essential to point out that the outputs are beyond the control of the production unit and the manager can regulate mainly the input variables, not the output variables. Although the differences in quantified efficiency are often minimal in applying the BCC or CCR model, it is not possible (in the field of spa care) to assume constant returns from scale in terms of linear increase of outputs with increasing inputs and vice versa. The assumption of constant returns to scale could only be accepted if all DMUs operate at the optimum size. Imperfect competition, regulatory, financial constraints, and other factors make this assumption much impossible.

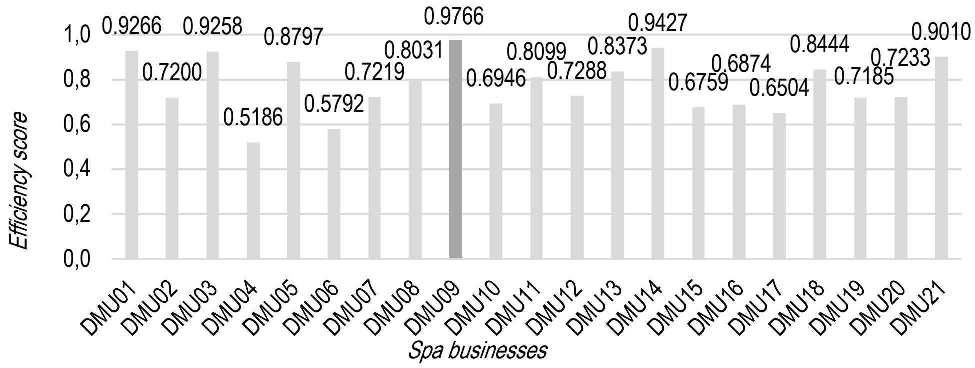

Figure 2. Average efficiency scores of the Slovak spa businesses calculated by DEA (2014-2018)

Sources: developed by the authors based on financial statements of analyzed businesses and statistical database of the National Health Information Centre of the Slovak Republic.

Within the application of the selected DEA model, no DMU could be considered the effective spa business as the level of technical efficiency did not reach the value of 1 (or 100%) every year over the monitored period. The highest efficiency score on average was reached by DMU09 – Spa Lúcky, j.s.c. (0.9766) thanks to considerable investments in the expansion of spa capacities, which led to an increase in the number of visitors and the attractiveness of the spa itself. Overall, the lowest average efficiency of 0.5186 was achieved by DMU04 – Spa Brusno, j.s.c., which recorded the most unacceptable values of the variables analyzed. The negative decline over the years 2014-2018 was caused by major financial problems of recent years, which led to an annual decreasing number of visitors. Nowadays, the company is restructuring. Therefore, the efficiency score continues to fall markedly. The causes of declining efficiency in most Slovak spa enterprises could be found in several areas, not just financial ones. However, the enterprises could influence their performance mainly by their own business activity. Thus, it is very important to focus on achieving a profit in a sufficient amount to improve the overall financial performance. One way to reach this goal can also be investing in tourist infrastructure, accommodation, catering, sport, or cultural facilities. Looking at the development trend of the reporting period, a total of 13 spa companies have become more efficient (DMU01, DMU02, DMU03, DMU05, DMU07, DMU11, DMU12, DMU14, DMU15, DMU17, DMU18, DMU20, DMU21) by an average of 12.70%. The remaining 8 businesses (DMU04, DMU06, DMU08, DMU09, DMU10, DMU13, DMU16, DMU9) recorded a 13.53% decrease in efficiency score compared to 2014. In summary, the average efficiency score of all Slovak spa businesses ranged around 0.7746. Thus, better results were achieved than in the case of the SMLP application.

Based on previous partial analyses, this study focused on revealing the degree of resulting rank compliance of spa companies in applying both selected methods of business efficiency quantification (SMLP and DEA). When calculating the degree of resulting rank compliance, the Spearman rank correlation was applied. Table 2 below shows the resulting average efficiency ranking of spa businesses based on applying the selected assessment methods during the years 2014-2018. Table 2 shows that DMU04 – Spa Brusno, j.s.c., DMU10 – Spa Nimnica, j.s.c. and DMU17 – Spa Číž, j.s.c. reached the same average resulting rank within the application of selected methods of efficiency evaluation. In turn, other input data and indicators entering the calculations of both methods led to a bit different efficiency assessment. Averaging the position of spa businesses in compiled rankings, the most efficient DMUs were DMU09 – Spa Lúcky, j.s.c., DMU21 – Spa Pieniny Resort, l.l.c., DMU03 – Spa Bojnice, j.s.c., DMU14 – Spa Trencianske Teplice, j.s.c. and DMU04 – Spa Dudince, j.s.c. Otherwise, the lowest level of efficiency was reported by DMU04 – Spa Brusno, j.s.c., DMU17 – Spa Číž, j.s.c., DMU15 – Spa Vysne Ružbachy, j.s.c., DMU10 – Spa Nimnica, j.s.c. and DMU02 – Spa Horezza, j.s.c. Notably, both methods almost equally divided the businesses into two groups – with efficiency score above (10 DMUs) and below the overall achieved average (11 DMUs). In turn, SMLP application, DMU01, DMU03, DMU05, DMU06, DMU08, DMU09, DMU13, DMU14, DMU18, DMU21 were included in the group with a higher level of efficiency than the average. DMU01, DMU03, DMU05, DMU08, DMU09, DMU11, DMU13, DMU14, DMU18, DMU21 were placed using the selected DEA model above the overall average. Thus, only a slight deviation from the same results was found for DMU06 and DMU11.

Table 2. The average resulting rank of the businesses compiled based on SMLP and DEA

Business	Rank		$(x_i - y_i)^2$	Business	Rank		$(x_i - y_i)^2$
	SMLP (x_i)	DEA (y_i)			SMLP (x_i)	DEA (y_i)	
DMU01	7.	3.	16	DMU12	20.	11.	81
DMU02	18.	14.	16	DMU13	10.	8.	4
DMU03	2.	4.	4	DMU14	6.	2.	16
DMU04	21.	21.	0	DMU15	17.	17.	1
DMU05	3.	6.	9	DMU16	14.	17.	9
DMU06	9.	20.	121	DMU17	19.	19.	0
DMU07	15.	13.	4	DMU18	8.	7.	1
DMU08	5.	10.	25	DMU19	13.	15.	4
DMU09	4.	1.	9	DMU20	11.	12.	1
DMU10	16.	16.	0	DMU21	1.	5.	16
DMU11	12.	9.	9				

Sources: developed by the authors.

As the Spearman rank correlation coefficient reached the level of 0.7753, it is evident that business efficiency results quantified by SMLP are closely related to results measured by the appropriate DEA model. However, the perfect degree of the positive association between these two variables (methods) was not confirmed. Based on this result and p-value lower than 0.05 (0.0026), the formulated H0 hypothesis was rejected while an alternative H1 hypothesis – accepted. In this regard, it can be concluded that there is a statistically significant linear relationship (relatively strong direct dependence) between the business efficiency evaluation quantified as the optimization task of SMLP and the DEA model. Figure 3 illustrates the results.

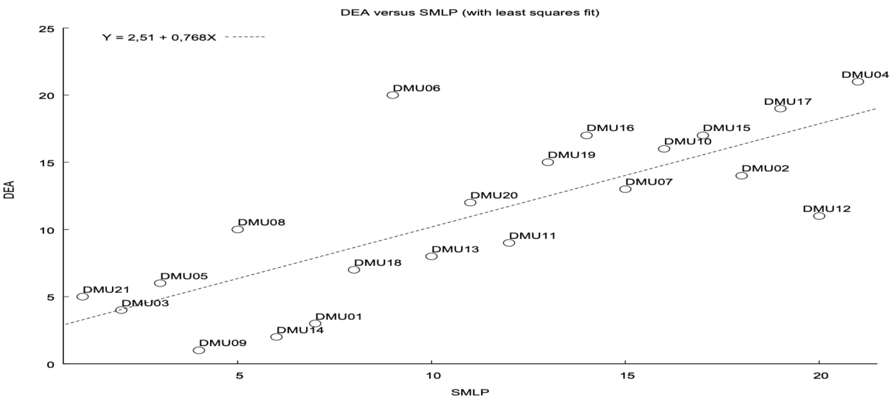

Figure 3. The result of Spearman rank correlation

Sources: developed by the authors.

Conclusions. Nowadays, the analysis and management of business efficiency are getting more and more attention due to the constantly changing global business environment bringing new, modern approaches to solve the issue. Therefore, the paper aimed to analyze the efficiency of Slovak spa businesses by applying the SMLP and an appropriate DEA model and detecting significant relation between these methods of business efficiency evaluation. The findings of partial analysis showed that the average efficiency score of Slovak spa businesses calculated by SMLP achieved the level of 0.5939. On the other hand, applying the suitable DEA model showed more acceptable average efficiency score results (0.7746). Based on the average results of the SMLP application, the maximum efficiency score (1.0000) was achieved by 2 spa businesses viz DMU03 (Spa Bojnice, j.s.c.) and DMU21 (Spa Pieniny Resort, l.l.c.). Surprisingly, the selected DEA model did not identify any efficient company. The highest score (0.9766) was achieved by DMU09 (Spa Lúcky, j.s.c.). By applying both methods, the lowest average efficiency was reached by DMU04 (Spa Brusno, j.s.c.). Besides, both methods almost equally divided the businesses into two groups – with efficiency score above (10 DMUs) and below the overall achieved average (11 DMUs). As the Spearman rank correlation coefficient reached the level of 0.7753, it means that business efficiency results quantified by SMLP are closely related to results measured by an appropriate DEA model. In summary, their alternative use within the efficiency level measurement of spa businesses was confirmed. This study provides several limitations. First, the sample size was too small, so it complicated identifying and confirming significant relationships between the analyzed methods. Therefore, the same research needs to be done in other tourism sectors or areas to conclude valid research findings. Another limitation is the data unavailability for more recent years and limited research studies relevant to the specific topic. Thus, the number of inputs and outputs could be perceived as constraint, as in the case of individual methods, only six variables were chosen. However, this research could be considered an important opportunity to identify new gaps in the prior literature and present the need for further development in these specific healthcare facilities, not only in Slovakia. The efficiency analyses carried out in this paper are also beneficial for practice as they may lead to the formulation of recommendations for improvement of the current state of Slovak spa tourism and the spa businesses themselves.

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Інноваційні методи оцінювання ефективності бізнесу: компаративний аналіз

Метою статті є оцінювання рівня ефективності санаторно-курортного бізнесу Словаччини. У рамках дослідження авторами проведено рейтингування санаторно-курортних закладів охорони здоров'я за рівнем їх ефективності бізнес-діяльності. Методологічною основою дослідження є симплексний метод лінійного програмування та компаративний аналіз середовища функціонування бізнес-моделей санаторно-курортних закладів охорони здоров'я. Об'єктом дослідження є санітарно-курортний бізнес Словаччини. Періодом дослідження обрано 2014-2018 роки. Для визначення прогресивних компаній було здійснено кількісне оцінювання ефективності діяльності санаторно-курортних закладів охорони здоров'я за допомогою оптимізаційиих моделей SMPL та BCC-DEA. У ході дослідження застосовано коефіцієнт рангової кореляції Спірмена для визначення потенційного ступеня кореляції бізнес-рейтингів. Практичну реалізацію усіх етапів дослідження здійснено з використанням інструментарію програмного забезпечення MS Excel, MS Excel Solver та Gretl. Авторами зазначено, що результати оцінювання ефективності бізнесу за допомогою методу лінійного програмування (SMPL) є схожими до результатів аналізу середовища функціонування (DEA). Таким чином, зазначені вище моделі можна вважати еквівалентними. Окрім цього, на основі отриманих результатів, досліджувані заклади було поділено на дві групи за ефективністю бізнес-діяльності 1) вище 10 DMU; 2) нижче загального середнього рівня – 11 DMU. Таким чином, найбільш ефективними закладами визначено DMU09 (Spa Lúcky, j.s.c.) та DMU03 (Spa Bojnice, j.s.c.). При цьому найнижчий показник ефективності визначено у DMU04 (Spa Brusno, j.s.c.). Результати дослідження мають практичне значення і можуть бути прийняті для підвищення ефективності бізнес-діяльності санітарно-курортних закладів охорони здоров'я у Словаччині та інших країнах.

Ключові слова: аналіз середовища функціонування, ефективність, вхідні дані, лінійне програмування, санаторно-курортний бізнес, результати.