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Benchmarking of contributory organisations within the framework of technical efficiency

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ABSTRACT
Organisations should evaluate their goals in the areas of customer service provision, overall organisational strategy, finance, and human resource management. The performance of specific services provided to the client should be monitored and evaluated in greater detail. The comparison should be made between similar organisations aiming to improve services and technical efficiency. Most organisations, profit and non-profit alike, do not know how to evaluate and compare their efficiency. Retirement homes were selected for evaluation. The review focused on the technical efficiency for the years 2015-2017. To achieve the goal, Data Envelopment Analysis (DEA) was used as a specialised model tool for assessing the technical efficiency, performance or productivity of a group of homogeneous or comparable production units based on selected inputs and outputs. Due to different types of inputs and outputs, the method was selected from among multi-criteria decision-making methods. Two models, Model X and Model Y, including specific inputs and outputs, were designed to evaluate and compare the technical efficiency of selected retirement homes. According to the results, the output-oriented model (Model Y) was more effective for retirement homes compared to the input-oriented model (Model X). The value added could be seen in the model combination and comparison between different studies, which helps to understand the transferability of the results. The analysis confirmed the necessity to combine the DEA method with the quality of service assessment to be able to benchmark the real efficiency of service of a selected type of an organisation.

KEY WORDS
contributory organisations, technical efficiency, Data Envelopment Analysis, comparable units

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Introduction

Performance measurement and management are important for both profit and non-profit organisations. Performance should be monitored by non-profit organisations in contexts of the provision of public services, employee appraisals, subsidies, and donor commitments. Typical areas that should be targeted evaluating the performance of a non-profit organisation are cost per client and per service provided, number of hours devoted to one client, number of clients per day, proportion of complaints in the total number of clients, cash-flow, number of bed-hours and client-hours, client satisfaction rates, number of employees and their attendance, occupancy rate of facilities. According to Malíková (2011), several methods and techniques can be used to measure the quality and efficiency of social services such as quality standards of social services; supervision, intervision; TQM (Total Quality Management); ABC (Activity Based Costing), Balanced Scorecard; controlling; benchmarking; complaints; self-assessment and others. The methods range from simple metrics to complex metrics such as Balanced Scorecard. This is a system of performance management and measurement of an organisation, which is based on the establishment of a balanced system of interrelated performance indicators for a particular enterprise. The main characteristic of the Balanced Scorecard model is that it formulates the relationships between inputs, processes and results and focuses on the importance of managing these elements to achieve strategic priorities of an organisation.

In performance measurement of profit and non-profit organisations, most frequently encountered problems relate to low awareness of performance measurement methods and techniques, fragmented and inconsistent data, and insufficient usability of performance indicators, especially in contributory and non-profit organisations, where it is impossible to compare their technical efficiency (Mook, 2014; Moullin, 2017; Lepir et al., 2017; Meyer, 2018). The problem of assessing the performance of a contributory organisation may also be related to a one-year service financing system. This period may be too short for strategic planning or service development, and many measures might fail to manifest within one year. At the same time, there may be uncertainty about the future scope of such organisations and the range of provided services. The 4E (Economy, Efficiency, Effectiveness, Equity) input-output model is preferred not only for healthcare but also in social care services to support the efficiency and cost reduction (Vaňková & Vrabková, 2014; Dooren, Bouckaert & Halligan, 2010). According to the authors, it is possible to define technical and allocative efficiency of organisations, when technical efficiency is concerned with output maximisation and input minimisation, and, frequently, a mathematical model is used for performance evaluation. By contrast, allocation efficiency deals with cost-effectiveness, and the main point is to find the best combination of costs and maximum output in service units. Such models are based on cost analyses.

The main goal of this paper is to evaluate the technical efficiency of contributory organisations operating in the Czech Republic. Six retirement homes were included in the performance analysis. Individual retirement homes were denoted by abbreviations HE1 – HE6. The analysis was realised over the period 2015-2017 as a case study. The main interests of beneficiaries (residents of the retirement homes) reflected in the need for high quality and accessible services.

1. Literature review

Performance measurement defines information or feedback on actions taken to achieve strategic objectives and client satisfaction. Generally, the performance evaluation of a service provider is a time-consuming, complicated process and should include client satisfaction (Zemke et al., 2018). In general, performance can be defined according to Wagner (2009, p. 17) as "a characteristic which describes how the examined subject performs certain activity on the basis of similarity to the reference method process of certain activity. This interpretation assumes the ability to compare examined and reference phenomenon in the sense of criteria scale." A key feature of performance concepts applicable to profit and non-profit organisations could be the measurement and management of technical efficiency.

There is a difference in efficiency measurement, and the focus differs depending on the target "customer." The main interest of social service providers (employed caregivers, social workers etc.) is safe premises and good working conditions (Lepir et al., 2017). Research published in the area of non-profit organisations and their performance is still scarce and underdeveloped (Sousa-Zomer & Miguel, 2018). A growing variety and diversity of performance evaluation are observed in healthcare delivery using health outcomes. Kasthurirathne et al. (2018) and van der Kooy et al. (2017) evaluated the capacity for clinical, socioeconomic and public health data sources to predict the need for various social service referrals. The evaluation should also consider Those factors attributed to "client orientation" domains (such as choice and continuity, prompt attention, quality of basic amenities, social consideration, and technical efficiency of facilities) in line with performance concepts and efficiency.

Over the past two decades, several researchers presented methods that allowed to measure efficiency to be able to benchmark results. Tan et al. (2017) and Maslihatin (2016) filled a considerable gap in the literature by proposing methods to measure service and quality performance to improve the performance efficiency of an organisation. According to Maslihatin (2016), non-profit organisations have the following objectives: (i) provide convenience in service; (ii) provide the required information society; (iii) improve intimacy with the consumer; (iv) measure the technical efficiency; (v) reduce costs; (vi) optimise resource; (vii) simplify procedures, improve productivity; (viii) share information; (ix) more responds and improving e-literacy. The paper of Tan et al. (2017) analysed efficient and inefficient levels of service performance using the Data Envelopment Analysis (DEA) and Balance Scorecard (BSC) techniques to bridge the existing gap in performance measurement. Aiming to satisfy clients while achieving low cost and patronage (loyalty), service providers have been measuring the performance of a system perceiving it as an important task in management used for purposes of control and planning.

Traditional studies of the Data Envelopment Analysis (DEA) view systems as a whole when measuring the efficiency, ignoring the operation of individual processes within a system. However, Network DEA allows considering the evaluation of changes that occur within the process (Chodakowska & Nazarko, 2016). Lotfi et al. (2010) proposed a methodology named CINDB (Combined Interval Net DEA and BSC) to evaluate the performance of an organisation considering financial and non-financial perspectives. Input and output measures for the integrated DEA-BSC model are grouped in "cards" which are associated with BSC. The BSC provides a clear representation of the relationship and logic between the key performance indicators (KPI) of four perspectives: financial, customer, internal process, and learning and growth. Also, Moullin (2017) performance management incorporated strategy mapping, service improvement, measurement and evaluation into the framework.

The methods were developed to support sustainability and to aid a high-quality measurement of performance. Other important research should be mentioned, i.e. by Bottani et al. (2017) who assessed sustainability at the organisation's level considering three key perspectives — economic, environmental and social — based on fuzzy logic and, in particular, on a monotonic hierarchical fuzzy inference tool as an effective means to gather the judgements and scores against the key performance indicators (KPIs) of each sustainability perspective into an aggregated index. Chodakowska and Nazarko (2016) presented the concept of environmental efficiency analysis based on the DEA in the case of desirable and undesirable results and illustrated by a case study of European countries. This assessment tool could be useful for benchmarking studies. At the same time, Raifman et al. (2018) presented their model for healthcare confounders to assess the quality of healthcare organisations which could be transferable into contributory and non-profit organisations. Finally, the leading model of efficiency evaluation is still based on works by Mook (2014) who developed a non-profit integrated social accounting (NISA) model, which considers particular objectives of non-profit organisations (achieving their mission and remaining viable as an organisation), their specific characteristics (e.g., the engagement of volunteers), and their economic, social and environmental impacts. The conceptual framework includes defining social accounting, setting the boundaries of the reporting entity, identifying the objectives of non-profit reporting, identifying the users of the accounts and their information needs, and considering the questions that must be answered to know whether the organisation is achieving its goals.

The NISA model incorporates four elements: (1) economic and human resources; (2) economic, social and environmental value creation; (3) internal systems and processes; and (4) organisational learning, growth and innovation. The NISA model provides a mechanism to address both functional and strategic accountability concerns of an organisation, its effectiveness and efficiency, and to drive its behaviour through feedback and readjustment. This is the main reason behind the wide use of the model in practice. Others models only improved methods of measurements or inputs for the model, as demonstrated by studies of Bittencourt et al. (2018) and Ventura et al. (2018) who focused on hospital capacity management to improve organisational performance and deal with increased demand in the healthcare sector. Their research determined operation measures, such as utilisation rate, waiting probability, estimated bed capacity, capacity simulations and demand behaviour assessment. The results showed space for improvement in capacity management, which is needed to manage technical capacity. The models are significant in helping profit and non-profit organisations to achieve their sustainability objectives and could help to create socially sustainable healthcare or social care facilities (Herrera et al., 2017; Meza-Ruiz et al., 2017; Djukic & Maric, 2017; Kaczmarek, 2014).

The research gap was found in the area of performance measurement in public organisations, especially contributory organisations, which are co-financed from state and municipal budgets. Contributory organisations in the Czech Republic (founded in accordance with the law 250/2000 Coll.) are legal entities under the public law serving to perform tasks in the interest of the public, especially in the fields of education, culture and social care. The organisations are established by the state or territorial self-governing units of regions or municipalities. They are founded to perform activities to achieve goals that are not profit-based. Contributory organisations of territorial self-governing units are founded to provide beneficial or necessary services deemed as such by municipalities, regions and citizens. Usually, contributory organisations are established by territorial self-governing units (Matoušek et al., 2007). Research questions were formulated based on the findings: Is it possible to use technical efficiency to benchmark selected contributory organisations? Would it be possible to evaluate their performance using some models?

2. Research methods

There are several mathematical, statistical or other methods available for the evaluation of effectiveness, such as AHP or DEA Models (Franek & Kashi, 2017). The DEA model compares units with the best units. This method of estimating a production function is based on the linear programming theory. The method is used both in the private the public sectors (Dlouhý, Novosadová & Jablonský, 2007; Borůvková & Kuncová, 2012; Nazarko & Šaparauskas, 2014). So, it was selected as the best method to be used for the presented case study.

Technical efficiency measurement is presented in the form of a case study, in which six contributory organisations were selected from the field of care for older adults placed in residential social facilities operating in the Czech Republic. The study is based on secondary data collection. Comparison of the capacities of selected retirement homes was based on annual and activity reports of individual facilities. Annual reports allowed understanding ways used by individual facilities to adapt their services to client requirements and the market demand. The evaluation was based on annual reports for the years 2014-2016. The evaluation of the performance of selected retirement homes was made using the DEA model. The DEA model is a tool for estimating the technical efficiency of homogeneous production units. The evaluation process was realised in two models, namely, the input-oriented model (Model X) and the output-oriented model (Model Y). Each model had its specific inputs and outputs. The models were oriented towards constant yields of range (CRS) and variable yields (VRS). The data were processed using Microsoft Excel.

2.1. DEA Model process

DEA models are based on the fact that a set of production options is available for the problem and consists of all possible combinations of inputs and outputs. A set of production options is defined by an effective boundary. If a combination of the inputs and outputs of a unit is not within this limit, this is not an effective unit. Then, the number of inputs or outputs must be adjusted. An efficient unit (which lies at the limit of production possibilities) uses a small number of inputs on a large number of outputs. Each unit that produces certain effects (so-called outputs) consumes certain resources (inputs) for the production. By nature, outputs maximise as their higher value leads to higher performance of the tracking unit. On the other hand, there is the minimising nature, which relates to the use of inputs consumed by the production unit to create the effects. A lower value of these inputs leads to higher performance of the tracking unit (Toloo, 2014; Liu, Lu & Lin, 2013).

DEA models are oriented towards inputs (input-oriented models) or outputs (output-oriented models) or are slack-based models. Input-oriented models reduce the number of inputs while maintaining the current output, while output-oriented models suggest increasing the output while maintaining a given amount of inputs. Slack-based models represent a combination of both models. At the moment of reaching the effective boundary, there is a simultaneous reduction or increase of inputs and outputs (Toloo, 2014). In the case of scale yields, models can be classified into CCR models and BCC models. CCR models can be used within constant yields from a range, that is, if the unit input increases, the output will also increase by one unit. Here, conical data packaging is constructed. The weights of the inputs and outputs are set for each unit so that each unit achieves the maximisation of the technical efficiency coefficient, while the weights must not be negative

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and the technical efficiency coefficients must not exceed the values of 1. Constant yields from a range are expressed in terms of:

$$f(tX,tY) = ft(X,Y) = tQ$$

where X represents the number of inputs consumed, Y is the number of outputs produced, t is any constant for which t ≠ 0. By meeting the condition that the unit efficiency is less than or equal to 1, the CCR maximises the efficiency model of the qth unit. The model calculates the input weight (v_j) and the output weight (u_i) to be as effective as possible for the nominal unit at the maximum unit efficiency of the other units. This model represents the role of linear angular programming expressed as:

Maximise:

$$z = \frac{\sum_i^r u_i y_{iq}}{\sum_j^m v_j\, x_{jq}}$$

Conditions:

$$\frac{\sum_i^r u_i y_{ik}}{\sum_j^m v_j\, x_{jk}} \le 1 \qquad k = 1, 2, \dots, n,$$

$$u_i \ge \varepsilon \qquad i = 1, 2, \dots, r,$$

$$v_j \ge \varepsilon \qquad j = 1, 2, \dots, m,$$

Indicator z is the unit's efficiency Uq, ε represents an infinitesimal constant, by means of which the model ensures that all weights of inputs and outputs will be positive and will thus be at least somewhat included in the model, x_ik, i = 1,2,...,m, k = 1,2,...,n, is the i-th unit input value Ui and y_ik, i = 1,2,...,r, k = 1,2,...,n, is the value of the i-th output for the unit Ui. Using the Charnes-Cooper transformation, a standard role of linear programming can be obtained as:

Maximise:

$$z = \sum_i^r u_i y_{iq}$$

Conditions:

$$\sum_i^r u_i y_{ik} \le \sum_j^m v_j x_{jk} \qquad k = 1, 2, \dots, n,$$

$$\sum_j^m v_j x_{jq} = 1$$

$$u_i \ge \varepsilon \qquad i = 1, 2, \dots, r,$$

$$v_j \ge \varepsilon \qquad j = 1, 2, \dots, m,$$

This model is marked as the primary CCR-based model (CCR-I primary model) where the optimal efficiency value is 1. For the model oriented to the outputs (the primary CCR-O model), the formula is expressed as:

Maximise:

$$g = \sum_j^m v_j x_{jq}$$

Conditions:

$$\sum_i^r u_i y_{ik} \le \sum_j^m v_j x_{jk} \qquad k = 1, 2, \dots, n,$$

$$\sum_j^m u_i y_{iq} = 1$$

$$u_i \ge \varepsilon \qquad i = 1, 2, \dots, r,$$

$$v_j \ge \varepsilon \qquad j = 1, 2, \dots, m.$$

For the BCC model, variable yields to range are expected (increasing, decreasing, constant)

$$f(tX,tY) < resp. = resp. > tf(X,Y) = tQ$$

The X expresses the number of inputs consumed, Y the number of outputs produced and t is any constant for which this is valid t≠0. Conical data packaging in this case converts to convex. This means that there are more efficient units in the BCC than in the CCR models, only one unit is effective here, and efficiency in the BBC model should not be worse than in the CCR models. The mathematical model of the primary BCC model that is input-oriented (primary BCC-I model) can be expressed as:

Maximise:

$$z = \sum_i^r u_i y_{iq} + \mu$$

Conditions:

$$\sum_i^r u_i y_{ik} + \mu \le \sum_j^m v_j x_{jk}\,, k = 1, 2, \dots, n,$$

$$\sum_j^m v_j x_{jq} = 1,$$

$$u_i \ge \varepsilon \qquad i = 1, 2, \dots, r,$$

$$v_j \ge \varepsilon \qquad j = 1, 2, \dots, m,$$

$$\mu - any\ value,$$

The μ defines a dual variable assigned convex condition e^T λ=1. In the CCR model, the value of the variable is equal to 0 (μ=0); however, the BCC model may be random. In addition to the zero value, both positive and negative values can be achieved. The primary BCC model oriented towards outputs (the primary BBC-O model) is formulated as:

Maximise:

$$g = \sum_{i}^{m} v_j x_{jq} + v,$$

under conditions:

$$\sum_{i}^{r} u_i y_{ik} \leq \sum_{j}^{m} v_j x_{jk} + v, \quad k = 1, 2, \dots, n,$$

$$\sum_{i}^{r} u_i y_{iq} = 1,$$

$$u_i \geq \varepsilon \qquad i = 1, 2, \dots, r,$$

$$v_j \geq \varepsilon \qquad j = 1, 2, \dots, m,$$

$$v - any\ value,$$

The v is the dual variable that belongs to the condition of convexity e^T λ=1 of the dual BCC-O model. For the BCC effective unit, the optimal value of the target function g^* is equal to 1, for inefficient units, values greater than 1, and it sets the rate of increase in output to reach the effective boundary.

Tab. 1. Basic statistical characteristics of inputs and outputs of the Model X for 2015-2017

	2015	2016	2017
min			
x1	1.02	1.03	1.01
x2	197.11	203.32	211.36
y1	388.61	402.46	415.12
max			
x1	2.08	2.03	1.98
x2	301.12	318.18	329.76
y1	451.25	464.51	472.31
mean			
x1	1.43	1.44	1.42
x2	225.34	232.79	242.06
y1	423.93	427.09	443.54
standard deviation			
x1	0.33	0.29	0.28
x2	34.57	39.14	40.27
y1	22.22	26.42	26.91

3. Research results

3.1. Basic characteristics of the models: inputs and outputs

In the input Model X, two inputs (x1, x2) and one output (y1) were selected. The input x1 represents calculated share of the number of beds per employee, the input x2 — wage costs per employee (in thousands of CZK/year) and the output y1 of the Model X is a share of total earnings per employee (in CZK thousands of CZK/year). Total revenues include revenues from the sale of services provided, fund revenue, other operating revenues, interest revenues and revenue (funds) received by the founder. The basic characteristics of inputs and outputs of the Model X are shown in Table 1 for all selected retirement homes for the years 2015-2017. The input x2 and the output y1 are given in thousands of CZK.

Tab.1 shows nearly constant development of the average input x1 in the reference period, while the input x2 shows wage cost per employee. The output y1 has a growing tendency. The values of the average share of the number of beds per employee (x1) reflect the humanisation in the facilities and the increase of capacities in some homes. The share of average total earnings per employee (y1) increased every year mainly due to higher transfers from the founders.

The Model Y was designed to evaluate the efficiency of one input (x1) and two outputs (y1, y2). The

Tab. 2. Basic statistical characteristics of inputs and outputs of the Model Y for the period 2015-2017

	2015	2016	2017
min			
x1	269.32	294.23	304.28
y1	86.11	71.53	99.43
y2	174.33	182.13	193.12
max			
x1	423.23	442.06	441.23
y1	212.36	192.29	217.39
y2	271.13	276.39	279.99
mean			
x1	321.15	335.33	344.85
y1	124.56	118.87	141.11
y2	213.19	223.77	231.34
Standard deviation			
x1	50.14	52.02	47.26
y1	47.04	44.09	39.65
y2	34.66	34.59	30.47

input x1 determines the amount of operating costs per one bed in the facility (in thousands of CZK/year) and outputs y1, y2 — the size of funds and operating incomes, also converted into beds used by clients (in thousands of CZK/year). Operating costs relate to the operating activities of the organisation and include the cost of consumed materials and energy, wages, insurance, depreciation, taxes, and other operating costs. In terms of operating revenues, it mainly includes revenues from the sales of services, from the use of funds and other revenues from the operation of the facility. Basic characteristics of inputs and outputs of the Model Y are given in Table 2 for all selected retirement homes for the years 2015-2017. The data are in thousands of CZK.

In Table 2, the growing tendencies of development were reflected by average values of the input x1 and the fluctuation tendency of the output y1. A slight upward trend was also observed for the output y2. The average cost per single bed (x1) increased each year. When comparing the year 2014 with the lowest average cost in the year 2017, there was a 4.3% increase. In terms of average funds of the founder per client (y1), it can be noted that the increase between 2015 and 2017 was 13.3%. The annually growing output y2 (average operating income per bed) can be positively evaluated.

3.2. Results of the analysed models

DEA of the Model X: the Model X displays input-oriented technical efficiency in constant yields of the range (CRS) and variable yields (VRS) in the analysed retirement homes (HE1 – HE6), see Tab. 3. The optimum unit efficiency ratio is 1. The inefficient units have an efficiency rate less than 1 and indicate the need to change inputs or reduce them to increase the efficiency of the unit (HE1 – HE6). The technical efficiency factor is, therefore, the interval <0;1>.

Table 4 shows the results of performance analysis focusing on technical efficiency in constant yields from a range where the same change in inputs is accompanied by the same change in outputs. Performance results are converted into percentages where effective units reach 100%, while inefficient units are less than 100%.

It is obvious from the table that the best values (100%) were achieved for the three-year period by HE2 except for the year 2015, HE4 in the year 2015, HE6 in 2016 and HE5 in 2017. HE3 was always in the interval 90-99% in years 2015-2017, HE5 was in this interval in 2015 and 2016. HE2 and HE5 were among the other effective units in the 90-99% range. The most inefficient institution was the HE1, which was the weakest in 2015 and 2017. In addition, the HE6 was low effective in 2015, at a range of 80-84%.

As for variable yields from the range, significant differences in performance can be observed compared to constant yields from the range, see Table 5. Most retirement homes reached or achieved almost 100% efficiency, especially in 2016 and 2017. Only one case was observed having a significant deviation from the optimal efficiency level for HE6 in 2015 with a lower threshold value below 89%.

Tab. 3. Results of the Model X according to CRS and VRS in 2015-2017

	2015		2016		2017	
	CRS	VRS	CRS	VRS	CRS	VRS
HE1	0.8421	0.9485	0.8726	0.9652	0.8253	1.0000
HE2	0.9263	0.9752	1.0000	1.0000	1.0000	1.0000
HE3	0.9011	0.9926	0.9161	1.0000	0.9428	1.0000
HE4	1.0000	1.0000	0,9696	1.0000	0.9375	0.9617
HE5	0.9297	0.9808	0.9247	1.0000	1.0000	1.0000
HE6	0.8362	0.8691	1.0000	1.0000	0.9337	1.0000

Tab. 4. Aggregate performance results of the Model X Constant Yields from a Range (CRS)

[%]	2015	2016	2017
100	HE4	HE2, HE6	HE2, HE5
99 – 90	HE2, HE3, HE5	HE3, HE4, HE5	HE3, HE4, HE6
89 – 85		HE1	
84 – 80	HE1, HE6		HE1

Tab. 5. Summary of Variable Range Performance Parameters (VRS) of the Model X

[%]	2015	2016	2017
100	HE4	HE2, HE3, HE4, HE5, HE6	HE1, HE2, HE3, HE5, HE6
99 – 90	HE1, HE2, HE3, HE5	HE1	HE4
89 – 85	HE6		
84 – 80			

Retirement homes with the level of effectiveness at the entry-level model below 100% should reduce their inputs or modify inputs and outputs proportionally. The input factors are the number of beds and the wage costs per employee in this case. By reducing them while retaining the output characteristics, their position in the model could be improved. However, the reduction in employee wages may lead to loss of motivation, work effort or termination of employment by employees. This would be mostly felt by the clients of the facilities, who would not be provided with services of a sufficient degree or quality. As far as the number of beds in homes is concerned, this would mean a considerable dissatisfaction of some existing clients who would have to leave the retirement home. At the same time, as the number of people interested in social service provision increases in facilities every year, this would result in an increased average waiting time and a reduced chance of getting a place.

DEA Model Y: the Model Y shows output-oriented technical efficiency, within constant yields of the range (CRS) and variable yields (VRS) in the analysed retirement homes (HE1 – HE6), see Table 6. The weight of the technical efficiency coefficient of the unit must equal to 1. The optimal coefficient rate is 1, while the inefficient units have a performance rate greater than 1. Technical efficiency factors must not be below 1. This model determines the optimal amount of inputs so that an inefficient unit could become an effective unit.

Table 7 shows the results of the performance analysis focused on technical efficiency within constant yields from the range. Performance results are converted to percentages where effective units reached 100%, while inefficient units had values greater than 100%. It can be noticed that in this model, the efficiency of a larger number of homes was higher than in the Model X. The two most efficient homes were HE2 and HE4, which remained such each year. HE6 reached 100% efficiency in 2016 and 2017, HE5 — in 2015. HE2, HE4 and HE6 homes did not need to increase their outputs to use inputs effectively.

The remaining retirement homes reached efficiency levels above 100%. The worst were HE1 and HE3 in 2015. In this case, homes that were not efficient in the output-oriented model need to increase their outputs while maintaining the input level x_1 (operating costs per one bed), or the numbers of inputs and outputs has to change proportionally. The monitored outputs were of the size of funds from the founder and operating income converted into per bed. Increasing the funds from founders of the retirement homes would provide more funding to help improve the quality of service provided to individual clients. For the founder, on the contrary, it would mean spending more money from the budget. The question, therefore, remains whether or not the founders (mostly the regions) would have additional funds available and whether they would be willing to provide them to the facilities. In the case of an increase in total revenues, it is possible to increase, for example, the offered services or, to extend the level of service offered to clients in the context of activities of

Tab. 6. Results of the Y-model according to CRS and VRS in 2015-2017

	2015		2016		2017	
	CRS	VRS	CRS	VRS	CRS	VRS
HE1	1.0076	1.0000	1.0027	1.0031	1.0022	1.0020
HE2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
HE3	1.0057	1.0056	1.0036	1.0036	1.0002	1.0007
HE4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
HE5	1.0000	1.0000	1.0026	1.0000	1.0031	1.0000
HE6	1.0037	1.0016	1.0000	1.0000	1.0000	1.0017

Tab. 7. Summary performance results of constant range yields (CRS)

[%]	2015	2016	2017
100	HE2, HE4, HE5	HE2, HE4, HE6	HE2, HE4, HE6
100,01 – 100,20		HE1, HE5	HE1, HE3
100,30 – 100,40	HE6	HE3	HE5
100,50 – 100,60	HE3		
100,70 +	HE1		

Tab. 8. Summary performance results of variable yields from a range (VRS) in the Model Y

[%]	2015	2016	2017
100	HE1, HE2, HE4, HE5	HE2, HE4, HE5, HE6	HE2, HE4, HE5
100,01 – 100,20	HE6		HE1, HE3, HE6
100,30 – 100,40		HE1, HE3	
100,50 – 100,60	HE3		
100,70 +			

Tab. 9. Results of the Model X within constant yields from a range (CRS) and variable yields form a range (VRS)

2015	HE1	HE2	HE3	HE4	HE5	HE6
CRS	0.8421	0.9263	0.9011	1.0000	0.9297	0.8362
VRS	0.9485	0.9752	0.9926	1.0000	0.9808	0.8691
2016						
CRS	0.8726	1.0000	0.9161	0.9696	0.9247	1.0000
VRS	0.9652	1.0000	1.0000	1.0000	1.0000	1.0000
2017						
CRS	0.8253	1.0000	0.9428	0.9375	1.0000	0.9337
VRS	1.0000	1.0000	1.0000	0.9617	1.0000	1.0000

Tab. 10. Results of the Model Y within constant yields from a range (CRS) and variable yields from a range (VRS)

2015	HE1	HE2	HE3	HE4	HE5	HE6
CRS	1.0076	1.0000	1.0057	1.0000	1.0000	1.0037
VRS	1.0000	1.0000	1.0056	1.0000	1.0000	1.0016
2016						
CRS	1.0027	1.0000	1.0036	1.0000	1.0026	1.0000
VRS	1.0031	1.0000	1.0036	1.0000	1.0000	1.0000
2017						
CRS	1.0022	1.0000	1.0002	1.0000	1.0031	1.0000
VRS	1.0020	1.0000	1.0007	1.0000	1.0000	1.0017

the facility. Increasing staff expertise and qualifications can also be a key to success.

Regarding variable yields from a range (VRS), 100% efficiency was achieved annually for most retirement homes, see Table 8. In 2017, however, retirement homes HE1, HE3 and HE6 reached an average of around 100.10%. In this case, however, it cannot be said that this is a poor indicator of their activity. There is some possibility of further improvement. Best performance results were reached by HE2, HE4 and HE5 in 2017.

In the analysed period, the worst position was held by HE3 in the model VRS with an average efficiency of 100.56%. In 2015 and 2016, HE1 (100.76% for 2014 and 100.27% for 2016) and HE5, HE5 obtained in the CRS model in 2016 (100.26%) and 2017 (100.31%).

Model X and Constant Yields: When comparing the results of the technical efficiency in Model X within constant yields of the range (CRS) and variable yields of range (VRS), the VRS values for individual retirement homes were better than in the CRS model. In 2015, only one retirement home, HE4, was fully effective in terms of technical efficiency. HE2 and HE6 were fully effective in 2016. HE3, HE4 and HE5 were fully effective only in the VRS model in 2016 (Table 9). In 2017, HE2 and HE5 were fully effective (both in the CRS model and in the VRS model). Full efficiency in the VRS model was reached by HE1, HE3 and HE6 in 2017, see Table 9.

Model Y and Constant Yields: When comparing the results of technical efficiency in the Model Y within constant yields of range (CRS) and variable yields of range (VRS), VRS values for individual homes were the same as in the Model X, the results were better than in CRS.

However, compared to the Model X in terms of revenues from the scale, there were more efficient homes in the analysed period 2015-2017, see Table 10. HE2, HE4 and HE5 achieved the best results in 2015. In addition to these homes, the HE1 achieved full efficiency in the VRS model and the remaining homes were fully effective within the VRS model. As far as the CRS model is concerned, the individual results were above the optimal level of 100% efficiency. In both models, HE2, HE4 and HE6 achieved the best results in 2016. Also, fully effective was HE5 in the VRS model in 2016. Full efficiency achieved HE2 and HE4 in both models in 2017. Moreover, HE5 was fully efficient in the VRS model in 2017. In the CRS model, it was HE6 in 2017.

4. Discussion of the results

Evaluations have shown that the results of the output-oriented Model (Model Y) are better as they show more effective retirement homes compared to an input-oriented model (Model X). The results of technical efficiency modelling both in the Model X and the Model Y show that better results over the three-year period were achieved by homes in the VRS model (variable yields from a range) than the CRS model (constant yields from a range), not only in terms of the number of effective retirement homes (an effective unit is equal to 1, an inefficient unit is lower/higher than 1), but also within the resulting values of technical inefficiency of individual retirement homes. The number of effective units in the CRS-oriented model was one or two in incremental years; for the VRS-based model, it was one home for the first year (2015) and five homes for the elderly in the next two years. In the CRS-based model, some retirement homes achieved technical efficiency rates lower than 85% in 2015, 2016 and 2017. This was specifically the case of HE1 in 2015 and 2016, and HE6 in 2015. The situation in the VRS model orientation was better. There, most retirement homes tended to be effective. Ineffective units should adjust (reduce) their inputs to reach an effective limit. The monitored inputs (x1, x2) in the Model X were the number of beds per employee and the wage costs per employee.

In the output-oriented model (Model Y), the situation is very similar to the Model X. Here, the number of technically efficient units (retirement homes) within the VRS was greater than within the CRS-oriented model. The number of effective units in the CRS-oriented model was three in each year; for the VRS-based model, this ranged from three to four homes. It can be said, therefore, that the Model Y achieved full efficiency for more retirement homes within the CRS model than this was in the case of the Model X. As for the homes that were not fully effective, it can be said that their level was mostly tight above the threshold of effective level. The worst results in the CRS-oriented model were achieved by three homes in 2015, namely, HE1, HE3 and HE6 with an efficiency rate of more than 100.37%. In 2016, it was HE1, HE3 and HE5 with an efficiency rate of more than 100.36%, and in 2017, HE1 and HE5 with an efficiency rate of more than 100.31%. In the VRS model, this was HE3 in 2015, HE6 with an average value of more than 100.16%; HE1, HE3 with an average value higher than 100.31% in 2016; and HE1 and HE6 with an average value of 100.17% in 2017. Ineffective retirement homes should try to increase outputs while maintaining input values. Outputs, in this case, are funds from founders and operating income per one bed. Another possibility could be associated with a proportional change of inputs and outputs. This problem motivated to compare optimistic results

Tab. 11. Comparison of technical efficiency in different sources based on DEA

Authors	Country	Focus group/sample	period	Technical efficiency
Case study	CZ	Retirement homes (6)	2015-2017	85% to 93%
Borůvková & Kuncová, 2012	CZ	Eye care clinics (4)	2009-2011	80%
Dlouhý, Novosadová & Jablonský, 2007	CZ	Hospitals (22)	2003	86%
Vaňková & Vrabková, 2014	CZ	Hospitals (17)	2010-2012	Average 90%
Björkgren et al., 2001	FI	Nursing homes (65)	1995	85% to 87%
Garavaglia et al., 2011	IT	Nursing homes (40)	3 years	78% to 85%
Luasa et al., 2013	IRL	Nursing homes (39)	-	63%

with previous studies, published before, but based on the DEA model evaluation (Table 11).

In comparison with rather similar studies based on DEA models, the performance rate was higher in the presented study than in studies conducted by other authors, which may signal about limitations: (i) a small sample of contributory organisations; (ii) a different time period, iii) different systems of payment for social care in social services in different countries.

Conclusions

Relevant and unique results were obtained by modelling the technical efficiency according to DEA models, but the evaluation was limited by selecting the assessed set of production units (retirement homes) and by selecting input and output parameters that limit the view of efficiency results for individual retirement homes. However, the methodology for the analysis and evaluation of technical efficiency has been presented both for organisations and their founders.

The DEA approach has been used to measure the performance of service providers from different areas to know their service levels. It also analyses the quality of service by making use of different cross-efficiency data envelopment analysis models to discriminate the units.

The technical efficiency evaluation should be taken as a sub-evaluation of an organisation as a part of the organisation's overall performance evaluation. The paper aims to provide a case study on the assessment of the technical efficiency of non-profit organisations and ways to perform benchmarking. However, it is important and necessary to obtain input and output information. These parameters should be selected with respect to what the organisation wants to monitor and evaluate.

The technical efficiency of retirement homes as contributory organisations has been investigated within an input-oriented model (Model X) and an output-oriented model (Model Y), with a focus on constant and variable yields on the scale (CRS and VRS). The value of 100% seems to be effective. Though, achieving 100% of technical efficiency does not always represent everything that should be achieved. Attention should also be paid to the qualitative aspect of evaluation, which includes the assessment of client and employee satisfaction, judgement of whether the social services are provided to the appropriate degree and quality, and evaluation of the overall reputation of the residential social facilities. This technical efficiency should be a part of the prepared comprehensive performance evaluation model where partial indicators would be developed to assess the effectiveness of non-profit organisations.

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