Scientific Annals of Economics and Business
70 (4), 2023, 567-583
DOI: 10.47743/saeb-2023-0027

Assessment of the Efficiency of Public Hospitals in Romania

Laura Asandului*, Raluca-Elena Caunic, Paul Coțofrei*****

Abstract:

Considering the high pressure on the healthcare limited resources, mainly on hospitals, determined by the population ageing, and the increased incidence of chronic and infectious diseases, it is essential to both decrease expenditures and provide good quality healthcare. In this paper we focus on the efficiency of Romanian public hospitals. Our research goals are to identify and examine the inefficient public hospitals in Romania; to determine sources of inefficiency in Romanian public hospitals; to describe a potential reduction in all inputs on average to rationalize hospital resources; and recommend that hospital management be improved. We propose an approach that contains preliminary data analyses to obtain homogeneous distributions, then we use Data Envelopment Analysis to estimate the technical efficiency scores for the hospitals in the sample. The results showed that more than half of the examined small hospitals were technically inefficient and that they could have produced a larger number of discharges and consequently an increased number of inpatient days. Possible reductions in inputs were also indicated. These results suggest ways of improving hospital management and restructuring and reorganizing decisions that can be implemented in the hospital network.

Keywords: hospital efficiency; healthcare; Data Envelopment Analysis.

JEL classification: I10; I18; H51; C14; C67.

* Faculty of Economics and Business Administration, Alexandru Ioan Cuza University of Iași, Romania; e-mail: *lasandului@gmail.com* (corresponding author).

** Faculty of Economics and Business Administration, Alexandru Ioan Cuza University of Iași, Romania; e-mail: *raluca_caunic@yahoo.com*.

*** Information Management Institute, Neuchatel University, Switzerland; e-mail: *paul.cotofrei@unine.ch*.

Article history: Received 6 May 2023 | Accepted 18 August 2023 | Published online 14 September 2023

To cite this article: Asandului, L., Caunic, R.-E., Coțofrei, P. (2023). Assessment of the Efficiency of Public Hospitals in Romania. *Scientific Annals of Economics and Business*, 70(4), 567-583. https://doi.org/10.47743/saeb-2023-0027.

Copyright
This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License.

1. INTRODUCTION

The present global demographic challenges, such as the change in the population age structure in terms of demographic aging, the rise in the incidence of chronic and infectious diseases, and the increased complexity of the diseases are putting high pressure on the resources of the healthcare systems in all countries. Moreover, the technological development of medical equipment is closely linked to the development of new competencies and abilities of human resources in medical care. Both, the progress of the technological and human resources, determine the improvement in the diagnosis and, therefore the rise of the quality of healthcare. All the above, need high expenditures and good health system financing. In a world where resources are limited, it is essential to reduce costs, and at the same time, to provide good quality healthcare. In an important paper, Donabedian *et al.* (1982, p. 975) argue that "much of the current concern about the healthcare field centers on the rapid rise in health expenditures that has occurred over the past 20 years", and arguably in these last decades they have continued to go up.

In many countries, hospital expenditures are between 50 to 75% of the expenses in the health sector (Chisholm & Evans, 2010). In the context of the demand for increased health services quality (Pecoraro *et al.*, 2015), and since improving health services quality involves improving efficiency, hospital efficiency must be measured and analyzed because if hospitals are ineffectively organized, "their potentially positive impact on health will be reduced or even be negative" (McKee & Healy, 2002, p. 3).

Since 2001 the American Institute of Medicine (IOM) for science-based advice on medicine and health has included efficiency as one of the six aims for the 21^{st} century health system. Efficiency in the healthcare industry is considered to mean "avoiding waste, including waste of equipment, supplies, ideas, and energy" while providing good quality services to cover the population's needs for medical care (Institute of Medicine (US) Committee on Quality of Health Care in America, 2001, p. 3). To control the increasing healthcare costs measuring the efficiency of healthcare providers has become a necessity. An argument is that hospitals are "the main cost driver in worldwide healthcare systems throughout the world, and face increasing pressure to improve efficiency" (Kohl *et al.*, 2019, p. 245).

This paper aims to evaluate the efficiency of public hospitals in the Romanian health system using Data Envelopment Analysis (DEA), which is one of the most frequently used nonparametric methods for efficiency assessment. In Romania, only several studies (Voinea & Pamfilie, 2009; Duran *et al.*, 2017; Rotea *et al.*, 2018; Stefanescu, 2019; Caunic, 2020; Caunic *et al.*, 2021) have been done on both, the efficiency of hospitals and the advantages of modern analysis methods, such as DEA.

The paper is organized as follows. After the introductory section, an in-depth description of the Romanian Health System and a detailed literature review focused on the use of DEA for hospital efficiency evaluation, emphasizing the existing gap in Romanian research on this topic, is included in Section. Section 2 focuses on the methodological aspects, such as data description, variables selection, and methods used. The results of the DEA model application in the case of Romanian public hospitals are analyzed in Section 3. Section 4 of the paper contains the conclusions of the research and discussions.

1.1 The Romanian Health System

Romania has made minor progress in the healthcare sector since its EU accession in 2007. Some hospital indicators have improved over the years, such as the average length of stay, which has steadily decreased and has converged with the EU average, along with the increase in the share of day cases. However, the health spending for inpatient care still reaches one of the highest proportions among EU countries (44%, in 2019), despite efforts to strengthen primary care, which continues to be underutilized and does not fulfill its gatekeeping role. Medical conditions that could be treated and monitored efficiently at the level of primary care are still assisted in hospitals, leading to higher expenses at hospital level. As external reports have indicated, the performance of the Romanian health system has been one of the lowest among EU countries over the past years (Björnberg & Phang, 2019; OECD, 2019). The national strategy in the healthcare sector for 2014-2020 failed to produce significant positive improvements.

Health services for the population are provided by public and private hospitals, general practitioner cabinets, medical clinics, medical laboratories, pharmacies, etc. Most health services are provided in hospitals, which means an increased workload and pressure on hospitals, especially public ones. According to the National Institute of Statistics in Romania (NIS), 532 public and private hospitals provided inpatient services and one-day hospitalization services in 2019 (National Institute of Statistics, 2020).

The percentage of health expenditures on patients in hospitals is 44% in Romania, while the European average is 29% (OECD, 2021). In Romania, the expenditures on primary and ambulatory care are very low, i.e. 18 % (EU average is 30 %). Moreover, Romania spends only 1.7 % of total health expenditures on prevention, compared to 3.1 % in the EU (OECD, 2019).

Hospitals operate on the principle of financial autonomy, based on the amounts provided in the contracts for the provision of medical services, as well as from amounts obtained, from individuals and legal entities according to the law. In addition, they receive funds from the state budget or from local budgets ("Hospitals Law No. 95," 2006).

Some characteristics and, at the same time, problems of the health system in Romania include low financing, administrative issues, underused primary care health services (Issue Monitoring, 2020), and very few and ineffective preventive measures. Moreover, in a health system that is "hospital-centric", primary care is underutilized, and hospital services are overutilized. In his paper, Fatulescu (2011, p. 199) emphasizes that the Romanian Health System has several flaws such as "bureaucracy and inconsistency in adopted laws and decisions", a diminished health budget, and the fact that "the system needs to be completely re-evaluated". Another issue is the legislation and its frequent changes[1].

In terms of the healthcare workforce, there were 3.2 doctors per 1000 inhabitants (the EU average is 3.9 doctors per 1000 individuals) in Romania in 2019, and 7.5 nurses per 1000 inhabitants (the EU average is 8.4 nurses per 1000 individual) (OECD, 2019). On the one hand, the relatively low number of medical specialists affects access to healthcare; on the other hand, many patients call the hospitals' emergency departments when they need treatment for minor medical issues, even if these are non-urgent, and do not rely on primary care. Another problem is the specialists' territorial distribution, with a larger concentration in the big cities, which affects the access to healthcare of the people from villages and small cities.

The National Health Strategy 2014-2020 includes measures for reducing avoidable hospitalizations by giving greater weight to the services offered by the outpatient clinic

(Ministry of Health, 2014). Negative effects on the efficiency of public funds have the fact that 14% of the population is not insured, meaning that this percentage has access only to the minimum package of services, which leads to the overuse of emergency medical services and late detection of chronic diseases. Covering the population's medical needs through the health services at the base of the health system (family doctor and specialist outpatient clinic) is a priority in increasing the health system's efficiency.

1.2 Literature Review

Data Envelopment Analysis is a recognized method for efficiency measurement. Since its introduction in 1978 by Charnes, Cooper and Rhodes (Charnes *et al.*, 1978), it was widely used in various fields due to its property to handle multiple inputs and outputs simultaneously. Moreover, being a nonparametric method, it doesn't require the specification of a functional form between inputs and outputs. In this context, in recent years, there is an exponential growth in the number of publications related to DEA due to, among other reasons, the existence of available software (Hollingsworth, 2008). The vast literature on DEA has become a roadmap of the lessons learned, including important theory breakthroughs and a large number of works on DEA applications that bring evidence for practice (Kohl *et al.*, 2019).

In the healthcare literature, earlier publications also tried to set DEA closer to practice, showing evidence that DEA results can bring valuable information for the decision-making process on resource planning and relocations. African studies conducted by Kirigia *et al.* (2002) and Kirigia and Asbu (2013) have measured the technical efficiency of public hospitals in Kenya and Eritrea using DEA. They have brought evidence that could have supported the transfer of excess medical staff from hospitals to primary healthcare, to strengthen the primary sector of the health system. Guillon *et al.* (2022) studied the efficiency of 31 district hospitals in Zimbabwe using the DEA output-oriented method. Recent Brazilian work has highlighted the potential of DEA in guiding patients and resources relocations during the health crisis, given the high scarcity of resources (Nepomuceno *et al.*, 2020; Ferraz *et al.*, 2021).

After the year 2000, for some time, most studies on DEA application in healthcare came from the U.S.; they compared the efficiency of private and public hospitals or examined the efficiency of hospitals according to care intensity (acute, intensive, and long-term patients) or hospital division (medical, surgical or psychiatric) (Hollingsworth, 2008; O'Neill *et al.*, 2008).

Data Envelopment Analysis oriented toward inputs, used to measure the overall technical efficiency, pure efficiency, and efficiency of scale was applied to Spanish hospitals (Ortega-Díaz *et al.*, 2020) . Spanish scholars used DEA in combination with other statistical methods to analyze the efficiency of Spanish hospitals during the period of economic recession between 2010 and 2013. García-Cornejo and Pérez-Méndez (2020) proved the effectiveness of cost-control health policies that were put in place, using the level of development of standardized cost systems as the main explanatory variable for variations in overall technical efficiency of 159 Spanish hospitals. Ortega-Díaz *et al.* (2020) found that the Spanish hospitals with a public-private partnership structure were the most efficient during the economic crisis and that this organizational structure favored them. In their paper, Pecoraro *et al.* (2015) followed the methodology proposed by Donabedian and evaluated the efficiency and performance based on the analysis of hospital bed management.

Kocisova *et al.* (2018) used DEA to verify the reliability of the performance model for Polish hospitals, developed by the Polish Minister of Science and Higher Education. The authors measured the technical efficiency of the hospitals at an aggregate level (regional level), investigating the differences in the efficiency of the hospital network in each Polish province, thus considering the influence of environmental variables such as the geographic location and the degree of urbanization that condition the demand for hospital services. The efficiency of public hospitals in Greece was studied by *Mitropoulos et al. (2013)*.

In Romania, there is a significant knowledge gap concerning the efficiency of healthcare at a micro-level. Nistor *et al.* (2017) have measured the efficiency of 20 county hospitals, using DEA under the variable return to scale assumption, and Tobit regression to identify the factors that influence the efficiency level. Using administrative hospital data from 2014, they found that 75% of the investigated hospitals were efficient in the investigated year. Also, the number of doctors and the level of operating expenditures proved to have a negative influence on the efficiency level. The hospital performance in Romania was put into the spotlight by the Ministry of Health through the project "Performance auditing of public hospitals with arrears", which was carried out in Romania for a sample of 10 public hospitals with arrears (Duran *et al.*, 2017). In their paper, based on the reports of this auditing project, Duran *et al.* (2019) evaluated the governance of Romanian public hospitals, aiming for a better understanding of the performance of the country's hospitals. The implementation of an integrated management system for hospital performance was presented by Voinea and Pamfilie (2009) and extended by Stefanescu (2019) to the concept of integrated hospitals as a way of increasing the efficiency of healthcare facilities in Romania.

Quantitative studies on the hospitals' activity and efficiency became easier to carry out after the implementation in 2008 of the Diagnosis-Related Group (DRG) reimbursement system at the national level, which facilitated the creation of a national database with main indicators of medical activity in hospitals. The DRG reimbursement system of inpatient services is based on the correlation between the diagnosis and the average costs for its treatment. Healthcare units are reimbursed by the National Health Insurance House according to the monthly case-mix index and the number of treated patients (P. Radu, 2006). A series of papers have focused on the effects of the implementation of the DRG reimbursement systems in Romanian public hospitals. Researchers have highlighted the weak correlation between the relative values borrowed from the Australian DRG system and the real costs of the corresponding cases treated in Romanian facilities, which leads to inequitable financing, increased hospital debts, and inefficiency (C. P. Radu *et al.*, 2010; Antohi, 2017).

Rotea *et al.* (2018) have brought evidence for the role of the human factor in increasing hospital efficiency. The authors highlighted the impact of wage growth for the medical staff in 2018 on the hospital's case-mix index, as a complex indicator reflecting the entire activity of the hospital. The relevance of hospital activity indicators for the management team was highlighted by Talaghir *et al.* (2018). More recently, Caunic (2020) used DEA to assess the technical and scale efficiency of the Romanian public hospitals in the North-Eastern region of the country. The analysis showed that 89% of the hospitals were technically inefficient in 2019. The results showed that the inefficiencies were in the form of scale inefficiency for 39% of the hospitals, implying that these hospitals did not operate at their optimal scale size. Caunic *et al.* (2021) used DEA to assess the technical efficiency of the Romanian public hospitals that were designated in 2020 as support units for COVID-19 treatment showing good management of the resources during the pandemic year 2020. Half of the facilities studied were placed on the efficiency frontier and none had an efficiency score lower than 0.60. Another study on Romanian public hospitals was developed by F. Radu *et al.* (2022) regarding the quality of medical services and patient satisfaction. Talaghir *et al.* (2018) analyzed Romanian public hospitals using hospitalized morbidity indicators based on DRG and an indicator of the organizational structure of the hospital.

2. DATA AND METHODOLOGY

2.1 Data Sources

In this paper, we used data published on the website of the National Institute for Health Services Management (2022). The data regarding hospitalizations in 2019 are available for 379 public healthcare facilities, out of which the psychiatric hospitals, penitentiary hospitals, and hospitals for chronic patients (asylums, sanatoriums, or recovery centers) have been excluded because they are either the subject of specific studies due to their special pathology, or due to the special social characteristics of the assisted patients, or because these have different reimbursement system from the acute-care hospitals. We also removed hospitals with unavailable data on certain indicators. We obtained a sample of 304 public hospitals divided into two categories: 250 hospitals that had Intensive Care units (ICU) and 54 hospitals that did not have ICU. We continued the analysis with 54 hospitals with no ICU. Hollingsworth (2008) argued that the evaluated hospitals should be of the same type and should provide the same services since DEA is sensitive to outliers. The inclusion of different units would confound the results which are often “conditional upon basic differences in sample or study design, rather than a real variation of efficiency” (Hollingsworth, 2008, p. 1113).

2.2 Variables

The selection of inputs and outputs was done based on the literature for the construction of a robust DEA model in hospital efficiency assessment. According to Ozcan (2008), a robust DEA model for hospital efficiency assessment should include three categories of input variables: capital investments, labour and operating expenses. In this analysis, we used labour and capital as input variables, which most of the DEA studies on hospitals are focused on (Alatawi *et al.*, 2020). We used the number of beds as a proxy for capital investments, and the number of doctors and nurses as a proxy for labour. The number of hospital beds is a proxy for resources; thus, their use indicates resource use and efficiency.

The output variables include the number of inpatient-days and the number of discharges. Following Eurostat (2018),“hospital discharge occurs when a hospital patient is formally released after an episode of care. The reasons for discharge include completing treatment, signing out against medical advice, and transferring to another healthcare institution or death”. To account for the diversity, complexity, and severity of patient illnesses treated at a hospital, following Ozcan (1992), we used the case-mix index to adjust hospital discharges. The reason for this adjustment is that the case-mix index is based on patient diagnosis-related groups (DRGs) which provides a ”relative weight for acuity” of the cases treated by each healthcare facility and thus accounts for the diversity of the health services demand and provision (Ozcan, 2008, pp. 107-108). The use of hospital discharges as an output variable without the weights provided by the case-mix or the case index could introduce a bias in the efficiency scores as hospitals with a more complex case-mix are likely to obtain lower efficiency scores (Tiemann & Schreyögg, 2012). As output variables of the medical activity, as a production activity, we used the number of cases discharged adjusted with the hospital case-mix index (CMI), to ensure the comparability of medical facilities treating patients with different pathologies (García-Cornejo & Pérez-Méndez, 2020). The hospital case-mix index is calculated based on the DRG classification of each patient discharged.

The number of inpatients is an indirect measure of hospital income, given that the reimbursement of cases depends on their complexity index, and thus it is considered that this indicator would more accurately reflect the core activity of the hospital (O'Neill *et al.*, 2008). The number of days of hospitalization determines the use of human resources and the number of beds; thus, it can be said it is an indirect measure of the quality of the healthcare provided. Atılgan (2016) argues that using both variables (the number of discharges, adjusted with the case-mix index of the hospital and the number of hospitalization days) could lead to more reliable results regarding aspects of healthcare delivered by hospitals since inpatient days reflect the resources utilization and it is closely linked to costs and quality of care. Therefore, the two indicators together capture aspects related to costs and patient accommodation, as well as aspects related to treatment, through complexity and duration.

Table no. 1 – Specification of variables used in the analysis.

Variable	Description
Inputs	
Beds	Number of operational beds approved by the Public Health Directorate
Doctors	Number of full-time and part-time employed doctors with a free medical practice certificate issued by the Romanian College of Physicians
Nurses	Number of full-time and part-time employed nurses
Outputs	
Hospital discharges case-mix adjusted	Number of cases treated and discharged in 2019, adjusted with the case-mix index obtained by each hospital in 2019
Inpatient days	Number of inpatient days for each hospital in 2019

The specification of the set of variables considered in our analysis is summarized in Table no. 1. Following the relation $n > 2 * (inputs + outputs)$, with 3 inputs and 2 outputs, the sample size of $n = 54$ hospitals is adequate, according to Wilson (2018).

2.3 Methods

Initial investigations on data contain summary statistics to describe the data set in terms of heterogeneity. Several methods were used to identify outliers to which Data Envelopment Analysis (DEA) is sensitive. In the second stage, as DEA is applied to homogenous units, a cluster analysis was applied to identify the groups of similar hospitals. For the development of a robust DEA, able to provide reliable efficiency scores for hospitals, we applied jack-knife analysis. Following Ozcan (1992), we investigated the sensitivity of the method to the variables included in the models of efficiency. In this way, in every homogeneous subset of hospitals, each hospital is compared with its reference subset and not with all hospitals from the data set. Therefore, the efficiency score of a hospital is determined considering the "subset of its peer subgroup" (Samoilenko & Osei-Bryson, 2010)

DEA is an advanced non-parametric method for efficiency measurement that has its origins in the work of Farrell (1957). It is widely used in the healthcare sector because it can handle multiple inputs and outputs at the same time, without requiring to specify either the functional form relating inputs to outputs or the weights used for them. Also, the efficiency measure is related to best practice, not to average practice, as in regression analysis and thus it gives the possibility to explain the behaviour of individual units that are evaluated (Golany & Roll, 1989; Shahhoseini *et al.*, 2011). DEA is based on the principle of the production process, meaning that the evaluated individual units transform inputs into outputs. Thus, it can be conducted under the assumption of constant return to scale (CRS) or variable return to scale (VRS), with input orientation or output orientation. The output-oriented analysis involves maximizing output based on available inputs. Alatawi *et al.* (2020) argued that the VRS assumption is more appropriate when the human factor is involved in the production process because employees can't work at a constant rate. The VRS assumption is also recommended for the managerial perspective because it allows understanding the scale of operations affecting productivity.

For the current study, we applied the DEA-VRS output-oriented model since in Romania the number of resources that public hospitals commit to the production process does not depend on the direct decisions of the managers but on the decisions of local and central authorities. The number of operational beds is approved by the Public Health Directorate and staffing is done with the approval of the Ministry of Health or the approval of the authorities under whose subordination the hospital is located.

3. RESULTS

In Table no. 2 the results show that the smallest coefficient of variation is 49.12%, meaning that the data set is heterogeneous. Because DEA is highly sensitive to units with extreme values as input(s) or output(s) (Bogetoft & Otto, 2011), and "most influential observations are outliers" (Ahamed *et al.*, 2016, p. 1) the identification and removal of the outliers is a necessary stage.

Table no. 2 – Descriptive Statistics for the sample of 54 hospitals

Variables	Min	Max	Mean	Std. deviation	Coeff. of variation
Inputs					
Beds	25	311	121.43	59.75	49.21
Doctors	4	44	14.41	8.53	59.18
Nurses	16	171	55.45	28.42	51.26
Outputs					
Discharges adjusted with the case-mix	844.6	8684.91	2854.87	1658.07	58.08
Inpatient days	992	43052	11658.67	8257.68	70.83

To identify the outliers in the sample of 54 hospitals, we applied the following methods: Boxplot, Mahalanobis method, interquartile rang (Tukey, 1977), adapted for asymmetric distributions (Carling, 2000), and Hierarchical Cluster. All the results identified two hospitals as outliers: the Municipal Hospital of Ploiesti that records maximum values for 4 variables (*doctors*, *nurses*, *discharged cases* and *number of days in hospital*), and the Vatra Dornei Municipal Hospital that has high values for the variables *discharged cases* and *hospitalization days*. Thus, these hospitals were removed, and a sample of 52 hospitals resulted.

We applied cluster analysis to the sample of 52 hospitals and got three homogeneous clusters (sub-samples). After setting the number k of clusters as two (Figure no. 1, top-left), one of the generated sub-sample has a variance three times bigger than the second one (109.93

vs. 32.27). Therefore, we continued the analysis by splitting into three clusters, and four respectively (Figure no. 1, top-right and bottom). For the case $k = 4$, two of the clusters overlap, so we continued the analysis with $k = 3$ clusters (containing 29, 13, and 10 units).

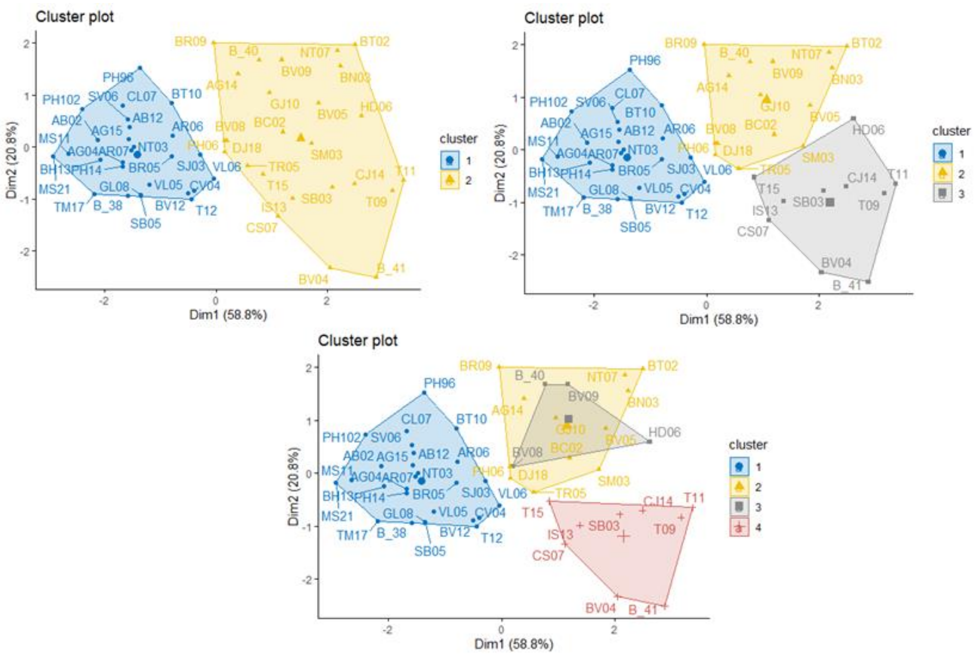

Figure no. 1 – The output of cluster analysis using two clusters (Top-Left), three clusters (Top-Right) and four clusters (Bottom)

Descriptive statistics for the largest sub-sample (Cluster 1) representing 29 small hospitals with no ICU are presented in Table no. 3. The average hospital size is 85.17 beds, ranging from 25 to 154 beds per hospital. The mean number of doctors per hospital is 9 and it ranges from 4 to 23 doctors. The number of nurses ranges from 16 to 55, with a mean of 36 nurses per hospital. Concerning outputs, the hospitals in the sample have discharged 1906 cases on average, with a mean length of stay of 7676.76 days.

Table no. 3 – Descriptive Statistics for the subsample of 29 hospitals

Variables	Min	Max	Mean	Std. deviation	Coeff. of variation
Inputs					
Beds	25	154	85.17	30.73	36.07
Doctors	4	23	9.30	4.19	45.03
Nurses	16	55	35.86	10.00	27.87
Outputs					
Discharges adjusted with the case-mix	844.60	3720.05	1905.61	733.64	38.50
Inpatient days	992.00	14549.00	7673.76	3654.98	47.63

The mean number of beds of the sub-sample of 13 hospitals is 181.15, with a coefficient of variation of 33.46%, the mean number of doctors per hospital is 17.85 (coefficient of variation 41.10%), the mean number of nurses is 76.73 (coefficient of variation 22.19%), the mean length of stay is 10104, and the mean number of discharges is 2599.15. As we can see, the mean values of input variables for Cluster 2 are at least two times greater than those of Cluster 1. The Cluster 3 includes 10 health units (three times smaller than Cluster 1) with an average number of beds of 126. In the hospitals from this cluster more cases were treated compared to the hospitals in the other two clusters: 3612.70, compared to 2599 (Cluster 2), and 1778 discharged (Cluster 1), on average.

We continued the analysis with the largest cluster out of the three clusters obtained, containing 29 hospitals (see the complete list in Annex, Table no. A1). The hospitals in this sample are small capacity, located in small towns or rural areas. They are important from the perspective of ensuring basic medical care for the population in these areas, as they target chronic conditions. For more complex ailments, the only option people have is to access the medical services of large hospitals, located in urban areas. Concerning the process of restructuring the hospital network, the question arises whether the hospitals can perform with the current funding scheme, whether they need to expand or shrink, taking the form of day medical centers.

Bed occupancy rate in acute care is calculated as the number of hospitalization days divided by the number of beds multiplied by 365 days, with the ratio multiplied by 100. For the control of nosocomial infections, it would be ideal for hospitals to maintain a bed occupancy rate between 82-85% (Jones, 2011, p. 245). On the other hand, a low bed occupancy rate indicates underutilization of the service, associated with financial losses, as existing resources are not fully used.

As shown in Table no. 4, our data highlight a low bed occupancy rate in Cluster 1, which raises questions concerning the efficiency of the hospitals, even if we consider the chronic diseases, which might justify, in some cases, the low bed occupancy rate. There are not available all data necessary to compute this indicator (bed turnover rate).

Table no. 4 – Cluster 1 - descriptive statistics for Bed Occupancy Rate

Mean	28.17
Standard deviation	15.86
Minimum	1.86
Maximum	61.52
Coeff. of variation	10.47

Next, we continued the analysis by performing a jackknife analysis to test the robustness of the efficiency scores computed with DEA. The efficient hospitals in the sub-sample were dropped one at a time from the analysis and the efficiency scores were re-estimated. The similarity between the efficiency scores obtained for the entire sub-sample and the efficiency scores obtained based on dropping each efficient hospital was tested using the Pearson correlation coefficient. Following Cinaroglu (2021) and Zere *et al.* (2006), we considered that a high correlation implies a high similarity between the efficiency scores indicating that DEA efficiency estimations are robust.

Twelve efficient hospitals and 17 inefficient hospitals were identified. The average technical efficiency score is 0.81 (81% technical efficiency). Thus, about 41% of the 29 hospitals are technically efficient, while the remaining 59% are inefficient.

Table no. 5 – Slacks for the inefficient hospitals

Input slacks	Mean	Percentage of possible change
Beds	0.10	-10%
Doctors	0.09	-9%
Nurses	0.06	-6%
Average inputs' slack	0.08	-8%
Output slacks		
Discharges	0.02	+2%
Impatient days	0.11	+11%
Average output slacks	0.07	+7%

Table no. 5 summarizes the slacks for inefficient hospitals (see also Table no. A2). The mean represents the combined scores of slack for all inefficient hospitals, calculated for every input and output. Table no. 5 also summarizes the main sources of inefficiency in terms of inputs and outputs for inefficient hospitals. With the same resources, the efficiency of the hospitals analyzed could have been, on average, 7% higher. The 17 inefficient hospitals could have treated 2% more patients on average, and the length of hospitalization could have been 11% longer on average. An increased number of cases would lead to a higher efficiency of using hospital beds and therefore an increased bed turnover rate. Also, the increased number of cases would lead to an increased number of inpatient days, although hospitals aim to maintain the length of stay to certain limits, to control costs and avoid unnecessary expenses.

An increased number of cases also means a higher addressability of the hospitals which might not be realistic, since most patients prefer to use the services of larger hospitals, which are better equipped and have more specialties and treatment possibilities. Adding new services and possibilities of treatment to the existing ones to increase the addressability of the hospitals would automatically require an increase in inputs.

In terms of inputs, to achieve the reported results by the 17 inefficient hospitals, the level of existing resources could have been reduced by 8% on average. The number of beds shows the most substantial possible reduction, by an average of 10% for treating the same number of patients, which means increasing the turnover bed rate. **S**pecialized human resources could also have been reduced, on average, by 9% and 6%, respectively, or directed to other medical facilities (as needed). These results can be explained considering the specificity of some hospitals included in the sample and their localization.

4. CONCLUSIONS

Our paper aims to bring new evidence on the efficiency in the Romanian healthcare sector, poorly investigated at the national level. We have evaluated the efficiency of a sample of small hospitals, given that small hospitals are predominant in the Romanian health network. This is the first study using DEA on the efficiency of small public hospitals in small cities and in rural areas in Romania. The added value of the study consists of the approach used in the analysis, which is more adequate to the analyzed data. To obtain reliable results, the preliminary analyses are a necessary stage for the analysis in the case of heterogeneous groups such as hospitals.

The descriptive analysis showed an important heterogeneity of the data. Due to this element, we applied the Boxplot, the Mahalanobis method, and the interquartile range to identify potential outliers. We removed the identified outliers and applied cluster analysis to the sample without outliers which resulted in three homogeneous groups of hospitals. We have focused our investigation on small hospitals with no ICU department, that are treating low-complexity cases or chronic diseases and have the features of health centers rather than hospitals. The question that arises here is whether it is justified to maintain these units in the hospital category, benefiting from a funding equivalent to hospitals or it would be more profitable to convert them into health centers, with a lower consumption of resources for treating the same type of patients. Since the whole sample of 52 hospitals includes small general hospitals and small specialized hospitals for chronic illnesses, for the validity of the results, the clustering method was applied to obtain sub-samples with higher similarity among units. As a result, the DEA was applied on the Cluster 1 (the largest one), containing 29 hospitals, all small capacity units, located in small towns or rural areas. The data envelopment analysis was conducted under the assumption of a variable return to scale, output oriented. Finally, we used the jackknife analysis to test the robustness of the efficiency scores computed with DEA.

The findings indicated that more than 50% of the investigated hospitals were inefficient and that they could have produced 13% more output. An increase in the outputs of the small hospitals would lead to higher productivity of hospital beds and an increased bed turnover rate. This objective could be achieved by increasing their addressability through new medical services and thus avoiding the overload of the larger hospitals, which most patients choose.

At the same time, the inputs could have been reduced by 8% to treat the same number of cases. The inputs could be reduced or better oriented by restructuring the hospitals that have the same profile, located in the same geographical area, as it was highlighted by our results (there are two small hospitals specialized in treating pulmonary chronic diseases, in Argeș county, and 3 small hospitals specialized in pulmonary chronic diseases, in Prahova county). Decreasing the inputs means decreasing the number of beds and the number of medical personnel (doctors and nurses). The decrease in the number of beds for every hospital complies with the EU legislation and it is done in observance of certain legal criteria, but it also depends on the hospital within a certain legal framework. Even so, the number of hospital beds continues to be quite large compared with the EU average. In 2019, Romania had 7 hospital beds per 1000 population while the EU average was 5.3 beds (OECD, 2021). Although after the EU accession there was a decreasing trend in the number of hospital beds, as recommended by external evaluators such as World Bank, this decreasing trend did not maintain, and the country still has a very hospital-centric health system with many beds and high hospital costs.

The number of inpatient days is closely linked also to the quality of care. Increasing hospitalization days leads to increased hospitalization costs, and longer bed occupancy, which leads to increased nosocomial infections, but also increased waiting time for other patients. The longer the patient stays, the greater the risk of nosocomial infections. The findings show that the inefficient hospitals could have treated more patients, meaning they could have had a higher occupancy rate. Considering these aspects, concerning the inpatient days, we could conclude that our results indicate optimal management (case management for a shorter period of hospitalization) of the inpatient cases, in a shorter hospitalization period, given the existing resources. But this is not the case for the sub-sample analyzed, since the descriptive statistics have highlighted a quite low mean of bed occupancy rate. Given the level of resources, overall, these hospitals could have treated more patients in 2019 and could have had a higher number of inpatient days with no risk of breaking the patient safety criteria.

In Romania, the territorial distribution of doctors and nurses is heterogeneous, meaning that there are regions with insufficient medical personnel and large cities with a high concentration of doctors and nurses. The number of employed doctors is directly related to performance indicators, such as bed occupancy rate. The specialized medical staff is concentrated in the university cities. There is a risk of reducing the resources of small hospitals: the disadvantaged local population could be deprived of basic medical services. For the continuity and survival of the county hospitals, a restructuring of the health network, as well as new management strategies are necessary. Also, given the high scarcity of resources and the growing costs in healthcare, more attention must be paid to the way hospitals use their current resources.

The financing system of public hospitals forces their management to orient the decisions towards maximizing the attraction of financial resources from the contracts with the health insurance houses and less towards the identification of new sources of financing. The health unit's performance indicators are mainly calculated in relation to the services provided in continuous hospitalization and in direct relation to the revenues realized from the contracts with the insurance companies. Moreover, attracting non-reimbursable European funds is a very important managerial objective, but the time elapsed between the submission of the grant application and the signing of the grant agreement is often much bigger than the initial estimate given by the call for projects.

This research provides information for managers on improving small hospitals' efficiency and its implications on health policy. The findings suggest that inefficient hospitals need to reorganize to become efficient, taking measures regarding both inputs and outputs: reducing the inputs, in case of underutilization or maximizing the outputs, according to available inputs.

ORCID

Paul Cotofrei https://orcid.org/0000-0002-4103-5467
Laura Asandului https://orcid.org/0000-0002-6582-6028

References

Ahamed, S. K., Naidu, M. M., & Subba Rami Reddy, C. (2016). Outliers/Most Influential Observations in Variable Returns to Scale Data Envelopment Analysis. *Indian Journal of Science and Technology, 9*(2), 1-7. http://dx.doi.org/10.17485/ijst/2016/v9i2/80361

Alatawi, A. D., Niessen, L. W., & Khan, J. A. M. (2020). Efficiency Evaluation of Public Hospitals in Saudi Arabia: An Application of Data Envelopment Analysis. *BMJ Open, 10*(1), e031924. http://dx.doi.org/10.1136/bmjopen-2019-031924

Antohi, V. M. (2017). Romanian Healthcare Financing Based On The Diagnosis-Related Group Payment System (DRG). In A. Sandu, T. Ciulei, & A. Frunza (Eds.), *Multidimensional Education and Professional Development: Ethical Values* (Vol. 27, pp. 19-28): Future Academy. http://dx.doi.org/10.15405/epsbs.2017.07.03.4

Atılgan, E. (2016). The Technical Efficiency of Hospital Inpatient Care Services: An Application for Turkish Public Hospitals. *Business and Economics Research Journal, 7*(2), 203-214. http://dx.doi.org/10.20409/berj.2016217537

Björnberg, A., & Phang, A. Y. (2019). *Euro Health Consumer Index 2018*. Retrieved from https://healthpowerhouse.com/media/EHCI-2018/EHCI-2018-report.pdf

Bogetoft, P., & Otto, L. (2011). *Benchmarking with DEA, SFA, and R* (Vol. 157). New York: Springer http://dx.doi.org/10.1007/978-1-4419-7961-2

Carling, K. (2000). Resistant Outlier Rules and the Non-Gaussian Case. *Computational Statistics & Data Analysis, 33*(3), 249-258. http://dx.doi.org/10.1016/S0167-9473(99)00057-2

Caunic, R.-E. (2020). Technical and Scale Efficiency in Romanian Public Hospitals: Estimating with Data Envelopment Analysis. *Proceedings of the International Conference on Applied Statistics, 2*(1), 66-76. http://dx.doi.org/10.2478/icas-2021-0006

Caunic, R.-E., Asandului, L., & Bedrule-Grigoruță, M. V. (2021). A Data Envelopment Analysis of the Response of Healthcare Facilities to Coronavirus Pandemic: Evidence from Romania. *EURINT 2021, 8*(July), 23-40.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the Efficiency of Decision Making Units. *European Journal of Operational Research, 2*(6), 429-444. http://dx.doi.org/10.1016/0377-2217(78)90138-8

Chisholm, D., & Evans, D. (2010). *Improving Health System Efficiency as a Means of Moving towards Universal Coverage*. Retrieved from https://www.who.int/publications/m/item/improving-health-system-efficiency-as-a-means-of-moving-towards-universal-coverage

Cinaroglu, S. (2021). Geographic Distribution of the Efficiency of Childbirth Services in Turkey. In Y. I. Topcu, O. Ozaydin, O. Kabak, & S. O. Ekici (Eds.), *Multiple Criteria Decision Making* (pp. 131-154). Cham: Springer. http://dx.doi.org/10.1007/978-3-030-52406-7_5

Donabedian, A., Wheeler, J. R. C., & Wyszewianski, L. (1982). Quality, Cost, and Health: An Integrative Model. *Medical Care, 20*(10), 975-992. http://dx.doi.org/10.1097/00005650-198210000-00001

Duran, A., Chanturidze, T., Gheorghe, A., & Moreno, A. (2019). Assessment of Public Hospital Governance in Romania: Lessons From 10 Case Studies. *International Journal of Health Policy and Management, 8*(4), 199-210. http://dx.doi.org/10.15171/ijhpm.2018.120

Duran, A., Chanturidze, T., Moreno, A., & Gheorghe, A. (2017). *Performance Auditing of Selected Public Hospitals with Arrears*. Retrieved from https://ms.ro/media/documents/A0775_-Final-Report_010517_updated-_ENG.pdf

Eurostat. (2018). Statistics explained - Glossary: Hospital discharge. Retrieved from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Hospital_discharge

Farrell, M. J. (1957). The Measurement of Productive Efficiency. *Journal of the Royal Statistical Society. Series A (General), 120*(3), 253-281. http://dx.doi.org/10.2307/2343100

Fatulescu, P. I. (2011). Romanian Health System: Lessons Still to Learn. *Acta Universitatis Danubius. Œconomica, 7*(3), 193-202.

Ferraz, D., Mariano, E. B., Manzine, P. R., Moralles, H. F., Morceiro, P. C., Torres, B. G., . . . Rebelatto, D. A. D. N. (2021). COVID Health Structure Index: The Vulnerability of Brazilian Microregions. *Social Indicators Research, 158*(1), 197-215. http://dx.doi.org/10.1007/s11205-021-02699-3

García-Cornejo, B., & Pérez-Méndez, J. A. (2020). Influence of Cost Systems on Efficiency. An Analysis of Spanish Hospitals Using Public National Databases. *Revista de Contabilidad, 23*(2), 249-262. http://dx.doi.org/10.6018/rcsar.365031

Golany, B., & Roll, Y. (1989). An Application Procedure for DEA. *Omega, 17*(3), 237-250. http://dx.doi.org/10.1016/0305-0483(89)90029-7

Guillon, M., Audibert, M., & Mathonnat, J. (2022). Efficiency of District Hospitals in Zimbabwe: Assessment, Drivers and Policy Implications. *The International Journal of Health Planning and Management, 37*(1), 271-280. http://dx.doi.org/10.1002/hpm.3337

Hollingsworth, B. (2008). The Measurement of Efficiency and Productivity of Health Care Delivery. *Health Economics, 17*(10), 1107-1128. http://dx.doi.org/10.1002/hec.1391

Hospitals Law No. 95, 95 C.F.R. (2006).

Institute of Medicine (US) Committee on Quality of Health Care in America. (2001). *Crossing the Quality Chasm: A New Health System for the 21st Century*. Washington (DC): National Academies Press. http://dx.doi.org/10.17226/10027

Issue Monitoring. (2020). Health Care System in Romania. Retrieved from https://issuemonitoring.eu/sistemul-de-sanatate-din-romania-politici-publice/

Jones, R. (2011). Hospital Bed Occupancy Demystified. *British Journal of Healthcare Management, 17*(6), 242-248. http://dx.doi.org/10.12968/bjhc.2011.17.6.242

Kirigia, J. M., & Asbu, E. Z. (2013). Technical and Scale Efficiency of Public Community Hospitals in Eritrea: An Exploratory Study. *Health Economics Review, 3*(1), 6. http://dx.doi.org/10.1186/2191-1991-3-6

Kirigia, J. M., Emrouznejad, A., & Sambo, L. G. (2002). Measurement of Technical Efficiency of Public Hospitals in Kenya: Using Data Envelopment Analysis. *Journal of Medical Systems, 26*(1), 39-45. http://dx.doi.org/10.1023/A:1013090804067

Kocisova, K., Hass-Symotiuk, M., & Kludacz-Alessandri, M. (2018). Use of the DEA Method to Verify the Performance Model for Hospitals. *E+M Ekonomie a Management, 21*(4), 125-140. http://dx.doi.org/10.15240/tul/001/2018-4-009

Kohl, S., Schoenfelder, J., Fügener, A., & Brunner, J. O. (2019). The Use of Data Envelopment Analysis (DEA) in Healthcare with a Focus on Hospitals. *Health Care Management Science, 22*(2), 245-286. http://dx.doi.org/10.1007/s10729-018-9436-8

McKee, M., & Healy, J. (2002). The Significance of Hospitals: An Introduction. In M. McKee & J. Healy (Eds.), *Hospitals in a changing Europe* (pp. 3-14). Buckingham: Open University Press.

Ministry of Health. (2014). National Health Strategy 2014 - 2020*Anexa 1*(November), 1-76. Retrieved from https://old.ms.ro/upload/Anexa%201%20-%20Strategia%20Nationala%20de%20Sanatate%202014-2020.pdf

Mitropoulos, P., Mitropoulos, I., & Sissouras, A. (2013). Managing for Efficiency in Health Care: The Case of Greek Public Hospitals. *The European Journal of Health Economics, 14*(6), 929-938. http://dx.doi.org/10.1007/s10198-012-0437-0

National Institute for Health Services Management. (2022). Romanian Health Services Research and Evaluation Center. Retrieved from http://www.drg.ro/

National Institute of Statistics. (2020). *Health Units Activity in 2019*. Retrieved from https://insse.ro/cms/sites/default/files/field/publicatii/activitatea_unitatilor_sanitare_anul_2019.pdf

Nepomuceno, T. C. C., Silva, W. M. N., Nepomuceno, K. T. C., & Barros, I. K. F. (2020). A DEA-Based Complexity of Needs Approach for Hospital Beds Evacuation during the COVID-19 Outbreak. *Journal of Healthcare Engineering, 2020*(September), 1-9. http://dx.doi.org/10.1155/2020/8857553

Nistor, C. S., Ștefănescu, C. A., Sîntejudeanu, M. A., & Crișan, A.-R. (2017). Performance Through Efficiency in the Public Healthcare System – A DEA Approach in an Emergent Country. *Studia Universitatis Babes-Bolyai, Oeconomica, 62*(1), 31-49.

O'Neill, L., Rauner, M., Heidenberger, K., & Kraus, M. (2008). A Cross-National Comparison and Taxonomy of DEA-Based Hospital Efficiency Studies. *Socio-Economic Planning Sciences, 42*(3), 158-189. http://dx.doi.org/10.1016/j.seps.2007.03.001

OECD. (2019). *Romania: Country Health Profile 2019*. Paris: OECD Publishing. http://dx.doi.org/10.1787/f345b1db-en

OECD. (2021). *Romania: Country Health Profile 2021*. Paris: OECD Publishing. http://dx.doi.org/10.1787/74ad9999-en

Ortega-Díaz, M. I., Ocaña-Riola, R., Pérez-Romero, C., & Martín-Martín, J. J. (2020). Multilevel Analysis of the Relationship between Ownership Structure and Technical Efficiency Frontier in the Spanish National Health System Hospitals. *International Journal of Environmental Research and Public Health, 17*(16), 1-19. http://dx.doi.org/10.3390/ijerph17165905

Ozcan, Y. A. (1992). Sensitivity Analysis of Hospital Efficiency under Alternative Output/Input and Peer Groups: A Review. *Knowledge in Society, 5*(4), 1-29. http://dx.doi.org/10.1007/BF02692773

Ozcan, Y. A. (2008). Hospital Applications. In Y. A. Ozcan (Ed.), *Health Care Benchmarking and Performance Evaluation: An Assessment using Data Envelopment Analysis (DEA)* (pp. 103-117). Boston, MA: Springer US. http://dx.doi.org/10.1007/978-0-387-75448-2_8

Pecoraro, F., Luzi, D., Cesarelli, M., & Clemente, F. (2015). A Methodology of Healthcare Quality Measurement: A Case Study. *Journal of Physics: Conference Series, 588*(1), 1-5. http://dx.doi.org/10.1088/1742-6596/588/1/012027

Radu, C. P., Chiriac, D. N., & Vladescu, C. (2010). Changing Patient Classification System for Hospital Reimbursement in Romania. *Croatian Medical Journal, 51*(3), 250-258. http://dx.doi.org/10.3325/cmj.2010.51.250

Radu, F., Radu, V., Turkeș, M. C., Ivan, O. R., & Tăbîrcă, A. I. (2022). A Research of Service Quality Perceptions and Patient Satisfaction: Case Study of Public Hospitals in Romania. *The International Journal of Health Planning and Management, 37*(2), 1018-1048. http://dx.doi.org/10.1002/hpm.3375

Radu, P. (2006). Introduction to the Diagnostic Reference Group (DRG) system *Hospital Management* (pp. 91-95): Public H Press.

Rotea, C. S., Logofatu, M., & Ploscaru, C. C. (2018). Quantitative Model for Assessing the Impact of Reward System Elements on Hospital Efficiency. *International Journal of Academic Research in Business & Social Sciences, 8*(8), 231-241. http://dx.doi.org/10.6007/IJARBSS/v8-i8/4461

Samoilenko, S., & Osei-Bryson, K. M. (2010). Determining Sources of Relative Inefficiency in Heterogeneous Samples: Methodology using Cluster Analysis, DEA and Neural Networks. *European Journal of Operational Research, 206*(2), 479-487. http://dx.doi.org/10.1016/j.ejor.2010.02.017

Shahhoseini, R., Tofighi, S., Jaafaripooyan, E., & Safiaryan, R. (2011). Efficiency Measurement in Developing Countries: Application of Data Envelopment Analysis for Iranian Hospitals. *Health Services Management Research, 24*(2), 75-80. http://dx.doi.org/10.1258/hsmr.2010.010017

Stefanescu, A. (2019). Designing the Smart Hospitals -Through Intelligently Integrated Tools of Quality and Cost Effectiveness. In D. Vrontis, Y. Weber, & E. Tsoukatos (Eds.), *Business Management Theories and Practices in a Dynamic Competitive Environment* (Vol. 12, pp. 1865-1867). Thessaloniki, Greece: EuroMed Press.

Talaghir, L.-G., Gheonea, V., Rus, C. M., Cretu, C.-M., & Iconomescu, T.-M. (2018). Statistical Analysis of Hospitalized Morbidity Indicators based on DRG in Romanian Public Hospitals. *Revista de Cercetare si Interventie Sociala, 61*(June), 163-186.

Tiemann, O., & Schreyögg, J. (2012). Changes in Hospital Efficiency after Privatization. *Health Care Management Science, 15*(4), 310-326. http://dx.doi.org/10.1007/s10729-012-9193-z

Tukey, J. W. (1977). *Exploratory Data Analysis* (Vol. 2): Addison-Wesley.

Voinea, L., & Pamfilie, R. (2009). Considerations Regarding the Performance Improvement of the Hospital Healthcare Services from Romania by the Implementation of an Integrated Management System. *Amfiteatrul Economic, 11*(26), 339-345.

Wilson, P. W. (2018). Dimension Reduction in Nonparametric Models of Production. *European Journal of Operational Research, 267*(1), 349-367. http://dx.doi.org/10.1016/j.ejor.2017.11.020

Zere, E., Mbeeli, T., Shangula, K., Mandlhate, C., Mutirua, K., Tjivambi, B., & Kapenambili, W. (2006). Technical Efficiency of District Hospitals: Evidence from Namibia using Data Envelopment Analysis. *Cost Effectiveness and Resource Allocation, 4*(1), 1-9. http://dx.doi.org/10.1186/1478-7547-4-5

ANNEXES

Table no. A1 – The complete list of 29 hospital units from Cluster 1

Nr.	Hospital
1	Center for Evaluation and Treatment of Drug Addictions for Young People "Saint Stelian"
2	Town Hospital of Rupea
3	Town Hospital of Baraolt
4	Pneumophthisiology Hospital from Leamna
5	Town Hospital of Targu Bujor
6	Health Center from Sangeorgiu de Padure
7	Sovata-Niraj Hospital
8	Pneumophthisiology Hospital from Drajna
9	Town Hospital of Agnita
10	General Hospital from Sibiu subordinated to the Ministry of Transports
11	Clinical Evaluation and Recovery Center for Children and Teenagers "Cristian Serban Buzias"
12	Pneumophthisiology Hospital from Mihaiesti

Nr.	Hospital
13	Town Hospital of Brezoi
14	Hospital for Pulmonary Diseases from Breaza
15	Pneumophthisiology Hospital from Campulung
16	Town Hospital of Jibou
17	Town Hospital of Faurei
18	Municipal Hospital from Sacele
19	Town Hospital of Sebis
20	Town Hospital of Stei
21	Pneumophthisiology Hospital from Leordeni
22	Hospital for Chronic Diseases from Lipova
23	Hospital for Chronic Diseases from Campeni
24	Town Hospital of Bicaz
25	Pneumophthisiology Hospital from Calarasi
26	Pneumophthisiology Hospital from Aiud
27	Pneumophthisiology Hospital from Botosani
28	Pneumophthisiology Hospital from Floresti
29	Hospital for Chronic Diseases from Siret

Table no. A2 – The slack variables for the set of inefficient hospital units from Cluster 1, in descending order of PTE score

Nr.	Hospital	Pure technical efficiency (PTE)	slacks for beds	slacks for doctors	slacks for nurses	slacks for discharges	slacks for hospitalization days
	Inefficient hospitals; PTE score < 1						
1	Town Hospital of Brezoi	0.97	0.00	0.00	**0.04**	0.00	**0.13**
2	Hospital for Pulmonary Diseases from Breaza	0.90	**0.12**	0.00	0.00	0.00	**0.40**
3	Pneumophthisiology Hospital from Campulung	0.88	**0.36**	0.00	0.00	**0.33**	0.00
4	Town Hospital of Jibou	0.80	0.00	**0.54**	**0.03**	0.00	0.00
5	Town Hospital of Faurei	0.78	0.00	0.00	**0.09**	0.00	**0.23**
6	Municipal Hospital from Sacele	0.78	0.00	**1.51**	**0.32**	0.00	0.00
7	Town Hospital of Sebis	0.70	**0.37**	0.00	0.00	**0.10**	0.00
8	Town Hospital of Stei	0.67	0.00	0.00	**0.09**	0.00	**0.10**
9	Pneumophthisiology Hospital from Leordeni	0.64	**0.61**	0.00	0.00	**0.09**	0.00
10	Hospital for Chronic Diseases from Lipova	0.63	0.00	**0.27**	0.00	0.00	0.00
11	Hospital for Chronic Diseases from Campeni	0.63	**0.17**	0.00	0.00	0.00	**0.41**
12	Town Hospital of Bicaz	0.58	0.00	**0.12**	**0.15**	0.00	0.00
13	Pneumophthisiology Hospital from Calarasi	0.57	**0.24**	0.00	**0.13**	0.00	0.90
14	Pneumophthisiology Hospital from Aiud	0.52	**0.29**	0.00	0.00	0.00	0.00
15	Pneumophthisiology Hospital from Botosani	0.49	0.00	**0.13**	**0.33**	0.00	0.00
16	Pneumophthisiology Hospital from Floresti	0.44	**0.69**	0.00	**0.44**	0.00	**1.03**
17	Hospital for Chronic Diseases from Siret	0.38	0.00	0.00	**0.04**	0.00	**0.12**

Notes

[1] Health Law no. 95/2006, Hospital Financing Law, Public Acquisitions Law no. 98/2016, Contract that states the conditions for providing medical care, etc.