ORIGINAL RESEARCH

Technical efficiency of Kosovo public hospitals

Emiljan Karma PhD[1], Dr. Silvana Gashi [2]

[1] Research Centre on Developing Economies, Faculty of Economic, Political and Social Sciences, Catholic University Our Lady of Good Counsel, Tirana, Albania
[2] Management Department, Faculty of Business, University "Aleksandër Moisiu", Durrës, Albania

Corresponding author: Emiljan Karma, PhD.
Address: Univ. Katolik Zoja e Keshillit te Mire, Rruga D. Hoxha, 23, Tirana (Albania)
Telephone: 00355695639061
Email: e.karma@unizkm.al

Abstract

Aim: The goal of this paper is to evaluate the technical efficiency of Kosovo public hospitals and to propose ways to improve the situation.

Methods: An input-oriented Data Envelopment Analysis model with a constant return to scale was applied for a 3-year period from 2018 to 2020. Input variables of number of beds, number of specialists and how they are used to produce outputs of inpatient discharges and surgical operations, are examined.

Results: The analysis highlights the marked hospital technical inefficiencies. This study clearly points out the greater attention of public healthcare institutions toward production efficiency. Results illustrate that at least half of Kosovo Public Hospitals operate inefficiently compared to their counterparts. Inefficient, compared to efficient hospitals, on average utilize at least (depending on scenarios analysed) 30% more beds and specialists.

Conclusions: The resources available for public health services in Kosovo are the lowest in Europe and the challenge remains to secure financial resources and use them effectively. The study illustrates that most of Kosovo Public Hospitals run inefficiently. Productivity is low, efficiency needs to be improved, especially in terms of introducing modern treatment methods such as daycare. Based on this research, it seems advisable to decrease the number of beds while rationalizing the number of specialized physicians with respect to the special requirements of therapeutic and diagnostic processes in the individual hospitals.

Keywords: *DEA, efficiency; Kosovo, public health; Tobit regression.*

Introduction

Healthcare services in Kosovo are provided through a network of health institutions organized at three levels: primary- (KPSH), secondary- (KDSH) and tertiary level (KTSH). Healthcare services are organized and provided by healthcare providers such as hospital services, home health care services and emergency ones. These services are provided in public and private health institutions. Based on the Law on Health 04 / L-125 (1), the Ministry regulates, supervises, and controls the health care implementation in public and private institutions at all three levels of health care.

The resources available for public health services in Kosovo are the lowest in Europe and the challenge remains to secure financial resources and use them effectively (2). Over the past decade, Kosovo has experienced a rise in health care spending. During the 11-year period covering 2010 to 2021, Kosovo's per capita health care spending (in U.S. dollars) increased 1,9 times from $49 in 2010 to $141 in 2021 (3,4). Kosovo's total health expenditure, as a percentage of gross domestic product, rose from 1.6% in 2010 to 3.5% in 2021 (3,4). This study on the health system of Kosovo seeks to identify the technical inefficiencies present in public hospitals in Kosovo considering the necessary interventions to improve cost – effectiveness. Hospitals are the key resource units in a health care system. They consume the majority of a country's health expenditures, and the important role they play in the delivery of health care services place them at the root of many pressing issues. Because of their importance, hospitals strongly influence their health care system's efficiency (5). Performance in the production theory refers to an optimal combination of inputs to achieve maximum outputs, thereby reducing waste (6). Regarding efficiency, we refer to the way that public hospitals allocate (allocative efficiency) and utilize their inputs (productive efficiency) to produce outputs in terms of specialized services. Efficiency refers to the use of an input to generate output; previously defined as the output-to-input ratio, such as cost per unit or production per hour of labour (7). Literature (8 - 10) has shown that a traditional method (ratio analysis) is not relevant in measuring the overall performance of a DMU (Decision Making Unit). Ratios are based on a single input and single output and measure the performance on a single indicator, which does not serve the purpose of measuring the hospital efficiency. The modern efficiency method can be extended to more inputs and outputs and can be used to measure the DMUs performance. The study proposes relative effectiveness as a metric that can be used relatively to assess the success of DMUs in terms of social and financial aspects.

To our knowledge, this is the first study that directly investigates the Kosovo Public Hospitals' efficiency using a non-parametric method like DEA. There are studies that use the traditional method (parametric and ratio analysis) in evaluating indirectly but partially the efficiency in health care institutions. Lleshi (11) conducted a study using the parametric model to evaluate the quality assurance concerning the Quality Based Management System. Bytyqi et al. (12) use a quantitative approach, with an explorative-descriptive design to examine the leadership profile and quality in primary, secondary and tertiary public health institutions in Kosovo. Tahiri et al. (13) conducted a study using the traditional method to evaluate the patient satisfaction with the primary health care service in Gjilan Region, Kosovo. Hoxha et al. (14) conducted a study using multiple linear regression analysis to assess predictive factors for patient satisfaction with healthcare services as a measure of the quality of hospital care in public and private hospitals in Kosovo. Kosovo Agency of Statistics (15-17) periodically reports the efficiency indicators of public hospitals activity in Kosovo (indicators which are based on a single input and single output).

Methods

The evaluation of health services has been addressed by a number of authors worldwide. Multi-criteria methods are widely used for the evaluation as tools that are able to assess the efficiency of inputs and show the opportunities for the improvement of inefficient units, but also to identify exemplary units. One of the tools able to determine the rate of technical efficiency of production units is the Data Envelopment Analysis (DEA) Model.

DEA is a non-parametric method that evaluates the relative technical efficiency of decision-making units (DMUs) in terms of input / output combination. DEA analyzes the efficiency with which DMU (in this study, hospital) uses inputs to produce its outputs. This method identifies the optimal input/output combination and represents it with the "best practice frontier," or data envelope. DMUs that compose this frontier are assigned an efficiency score of one and are technically efficient relative to their peers (18). All other DMUs are assigned a score of between less than one, but greater than zero (18,19).

The first DEA Model was formulated in the study published by Charnes, Cooper, Rhodes (20). This model is based on the assumption of constant returns to scale and maximizes the efficiency of the evaluated production unit under the condition that the efficiency of all other units is less than or equal to one. The modelling of technical efficiency was performed using the input-oriented model that expects that inefficient units should reduce their inputs with respect to the outputs attained. However, it is also a well-known fact that reductions in key human resources (physicians, general nurses, and midwives) have a negative impact on the quality of the services provided in both public health and social services (21,22).

The two basic DEA models are the CCR model of Charnes, Cooper, Rhodes (20) and the BCC model of Banker, Charnes, Cooper (23). CCR assesses technical efficiency under a Constant Return to scale (CRS) condition (20). Considering that this is often not the case, Banker et al. (23) introduced the Variable Return to Scale (VRS) condition, so that an institution will be compared to a similarly sized institution that has similar return to scale (24). In the basic DEA model, there are two approaches that can be used, the input-oriented approach, which maximizes proportional input reduction by holding outputs constant, and the output-oriented approach, which maximizes proportional output increase while keeping inputs constant (20). Our analysis only uses the input-oriented approach with its CRS model:

$$\theta^{*}=\min \theta_k, \qquad \textit{subject to}$$

$$\sum_{j=1}^{n} \lambda_j \, y_{rj} \leq y_{rk} \qquad r = 1, 2, \ldots, s$$

$$\sum_{j=1}^{n} \lambda_j \, x_{ij} \geq \theta^{*} \, x_{ik} \qquad i = 1, 2, \ldots, m$$

$$\lambda_j \geq 0 \qquad \forall \, j = 1, 2, \ldots, n$$

DEA show an exponential growth in its use in academic research over the last forty years (25). Technical Efficiency is analysed in two stages. First, we calculated the relative technical efficiency using the basic outline of the input-oriented DEA Model with CRS (constant returns to scale). In the second stage, a regression analysis is performed to relate efficiency scores to contextual factors for investigating their influence on the relative efficiency in the provision of hospital services. The

description of the production units evaluated - public hospitals (DMUs), the inputs and outputs, and evaluation models are specified below. Statistical analyses are performed using STATA 16 software.

DMUs in the context of the Health System

As of 31 December 2020, a total of 8 public hospitals operated in Kosovo, with a total capacity of 3872 beds: University Clinical Centre Kosovo (QKUK) and seven Public Hospitals (regional hospitals).

According to the Ministry of Health (26), the expenses of public health for inpatient and outpatient care in secondary and tertiary health care providers increased during the period 2010 – 2018 (passing from 45% to 70% of the Kosovo health budget). The hospital network comprises both public and private hospitals, while public hospitals are unambiguously dominant. Significant changes implemented in the last 20 years were aimed at making the public health system more efficient, whether from the perspective of the hospitals' operation or in terms of hospital care funding changes.

Although much was accomplished, reforms largely failed due to the discrepancy between the identification of internal needs and external priorities that drove health reform process (World Bank and other donors). Secondly, the weak State capacities and the political instability contributed to slowing down the implementation of reforms (2). This research focuses on public hospitals that provide comprehensive acute inpatient care.

Inputs and Outputs

There is no clear guideline on how to select among a variety of indicators. The articles specified below demonstrate the combination input/output changes in various studies.

Medarević et al. (27) conducted a study to evaluate the efficiency and productivity of Public Hospitals in Serbia between 2015 – 2019. Their method was the input – oriented method and the proposed DEA Model comprises the number of beds, the number of health workers (without physicians), the total number of physicians. The output variables included the number of inpatient episodes and the number of outpatient episodes.

Torabipur et al. (28) aimed to measure the hospital productivity using a cross - sectional study in which the panel data comprised a 4-year period from 2007 to 2010. The input measures included are the number of nurses, number of beds and number of physicians. The output measures included are number of the outpatients and inpatients, average of hospital stay, and number of surgeries.

Kundurjiev et al. (29) focused on the efficiency in healthcare and especially technical efficiency in psychiatric hospital care. The proposed DEA Model includes as inputs hospital beds, physicians, nurses, and as outputs inpatients and bed – days.

Pirani et al. (30) focused on the evaluation of the efficiency of public hospitals between 2012 and 2016. Their method was the output-oriented DEA Model positing variable returns to scale, while the input variables comprised the number of hospital admissions, the number of nurses, and the number of available beds. The output variables included the average length of stay and the bed turnover interval.

Ghahremanloo et al. (31) point to the importance of performance evaluation as a relevant tool for hospital management. The proposed DEA Model includes the evaluation of the overall hospital efficiency. The model's input indicators comprise the number of healthcare professionals, the number of other staff, and the number of beds. The output indicators include the bed occupancy rate and the bed turnover rate.

Varabyova et al. (32) focused their research on applying the non-parametric methods (such as DEA and FDH) to evaluate certain Italian and German hospitals. Their input indicators were the number of beds, the number of physicians and the number of

nurses (the personnel data are specified in a full-time equivalent), while the output indicators were the selected inpatient adjusted and day cases.

However, to use DEA correctly, the number of DMUs must be high enough: the larger the number of variables used, the larger the number of DMUs (33). Given that the number of DMUs in Kosovo is only eight, two inputs indicators and two output indicators were chosen to fulfil the objective of the article. Secondly, after conducting a review of the available literature (34, 35) we decided to use these inputs and outputs: X1 - number of hospital beds available in public hospitals (input); X2 – number of specialized physicians (input); Y1 – number of hospitalized patients by year (output); Y2 – number of surgeries by year (output).

The performance estimation of efficiency according to the DEA Model is implemented using four specific models. The first two models contain two outputs and one input and estimate the efficiency with constant returns to scale (CRS) method. These models are indicated as X1-CRS (X1; Y1-Y2) and X2-CRS (X2; Y1 – Y2). Consequently, the partial efficiency is estimated from the perspective of the individual inputs (X1, X2). The other two models contain two inputs and one output and estimate the efficiency with CRS method. These models are indicated as Y1-CRS (X1-X2; Y1) and Y2-CRS (X1-X2; Y2). Consequently, the partial efficiency is estimated from the perspective of the individual outputs (Y1, Y2).

Results

The distribution of the results between the individual inefficiency levels (mild, moderate, strong) confirms that models x1 - CRS attain the worst results, while the best results are attained by y1 – CRS. Of the 8 general hospitals included in the study, the average efficiency rate fluctuates from 70% to 91% depending on the model applied.

According to this analysis, the best performance, in all models, is obtained by the Public Hospital of Vushtrri. On the other side, considering these input – output indicators, the worst performance is obtained by the Public Hospital of Gjilan. DMUs efficiency ranking, the means of input and output variables, for both efficient and inefficient hospitals, are presented in Table 1.

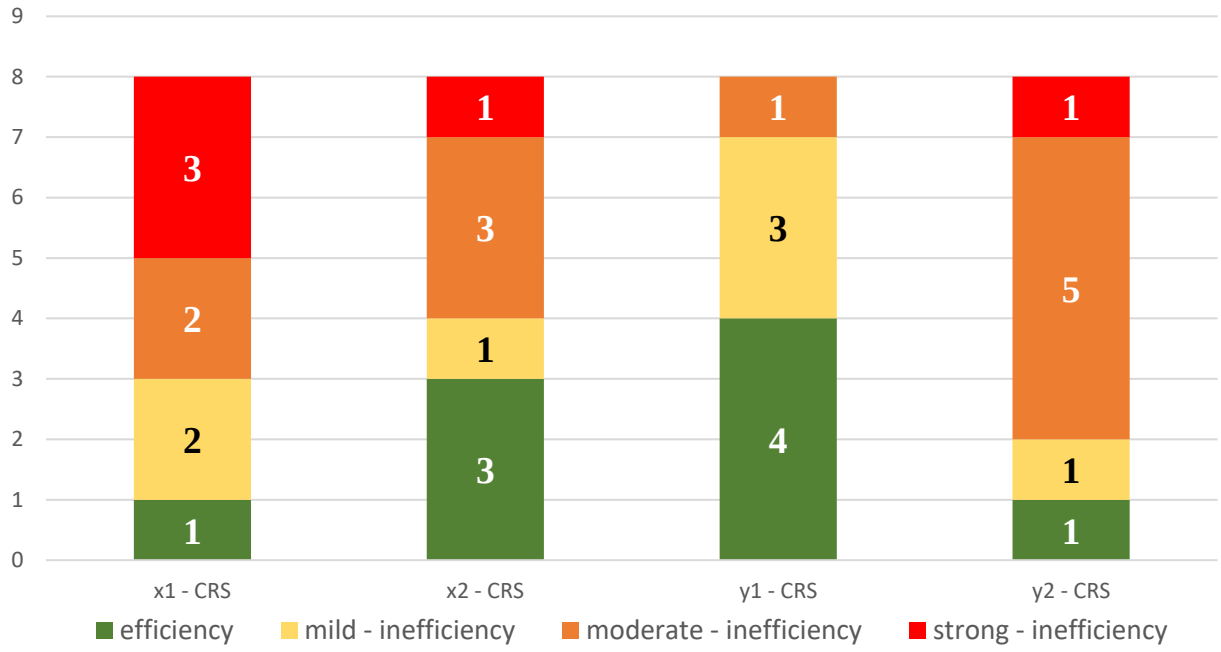
Table 1. Hospital efficiency results

DMU	Efficiency ranking (by model)			
	x1 - CRS	x2 - CRS	y1 - CRS	y2 - CRS
Prizren	4	1	1	2
Peje	6	4	5	5
Gjilan	8	7	7	8
Vushtrri	1	1	1	1
Mitrovice	2	6	1	4
Gjakove	6	1	1	7
Ferizaj	3	8	8	6
QKUK	5	5	6	3
The efficiency rate of 8 general hospitals by models				
Mean	0,70	0,87	0,91	0,72
Mean (%)	70	87	91	72
St. Deviation	0,17	0,24	0,33	0,48

Efficient hospitals are using fewer inputs to produce more outputs compared to inefficient hospitals. The extent of the inefficiency changes according to the

models used. The presence of inefficiencies indicates that a hospital has excess inputs or insufficient outputs compared to those hospitals on the efficiency frontier. The distribution of DMUs based on the efficiency score is presented in Figure 1.

Figure 1. Distribution of DMUs by efficiency score



Note: [0-0,5[score: strong-inefficiency; [0,5 – 0,7[score: moderate inefficiency; [0,7-0,99[mild-inefficiency; [1] score: efficiency

For the efficiency comparison over time, a Mann-Whitney test is used (36-39). This non-parametric test identifies whether the efficiency scores from one year to another have a significant difference. Following the results (see Table 2), we can conclude that there are no significant differences in all models with the exception of model Y2 – CRS: in this case, it can be seen a statistically significant efficiency improvement during 2019 and 2020 compared with the year 2018.

The selected Tobit model (40, 41) for explaining the observed hospital inefficiencies contains the following variables: hospital size (SIZE), Average Length of Stay (ALOS) and bed occupancy rate (BOR). The Tobit model was performed for the four scenarios (x1-crs; x2-crs; y1-crs; y2-crs).

Table 2. Results of the Mann – Whitney test (year efficiency comparison).

	X1 - CRS			X2 - CRS			Y1 - CRS			Y2 - CRS		
	18/19	18/20	19/20	18/19	18/20	19/20	18/19	18/20	19/20	18/19	18/20	19/20
U - value	15,5	15	24	20	28	27	19	27	25	*11.5*	*12*	30
Z – value	-1,68	-1,73	-0,78	-1,2	-0,36	0,47	-1,31	-0,47	0,68	*-2,1*	*-2,04*	0,15
P - value	0,09	0,08	0,43	0,23	0,71	0,63	0,19	0,64	0,49	*0,04**	*0,04**	0,87

Note: p* = 0.05 (significance level)

Table 3 presents the Tobit regression model results. Results from the regression analysis indicate that the coefficient for bed occupancy rate has a positive coefficient in all efficiency models indicating that the higher the bed occupancy rate the higher the efficiency score (in X1 – CRS model, 1% increase in bed occupancy rate increases the

efficiency score by 0,0143054 all other factors remaining constant. The score coefficient is statistically significant at the 1% level). The coefficient for the hospital size is positive in all efficiency models but significant only for X2 – CRS and Y1 – CRS models. The coefficient for ALOS has a negative and significant coefficient in all models indicating that the higher the average length of stay the lower the technical efficiency score.

Table 3. Results of Tobit Model

Efficiency Model	Variable	Coefficient	t	P > |t|
	SIZE	-0,0082051	-0,50	0,640
	BOR	0,0143054	22.99	0,000**
	ALOS	-0,1625514	-15.23	0,000**
	cons	0,6849855	20.51	0,000**
	Sigma	.0094139		
X1 - CRS	**p < 0,01	*p < 0,05		
	N. observations			8
	LR chi2			45,13
	Prob > chi2			0,0000
	Log likelihood			25,973067
	Pseudo R2			-6,6161
	SIZE	0,5481224	4,07	0,010*
	BOR	0,0204997	4,04	0,010*
	ALOS	-0,2820566	-3,24	0,023*
	cons	0,7138949	2,62	0,047*
	Sigma	0,0767903		
X2 - CRS	**p < 0,01	*p < 0,05		
	N. observations			8
	LR chi2			10,06
	Prob > chi2			0,018
	Log likelihood			9,1819099
	Pseudo R2			-1.2127
	SIZE	0,3574446	3,48	0,018*
	BOR	0,0125095	3,23	0,023*
	ALOS	- 0,2419334	-3,64	0,015*
	cons	1,115265	5,36	0,003**
	Sigma	0,00586798		
Y1 - CRS	**p < 0,01	*p < 0,05		
	N. observations			8
	LR chi2			8,39
	Prob > chi2			0,0387
	Log likelihood			11,33377
	Pseudo R2			-0,5873
	SIZE	0,2358457	2,35	0,065
	BOR	0,0244741	6,48	0.001**
	ALOS	- 0,1787922	-2,76	0,040*
	cons	0,1009707	0,50	0,640
	Sigma	0,0571663		
Y2 - CRS	**p < 0,01	*p < 0,05		
	N. observations			8
	LR chi2			16,24
	Prob > chi2			0,0010
	Log likelihood			11,542818
	Pseudo R2			-2,3711

Discussion

This study is one of the first attempts at analyzing technical the efficiencies of Public Hospitals in Kosovo by using DEA methodology. The study illustrates that the large majority of Kosovo Public Hospitals run inefficiently. These results are not surprising and are further support of the conventional beliefs that the Kosovo health and hospital systems are not effective and efficient (42). Because the hospital system is the largest component of the health system, it can be said that to a great degree, the efficiency of the hospital system determines the health system efficiency. As shown in Table 1, inputs are wasted and not utilized in the production of hospital services.

The above results may indicate—within the context of the evaluation logic according to the input-oriented DEA Model—those inefficient hospitals should primarily consider reducing the number of beds and secondly discuss the number of specialized physicians. However, this recommendation must be considered individually in the hospital conditions, especially those showing an extensive inefficiency degree, even if this includes at least 50% of all the public hospitals.

The evaluation of the technical efficiency results according to hospital size shows that big hospitals are not necessarily the leaders within the set analysed (e.g., the Hospital of Vushtrri is a small structure with only 63 beds.).

Based on this research, it seems advisable to decrease the number of beds while rationalizing the number of specialized physicians with respect to the special requirements of therapeutic and diagnostic processes in individual hospitals. In the case of physicians, any interference in their numbers should only be made based on special evaluation processes, because a reduction in the number of physicians is likely to decrease the quality of healthcare (21, 22).

With this information, policymakers and managers will be able to make educated choices in which path to take to increase efficiency. Since hospital managers generally have more control over their inputs, they may devote more attention to the examination of total inefficiencies generated by excessive input usage. However, examinations of output inefficiencies can also provide strategic direction for the hospital by indicating where to increase its efficiency. By analyzing output inefficiencies and excess inputs, policymakers and managers can attempt to make hospital and health systems more efficient.

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