MEASUREMENT OF TECHNICAL EFFICIENCY IN SELECTED UNIVERSITY HOSPITAL

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Abstract

This paper deals with the measurement and evaluation of technical efficiency in the selected university hospital in terms of selected departments of the hospital. High inefficiency in Slovak healthcare is a problem since the formation of the Slovak Republic. If we want to reduce inefficiency in Slovak healthcare, it is imperative that each individual hospital in each of its departments has taken all necessary measures to improve efficiency. Selected on the basis of input and output variables we analyzed development of effectiveness in the time. To measure technical inefficiency, we used the method Data envelopment analysis and specifically models BCC, which assumes that returns to scale are variable and CCR model, expecting constant returns to scale. To examine the inefficiency in particular department in particular year, we were using input models, which focus on reducing inefficiency by changing the inputs, and output models that reduce inefficiency by changing the output variables, which improves inefficiency of that department in that year. We cannot improve the inefficiency of departments in the past, but a detailed analysis of the causes of problems can provide reliable data for future decision for managers of hospital. This work after careful evaluation of the results of measurements presents these recommendations.

Key words: technical efficiency, DEA, hospital

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Introduction

The health sector is one of the fastest growing areas of the economy in most of developed countries. Government and taxpayers invest amount of money into healthcare, either directly or indirectly, and expect high quality service. In fact, the performance of this sector is different and is characterized by long waiting times, inefficiency, low productivity, stressful healthcare professionals and patient's dissatisfaction. The health system consists of a comprehensive set of subjects, actions and processes. Measuring performance provides information on existing practices, values and assumptions and allows developing a systematic

method of identifying deficiencies and improving future performance. Errors within medicine have a significant negative impact on patient safety. Medical errors have become a major problem worldwide since late 1999, when the Institute of Medicine published its report, which states that 44.000 to 98.000 people die in U.S. hospitals each year because of errors (Institute of Medicine, 2000). Liberatore (2013) in own review of the application of Six Sigma in health care facilities identified 88 hospitals and health care providers, which in their conditions applied the concept of SS / LSS (Six Sigma / Lean Six Sigma). Within these facilities have been implemented globally 171 implementations in different departments. Improvement of time (38%) and reducing the error rate (30.4%) were the most frequently observed factors. The first study examining the healthcare facility using SFA (Stochastic Frontier Analysis) was conducted by Wagstaff (1989), who examined 49 Spanish hospitals. Utilizing parametric SFA models in the evaluation of the efficiency of hospitals, however, is somewhat typical for American studies (Rosko, 2001), although in the current literature can be seen more European authors who have decided to use this framework for their use (Herr et al., 2011). Regarding the number of units (DMU - Decision Making Unit), studies in the available literature vary. You might encounter major studies involving a nationwide sample, such as work of Herwartz and Strumann (2012), who investigated the 1600 German hospitals, pursuing smaller number of local units, such as the contribution of Tarazona et al. (2010), who examined 22 hospitals in the district of Valencia, Spain. So far, however, we have in the domestic or foreign literature not met with the article in the context of the issue, to determine the exact or set the recommended number of units. In principle it is in most cases the evaluation of the effectiveness of hospital units tailored to the needs of the country or region, based on which the specified number of units is surveyed. We believe, therefore, that for the observance of basic assumption, and thus preserve the logic of measurement and evaluation of the efficiency of hospitals through selected methods is necessary to monitor at least two units.

1 Methods

To assess the technical efficiency there are used several types of models. According to Cooper and Seiford (2007) we divide the main DEA models to CCR model, BCC model and additive model of DEA. The main difference between the first two models is the returns to scale. CCR model considers during conversion the constant returns to scale; contrary BCC model considers that in the observed DMU are returns to scale variable. CCR and BCC models are further subdivided into input and output, depending on whether we want to achieve technical efficiency by inputs or outputs change. It should be noted that DMU is

technically efficient if the value of technical efficiency is equal 1. Additive model represents special approach, whereby the technical efficiency is achieved by simultaneous change of inputs and outputs of the model. For the purposes of this work we used CCR and BCC models, namely the input model BCC and CCR input model. We did not use the output model, whereas output variables listed in the next chapter, are extremely difficult to be influenced from the position of hospital. In studied hospital we measured and evaluated the effectiveness of 5 units, while we present 4 of them. In case of 5th, orthopedic department, worst results were achieved according to the input CCR model during the first two years studied. Years 2009-2013 represented a period of full technical efficiency according to both input DEA models. The criterion for selection of these departments was the number of patients admitted.

1.1 Data

In the studied hospital we measured and evaluated the effectiveness of five bedded departments of selected Slovak University Hospital: Department of Internal Medicine, Department of Gynecology, Department of Surgery, Department of Orthopedic and Trauma surgery department. Criterion for the selection of these departments was the number of patients admitted and we selected 5 departments with the highest number of patients admitted. Summary ratio of the number of patients admitted in these units to the total number of patients admitted to the inpatient department in the last year was about 31 %. We have not measured technical efficiency among departments, since every department needs a different structure of the individual inputs and outputs, which could distort the data. To address the technical efficiency using DEA models are required input and output variables. Individual input and output variables are chosen on the basis of the most frequently used variables in this field at home and abroad with respect to the possibility of obtaining these data and principle of processing such analysis. To some extent, we used Lacko et al. (2014), where were used input and output variables in the environment of Slovak healthcare. For the needs of our work are preserved input variables number of doctors and number of nurses, input variable material costs was not provided by hospital. Input variable number of other personnel was unsatisfactory because for individual departments is difficult to determine how many other types of employees work for each department, as some sections are centralized. We have replaced them with other commonly used input variables and those are mortality and number of beds. All of these variables are given in absolute terms. Among output variables we included number of days of treatment, bed occupancy (in %) and number of patients. The

values of these variables we managed to get for the years 2007-2013, and each department in a given year was treated as a separate DMU. Thus, we subsequently measured efficiency according to the input DEA BCC and CCR models and subsequently determined the need for input changes in absolute terms. Whereas, those data are sensitive for hospital, they cannot be presented in this paper.

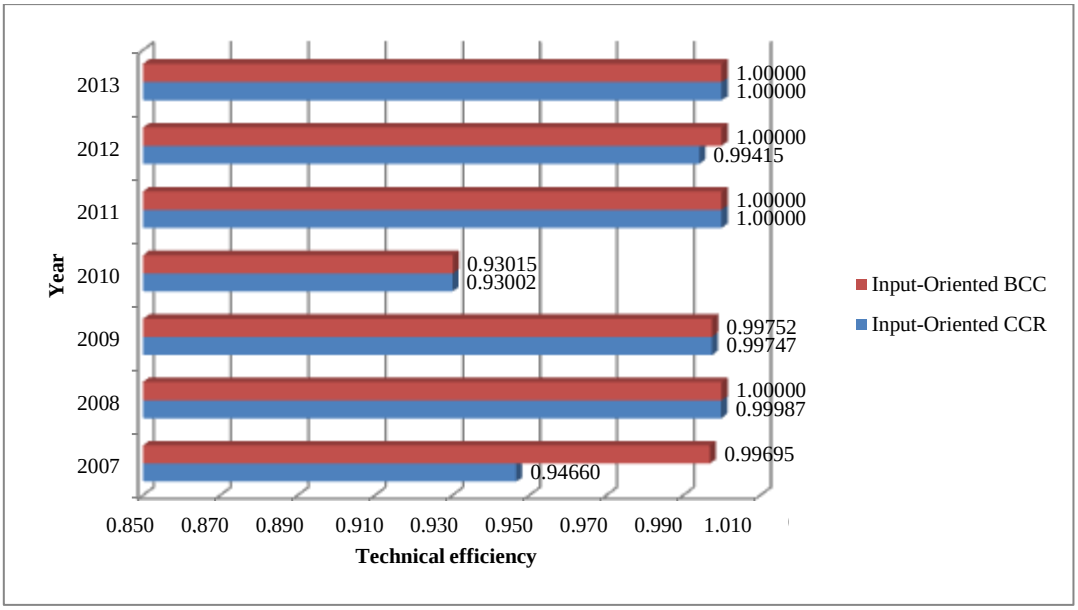
2 Results

This section describes the values measured, divided into chapters by selected inpatient departments of selected hospital.

2.1 Department of internal medicine

The results of measurements using input DEA BCC and CCR models for the department of internal medicine are presented on the chart.

Fig.1: The values of technical efficiency in the department of internal medicine



Source: own processing

The values of technical efficiency in this department had uneven progress. During the last three years of measurements was this department, except the input CCR model in 2012, technically efficient. CCR inefficiency in 2012 was almost negligible. The lowest technical efficiency was monitored in 2010, where both models showed the value of technical efficiency of about 0.93. Noteworthy is to point out CCR efficiency in 2007, where technical efficiency reached 0.9466, which is a slight deviation from the technical efficiency. During all monitored years was the department BCC efficient, meaning that technical BCC inefficiency

was low. Table 1 shows the values of the necessary reduction of the absolute values during each year. As we can see, in 2012, these values were almost negligible; while in the years 2007 to 2010 were quite high, especially for CCR model.

Tab. 1: Efficient input target for department of internal medicine (in absolute numbers)

Year	Efficient Input Target							
	CCR				BCC			
	Number of doctors	*Number of nurses*	*Mortality*	*Number of beds*	*Number of doctors*	*Number of nurses*	*Mortality*	*Number of beds*
2007	-9.81	-6.09	-15.58	-23.86	-3.37	-0.19	-0.89	-9.38
2008	-11.28	-6.34	-0.04	-22.00	0.00	0.00	0.00	0.00
2009	-16.18	-19.14	-0.74	-19.16	-11.67	-16.61	-0.72	-10.35
2010	-14.57	-11.08	-21.75	-19.96	-8.17	-7.47	-21.71	-7.49
2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2012	-1.11	-2.54	-1.72	-1.69	0.00	0.00	0.00	0.00
2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

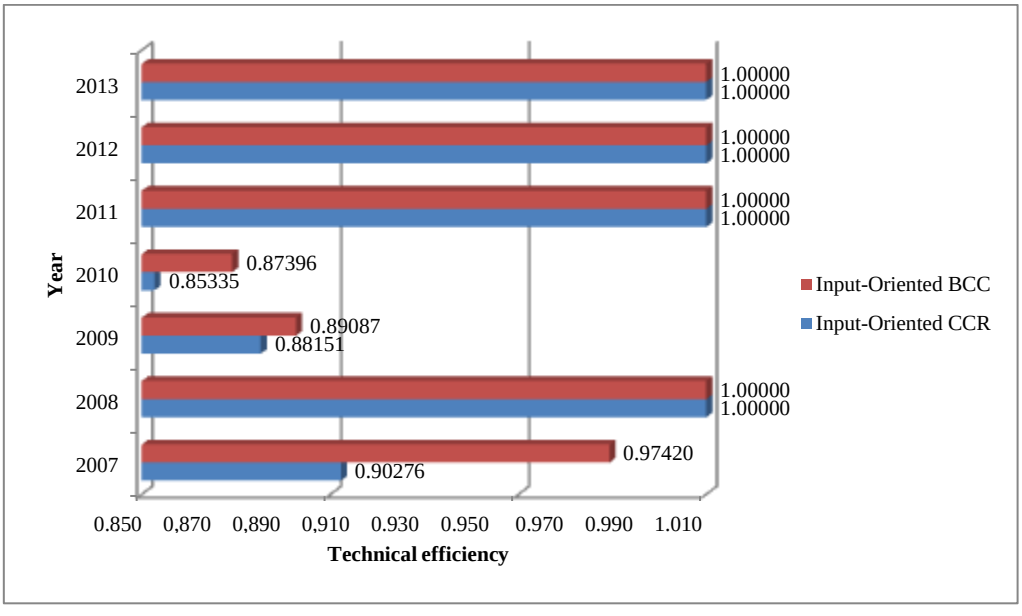
Source: own processing

The highest values were reached in number of beds variable, where it was necessary to reduce this variable during these four years by about 20. Hard part is to reduce mortality variable, since we assume that the hospital performs medical activity with 100% will. At the internal department is one of the highest mortality which results from the complexity of the cases treated. The number of necessary changes in medical staff is also quite high.

2.2 Gynecological department

To view the values of technical efficiency in this department note the following chart.

Fig.2: The values of technical efficiency in the gynecological department



Source: own processing

Also gynecological department has been over the last three years technically efficient. The worst technical efficiency was monitored in 2009 and 2010, when the values of individual technical efficiencies were from 0.85 to 0.89. These values of technical efficiency were the lowest of all analyzed departments. In 2008, the hospital was technically efficient, but the year before, the value of CCR efficiency was 0.90.

The necessity of reducing the number of doctors and nurses is not so significant. We can mention that mortality on this department was quite low. Instead, we would focus on reduction of number of beds.

Tab. 2: Efficient input target for gynecological department (in absolute numbers)

Year	Efficient Input Target							
	CCR				BCC			
	Number of doctors	*Number of nurses*	*Mortality*	*Number of beds*	*Number of doctors*	*Number of nurses*	*Mortality*	*Number of beds*
2007	-3.77	-2.40	-1.07	-18.56	-3.04	-0.64	-1.00	-13.42
2008	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2009	-4.17	-3.21	-0.12	-12.71	-4.06	-2.96	-0.11	-11.96
2010	-5.07	-4.05	-0.15	-13.42	-4.82	-3.48	-0.13	-11.73
2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

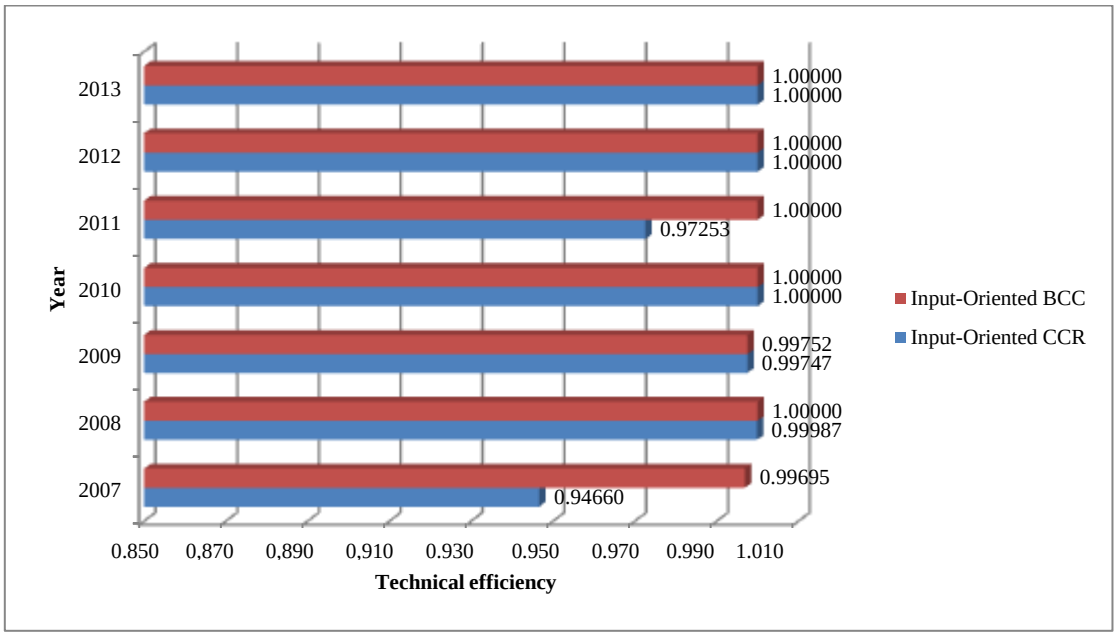
Source: own processing

In 2007, where the technical inefficiency was not as low as in 2009 and 2010 CCR model even recommended to reduce the number of beds by more than 18. Model BCC showed numbers were necessary reduction is somewhat smaller.

2.3 Department of surgery

To compare the technical efficiency of the department of surgery, focus on to the following figure 3. After the view of the results of the technical efficiency of this department, we must say that in this department during each year, no major changes happened. It is important to realize that the DEA models determine always at least one DMU, whose combination of inputs and outputs is the best, as effective. It therefore does not mean that this department is actually working efficiently, even if it is possible.

Fig.3: The values of technical efficiency in the department of surgery



Source: own processing

In 2007 and 2011 according to input CCR model was slightly technically inefficient. Although the values of technical inefficiencies were high, the need for input changes in absolute terms is quite high.

Tab. 3: Efficient input target for department of surgery (in absolute numbers)

Year	Efficient Input Target							
	CCR				BCC			
	Number of doctors	*Number of nurses*	*Mortality*	*Number of beds*	*Number of doctors*	*Number of nurses*	*Mortality*	*Number of beds*
2007	-6.04	-3.29	-5.07	-21.21	-2.08	-0.10	-0.29	-8.33
2008	-6.94	-3.43	-0.01	-19.56	0.00	0.00	0.00	0.00
2009	-7.50	-4.95	-0.24	-17.03	-4.72	-3.57	-0.24	-9.20
2010	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2011	-12.95	-4.00	-2.65	-2.76	-12.01	-2.11	-0.55	0.00
2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

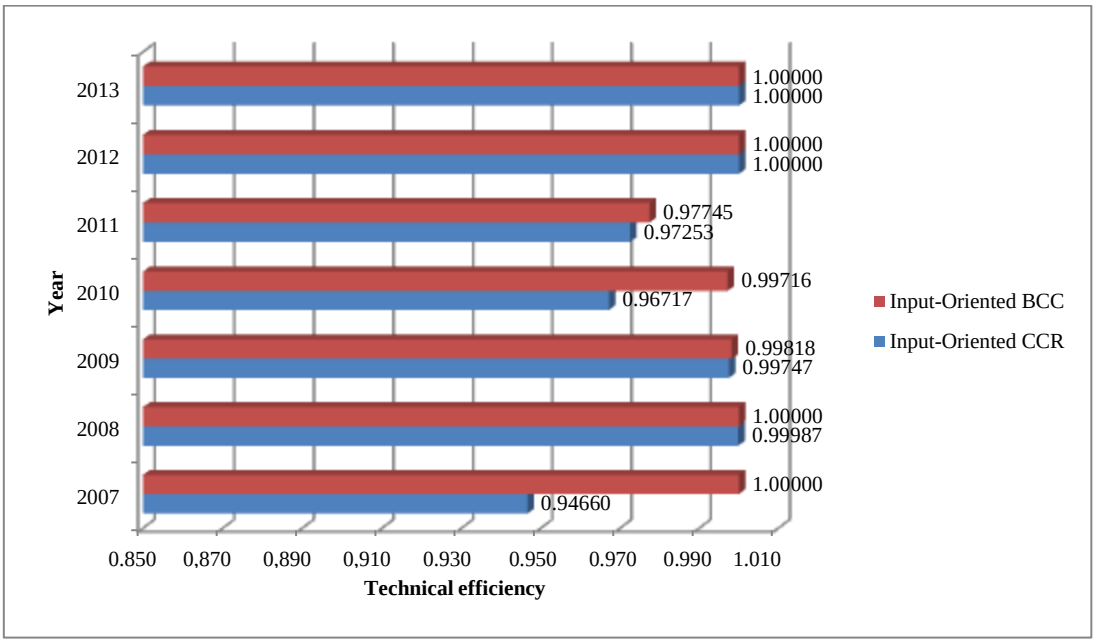
Source: own processing

This department has reached outstanding values apparently due to a good combination of inputs and outputs, on the other hand were not, unlike the outputs, most optimal. We can see a trend that during the first three examined years was, according to both models, particular problem in the number of doctors and the number of beds, and in 2011 it was not so serious problem with beds but compared to last year, it was necessary to further reduce the number of doctors.

2.4 Department of trauma surgery

Technical efficiency of the final examined department had following development.

Fig. 4: The values of technical efficiency in the department of trauma surgery



Source: own processing

This department experienced technical efficiency under both models in the last two years studied. According to the input BCC model, department has been effective also in the years 2007 and 2008. Values of technical efficiency according to the input CCR model in 2008 and 2009 were very close to 1. Slightly increased technical inefficiency was under input CCR model achieved in 2007, 2010 and 2011.

Tab. 4: Efficient input target for department of trauma surgery (in absolute numbers)

Year	Efficient Input Target							
	CCR				BCC			
	Number of doctors	*Number of nurses*	*Mortality*	*Number of beds*	*Number of doctors*	*Number of nurses*	*Mortality*	*Number of beds*
2007	-8.68	-4.79	-1.15	-6.60	0.00	0.00	0.00	0.00
2008	-9.98	-4.99	0.00	-5.00	0.00	0.00	0.00	0.00
2009	-8.78	-7.19	-0.05	-2.16	-5.07	-5.17	-0.04	-0.16
2010	-7.89	-8.72	-1.61	-2.96	-6.65	-6.18	-1.23	-0.26
2011	-11.43	-5.82	-0.60	-20.11	-6.62	-2.50	-0.49	-16.89
2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: own processing

High need for change of individual inputs under both models is most significant in 2011, where models more significantly advised to reduce the number of beds than over the

remaining years. Likewise, it is in case of number of doctors, but the need to reduce the number of medical jobs is not so significant.

Conclusion

The healthcare sector is facing significant challenges throughout the world. Costs and increasing the quality of healthcare itself consistently fails to meet expectations. Quality management is one of the major strategic issues in health care organizations. However, there is only a minimal consensus on the precise definition and importance of quality and quality management, as many tools are directly taken from industry. However there are some major differences between medicine and industry, to be taken into account before the actual transformation and implementation of health. Measuring performance of hospitals does not belong to modern issues and literature devotes considerable attention for several years. It represents a major global phenomenon and publications in this field are recorded since the mid-80s. In the last 10 years, many countries have introduced various forms of performance measurement in hospitals. There is a constant increasing need to provide an effective tool to measure process performance in terms of tertiary health care, in particular to identify deficiencies and propose measures to eliminate them. In general, within health care facilities, it assesses the structure, process and output.

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