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EFFICIENCY COMPARISON OF INTEGRATED AND INDEPENDENTLY MANAGED HOSPITALS: A CASE STUDY OF CENTRAL BOHEMIA

This paper discusses the issues concerning the efficiency of integrated and independently managed hospitals in a selected region of Czech Republic – Central Bohemia. A DEA method was used to evaluate the efficiency for both. The subjects of the analyses are 5 hospitals which are part of one holding and 7 other hospitals in the same region, managed independently.
Keywords: *data envelopment analysis (DEA); holding; hospital; integration; efficiency.*
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ПОРІВНЯННЯ ЕФЕКТИВНОСТІ ІНТЕГРОВАНИХ ТА НЕЗАЛЕЖНИХ ЛІКАРЕНЬ: ЗА ДАНИМИ ЦЕНТРАЛЬНОЇ БОГЕМІЇ

У статті розглянуто питання, що стосуються ефективності інтегрованих та незалежних лікарень в обраному регіоні Чехії – Центральній Богемії. Метод аналізу середовища функціонування застосовано для оцінювання ефективності обох категорій лікарень. В аналізі детально розглянуто 5 лікарень, що входять до холдингу, а також 7 автономних лікарень.
Ключові слова: *аналіз середовища функціонування; холдинг; лікарня; ефективність.*
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СРАВНЕНИЕ ЭФФЕКТИВНОСТИ ИНТЕГРИРОВАННЫХ И НЕЗАВИСИМО УПРАВЛЯЕМЫХ БОЛЬНИЦ: ПО ДАННЫМ ЦЕНТРАЛЬНОЙ БОГЕМИИ

В статье рассмотрены вопросы, касающиеся эффективности интегрированных и независимых больниц в избранном регионе Чехии – Центральной Богемии. Метод анализа среды функционирования применён для оценки эффективности обеих категорий больниц. В анализе детально рассмотрены 5 больниц, входящие в холдинг, а также 7 автономно управляемых больниц.
Ключевые слова: *анализ среды функционирования; холдинг; больница; эффективность.*

Introduction. In 2013, hospitals in Czech Republic spent 131.3 bln CZK from the total of 290.9 bln CZK allocated to the healthcare sector. This amount represents approximately 7.12% of GDP (UZIS, 2014). Due to the fact that health care expenditures have a tendency to increase, it is necessary to find methods to keep them at an acceptable level. One of the ways of doing so is by different modes of integration – connecting various institutions to one unit.

According to J. Matysiewicz (2011), the healthcare services market is predisposed to integrations. This flows from the following reasons:

- the structure of the size of medical centres has a high level of sector dispersion;
- for a long time centres in the public sector were not independent and were not in competition with one another;

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- the structure of patients' needs and restrictions in centres' resource are those essential factors forcing cooperation;
- system solutions in health protection take into consideration the possibilities of integrating small medical centres as well as private doctors' practices.

J. Matysiewicz (2011) presents 6 hypothetical forms of alliances at the healthcare market (Table 1).

Table 1. **Hypothetical forms of alliances at the healthcare service market** (Matysiewicz, 2011)

Focused alliances	Complex alliances	Joint venture alliances
Agreement with a firm supplying the market with specific specialists	Agreement between hospitals cooperating in given fields such as research works, provision, prevention etc.	Creating a new economic subject with a foreign health centre, a pioneer in certain treatment methods
Cooperation	**Alliances of two partners**	**Consortia**
Starting cooperation with another health centre to achieve joint realisation of undertakings and complicated medical procedures	Agreements between two health centres of different speciality, e.g. a gynaecology clinic and a laboratory	Agreement of a larger number of partners in order to offer a wider package of services. It can be in a form integrating a large number of small firms of the same speciality under the same brand using on a franchise model

Integration tendencies are described in many scientific articles, e.g. by F.K. Ackerman et al. (1992), R.D. Baker (2001), G.J. Bazzoli et al. (2000), P. Clement (1997), T. Lake et al. (2003) etc., with an emphasis on positive benefits from such merger.

In general, integrating services offers: 1) more access to capital to improve facilities; 2) economies of scale to improve technical services. On the other hand, staff, physicians and community lose considerable autonomy under integrated services (Shortell, 1988).

Integration can be either horizontal, or vertical. Horizontal integration is defined as coordination of activities across operating units which are at the same stage in the process of delivering services. Horizontal integration involves grouping organisations which provide a similar level of care under one management umbrella. Vertical integration is defined as coordination of services among operating units which are at different stages of the process of patient services' delivery (Pan American Health Organization, 2008).

We can see a trend of integration not only in the sector but also in hospital services as such. For example, in the USA, a number of hospital integrations dramatically increased integration in past 20 years (Huckman, 2006; Gaynor and Gentler, 1999). Integration in the USA typically refers to horizontal integration of hospitals or physicians and vertical integration of hospitals and physicians (Bazzoli et al., 2000). A similar trend has been observed in Czech Republic during the recent decades. When focusing on horizontal integration two primary benefits can be seen: 1) increased market power; 2) greater efficiency (Huckman, 2006; Lake et al., 2003). A number of international authors describe benefits and risks of jointing, e.g., F.K. Ackerman et al. (1992), R.D. Baker (2001), G.J. Bazzoli et al. (2000),

P. Clement (1997), T. Lake et al. (2003), J. Matysiewicz (2011) etc. The authors state the following positive points:

- better access to resources due to collective purchase;
- greater negotiating power;
- motivation for investing in new technologies which allows the quality of services to rise;
- reducing costs and improving medical technology through information exchange;
- eliminating service duplication;
- diminishing doctors' mistakes due to a larger number of cooperative specialists;
- providing complex services;
- allocating risks among multiple organisations;
- more resources for marketing flowing from the synergy effect;
- enhanced relationships with clients.

On the other hand, several authors such as P.K. Halverson et al. (1997) or A.M. Zuckerman (2006) also state the disadvantages of integration. Among others they list the following:

- Additional costs from interorganisational cooperation.
- Loss of autonomy and control.

S.I. Walston et al. (1996) summarise the benefits of vertical integration in the healthcare as follows:

- Lowering costs and eliminating unneeded services – confirmed by the studies of (Ackerman, 1992; Brown and McCool, 1986; Coddington, 1994; Conrad and Dowling, 1990; Conrad, 1993; Findlay, 1993; Gillies, 1993; Johnson, 1993; Peters, 1991; Shortell, 1988; Wheeler, 1986).
- Economics of scale – confirmed by (Ackerman, 1992; Brown and McCool, 1986; Findlay, 1993; Peters, 1991).
- Increased market and negotiating power – confirmed by (Conrad and Dowling, 1990; Findlay, 1993; Fox, 1989; Johnson, 1993; Peters, 1991; Shortell, 1989).
- Profit and market share gains – confirmed by (Brown and McCool, 1986; Coddington, 1994; Wheeler, 1986).
- Better recruitment and retention – confirmed by (Coddington, 1994; Peters, 1991).
- Environmental acceptance – confirmed by (Zuckerman and D'Aunno, 1990).

All the studies agree on the benefits of vertical integration.

Most researchers, such as L.R. Burns et al. (1998), S.M. Shortell (1998) and G.J. Bazzoli et al. (2000) presume that horizontal and vertical integration do not have influence on revenue increase. They insist that integration has some influence on profit increase through reduced expenses. In addition, this result differs from the results of P. Clement et al. (1997), who claimed that horizontal integration has influence on revenue increases. K. Yang (2004) shows that hospitals with only functional integration are more profitable than hospital with clinical and functional integration.

Benchmarking as a tool for efficiency measurement. Benchmarking is the process of continued learning based on identifying best practices which bring best results in other companies and replicating such practices with an aim to improving one's own position at a market (Camp, 1995). Over time, the focus gradually shifts from goods or services to processes and strategies as it is assumed that business performance and processes within companies bring greater efficiency (Ralston et al., 2001).

The following benchmarking methods can be used to measure the efficiency of healthcare organisations (Prochazkova, 2011):

a) Parametric methods:
- SFA (Stochastic Frontier Analysis);
- COLS (Corrected Ordinary Least Squares);
- OLS (Ordinary Least Squares);

b) Non-parametric methods:
- DEA (Data Envelopment Analysis);
- PI (Performance indicator);
- TFP (Total Factor Productivity).

For the purposes of the research presented here, the research team chose DEA method, which is, according to previous researches and relevant literature, the most commonly used method in the healthcare field. To calculate the efficiency of companies and organisations by means of DEA the total cost is often used as an input and profit – as an output. However, the matter is more complicated in the case of hospitals and the authors of other research papers often use (mainly regarding applied health systems) the number of beds, the number of doctors, the number of employees, a case mix (weighted index of cost per one medical case), the operating cost, the total assets of a hospital etc. as the input and the number of procedures, the number of newborn babies, the number of people discharged, the number of people hospitalised, the number of days in a hospital as output, e.g. by (Clement, 2008; Giokas, 2002; Nayar and Ozcan, 2007).

Research objectives and methodology used. The aim of the research conducted at the Faculty of Management and Economics, Tomas Bata University in Zlin, was to find an answer to the following research question: *Does networking of regional hospitals lead to improving performance of hospitals?*

The main file consisted of 188 hospitals in operation as of or before June 30, 2013, in Czech Republic, of which 97 hospitals are owned by the county, municipality or town. The research found that 28% of the hospitals owned by the county, municipality or town in Czech Republic (i.e., 27 hospitals) have formed an association aimed at improving the economy, better patient care, greater opportunities for career growth for employees. It is also based on the principle of solidarity, since health regulations do not favour small hospitals, and placement of acute healthcare is provided throughout the region.

The trend of hospital associations owned by regions began in 2004, when the first association of hospitals was created. This trend continues to this present day. Currently (as of January 1, 2015), there are 5 hospital associations owned by the regions in Czech Republic (Table 2).

Hospitals of Central Bohemia were chosen for analysing the efficiency as in this region both independent hospitals and healthcare holdings operate, which is the sub-

ject of our extended research. The data were obtained from various sources such as annual reports and the Institute of Health Information and Statistics of the CR yearbook. The latest available information from the year 2013 was used. In 2013, there were 24 hospitals in Central Bohemia. For analytic purposes, further selection was undertaken. First, hospitals which only provide long-term care were excluded for such hospitals have different aims and therefore different effectiveness indicators. Next, hospitals for which it was impossible to gather information about operational costs for the input data for DEA analysis were excluded. In total, the subjects of analysis were 5 hospitals which are part of Central Bohemian Holding and 7 independent hospitals (Table 3).

Table 2. **Holdings in Czech Republic,** *authors'*

Holding	Founded
Health holding of the Kralovehradecky region	2004
Hospitals of the Ustecky region	September 1, 2007
Hospital holding of the Stredocesky region	September 18, 2009
Health holding of the Plzen region	June 30, 2010
Hospitals of the Pardubicky region	January 1, 2015

Table 3. **Hospitals in Central Bohemia,** *authors'*

Name of hospital	
Rudolf and Stefanie Benesov Hospital	Holding
Kladno Regional Hospital	
Kolin Regional Hospital	
Mlada Boleslav Regional Hospital	
Pribram Regional Hospital	
NH Hospital	Independent hospitals
JESSENIA, Hospital Beroun	
Hospital Melnik	
Hospital Nymburk	
Municipal Hospital Mestec Kralove	
Hospital Ricany	
MEDITERRA – Sedlcany	
PRIVAMED Healthia, Masaryk Hospital, Rakovnik	Excluded hospitals
Hospital Slany	
Hospital Kutna Hora	
Municipal Hospital Caslav	
ANESAN, Cesky Brod	
P-P Clinic, Kladno	
RHG, Hospital Kralupy nad Vltavou	
Centrum of Integrated Oncology Care, Hospital Mesice, CIOP	
ALMEDA, Hospital Neratovice, Neratovice	
PP Hospitals, Hospital Brandys nad Labem	
Hospital Trebotov	
RHG, Municipal Hospital Roztoky	

DEA is commonly used to evaluate the relative efficiency of a number of DMUs. The basic DEA model in A. Charnes et al. (1978), called the CCR model, has led to several extensions, most notably the BCC model of Banker et al. (1984) assumes that

there are n DMUs (DMU_j: $j = 1, 2, ..., n$), which consume m inputs (x_i: $i = 1, 2, ..., m$) to produce s outputs (y_r: $r = 1, 2, ..., s$). The BCC input oriented (BCC-I) model evaluates the efficiency of DMU_0, DMU under consideration, by solving the following linear program:

Equation:

$$\begin{aligned}
&\max \sum_{r=1}^{s} u_r y_{rj} - u_0 \\
&s.t. \sum_{i=1}^{m} w_i x_{io} = 1 \\
&\sum_{r=1}^{s} u_r y_{rj} - u_{0\cdot} - \sum_{i=1}^{m} w_i x_{ij} \le 0, j = 1,2,\ldots n \\
&u_{0,} free \\
&w_i \ge \varepsilon, i = 1,2,\ldots,m \\
&u_r \ge \varepsilon, r = 1,2,\ldots,s.
\end{aligned} \tag{1}$$

where x_{ij} and y_{rj} (all nonnegative) are the inputs and outputs of the jth DMU; w_i and u_r are the input and output weights (also referred to as multipliers); x_{i0} and y_{r0} are the inputs and outputs of DMU_0. Also, ε is non-Archimedean infinitesimal value for forestalling weights to be equal to zero. In account of the fact that the basic DEA models identify more than one DMU as efficient units, finding the most efficient DMU is an issue.

G.R. Amin and M. Toloo (2007) proposed an integrated model for finding most CCR-efficient DMU, as follows:

$$\begin{aligned}
&M^* = \min M \\
&s.t. M - d_j \ge 0, j = 1,2,\ldots,n \\
&\sum_{i=1}^{m} w_i x_{ij} \le 1, j = 1,2,\ldots,n \\
&\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} w_i x_{ij} + d_j - \beta_j = 0, j = 1,2,\ldots n \\
&\sum_{j=1}^{n} d_j = n - 1 \\
&0 \le \beta_j \le 1, d_j \in \{0,1\}, j = 1,2,\ldots,n \\
&w_i \ge \varepsilon, i = 1,2,\ldots,m \\
&u_r \ge \varepsilon, r = 1,2,\ldots,s,
\end{aligned} \tag{2}$$

where d_j as a binary variable represents the deviation variable of DMU_j; DMU_j is most CCR-efficient if and only if $d_j = 0$. The constraint $\sum_{j=1}^{n} d_j = n - 1$ forces among all the DMUs for only single most CCR-efficient unit (Toloo and Nalchigar, 2009).

CCR model is designed with the assumption of constant returns to scale. This means there is no assumption that any positive or negative economy of scale exists. It is assumed is that a small hospital should be able to operate as efficiently as a large one

– that is, with constant returns to scale. In order to address this, R.D. Banker, A. Charnes and W.W. Cooper (1984) developed the BCC model. The BCC model is closely related to the standard CCR model as is evident in the dual of the BCC model:

$$\begin{aligned} &\min(\theta,\lambda)=\theta \\ &\theta\chi_0 - x\lambda = s^- \\ &Y\lambda = y_0 + s^+ \\ &e\lambda = 1 \\ &\lambda \geq 0, s^+ \geq 0, s^- \geq 0. \end{aligned} \tag{3}$$

The difference compared to CCR model is the introduction of the convexity condition $e\lambda = 1$. This additional constraint gives the frontiers piecewise linear and concave characteristics (Schaar and Sherry, 2008).

DEA model can be input- or output-oriented. The input oriented model contracts inputs as far as possible while controlling outputs. The output-oriented model expands outputs as far as possible while controlling inputs (Martic, 2009).

The following input and output criteria were chosen for DEA analysis of the hospitals:

a) the operating cost in the year 2013 as the input;

b) the following 3 indicators, all for the year 2013, as outputs:

- The number of beds;
- The number of hospitalised patients;
- Bed usage in days.

DEA analysis results for hospitals of Central Bohemia. The results of the efficiency DEA analysis of the 12 chosen hospitals using the two basic DEA models are presented in Table 4. For output-oriented models, the level of efficiency is calculated to be higher than one. From the interpretation point of view, a hospital with an efficiency value of 100% can be considered as efficient. Based on the theoretical assumptions it is evident that BCC models have at least the same or higher effectiveness as CCR models. Therefore, it is apparent that the most efficient hospitals in Central Bohemia are Hospital Nymburk and Municipal Hospital Mestec Kralove based on the BCC model, 6 hospitals can be considered as efficient. However, these are the largest or smallest hospitals based on the number of beds, so unless such hospitals are extremely inefficient it can be assumed that according to the BCC model, which is based on a variable return of the scale, these hospitals shall appear to be efficient. The table is divided into two parts, the hospitals which are a part of a holding are in the first group and the independent hospitals form the second one. Based on the CCR model none of the hospitals which are part of a holding can be considered efficient, however based on the BCC model 3 of those hospitals are efficient. Our attention is focused on the CCR model, where we consider the return to scale to be constant. Excluding the CCR and BCC model results, the input data for this analysis are also included in the table.

The following table (Table 5) presents how individual hospitals should improve the outputs while keeping the same level of inputs. The values are based on the CCR model. The output values stated in the table are therefore the desirable values to reach the same level of efficiency as the most efficient hospital currently has. Such a model

offers an opportunity for benchmarking. It allows stating what would be the value of a hospital if this hospital was as efficient as the Municipal Hospital Mestec Kralove and the Hospital Nymburk, which are considered as the most efficient hospitals in this research. Taken as an example, one of the abovementioned hospitals – the Rudolf and Stefanie Benesov Hospital, we can say that the number of beds would have to be increased from current 386 to 563, the number of patients would have to be increased to 32614.417 and bed usage in days would have to change from 211.2 to 932.793 while operating costs would have to remain as 740,041,000 CZK.

Table 4. **Analysis results – output-oriented models,** *authors'*

Name of hospital	CCR, %	BCC, %	Number of beds	Number of hospitalised patients	Bed usage in days	Operating costs, CZK
Rudolf and Stefanie Benesov Hospital	68.5	91.6	386	16592	211.2	740041000
Kladno Regional Hospital	65	100	531	26523	263.5	1073400000
Kolin Regional Hospital	54.2	100	541	24921	236.1	1311933000
Mlada Boleslav Regional Hospital	56	96.3	483	24926	254.4	1133144000
Pribram Regional Hospital	79.7	100	478	18274	198.7	787742000
NH Hospital	40.2	99.5	231	13240	276.8	754679000
JESSENIA, Hospital Beroun	52.9	95.4	165	4832	270.3	409516000
Hospital Melnik	82.6	98.3	284	13228	232.4	451930000
Hospital Nymburk	100	100	156	9862	258.3	204925000
Municipal Hospital Mestec Kralove	100	100	48	2329	290.3	113471000
Hospital Ricany	99.3	100	65	4661	242.4	131876000
MEDITERRA – Sedlcany	93	99	38	1434	287.5	120837000

Table 5. **Hospitals output values,** *authors'*

Name of hospital	Number of beds	Number of hospitalised patients	Bed usage in days	Operating costs, CZK
Rudolf and Stefanie Benesov Hospital	563.359	35614.417	932.793	740041000
Kladno Regional Hospital	817.13	51657.293	1352.979	1073400000
Kolin Regional Hospital	998.714	63136.676	1653.641	1311933000
Mlada Boleslav Regional Hospital	862.611	54532.469	1428.284	1133144000
Pribram Regional Hospital	599.672	37910.024	992.918	787742000
NH Hospital	574.502	36318.869	951.244	754679000
JESSENIA, Hospital Beroun	311.746	19707.926	516.179	409516000
Hospital Melnik	344.034	21749.097	569.64	451930000
Hospital Nymburk	156	9862	258.3	204925000
Municipal Hospital Mestec Kralove	48	2329	290.3	113471000
Hospital Ricany	80.117	4692.176	244.021	131876000
MEDITERRA – Sedlcany	51.116	2480.188	309.145	120837000

Conclusion. DEA results did not confirm the assumption that horizontally integrated hospitals work more efficiently than the independent ones. Taking the example of 12 hospitals in Central Bohemia we can assert that the benefit of horizontal

integration cannot be judged solely from the results of economic or medico-economic indicators.

Table 6 shows the ranking of hospitals based on the results of DEA analysis (independent hospitals are highlighted in dark colour, horizontally integrated hospitals are highlighted in light colour).

Table 6. **Hospital ranking based on DEA method,** *authors'*

	Name of hospital	CCR, %
1.-2.	Hospital Nymburk	100
1.-2.	Municipal Hospital Mestec Kralove	100
3.	Hospital Ricany	99.3
4.	MEDITERRA – Sedlcany	93
5.	Hospital Melnik	82.6
6.	Pribram Regional Hospital	79.7
7.	Rudolf and Stefanie Benesov Hospital	68.5
8.	Kladno Regional Hospital	65
9.	Mlada Boleslav Regional Hospital	56
10.	Kolin Regional Hospital	54.2
11.	JESSENIA, Hospital Beroun	52.9
12.	NH Hospital	40.2

While interpreting the results, it is important to consider the limits of this research. The first limitation comes from the fact that 3 outputs and 1 input were taken into account, but a number of other indicators such as the number of doctors, the number of employees, the total assets of a hospital, the number of procedures, the number of new-born babies, the number of discharged patients, number of hospitalised patients or the quality of healthcare were beyond consideration. In particular, measuring the quality of healthcare is very problematic, even though researches on healthcare quality do exist, for example, by means of the criteria of Picker's institute of patients' satisfaction or by means of the indicators defined by NIAHOSM (National integrated accreditation for healthcare organisation) and JCI (Joint Commission International). As this analysis surveyed only hospitals in Central Bohemia, further research could be undertaken in all hospitals of Czech Republic or even in selected international hospitals.

Although the research has not clearly shown higher efficiency in horizontally integrated hospitals through economic and non-economic indicators, the results shall not be interpreted as opposite to the research results published by F.K. Ackerman et al. (1992), R.D. Baker (2001), G.J. Bazzoli et al. (2000), P. Clement (1997), T. Lake et al. (2003), J. Matysiewicz (2011) etc. These authors concentrate mainly on non-financial benefits of horizontal integration while our team investigates specific measurable financial efficiency.

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