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Daniella Mihalik-Kucsma
University of Miskolc, Hungary

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Abstract

The key role of performance assessment and management was first recognized by large corporations (Bass, 1972), which achieved notable efficiency and success through structured processes and appropriate systems. This trend is reflected in the growing national and international literature on the subject. The relevance of this topic is underscored by the importance of the healthcare sector and the increasing emphasis on service quality. Like the business sector, the public sector must adopt proven methodological solutions to improve performance. Healthcare plays a vital role in society, making its analysis a significant scientific endeavour. This study explores when a healthcare institution operates efficiently and what methods can be used to measure this efficiency at different stages of development. A relative effectiveness indicator is introduced as a potential guideline for evaluating institutional performance within a defined framework. The relationship between efficiency and performance is examined in the context of long-term sustainability. While healthcare primarily focuses on healing, economic analysis is also essential, as financial factors often influence access and outcomes (Pulay, 2011). A research gap is identified in the area of performance management in publicly funded healthcare institutions. Despite existing studies, a comprehensive synthesis focusing on performance measurement and comparative effectiveness is still lacking.

Introduction

Competition is intensifying across all sectors, and the public domain—including healthcare institutions—is no exception. The health sector presents unique challenges, often functioning as a "one size fits all" system, where patients are not only recipients of care but also active participants with direct insight into specific aspects of service delivery. This involvement allows them to form opinions and expectations, which adds complexity to performance evaluation. This phenomenon is increasingly reflected in both national and international literature. However, despite the growing interest, many studies remain fragmented or fail to offer comprehensive frameworks and examples of best practices in assessing healthcare efficiency. This article aims to address two key objectives. First, it seeks to explore how differences in efficiency among healthcare institutions—at a given level of progressivity—can be identified and characterized, and what methodological limitations may arise in doing so. Second, the study presents an empirical analysis based on a selected sample, offering practical insights into institutional performance and efficiency measurement in publicly funded healthcare settings.

Overview of the Healthcare System

One of the key constraints in analysing efficiency differences across institutions is the specification and progressivity level of the healthcare provider. The health sector is a priority for governments due to its complexity and the need to adapt to diverse services and technological advancements (Dénes et al., 2024).

Progressivity Levels in Healthcare

Healthcare institutions operate at different levels of progressivity, which influences both service delivery and resource allocation. This typology was used in sample selection and system classification. Based on documentation from a hospital in a capital city, the following categories are defined:

1. General outpatient specialised care: Ad hoc and chronic care at the basic outpatient level.
2. Specialised outpatient care: Advanced care requiring specific expertise or equipment.
3. Specialised outpatient department: Equivalent to inpatient care at progressivity level II.

Three main levels of care are distinguished:

- Basic care: Provided by all institutions, including general practitioners.
- Intermediate care: Offered by at least one provider per county or capital, typically institutions with 600–1250 beds.
- Advanced care: Delivered by university hospitals or national-level specialised institutions.

Structural Levels of the Health System

According to Kincses (2004), the health system consists of five distinct levels (Mbau et al. 2023):

1. Prevention
2. Primary care
3. Outpatient care
4. Inpatient care
5. Rehabilitation

Prevention

Prevention plays a vital role in reducing system overload. During the COVID-19 pandemic, vaccination strategies were developed with prevention in mind (Tomczyk et al., 2022). Research shows that up to 50% of chronic diseases can be prevented through targeted strategies (Barcs & Forrai, 2020). Prevention depends not only on government policy but also on citizen behaviour.

Primary Care

Primary care, especially GP services, has three main functions: treating health problems, managing patient records, and acting as medical experts (National Centre for Public Health, 2020). Coordination challenges persist, as patients often face uncertainty regarding referrals (Tanjung et al., 2011).

Outpatient and Inpatient Care

Outpatient care complements primary care and often prevents hospitalisation. However, many patient journeys involve both outpatient and inpatient services (Török & Kovács, 1997). Inpatient care, especially in publicly funded hospitals, is the most resource-intensive level (Pexito, 2020).

Rehabilitation

Rehabilitation completes the care cycle and reduces recovery time and hospital readmissions. It should be an integral part of the system (Wade, 2015), offering personalised support for regaining independence (Berkő, 2020; Burton et al., 2015).

Defining Efficiency in Healthcare

Efficiency is a core concern in public service organisations.(Andrews & Emvalomatis (2024)) To measure it, one must first define what efficiency means in a given context (Fodor, 2016). Three key dimensions are:

- Service efficiency: Delivering services with minimal but necessary resources.
- Technical efficiency: Measuring operational inputs like staff hours and equipment usage (Gaál, 2012).
- Allocation efficiency: Providing services most valued by society (Pulay, 2012; Pulay et al., 2020).

Methodological Considerations

Efficiency must be evaluated using appropriate methodologies. Key criteria include relevance, clarity, consistency, and sector-specific adaptability (Horváth, 2016; Kucsma, 2019). A system must be understandable and sustainable for staff, and models should avoid distortions in measurability (Veresné Somosi et al., 2016, Wagner at al 2025).

Method

The DEA (Data Envelopment Analysis) method is particularly useful in hospitals because it enables objective, multidimensional comparisons of healthcare institutions' performance—supported by both domestic and international literature. DEA is a non-parametric efficiency evaluation method that assesses the relative performance of institutions based on multiple input (e.g., medical staff, bed capacity, costs) and output (e.g., number of treated patients, recovery rates) indicators. One of its key advantages is that it does not require a predefined functional relationship between inputs and outputs, making it highly adaptable to the complex environment of the healthcare sector. Hungarian studies, such as Kucsma and Varga (2021), have shown that DEA can identify efficiency reserves in hospitals, supporting system-level optimization. Similarly, Dénes et al. (2017)

demonstrated the method's applicability in analyzing size and operational efficiency in musculoskeletal rehabilitation departments.

On the international stage, Zubir et al. (2024) conducted a systematic review on how DEA input and output variables are selected in hospital efficiency studies, confirming that DEA is a widely used benchmarking tool in healthcare management. Eappen and Vajjhala (2024) emphasized that DEA contributes to performance evaluation, resource allocation, and optimization, especially in hospital, outpatient, and nursing care services. Furthermore, Gavurova et al. (2021) applied a dynamic network DEA model to compare the efficiency of healthcare systems across OECD countries, highlighting that DEA is suitable not only for institutional but also for system-level performance assessment.

Results

The practical part of my article focuses on a quantitative method, Data Envelopment Analysis (DEA), a very specific technique for identifying decision-useful information in healthcare institutions that involve the integrated operation of multiple decision-making units (Iberhalt, 2016).In this chapter, I present the main results of the efficiency review for the period 2017-2021.In the institutions included in the study, difficulties such as limited resource management were identified in the literature review, so it is worthwhile to identify a best practice in efficiency and compare it to this. This step will support the institutions to become aware of a good practice that can be used to model and implement efficiency processes in their own institutions. I used an input-oriented approach, where I tried to minimize inputs for a given level of output. The scale-insensitive CRS model assumes the same rate of incorporation of resources (output/input ratio is constant). The method presented in this paper assumes constant scale-out, i.e. perfect substitutability of outputs at a fixed rate. In the literature, this condition is referred to as CRS (constant return on scale) or CCR (Charnes-Cooper-Rhodes 1978) (National Development Agency). One of the most striking advantages of the method is that the determination of reduced input values is not arbitrary (Dózsa-Ecseki, 2012). As a starting step in applying the method, I looked for input and output indicators, which are described in Table 1. The indicators were selected primarily to test the method on the basis of the literature and the case studies processed. Prior to the actual efficiency test, more in-depth research is warranted to select the appropriate indicators and then finalise my input parameters. In the present selection, I identified as a main objective to ensure that the indicators used are significant on the one hand and to avoid multicollinearity on the other. In addition, the selection criteria are availability, relevance to the purpose and relevance. The limited availability of a significant number of the variables identified as a result of the international outlook in the national central statistical register is also a limitation of the analysis.

Table 1. Scope of Potential Indicators to be included in the Paper

Input	Output
number of beds (pieces)	outpatient (main)
number of doctors (persons)	number of nursing days (number)
number of nurses (persons)	other case (care) (pieces)
Non-medical staff (administrative staff, maintenance and	total cases (care) (pieces)

Input	Output
pharmacy staff) (headcount)	number of operations (pieces)
total staff (persons)	inpatient care (HUF)
devices (pieces)	surgical care per capita (HUF)
total cost (HUF)	other services (pieces)
other costs (HUF)	revenue (HUF)
per capita health expenditure (HUF)	

Source: own editing (epartners.hu, hospital bed count and inpatient traffic statement KSH database)

Taking these factors into account, the following limitations of the efficiency analysis for domestic hospitals can be identified: the small number of variables that can be included based on available statistical data,the lack of standardisation (e.g. job descriptions),the output volume limit (the limit on how much of a given health service a hospital can deliver in a month. Each year, the state determines how much a hospital can receive per month for different types of care, and how much of that the National Health Insurance Fund Administrator (NEAK) will pay the hospital if it exceeds the limit), the complexity of ownership (public and private).On this basis, I have selected the input and output indicators in Table 2 for my calculations. In the literature sources processed, there are cases that use a higher input/output indicator and others that use a lower one (2 input/output). In this respect, the indicator available from my public database and providing results with sufficient detail can be characterised as 4 input and 4 output indicators.

Table 2. Indicators included in the Research

Input indicators	Output indicators
active hospital beds (number)	number of beds actually in operation (number)
total staff (persons)	number of patients discharged (persons) *
number of nursing days that can be completed (number)	number of nursing days completed (number)
total expenditure (HUF)	total revenue (HUF)

*: Total number of patients discharged: patients who left, transferred to another department and patients who died.

Source: own editing

Discussion

As a first step, we looked for indicators in each area and made the following suggestions: the source of the indicators is the database of the Central Statistical Office (2017-2021) and the budget reports of the individual institutions (the budget reports are processed from the CrefoPort database), for the indicators, the average of 5 years has been included in the analysis, allowing to filter out year-to-year fluctuations (while taking structural changes into account), Although the last analysed data point in the paper is from 2021, this timeframe was intentionally selected to capture the full impact of the COVID-19 period. A comprehensive database was compiled to reflect the structural and operational changes that occurred during the pandemic, including prevention strategies, resource allocation, and institutional responses. However, it is important to note that more recent research has emerged since then, indicating shifts in efficiency trends and methodological approaches. These newer studies offer valuable insights that may differ from patterns observed during the pandemic, and they will be considered in the interpretation and contextualisation of the findings. I looked for a relationship between performance and actual performance (the difference between the expected maximum and the actual performance in relation to the organisation's capabilities) (Barnum, 2009)To support the efficiency assessment of hospitals, a set of indicators can be defined, which can be broken down into input and output indicators, following the DEA methodology. In the paper of hospitals, I included 4 indicators in each indicator group.

The units in the DEA analysis are state-run institutions in Hungary, and each unit is topologized by the total number of beds. County hospitals with bed numbers between 600 and 1250 beds were included in the analysis. The list of hospitals is not exhaustive, as I have not examined institutions that typically serve a specialised field (e.g. psychiatry). The number of beds is given next to the names of the hospitals, which I have determined on the basis of the KSH database (for the year 2021). The composition of the hospitals I have examined needs to be checked from time to time, as the structure of society changes, as do the number of beds in hospitals. It is also important to mention that the years 2019 and 2020 were a turning point in the life of the health sector, as the Covid 19 pandemic broke out at this time and brought a big change not only to our daily lives but also to the hospitals (ENSZ, 2015, Iyengar et al 2020). As stated in the previous research history, several of the hospitals in Hungary correspond to institutions with between 600 and 1250 beds, however, the number of wards is also important as my primary aim was to research care units with similar composition, so there were some institutions excluded from my sample. The other reason for exclusion was financial autonomy. Several institutions have undergone integration to become affiliated institutions of a University Teaching Hospital, so I did not include these institutions in my analysis. Figure 1, in turn, shows the full sample included in the paper, which have been given letter codes for anonym information.

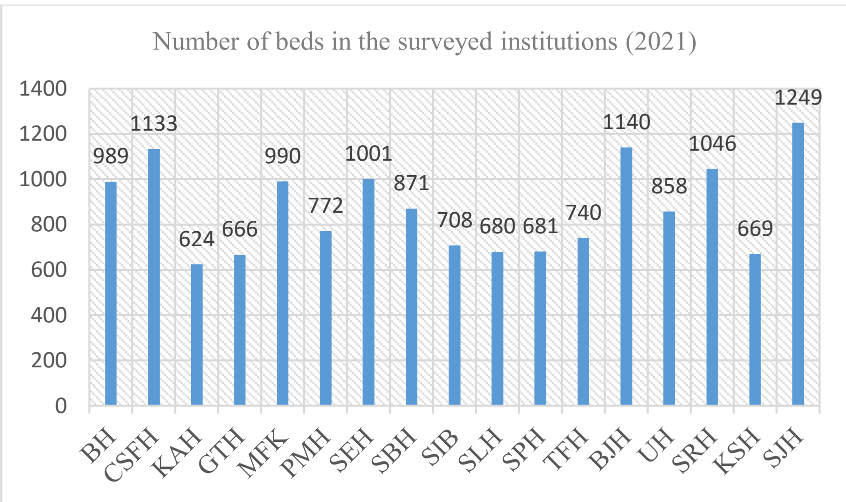

Figure 1. Hospitals with a General Profile of 600-1250 Beds included in the Study
Source Own editing based on KSH

My DEA analysis was based on a database defined on the basis of the values of the indicators provided in advance. The analysis primarily analyses efficiency, where the maximum value assigned to each unit is 1 (100%). The procedure calculates a so-called best practice threshold based on the data of the best, i.e. the efficient decision-making units with an efficiency value of 1, and then gives the efficiency reserves of the poorest performing hospitals as a percentage. (Johnes 2006, Koltai et,al 2019)) Based on this, it can be concluded that institutions with an efficiency indicator of 1 operate with a reliable efficiency . For those hospitals that do not reach the maximum value relative to the best value of the indicator, it is worthwhile to make a deeper analysis, as there is a difference in their operations compared to other institutions. Since I have developed my database on a yearly basis, I have done both the annual evaluations and the DEA analysis of the averages over the years. In the following, I will focus on the annual assessments, which will show a more accurate result, and it will be possible to review the indicators of each institution from year to year. In Table 3, I give details of the institutions which have not obtained a value of 1 for the year, since the inefficiency of an institution is defined as the inefficiency of an institution with an efficiency indicator value of less than 1.

Table 3. Institutional Efficiency Indicator

	2017	2018	2019	2020	2021
CSFH	0,9969	0,99111	0,97158	0,90299	
SJH		0,99461	0,98049		0,93683
GT					
SEH			0,96641	0,98475	0,99641
SBH			0,98151	0,98149	0,9977
BJH	0,9948	0,98441	0,90435	0,92715	
SRH	0,99406	0,9921	0,94931	0,96372	0,99943

Source:Own edit

Table 3 illustrates the change in efficiency of the lower performing institutions compared to themselves and to each other. It can be clearly seen that CSFH has reached the expected level of operational efficiency by 2021 with a minimum change in efficiency. SJH shows a significant fluctuation and a deteriorating trend. SEH met the efficiency expectations in the first two years of the period under review, but became problematic during the COVID period, and is continuously being improved. SBH's activity is similar to that of the Sopron institution, where the pandemic-induced change has led to a decline in efficiency. The most significant efficiency loss in the case of BJH is that caused by COVID, which took the institution about 2 years to bring up to the desired level. The efficiency of the SRH can be considered homogeneous except for 2019 and 2020, obviously the management of the pandemic had a negative impact on the efficient use of resources. Overall, two types of efficiency trends can be identified (Kucsma 2019) efficiency indicators change suddenly after a few years of trend (SJH),or COVID, the management of the situation has led to a visible drop in efficiency.

The table presents the DEA-based efficiency scores of individual hospitals between 2017 and 2021. The scores range from 0 to 1, where a value of 1 represents the theoretical maximum, indicating full efficiency. Institutions that achieve a score of 1 are classified as “best practice” units, while lower scores suggest the presence of efficiency reserves that may be addressed through targeted improvements.

Table 3 presents targeted recommendations derived from frontier calculations, which can be applied to individual institutions based on their relative efficiency performance. These suggestions reflect the operational gaps identified through DEA analysis and offer institution-specific directions for improvement, benchmarking, and resource optimization. By aligning each hospital's performance with the best-practice frontier, the table serves as a strategic tool for guiding efficiency-enhancing interventions.

Table 3. Development Direction

Development Area	Description	Example Measures
Resource Optimization	Reducing unnecessary inputs while maintaining service quality	Reassessing bed capacity; optimizing staff allocation
Output Enhancement	Increasing the volume of services delivered with existing resources	Digital appointment systems; streamlining patient pathways
Organizational Rationalization	Restructuring internal processes and improving coordination	Multidisciplinary teams; interdepartmental collaboration
Technological Advancement	Upgrading IT systems and enabling data-driven decision-making	Electronic health records; predictive analytics
Performance Management	Establishing benchmarking and setting measurable performance targets	Annual efficiency audits; internal performance dashboards
Structural Reconfiguration	Revisiting institutional structure and service profiles	Centralizing specialized services in regional hubs

Source:Own edit

Conclusion

The results of the DEA analysis clearly demonstrate that there are measurable and institution-specific differences in operational efficiency among the hospitals examined during the 2017–2021 period. By applying the selected input and output indicators, the DEA model quantified how effectively each hospital utilized its available resources to deliver healthcare services. While the calculation of efficiency scores is a central outcome of the analysis, its true value lies in the insights it provides into the underlying performance dynamics of each institution. Specifically, the model highlights the gap between actual performance and the efficiency frontier, thereby identifying the *correction potential*—the extent to which an institution can improve by aligning itself with best-performing peers.Beyond the numerical scores, the analysis draws attention to the strategic importance of both input and output variables. Hospital performance is not solely determined by the balance between expenditures and revenues; rather, it is shaped by how effectively an institution leverages its structural capacities, human resources, and financial inputs to generate meaningful health outcomes. The ability to adapt to changing conditions, optimize internal processes, and implement a well-defined operational strategy plays a critical role in achieving high efficiency.

In this context, the DEA method proves to be a robust and appropriate tool for evaluating institutional performance. It not only enables the identification of high-performing hospitals but also provides a framework for less efficient institutions to recognize areas for improvement. By translating efficiency gaps into actionable development directions, the analysis supports evidence-based decision-making and contributes to the broader goal of enhancing the sustainability and effectiveness of the healthcare system.

Recommendations

Based on the comprehensive efficiency analysis conducted using DEA methodology and the carefully selected input and output indicators, I recommend that future evaluations of hospital performance in Hungary continue to apply this structured approach. The use of multi-year averages and the inclusion of both financial and operational metrics provide a robust foundation for identifying performance gaps and best practices. Furthermore, I suggest expanding the dataset to include more recent post-pandemic data and integrating qualitative factors such as patient satisfaction and staff workload. These additions would enhance the depth of the analysis and allow for a more holistic understanding of institutional efficiency. Given the structural changes in the healthcare sector and the evolving challenges faced by hospitals, it is essential to regularly update the sample and indicator set to reflect current realities. This will ensure that the findings remain relevant and actionable for policymakers, hospital administrators, and researchers alike.

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Author Information

Daniella Mihalik-Kucsma, Phd

https://orcid.org/0000-0002-6518-1901

University of Miskolc

3515 Miskolc Egyetemváros

Hungary

Contact e-mail: *daniella.kucsma@uni-miskolc.hu*