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AN EVALUATION OF BLU HOSPITAL EFFICIENCY: A QUANTITATIVE APPROACH WITH DATA ENVELOPMENT ANALYSIS

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ABSTRACT
Research Originality — This study is the first to assess the efficiency of Public Service Agency (BLU) hospitals in Indonesia using data envelopment analysis (DEA). It provides a comprehensive evaluation of hospital efficiency in multiple categories and identification of benchmark hospitals and areas for improvement. The study offers insights into hospital resource management efficiency to help policymakers in optimizing hospital performance.
Research Objectives — This study aims to evaluate the efficiency of 32 BLU hospitals in Indonesia by analyzing their inpatient and outpatient services, human resource allocation, and bed utilization efficiency. It also investigates historical performance trends from 2016 to 2020 to assess long-term efficiency patterns.
Research Methods — The study employed DEA, which is a non-parametric approach widely used for efficiency analysis. The evaluation was based on four input variables and seven output variables categorized into four main efficiency measures: inpatient services, outpatient services, human resources, and bed utilization. The efficiency scores were calculated using BCC-I and Super-Radial BCC-I models.
Empirical Results — The findings showed that 15 hospitals were efficient, while 17 hospitals exhibited inefficiencies. Nine hospitals consistently demonstrated efficiency across all categories from 2016 to 2020, whereas four hospitals consistently underperformed in at least one category. The study also indicates that hospitals with lower efficiency scores can benchmark against efficient hospitals to improve performance.
Implications — The findings of this study have policy implications for healthcare administrators and government agencies. The Directorate of BLU Financial Management Development can use the DEA results to guide hospital efficiency improvements. In addition, inefficient hospitals can use these findings to identify performance gaps and adopt best practices. Future studies could integrate other methods such as the Malmquist productivity index (MPI) or balanced scorecard (BSC) for a more comprehensive assessment.

Keywords: DEA, Hospital, Public Service Agencies, Efficiency
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INTRODUCTION

Public Service Agency

The Sustainable Development Goals (SDGs) developed by the United Nations General Assembly include health as a key component to achieve optimal health and improved well-being at all stages of life by 2030 (*United Nations*, 2015). The SDGs on health not only focus on disease prevention or health disorders but also cover physical, mental, and social well-being. Therefore, as a human right, health must be fulfilled by organizing effective health development and providing quality health services for the public.

Compared to other countries, Indonesia's health quality remains relatively low or is lagging behind. According to the 2020 Human Development Report published by the United Nations Development Programme (UNDP), Indonesia has upgraded its category to High Human Development from the previous

Medium Human Development in 2018. However, Indonesia ranked 107th among 189 countries, a position that had improved from 111th in 2019 and 116th in 2018. Meanwhile, when compared to the rankings of other ASEAN countries, Indonesia ranked 4th below Singapore, Malaysia, and Thailand in terms of health. In addition, in the 2020 Legatum Prosperity Index, Indonesia was ranked 97th in health among 164 countries.

Hospital resources are required to meet the needs of patients to achieve health development goals. Therefore, the participation and support of hospitals as health service institutions is crucial. However, many hospitals are ineffective in managing their resources (Abdurachman et al., 2019). In most countries, improving efficiency and reducing costs in hospitals are prioritized as they account for a large part of the total health expenditure (Dubas, et al, 2020). To reduce the potential for inefficiency in hospitals, the Indonesian government has implemented a strategy by changing the status of some hospitals into Public Service Agency (BLU). Through this status change, hospitals are expected to have the flexibility in managing their resources to be more efficient.

The concept of efficiency, as explained by (Sickles and Zelenyuk, 2019), refers to the ability of a company to efficiently produce the greatest quantity of outputs from the available inputs. In the field of health, work efficiency emphasizes the measurement of the efficiency of hospitals with a focus on the comparison of their productivity and effectiveness in utilizing their internal resources (Jacobs, 2001).

APPLICATION IN PRACTICE

- **Key findings for policymakers**: Of the 32 BLU hospitals analyzed, only 15 were considered efficient, while the other 17 had the potential for improvement.
- **Inefficient hospitals** can use the 15 efficient hospitals as a benchmark to improve services and resource management. To support this, the Ministry of Health needs to develop a strategy to improve efficiency, including optimization of health workers, budget, and bed utilization. In addition, regular evaluations using the data envelopment analysis (DEA) can help identify areas of improvement, thus allowing hospitals to sustainably improve the effectiveness of health services.
- **All hospitals must strive to improve efficiency** to provide better health services for the community.

According to (Simamora and Sinuhaji, 2021), there are two methods for measuring efficiency: the parametric methods and non-parametric methods. One non-parametric method suitable for measuring efficiency is data envelopment analysis (DEA), which considers the number of inputs and outputs. This method does not require parameters and is widely used for performance evaluation and benchmarking in various institutions, such as education, hospitals, banking, production plans, and others (Priyatno et al., 2022).

To measure the level of efficiency, many government agencies use earnings before interest, tax, depreciation, and amortization (EBITDA). EBITDA is a commonly used matrix to assess a company's performance in generating profit. However, profit is not the only goal of hospitals as there are several other goals, such as providing quality health services for the public. Therefore, the use of EBITDA cannot fully measure the efficiency of BLU hospitals, which also have the goal of providing optimal health services for the public. Additional methods are needed, such as DEA in this case, to allow a more comprehensive measurement of efficiency levels.

Several studies have examined efficiency in the health sector using DEA. Cetin and Bahce (2016) examine the efficiency of the health sector in 34 member countries of the Organisation for Economic Cooperation and Development (OECD) by using input variables that consist of the number of doctors, the number of patient beds, and health expenditure. They found that 11 countries have efficient health systems, 15 countries are inefficient, and eight countries are outlier or eliminated. A similar study is also conducted by Ali et al. (2017) in 12 hospitals in Ethiopia by considering the number of beds, available medical personnel, and drug procurement costs as the inputs. Meanwhile, Gigantesco and Giuliani (2011) analyze the efficiency level of 50 hospitals in Italy by using inputs that comprise the number of beds, the number of doctors, and the number of nurses.

In the context of BLU hospitals, Wiranusa (2017) investigates the efficiency of 40 central government general hospitals. The study uses six inputs, including the number of basic medical personnel, the number of specialist medical personnel, the number of paramedics and other health workers, the number of non-medical personnel, the number of beds, and realization of expenditure. Based on the results of the research, the BCC-I method identifies 33 hospitals as efficient, while PCA-BCC-I identifies 10 hospitals as efficient. This study examines 40 hospitals that are mixed and not separated into special groups, and all of these hospitals have different classes. Similar research is conducted by Irwandy and Sjaaf (2018) on 25 BLU hospitals in South Sulawesi. There are several input variables and output variables that are most frequently used in measuring hospital efficiency. Research by Fazria and Dhamanti (2021) on 3,504 hospitals in 23 countries shows that the most widely used inputs are the number of beds, medical personnel, non-medical staff, medical technician staff, and operational costs. Similarly, some of the most used outputs for measuring hospital efficiency are the number of inpatients, the number of surgeries performed, the number of emergency visits, outpatient services provided, and length of hospital stay. These variables are frequently used to assess hospital efficiency in the DEA application.

Currently, there is no measurement of BLU hospital efficiency that can be applied globally in the management of hospital resources. This is because the outputs produced by hospitals have considerable diversity which can cause difficulty in determining the input and output parameters in efficiency measurements as there are many interrelated factors. In addition, the resulting cost function is not simple since it involves many input factors (Andrews & Emvalomatis, 2024). On the other hand, there are no proper devices or methods for measuring the efficiency level of BLU hospitals because efficiency and productivity vary greatly, making it difficult to determine their efficiency. This research, which focuses on efficiency measurement of BLU hospitals in Indonesia from 2016 to 2020 by using DEA, seeks to improve the quality of existing research. This study aims to measure the level of efficiency and provide suggestions for improvement or development of BLU hospitals.

LITERATURE REVIEW

Concept of Efficiency

In general, the concept of efficiency has been discussed by (Sickles and Zelenyuk, 2019) in their book entitled "Measurement of Productivity and Efficiency". Efficiency is not only related to the cheapest production but also involves the best way to allocate available production resources to produce the greatest possible output. Charnes et al., (2017) then developed a concept with a focus on measuring company data called the decision-making unit (DMU). In their study, they develop a method to measure the efficiency of each DMU to improve performance.

Technical efficiency, allocative efficiency, and economic efficiency are the three types of efficiency classified by (Sickles and Zelenyuk, 2019). Technical efficiency refers to the ability of a DMU to produce a maximum output with available inputs or to produce a specific output by using a minimum set of inputs. In addition, allocative efficiency is calculated as the proportion of the lowest cost required by a DMU to produce a certain number of outputs and the actual cost of DMU adjusted for technical efficiency. Finally, economic efficiency occurs when the amount of goods and services is successfully produced with a certain number of inputs. It is a combination of allocative and technical efficiencies.

According to (Widyastuti and Nurwahyuni, 2021), there are two approaches to efficiency measurement, which are an output-oriented approach and an input-oriented approach. The output-oriented approach aims to increase the number of outputs that can be produced by using the same level of inputs, while the input-oriented approach aims to reduce the number of inputs needed to produce the same level of outputs. In an input-oriented approach, an entity will minimize its production costs to produce the same level of outputs.

Concept of BLU Hospitals

In the public service system in Indonesia, the Public Service Agency (BLU) is a reform of state financial management that aims to provide flexibility for government work units, enabling them to manage resources in a more efficient and professional manner. BLU exists as a solution for government agencies. It provides public services that prioritize efficiency and effectiveness without being completely bound to the government budgeting bureaucratic mechanism. With such scheme, BLU can manage its own revenue to improve service quality without having to rely entirely on the state budget.

In the health sector, BLU hospitals have a fundamental difference from general hospitals that are directly managed by the government. General hospitals operate with funds that are fully sourced from the state budget or regional budget, with limited management flexibility. Meanwhile, BLU hospitals have the flexibility to manage their own income, including the income derived from the health services provided for the public. With such model, BLU hospitals are expected to be able to improve operational efficiency, service quality, and financial capacity to support the sustainability of health services.

Hospitals, according to the definition of the World Health Organization (WHO), are an integral component of health and social organizations that function to provide complete health services, including preventive and curative services, for patients undergoing treatment as either inpatients or outpatients. The types of services provided by hospitals can be divided into two: general hospitals that handle various types of diseases and the field of health, and special hospitals that focus on one type of disease or a specific field, such as special hospitals for heart, cancer, lung, and psychiatry (Permenkes RI No. 340 of 2010).

After the enactment of Law No. 1 of 2004 on the State Treasury, the term BLU emerges as part of the spirit of financial reform. The transfer of financial management status from a state-owned company to BLU aims to increase the flexibility and efficiency of hospital resource management. Initially, only 13 hospitals transitioned from state-owned companies (Perjan) to BLU. Until 2022, the number of BLU hospitals had increased to 252, consisting of 107 work units divided into subgroups, including a network of hospitals operated by the Indonesian National Police, the Indonesian National Armed Forces, the Ministry of Health, and health centers. The financial management model of BLU is expected to improve the performance of health services provided by BLU hospitals.

Concept of Data Envelopment Analysis (DEA)

DEA was first developed by three American scientists named Charnes, Cooper, and Rhodes in 1978. This method focuses on the evaluation of the relative efficiency of a business unit based on the calculations of several inputs and outputs. DEA is often considered as a linear programming model since it calculates the output and input ratios of specific business units to evaluate their performance. With DEA, we can compare efficiencies between different business units and determine strategies to improve efficiency and productivity (Charnes et al., 2017). The decision-making unit or DMU is the unit that becomes the main focus in efficiency analysis (Soares et al., 2017). Proper use of DEA can serve as a reference for evaluating DMU resources, provided that the data used can represent the DMU process and allows for a comparison with other DMUs (Al Subhi, 2022).

There are two models used in DEA: the Charnes–Cooper–Rhodes (CCR) model and the Banker–Charnes–Cooper (BCC) model. The first model, DEA-CCR, was developed by Charnes et al. in 1978 and is often referred to as the constant return to scale (CRS) model. This model assumes that each business unit operates at an optimal level of efficiency. In contrast, the DEA-BCC model was develop from DEA-CCR by Banker et al. (1984). This model considers volatile variable return to scale (VRS), where the size of the input or output may affect the efficiency value. Since not all business units can operate optimally, this can affect the efficiency value generated DEA.

Literature has shown that DEA is the most popular method for measuring hospital efficiency. Ahmed et al. (2019) apply the DEA approach to estimate the technical efficiency of health systems in Asian countries. This model has been employed by Zhao et al. (2020) to study hospital efficiency in 31 provinces in China, by Pirani et al. (2018) to investigate 17 general hospitals in Iran, by Sultan and Crispim (2018) to study 11 general hospitals in the Palestinian West Bank, by Şahin and İlgün (2019) for the examination of 865 hospitals in 81 provinces in Turkey, by Zheng et al. (2018) to assess 84 hospitals in China, by Irwandy and Sjaaf (2018) to study 25 BLU hospitals in South Sulawesi, and by Wiranusa (2017) to evaluate 40 BLU hospitals throughout Indonesia.

Research conducted by Irwandy and Sjaaf (2018) and Wiranusa (2017) involved a direct comparison of all hospitals that served as the research objects. This is considered unfair since the inputs used may vary; for example, in general hospitals, the typical duration for inpatient input is only 3 days, while in psychiatric hospitals, the same input can take 6 months. Therefore, the hospitals in this current study were divided into several clusters consisting of the same types of hospital. These clusters include ex-special hospitals, psychiatric hospitals, other special hospitals, pulmonary hospitals, and general hospitals. The purpose of clustering is to allow a more equitable comparison of similar hospitals.

METHODS

Research Type and Research Objects

This study used descriptive research design with a quantitative approach. The population of this study was all BLU hospitals in Indonesia. The entire population was taken as a sample in this study. In determining the sample, the factors considered were the availability of data from the financial statements, human resources, and hospital service indicators from 2016 to 2020. Based on these criteria, 32 BLU hospitals were selected, comprising 16 general hospitals and 16 special hospitals. They were then divided into several clusters, including 13 general hospitals, three ex-special hospitals, eight other special hospitals, three pulmonary hospitals, and five psychiatric hospitals.

Data Types, Data Sources, and Data Collection Techniques

This study used secondary data obtained through a documentation data collection technique. There were two types of data collected in this study, namely financial data and service data. The financial data was sourced from the Online Monitoring of the State Treasury and Budget System (OMSPAN), e-rekon, and the Integrated Account Management System (SPRINT). The three applications were developed by the Ministry of Finance and have been used by all the work units within the scope of the Ministry of Finance for state treasury. The service data was sourced from the Integrated Online System of Public Service Agency (BIOS), which is a web-based application that integrates financial and service data from BLU to improve business process efficiency, analyze data, and support decision-making. The BLU hospital information system under the auspices of the Ministry of Health is also included in this application.

Operational Definition of the Variables

Two factors to consider in determining the input and output indicators in this study were the analysis of previous studies that used DEA in identifying these indicators in hospitals and the availability of the data obtained from hospitals in the periods of 2016-2020. The mapping of the input and output indicators is presented in Table 1.

Table 1 Output and Input from Studies Included in This Research

Research	Output	Input
Sahin & Ozcan (2000)	1. Number of outpatient visits 2. Inpatients 3. Death rate (number of inpatients who died/total number of inpatients)	1. Number of beds 2. Number of specialists 3. Number of general practitioners 4. Number of nurses 5. Other health professionals (pharmacists, physiotherapists, midwives, etc.) 6. The value of spending from revolving funds
Narci et al. (2014)	1. Discharged patients (including the deceased) 2. Number of outpatient visits 3. Number of cases in emergency room 4. Number of surgeries 5. Number of daycare patients	1. Number of beds 2. Number of specialists 3. Number of general practitioners 4. Number of other full-time staff
Hofmarcher et al. (2002)	1. Number of patient days 2. Number of discharges 3. LDF points	1. Number of medical personnel 2. Number of paramedics 3. Number of administrative staff 4. Number of beds 5. Number of wards

Source: Data processed by the author

Previous research conducted by Sahin and Ozcan (2000), Narci et al., (2014), and Hofmarcher et al. (2002) uses 18 input and output parameters. However, by considering the availability of data from the hospitals, the 18 existing parameters were narrowed down to 4 input parameters and 7 output parameters. The description of these indicators is according to the definition given by the Ministry of Health (2005).
The input variables of this study were:

1. Total medical human resources: the number of doctors working in the hospital during the study period
2. Total non-medical human resources: the total number of non-medical personnel, consisting of financial administrators, other health workers, legal institutions, computer institutions, and public relations institutions working in the hospitals
3. Operational expenditure: the amount of expenditure spent on hospital operational activities during the study period
4. Number of beds: the total number of beds for inpatients available in the hospitals during the study period

The output variables of this study were:

1. Inpatients: the number of patients who receive care from hospital staff due to their medical condition, requiring the patients to be hospitalized during the study period
2. Outpatients: the number of patients who receive medical services for observation, diagnosis, treatment and rehabilitation, and other health services without hospitalization
3. Revenue: the amount of income received by the hospitals during the study period
4. Bed Occupancy Ratio (BOR): the ratio between the number of beds currently in use and the total number of beds available in the hospitals during the study period
5. Bed Turnover (BTO): the number of times a bed is used in one research period, which measures how often a bed is used and cleaned in each period
6. Average Length of Stay (AVLOS): the average number of days for patient treatment
7. Turnover Interval (TOI): the average time in days in which a bed remains unoccupied after a patient departs, before being assigned to a new patient.

All the above indicators had been measured and had a low correlation. The determination of the number of indicators considered the efficiency analysis requirements, in which the number of the existing samples (32) had to be at least twice the total number of parameters used (2x11).

In this study, there were several efficiency categories measured, including the following:

1. Inpatient efficiency, with the inputs being the total number of medical human resources, the total number of non-medical human resources, number of beds, and expenditure, and the outputs being inpatients, BOR, AVLOS, BTO, TIO, and revenue

2. Outpatient efficiency, with the inputs being the total number of medical human resources, the total number of non-medical human resources, and the outputs being the outpatients and revenue
3. Human resource efficiency, with the inputs being the total number of medical human resources and the total number of non-medical human resources, and the outputs being inpatients and outpatients
4. Bed efficiency, with the inputs being the total number of medical human resources, the total number of non-medical human resources, and number of beds, and the outputs being AVLOS, BTO, and TOI.

Methods of Data Analysis

This study used a popular non-parametric analysis method to measure hospital efficiency, namely DEA. The VRS assumptions were used with several tests, including BCC and Super Efficiency. This research focused on input orientation because it is easier to control than output. In addition, there were several rules from the government related to input standards. DEA has the advantage of being able to evaluate the efficiency of business units by accommodating many inputs and outputs in various dimensions (Irwandy & Sjaaf, 2018). By considering the interconnectedness and diversity of the hospital inputs and outputs, the efficiency measurement produced using DEA becomes more accurate.

The mathematical model used to calculate DEA is as follows:

$$\theta_k = \frac{\sum_r^t u_r \, y_{kr}}{\sum_i^m v_i \, x_{ki}} \quad \text{.......} \ (1)$$

where:

u_r = weight of output r, r = 1, 2, 3, ..., t
v_i = weight of input i, i = 1, 2, 3, ..., m
y_{kr}= value of the r^{th} output of a k^{th} DMU
x_{ki} = value of the i^{th} input of a k^{th} unit
k = DMU type, k = 1, 2, 3, ..., n
t = number of outputs
m = number of inputs
n= number of DMUs

In this study, the DMUs were 32 BLU hospitals. The number of inputs and outputs varied depending on the categories described earlier.

DEA was carried out using the DEA Solver software by selecting the BCC-I and Super-Radial BCC-I models. Wiranusa (2017) explains the stages of DEA as follows:

1. Determining the DMU. To determine the analysis units in this study, 32 BLU hospitals, consisting of 16 general hospitals and 16 special hospitals, were selected. These units were used as the population in this study.
2. Determining the orientation of the DEA model. Companies cannot directly control the outputs but can control the inputs to reduce expense potential (Ali et al., 2017). In this case, hospitals had the input standards from the government; therefore, the input-oriented model was used.
3. Selecting the input and output variables. The selection of variables was based on previous research, in which four input variables and seven output variables were selected.
4. Weighing each input and output variable. Similar studies found no differences in the weighing of each variable (Azreena et al., 2018). The weighing for the input variable used the following equation:

$$\text{MD : NM : BO : TT} = 1 : 1 : 1 : 1 : 1 : 1 \quad \text{.......} \ (2)$$

   The weighing of the output variables used the following equation:

$$\text{RI : RJ : JP : BO : AV : BT : TO} = 1{:}1{:}1{:}1{:}1{:}1{:}1{:}1 \quad \text{.......} \ (3)$$

5. Determining the DEA model to use. Banker, Charles, and Cooper created a DEA model with a variable return scale (VRS), where the addition of *n* input is not always directly proportional to the addition of *n* output (Ramanathan, 2011). Not all hospitals operate optimally. According to Fernández-Montes et al. (2012), this model is suitable for service sectors, such as hospitals. Therefore, the DEA-BCC model was used.
6. Calculating the DEA model on the DEA Solver LV8 application.
7. Conducting an analysis of hospital efficiency level. According to Siagian (2012), the following are the stages of the analysis of DEA efficiency level:
   - Radial efficiency analysis, with categories of efficient (efficiency value = 100%) and inefficient (efficiency value < 100%).
   - Benchmark analysis, to determine efficient hospitals that can serve as models for inefficient hospitals.

RESULTS AND DISCUSSION

Results

DEA Efficiency

Table 2 shows the results of the calculation of the efficiency of BLU hospitals in 2020 using DA BCC-I.

Table 2 Efficiency of BLU Hospitals in 2020

DMU	2020			
	INPATIENTS	OUTPATIENTS	HR	BED
EX-SPECIAL HOSPITALS				
258462	1	1	1	1
415520	1	1	0.8256	0.836
415630	1	1	1	1
PSYCHIATRIC HOSPITALS				
415454	1	1	1	1
415505	1	1	1	0.4266
415542	1	1	1	0.6067
415598	1	0.8925	0.7693	1
415670	1	1	1	1
OTHER SPECIAL HOSPITALS				
015514	1	1	0.753	1
257847	1	1	1	1
415491	1	1	1	1
415567	1	1	1	1
415706	1	1	1	1
520611	1	0.9206	0.7487	0.4593
520628	1	1	0.3941	0.4843
548890	1	1	1	1
PULMONARY HOSPITALS				
415485	1	1	1	1
415511	1	1	1	1
415551	1	1	1	1

DMU	2020			
	INPATIENTS	OUTPATIENTS	HR	BED
GENERAL HOSPITALS				
415423	1	1	1	0.8975
415432	1	1	0.7312	1
415448	1	0.9024	0.5704	1
415479	1	1	1	0.8331
415536	1	1	1	1
415573	1	1	1	1
415582	1	0.8031	0.5008	1
415618	1	1	0.8899	1
415624	0.984	0.8357	0.4699	0.6007
415661	1	1	0.4887	0.8634
532214	1	1	0.7437	1
538815	1	0.849	0.8799	1
548886	1	1	1	1

Source: DEA Solver LV 8 output, processed

The results of the calculation using DEA are considered efficient if all categories are valued at 1, in other words, all of the inputs have been used to the maximum to achieve maximum outputs (Saputra, 2018). From the results of the calculation in Table 2, the efficient hospitals based on the hospital categories were as follows:

1. Ex-special hospitals that had an efficient value were 258462 and 415630.
2. Psychiatric hospitals that had an efficient value were 415454 and 415670.
3. Othe special hospitals that showed an efficient value were 257847, 415567, 415706, and 548890.
4. All pulmonary hospitals had an efficient value in 2020.
5. General hospitals that showed an efficient value were 415536, 415573, and 548886.

A total of 15 hospitals, out of a total of 32 hospitals studied, had efficient values in all categories.

Table 2 also shows that almost all hospitals, except 415624, were identified as efficient in the inpatient category. This indicates that almost all hospitals have deployed all their inputs successfully, including expenditure, number of beds, medical human resources, and non-medical human resources, to produce maximum outputs, including inpatients, BOR, AVLOS, BTO, TIO, and revenue. However, this did not guarantee that the hospitals were efficient in other categories. For the outpatient category, six hospitals remained inefficient, including 415598, 520611, 415448, 415582, 415624, and 538815.

Out of 19 hospitals in the non-general hospital cluster, including ex-special hospitals, psychiatric hospitals, other special hospitals, and pulmonary hospitals, only 7 hospitals were still inefficient or having a value of less than 1 (63%). Efficient hospitals must maintain their efficiency in providing care to the public because their services are intended for patients with special cases. For example, psychiatric hospitals offer support for individual with psychiatric disorders, while pulmonary hospitals cater to patients with lung-related problems.

For general hospitals, of the 13 hospitals in this category, there were only 3 efficient hospitals (23%). The remaining 12 remained inefficient. The Ministry of Health needs to improve the efficiency of these 12 hospitals. An increase in efficiency is crucial because, unlike special hospitals, general hospitals usually serve patients with more general cases. In general, the efficiency of non-general hospitals was relatively good with 63% of the hospitals being efficient in all categories, while general hospitals were far from being efficient, as evidenced by only 23% of these hospitals were considered efficient in all categories.

DEA Benchmark

As shown in Table 2, hospitals considered efficient were those identified with number 1. These hospitals can serve as a benchmark or example for other hospitals that had a score of below 1 or were inefficient, including:

1. Ex-Special Hospitals
   In this cluster, Hospital 415520 should improve its efficiency in human resources and bed efficiency by following the benchmark from other hospitals in the category, such as 258462 and 415630.
2. Psychiatric Hospitals
   Two hospitals in this category, Hospitals 415505 and 415542, were considered inefficient in terms of beds. They should improve their practices by using the other three hospitals, which are 415454, 415598, and 415670, as a reference point. In other categories, Hospital 415598 was also considered inefficient in terms of outpatients and human resources. This hospital can adopt the benchmark from other hospitals to improve outpatients and human resources inputs.
3. Other Special Hospitals
   In this cluster, the hospital considered inefficient in the outpatient category was 520611. Hospital 520611 should emulate the standards set by the other hospitals in this cluster. In the human resources category, there were three inefficient hospitals: 015514, 520611, and 520628. In the bed category, there were two hospitals considered inefficient, specifically 520611 and 520628.
4. Pulmonary Hospitals
   In this cluster, all hospitals were considered efficient, thus requiring no improvements.
5. General Hospitals
   In this cluster, the inefficient hospital in the inpatient category was 415624. To make improvements in this category, Hospital 415624 can observe the benchmark of the other hospitals in this category. In the outpatient category, there were four hospitals considered inefficient: 415448, 415582, 415624, and 538815. In the category of medical human resources, eight hospitals were considered inefficient. These are 415432, 415448, 415582, 415618, 415624, 415661, 532214, and 538815. In the category of non-medical human resources, there were four hospitals considered inefficient, including 415234, 415749, 415624, and 415661.

Overall, out of 32 hospitals studied, 15 were determined to be efficient across all categories. On the other hand, there remained 17 hospitals that were inefficient in one or more categories. If these 17 hospitals want to improve their services for the community by increasing the efficiency of their hospitals, they can look to 15 exemplary hospitals considered efficient for benchmarking. However, these 15 hospitals should consistently maintain their efficiency to enable the community to obtain better health services.

Discussion

Hospital's Historical Data

Hospital data from 2006 to 2020 were also gathered to complete the analysis in this study. The complete results can be seen in Appendix 1. From the analysis of the historical data, nine hospitals were efficient in five years in all categories. They were 258462, 415630, 415454, 415670, 415491, 415485, 415511, 415536, and 54886. They should maintain their efficiency in the coming years to ensure consistent services.

Of 32 hospitals studied, several hospitals remained inefficient in several categories every year. Hospital 520628 was inefficient in the outpatient and bed categories, while Hospital 415423 was inefficient in providing beds for 5 years. Hospital 415582 was inefficient in terms of the availability of sufficient human resources. Hospital 415624 was inefficient in the categories of human resources and beds.

There were cases where hospitals achieved efficiency improvements only to revert to inefficiency. For example, Hospital 415448 made improvements in 2016, and in 2017 it was considered inefficient in outpatients and human resources. The hospital had made improvements, resulting in an efficient value in 2018. However, in the following years, specifically in 2019 and 2020, it was no longer efficient.

CONCLUSION

The achievement of health development goals highly depends on the role of hospitals as health service institutions. Efficiency in the management of resources in hospital is an important factor in ensuring optimal health services for the community. However, the results of the analysis revealed that many hospitals continued to struggle to manage their resources efficiently. In 2020, out of 32 BLU hospitals assessed, only 15 hospitals were considered efficient, while the other 17 hospitals were considered inefficient. Therefore, these 15 hospitals can serve as a benchmark for other hospitals to make changes in the area of improvement. The score in 2020 ranged between 0.4266 and 1.

To complete the analysis, the historical data from 2006 to 2020 was also processed. The results showed that nine hospitals remained efficient for 5 years. There were four hospitals that never achieved an efficient score in one of the research categories. Overall, not all BLU hospitals managed by the Ministry of Health in Indonesia are efficient. In this case, the Ministry of Health can still make numerous improvements to help these 32 BLU hospitals increase their efficiency in providing health services to the community.

Based on the previous discussion, this study offers the following suggestions:

1. The use of DEA can provide useful insights for the Directorate General of Treasury of the Ministry of Finance to evaluate the performance of BLU hospitals. The results of the DEA measurement can be used by hospitals that are currently inefficient to improve their efficiency by looking at hospitals that are considered efficient.
2. In this study, only the measurement of efficiency level was carried out at BLU hospitals using DEA, which aimed to observe the inputs and outputs. Future studies can use additional methods such as principal factor principal component, Malmquist productivity index, or even a combination with other methods such as balanced scorecard (BSC).

This research has several limitations.

1. To conduct research using DEA, all input and output variables must be measurable and specific. In addition, the determination of which variables to include in the study is also greatly influenced by the subjectivity of the researcher. Therefore, errors in selecting input and output variables can result in different or biased results.
2. In this research, several input and output variables could be added, but due to limited data, these variables could not be included.

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Appendix 1 BLU Hospital's Historical Data

DMU	2016				2017				2018				2019				2020			
	RAWAP	RAJAL	SDM	BED	RAWAP	RAJAL	SDM	BED	RAWAP	RAJAL	SDM	BED	RAWAP	RAJAL	SDM	BED	RAWAP	RAJAL	SDM	BED
RS EKS KHUSUS																				
258462	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
415520	1	1	1	1	1	1	1	1	1	1	0.742	0.7676	1	1	0.7011	1	1	1	0.8256	0.836
415630	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RS JIWA																				
415454	1	0.7334	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
415505	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.8729	1	1	1	0.4266
415542	1	1	1	0.6255	1	0.9424	1	0.6193	1	1	1	0.6415	1	1	1	0.5517	1	1	1	0.6067
415598	1	0.6322	0.8889	1	1	1	0.9397	1	1	1	0.8896	1	1	1	0.9142	1	1	0.8925	0.7693	1
415670	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RS KHUSUS LAINNYA																				
015514	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.5494	1	1	1	0.753	1
257847	1	1	0.8573	1	1	1	0.8785	1	1	1	0.9938	1	1	1	0.2622	1	1	1	1	1
415491	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
415567	1	0.8237	0.8139	1	1	0.87	0.8683	1	1	0.9938	0.9467	1	1	1	0.2228	1	1	1	1	1
415706	1	1	0.6658	1	1	0.9375	0.6627	1	1	0.9662	0.747	1	1	1	0.349	1	1	1	1	1
520611	1	0.5628	1	0.5676	1	0.7414	1	0.6117	1	0.7522	1	0.7243	1	0.8719	0.6119	0.5358	1	0.9206	0.7487	0.4593
520628	1	1	1	0.5719	1	1	0.8959	0.6945	1	1	0.8521	1	1	1	0.4634	1	1	1	0.3941	0.4843
548890	1	1	1	1	1	1	1	0.9999	1	1	1	1	1	1	1	1	1	1	1	1
RS PARU																				
415485	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
415511	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
415551	1	1	1	1	1	1	0.912	1	1	1	1	1	1	1	1	1	1	1	1	1
RS UMUM																				
415423	1	1	1	0.7707	1	1	1	0.7031	1	1	1	0.6867	1	1	1	0.6086	1	1	1	0.8975
415432	1	1	0.9005	1	1	1	1	1	1	0.9845	0.8662	1	1	0.9571	0.7804	1	1	1	0.7312	1
415448	1	0.9892	0.9988	1	1	0.9831	0.9709	1	1	1	1	1	1	0.9204	0.812	1	1	0.9024	0.5704	1
415479	1	1	0.9319	1	1	1	0.825	0.8025	1	1	1	0.8711	1	1	0.7129	0.8187	1	1	1	0.8331
415536	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
415573	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
415582	1	1	0.7931	1	1	0.8792	0.7609	1	1	0.9005	0.7781	1	1	1	0.6093	0.8034	1	0.8031	0.5008	1
415618	1	1	1	1	1	1	0.8697	1	1	1	0.9906	1	1	1	0.7194	1	1	1	0.8899	1
415624	1	0.7635	0.726	0.889	1	0.9743	0.6873	0.743	1	1	0.7127	0.7802	0.9826	0.9481	0.6032	0,7984	0.984	0.8537	0.4699	0.6007
415661	1	1	0.7667	1	1	1	0.8401	1	1	1	1	1	1	1	0.9977	1	1	1	0.4887	0.8634
532214	1	1	1	1	1	1	1	1	1	1	0.9643	1	1	1	0.8416	1	1	1	0.7437	1
538815	1	0.9428	0.8895	0.9155	1	1	1	1	1	1	1	1	1	1	1	1	1	0.849	0.8799	1
548886	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Source: DEA Solver LV 8 output, processed