PalArch's Journal of Archaeology of Egypt / Egyptology

ANALYSIS OF EFFICIENCY LEVEL USING DATA ENVELOPMENT ANALYSIS (DEA) METHOD AT THE INDONESIAN HOSPITALS

Yuli Eni[1], *Edi Abdurachman*[2], *Rudi*[3]
Management Department, BINUS Business School Undergraduate Program,
Bina Nusantara University,
Jakarta, Indonesia 11480
yeni@binus.edu; edia@binus.edu; rudi@binus.edu

Yuli Eni1, Edi Abdurachman, Rudi: Analysis of Efficiency Level Using Data Envelopment Analysis (DEA) Method at the Indonesian Hospitals-- Palarch's Journal Of Archaeology Of Egypt/Egyptology 17(7). ISSN 1567-214x

Keywords: **Data Envelopment Analysis, Efficiency, Hospital Industry**

Abstract
Every year the population in Indonesia continues to grow, data shows that the population number has increased from 244.78 million in 2016 rose to 258.70 million in 2016 (Pusat Data dan Informasi, 2016). Increasing in population growth requires special attention, especially in terms of health. There are many efforts made by the government to improve the health status of the public, one of them that can be seen with the number of hospitals increased each year and supported with health facilities and services. But in fact, there are still facilities that are not used maximally. Therefore, there are still many –inefficient hospitals. One of the reasons is that not all hospitals have applied operational standards. The objective of this study is to measure the efficiency level of the hospital industry, and to improve the efficiency of hospitals in Indonesia. The efficiency can show the level of hospital industry in Indonesia by using Data Envelopment Analysis (DEA). DEA is one of the non-parametric methods for processing input and output variables used to calculate relative efficiency levels. The study was conducted by relying on output and input data from 2012 to 2016. Measurement of DEA efficiency uses BCC model with input orientation (nurses, physicians, pharmacists, and beds) and output (outpatient visit). The results of this study indicate that there are inefficiencies in 2013 and 2015 where an efficiency level of 99.97 % and 99.98% with input orientation and 99.96 % and 99.97% with output orientation respectively.

INTRODUCTION

Background

Indonesia is one of the countries with the highest population. It is number 4 in Asia with 258,316,051 people. Every year the population in Indonesia continues to grow, data shows that the population number has increased from 244.78 million in 2016 rose to 258.70 million in 2016 (Pusat Data dan

Informasi, 2016). Increasing in population growth requires special attention, especially in terms of health. The health sector becomes a major challenge for the government, because with the increase of population means government should pay attention to the amount of growth of health service distribution in terms of facilities and infrastructure, especially in densely populated areas. One of the indicator of the level of public health is the availability of adequate health facilities and infrastructure. According to Undang – Undang No. 36, Year 2009 about Health, states that health care facilities are a tool and or a place used to carry out health service efforts, whether promotive, preventive, curative or rehabilitative by the government, local government and or community (depkes.go.id, 2016). One of the health facilities is the hospital. There are many efforts made by the government to improve the health status of the public, one of them that can be seen with the number of hospitals increased each year. In 2013 the number of hospitals amounted to 2228 has increased to 2601 in 2016 (depkes.go.id, 2016).

In addition, the Government through the Kemenenterian Kesehatan (KemenKes) has sought to improve the health status of the community through several programs, namely the Jaminan Kesehatan Nasional (JKN), the fulfillment of health human resources, the development and improvement of the quality of health infrastructure and health services. If we look at it, there are many efforts made by the government, then the next thing to look back on is how effective and efficient the programs are. Especially the facilities that have been provided by each hospital. This is important because facilities in the hospital should be used efficiently to maximize the utilization of the facility. But in fact, there are still facilities that are not used maximally. Therefore, there are still many –inefficient hospitals. One of the reasons is that not all hospitals have applied operational standards, in this case related to hospital service accreditation standard. Until 2016, the percentage of accredited hospitals is only about 33.12% of the 2601 existing hospitals. This has been a major issue because it will affect the quality of hospital services to the community.

There are many methods to measure the operational efficiency of a hospital as reflected in each hospital operating standard. Some statistical techniques can help to measure this, one of them with DEA (Data Envelopment Analysis). DEA is a non-parametric method for efficiency measurement. DEA can measure the efficiency level of Decision Making Unit (DMU) with multiple input and multiple output of a company. It is supported by (Varabyova & Schreyogg, 2013) where efficiency measurements can be assessed through the multiple input variables.

In China, the efficiency level of hospitals, according to (Hu, Qi, & Yang, 2012) uses the total number of outpatient and emergency room visits and the total number of inpatient days, and patient mortality and uses DEA model. In Vietnam, according to (Pham, 2011), the efficiency level can be assessed by using DEA model (Data Envelopment Analysis) in the journal using Beds and Personnel as the input variables; meanwhile, the output variables consist of outpatient visits, inpatient days visit, and surgical operations. The study conducted by (Vitikainen, Street, & Linna, 2009) uses beds, employee, price of capital, price of labor as input variables, and total hospital admissions, emergency room visits, outpatient surgeries as output variables, and DEA model.

Researchers use DEA method using input variables consisting of nurses, physicians, pharmacists, and beds, as well as output variables consisting of outpatient visits in Indonesian hospitals. DEA calculates a relative efficiency score by converting input and output variables into one performance calculation for each DMU. By using DEA method, the researchers can know the efficiency level of hospital in Indonesia and know the factors causing inefficiency in DMU.

Based on the background of this study, the researchers decided to use DEA method to measure the efficiency level of hospital in Indonesia in a paper entitled "Analysis of Efficiency Level Using Data Envelopment Analysis (DEA) Method at the Indonesians Hospitals".

Research Questions

Based on the background of the study, the research questions are:

1. What is the efficiency level of the Indonesian hospitals?
2. What are the results of targeting increases and decreases in input variables consisting of nurses, physicians, pharmacists, beds as well as output variables consisting of outpatient visits in inefficient Indonesian hospitals?

Scope of the Study

The scope of this study was limited to the input variable consisting of nurses, physicians, pharmacists, and beds as well as output variables consisting of outpatient visits in Indonesian hospitals. In this study, the variables are expected to determine the efficiency of the network service unit. This study uses Data Envelopment Analysis (DEA) model for measuring the efficiency of Indonesian hospitals by comparing the input and output data over the last 5 years (2012-2016) obtained from the annual report.

Objectives of the Study

The objectives of this study are:

1. To examine the efficiency level of the Indonesian hospitals.
2. To determine the targeting increase and decrease in input variables consisting of nurses, physicians, pharmacists, and beds as well as output variables consisting of outpatient visits in inefficient Indonesian hospitals.

LITERATURE REVIEW

Efficiency

Robbins & Coulter (2010) stated that efficiency is used to obtain the greatest output of the smallest input. The allocation of existing resources within a company can be used optimally to be more efficient. Efficient is also called "doing things right" by not wasting the available resources.

According to Handoyo (2008), Efficiency is an ability to solve a work correctly or in the mathematical concept of a calculation of the ratio between output and input. This is supported also by Mulyadi (2007) stating that: "Efficiency is accuracy of ways (effort, work) in running things by maximizing the use of time, effort and cost. Efficiency also means the ratio between input and output or cost and profit."

It can be concluded that efficiency is a way to maximize available resources with all forms of business undertaken to minimize waste in terms of time, effort and cost.

Data Envelopment Analysis (DEA)

Data Envelopment Analysis (DEA) was firstly introduced by Charnes, Cooper and Rhodes in 1978. DEA is a non-parametric approach which is basically the development of the Linear Programming (LP) model. Solving a problem using the LP model is usually done by formulating mathematically. The goal to be achieved and the obstacles that will be faced in achieving the goal is the concept of Linear Programming.

While the purpose of DEA analysis is to assess the efficiency in which using input variables to achieve output, whereby it aims to maximize efficiency. In addition, DEA calculates the efficiency of an organization that is in the group against the best organizational performance in the same group (Cooper, Seiford, & Tone, 2007).

Cook, Tone, & Zhu (2014) state that DEA is a non-parametric method in operation and economic research to estimate production limits. In addition, Sutawijaya & Lestari (2009) state that DEA is an analytical tool used to measure efficiency for health research, education, transportation, manufacturing and banking. Beside that, Iliyasu (2015) state that DEA has application in manufacturing, healthcare, transportation, education, environment and energy, finance and banking.

Decision Making Unit (DMU)

Decision Making Unit (DMU) is an entity that uses input to generate output. The term of DMU in DEA can be used for various units such as banks, hospitals, units from factories, departments, universities, schools, power stations, police stations, one roof system offices, tax offices, prisons and anything that has operational characteristics (Almumani, 2013).

Ramanathan (2003) in (Pamungkas, Wahyunadi, & Firmansyah, 2016) mentions that there are two factors influencing the selection of DMU, i.e. the DMU should be homogeneous units. The units perform the task and have the same objective. Inputs and outputs that characterize the performance of the DMUs should be identical, but different only in intensity and magnitude.

BCC (Banker-Charnes-Cooper) Model

BCC model (Banker, Charnes and Cooper, 1984) is also known as the variable return to scale (VRS), i.e. different increase in input and output. Increased proportion can be increasing return to scale (IRS) or it can be also decreasing return to scale (DRS).

This model has the assumption that the ratio between input and output additions is not the same. For example, any input additions x times will not cause the output to increase by x times, but it can be decreasing returns to scale or increasing returns to scale (Gunawan, 2013).

Slack

Slack can represent the remaining inefficiency part. After proportional reduction in input or increase in output, if the DMU cannot reach the efficiency limit (for efficient targets), slack is required to push the DMU to the border or target to be achieved (Ozcan, 2014).

RESEARCH METHODOLOGY

The method used in this research is descriptive quantitative method. The research is aimed to know the efficiency level of the Indonesian hospitals and to enhance target-setting and reduction of inputs and outputs that are not efficient.

In this study, the researchers use BCC model which is also known as the VRS (Variable Return Scale) to measure the efficiency level of hospitals in Indonesia. The input variables used are bed, employees, medical personnel, and nurses. Meanwhile, the output variables for assessing hospital efficiency uses outpatient visits.

In conducting this research, the researchers collect quantitative data, i.e. hospital data such as nurses, physicians, pharmacists, beds and outpatient visits in Indonesian hospitals for the year of 2012-2016. In this case the Decision Making Unit is year. The data collected are then grouped into two categories of variables namely input data and output data. The data are analyzed using the Data Envelopment Analysis method. The mathematical model for the DEA approach is the following:

$$\text{Maximize} \quad \sum_{r=1}^{s} u_r y_{rk}$$

$$\text{subject to} \quad -\sum_{i=1}^{m} v_i x_{ij} + \sum_{r=1}^{s} u_r y_{rj} \le 0$$

$$\sum_{i=1}^{m} v_i x_{ik} = 1$$

$$v_i \ge 0 \text{ and } u_r \ge 0$$

K # operting units (DMUs) $k = 1,..., K$

N # inputs $i = 1,..., N$

M # outputs $= 1,..., M$

O_{jk} observed level of output j from DMU k

I_{ik} observed level of input i from DMU k

v_i weight on input i

u_j weight on output j

E_k efficiency of DMU (0-100%)

$$E_k = \frac{\sum_{j=1}^{M} u_j O_{jk}}{\sum_{i=1}^{N} v_i I_{ik}}$$

Where u_r is the weight for the r^{th} output variable y_r, v_i is the weight for the i^{th} input variable x_i. In this study uses only one out variable y namely Outpatients visit and four variables inputs namely Nurses, Physician, Pharmacist and Beds.

RESULTS AND DISCUSSION

These results indicate the efficiency level of the hospital from year to year. The efficiency level in Data Envelopment Analysis can be seen from the value that is in the range 0-1 where the value 1 denotes 100% efficiency level which means the DMU is efficient. Meanwhile, the efficiency is below the value of 1 or 100% means that the DMU is not yet efficient.

Table 1. *Hospital Efficiency*

Year	Efficiency	
	Input Oriented	**Output Oriented**
2012	1	1
2013	0.9997	0.9996

2014	1	1
2015	0.9998	0.9997
2016	1	1

In DEA analysis, there are 2 approaches: input oriented or output oriented. Input oriented is oriented to input in DEA analysis, where DEA analysis focuses on reducing inputs to achieve efficiency. While output oriented is oriented to output, where the analysis aims to add the level of output to achieve efficiency.

Results of Overall Hospital Efficiency Calculations in Indonesia 2012 - 2016 can be seen that the efficiency in 2012, 2014, and 2016 is efficient, which means the proportion of input and output in those years is optimal. While in 2013 and 2015, the efficiency of the Indonesian hospitals is not yet optimal i.e. 99.97 % and 99.98% in input oriented and 99.96 % and 99.97 % in output oriented. It means that the hospitals in 2013 and 2015 should have reduced the input level to reach 0.03% and 0.02% of efficiency (Input Oriented) or the Indonesian hospitals should have increased the amount of output to reach 0.04 % and 0.03 % of efficiency (Output Oriented) in 2013 and 2015.

Slack Analysis

In Table 2 and Table 3, we can see the result of slack in the slack column in each input and output. The result of the slack is calculated using DEA-SOLVER-LV8 software, where the number 0 in slack indicates that the input or output is optimal. Meanwhile, the input or output variables that have slack means the level of input or output has not been optimal, so it must be reduced or improved.

Therefore, it can be ascertained that DMU that has slack 0 on all input and output variables is declared efficient, because all the output and input is optimal. While DMU which has variable input or output with slack means DMU is not efficient because there are still input or output variables that have not been optimal.

From the DEA analysis of the hospital sector as a whole, there are 3 efficient DMUs and 2 inefficient DMUs, the efficient DMU is in 2012, 2014, and 2016, whereas inefficient DMU is in 2013 and 2015. It can also be seen in the slack analysis where output and input from 2012, 2014, and 2016 have slack 0. While in 2013, there is a slack in input variables namely Nurses, Pharmacists, and Beds. While in 2015, there is a slack in input variables namely Nurses and Pharmacists.

				Slack	Slack	Slack	Slack	Slack
No.	**DMU**	**Score**	**Rank**	**Nurses**	**Physicians**	**Pharmacists**	**Beds**	**Outpatient visits**
1	2012	1	1	0	0	0	0	0
2	2013	0.9997	5	45,697	0	9971,78	18163.4	0
3	2014	1	1	0	0	0	0	0
4	2015	0.9998	4	9.967	0	2120,76	0	0
5	2016	1	1	0	0	0	0	0

Table 2. *Slack BCC Input Oriented*

Table 3. *Slack BCC Output Oriented*

No.	DMU	Score	Rank	Slack Nurses	Slack Physicians	Slack Pharmacists	Slack Beds	Slack Outpatient visits
1	2012	1	1	0	0	0	0	0
2	2013	0.9996	5	88,652	0	9948.24	18071.1	0
3	2014	1	1	0	0	0	0	0
4	2015	0.9997	4	40,841	0	2069.64	0	0
5	2016	1	1	0	0	0	0	0

In 2013, the inefficiency is an evident from the considerable slack value in the three DMU variables i.e. input variables namely Nurses, Pharmacists, and Beds with slack of 45, 697, 9971,78, and 18163.4 for input oriented as well as 88,652, 9948.24, and 18071.1 for output oriented. Meanwhile in 2015, inefficiency is clearly visible from the value of a large enough slack on the three DMU variables i.e. input variables namely Nurses and Pharmacists with slack of 9, 967, 2120.76 for input oriented as well as 40.841 and 2069.64 for output oriented.

Projection Analysis

From Table 4 and Table 5, it can be seen that input and output variables have 3 columns of data, projection and difference (diff.). Data is a column that contains the level of input used or the level of output produced at that time. While projection is the amount of input or output that must be used or produced to achieve efficiency. Differentiation is the difference between the data and the projection to be used so that it can show how many inputs should be reduced and how much the output should be increased in percentage.

In Table 4, DMU which has differentiation value from data and projection is in 2013 and 2015. This is because 2013 and 2015 have not been operating efficiently. Therefore, there is an input or output that must be changed to achieve efficiency. The changes are seen in the differentiation. In Table 4, it can be seen that differentiation occurs in the variables of Nurses, Physicians, Pharmacists, and Beds.

In Table 5, it can be seen that DMU which has differentiation value from the data and its projection is in 201 3 and 2015. This is because 2013 and 2015 have not been operating efficiently. Therefore, there is an input or output that must be changed to achieve efficiency. The change is seen in the differentiation column. Table 5 also shows that differentiation occurs in the variables of Nurses, Pharmacists, Beds and Outpatient Visits.

Table 4. *Results of Overall Projection (Input Oriented)*

				Nurses			Physicians			Pharmacists			Beds			Outpatient Visits		
No.	DMU	Score	Rank	Data	Projection	Diff. (%)	Data	Projection	Diff. (%)	Data	Projection	Diff. (%)	Data	Projector	Diff. (%)	Data	Projector	Diff. (%)
1	2012	1	1	426713	426713	0	82920	82920	0	31223	31223	0	203768	203768	0	255593	255593	0
2	2013	0.9997	5	440995	440801	-0.044	86852	86822.7	-0.034	4643 7	36449.6	-21.507	245340	227094	-7.437	268780	268780	0

3	2014	1	1	455755	455755	0	90938	90938	0	48681	48681	0	236610	236610	0	282552	282552	0
4	2015	0.998	4	471009	470883	-0.027	95174	95150.6	-0.025	51033	48899.7	-4.18	274016	273949	-0.025	296893	296893	0
5	2016	1	1	486773	486773	0	99557	99557	0	53500	53500	0	303192	303192	0	311807	311807	0

Table 5. *Results of Overall Projection (Output Oriented)*

				Nurses			Physicians			Pharmacists			Beds			Outpatient Visits		
No.	DMU	Score	Rank	Data	Projection	Diff. (%)	Data	Projection	Diff. (%)	Data	Projection	Diff. (%)	Data	Projection	Diff. (%)	Data	Projection	Diff. (%)
1	2012	1	1	426713	426713	0	82920	82920	0	31223	31223	0	203768	203768	0	255593	255593	0
2	2013	0.996	5	440995	440906	-0.02	86852	86852	0	46437	36488.8	-21.243	245340	227269	-7.366	268780	268879	0.037
3	2014	1	1	455755	455755	0	90938	90938	0	48681	48681	0	236610	236610	0	282552	282552	0
4	2015	0.997	4	471009	470968	-0.009	95174	95174	0	51033	48963.4	-4.055	274016	274016	0	296893	296971	0.026
5	2016	1	1	486773	486773	0	99557	99557	0	53500	53500	0	303192	303192	0	311807	311807	0

Projection Table

In variable of Nurses, it can be seen that the data have a value of 440995 meaning that, in 201 3, the average Nurses overall are 440995, while the projection number shows the 440801 which means if the DMU 2013 should reach the efficient level, the number of input Nurses should be reduced from 440995 to 440801.

In other words, Nurses should be reduced by 194 or reduced by 0.044 % from the previous. Similarly, for other input variables of Physicians, Pharmacists, and Beds.

If you should reach an efficient level, the number of Physicians should be reduced by 29.3 or reduced by 0.034 % from the previous level. Meanwhile, the variable of Pharmacists should be reduced by 9987.4 or minus 21.50%. In addition, the variable of Beds should be reduced by 18,246 or reduced by 7.437%.

Table 6. *Overall Projection in 2013 (Input Oriented)*

	Data	Projection	Diff. (%)
Nurses	440995	440801	-0,044
Physicians	86852	86823	-0.034
Pharmacists	46437	36450	-21,507
Beds	245340	227094	-7,437

Table 7. Overall Projection 2015 (Input Oriented)

	Data	Projection	Diff. (%)
Nurses	471009	470883	-0,027

Physicians	95174	95151	-0,025
Pharmacists	51033	48900	-4.18
Beds	274016	273949	-0,025

In the variable of Nurses, it can be seen that the data have a value of 471009 meaning that in 2015 the average Nurses overall are 471009, while the projection number indicates the number 470883 which means if the DMU 2015 should reach the efficient level, the number of Nurses must be reduced from 471009 to 470883. In other words, Nurses should be reduced by 126 or reduced by 0.027 % from the previous level. Similarly, it applies for other input variables of Physicians, Pharmacists, and Beds. If it should reach an efficient level, the number of Physicians should be reduced by 23 or minus 0.025 % from the previous level. Meanwhile, the variable of Pharmacists should be reduced by 2133 or minus 4.81%. In addition, the variable of Beds should be reduced by 67 or minus by 0.025%.

Table 8. *Overall Projection in 2013 (Output Oriented)*

	Data	**Projection**	**Diff. (%)**
Nurses	440995	440906	-0.02
Pharmacists	46437	36488,76	-21,423
Beds	245340	227268.9	-7,366
Outpatient Visit	268780	268878.9	0.037

In the variable of Nurses, it can be seen that the data have a value of 440995 meaning that, in 2013, the average Nurses overall are 440995, while the projection number shows the 440906 which means if the DMU 2013 should reach the efficient level, the number of Nurses should be reduced from 440995 to 440906. In other words, the Nurses should be reduced by 89 or reduced by 0.02 % from the previous level.

Similarly, for other input variables of Pharmacists, and Beds. If it should reach an efficient level, the amount for Pharmacists should be reduced by 9948.24 or reduced by 21.423%. Beds should be reduced by 18071 or reduced by 7.366%. Meanwhile, the Outpatient Visit must be added to equal to 98,9 or equal to 0,037% to reach efficient level.

Table 9. *Overall Projection in 2015 (Output Oriented)*

	Data	**Projection**	**Diff. (%)**
Nurses	471009	470968.2	-0.009
Pharmacists	51033	48963,36	-4,055
Outpatient Visit	296893	296971.5	0.026

In the variable of Nurses, it can be seen that the data have a value of 710095 meaning that in 2014, the Average overall Nurses are 471009, whereas the projection number indicates the number of 470,968.2 which means if the DMU 2015 should achieve efficiency, input variable of nurses should be reduced from 471009 to 470968.2. In other words, the Nurses should be reduced by 40.8 or reduced by 0.009 % from the previous level. Similarly, it applies for other input variables of Pharmacists. If it

should reach an efficient level, the amount for Pharmacists should be reduced by 2069.64 or reduced by 4.055%. Meanwhile, Outpatient Visit in output variable must be added equal to 78,5 or equal to 0,026 % to reach efficient level.

CONCLUSIONS AND SUGGESTIONS

Conclusions

From the results and discussion, it can be concluded that:

1. Based on the analysis of the overall efficiency, it can be seen that the levels of efficiency of the Indonesian hospitals in 2013 and 2015 are not at an efficient level of 99.97 % and 99.98% in input oriented and 99.96 % and 99.97 % in output oriented.
2. Based on slack analysis, it can be seen that 2013 is in inefficiency. It can be clearly seen from the value of a large enough slack in three DMU variables namely input variables of Nurses, Pharmacists, and Beds with slack of 45, 697, 9971,78, and 18163.4 respectively for input oriented as well as 88, 652, 9948.24, and 18071.1 respectively for output oriented. Meanwhile, in 2015, the inefficiency can be clearly seen from the value of a large enough slack in three DMU variables namely input variables of Nurses and Pharmacists with slack of 9,967, 2120.76 respectively for input oriented as well as 40.841 and 2069.64 respectively for output oriented.

Suggestions

Based on analysis, here are some suggestions that can be given:

1. Researchers who will conduct further research are suggested to collect more data of input and output from the hospitals so that the results of research can be more detailed.
2. Researchers who will conduct further research are suggested to be able to perform efficiency level analysis with other methods in parametric method. Therefore, the results of subsequent research can complement this research because the results can be compared. Selection of other methods may also provide more inputs to the Indonesian hospitals based on the required conditions.

REFERENCES

Banker, R. D., Charnes, A. & Cooper W. W. (1984). Some models for the estimation of technical and scale inefficiencies in data envelopment analysis. *Management Science, 30*, 1078 – 92.

Cook, W. D., Tone, K., & Zhu, J. (2014). *Data Envelopment Analysis: Prior to choosing a model*. Omega: Springer.

Cooper, W. W, Seiford, L. M, & Tone, K. (2007). *Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References and DEA-Solver Software* (2nd edition). New York: Springer.

Gunawan, F. A. (2013). Analysis of efficiency level of BUMN Bank with Data Envelopment Analysis (DEA) Approach. *Journal of Management Science & Research*, *2*(8), 1-17.

Handoyo, R. (2008). *Module in House Student Training Data Envelopment Analysis*. Surabaya: Department of Economics Faculty of Economics Airlangga University.

Hu, H.-H., Qi, Q., & Yang, C.-H. (2012). Evaluation of China's regional hospital efficiency: DEA approach with undesirable output. *Journal of the Operational Research Society*, 715-725.

Iliyasu, A., Mohamed, Z. A. & Terano, R. (2015). Data envelopment analysis models and Software packages for academic purposes. *Pertanika Journal of Scholarly Research Reviews*, 27-32.

Mulyadi. (2007). *Management Planning and Control Systems*. Jakarta: Salemba Four.

Ozcan, Y. A. (2014). *Health Care Benchmarking and Performance Evaluation*. New York: Springer.

Pamungkas, B. D., Wahyunadi, & Firmansyah, M. (2016). Analisis efisiensi Puskesmas di Kabupaten Sumbawa tahun 2015. *Jurnal Ekonomi dan Studi Pembangunan*, *8*(2), 183-206.

Pham, T. L (2011). Efficiency and productivity of hospital in Vietnam. *Journal of Health Organization and Management*, *25*(2), 195-213.

Ramanathan, R. (2003). An introduction to data envelopment analysis—A tool for performance measurement. *Sage Publications*.

Robbins, S. P. & Coulter, M. (2010). *Management* (10th Ed.). Prentice Hall.

Sutawijaya, A., & Lestari, E. P. (2009). Efficiency of Indonesian banking techniques post economic crisis: An empirical study of the application of DEA model. *Journal of Development Economics*, 49-67.

Varabyova, Y., & Schreyogg, J. (2013). International panel of analysis of OECD countries using parametric and non-parametric approaches. *Elsevier*, 10.

Vitikainen, K., Street, A., & Linna, M. (2009). Estimation of hospital efficiency - Do different definitions and casemix measures for hospital output affect the results? *Science Direct*, 149-159.

http://www.depkes.go.id/resources/download/pusdatin/profil-kesehatan-indonesia/Profil-Kesehatan-Indonesia-2016.pdf