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The Performance of Public Health Sector in Aceh, Indonesia

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Abstract—This study aims to analyze the performance measurement of the public health sector in Aceh province, where this province consists of 17 municipalities and 5 cities. The measurement issue in this study is in terms of efficiency by using a non-parametric method that is Data Envelopment Analysis (DEA). The results of this study showed the performance measurement of the public health sector in Aceh using two output variables: life expectancy and infant survival rate and three input variables: number of doctors, nurses and public health centre. Among 23 districts in Aceh, the highest life expectancy is in Lhokseumawe and Banda Aceh (71). In contrast, the lowest is 63 in Subulussalam. Another output variable chosen is infant survival rate, where the highest rate is 999 per 1,000 live births in Aceh Tenggara and the lowest is 51 per 1,000 live births in Simeuleu. Based on measures of quantity inputs, the result shows that among all districts of Aceh, less than 30% are considered efficient.

Keywords: data envelopment analysis (DEA); efficiency measurement; public health policy

I. INTRODUCTION

Human capital investment is important to boost economic growth so health financing is one of the main factors in the national health system. In Indonesian law, at least 10% of the regional government budget is allocated to the health sector and in Aceh, the total budget for health is 14% (Aceh District Level Health Office 2017). Even though the total budget for health meets the Indonesian standard, the Indonesian Ministry of Health (2018) stated that 37.9% of children in Aceh are claimed as stunted and this is the highest percentage in Indonesia. Moreover, according to World Bank (2006), Aceh has a high number of health workers and a large number of health care facilities, but the quality of resources is not supported such as lack of availability of medication, unreliable electricity supply and staff, which is frequently absent.

Stunting is an inadequate height condition for children aged 0 - 59 months and this condition not only affects physical growth at a young age but also affects the ability to think which will ultimately have an impact on being unproductive in the labour market. 37.9% of stunted children in Aceh shows that this province has problems in poverty and poor child development. This province that has received special autonomy funds since 2008 until now, has become one of the provinces with the highest regional income but the percentage of stunted children in Aceh is the largest in Indonesia. Thus, health performance in Aceh needs to be studied.

This study uses the input and output approach to measure the health performance in Aceh, where Infant Survival Rate derived from Infant Mortality Rate and Life Expectancy is used as the output variables. Research from Prajapati & Singh (2015) explains that a decrease in IMR shows an increase in the probability of survival of children. Their study conducted in 1985-2010 for major states of India revealed the fact that negative relationship between IMR and life expectancy. In Aceh province, one of the programs to reduce the risk of infant mortality is Coverage of First Neonatal Visit (KN1) is still below the national average (Ministry of the health of the Republic of Indonesia 2018). Furthermore,

Statistics of Aceh province (2017) and Aceh district-level health office (2017) show large gaps in the values of the output variables. First, among 23 districts in Aceh, the highest life expectancy is in Lhokseumawe and Banda Aceh, 71. In contrast to this, the lowest is 63 in Subulussalam. Another output variable chosen is infant survival rate, where the highest rate is 999 per 1,000 live births in Aceh Tenggara and the lowest is 51 per 1,000 live births in Simeuleu.

Since life expectancy and Human Development Index are related, a closer look towards HDI seems interesting. According to Statistics of Aceh Province (2017), human development in Aceh continued to experience progress and improvement starting with 67.09% in 2010 to 70.00% in 2016. In the period 2015 to 2016, the level of human development for all districts in Aceh increased. Subulussalam, Aceh Singkil, Aceh Timur and Aceh Selatan were the four districts with the fastest progress while Aceh Besar, Aceh Jaya, Aceh Utara and Pidie experienced the slowest progress. The report also explains that Banda Aceh with the highest HDI is due to high quality in education and standard of living, meanwhile high HDI in Langsa and Lhokseumawe is because of education.

Some previous related studies have conducted a similar study with this present study which examined the performance of public health such as a study conducted by Scutchfield et al. (2009), Bouphan et al. (2015), and Noto et al. (2021). Scutchfield et al. (2009) in their study, examined past, current, and future issues in developing and using public health performance data for improving the public health system. The result of this study showed that there are major areas of concern that must be addressed by the public health practice organizations, governmental public health entities, and the public health systems research communities. These include ensuring that data are collected regarding public health infrastructure, practice, and performance; that the data are standardized regardless of where they are collected, or by whom, so that they are well understood by all of the public health actors, and that data instruments are validated and reliable and ask appropriate questions to derive the data needed to address issues in a public health organization, administration, and finance. Bouphan et al. (2015) in their study analyzed individual attributes and administrative factors that influence the Public Health Performance Evaluation of sub-district health-promoting hospital directors in Nakhon Ratchasima province, Thailand. The result of this study indicated that there are three significant predictors which contributed 60.90 percent of the total variance of the Public Health Performance Evaluation. The three significant predictors are method, materials, and man. Moreover, the study conducted by Noto et al. (2021) that assess how and with what degree the management of public hospitals have embraced in practice the updated concept of performance and their new role, showed that in recent years, the concept of performance in hospitals evolved toward the adoption of an outcome-based and population-based perspective. Additional effort should be devoted toward improved collaboration and integration of care with other settings.

Based on the background of the previous studies above, this study aims to analyze performance measurement of the public health sector in Aceh, where this province consists of 17 municipalities and 5 cities. The measurement issue in this study is considered in terms of efficiency measurement. Although the method proposed and used can be applied to several sectors besides public health, this research only focuses on the efficiency evaluation in the public health sector in Aceh province. Aceh is chosen because the area of study towards efficiency measurement seems still limited in Aceh. This province is also special because of receiving autonomy funds from the Indonesian government and recently a case of stunting in Aceh is the highest in Indonesia.

II. METHOD

This study is conducted in Aceh province, where this province consists of 17 municipalities and 5 cities. All the data collected in this study used secondary data, where the details of data sources are explained in table 1.

There are many input and output variables that can be used to measure health attainment. Choosing variables in DEA is important since if the number of input and output variables is more, the dimensionality of the production space will increase and the discriminatory power of the DEA will reduce (Subramanyam, 2017). Following the approach from Afonso & Aubyn (2005), this study uses the same efficiency measurement technique which implies “more is better” so that output used is Infant Survival Rate where it is derived from the data of infant mortality rate.

Table 1. Data sources

Variable	Units	Source
Output		
Life expectancy	Age	Statistics of Aceh Province (2017)
Infant Survival Rate	Per 1,000 live births	Aceh District Level Health Office (2017).
Input		
Number of doctors		Health Regional Office of Aceh Province (2019)
Number of nurses		Health Regional Office of Aceh Province (2019)
Number of public health centre (Puskemas)		Health Regional Office of Aceh Province (2019)

$$\text{Infant Survival Rate (ISR)} = \frac{1000 - \text{Infant Mortality Rate (IMR)}}{\text{IMR}}$$

Therefore, the frontier model for health in this study has two outputs: the infant survival rate and life expectancy. Quantitative inputs are the number of doctors, nurses and of public health centres.

Data Envelopment Analysis (DEA) as a non-parametric method is chosen based on the literature of measuring efficiency that allows the estimation of efficiency frontiers and efficiency losses. Since DEA requires input and output variables to calculate efficiency in the public health sector, this study uses 3 inputs and 2 outputs. This study only uses one-year data, which is the most recent data to measure efficiency in 23 districts in Aceh.

According to Cooper et al. (2007), there are some common criteria for selecting input and output variables:

Numerical data: data for each input and output is assumed to be positive.

Input, output and the choice of DMUs should represent the purpose of the study that will be included in the relative evaluation of the DMUs.

The number of inputs that is smaller and larger output amounts is preferable, in principle.

The measurement units of input and output need not be consistent.

Another important point regarding model specification is the degrees of freedom. Bowlin (1998) explains that there is a rough rule of thumb in selecting the number of Decision Making Unit that eventually will affect the degrees of freedom. The number of observations (N or DMU) should exceed the number of inputs and outputs multiplied by three to avoid the risk of getting too many efficient DMU and to have enough degrees of freedom. Here, there are 23 observations, more than the critical level which is 15 (3 inputs and 2 outputs times 3).

III. RESULT AND DISCUSSION

The Analysis of Input and Output Variables

Table 2 exhibits the descriptive statistics on input and output variables and also explains big gaps in the values of the output variables. First, among 23 districts in Aceh, the highest life expectancy is in Lhokseumawe and Banda Aceh (71). In contrast, the lowest is 63 in Subulussalam. The reason for the large difference in life expectancy might be due to the distance from Banda Aceh. Another output variable chosen is infant survival rate, where the highest rate is 999 per 1,000 live births in Aceh Tenggara and the lowest is 51 per 1,000 live births in Simeuleu. This variable is used since the method to analyse efficiency by DEA requires the principle "more is better". Apart from the explanation of output variables, Table 4.1 also shows the descriptive statistics on the input variables used in this study. Following previous studies to measure the performance of the health sector, this paper chooses three input variables: the number of doctors, the number of nurses and the number of public health centres. As the biggest city in Aceh province, Banda Aceh has the highest number of doctors and nurses compared to all districts and passes the average value. On the contrary, the lowest number of doctors and nurses is in Sabang and Subulussalam, respectively.

Table 2. Descriptive Statistics on Input and Output variables (N = 23)

Variable	Mean	Std. Dev	Min	Max
Output				
Life expectancy	67.6	2.25	63	71
Infant Survival Rate	168.5	206	51	999
Input				
Number of doctors	97	90.3	36	475
Number of nurses	439	336	172	1375
Number of public health centre (Puskemas)	17	9.67	5	44

The Analysis of Efficiency Measurement

Table 3 summarizes efficiency results for health performance using Data Envelopment Analysis using three input variables and two output variables. Seven among 23 districts in Aceh province analyzed with this formulation for health is considered as efficient. These districts are Aceh Tenggara, Aceh Besar, Banda Aceh, Sabang, Langsa, Lhokseumawe and Subulussalam. Hence, the result from DEA explains that less than one-third of the entire Aceh province is considered efficient for health performance. The focus of this study in terms of evaluating efficiency frontier is on measures of quantity inputs and the result also exhibits the average score of input efficiency 0.734.

Based on the districts considered as efficient and the data for input and output variables, they can provide more information. Banda Aceh as the capital and largest city in the province of Aceh is not surprising to be the best performer. A closer look towards the data of input variables, Banda Aceh also has the highest number of doctors and nurses even though one more input variable i.e. the number of public health centres (Puskesmas) are not the highest. Different from Banda Aceh having the highest number of inputs as one of the efficient districts, Sabang, Langsa and Subulussalam which are also considered efficient even have the lowest values for the number of inputs. Another interesting point from this result is about the lowest rank among the other districts performing inefficient which is Pidie. A comparison of input variables between Pidie and Banda Aceh, Pidie has more public health centres (Puskesmas) than Banda Aceh but the other inputs: number of doctors and nurses are quite similar with Banda Aceh.

Table 3. DEA results for public health performance in Aceh

District	Input oriented		Output oriented		Peers	CRS TE
	VRS TE	Rank	VRS TE	Rank	Input/ output	
Simeulue	0.93	10	0.927	19	Sabang,Subulussalam/ Lhokseumawe,Sabang	0.881
Aceh Singkil	0.677	15	0.948	17	Sabang,Subulussalam/	0.656
Aceh Selatan	0.748	13	0.911	22	Sabang/Lhokseumawe, Sabang	0.702
Aceh Tenggara	1	1	1	1	Aceh tenggara	1
Aceh Timur	0.401	20	0.958	14	Sabang/Sabang, Lhokseumawe	0.393
Aceh Tengah	0.416	19	0.959	13	Sabang/Lhokseumawe, Sabang	0.405
Aceh Barat	0.977	8	0.957	15	Sabang/Lhokseumawe, Sabang	0.935
Aceh Besar	1	1	1	1	Aceh besar	1
Pidie	0.196	23	0.93	18	Sabang,Subulussalam/ lhokseumawe	0.186
Bireuen	**0.248**	**22**	**0.986**	**8**	**Sabang/Lhokseumawe**	**0.248**
Aceh Utara	0.332	21	0.958	14	AcehTenggara,Sabang, Subulussalam/ Lhokseumawe	0.326
Aceh Barat Daya	0.758	12	0.912	21	Sabang/Sabang, Lhokseumawe	0.693
Gayo Lues	0.633	16	0.917	20	Aceh Tenggara,Sabang, Subulussalam/ Lhokseumawe,Sabang	0.608

Aceh Tamiang	**0.498**	**17**	**0.972**	**12**	**Sabang, Subulussalam/ Sabang, Lhokseumawe**	**0.493**
Nagan Raya	0.945	9	0.985	9	Sabang/Lhokseumawe, Sabang	0.932
Aceh Jaya	0.896	11	0.956	16	Sabang/Lhokseumawe, Sabang	0.857
Bener Meriah	0.486	18	0.976	11	Sabang/Lhokseumawe, Sabang	0.479
Pidie Jaya	0.741	14	0.983	10	Sabang/Lhokseumawe, Sabang	0.731
Banda Aceh	1	1	1	1	Banda aceh	1
Sabang	1	1	1	1	Sabang	1
Langsa	1	1	1	1	Sabang/ Sabang	1
Lhokseumawe	1	1	1	1	Lhokseumawe/ Lhokseumawe	1
Subulussalam	1	1	1	1	Subulussalam	1
Average	0.734		0.967			0.715

Notes: 3 inputs – doctors, nurses and public health centre (*Puskesmas*) – 2 outputs – infant survival rate and life expectancy- Districts in **bold** show the efficiency frontier. CRS TE is a constant return to scale technical efficiency. VRS TE is a variable return to scale technical efficiency.

Policy Implication

Table 4 explains policy implications for each district, where the policy is used for improving the performance of public health. In DEA, these policy implications are obtained from slack movement in the result column. Slack represents the potential improvements in the input and output variables for the inefficient units. Hence, by increasing output variables or decreasing input variables, the performance of each district can be improved. As explained in the DEA framework in section 2, this study uses a DEA by Banker, Charnes & Cooper (BCC) that has an assumption of Variable Return to Scale (VRS) and focuses on measures of quantity inputs (input-oriented). Therefore, table 4 represents how many inputs should be reduced to obtain the efficient result for each DMU (here DMU is a district).

Table 4. Policy implication

District	**Policy implication**		
	Doctor	Nurse	Puskesmas
Simeulue	0	61.5	7.5
Aceh Singkil	0	59	2
Aceh Selatan	26.5	0	15
Aceh Tenggara	0	0	0
Aceh Timur	7	0	6
Aceh Tengah	9	0	4
Aceh Barat	25.5	0	8
Aceh Besar	0	0	0
Pidie	0	89	0
Bireuen	0	10	0.2
Aceh Utara	0	47	2.5
Acceh Barat Daya	6	0	4.9
Gayo Lues	0	48	0
Aceh Tamiang	0	39	2.7
Nagan Raya	23.5	0	9
Aceh Jaya	25	0	6
Bener Meriah	2.3	0	1.3
Pidie Jaya	16.3	0	4
Banda Aceh	0	0	0
Sabang	0	0	0
Langsa	41	223	0
Lhokseumawe	0	0	0
Subulussalam	0	0	0

Notes: 3 inputs – doctors, nurses and public health centre (*Puskesmas*)

Districts in **bold** show the efficiency frontier.

In Indonesia, there are two provinces receiving special autonomy funds (dana otsus): Papua and Aceh. Aceh's fiscal revenue has increased several times since 1999, especially after decentralization and having special autonomy status. With a lot of money and having many opportunities to develop the economy, Aceh is one of the richest provinces in Indonesia but the percentage of stunted children in Aceh is the largest in Indonesia. According to World Bank (2006), government spending on the health sector has increased since 2002 and Aceh also has a high number of health workers and a large number of health care facilities. However, quality of resources is not supported such as lack of availability of medication, unreliable electricity supply and staff, who is frequently absent.

Human capital investment is important to boost economic growth so health financing is one of the main factors in the national health system. In Indonesian law, at least 10% of the regional government budget is allocated to the health sector and in Aceh, the total budget for health is 14% (Aceh District Level Health Office 2017). Stunting is one of the targets of Sustainable development Goals (SDGs), aiming to eliminate hunger and all forms of malnutrition. According to Indonesian Health Ministry (2018), stunting is a major nutritional problem in Indonesia compared to others. WHO (2018) explains that Indonesia is the third country with the highest prevalence of stunted children in the South-East Asia Regional (SEAR). To solve this problem, the Indonesian government set stunting as one of the priority programs so that sensitive and specific nutritional intervention can be a solution to prevent and reduce the number of stunted children.

The sensitive and specific nutritional programs have different approaches depending on their target i.e., directly and indirectly to the health sector. The nutrition-specific of programs are aimed at addressing the direct causes of nutritional problems and are within the scope of health policy and nutrition-sensitivity programs overcome the indirect causes such as education, sanitation and social protection. Nutrition-specific actions are carried out in the health sector yet only contribute about 30%. On the other hand, nutrition-sensitivity actions account for 70% to tackle the nutritional problem in Indonesia (Indonesian Health Ministry 2016). The study from Ruel & Alderman (2013) investigates the effects of the two-different programs (specific and sensitive nutritional interventions) in four sectors i.e., agriculture, social safety, child development and education. They conclude that a significant number of the programs that is not initially intended to improve nutrition yet can possibly to do so.

IV. CONCLUSION

Based on the results obtained, it can be drawn conclusion; first, this study explains the performance measurement of the public health sector in Aceh using two output variables: life expectancy and infant survival rate and three input variables: number of doctors, nurses and public health centre. Among 23 districts in Aceh, the highest life expectancy is in Lhokseumawe and Banda Aceh (71). In contrast, the lowest is 63 in Subulussalam. Another output variable chosen is infant survival rate, where the highest rate is 999 per 1,000 live births in Aceh Tenggara and the lowest is 51 per 1,000 live births in Simeuleu. Based on measures of quantity inputs, the result shows that among all districts of Aceh, less than 30% are considered efficient. There are some important points, the first point is Banda Aceh as the largest and capital city is the best performer and Pidie is in the lowest rank. Secondly, one of the input variables used is the number of public health centres but this variable does not have a significant effect to be considered as an efficient district that can be seen from a comparison between Pidie's performance and Banda Aceh's performance. By analyzing the efficiency, this study can explain policy implications to improve the performance of the public health sector in Aceh. The section on policy implication, explains how to manage 3 types of inputs (doctor, nurse and public health centre) for each district to obtain efficiency. There are 6 regions or districts in Aceh province that are already classified as efficient (district written in bold): Aceh Tenggara, Aceh Barat, Banda Aceh, Sabang, Lhokseumawe and Subulussalam. We can see from the table that all 6 districts do not have to increase or decrease the input variable. Meanwhile, there are 17 areas in Aceh that still need to manage the inputs. For example, Langsa needs to improve its performance by reducing the number of nurses by 221 people and the number of doctors by 41 people to achieve efficiency. Slightly different from Langsa that

needs to improve its performance in two inputs, Pidie and Gayo Lues only need to reduce the number of nurses by 89 and 48 people, respectively.

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