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Efficiency Analysis of Health Sector Expenditure Allocation in 2020 (Case Study in Purwomanggung Area)

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Abstract : *This study aims to analyze the level of efficiency of local government health sector sending during the Covid-19 pandemic and productivity in the health sector. The measurement of efficiency and productivity values was obtained using the Data Envelopment Analysis (DEA) and Malmquist Productivity Index (MPI) analysis methods. The assumptions used are Variable return to scale (VRTS) and output oriented. The results of the study indicate that there is 1 district/city in the Purwomanggung area that is not yet efficient, both technically cost and technically the health system. The total factor productivity change indicates that in MPI 1 there are 3 district/cities in the Purwomanggung area that have experienced close shifts in both the production frontier and efficiency frontier and in MPI 2 there is 1 district/city that are close to both the production frontier and the efficiency frontier.*

Keywords : *Covid-19, Health Sector Expenditure, Data Envelopment Analysis (DEA), Malmquist Productivity Index (MPI), Technical Efficiency, Purwomanggung.*

I. INTRODUCTION

Health has an important role in creating quality human resources. Todaro & Stephen C (2006) argue that health can be seen as a vital component of growth and development. One of the factors that influence the high and low level of health is how much financing is used for the health sector (Sujudi, 2003). A health system will be economically viable when providing appropriate and relevant services (Adabavazeh et al., 2020). Therefore, increasing productivity and optimal resource allocation, improving the quality of health services, controlling efficient health costs, and considering the right policies are very important in dealing the Covid-19 pandemic. One of the policies related to handling Covid-19 is the provision of access to health services which is encouraged through government spending in the health sector (Sueyoshi et al., 2021). The larger of spending allocation in health sector that spent by the government, then the better achievement of the level of public health. One of the indicators of public health level is indicated by life expectancy (UHH).

Purwomanggung area is one of the strategic areas that has a low level of performance in the health sector because it still has not reached the target and is below 100%, where the minimum service standard (SPM) indicators in the health sector that have reached the target are only a small part which is not in accordance with the amount of local government spending used for health expenditure. This indicates that the implementation of health services in the Purwomanggung area is still not carried out properly if referring to the government policy regarding minimum service standard in the health sector in Indonesia (Permenkes No. 74 Th 2008), in accordance with the minimum service standard technical guidelines, there are 18 indicators that must be achieved. The increase of UHH in the Purwomanggung has a very small growth trend. Positive cases of Covid-19 and patients who have been declared dead due to Covid-18 are also quite a lot in Purwomanggung. This indicates that the amount of government spending used for health sector and handling Covid-19 has not created a better public health level in the Purwomanggung area, or indicates an inefficiency in local government spending on the health sector in the Purwomanggung area. This study aims to determine the technical efficiency value of health spending costs and the value of technical efficiency of the health service system in the Purwomanggung are and to determine the target of improving the use of inefficient district/city heath spending costs in order to achieve an efficiency.

II. LITERATURE REVIEW

Government spending reflects the policies implemented by the government. If the government has established a policy to purchase goods and services, government spending reflects the costs that must be incurred by the government to implement the policy. Health plays an important role in creating quality human resources. Todaro & Stephen C (2006) argue that health can be seen as one of the vital components of growth and development. In the Health sector, it is necessary to measure health outcomes both in terms of physical and health values. This is to evaluate its economic efficiency. The results of this health measurement are manifested in the health status to be achieved.

Measuring efficiency can be seen through two sides, namely the costs incurred per unit of product (input to output) or the product produced per unit of resource (output to input). Efficiency measurement is carried out using a comparison between the output produced to the input used (Mardiasmo, 2012). The larger of output produced from the input used, the higher level of efficiency. An operational activity can be said to be efficient if the results of its work can be achieved by using the lowest resources and funds (spending well).

Research conducted by Faslan Syam Sajiah (2019), measured public sector efficiency using technical efficiency measurements, where the efficiency value is measured using a number of inputs which then produce a certain number of outputs. Furthermore, technical efficiency can be divided into 3, namely cost technical efficiency, system technical efficiency, dan overall efficiency. Technical efficiency of costs is the measurement of the level of use of economic advice or a number of inputs in the form of the amount of nominal value of health expenditures issued by the government to produce a number of output indicators of intermediate results consisting of facilities and health services. An efficient condition will be achieved when a nominal amount of health work used in a certain number of health services can provide output in the form of maximum health facilities and services. Efficient conditions will be achieved when a nominal amount of health expenditure used in a certain amount can produce output in the form of maximum health facilities and services. Efficient conditions will be achieved if the amount of health spending with a certain amount can produce an optimal level of public health.

Banker et al., (1984) introduces a non-parametric method for measuring technical efficiency using Data Envelopment Analysis (DEA) which had previously been developed by Charnes et al., (1978). Data Envelopment Analysis is a method used to evaluate the level of efficiency of a work unit with multiple output and multiple input variables through a linear programming approach. The DEA works by identifying the units to be evaluated, the inputs and outputs of a particular unit. Then the calculation of the productivity values is carried out and identifies which units do not use the input efficiently or do not produce outputs effectively.

III. RESEARCH METHOD

The analytical methods used in this research are Data Envelopment Analysis (DEA) and Malmquist Productivity Index (MPI). The selection of this analytical method is based on the consideration that DEA analysis is able to measure the relative efficiency of a unit economic activity (UKE) in conditions of many inputs and many outputs (multi-input and mulit-output. Meanwhile, MPI is used to analyze changes in productivity in the health sector.

Data Envelopment Analysis (DEA)

In measuring efficiency, it is basically the ratio between input and output, with the following formula :

Efficiency = $\frac{number\ of\ weighted\ outputs}{number\ of\ weighted\ inputs}$ ..... (1)

Furthermore, the measurement of efficiency involving inputs and outputs with relative efficiency measurements are weighted as follows :

Efficiency of unit j = $\frac{u_1 y_{1k} + u_2 y_{2k} + \cdots}{v_1 x_{1k} + v_2 x_{2k} + \cdots}$ .....(2)

However, this measurement still has limitations in the form of difficulty in determining balanced weights for inputs and outputs. Thus, DEA assumes that each UKE will choose the weight that maximizes its efficiency ratio (maximize total weighted output/total weighted input). To calculate efficiency, linear programming is used as follows :

Maximize $Z_k = \sum_{r=1}^{s} U_{rk} Y_{rk}$ ..... (3)

With constraint :

$\sum_{r=1}^{s} U_{rk} Y_{rk} - \sum_{i=1}^{m} V_{ik} X_{ik} \leq 0; k = 1,2, \ldots, n, \ldots$ ……..(4)

$\sum_{i=1}^{m} V_{ik} X_{ik} = 1$……..(5)

$U_{rk} \geq 0 ; r = 1,2, \ldots, s, \ldots$ …… (6)

$V_{ik} \geq 0 ; i = 1,2, \ldots, m, \ldots$ ……(7)

Explanation :

Z_k = Observed districts/cities

K = Districts/cities assesses in the analysis

Y_{rk} = Number of outputs r produces by UKE k

X_{ik} = Number of inputs I used UKE k

s = The number of outputs produced (service, health facilities, health level)

m = The number of inputs used (health spending)

U_{rk} = The weighted weight of the output r produced by each UKE k

V_{ik} = The weighted weight of the inputs I produced by each UKE k

DEA have several managerial values. First, DEA generates efficiency for each UKE, relative to the other UKEs in the sample. This efficiency number allows an analyst to identify the UKEs that need the most attention and plan corrective actions for those that are not/less efficient.

Malmquist Productivity Index (MPI)

Gaspersz, (2020) argue that productivity is defined as the ratio of the amount produce (output) of a unit of productive activity to the total number of resources (input) used be the unit. The input costs include all costs. For example, the cost of production and equipment. While the output can consist of sales, revenue, *market share*. Productivity is a combination of effectiveness and efficiency. Effectiveness is related to the expected output according to the target. While the efficiency of the use of resources to a minimum with maximum results, so that productivity can be formulated.

According to Coelli (1996) statement the value of productivity is determined from the value of Total Factor Productivity Change (TFPCh) with the assumption that the value is more than one comma (>1,). Moreover, TFPCh is influenced by Efficiency Change (EFFCh) and Technology Change (TECHCh). EFFCh means the change in efficiency of the entire average year of the period under test. TECHCh means technological factors that can change productivity levels. This technological factor is always related to the addition of technological inputs so that the average productivity value can increase. The results of the TECHCh are a general description that there is a need to improve technology as much as 0, because the number of productivity is 1, the a value that is more than 1 is the amount that needs to be increased. The value of EFFCh is always below zero comma (0,), because the maximum efficiency value is at number 1.

IV. RESULT AND ANALYSIS

A. Description of Research Object

Operational definitions are used to provide scope limitations or affirmations regarding the variables used in the study. Moreover, operational definitions are used to prevent differences in understanding. The operational definition used in this study is:

Input Variable

Local Government Expenditure in Health Sector

Is the amount of local government expenditure in the field of health in districts/cities that have been realized in 2020. The unit used is million rupiah.

Number of Health Workers

It is the number of health workers (doctors and nurses) in hospitals and health centers in districts/cities in 2020.

Amount of Funds for Covid-19

This is the amount of local government expenditure used for social assistance for people affected by Covid-19. The unit used is million rupiah.

Output Intermediate Variable

Ratio The Numbers of Health Centers per 100.000 Population

The number of health centers per 100.000 population is one of the indicators used to determine the affordability of the population to health facilities and services in the form of health centers in an area (Dinas Kesehatan Provinsi Jawa Tengah, 2021). Variables of the number of health centers used include the number of health centers, inpatient health centers, supporting health centers, and mobile health centers. The calculation of this indicator is obtained through the formula:

$$\frac{\text{The number of health centers in a certain area in one year}}{\text{The number of people in an area in the same period of time}} x\ 100.000$$

Ratio The Number of Hospital Beds per 100.000 population

It is an indicator that describes the health service facilities provided by the government in government-owned hospitals in a given year (Jafarov & Gunnarsson, 2008). The indicator calculation is obtained through the formula:

$$\frac{\text{The number of beds available in a hospital in a given area in a year}}{\text{The number of people in an area in the same period of time}} x\ 100.000$$

Output Variable

Number of Confirm Patients Recovered from Covid-19

Based on Decree of the Minister of Health (KMK) Number HK.01.07/Menkes/413/2020, the patient's condition is declared cured if it has met the criteria for completing isolation and receiving a statement letter after monitoring. This definition of cures applies to confirmed asymptomatic patients, mild symptoms, moderate symptoms, and severe/critical symptoms. The unit used is people (Keputusan Menteri Indonesia, 2020).

Number of confirmed patients who died from COVID-19

Death from COVID-19 is defined for surveillance purposes as death from a clinically compatible (matched) disease in a probable or confirmed case of COVID-19, unless there is a clear alternative cause of death that cannot be attributed to COVID disease (eg trauma). There should be no period of complete recovery between the period of illness and the time of death (World Health Organization, 2021). The unit used is person.

Life Expectancy (UHH)

UHH is the average years of life that will still be lived by someone who has managed to reach age x, in a certain year, in a mortality situation that applies in his community (Badan Pusat Statistik Jawa Tengah, 2020). The unit used is year.

B. Result and Analysis

Technical Efficiency Analysis of Health Costs

The score of the technical efficiency of health costs in the Purwomanggung area is obtained by using the input variables and output intermediate variables. This intermediate output variable reflects how much the local government in the Purwomanggung area is trying to provide adequate health facilities for its people. The value of cost technical is used to see how far the level of efficiency in the use of inputs in the form of health expenditures issued by each local government in the Purwomanggung are to produce basic health facilities and services in order to achieve public health status. The following is the result of the technical efficiency value of health costs in the Purwomanggung area.

Table 1. Score of Health Costs Technical Efficiency in Purwomanggung 2020

Unit name	Score	Efficient	Condition
Kab. Purworejo	100,0%	True	Green
Kab. Wonosobo	100,0%	True	Green
Kab. Magelang	68,5%	False	Red
Kota. Magelang	100,0%	True	Green
Kab. Temanggung	100,0%	True	Green
Rata-rata	93,7%		

Based on the results of analysis using DEA method during Covid-19 pandemic in 2020, it shows empirical result about technical efficiency of local government health costs in the Purwomanggung area. The result of technical efficiency for health cost in Purwomanggung area show that there is 1 regency with the red conditions or can be interpreted as very inefficient, namely Magelang Regency. This inefficiency is due to the use of too many inputs, especially in the input of health spending and Covid-19 funds, but it is not balanced with optimal output. This indicates that in the area there is still a phenomenon of wasting health spending that is too large but not followed by the provision of basic health facilities and facilities for the community. Districts tha can be used as benchmarks are Magelang City and Wonosobo Regency with lambda score are 0,574 and 0,025 respectively. The lambda score can be used by the inefficiency area as a reference in maximizing output and minimizing input. The largest lambda value or close to 1, indicates that there is a strong relationship between DMU.

Purworejo Regency, Wonosobo Regency, Magelang City and Temanggung Regency which have a technical cost efficiency score of 100%, indicating that these regions are efficient in using a number of input costs that are spent by the government in health sector during the Covid-19 emergency, especially those allocated for provision output of basic health facilities and services. In other words, each additional input I the form of costs used to finance health spending has resulted in an additional number of outputs of the same amount.

Technical Efficiency Analysis of Health Service System

The value of technical efficiency in health system is obtained by entering the input in the form of intermediate output variables. The outputs that are compared to produce the score of technical efficiency in health system are epidemiological indicators and indicators of public health status in form of the number of confirm patients recovering from Covid-19, the number of confirmed patients dying from Covid-19, and life expectancy. The value of technical efficiency in health system describes the level of efficiency of the local government in Purwomanggung area in seeking basic health facilities and services in form the number of health centers available in each district/city, as well as bed facilities available in government-owed hospitals. Assuming that the amount of input of health facilities and services sought by the local government is able to produce a number of public health level of different quantity (not constant). The following is the result of technical efficiency of health service system in Purwomanggung area

Table 2. Score of Health Service System Technical Efficiency

Unit name	Score	Efficient	Condition
Kab. Purworejo	99,4%	False	Amber
Kab. Wonosobo	100,0%	True	Green
Kab. Magelang	100,0%	True	Green
Kota. Magelang	100,0%	True	Green
Kab. Temanggung	100,0%	True	Green
Rata-rata	99,88%		

Based on the result of the table above, it can be concluded that the empirical result regarding the technical efficiency of local government health spending system in the Purwomanggung area in 2020. The result of the calculation indicated that there are districts that have not yet reached an efficient condition, namely Purworejo Regency, which empirically the area is classified as an inefficient area in technical system. This inefficiency is because the output produced is not optimal with a number of inputs used. This indicates that the policy of increasing the number of facilities and service in inefficient areas if not followed by an improvement in the health system will have a negative impact on the achievement of public health status. Areas that can be used as benchmarks are Temanggung Regency, Magelang Regency, and Magelang City with each lambda score are 0,656, 0,289, and 0,055.

Reviewed from the achievement of the average score of technical efficiency of the system during the research period, it was found that the results were slightly different from the achievement od costs technical efficiency. Based on the results from DEA calculation, empirical results are obtained in the form of achieving a system technical efficiency condition that is much better than the costs technical efficiency condition.

Wonosobo Regency, Magelang Regency, Magelang City and Temanggung Regency which have achieved system technical efficiency of 100% indicate that empirically these areas belong to the efficient category in using optimal public health basic facilities and services.

Target for Improvement of Input and Output Variables to Achieve Efficient Conditions

The advantage of the analysis of efficiency calculations using the DEA method is that it is able to create scenarios for improving inputs and outputs that should be used by UKEs that have not yet reached efficient conditions through the identification of too many inputs or too low outputs. Following are the results of the scenario of improving input and output variables to improve the efficiency level of regions that are not yet efficient.

Table 3. Target for Improvement of Input Output Variables in Achieving Technical Efficiency in Cost and Technical Expenditure System for Health Sector which is not yet Efficient in 2020

District/City	Input / output name	Value	Target	Potential Improvement
Magelang Regency	Cost Technical Efficiency			
	Health Center Ratio	2,23	3,26	46,09%
	Bed Ratio	27,69	472,43	1.606,13%
	Government Expendit	370294261929	296.574.988.887,11	-19,91%
	Health Workers	1774	1.774,00	0,00%
	Covid19 Fund	62788537180	51.164.900.633,56	-18,51%
	System Technical Efficiency			
	Covid19 recovered patient	4408	4.408,00	0,00%
	Covid19 patient dies	67	67,00	0,00%
	UHH	74	74,00	0,00%
	Health Center Ratio	2,23	2,23	0,00%
	Bed Ratio	27,69	27,69	0,00%
District/City	**Input / output name**	**Value**	**Target**	**Potential Improvement**
Kabupaten Purworejo	Cost Technical Efficiency			
	Health Center Ratio	3,5	3,50	0,00%
	Bed Ratio	130,92	130,92	0,00%
	Government Expendit	459027275863	459.027.275.863,00	0,00%
	Health Workers	2028	2.028,00	0,00%
	Covid19 Fund	14356742092	14.356.742.092,00	0,00%
	System Technical Efficiency			
	Covid19 recovered patient	1703	1.707,16	0,24%
	Covid19 patient dies	75	75	0,00%
	UHH	75	75,18	0,24%
	Health Center Ratio	3,5	3,5	0,00%
	Bed Ratio	130,92	130,92	0,00%

Based on further calculations regarding the targets that must be achieved by regions that are not yet efficient both technically in terms of allocation and technical systems in health spending as summarized in the table above, regarding the condition of technical efficiency for allocations and system that occur in districts/cities in Purwomanggung area. Regions that have achieved ideal efficiency conditions in spending the health sector are regions that both technically cost and technically the system has manged to achieve a score of 100% as has been achieved by Wonosobo Regency, Magelang City, and Temanggung Regency.

Districts that are technically cost efficient are not necessarily also technically efficient systems. This happened in Magelang Regency and Purworejo Regency. Magelang Regency can achieve perfect efficiency conditions in technically system with an efficiency score of 100%, but technically Health costs are far below the efficient condition with an efficiency score of 68.5%. Based on these results, in this case the regional government of Magelang Regency can evaluate health spending policies during the Covid-19 pandemic regarding the efficiency achievement that occurred. If the Health spending policy making is more oriented towards achieving technical cost efficiency, then the policy steps that can be taken are to reduce the amount of Health expenditure allocation by 19.91% of the current total value of Rp. 370,294,261,929 to Rp. 296,574,988,887.11 and suppressed the amount of Covid-19 fund allocation by 18.51% of the current total value of Rp. 62,788,537,180 to Rp. 51.164.900.633.56. Furthermore, the government must increase the output target of health facilities and services in form of a ratio of the number health centers by 46,09% from the total values ratio of 2,23 to 3,36 or equivalent to increasing the number of health centers from the total value of 29 units to 43 units of health centers. The government must also increase the ratio of the number of beds available in hospitals by 1606.13% from the total value ratio of 27.69 to 472.43 or equivalent to increasing the number of beds in hospitals from the total value of 360 beds to around 6145 beds. However, if the Magelang Regency Government is more oriented towards achieving system technical efficiency, then the policies taken during the Covid-19 pandemic are appropriate and there is no need to change the number of targets both in terms of input and output.

As for Purworejo Regency, if viewed from the technical system, the policy that can be carried out by the Purworejo district government is to provide better basic health services, especially for Covid-19 patients so that more patients exposed to the virus can recover. Moreover, the government of Purworejo Regency should try to increase the achievement of life expectancy by 0.24%.

Malmquist Index Productivity (MPI)

The calculation of the Malmquist index is able to provide an interpretation during the period being tested and provide an average interpretation of the period being tested.

Table 4. Productivity Result

MPI 1 (variabel input & output intermediate tanpa variabel covid-19)					
DMU	**EFFch**	**TECHch**	**PEch**	**sech**	**TFPch**
1	2.297	1.054	2.205	1.042	2.412
2	0.811	0.366	1.000	0.811	0.297
3	2.184	1.074	1.000	2.184	2.345
4	1.000	0.924	1.000	1.000	0.924
5	1.064	1.001	1.000	1.064	1.065
Mean	1.315	0.835	1.184	1.111	1.021
MPI 2 (variabel output intermediate & variabel output tanpa variabel covid-19)					
DMU	**EFFch**	**TECHch**	**PEch**	**Sech**	**TFPch**
1	0.674	0.589	1.000	0.674	0.397
2	2.150	0.803	1.045	2.057	1.726
3	1.000	0.899	1.000	1.000	0.899
4	1.093	0.907	1.000	1.093	0.992
5	1.719	0.579	1.000	1.719	0.996
Mean	1.222	0.741	1.009	1.211	0.906

The result from the Technical Efficiency Change (Eff Ch) for 5 dmu show that in MPI 1, there are 3 dmu which have increased efficiency (Eff Ch >1), 1 dmu decreased efficiency (Eff Ch <1). There is only 1 dmu does not shift or stagnate. In MPI 2 results, there are 3 dmu which have increased efficiency, 1 dmu has decreased efficiency and 1 dmu which is stagnant. This shows that 60% of the dmu samples in 2019 to 2020 in the results of MPI 1 and MPI 2 experienced a position shift towards being closer to the efficiency frontier and the rest did not shift from their original position or even experienced a shift away from the efficiency frontier.

The calculation of Technological Efficiency (Tech Ch) of 5 dmu shows that in the results of MPI 1 there are 3 dmu that experience a shift towards the production frontier (Tech Ch > 1) and the remaining 2 dmu experience a shift away from the production frontier (Tech Ch < 1), while the results MPI 2 of all dmu experienced a shift away from the production frontier during these 2 periods (Tech Ch < 1).

Calculation of Total Productivity Change (Tfp Ch) for 5 du shows that in MPI 1 results, there are 3 dmu that shifted towards the production frontier and efficiency frontier (Tfp Ch>1) and 2 dmu experienced a shift away from the production frontier of efficiency frontier for 2 periods (Tfp Ch<1) includes 1 dmu which stagnates in efficieny frontier shift. Meanwhile, in MPI 2 results, there is only 1 dmu that experiences a shift towards the production frontier and efficiency frontier, and the remaining 4 dmu shifts away from the production or efficiency frontier, including 1 dmu which stagnates in efficiency shifts. The result of the calculation of Total Productivity Change is a multiplication between Efficiency Change and Technological Change so if a dmu experiences a shift away from its frontier on one of the frontiers (efficiency and/or production) then the overall dmu becomes unproductive.

Annual average result in 2019/2020 from MPI 1 show productivity changes for technical efficiency (Eff Ch) is 1,315 which is higher than the technological change (Tech Ch) that is 0,835 and total factor productivity change (Tfp Ch) is 1,021. Meanwhile, the results of MPI 2 show that the change in productivity for technical efficiency (Eff Ch) is 1,222 which is greater than the change in technology (Tech Ch) that is 0,741 and the total factor productivity change (Tfp Ch) is 0,906. So that changes in productivity in both MPI1 and MPI 2 are dominated by changes in technical efficiency rather than changes in technology (Eff Ch > Tech Ch).

V. CONCLUSION

From the results of the analysis of the efficiency of health spending in the Purwomanggung area, it can be conclude that in the area there is 1 district whose technical efficiency value of health costs has not yet reached 100%, namely Magelang regency with an efficiency score of 68,5%. This reflects if the area has not been able to optimally allocate health expenditures budgeted by the government or it can be said if there has been a waste of too large health expenditure costs but is not followed by an increase in basic health facilities and services needed by the community to achieve optimal health level. While technically the health service system, the district that has not reached 100% efficiency is Purworejo Regency, this indicates that the policy of increasing the number of health facilities and services in inefficient areas if not followed by an improvement in the health system will have a negative impact on the achievement of public health status.

The value of the Malmquist index in measuring the level of productivity is seen from the Tfp Ch value. The results of MPI 1 as a whole show that the productivity value has mostly increased. Purworejo Regency is in the top rank in obtaining the average productivity score, followed by Magelang Regency and Temanggung Regency. While in MPI 2 the overall value of productivity did not increase. Only Wonosobo Regency experienced an increase in productivity value.

For the average value of technical efficiency (Eff Ch) is greater than the value of technological change (Tech Ch) in both MPI1 and MPI 2. So that changes in productivity are dominated by changes in technical efficiency rather than changes in technology.

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