

TECHNICAL EFFICIENCY OF SECONDARY SCHOOLS IN MALAYSIA

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ABSTRACT

Background and Purpose: The purpose of this study is to investigate the level of technical efficiency of Malaysia's secondary education. Education efficiency has become an important issue since the education sector is the recipient of high priority budget allocation. An evaluation of whether the budget distribution for secondary education is technically efficient is necessary because secondary education represents almost 40% of the national education budget.

Methodology: The study applied the Data Envelopment Analysis (DEA) in examining the level of technical efficiency for a sample of 626 secondary schools from four selected states, namely, Selangor, Melaka, Kedah, and Terengganu. The sample was further split into schools from developed and less developed states, and urban and rural areas.

Findings: The results revealed that secondary schools in the four sample states were technically inefficient (almost 98%). Most schools were at a moderate level of technical efficiency (score range between 0.5-0.79). Interestingly, schools in rural areas and less-developed states showed better technical efficiency than those in urban areas and developed states. Given the government's total expenditure, academic achievement could be increased by almost 30 percent with an improvement in inefficiency.

Contributions: The study's fundamental implications are that inefficient secondary schools need to increase their efficiency by ensuring effective budget spending and adequate expenditure distribution monitoring. More schools need to be constructed or repaired, and old schools/buildings upgraded. The sector also needs to expedite compliance with the 17:1 student-teacher ratio set by the Education Ministry to improve teaching delivery quality.

Keywords: Data envelopment analysis, government spending, secondary school, student and teacher ratio, technical efficiency.

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1.0 INTRODUCTION

The education sector efficiency, especially secondary education, has been an important issue given that secondary education spends almost 40% of Malaysia's total budget allocated to the education sector for 2010-2014. In 2013, secondary schools spent RM12,709,998,930 (32.8%) from RM38,700,000,000, increased to RM15,917,587,279 (39.2%) from RM40,596,000,000 in 2014. The education sector always prioritizes the provision of government spending on an annual basis. As such, assessing whether the provision made for education is technically efficient is crucial for the policymakers in the education sector to strategize further development in teaching and learning.

Malaysian secondary schools' academic achievement is not in line with Malaysia's high expenditure on secondary education. For example, the Organisation for Economic Co-operation and Development (OECD) study in 2012 revealed that Programme for International Student Assessment (PISA), measures achievement in mathematics, science, and problem-solving for 15-year-old students, reported that Malaysian student achievement lagged far behind. Malaysia was ranked 52 out of 65 participating countries. Besides, students' achievement in the Malaysian Certificate of Education (MCE) showed a low level of 4.51-6.75 for the National Average Grade (NAG). This was categorized as 'Satisfactory' over a scale of 0 to 9, ranging from 'Excellent' (0.00 - 2.25), 'Good' (2.26-4.50) down to 'Potential' (6.76 - 9.00).

Secondary school efficiency is questioned given that Malaysia spent USD1,307 based on the purchasing power parity (PPP) compared with USD701 for Thailand, USD860 for Chile, and USD832 for Mexico (Education Development Plan for Malaysia 2013-2025). Despite the

relatively high expenditure, Malaysia's achievements were about the same as these countries. The academic standard appeared to be incommensurate with high spending. In cognizance of this large disparity, a study on the level of technical efficiency of secondary schools in the country will be conducted to quantify it and suggest improvements.

The low-level achievement of secondary school students in Malaysia could be attributed to several factors. A high student-teacher ratio could be the main reason. Data shows that most secondary schools in Malaysia have a sizeable student-teacher ratio of more than 17:1. Besides, the enormous government spending on secondary schools is also an important determinant. It is thus crucial to measure technical efficiency to formulate solutions to improve educational efficiency and attainment. For example, Tsakiridou and Konstantinos (2013) suggested that the socioeconomic status of the family, school area, and school innovations are positively related to educational efficiency. In contrast, Scippacercola and Ambra (2014) showed that the number of students per class and teachers' qualification has a significant impact on their achievement.

A study on secondary school efficiency will benefit policymakers in the following ways: First, they would assist policymaking in the Ministry of Education, State Education Department, and at the school level through current information on the level of technical efficiency for individual schools. Inefficient schools can thus improve their academic achievement through the existing inputs. Second, the State Education Department could focus on schools that have achieved a minimum level of technical efficiency in the distribution of government spending. Such expenditure distribution can better be monitored, allocation made more efficient, and leakage prevented or minimized. Third, schools with low technical efficiency can improve their academic achievement by using existing inputs. And fourth, the efficiency measures resulting from this study will be an improvement over the use of MCE results as in past assessments (Podinovski, Ismail, Bouzdine-Chameeva, & Zhang, 2014). Furthermore, the MCE results reflect Malaysia's actual examination situation compared to previous studies that used international examination results such as Trends in International Mathematics and Science Study (TIMSS) (Nahar & Arshad, 2014). Additionally, the study will also provide continuity on previous studies in measuring school efficiency between developed and less developed states and between urban and rural schools.

This study addresses the following questions: How efficient is the secondary schools' in Malaysia? How efficient are secondary schools in developed and less developed states? To what extent is the efficiency of secondary schools in urban and rural areas different? What are

the efficiency gaps between secondary schools? Using Data Envelopment Analysis (DEA), this study analyzed the technical efficiency of Malaysian secondary schools.

2.0 LITERATURE REVIEW

Efficiency is defined as the deviation from the frontier representing the maximum output attainable from each input level (Lavado & Cabanda 2009). It is fundamentally a comparison between inputs used and attained outputs. In education, performance measurement in terms of efficiency is defined as total weighted output divided by total weighted input. Measuring the efficiency of public secondary schools is not an easy task. The researchers' common challenges are a public secondary school's characteristics, basically, a non-profit organization, which typically have simultaneous production of multiple outputs, using a variety of inputs, and lacking price information (Johnes, 2006). This diversification of inputs and outputs has led to no commonly accepted measurements of efficiency. In Malaysia, difficulties in collecting input and output information are the added barriers in measuring public secondary school's efficiency. Thus, it is not surprising that there is limited public secondary school studies' efficiency to our knowledge. To date, such efficiency studies in Malaysia included those by Nahar and Arshad (2014), Podinovski et al. (2014), and Arshad (2013). None of these has compared the developed and the less developed states' efficiency and between the urban and rural schools.

However, the literature has recorded numerous empirical studies on the measurement of efficiency in primary and secondary schools in developed and developing countries, but research in Malaysia is relatively rare. Examples of past studies have been cited for Indonesia (Simamora, Abbas, Kanwal, & Kuncoro, 2019; Akbar, 2018), Italy (Scippacercola & Ambra, 2014), Europe (Prior, 2013; Aristovnik & Obadić, 2014), Greece (Tsakiridou & Konstantinos, 2013), OECD (Crespo-Cebada, Pedraja-Chaparro, & Santín, 2014), and the United Arab Emirates (Badri, Mohaidat, & El Mourad, 2014).

Two approaches have dominated measurement of secondary education efficiency; namely, Data Envelopment Analysis (DEA) (Johnes & Virmani, 2020; Akbar, 2018; Xu & Liu, 2017; Haelermans & Ruggiero, 2017; Johnson & Ruggiero, 2014) and the Stochastic Frontier Analysis (SFA) (Scippacercola & Ambra, 2014; Muvawala & Hisali, 2012). The DEA and SFA are both measures of limitation, with DEA using a non-parametric approach and the SFA using the parametric approach. Based on the literature, many of these studies dealt with technical efficiency measures, especially in education, closely related to primary school, secondary school, and tertiary education.

DEA models have been used to assess school performance and efficiency in many countries. The study by Yahia and Essid (2019) showed that almost 96.5% of Tunisian schools were inefficient, and on average, these schools could have improved their results by 27% using the same resources. Nauzeer, Jaunky, and Ramesh (2018), who measured the efficiency level of 141 Mauritian colleges on a scale of 0.000 to 1.000 showed the average score of 0.872 for Constant Return to Scale (CRS) and 0.909 for Variable Return to Scale (VRS). Johnes (2015) provided an overview of the use of operational research (OR) in education. The author also presented a survey on the government's problems, managers and consumers of education, and the OR techniques applied to improve operations and provide solutions. De Witte and López-Torres (2017) provided an extensive overview of the literature on efficiency in education. They summarized the papers on education with the different methodologies applied, the inputs, outputs, and contextual variables used and data sources. An earlier study by Stergiou (2013) measured the efficiency level of primary school education in Greece using DEA to assume that schools aim to maximize students' educational attainments under a budget constraint. He recorded an average efficiency of 76.26%, ranging from 40.4% to 100%.

Some studies investigated the relationship between educational achievement and inputs, such as student-teacher ratio and government spending (Ajani & Akinyele, 2014; Badri et al., 2014; Nahar & Arshad, 2014; Agasisti, 2013; Stergiou, 2013; Muvawala & Hisali, 2012). There is a growing consensus in the literature that a higher student-teacher ratio is preferred since it improves student performance and educational attainment. Other academic inputs considered as vital, such as expenses per student, have been incorporated in several studies, including Akbar (2018), Badri et al. (2014), Nahar and Arshad (2014), Prior (2013), Rialp and Prior (2014) and Agasisti (2014).

Studies on the measurement of secondary education efficiency, using various variables as outputs, have also been recorded. Among these are student achievement, such as test scores, as reported in Grosskopf, Hayes, and Taylor (2014). Podinovski et al. (2014) used the MCE examination results in their study in Malaysia. Nahar and Arshad (2014) used the results of the Trends in International Mathematics and Science Study (TIMSS) examination for their study, which covered the Organisation of Islamic Cooperation (OIC) countries. Similarly, Agasisti (2014) used examination results in his analysis of 20 European Union countries. Other variables, such as the passing percentage/number of graduates, have also been used as the output to the study by Aristovnik and Obadić (2014) on selected European Union (EU) and Organisation for Economic Co-operation and Development (OECD) countries. Also, the

number of students has also been used as a variable in Hussain, Mehmood, Siddique, and Afzal (2015).

The model that is said to be suitable for service-based and non-profit secondary schools is output-oriented. This output orientation explains that the achievement or output must be maximized with the amount of input given. This model is used when management or policymakers aim to increase productivity for secondary schools without increasing input levels. Some of the efficiency studies of output-oriented techniques include Stergiou (2013) and Agasisti (2014).

In the Malaysian context, the issue of secondary school efficiency has not been sufficiently studied. An example of such a study was conducted by Nahar and Arshad (2014), which involved 40 countries using the TIMSS exam results in 2011. The results revealed that of the 16 nations selected for study from the OIC, including Malaysia, none were efficient in using learning resources than non-OIC countries. In this study, the MCE results were used for Malaysia. Another study on Malaysia involved 221 schools in Kedah, Penang, and Perlis, using the DEA method (Podinovski et al., 2014). The study was conducted to fill the gap between past research concerning variable inputs that included input per-pupil operating expenses and student-teacher ratios. It also took into consideration the need for larger sample size and the economic status between developed and less developed states and urban and rural schools.

3.0 RESEARCH DESIGN

3.2 Data

This study used a secondary panel data set of 626 secondary schools for the year 2010-2014. It categorized the states in Malaysia based on the Composite Development Index, which comprised the Economic Development Index and the Social Development Index (Economic Planning Unit, 2006). The status for developed and less developed states were based on gross domestic product per capita. Only two states represented the developed states (Selangor and Melaka), while two other states represented the less developed ones (Kedah and Terengganu).

This study employed the DEA technique output orientation, assuming Variable Return to Scale (VRS) (Banker, Charnes, & Cooper 1984). The output variable was the School Average Grade (SAG) sourced from MCE results. The input used was per-pupil operating expenses and student-teacher ratios. Table 1 provides definitions of the output and input variables used in the study.

Table 1: Output and input variables

Output/Input	Description
<u>Output</u>	
School Average Grade (SAG)	The average results of all the subjects taken in the Malaysian Certificate of Education (MCE). SAG has a scale between 0 to 9, where score 1 represents the best achievement. There are four grade categories, namely Excellent (0.00 - 2.25), Good (2.26 - 4.50), Satisfying (4.51 - 6.75), and Potential (6.76 - 9.00).
<u>Input</u>	
Per-pupil operating expenses (Exp)	The flow of per-pupil operating expenses involved as government spending in each school $Exp = \frac{\text{Operating expenses}}{\text{Number of students}}$ The number of students per teacher in a class.
Student-teacher ratios (Str)	

3.2 Data Envelopment Analysis

The DEA established by Farrell (1957), is a non-parametric linear programming technique that evaluates a set of comparable entities' relative efficiency by some specific mathematical programming models. These entities are often called decision-making units (DMUs), using multiple inputs to obtain various output levels. The good production function is generated through a set of DMUs that produce the maximum output for a given level of input compared to other DMUs. The relative portion of the efficiency measure is one unit used compared to other units. For each DMU, the DEA efficiency score is generated by comparing the other DMU's inefficiencies with the production frontier. An efficient DMU will form the frontier efficiency score as one, while a DMU that does not form a frontier will approach efficiency with less than one. The DEA method is increasingly important as a tool for assessing an organization's efficiency and performance.

Given the above, the DEA method is more frequently used in efficiency measurement. This option is due to its advantages since it does not require assumptions on the form of function. It evaluates the maximum performance of each DMU and allows for revenue generation. The endogeneity is not an issue in DEA because frontier's shape depends only on

individual observations, not on any assumed functional form. The DEA may also provide suggestions on improving less inefficient DMUs towards greater efficiency through slack adjustments.

The DEA has several limitations since it is based on several simplifying assumptions that need to be acknowledged when interpreting the results. The DEA results are particularly sensitive to measurement errors. An understated input or overstated output may produce outlier results and distort the frontier, thus reducing neighboring units' efficiency score. The DEA scores are also sensitive to input and output specification and the size of the samples. For example, increasing the DMU sample size reduces the average efficiency score, which may artificially inflate the efficiency scores.

In measuring relative efficiency, a benchmark DMU (i.e., for schools) is used to evaluate other schools' performance and position them relative to the frontier. The school that lies on the frontier is regarded as an efficient school as per the benchmark. In this study, schools' relative performance is assessed according to the distance between efficient and inefficient ones. The level of efficiency can be measured in two ways; output or input-oriented. Since the average student score's output will be maximized in this study, the output-oriented model will thus be adopted. The output-oriented measurements will indicate how the output (average student score) must be proportionally increased to achieve the frontier while keeping inputs constant.

The selection of a set of weights that combines multiple outputs and multiple inputs is at the forefront of DEA analysis. The DMUs are selected as follows: 1) Numerical data are available for each input and output, with data assumed to be positive for all DMUs. 2) The smaller input quantities are generally more preferable, while a larger output amount is also preferable, and as such, the efficiency score should reflect this principle. 3) The measurement units of the different inputs and outputs need to be congruent. For example, some of the inputs are in the number of teachers (in terms of number) or average secondary school expenses (in terms of Ringgit Malaysia). Simultaneously, the output can also be the average student score grade (in terms of the score, ranging from 0 to 9).

Assuming that n input items and m output items are selected, let the input and output data for DMU $_j$ be $(x_{1j}, x_{2j}, \dots, x_{nj})$ and $(y_{1j}, y_{2j}, \dots, y_{mj})$ respectively. The input data matrix X and output data matrix Y can be arranged as follows:

$$X = \begin{pmatrix} X_{11} & \cdots & X_{1n} \\ \vdots & \ddots & \vdots \\ X_{m1} & \cdots & X_{mn} \end{pmatrix} \quad (1)$$

$$Y = \begin{pmatrix} Y_{11} & \cdots & Y_{1n} \\ \vdots & \ddots & \vdots \\ Y_{m1} & \cdots & Y_{mn} \end{pmatrix} \quad (2)$$

Where X is an (n x n) matrix and Y an (m x n) matrix

DEA can be performed by linear programming techniques where each DMU endeavors to maximize the efficiency ratio (output to input) by selecting the best set of weights. Mathematically, in the case of multiple outputs and multiple inputs, the data is assumed to contain J DMU ($j = 1, \dots, J$). Each DMU j contains x_n inputs ($n = 1, \dots, N$) to produce the output y_m ($m = 1, \dots, M$). To measure basic productivity (productivity = output/input), the DEA ratio form can be described as $\sum_{m=1}^M u_m y_m / \sum_{n=1}^N v_n x_n$, where u_m is the output weight, and v_n is the input weight. The output and input weights are estimated to be the best for each DMU to maximize relative efficiency. Linear mathematical programming is employed to solve the optimal value of weight as:

$$\text{For every } j; \max_{u,v} \frac{\sum_{m=1}^M u_m y_{mj}}{\sum_{n=1}^N v_n x_{nj}} \quad (3)$$

$$\text{Subject to; } \frac{\sum_{m=1}^M u_m y_{mj}}{\sum_{n=1}^N v_n x_{nj}} \leq 1, \text{ for every } j = 1, \dots, J$$

$$u_m, v_n \geq 0, m=1, \dots, M; n=1, \dots, N$$

The values of u and v , the first constraint in the DMU's maximum efficiency value, are less than or equal to one (1), with 1 as the best score. The second constraint is to ensure that the inputs and outputs are not negative. The problem in equation (3) is that it has infinite solutions. If (u^*, v^*) is a solution, $(\alpha u^*, \alpha v^*)$ is also a solution (Coelli, 1996). This problem can be solved by adding another constraint, $\sum_{n=1}^N v_n x_{nj} = 1$, which is:

$$\text{For every } j, \max_{\mu, v} \sum_{m=1}^M \mu_m y_{mj} \tag{4}$$

Subject to:

$$\begin{aligned} \sum_{n=1}^N v_n x_{nj} &= 1 \\ \sum_{m=1}^M \mu_m y_{mj} - \sum_{n=1}^N v_n x_{nj} &\leq 0, \text{ for } j = 1, \dots, J \\ \mu_m, v_n &\geq 0 \end{aligned}$$

The changes of u and v to μ and v respectively result from a linear programming transformation from the multiplier's linear form (Coelli, 1996). The objective of equation (4) is to maximize the DMU output j depending on the constraint that the sum of the DMU input weights is equal to 1. Simultaneously, the objective function is to maintain a condition where the output weight does not exceed the input weight. The linear program in equation (4) is the output orientation under the assumption of constant returns on the scale (Constants Return to Scale- CRS).

DEA linear programming duality means that the maximum value of the objective function in the form of multiplier [such as equation (4)] can also be expressed as the minimum value of the objective function, also known as the envelope form as follows:

$$\begin{aligned} \text{For every } j, \min \theta_j, \lambda \theta_j \\ \tag{5} \end{aligned}$$

Subject to:

$$\begin{aligned} \sum_{j=1}^J \lambda_j y_{mj} &\geq 0, \text{ for } m=1, \dots, M \\ \theta_j x_{nj} - \sum_{j=1}^J \lambda_j y_{mj} &\geq 0, \text{ for } n=1, \dots, N \\ \lambda_1, \dots, \lambda_j &\geq 0, \end{aligned}$$

Where θ_j is the technical efficiency of the DMU j , and λ is the weight vector for each DMU. Equation (5) must be solved J times, once for each DMU in the sample. Each different set of λ is for every j in linear programming. Equation (5) is the input orientation for the DEA linear programming under CRS. By adding the constraint $\sum_{j=1}^J \lambda_j = 1$, equation (5), the linear programming under the CRS is now modified to the Variable Return to Scale (VRS) as follows:

$$\text{For every } j \sum_{m=1}^J \lambda_j y_{mj} \geq y_{mj}, \text{ for } m=1, \dots, M \quad (6)$$

Subject to:

$$\theta_j x_{nj} - \sum_{m=1}^J \lambda_j y_{mj} \geq 0, \text{ for } n=1, \dots, N$$

$$\sum_{j=1}^J \lambda_j = 1$$

$$\lambda_1, \dots, \lambda_j \geq 0,$$

Where the purpose of convex shape, according to Coelli, Rao, O'Donnell, and Battese (2005), is to indicate that the data distance in the envelope was much narrower than the concave form of the CRS and that the technical efficiency score was greater than or equal to that obtained in the CRS model. The wellness constraints also ensure that each DMU is simply benchmarked or compared to a DMU of the same scale. If the DMU_j is technically efficient (θ_j is equal to one (1)), the " λ_j " weight is one (1), while the λ weight for the other DMU is empty (0). In cases where DMU_j is inefficient, the λ weighting of any (or part) of the other DMUs must be positive - DMUs with high λ show a high position, such as DMU_j. The shape of the VRS DEA output orientation envelope can be shown as:

$$\text{For every } j, -\phi_j y_{mj} + \sum_{m=1}^J \lambda_j y_{mj} \geq 0, \text{ for } m=1, \dots, M \quad (7)$$

Subject to:

$$x_{nj} - \sum_{m=1}^J \lambda_j x_{mj} \geq 0, \text{ for } n=1, \dots, N$$

$$\sum_{j=1}^J \lambda_j = 1$$

$$\lambda_1, \dots, \lambda_j \geq 0$$

Where θ_j is the output weight for the DMU_j to be maximized, and λ is as described above. The value of θ_j is $1 \leq \theta_j < \infty$. The technical efficiency measurement for DMU_j is given by $1/\theta_j$ (Coelli, 1996). To maximize θ_j , the first constraint places the condition where each DMU's output weight must be less than or equal to the total output weight for all DMUs. The second constraint states that DMU_j input minus the amount of input for all DMUs must be greater or equal to zero. The third constraint requires that the sum of all other weights equal one (1), and the last constraint is to ensure that the λ value is not negative. The λ value can be used to calculate the input and output targets for a DMU_j as follows:

Output target $m : \lambda_1 y_{m1} + \dots \lambda_J y_{mJ}$, for $m=1, \dots, M$,

Input target $n : \lambda_1 x_{n1} + \dots \lambda_J x_{nJ}$, for $n=1, \dots, N$

(8)

Input and output targets can be used by DMU_j to improve efficiency. With the knowledge of how to calculate CRS and VRS technical efficiency, the calculation of scale efficiency can be described.

4.0 ANALYSIS AND DISCUSSION

In the first stage of analysis, the study aims to measure the overall efficiency regarding the average student score using a non-parametric measure of the DEA. There are two inputs; student-teacher ratio and per-pupil operating expenses (in terms of Ringgit Malaysia). Simultaneously, the output is the average student score, which reflects the school's academic achievement.

Table 2 shows the descriptive analysis of inputs and outputs used in this study based on 2950 observations. The median value of output is 5.21, with the minimum value 1.23, and the maximum value 7.49. It shows the best SAG at 1.23, and the worst 7.49, and the standard deviation of output 1.01. There are two inputs used, per-pupil operating expenses with a median value of 15.52, a minimum of 13.15, a maximum of 17.75, and a standard deviation of 0.60. The second inputs used were the student-teacher ratio (Str) with a median of 13.28, a minimum of 2.6. The grade of 21.1 shows the lowest Str is 3 students per teacher, and the highest is 21 students per teacher and a standard deviation of 2.659.

Table 2: Descriptive statistics of input and output variables

	Observation	Min	Standard deviation	Minimum	Maximum
Output					
SAG	2950	5.21	1.01	1.23	7.49
Input					
Per-pupil operating Expenses (Exp)	2950	15.52	0.60	13.15	17.75
Student-teacher ratio (Str)	2950	13.28	2.66	2.6	21.1

Table 3 shows secondary schools' technical efficiency in four selected states in Malaysia for 2010-2014. The output maximization model provides information as to what extent the average student score could be improved, given its inputs. The efficient school is regarded as achieving a higher average student score, given the low levels of inputs. Each efficiency value is restructured based on an efficient, high, medium, and low level. The efficiency at the low level was on a scale of ≤ 0.49 , medium (0.5-0.79), high (0.8-0.99), and efficient (1.00) (Sulaiman, Yusof, & Ismail, 2015). Overall, secondary schools in Malaysia are technically inefficient. These findings are in line with the results by Arshad (2013). In 2014 only 12 schools were technically efficient, and high-efficiency levels have shown improvement over the years. In comparison, schools with medium and low-level efficiency showed a declining percentage. For example, in 2014, only 73 schools were in the lower category compared to 82 schools in 2013. This shows that the level of efficiency in Malaysia as a whole is improving.

Table 3: Secondary school efficiency level

Level	2010	2011	2012	2013	2014
1	4 (0.64%)	8 (1.28%)	6 (0.96%)	7 (1.12%)	12 (1.92%)
0.8-0.99	49 (7.82%)	22 (3.51%)	161 (25.72%)	180 (28.75%)	222 (35.5%)
0.5-0.79	374	465	379 (60.5%)	357 (57.03%)	319 (50.96%)
≤ 0.49	(59.74%)	(74.28%)	80 (12.78%)	82 (13.10%)	73 (11.66%)
Total	199	131	626	626	626
	(31.79%)	(20.93%)			
	626	626			

Note: Low ≤ 0.49 , medium (0.5-0.79), high (0.8-0.99) and efficient (1.00)

Table 4 shows secondary schools' technical efficiency according to their location, either urban and rural areas, in Malaysia for 2010-2014. There were 398 schools in urban areas and 228 schools in rural areas. Urban secondary schools showed relatively lower efficiency levels compared to rural ones. In 2011 and 2012, there was only one (1) urban school at the highest efficiency level. In comparison, rural areas recorded 7 and 5 schools respectively, in the two years. Urban secondary schools had shown efficiency improvement at a high level from 20 in 2010 to 105 in 2014.

Similarly, rural schools' efficiency (high level) has increased from 29 schools in 2010 to 117 in 2014, thus indicating an academic improvement in the country. The moderate and low-level efficiency showed a declining number in both locations, with only 53 urban schools

and 20 rural schools in 2014. School academic achievement improved when the percentage of schools in the lower ranks decreases.

At the minimum efficiency level, urban schools showed lower efficiency than rural ones, especially for 2011, which recorded 11.8 percent compared to 19.5 percent in 2013. This indicates that rural schools are more efficient than urban schools. This result is in line with the study by Johnes and Virmani (2020), who found that rural schools often showed higher efficiency levels. Muvawala and Hisali (2012) also found urban schools to be technically inefficient than government-aided and rural schools. Conversely, Kantabutra (2009) found urban schools were also more efficient. Rural schools generally benefited from their closer ties with the local community. Their existence benefited the fragile local economy to the extent that their closure may affect the community (Barbara, Jerry, Craig, & Kent, 2002).

Table 4: The urban and rural schools efficiency score

Year	2010		2011		2012		2013		2014	
Efficiency level	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
1	2	2	1	7	1	5	0	7	6	6
0.8 -0.99	20	29	10	12	78	83	83	97	105	117
0.5 -0.79	295	175	281	184	260	119	252	105	234	85
≤ 0.49	81	21	106	25	59	21	63	19	53	20
Maximum	1	1	1	1	1	1	0.962	1	1	1
Minimum	0.14	0.21	0.11	0.20	0.14	0.20	0.16	0.20	0.21	0.23
Average	0.61	0.69	0.60	0.65	0.67	0.74	0.67	0.75	0.69	0.77
Sub total	398	228	398	228	398	228	398	228	398	228
TOTAL	626		626		626		626		626	

Note: Low ≤ 0.49, medium (0.5-0.79), high (0.8-0.99) and efficient (1.00)

Table 5 shows the technical efficiency levels of secondary schools related to developed and less developed states' economic status. There were 324 schools in the developed states and 302 schools in the less developed ones. Overall, the less developed states' efficiency level in 2014 was relatively better, with seven schools instead of five in the developed states. This suggests that economic status is not a determinant of secondary schools' success since school efficiency is higher in the less developed states. For example, in 2010, there were no efficient schools in the developed states than four in the less developed ones. In terms of economic status, schools in developed states show lower average efficiency than those in less developed ones in 2011, respectively 57.2 against 62.0 percent. This indicates that schools in less developed states have attained better levels of efficiency.

Table 5: School efficiency scores for developed and less developed states in Malaysia

Year	2010		2011		2012		2013		2014	
	Developed states	Less developed states	Developed states	Less developed states	Developed states	Less developed states	Developed states	Less developed states	Developed states	Less developed states
1	0	4	4	4	3	3	4	3	5	7
0.8 -0.99	16	33	6	16	64	97	73	107	93	129
0.5 -0.79	250	221	233	232	217	162	208	149	191	128
< 0.49	58	44	81	50	40	40	39	43	35	38
Maximum	0.91	1	1	1	1	1	1	1	1	1
Minimum	0.14	0.22	0.12	0.20	0.14	0.20	0.16	0.16	0.21	0.23
Average	0.62	0.67	0.57	0.62	0.67	0.67	0.689	0.72	0.71	0.74
Sub total	324	302	324	302	324	302	324	302	324	302
Total	626		626		626		626		626	

Note: Low ≤ 0.49 , medium (0.5-0.79), high (0.8-0.99) and efficient (1.00)

In the developed states in 2011, there were only 6 schools in the high-efficiency category, and the number had since increased to 64 in 2012, 73 in 2013, and 93 in 2014. The less developed states' corresponding progress was 16, 97, 107, and 129, respectively. In the moderate and low-level efficiency categories, schools in both developed and less developed states showed a gradual decline between 2010 and 2014. These trends indicate improved technical efficiency levels shown by secondary schools in both developed and less developed states.

The lowest minimum school efficiency recorded within the developed states' study period was 11.8 percent in 2011. This figure was lower than the 15.8 percent recorded in 2013 for the less developed states. The lowest average efficiency for the developed states was also lower at 57.2 percent in 2011 against 62.0 percent. The result suggests that secondary schools in less developed states are generally more efficient. The findings also showed that most secondary schools' technical efficiency was moderate (0.5-0.79). However, there were still some secondary schools that have low levels of efficiency despite their declining numbers.

The analysis between states with different economic status clearly showed a difference in efficiency, with the less developed states showing higher technical efficiency (0.8-0.99) than that of the developed ones. This indicates that the higher per capita income and better learning facilities in the developed states do not guarantee a comparatively higher academic achievement. It is probable that the larger number of student enrollments in developed states, due to more rapid development and modernization, could be the factor. The resulting increased congestion and consequent social problems among the students may have affected their academic achievement.

The study showed that secondary school's overall technical efficiency levels in rural areas are better than those in urban settings. Nevertheless, irrespective of the urban-rural locations, the schools' efficiency level shows improvement throughout the study. However, the larger -student-teacher ratio in urban secondary schools is vital since it may adversely affect students' academic performance. Every school, irrespective of location, should comply with the student-teacher ratio 17:1 set by the National Key Result Areas (NKRA), Ministry of Education. This problem can be solved by increasing the number of teachers and classrooms, repairing old schools, or building new ones. Maintaining the level of government spending is very important to ensure excellent academic achievement.

5.0 CONCLUSION

This study investigates the technical efficiency level in secondary schools in Malaysia's selected states, using the Data Envelopment Analysis (DEA) approach. The main results show that rural schools and those in the less developed states have better technical efficiency than urban schools and schools in the developed states. Each school's technical efficiency level is vital to gauge the level of use of inputs and how the school's academic achievement can be improved by using the two inputs.

The main findings from this study provided some implications for the stakeholders in Malaysia's education sector. First, the Ministry of Education must ensure that each school adheres to the standard set for the student-teacher ratio 17:1 since it is clear from the study that a small ratio is imperative to better academic achievement. More schools need to be constructed or repaired, and old schools/buildings upgraded to improve teaching delivery quality. Second, the State Education Department should focus on schools with a minimum technical efficiency level in the distribution of government spending. Besides, monitoring government expenditure distribution must be more efficient and frequent to ensure no expenditure distribution leakage. Third, the study's findings help the school identify the level of technical efficiency of each school. Guided by this information, inefficient schools can improve their academic achievement by using existing inputs. Finally, there may be lessons that policymakers can learn from the differences that we observe between efficiency scores obtained in rural and urban areas or developed and less developed states. This might plausibly allow less efficient providers to learn from good practice and encourage the authorities to examine and address the role of different allocation of resources.

This study has some limitations and may be improved for future studies. Further studies should include all the states in Malaysia so that comparisons can be made more broadly and

attendant research questions addressed more precisely. Besides, it needs to consider other inputs, such as parents' income and level of education. Other measuring efficiency methods, such as the Stochastic Frontier Analysis (SFA), can also be adopted.

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