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Measuring the Efficiency of Stadium Usage Using Data Envelopment Analysis (DEA)

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ABSTRACT

Malaysian government builds sport facilities all throughout Malaysia as an initiative to encourage a healthy lifestyle for the citizens. As these sport infrastructures require large cost to build, it is important to ensure that the usages are maximized. The main objective of this research is to investigate the monthly technical efficiency of nine stadiums usage, that are maintained by the Municipal Council in the Klang Valley in the year 2014. Data Envelopment Analysis (DEA) model is applied to identify the efficiency scores. The input and output variables that are used in this study are number of activities held in the stadiums every month and the monthly total expenses used for the stadium. Among the nine stadiums, Stadium Utama, Shah Alam is ranked as the most efficient stadium in comparison to other stadiums based on average monthly efficiency. The stadium that has the lowest score is Stadium Malawati Shah Alam.

Keywords: Data Envelopment Analysis, Efficiency Score

INTRODUCTION

Stadium is a large sports arena surrounded by terraced seating that is used as a venue for competition and training. Stadium can also be used as a venue for other functions such as concerts, expo, carnivals and etc. For instance, Stadium Titiwangsa, Kuala Lumpur under the management of Kuala Lumpur City Hall is open to public as a venue to hold private events such as wedding ceremony.

Ever since the first Malaysian plan, the Malaysian government allocated budget on building and maintaining sport facilities. In the Ninth Malaysian Plan, Malaysian Government allocates RM80 Millions for the construction of sport facilities in Sabah. This proves that the Malaysian government provides world class sports facilities for the citizens in order to encourage healthy lifestyle. As an evidence of the effort shown by the government, sport facilities are available in every state throughout Malaysia.

Since the number of sport facilities has increased in recent years, the study that evaluates the efficiency of stadium should be conducted. This is important as to ensure that the investments made in building and maintaining the stadiums are worthwhile and the usage is optimal. The evaluation will hopefully help the government's decision making process, whether a new stadium should be built in the near future.

LITERATURE REVIEW

Efficiency is defined by [1] as a set of input consists of time, expertise, manpower, etc. used in creating an output in a cost effective way. In conducting an efficiency experiment, the application of Organization for Economic Co-operation and Development (OECD), outlines several alternatives available in getting the results and compare which of the alternative requires the least resources. It is a very challenging task especially when the aim is to minimize operation cost.

From the perspective of this study, the efficiency is measured based on the frequency of use of the stadium. The stadium is said to be efficient when the usage is maximize. Due to that, most stadiums not only hold sport events but allow other non sports activities so that the usage is fully utilized and at the same time fees can be collected and can be used to maintain the premises, as stadiums require frequent maintenance.

The management team also contributes to the efficiency of any premise as proven by the study done by [2]. In this research they found that the sports arena can be used for other functions when a combination of good management and resources are well spend throughout the period of operation. The research includes management elements such as administrative management, space management, technical management and other services. Those elements were core criterion that every management should give attention to. According to Firdaus [3], Malaysia is still at the stage of assembling information and preparation of the needs in the facility management industry. Every organization needs to have a benchmark so that Malaysian companies are able to provide excellent services to customers, as smooth management process will reduce operational cost.

There are many past researches that focus on measuring facilities efficiency such as hospitals, hotels, clinics, educational institutions and other facilities. Research on stadium usage is not broadly implies between the researchers. In the field of sports research, most researches focus on player's performances, games evaluation, players selection, performances of participating nations in a game and etc.

[4] measures hospitality efficiency by comparing the results obtained using two methods. The methods were DEA and stochastic frontier regression (SFR) by considering five variables that are personnel salaries in day care centre, personnel salaries in non-patient care centre, other care centre cost, initial costs and administrative costs. In particularly, SFR collect random variables over time while DEA includes a deterministic process where it based on the philosophical in defining the real situation.

[5] applies DEA to measure teaching efficiency of higher education institutions. The output and input variables used include graduation and completion rates, university characteristics, quality of the student, personal characteristics, type of school attended, marital status and nationality. The data were evaluated using Variable Return to Scale (VRS). The most significance variable that contributes to the efficiency is university characteristics. [6] measure the efficiency of dialysis facilities based on twelve years data available for twelve dialysis centers, to define the productivity during operation. The study used Malmquist index proposed by [7]. Malmquist is an advance method under DEA

[8] defines DEA as a method that defines efficiency of decision making units (DMUs) by using a multiple input and output.[9] justify that the dual variables were used in close connection with the input and output of the study. The unit of the variables also may be different in this method. [10]stated that the efficiency score of one denote the facility as efficiency while the score between zero and one is consider inefficient. Based on [11], the results from DEA researches provide references to inefficient organization so that they can challenge themselves and be more efficient and productive.

Under DEA approach, there are several methods that differ from its fundamental. For this study, we will use Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS). CRS is a method used to make the connection between DEA efficiency measurement while VRS allows an increasing, constant and decreasing returns to scale. Based on[12], the difference between CRS and VRS is CRS requires DMUs to be conducted at an optimal scale while VRS is input oriented.

METHODOLOGY

In this study, the decision making units (DMUs) are the selected stadiums that are maintained by Municipal Council (Majlis Bandaran) located in the Klang Valley in year 2014. Table 1 shows the list of the DMUs. The input and output variables, are tabulated in Table 2.

TABLE 1. List of DMUs

DMU	Stadium
DMU_1	Stadium Utama, Shah Alam, Selangor.
DMU_2	Stadium Malawati, Shah Alam, Selangor.
DMU_3	Stadium Sultan Suleiman, Klang, Selangor.
DMU_4	Stadium MPSJ, Subang Jaya, Selangor.
DMU_5	Stadium Bandar Baru Salak Tinggi, Sepang, Selangor.
DMU_6	Stadium Kajang, Kajang, Selangor.
DMU_7	Stadium MPS, Selayang, Selangor.
DMU_8	Stadium Titiwangsa, Kuala Lumpur.
DMU_9	Stadium MBPJ, Petaling Jaya, Selangor.

TABLE 2. List of input and output

Variable	Explanation
Input 1: Stadium total expense.	Capital investments for the purpose of stadium maintenance in a month.
Output 1: Number of activities or events.	The total number of activities or events held in stadium.

Data Envelopment Analysis DEA can be conducted using multiple inputs as well as multiple outputs and it can also be in different units of measurement. This method has been widely used among researchers to calculate efficiency such as [4], [5],[6],[7] and [12].

Generally, the simple calculation of efficiency ratio is as follows:

$$\textbf{Efficiency} = \textbf{Outputs/Inputs} \qquad (1)$$

However, in DEA, multiple inputs and outputs are linearly aggregated using weights. Debnath et. al. (2015) measured efficiency as a ratio. Equation (2) and Equation (3) shows the mathematical form of the weighted calculations.

$$\textbf{Efficiency} = \frac{\textbf{Weighted Sum of Outputs}}{\textbf{Weighted Sum of Inputs}} \qquad (2)$$

For this study Constant Return to Scale (CRS) , input orientation is chosen to be used in analyzing the data. As our input variable and output variable, both can be controlled. Our DEA equations follow the research done by Kirigia et. al. (2001) in the following form.

$$\boldsymbol{Z_0} = \text{Min} \quad \emptyset - \boldsymbol{\varepsilon}(\sum_j \boldsymbol{S_j}^+ + \sum_i \boldsymbol{S_i}^-) \qquad (\mathbf{3})$$

subject to

$$\sum_{\boldsymbol{k}} \boldsymbol{\lambda_j x_{ik}} + \boldsymbol{S_i}^+ = \emptyset \boldsymbol{x_{ik_0}} \qquad \forall \boldsymbol{i}$$

$$\sum_{\boldsymbol{k}} \boldsymbol{\lambda_j y_{jk}} + \boldsymbol{S_j}^- = \boldsymbol{y_{jk_0}} \qquad \forall \boldsymbol{j}$$

$$\boldsymbol{S_i}^-, \boldsymbol{S_j}^+ \geq \mathbf{0} \qquad \forall \boldsymbol{i}, \forall \boldsymbol{j}$$

$$\boldsymbol{\lambda_k} \geq \mathbf{0} \qquad \forall$$

$$\boldsymbol{\varepsilon} > 0$$

where

U_j : Weight given to output j,
V_i : Weight given to input i,
n : Number of stadiums,
j : Number of outputs,
i : Number of inputs,
ε : Small positive number,
y_{jk} : Amount of output j produced by stadium j,
x_{ik} : Amount of input i used by stadium i,
k_0 : Stadium under assessment.
s^+, s^-: slack values

ANALYSIS AND RESULTS

This section describes the analysis and results of this study. Table 3 shows the technical efficiency of each DMU starting from January 2014 to December 2014. It can be seen from the table, Stadium Utama, Shah Alam showed high efficiency in January, February, May, June and September 2014, while in March, April and August, Stadium Sultan Suleiman were efficient. Stadium Titiwangsa level of efficiency was high during the two consecutive months at the end of the year. Lastly, the stadium that was efficient in October was Stadium Malawati, Shah Alam and Stadium MBPJ Petaling Jaya was efficient during July.

We can identify not only the efficient stadiums but also the inefficient stadiums. Stadium Utama Shah Alam was inefficient in July while Stadium Sultan Suleiman was inefficient in December. The reasons of being inefficient is due to lesser number of activities were conducted in that stadium however the expenditure including maintenance spending money were high for that particular month. The overall efficiency shows that both, Stadium Kajang and Stadium Titiwangsa were efficient throughout the year. Although Stadium Sultan Suleiman was efficient throughout the year, but due to the absence of activity in December the efficiency score decreases.

TABLE 3. Monthly technical efficiency of each DMU using CRS model (%)

DMU	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	**Avg.**	**Rank**
1	100	100	89.8	64.8	100	100	0.0	45.0	100	14.6	35.8	23.7	64.48	1
2	3.2	61.5	27.1	9.6	33.7	3.3	17.4	8.5	4.3	100	63.0	74.5	33.84	4
3	20.1	95.6	100	100.	84.6	22.6	83.2	100	43.6	79.8	13.3	0.0	61.90	2
4	9.3	12.9	11.9	9.4	20.8	16.1	6.6	12.5	8.5	13.6	17.2	14.6	12.78	9
5	12.7	19.5	15.3	10.2	23.3	11.5	14.9	14.9	7.5	14.1	21.0	10.4	14.60	8
6	31.2	41.7	8.5	28.3	61.4	35.1	15.2	38.5	17.7	23.8	43.0	32.0	31.37	5
7	37.7	40.4	27.3	19.6	23.5	22.6	20.5	47.1	5.3	9.4	23.2	7.6	23.68	7
8	71.0	6.6	57.9	45.5	36.5	52.1	21.8	39.7	26.7	67.2	100	100	52.08	3
9	5.7	26.9	18.2	10.6	63.3	15.3	100	18.3	20.9	9.6	51.0	9.5	29.11	6
Mean	32.3	45.0	39.6	33.1	49.7	30.9	31.1	36.1	26.0	36.9	40.8	30.3	35.98	

Table 4 shows the peers of every stadium each month. The peers comes from the efficient stadium for the month that will be the reference for stadiums that are less efficient.

TABLE 4. Summary of peers for every stadium followed by month in CRS model

DMU	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1	1	1	3	3	1	1		3	1	2	8	8
2	1	1	3	3	1	1	9	3	1	2	8	8
3	1	1	3	3	1	1	9	3	1	2	8	
4	1	1	3	3	1	1	9	3	1	2	8	8
5	1	1	3	3	1	1	9	3	1	2	8	8
6	1	1	3	3	1	1	9	6	1	2	8	8
7	1	1	3	3	1	1	9	3	1	2	8	8
8	1	1	3	3	1	1	9	3	1	2	8	8
9	1	1	3	3	1	1	9	3	1	2	8	8

As a conclusion, the research provides the results of efficiency scores based on the stadium that are considered in this study. The The most efficient stadium is Stadium Utama, Shah Alam and the least efficient stadium is Stadium MPSJ, Subang Jaya.

CONCLUSION AND RECOMMENDATIONS

The overall efficiency indicates that Stadium Utama, Shah Alam is the most efficient stadium while the least efficient stadium is Stadium MPSJ, Subang Jaya. Throughout the year, Stadium Utama, Shah Alam, Stadium Malawati, Stadium Sultan Suleiman, Klang, Stadium Titiwangsa, Kuala Lumpur and Stadium MBPJ, Petaling Jaya have a 100% efficiency score for at least a month in year 2014.

To improve the level of technical efficiency of stadium usage, the management should ensure that the stadium does not be left without any event. This is because the cost of the monthly maintenance remains the same even if there is no activity held. To overcome this situation, the management should include marketing activities as a strategy to encourage more tenants or activities to be held at the stadiums.

The future research in this area should include other variables that contribute to the stadium efficiency. It can be the number of employees involve in managing the stadium, the number of facilities provided in the stadium, the types of activities conducted in the stadium and other. Furthermore, the future study should include the stadiums that are available in different states in Malaysia.

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