Measuring performance efficiency of Malaysian football clubs using Data Envelopment Analysis

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ABSTRACT In year 2023, there are at least 3986 football clubs registered from all countries around the world. It was more exciting when the International Federation of Association Football (FIFA) World Cup was introduced, and it is held every four years with only qualified teams could take part in the tournament. Malaysian national team squad called Harimau Malaya is also currently training the best to be qualified in this World Cup. To enable them to take part in the prestigious match, they need to work hard to their best to perform well so that the club can be selected in the world match. These clubs do not have an idea about the level of their efficiency. Besides, they do not have the information on the best level of utilization of their available resources. This study intends to identify the efficiency level of the football clubs and determine the ideal inputs and outputs so that the efficiency of the clubs can be maximized. The data of inputs and outputs for each club was obtained from the matches which held in Malaysia Super League 2018. Data Envelopment Analysis (DEA) model is a mathematical approach that is used in this study to evaluate the relative efficiency of the decision-making units (DMU). The DMUs in this study are 10 selected local football clubs, and the input data chosen are stadium capacity, overall transferred players, total shots and corners. Meanwhile, the output data used are ranking, total goal scored and overall points. The DEA result generated has shown that only DMU1 and DMU2 have recorded a full score of efficiency, while other clubs were described as inefficient, and improvement strategy was recommended to the clubs to improve their level of efficiency. The improvement strategy has successfully generated the suggested values of inputs and outputs which are able to increase efficiency to a better level. This study provides valuable insights for the football clubs to improve their performance efficiency and consequently contribute to the quality of the national football performance in future world tournaments.

KEYWORDS: Efficiency, Data Envelopment Analysis, Football Clubs, Performance Measure, Improvement Strategy
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INTRODUCTION

Football has become the biggest national sport in this country. It is one of the important sport industries as it generates income through ticket sales and television broadcasting and creates numerous job opportunities (Zid, 2021). The Malaysia national football team was organized by the Football Association of Malaysia (FAM), which is the governing body for football in Malaysia (Hamid & Kendall, 2008). Malaysia national football team is known as Harimau Malaya, since the tiger or harimau in Malay has been the Malaysia's national symbol and is portrayed in the national emblem. Malaysia national football club aims to be ranked in the International Federation of Association Football (FIFA) World Ranking. The highest rank is one of the eligibility criteria for a club to be qualified to participate in the FIFA World Cup match. Based on the FIFA rankings, Harimau Malaya achieved their highest ranking, reaching the 75th position in 1993. However, their ranking then dropped to the lowest point of 175th in the world in March 2018. In the latest FIFA rankings, Malaysia has shown improvement, increasing from the 175th position to the 130th position in 2023 (Malay Mail, 2023). To go further and compete with the top football clubs, they must engage in extensive training and improve their performance.

There are various studies regarding the efficiency of football clubs in countries all around the world. However, there is a lack of studies examining the efficiency of Malaysian football clubs. Since Malaysian football clubs have no certain information about their level of efficiency, therefore

there is a need to determine the efficiency level of 10 selected football clubs in Malaysia. By knowing their efficiency level, the clubs can set a benchmark for their performance in relation to other clubs. In addition, a lack of strategic planning may cause problems for FAM to improve the football club's efficiency. They may not have the information on how to fully utilize the available resources. Therefore, the research objectives of this study are to measure the efficiency level of Malaysian football clubs and to propose an improvement strategy that can maximize the level of efficiency of Malaysian football clubs. To measure the efficiency level, data envelopment analysis (DEA) is utilized. By knowing their club efficiency level, FAM can improve the club performance by utilizing all available resources and strive to enhance its position in the FIFA world rankings.

LITERATURE REVIEW

Data Envelopment Analysis (DEA) is a nonparametric method to measure the efficiency of decision-making units (DMUs) with numerous input and output (Martić *et al*., 2009). Decision-making units are the set of peer entities that are used in evaluating efficiency performance by transforming input into output (Shewell & Migiro, 2016). The DEA model was first introduced in 1978 by Charnes, Cooper and Rhodes, known as CCR model, following the work of Farrell and Dantzig in 1957 (Shieh *et al*., 2022). The chosen inputs or referred to as resources, should have an impact on the outputs. The DEA model result score indicates the efficiency of the DMUs in using inputs to create output. The evaluation is indicated by scoring of the DMUs on a scale from 0 to 1. The score value of 1 indicates that the DMUs measured is fully efficient.

The function of DEA itself is not only for measuring efficiency performances but also shows the amount of inefficiency. Thus, it could help the researchers on what should be adjusted for the target values of input and output to be able to reach the level of efficiency (Vincova, 2005). DEA models have been divided into input-oriented and output-oriented. The input-oriented model focuses on how to minimize the input based on the given output level. Thus, efficiency can be achieved by lowering the inputs and maintaining the desired output level. On the other hand, under the output-oriented model, it focuses on how to maximize the output level based on the given inputs level. The efficiency transformation requires increasing the proportion of the outputs while keeping the inputs constant (Martic *et al*., 2009).

According to Cebrian *et al.* (2018), there are two main variables involved in efficiency in sports, which are the measurement of financial efficiency (economic) and the measurement of sports efficiency (non-economic). Sports efficiency refers to the player's performance after doing certain actions off the field. Various studies that focused on sport efficiency of football clubs utilized the method of DEA. Among them are the study on Brazilian football clubs (Roboredo *et al.*, 2015), Thailand football clubs (Chaiwuttisak, 2018), Spain football clubs (Gonzalez, 2018), Italian football clubs (Delice & Gercek, 2018), Turkish football team (Yilmaz *et al*., 2019) and Spain football clubs (Raja & Raja, 2021). In addition to these studies, the DEA approach has also been implemented to measure the efficiency of football teams participating in the World Cup 2014 (Gökgöz & Yalçin, 2018) and UEFA Champions League (Cebrian *et al.*, 2018). On the other hand, financial efficiency refers to how well a club can earn profit. Nowadays, football is an industry the moves huge amounts of financial capital and holds the attention of fans worldwide. However, due to certain issues like the financial crisis and Covid 19 pandemic, control over the financial resources is crucial. Miragaia *et al.* (2019) has evaluated the sport performance of European football clubs and the stability of their financial efficiency. The finding has revealed that clubs should improve their control over their financial resources because sport efficiency is positively related to financial efficiency.

METHODOLOGY

The input and output data for Malaysian football clubs is collected from the sports websites, www.transfermarkt.com, which is a worldwide football club website. The website provides all information such as market values, competition and forums for clubs all around the world. This study is intended to determine the efficiency of ten selected football clubs based on Malaysia Super League in 2018. The DEA model developed by Charnes *et al.* (1978) is used to evaluate the efficiency score for each football club. The model consists of sets, parameters, decision variables, objective functions and constraints that can be expressed as:

Sets: DMUs, $p = \{1, 2,..,n\}$
Inputs, $l = \{1, 2,..,i\}$
Outputs, $k = \{1, 2,..,j\}$

Parameters: x_{kp} = amount of output k^{th} produced by DMU p
v_{lp} = amount of input l^{th} produced by DMU p

Decision variables: y_{kp} = weight allocated to k^{th} output of DMU p
w_{lp} = weight allocated to l^{th} input of DMU p
E_p = the relative efficiency of DMU p

Maximize E_p,

$$\sum_{k=1}^{j} x_{kp} y_{kp} \tag{1}$$

Subject to,

$$\sum_{l=1}^{i} v_{lp} w_{lp} = 1, \tag{2}$$

$$\sum_{k=1}^{j} x_{kp} y_{kp} - \sum_{l=1}^{i} v_{lp} w_{lp} \leq 0; \quad p = 1,2, \ldots, n \tag{3}$$

$$x_{kp}, v_{lp} \geq 0 \tag{4}$$

The objective function (1) is aimed to maximise the efficiency of DMU p. Constraint (2) restricts that the total weighted sum of the inputs must be equal to unity one. Constraint (3) restricts that the value of the efficiency, which is given by the ratio of the weighted sum of the output to the input must be less than one. Constraint (4) ensures that all the inputs and outputs are non-negative.

As there are 10 football clubs taken in this study, therefore $p = \{1,2,3,4,5,6,7,8,9,10\}$ is the set of DMUs. The inputs are selected based on past studies, which are Chaiwuttisak (2018), Delice & Gercek (2018) and Cebrián (2018). There are a total number of four inputs in this study, which are stadium capacity, overall transferred players, total shots and corners, which implies the set of input as $l = \{1,2,3,4\}$. The stadium capacity refers to the maximum number of spectators that can be fitted in at one time. Transferred players are the number of players in and out for each club throughout the Malaysia Super League 2018. Total shots are the total attempts by players including both shots on and off target, while corners refer to the kick from the corner of the field aiming for the ball to go into the net. On the other hand, three variables are assigned for the outputs in this study, consisting of ranking, total goals scored and overall points. These outputs are selected based on studies by Delice & Gercek (2018). This implies the set of output as $k = \{1,2,3\}$. Ranking indicates the final position after the overall match results starting from the team that earned the highest points to the

lowest. Total goals scored refers to the number of successful goals throughout the league. Meanwhile, the overall points are the point count based on the total goals scored. The data on the inputs and outputs are shown in Table 1.

Table 1. Inputs and outputs data from selected Malaysian football clubs

Inputs	Outputs
Stadium capacity (people)	Ranking
Overall transferred players	Total goals scored
Total shots	Overall points
Corners	

RESULT AND DISCUSSION

Once the parameters have been substituted into the DEA model, the calculation of efficiency is carried out by measuring the weight of each input and output variable. The weight value is then used to calculate the efficiency score of each DMU. The model was run using QM for Windows software to generate results. Table 2 shows the summary of the result obtained on the relative efficiency of the football clubs in Malaysia.

Table 2. The relative efficiency of 10 selected football clubs in Malaysia

	Performance Efficiency
DMU1	100.00%
DMU2	100.00%
DMU3	99.82%
DMU4	99.56%
DMU5	99.37%
DMU6	99.28%
DMU7	70.59%
DMU8	89.47%
DMU9	84.00%
DMU10	77.97%

Based on Table 2, DMU1 has the most efficient results which has a relative efficiency value of 100%. One of the reasons is because it has the highest efficiency is that they have the most goals scored with 47 goals. It has proven to be an efficient club by maintaining the top ranking among other clubs with an overall total point of 59 points. Its stadium capacity can accommodate up to 40,000 spectators and it has improved its strategic plan by importing as many as 35 new players in the team. As a results, DMU1 has gained 262 total shots with 98 corners in Malaysia Super League in year 2018.

Apart from DMU1, DMU2 has also achieved the highest scale efficiency among the 10 selected clubs. It was ranked 6th place with a total of 37 goals scored among all the matches with 10 clubs in Super League 2018. DMU2 has shown the potential of its clubs to produce a maximum number of outputs by utilizing all the input. Its stadium can accommodate up to 32,387 people and it has the least transferred players (17). They have a lot of shots with a total of 263 attempts and corners with a count of 109 kicks. From these results, it can be concluded that DMU1 and DMU2 have fully utilized their inputs to produce the highest level of output.

There are four clubs that have been identified as having low performance, each recorded an efficiency below 90%. By considering this, the decision is made to improve the efficiency of DMU7, DMU8, DMU9, and DMU10, which are recorded as 70.59%, 89.47%, 84.00%, and 77.97%, respectively. For these clubs that are considered as less efficient, an improvement strategy is proposed to reach the maximum efficiency level. For this purpose, the El-Mahgary and Lahdelma (1995) model is used to improve the inefficiency results. By using this technique, the best values of the inputs and outputs can be determined in the attempt to push the efficiency to highest possible level. The model is given in Equation (5) which is

$$x_{iE'} = x_{iM}\,\lambda_{iM} + x_{iQ}\lambda_{iQ} \quad (5)$$

where

$x_{iE'}$ is the revised value of input or output i of the less efficient DMU
x_{iM} is the value of input or output i of reference set DMU M
λ_{iM} is the dual weight of the input or output i of reference set DMU M
x_{iQ} is the value of the input or output i of reference set DMU Q
λ_{iQ} is the dual weight of the input or output i of reference set DMU Q

Reference set is a set taken from the dual weight value of two DMUs with highest level of efficiency, namely DMU M and DMU Q. Equation (5) is used to calculate the dual weight for the less efficient DMU. The dual weight obtained from each reference set later is used as an indicator to evaluate the new suggested values of inputs and outputs for the DMU with less efficiency.

Table 3 provides the comparison between the current values and improvement values for inputs and outputs of all DMUs. These are the recommended values obtained by solving the El-Mahgary & Lahdelma (1995) model as an improvement strategy for the less efficient football clubs.

Table 3. The comparison between current and improvement values of inputs and outputs

		Inputs				Outputs		
		Stadium capacity	**Overall transferred players**	**Total shots**	**Corners**	**Ranking**	**Total goals scored**	**Overall points**
DMU7	Current value	42,500	35	291	119	2	35	36
	Improvement value	28,000	24	202	72	2	35	39
DMU8	Current value	25,000	29	262	107	8	35	27
	Improvement value	16,000	15	191	59	6	29	20
DMU9	Current value	40,000	33	247	114	4	35	34
	Improvement value	21,000	18	168	56	2	27	28
DMU10	Current value	50,000	36	272	120	5	32	34
	Improvement value	19,000	16	162	54	3	26	25

All improvement values for inputs namely stadium capacity, overall transferred players, total shots and corners for all DMUs are lower than the current values, The same trend is also recorded for the outputs, except for the overall points which suggested a higher value for the improvement strategy. Unlike inputs, the current and improvement values for the outputs only recorded small variations.

Table 4 presents the expected improved efficiency for DMU7, DMU8, DMU9 and DMU10. The table indicates that the inputs and outputs of these four clubs could be enhanced using the model proposed by the improvement model with a target to achieve a 100% efficiency level. The suggestion for these clubs is to consider reducing the values of both inputs and outputs, as indicated by the results in Table 3. This approach aims to maximize the efficiency of the football clubs.

Table 4. The comparison of calculated efficiency and expected efficiency after improvement

	Calculated Efficiency	Expected Efficiency after improvement
DMU 7	70.59%	99.82%
DMU 8	89.47%	99.62%
DMU 9	84.00%	99.09%
DMU 10	77.97%	99.91%

CONCLUSION

Two objectives proposed for this project were successfully achieved. For the first objective, the efficiency level of Malaysian football clubs was measured. The highest efficiency of 100% was recorded by DMU1 and DMU2, while the lowest efficiency is DMU7 with only 70.59%. For the second objective, an improvement strategy to maximize the level of efficiency of Malaysian football clubs was proposed. The efficiency level for DMU7, DMU8, DMU9 and DMU10 can be improved by changing the inputs and outputs to the optimized level. For future research, it is recommended to measure the efficiency level of each club using more inputs and outputs for both economic and non-economic variables to get a more practical approach to utilize the available resources efficiently.

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