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Ranking Selangor's Kindergarten of Malaysia: Using Data Development Analysis

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Abstract: Sending children to kindergarten at the early age can be considered as very important responsibilities for parent nowadays. In this study, it is supposed that a parent wants to get decision which kindergarten from 12 kindergartens of Selangor, Malaysia, should be selected to enroll their child. For each kindergarten 6 factors are selected inclusive 4 inputs such as expected number of students, cost of operating in a month, time in travelling and tuition fee per student and 2 outputs such as number of teachers and area of school. The study shows how a recent robust Data Envelopment Analysis (DEA) model, Kourosh and Arash Model (KAM) is applied to rank all kindergartens significantly, and suggests the best selection to the parent. Microsoft Excel Solver 2013 is used to solve KAM and represent its outcomes.

Keywords: Data envelopment analysis, Ranking, Kourosh and Arash method, Kindergarten

INTRODUCTION

Each child is precious and assets to the society and nations. Children and education are really associated to each other. The United Nations Educational, Scientific and Cultural Organization (UNESCO) introduced Education for All (EFA) demands for better and more options to sustenance young children and their families in all area where the child is growing their physically, emotionally, socially and intellectually [1].

Sending children to kindergarten at the early age can be considered as very important responsibilities for parent nowadays. The impact can be seen by increasing the number of available kindergartens especially those in urban area. Sometimes, selection of kindergarten is based on popularity, but the quality of education also needs to take into account for the child's development.

This study shows how Data Envelopment Analysis (DEA) techniques can help a parent to select a kindergarten among 12 available kindergartens in Kajang, Selangor, Malaysia in 2014. Six factors inclusive of 4 inputs and 2 outputs are considered to rank kindergartens for satisfying the parent. The 4 inputs are the expected number of enrolled students in the kindergartens, cost of operating in a month, time in travelling and tuition fees per student which the parent interest on less values of these factors. The 2 outputs are number of teachers and size of area that the parents would interest on high values of these factors. Data were gathered from the interviewed that we had with the principal of the schools and the parent.

Data Envelopment Analysis (DEA) is a non-parametric method which by linear programming models estimates a production frontier of a set of homogenous Decision Making Units (DMUs). It measures the relative efficiency of DMUs inclusive multiple inputs and outputs which can be used to rank DMUs significantly. A recent robust technique of DEA called Kourosh and Arash Model(KAM)[2] is applied to rank these 12 kindergartens with 6 selected factors.

The rest of this paper is organized in 5 sections. Next section is the literature review. Section 3 introduces data and Section 4 represents the results of applying the DEA models. Section 5 concludes the paper. Simulations are also calculated with Microsoft Excel Solver 2013.

LITERATURE REVIEW

Many parents nowadays have put a high expectation to their children to perform well, where it will cause a stress not to only their children but to parents instead. In Malaysia, kindergarten is an optional programme for children aged 4 to 5 years old, but mostly children are encouraged to be enrolled at 5 years old. These centers are privately-run and targeting children from middle-income to high income family. The fees is said to be charged are vary and largely determined by overhead costs and market forces. On the other hands, kindergarten classes conducted by Ministry of Education Malaysia (MOE) and other government agencies enable under-privileged children from lower

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income families' where fee is free or at minimal charge. All kindergarten has to follow the curriculum guidelines set by the MOE and in line with the National Private Education Malaysia (NPE) that enables kindergarten children to acquire basic communication social, and other skills in preparation for primary schooling [3].

Data envelopment analysis (DEA) is a linear programming methodology to measure the relative efficiency of Decision Making Units (DMUs) with multiple inputs and outputs. The first standard DEA model is proposed by Charnes, Cooper, and Rhodes (CCR) in 1978 [4] and improved in Variables Returns to Scale (VRS)by Banker, Charnes and Cooper (BCC) in 1984 [5]. DEA classifies whether DMUs are efficient, technically efficient or inefficient. The criterion for classification is determined by the location of DMUs' data point with respect to the estimated efficient frontier of an introduced Production Possibility Set (PPS). When the number of DMUs is small in comparison with the total number of variables the discrimination power of DEA was decreased [6]. However, a recent robust model in DEA, called Kourosh and Arash Model (KAM) was proposed by Khezrimotlagh et al. [7] to uniquely improve the discrimination power of DEA even the number of DMUs is less than the number of factors. KAM is simultaneously able to estimate the production frontier, the relative efficiency score, and benchmark and rank DMUs. By considering a very small negligible thickness for the estimated DEA efficient frontier, KAM is applied. When the thickness of the estimated DEA efficient frontier is zero, KAM is the weighted Additive model (ADD) proposed by Charnes et al. [8] and it is almost completely the same as Slack-Based Measure (SBM) model proposed by Tone [9-10].The ε-KAM in VRS for *n* DMUs with *m* inputs and *p* outputs is given by [7]:

$$\max \sum_{j=1}^{m} w_j^- s_j^- + \sum_{k=1}^{p} w_k^+ s_k^+,$$

Subject to

$$\sum_{i=1}^{n} \lambda_i x_{ij} + s_j^- = x_{lj} + \varepsilon_j^-, \text{for } j = 1,2,\dots,m,$$
$$\sum_{i=1}^{n} \lambda_i y_{ik} - s_k^+ = y_{lk} + \varepsilon_k^+, \text{for } k = 1,2,\dots,p,$$
$$\lambda_i \geq 0, \text{for } i = 1,2,\dots,n,$$
$$s_j^- \geq 0, \text{for } j = 1,2,\dots,m,$$
$$s_k^+ \geq 0, \text{for } k = 1,2,\dots,p.$$

The KAM best technical efficiency score and target with ε degree of freedom (ε-DF) are as follows:

$$x_{lj}^* = x_{lj} - s_{lj}^{-*} + \varepsilon_j^-, \text{for } j = 1,2,\dots,m,$$
$$y_{lk}^* = y_{lk} + s_{lk}^{+*} - \varepsilon_k^-, \text{for } k = 1,2,\dots,p,$$
$$KA_\varepsilon^{*l} = \frac{\sum_{k=1}^{p} w_k^+ y_{lk} / \sum_{j=1}^{m} w_j^- x_{lj}}{\sum_{k=1}^{p} w_k^+ y_{lk}^* / \sum_{j=1}^{m} w_j^- x_{lk}^*}.$$

The weights in KAM are defined as $w_j^- = 1/x_{lj}$and $w_k^+ = 1/y_{lk}$, where $x_{lj} > 0$ and$y_{lk} > 0$, and if $x_{lj} = 0$ or $y_{lk} = 0$, the weights are defined as 1. The components of epsilon vector, $\varepsilon_j^-$and ε_k^+, are defined as $\varepsilon \times \min\{x_{ij}: x_{ij} \neq 0, i = 1,2,\dots,n\}$ and $\varepsilon \times \min\{y_{ik}: y_{ik} \neq 0, i = 1,2,\dots,n\}$, respectively, where ε is a nonnegative real number. Indeed, the value of ε is considered as a very small nonnegative real number in order to have a negligible thickness of the efficient frontier. A technically efficient DMU is called KAM efficient with ε-Degree of Freedom (ε-DF) if $KA_0^* - KA_\varepsilon^* < \delta$, otherwise, it is called inefficient with ε-DF. The value of δ depends on the aim of measuring the efficiency scores of DMUs and would be defined by $\varepsilon/(m+p)$ or $\varepsilon/10$ or greater value to have at least one efficient DMU with ε-DF in the practice [2].

DATA SELECTION AND APPLYING KAM

Table 1 illustrates the data of 12 different kindergartens in Selangor in 2014.

Table 1: Data of 12 Kindergartens.

DMUs	Input1	Input2	Input3	Input4	Output1	Output2
A01	30	6000	12	295	4	1540
A02	28	6400	12	295	4	1400
A03	29	6800	15	625	5	1600
A04	27	7000	20	310	4	1540
A05	40	8250	18	325	6	1760
A06	30	6000	16	200	5	1400
A07	32	6800	15	400	5	1400
A08	38	7900	13	300	5	1760
A09	28	6200	14	325	4	1600
A10	29	6500	12	295	4	1540
A11	30	6500	12	295	5	1540
A12	30	6300	12	295	4	1540

The selected factors are introduced as follows:

Input1: Expected number of Students.
Input2: Cost of operating in a month (RM)
Input3: Time in travelling (minutes)
Input4: Tuition fee per student (RM)
Output1: Number of Teachers
Output2: Area of kindergarten (square feet)

A kindergarten which has less values of selected inputs and high values of selected outputs is suggested to the parent for enrolling their child.

The minimum non zero values of each factor are as follows

Factors	Input1	Input2	Input3	Input4	Output1	Output2
Min Values:	27	6000	12	200	4	1400

which by introducing ε as 10^{-6} the component of epsilon vector are:

$10^{-6}\times$ Min Values:	0.000027	0.006000	0.000012	0.000200	0.000004	0.001400

As can be seen the components of epsilon vector are completely negligible according to minimums of each factor [11]. Moreover, the value of δ is introduced as $\varepsilon/10$, that is, δ = 10^{-7}, to suggest the best selection among 12 available kindergartens. Therefore, if the value of $1-KA^{*}_{10^{-6}}$ is less than 10^{-7} for akindergarten is suggested to the parent, otherwise, it is rejected.

THE RESULTS OF KAM

The results of VRS DEA models such as BCC-IO, ADD VRS and 10^{-6}-KAM VRS are illustrated in Table 2. VRS (NIRS) is selected, because if the input values are increased twice (triple), output factors are not necessarily increased twice (triple).

Table 2: KAM outcomes with one millionth DF in factors.

DMUs	BCC-IO	0-KAM	10^{-6}-KAM	Rank	Decision	Reference Sets
A01	1.0000	1.0000	0.9999985	5	Reject with 10^{-6}-DF	A01, A06, A11
A02	1.0000	1.0000	0.9999979	7	Reject with 10^{-6}-DF	A02, A11
A03	1.0000	1.0000	0.9999955	9	Reject with 10^{-6}-DF	A03, A08, A09, A11
A04	1.0000	1.0000	0.9999976	8	Reject with 10^{-6}-DF	A02, A04, A09
A05	1.0000	1.0000	0.9999997	3	Reject with 10^{-6}-DF	A05, A06, A11
A06	1.0000	1.0000	1.0000000	1	Suggest with 10^{-6}-DF	A06
A07	0.9331	0.8169	0.8168768	12	Reject	A11
A08	1.0000	1.0000	0.9999996	4	Reject with 10^{-6}-DF	A08, A11
A09	1.0000	1.0000	0.9999982	6	Reject with 10^{-6}-DF	A09, A11
A10	1.0000	1.0000	0.9999953	10	Reject with 10^{-6}-DF	A02, A09, A10, A11
A11	1.0000	1.0000	1.0000000	1	Suggest with 10^{-6}-DF	A11
A12	1.0000	0.9302	0.9302313	11	Reject with 10^{-6}-DF	A01, A06, A11

From table, KAM suggests the parent to select kindergartens A06 and A11. Indeed, KAM ranks these 12 kindergartens while the thickness of the efficient frontier is around one hundredth.

CONCLUSION

DEA is usually applied to help managers to improve the efficiency of companies, factories or organizations. It can also be used from the consumer view while there are different brands or some available selections inclusive several factors values. This study shows how using DEA let a parent get decision to select akindergarten among 12 available kindergartens with 6 different factors. Subjective matter(s) may arise from a parent to another parent, however, KAM can easily be applied for each parent and this can be a direction for future researches.

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