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Measuring Efficiency of Telecommunication Customer Service Centres Using Data Envelopment Analysis

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Abstract: This paper investigates the relative efficiency of customer service centres for a telecommunication company in Malaysia using Data Envelopment Analysis (DEA). Thirteen customer service centres located across Klang Valley area are selected asDecision Making Units (DMUs) with four input factors such as cost of manpower, materials, premise rental and goods sold and three output factors such as revenue from service commission, retails sales and amount of bill collection. A recent robust DEA model, Kourosh and Arash Model (KAM) is applied to discriminate between DMUs appropriately. There are 9 technically efficient DMUs which 3 of them are efficient with 10^{-8}-Degree of Freedom (DF) and others were inefficient with 10^{-8}-DF. Simulations are performed with Microsoft Excel Solver 2013.

Keywords: Data envelopment analysis, Kourosh and Arash method, Efficiency, Telecommunication, Ranking.

INTRODUCTION

Telecommunication firms are companies that provides service of communication for their customers via technological means such as telephones, cellular and internet services. Telecommunication firms exist globally as individuals, families, and organizations need ways of communication with others to function. Because of that, telecommunication industry is one of the most important contributor in the service sector within an economy.

Advancements in transportation and communication have changed the world. The world seems a smaller place, in part because of the first telephone invented by Alexander Graham Bell in 1877. Several years afterward, first radio transmission was built by Italian inventor Guglielmo Marconi in 1894 and followed by NASA which has launched Echo satellite in 1960 to be used for many wide range of application in communication such as telephone and internet. In 1981, Internet Protocol v4 (Ipv4) and Transmission Control Protocol (TCP) was introduced. Since then, internet access has been improved with more function and become widespread, commercially used, later in the century, using the old telephone and television networks. Around 1990 internet access has begun to commercialize which evolutionarize the telecommunication industry.

This study measures the efficiency level of customer service centres of a telecommunication company in Malaysia. Cross-sectional data of 13 customer service centres which scatter across Kuala Lumpur and Selangor state of Malaysia are acquired. Data Envelopment Analysis (DEA) is applied to estimate the performance of each customer service centre. DEA is a non-parametric linear programming tool to assess relative efficiencies of a homogeneous group of Decision Making Units (DMUs) [1-2]. Khezrimotlagh *et al*. [3-4]recently improved the base of this knowledge and suggested a robust method called Kourosh and Arash Model (KAM) to increase the discrimination powers of DEA. KAM is concurrently able to estimate the production frontier, measure the relative efficiency score, benchmark and rank the assessed DMUs. KAM is based on the weighted Additive DEA model (ADD) [5] and Arash Method (AM) [6-7]. Four factors such as cost of manpower, materials, premise rental and goods sold are considered as inputs and three outputs such as revenue from service commission, retails sales and amount of bill collection are selected as outputs. The results of some DEA models are also represented to compare with the results of KAM.

The next section details out the review of related literatures. Section 3 contains the application of the DEA model and illustration of the results of the relative efficiency evaluation of the 13 customer service centers. The last section will conclude this paper. The analysis were carried out using Microsoft Excel Solver for the linear programming involved in DEA.

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DEA AND SELECTED FACTORS

DEA is a linear programming-based technique that converts multipleinputs and outputsvalues into a single comprehensive measure of efficiency [1]. This is accomplished by the construction of an empirically based production possibility frontier and the identification of peer Decision Making Units (DMUs). Each unit is evaluated by comparison against a composite unit that is constructed as linear combination of other DMUs [2].

An efficient DMU is defined as one that is able to produce greater values of services as other DMUs with using fewer values of inputs.DEA requires the values of inputs (used resources) and outputs(produced services or goods) and various parameters can be considereddepend on the type of performance or efficiency to be measured. This paper focuses in economic performance of the customer service centres, that is, the revenue over expenses. The output were measured in terms of revenue breakdown which encompassed by retail sales, commission acquired from each successful application, and the amount of bill collected for each outlet. The inputs were measured in terms of cost breakdown which encompassed by human resource cost (staff salary and benefits), material cost (stationery, office equipment and so on), rental cost for each outlet and the cost of each goods sold. Table 1 represents the selected factors.

Table-1: The selected inputs and outputs

Notation	Definition	Description
x_1	Manpower expenses	Cost spent on the employees' salary, overtime and other benefits
x_2	Materials expenses	Amount spent on materials used for operation such as stationery, office equipment and furniture/fittings
x_3	Premise rental	Amount spent on rental for each branch
x_4	Cost of goods sold	Gross cost of retail goods such as telephony equipments
y_1	Retail sales	Amount received from sales of goods
y_2	Service commission	Amount received from rendering service for principal company
y_3	Bill amount collected	Amount received from customer for bill payment

Table 2 lists 13 DMUs (telecommunication customer service centres) with the selected inputs and outputs data. Each outlet offers various services in terms of product registration, bill payment, retail sales and enquiries. Revenues of each outlet are generated from the commission for each successful product registration, the amount of bill collected and the retail price of telephony and internet equipment. In rendering the services, the company has to spend on daily operation expenses. For this study, the operation expenses and cost of goods sold were used as inputs while the revenue generated as output as illustrated in Table 1. The inputs are labeled as x_i for $i = 1,2, \dots ,4$ and the outputs are labeled as y_i for $i = 1,2,3$.

Table 2: Data of 13 DMUs with 7 factors

DMUs	x_1	x_2	x_3	x_4	y_1	y_2	y_3
A01	777,022.79	9,161.75	189,000.00	53,480.94	58,094.00	1,299,147.92	30,195,836.15
A02	574,517.53	7,423.50	120,000.00	30,789.20	35,431.30	661,106.32	48,116,285.58
A03	1,337,712.72	13,902.10	176,400.00	141,540.83	151,928.00	1,465,722.55	32,491,644.34
A04	687,264.05	8,372.92	184,800.00	75,706.49	85,539.30	1,037,068.14	9,365,961.19
A05	728,915.17	13,604.90	360,000.00	33,673.58	38,824.00	692,235.16	25,711,246.77
A06	462,912.16	12,107.97	45,600.00	45,007.69	49,747.50	611,970.24	7,216,114.62
A07	1,216,912.34	17,298.50	132,000.00	131,729.66	148,868.00	1,533,356.72	36,202,293.17
A08	604,481.10	8,909.64	84,000.00	45,299.73	51,196.90	524,880.95	10,782,692.52
A09	913,491.58	10,106.95	396,000.00	100,378.98	113,106.00	1,208,312.16	75,761,203.18
A10	1,204,685.09	12,250.62	108,000.00	101,555.31	120,911.90	1,284,533.68	15,222,248.77
A11	697,367.74	13,316.46	210,493.92	61,486.71	67,969.00	899,197.77	18,649,429.02
A12	568,515.67	6,699.50	132,000.00	50,881.29	56,894.50	769,922.55	23,333,484.22
A13	260,252.92	3,788.70	18,000.00	35,712.58	42,241.80	224,744.28	2,152,091.39

APPLYING DEA MODELS

Since, the number of factors are 7 in comparison with 13 selected DMUs,as Table 3 illustrates, Charnes, Cooper and Rhodes (CCR) [1] and weighted ADD in Constant Returns to Scale (CRS) [5] are not able to discriminate between DMUs appropriately.

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Table-3: The results of CRS DEA models

DMUs	CCR	ADD	10^{-8}-KAM	Rank	References with 10^{-8}-DF	10^{-6}-KAM	10^{-4}-KAM
A01	1	1	0.9999999958	5	A01, A02	0.99999958	0.99995835
A02	1	1	1	1	A02	1	1
A03	1	1	0.9999999966	4	A02, A03, A13	0.99999966	0.99996555
A04	1	1	0.9999999396	9	A01, A04, A07, A09	0.99999396	0.99939639
A05	0.9984	0.5248	0.5247779848	13	A02, A10	0.52477112	0.52408662
A06	1	1	0.9999999797	8	A06, A07	0.99999797	0.99979732
A07	1	1	0.9999999991	3	A02, A07	0.99999991	0.99999135
A08	0.9527	0.5581	0.5580877610	12	A02, A07	0.55808760	0.55807151
A09	1	1	1	2	A02, A09	1	0.99999954
A10	1	1	0.9999999894	6	A01, A07, A10	0.99999894	0.99989434
A11	0.9647	0.5722	0.5722238358	11	A01, A02, A07, A09	0.57222343	0.57218242
A12	0.9887	0.9619	0.9618739498	10	A01,A03, A07, A09, A10	0.96187306	0.96178428
A13	1	1	0.9999999807	7	A07,A13	0.99999807	0.99980741

There are 9 technically efficient DMUs, A01, A02, A03, A04, A06, A07, A09, A10 and A13. These 9 DMUs only refer to itself to benchmark the relative efficiency. According to Smith [8] as the variables increases, the ability to discriminate between the DMUs decreases. Raab and Lichty [9] suggested a general rule of thumb where the minimum number of DMUs is greater than three times the number of inputs plus outputs. However, Khezrimotlagh et al. [3] suggested a robust model, KAM, which can easily discriminate between DMUs with no specific conditions.

In order to apply KAM, the value of epsilon is introduced as 10^{-8} [10]. Indeed, data are quite large and the small values of epsilon makes a very small and negligible thickness in the frontier. The thickness of the frontier is 0.0436 while $\varepsilon = 10^{-8}$. Column 4 of Table 3 illustrates the best technically efficient scores of DMUs with 10^{-8}-degree of freedom (DF). There are only 3 efficient DMUs with 10^{-8}-DF, such as A02, A07 and A09when $\delta = 10^{-9}$ [3, 10]. A02 is the best customer service centres of telecommunication company followed by A09 and A07.Columns 4-5 illustrates the rank and reference sets for each DMU. Even if the value of epsilon is selected as 10^{-6} or 10^{-4} the rank of DMUs are not changed as shown in the last two columns of Table 3. Indeed, when the diameter of the forntier is introduced thicker and thicker, the relative efficiency scores of DMUs are still appropriate to discriminate DMUs.

CONCLUSION

This paper illustrates an application of KAM on 13 telecommunication customer service centres in Malaysia by considering 7 factors. KAM simply ranks all centres, shows the reference sets for each centre and identify the most efficient centres.

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