Data Envelopment Analysis (DEA) Evaluation Framework of Hotel Services

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Abstract: - Hotels are one of the serviced-based industries that contribute to the positive growth of modern economic of Malaysia through tourism activities. Due to this fact, the Malaysia government has included this sector into the Ninth Malaysia Plan and provided a lot of incentive to boost its performance. Thus, there is a need of mechanism to measure the performance of this industry to ensure it is on a good track. This research aims at designing a framework of Data Envelopment Analysis (DEA) in order to evaluate the performance of hotels. The main objectives of this research are to develop DEA framework for analyzing hotel performance and to evaluate the DEA framework using a set of data. For this purpose, a CCR models has been adopted and the implementation is done using the LINGO software. Based on previous study, seven inputs and three outputs as indicator of the hotel efficiency and productivity have been identified. Using these variables, a set of questionnaire has been constructed and distributed to 20 hotels in Ipoh. Only 16 hotels gave cooperation but the sample is quite diversified. All of the data collected are used to test the model that measures the efficiency, rank and benchmarks of the hotels. The findings of this hotel, in year 2009, three hotels are efficient which rated as 4 star and 3 star hotels. The most inefficient hotel scored only 0.1125 which fall under 1 star hotel. Finally, the researchers suggest that a similar study is done using Artificial Intelligence (AI) to overcome limitations of DEA approach.

Key-Words: - **Framework, Hotel services, Data envelopment analysis (DEA), Decision making unit, CCR model, Ipoh**

1 Introduction

The competitiveness of a country derives from the performance of its enterprise. The tourism industry has been identified as one of the key driver of the Malaysia's economic growth. This is reflected in the tourism receipts that have increased steadily from RM 17.3 billion in year 2000 to RM 52.3 billion in year 2009 (Ministry of Tourism Malaysia, 2010). The amount of receipts collected come from various activities offered by tourism industry in Malaysia. There are comprises of hotels, resort, lodging, tour services, travel agencies, restaurant and transport companies.

In order to encourage the positive growth of tourism industry, in the Ninth Malaysia Plan,

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tourism sector has been identified as one of the eight services sub-sectors to be focused for further development during the Third Industrial Master Plan (2006-2020). One of the planning is providing a lot of incentive for the hotel's owner to open up more hotels in Malaysia. A report done by Malaysia Association of Hotels (MAH) has shown that 35% of new hotels have been developed from 2005 until 2010 at various locations and registered with them.

As the number of hotel increased, the hotel enterprises must formulate competitive marketing strategy, strengthen corporate operation and upgrade quality of services. Hotel enterprises are one of the service-based industries that need to make great effort in improving their quality services and delivering a superior service quality. Service quality is an attitude or global judgment about the superiority of a service [1]. In general, to be part of the globally competitive industry, one needs to perform well by providing a service that exceeds customer's expectation. According to Gupta (2007), the success or failure of an organization is determined purely on service quality provided. Companies and organizations that virtually every industry employs customer satisfaction measures for the straightforward reason that satisfied customers are essential for a successful business. It is the ultimate goals of an organization as the customer are the greatest resources for both short-term and long-term survival of a company.

As stated by Martin (2002), the practice of excellent service quality has been proven to lead increased customer satisfaction. The level of customer satisfaction may be influenced by various attributes from external and internal factors. Therefore, majority of the hotel enterprises allocate a certain budget for them to spend in physical and material entity such as, renovation on interior design and investing on information and communication technologies (ICT) software and hardware. These are all done solely on protecting and maintaining their relationship with their customer for a long-term interest.

In order to sustain the relationship with their customer, hotel management needs to measure the performance of services provided. Performance is measured either by productivity or efficiency [4]. Productivity is defined as the ratio of outputs over inputs whereas efficiency is defined as a process that uses a lowest amount of input to create greatest amount of output [5]. Both factors are considered as relative measurements therefore a specific instruments is needed to measure them. Due to those constraints, a non-parametric, multivariate technique called Data Envelopment Analysis (DEA) is used. This study will design a framework that evaluates the performance of hotel services with DEA techniques. The framework is tested by collecting data of hotels in Ipoh.

2 Literature Review

DEA has been widely used by researcher to measure efficiency and productivity. It was first introduced by Charnes and friends year 1978. This mathematical, non-parametric technique describes the mathematical programming approach to the construction of production frontier and measurement of efficiency of developed model. According Carlos (2005), DEA is a productivity analysis tool that considers multiple input and output measurement in evaluating relative efficiency. DEA does not require prior assignments of financial performance to be utilized in order to complete the evaluation process. This approach has been is suitable to be applied to unit assessment of homogeneous such as banks, hospital and hotels. The unit of assessment is normally referred to as decision making unit (DMU) which converts input into output.

Charnes et al (1978) has proposed the first DEA model as CCR that had an input orientation and assumed constant-returns- to- scale (CRS). The second DEA model has been proposed that introduced the assumption of variable returns-to-scale (VRS) which is known as BCC model. The second model of DEA is proposed by Banker and friends in year 1984. Apart of these two prominent models, there are other less common DEA models in the literature. There are the addictive models introduced in year 1985, the multiplicative model in year 1982, the cone ratio model in year 1990 all proposed by Charnes and friends , the assurance region DEA model introduced by Thompson and friends in year 1990 and the super-efficiency model proposed by Anderson and Peterson in year 1993.

For this purpose of this study, the first model, CCR has been adopted as the model has been proven to produce a good result in terms of comparing input and output for the entire homogeneous unit and the ability to evaluate performance of other alternative unit [6]. For example, Figure 3.4.1 illustrates seven decision making units (DMU). For each DMU used one input (x) to produce one output (y). The DEA will identify

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a set of corresponding efficient units that can be utilized as benchmarks for improvement. A set of the less efficient unit can be identified by partitioning with a series of metrics that measures various distances from the hyperlane from its facets [7].

Based on the diagram, a set of DMU that can be considered as benchmark are DMU 1, 3, 4, 6 and 7 while DMU 2 and 5 are inefficient DMU. This example shows that the organization can improved the performance of its services improved by reducing the number of input or increasing the output.

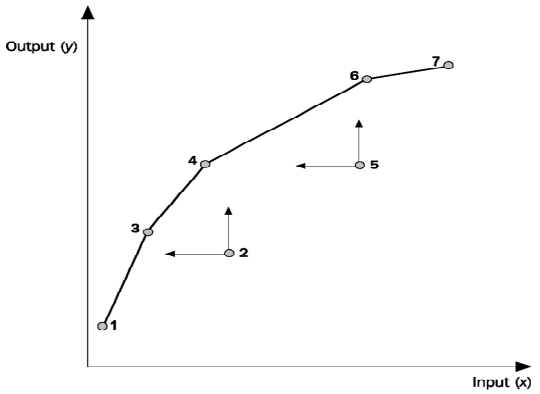

Fig. 1: Efficiency Production Function

Maximize: $$h_0 = \frac{\sum_{j=1}^{s} w_j y_{j0}}{\sum_{i=1}^{r} v_i x_{i0}} \quad (1)$$

Subject to:

$$\frac{\sum_{j=1}^{s} w_j y_{jm}}{\sum_{i=1}^{r} v_i x_{im}} \le 1 \qquad m = 1,2,...,\ n \quad (2)$$

$$w_j \ge 0; \qquad j = 1,2,...,s$$
$$v_i \ge 0; \qquad i = 1,2,...,r \quad (3)$$

where:

y_{j0} = the jth outputfrom DMU_0

x_{i0} = the ith input from DMU_0

w_j = the weightage variable for the jth output

v_i = the weightage variable for the ith input

n = number of DMU

s = number of input

r = number of output

where the unknown weight w_j and v_i are estimated by DEA on the base of data in order to obtain a relative efficiency measure for each unit. For this purpose, DEA arranges optimization contingent on each DMU performance to convert input into outputs in relation to the performance of all DMUs [8]. The weights of each DMU are separately estimated such that the efficiency level can be the maximum attainable.

Based on the CCR model, equation (1) accommodates the case of multiple outputs and

The CCR model laid down the following ratio form of DEA for evaluating DMU_0:

multiple inputs. The model seeks a set of w and v values which maximize h_0. In this fractional model, DMU_0's maximum efficiency score will be $h_0<1$ by virtue of constraints. The value h_0 obtained from the model will satisfy $o<h_0<1$, and in terms of efficiency rating, $h_0 =1$ represent full efficiency and $h_0<1$ indicates inefficiency is present. There are two ways of carrying out DEA: input oriented where a given level of output is achieved with the minimum amount of input and output oriented where the output is maximize for a given level of input.

However, most researchers believe that DEA has drawn a few limitations [9]. One of the drawbacks are the issues of sample size [4][10][11]. The sample size has a major impact on the entire result. A higher number of DMUs will increase the chance of encountering units close to the production frontier. Secondly, the DEA model does not provide prediction of the organization performance due to its limitation to prepare a model to be extended outside the database. As a result, DEA is said to be sample specific, which means that the outcome of the DEA model only applicable to that particular data. In other words, the analysis of DEA model is not suitable to be compared with a theoretical maximum [9].

Nevertheless, DEA model has been adopted as a new tool in operational research for measuring efficiency since it was first introduced. A lot of research has been done using DEA in measuring servicing industry performance, for example hotel efficiency. The analysis of hotel efficiency is restricted to papers researching in Europe, the USA and other countries in Asia (refer to Appendix B). This research will fill in the gaps by providing a

framework of selecting suitable metrics of input and output in order to investigate the performance of hotel services. For the purpose of this research, hotels in Ipoh have been selected as case study.

3 Result and Analysis

3.1 Respondent profile

In this study, a set of questionnaire have been sent to 20 hotels around Ipoh. Majority of the respondent reluctances to share the information as the data required is considered confidential. In order to increase responses, we personally met the manager and fortunately 16 hotels gave full cooperation. The respondents represent a diversified sample. It consists of 4 stars, 3 star 2 star and 1 star hotels which operating on valid license (refer to Table 1).

Table 1: Characteristics of Hotels In Ipoh 2009

Bil	DMU	Star	No. Rooms	Average Price	Occupation Rate (%)	No. Staff
1	Hotel A	4	200	245	100	341
2	Hotel B	4	250	245	98	299
3	Hotel C	3	200	288	95	236
4	Hotel D	3	150	250	85	165
5	Hotel E	3	120	200	85	142
6	Hotel F	3	262	198	65	249
7	Hotel G	3	120	120	97	185
8	Hotel H	3	290	190	100	231
9	Hotel I	3	100	180	85	120
10	Hotel J	3	86	169	98	112
11	Hotel K	2	45	70	50	35
12	Hotel L	2	111	119	80	83
13	Hotel M	2	29	99	45	28
14	Hotel N	2	25	70	55	33
15	Hotel O	2	120	80	55	42
16	Hotel P	1	15	55	25	10

Table 2 represents the characteristics of the respondent data and verifies that majority of hotels in Ipoh are considered small scale of hotels where the mean of worker and rooms are 131 and 120 respectively. A high average cost of labor and operational cost which are estimated RM9087.61 and RM 65844.11 respectively, because of two 4 star hotels in the sample. As these two hotels are one star above from the other units, logically they are spending more on laboring and operating costs to ensure their sophistications.

Food and Beverage (F&B) capacity mean is stated as 185. As 3 star hotels are predominate units in this sample, it affects the average number of restaurant and banquet seat. In fact, a 1 star hotel in this sample does not serve meal in their services. Most of the hotels have restaurant that able to accommodate 100 to 300 seats per occasion. However, the 4 star hotels and a couple of 3 star hotels do have ballrooms for customer to rent.

Table 2: Statistic Characteristic of The Input And Output For Year 2009

Variables	Units	Range	Mean
Output:			
Sales	Value in Ringgit Malaysia (RM)	232.114 - 1254360.48	654177.832
Number of guest	Number	1851 - 25367	8210
Night spent	Number	1722 - 28310	9018
Input:			
Full time and part time worker	Number	341-10	131
Cost of labor	Value in Ringgit Malaysia (RM)	11070.69 - 578111.80	90871.613
Rooms	Number	10-290	120
Operational cost	Value in Ringgit Malaysia (RM)	1274 - 552631.32	65844.11
External cost	Value in Ringgit Malaysia (RM)	175.50-268143.36	55360.25
F&B capacity(banqueting and restaurant seats)	Number	0-3500	185
Demand variability	Number	-	-

3.2 DEA empirical result

The implementation of CCR DEA model is done using the LINGO software. The application is programmed to accept seven inputs and three outputs as discussed in the research methodology. This program is coded to employ DEA equations and produces results containing the efficiency scores, benchmark and ranking. The results obtained from the DEA assessment will provide some insight to the efficiency and inefficiency level of each hotel in sample.

As depicted in Table 3, the average efficiency score across all hotels is 0.7709 where three out of 16 hotels are rated as most efficient by scoring 1.0000. These hotels are Hotel A, Hotel B and Hotel H. Hotel A and Hotel B are under 4 stars rating while Hotel H is rated 3 stars. Five hotels that close to full efficiency, Hotel C, Hotel D, Hotel E, Hotel F and Hotel G, where above the mean level, 0.7709. All of these hotels are rated as three star hotels. The rest of the sample, are designated as inefficient. Hotel P has the lowest score, 0.1125, indicating that this hotel is way below the average efficiency level. It is obviously difficult for the hotel to be efficient in the short-term. It will remain inefficient until there is a major change in terms of its operating and marketing strategy.

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Table 3: Results of Efficiency, Benchmarks and Ranking For The Hotels In Ipoh

Bil	DMU	Technical Efficiency, constant return to scale index (CCR model)	Benchmark	Frequency	Rank
H1	Hotel A	1.0000	H1	5	1
H2	Hotel B	1.0000	H2	9	2
H3	Hotel C	0.9736	H1,H2	0	4
H4	Hotel D	0.9120	H2	0	6
H5	Hotel E	0.9014	H1	0	7
H6	Hotel F	0.9562	H8	0	5
H7	Hotel G	0.8493	H2	0	8
H8	Hotel H	1.0000	H8	5	3
H9	Hotel I	0.6235	H1,H2	0	10
H10	Hotel J	0.4857	H2	0	13
H11	Hotel K	0.5231	H2	0	12
H12	Hotel L	0.6925	H1,H2	0	9
H13	Hotel M	0.5830	H2	0	11
H14	Hotel N	0.4230	H8	0	15
H15	Hotel O	0.4251	H8	0	14
H16	Hotel P	0.1125	H8	0	16
Mean		0.7709			
S.Deviation		0.2718			
No. Efficient		3			

The results shown in Table 3 also reveal some information on benchmarks and ranking of the hotel. Benchmarks or peer referent can be interpreted in two ways:

a) The inefficient unit can refer the benchmarks as role model for them to become efficient.
b) The efficient unit will acknowledge numbers of inefficient unit that used them role model.

From this study, Hotel B is the most frequently used as benchmarks by other less efficient unit. Other hotels can emulate the efficient hotel in order to improve their performance and productivity.

Referring to both Tables 1 and 3, the most efficient hotels are rated as 4 stars while only one hotel comes from 3 stars. The common factors shares by these three hotels are the number of rooms provided and the occupancy rate. It is worth noting that these outstanding performances were achieved in different regimes of price system, competition level and scale operations. This research also discovers that a 2 star rating hotel can be more efficient than 3 star hotel as shown by Hotel K and Hotel J. From the data of both hotels, Hotel J spent more on laboring and operating cost but the numbers of guest are lower compare to Hotel K. The 12th ranked hotel performs well under low operating cost by reducing the laboring cost and apparently allocating more on Food and Beverage division. This particular hotel is well known in Ipoh for providing excellent services for their restaurant and banquet.

Based on survey done during this research, there are only two factors that can increase the hotels' revenue namely, the food provided and on-going promotions. Most of the hotel manager believes that these two factors are playing crucial part in expanding their business as majority of their customer are form the local people. The lacks of the tourist come to Ipoh affecting the income of these hotels. The reasons behind this are most of the places of interest located out of the city. Seasonal tourist can be lure during the school holidays and Malaysia's festival. In order to maintain the hotels, the management prefer to hired part-time worker compare to full-time worker. This wills definitely reduce the labor expenses.

Referring to the statistical result of the model designed, the most efficient hotel is those with lower labor and capital cost and higher number of sales. One strategic marketing planning is to increase number of sales. This is widely applied by the efficient hotels as they are apparently aggressive in promoting on the third party system and on Internet. The hotels managements are also spending on hands-on training for their full-timer worker in order to prepared and upgrade the knowledge and skills. In turns, the staffs become valuable assets to the hotel as they become more efficient and productive. Combining these strategic planning, it certainly scores well among their loyal customers.

4 Conclusion

The main objectives of this research are to design a DEA framework to evaluate the performance of hotel services. The outcome of this study will assist the management of hotels in making a good decision in terms of increasing their revenue and focusing on their strength. This is done by identifying the internal and external factors that will contribute to their overall performance.

A well perform hotels are those that able to manage all their resources, reducing the expenses and at the same time sustaining their relationship with their customer. In order to achieve these goals, this research identifies seven input and three output variables to measure the performance of the hotels. The outcome of this research will beneficial to the management as each input and output selected are rated as efficient or inefficient. Therefore, the management will make a good decision and strategy plan for the benefits of the hotel.

The diversity of the sample also helps in validating the DEA model designed. The most efficient unit comes from the 4 stars rating hotel which they have sufficient budget to invest in marketing and hiring adequate staff. As mentioned in previous section, the main focus of the majority of Ipoh's hotel is on restaurants and banqueting

which constitute 80% of total revenues of hotels. Most of the marketing strategy plans are done on food promotion and banquet functions. They are willing to spend on renovation of the restaurants and ballrooms as well as state of the art audio-visual equipment.

This framework also able to differentiate between high-perform hotel and low-perform hotels using ranking system. With this system, the hotel management will able to have a valuable insight of situation among their competitors and the customers. The framework also helps in identifying the most suitable model of peer group by introducing the benchmarks for the less efficient hotels. This benchmarking strategy will group hotels with similar characteristic and identify which hotels should be emulated.

There are a few limitations of this model. Since the DEA are non-parametric techniques, the problems lies on the incommensurability of different output measurement as well as input measurement. The DEA model also disable to measure performance of a hotel for years as it will cater on current state and current data. These shortcomings can be overcome by using different approach or model. It is recommended that Artificial Intelligence (AI) techniques, specifically neural network, are adopted. AI has the capability of measuring and optimizing fuzzy data. This cannot be done using DEA. For future enhancement, a comparison between two types of frontier model, namely DEA and stochastic frontier regression (SFR) might able to produce a better analysis of efficiency and productivity.

As a conclusion, from this framework, three hotels in Ipoh are lie on the efficiency frontier in 2009. Five hotels are perform relatively well by scoring above the mean efficiency level of 0.7709 and there are eight hotels performed below the mean efficiency level.

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