

DATA ENVELOPMENT ANALYSIS TO MEASURE EFFICIENCY OF HOTELS IN MALAYSIA

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ABSTRACT

Performance evaluation has become an important improvement tool for hotels to be sustainable in today's highly competitive environment. Although the evaluation of hotel efficiency has been approached from various perspectives, difficulties were encountered when multiple inputs and outputs relative to a hotel's performance needed to be considered. The purpose of this paper is to examine Malaysian hotel efficiency by adopting an approach using a framework of non-parametric programming – Data Envelopment Analysis (DEA). DEA is very useful for application in a multiple inputs and outputs settings where it combines them objectively into an overall measure of organisational efficiency called the Malmquist's Total Factor Productivity (TFP) index. It is concluded that DEA can be used to measure the efficiency of Malaysian hotels.

1.0 Introduction

Malaysia is one of Asia's most popular tourist destinations, attracting 20.9 million tourists in 2007. Tourist receipts have also increased from RM36.3 billion in 2006 to RM 46.1 billion in the year 2007 (Ministry of Tourism, Malaysia, 2008). The statistics have shown that the tourism industry has emerged as an important sector of the Malaysian economy by virtue of the amount of receipts collected from its activities.

The tourism industry in Malaysia comprises hotels, resorts, lodgings, tour services, travel agencies, restaurants, catering services and transportation. The scope of tourism services has progressed from supplying services or mass products and markets to more innovative tourism packages. These include eco-tourism, edu-tourism, health tourism, sports tourism and event organisation (meetings, incentives, conferences and exhibitions).

In the Ninth Malaysia Plan, the tourism industry in Malaysia has been identified as having potential to increase its contribution to the service sector in particular and the economy in general. Indeed, under the Third Industrial Master Plan (IMP3) (2006-2020), tourism services have been identified as one of the eight service sub-sectors to be focused for further development during the IMP3 period. With the aim to enhance Malaysia as one of the global tourism destinations, the hotel sector, being one of the sectors in the tourism industry, plays an important role to maintain and improve its performance in order to contribute to the realisation of the plans.

Although hotels remain dominant in the travel accommodation sector in Malaysia, accounting for 85% (RM10, 738.4 million) of total travel accommodation value sales in the year 2006, hotel sales did not grow in tandem with the increase in arrivals and domestic trips. Hotel sales only grew by 4% as compared to the sales in year 2005 (RM10, 311.9 million) (Euromonitor, 2007). Oversupply of rooms and stiff competition among hotels

have driven down room rates (via discount and promotion). Meanwhile, some tourists opt for alternative accommodation such as campsites, motels, self-catering apartments, chalets, guesthouses, hostels, private accommodation and others (Euromonitor, 2007). As the result of oversupply of rooms, contribution from the hotel sector was severely affected. Therefore, there is a need to improve the efficiency of hotels.

In the face of a highly competitive environment and the rapid expansion of hotels arising from market demand and the changing economic climate, it is important for hotels to formulate marketing competition strategies, strengthen corporate operations and upgrade the quality of services. In formulating competition strategies, one must first measure the comparative performance of the entire industry, before one may understand one's strengths and weaknesses. Performance evaluation serves as an important reference for planning and construction policies. Therefore, to survive and be sustainable in the sector, it is very important for top management of hotels to find ways to improve their efficiency.

This study aims to measure the efficiency of the hotels operating in Malaysia. Consequently, this study will embark with the following objectives:

- To identify the best practices for hotels with regards to efficiency.
- To determine the factors contributing to the efficiency of the hotel.

2.0 Literature Review

2.1 Measurement of Efficiency

Efficiency measurement is an integral part of management control. It can be used not only as a reference in decision making, but also as the basis for improvements. Therefore, measurement of efficiency has become an important and broad-scope subject. Managers, economists and other researchers have attempted to accurately measure the efficiency of the hotel industry for many years using various approaches.

There are various methodologies employed in efficiency measurement. Some of the researchers focus on performance indicators such as cost-volume-profit analysis (Fay *et al.*, 1971; Jaedicke *et al.*, 1975 and Coltman, 1978), the lodging industry's sales receipt information (Van Doren & Gustke, 1982), the concept of perishable asset revenue management to measure performance (Kimes, 1989), lodging index (Wassenaar & Stafford, 1991), the RevPar (revenue per available room) index (Ismail *et al.*, 2002), a revenue performance indicator (Baker & Riley, 1994), and an efficiency indicator (Wijeysinghe, 1993). Cost-volume-profit analysis was introduced as a method to provide information on the profitability of a firm in relation to volume. It is useful in the business planning phase as well as in testing or evaluating forecast and in breakeven analysis. Besides, it can be applied to analyse an individual firm's performance and used at a regional level to compare various types of firms (Fay *et al.*, 1971; Jaedicke *et al.*, 1975 and Coltman, 1978).

The lodging industry's sales receipt information had been used to evaluate the industry's performance (Van Doren & Gustke, 1982). The researchers examined economic growth in various states and selected standard metropolitan statistical areas by evaluating aggregate receipts and per capita receipts. Anderson *et al.* (1999) indicated that this technique does not examine cost efficiency issues and does not provide a method of determining optimal

performance. Although this technique is useful in assessing hotel performance in aggregate, it provides no firm specific measures of performance. Meanwhile, Kimes (1989) applied a technique based on the concept of “perishable asset revenue management” to measure performance (PARM) in the hotel industry. PARM can be used by management to determine the optimal trade off between average daily rates and occupancy rates. PARM technique has the basic idea of charging the right price in order to select the right customers to fill the rooms while achieving the highest possible revenues.

On the other hand, Wassenaar & Stafford (1991) suggested the use of a lodging index indicator for the hotel/motel industry. The authors defined lodging index as the average revenue realised from each room, vacant or occupied, within a region or city during a given time period. The index is particularly effective for local travel destinations where average occupancy and room rates are not available. The index combines average occupancy and room rates into a single indicator but this method does not examine how efficiently firms are controlling costs. Baker & Riley (1994) introduced revenue performance indicator for the lodging industry such as the revenue/wage, gross profit/revenue, and net profit/revenue. While, Wijesinghe (1993) presented a method for calculating breakeven room occupancy that provides accurate calculations together with a system of effective management. The “general indicator to hotel efficiency” (GITHE) was suggested as a way to analyse the source of loss and thus give a better control of the business.

These performance indicators provide important and useful information for benchmarking based on accounting and financial performance in terms of simple ratios, but there are in fact many factors relative to hotel performance, and obviously these indicators have not taken into account the mix and nature of services provided. As suggested by Anderson *et al.* (1999), measuring the relative efficiency of a hotel requires methods that are more sensitive than accounting and financial ratio measures and that can explicitly consider various inputs and outputs of the hotel.

2.2 Data Envelopment Analysis

Some researchers employed DEA to measure efficiency. DEA is a non-parametric technique that was first introduced in the literature in 1978. Charnes, Cooper and Rhodes (1978) are the first who introduced the DEA to describe the mathematical programming approach to the construction of production frontiers and the measurement of efficiency of developed frontiers. The authors proposed a model (CCR, named after the authors) that had an input orientation and assumed constant returns-to-scale (CRS). However, the later study considered an alternative set of assumptions. Banker, Charnes and Cooper (1984) first introduced the assumption of variable returns-to-scale (VRS). This model is known as the BCC model.

Apart from the CCR and BCC models, there are five other basic DEA models, less common in the literature: the additive model (Charnes, Cooper, Gollany, Seiford & Stutz, 1985), the multiplicative model (Charnes, Cooper, Seiford & Stutz, 1982), the cone-ratio DEA model (Charnes, Cooper & Huang, 1990), the assurance region DEA model (Thompson, Langemeier, Lee & Thrall, 1990), and the super-efficiency model (Anderson & Peterson 1993). The additive model was used to identify input excesses and output shortfalls simultaneously. The cone-ratio and the assurance region models include *a priori*

information (for example, experts' opinion, opportunity costs, rate of transformation or rate of substitution) to restrict the results to the single best-performing decision making unit ,DMU, (assurance region model) or linking it with multi-criteria analysis (cone-ratio model). On the other hand, the super-efficiency model gives efficiency scores by eliminating the data on the DMU to be evaluated from the solution set. For the input model this can result in values which give the DMU the status of being "super-efficient". These values are then used to rank the DMUs and thereby eliminate some (but not all) of the ties that occur for efficient DMUs.

Other developments of DEA include the disentangling of technical and allocative efficiency (Anderson, Fok & Scott, 2000) and the Malmquist TFP index (Malmquist, 1953). Anderson, Fok & Scott (2000) defined allocative inefficiency as deviations from the efficient frontier that result from the failure of managers to use the optimal input mix in the production process. Whereas technical inefficiency as the product of pure technical inefficiency and scale efficiency in which pure technical represents failure to fully utilise inputs, given their allocation; and scale inefficiency represents failure to operate at constant returns to scale. In contrast, TFP measures productivity by obtaining an output-to-input ratio value which take into consideration all significant inputs and outputs. TFP approach is useful theoretically and empirically. TFP indices bring a strong theoretical basis in economics to its analysis as it can be derived from the theory of production functions. From a practical perspective, TFP indices are easier to understand than other nonparametric indices (Nyshadham & Rao, 2000). The Malmquist TFP index gained importance mainly because it can be calculated without price data, a distinct advantage if price information is unavailable or if prices are distorted.

The two scientific methods used to analyse efficiency quantitatively are the econometric frontier and DEA. However, both methods have their advantages and drawbacks. Unlike the econometric stochastic frontier approach (Anderson *et al.* 1999), the DEA allows the use of multiple inputs and outputs (Bell & Morey 1995; Morey & Dittman 1995). Moreover, since it is estimated with a nonparametric methodology (DEA), there is no need to impose any functional form on the data, or to make distributional assumptions for the inefficiency term.

Both methods assume that the production function of the fully efficient decision unit is known. In practice, this is not the case and the efficient isoquant must be estimated from the sample data. Therefore, the frontier is relative to the sample considered in the analysis. DEA is applied to unit assessment of homogeneous units such as banks, hospitals and hotels. The unit of assessment is normally referred to as a DMU which converts inputs into outputs. The identification of DMUs, inputs and outputs in an assessment is as difficult as it is crucial (Barros, 2005).

The DEA approach represents a method by which non-commensurate multiple inputs and outputs of an entity can be combined objectively onto an overall measure of organisational efficiency. DEA is also a benchmarking technique that assesses the relative efficiency of DMUs. Researchers interested in service industry performance have applied DEA to some sectors including banking (Angelidis & Lyroudi, 2006), nursing (Hsu & Hu, 2007) and insurance (Mahajan, 1991).

2.3 DEA-Based Studies in Hotel Industry

In the tourism literature, the analysis of efficiency is limited to a small number of studies, which focuses on the analysis on micro-units (e.g., hotels, corporate travel departments, etc.). Among the earliest, Morey & Dittman (1995) used data envelopment analysis to evaluate the general-manager performance of 54 hotels of an American tourism chain for the year 1993.

DEA was also used by several other researchers in hotels. Sanjeev (2007) evaluated the efficiency of 68 hotel and restaurant companies operating in India using the DEA methodology. The study found that the average score for all the companies as a group stands at 0.73 and thus, the hospitality industry is perceived as doing well.

Hwang & Chang (2003) used data envelopment analysis and the Malmquist TFP to evaluate the managerial performance of 45 hotels in 1998 and the efficiency change of 45 hotels from 1994 to 1998. The authors found that there was a significant difference in efficiency change due to a difference in sources of customers and management styles. Barros & Mascarenhas (2005), again using data envelopment analysis, measured the technical and allocative efficiency of 43 hotels in Portugal for the year 2001. Whereas Anderson *et al.* (2000) used the DEA-stochastic frontier approach to estimate average and firm-specific efficiency level in 48 hotels.

Meanwhile some studies employed DEA with other innovative measures to evaluate efficiency. Sun (2004) measured the hotel performance of 47 international tourist hotels in Taiwan for the period of 1997 to 2001 on various dimensions. The researcher used a production approach to design three performance models, which are managerial performance, room department performance and catering department performance. An exhaustive survey coupled with DEA has been done by Barros (2005) to evaluate the efficiency of individual hotels belonging to the Portuguese state-owned chain, Pousadas de Portugal. The author found that this technique can be used for the analysis of intrachain comparative hotel efficiency as well as to examine the competitiveness of the chain as a whole.

2.4 Variable Identification (Inputs and Outputs)

Bell & Morey (1995), looked at hotel efficiency, evaluated 31 travel departments and estimated their efficiency ratios using frontier models with the help of DEA. The researchers used four inputs: (1) actual levels of support costs (fees, labour, space, and technology), (2) actual levels of expenditure on travel (hotel, flight and car rental charges), (3) levels of environmental factors (means of negotiating discounts, percentage of trips with commuter flights required), and (4) nominal levels of other expenditures. The level of service provided (excellent and average) was used as the only outputs.

Meanwhile, Morey and Dittman (1995) also probed the efficiency of 54 hotels using DEA. The authors treated nine inputs: (1) salaries, (2) energy costs, (3) fixed market expenditure, (4) room division expenditure, (5) non-salary expenses with property, (6) non-salary expenses with administrative work, (7) non-salary expenses with variable advertising, (8) payroll and related expenses for administrative work, and (9) salaries and related expenses

with variable advertising. Four outputs were selected: (1) market share, (2) rate of growth, (3) total revenue and (4) level of service provided.

On the other hand, Johns, Howcroft and Drake (1997) used simple inputs and outputs that have no ratio or composite data. The researchers preferred non-financial data to be used in the analysis. The following four inputs and three outputs were being employed: (1) number of room nights available, (2) total labour hours, (3) total food and beverage costs, (4) total utilities cost; and (1) number room nights sold, (2) total covers served and (3) total beverage revenue. The use of the financial data such as beverage revenue, food and beverage material costs and utility costs was inescapable but their use were justified on the basis that they were constant across the country and constant with respect to time.

By using the DEA approach, Anderson *et al.* (2000) also evaluated the efficiency of 48 hotels. The authors estimated their allocative and technical efficiency by using cross-sectional data on prices, inputs, and outputs. Five inputs were chosen: (1) number of rooms, (2) full-time equivalent workers, (3) total gaming-related expenditure, (4) total expenditure on food and beverages and (5) various other expenditures. However, only two outputs were considered: (1) total revenue and (2) other revenue. While, Barros (2004) analysed the efficiency of a Portuguese public-owned hotel chain, ENATUR by using a stochastic cost frontier. The researcher measured the price of three inputs: (1) price of labour, (2) price of capital and (3) price of food. To compute the output, the value of sales and the number of nights occupied were being used.

3.0 Methodology

This research will apply a non-parametric approach, Malmquist TFP to measure the productive efficiency of selected Malaysian hotels. This index represents TFP growth of a DMU, in which it reflects (1) progress or regress in efficiency along with (2) progress or regress of the frontier technology between two periods of time under the multiple inputs and multiple outputs framework (Cooper, Seiford & Tone, 2007). This study employs the output-based approach where the question “By how much can output quantities be proportionally expanded without altering the input quantities used?” can be asked. In this study the productivity change is decomposed into two components namely, technological change (TECHCH) and technical efficiency change (EFFCH). EFFCH shows that the hotel can be more productive by utilising the existing technology and economic inputs more efficiently. TECHCH refers to the growth in TFP as a result of the technological advancements and innovations in the hotel system.

Malmquist productivity index measures the TFP growth between two data points by calculating the ratio of distances of each data point relative to a common technology. Fare *et al.* (1994) specifies an output-based Malmquist productivity change index between period t (the base period) and the period $t+1$ is given by:

$$M_o(y_{t+1}, x_{t+1}, y_t, x_t) = \left[\frac{d_o^t(x_{t+1}, y_{t+1})}{d_o^t(x_t, y_t)} \times \frac{d_o^{t+1}(x_{t+1}, y_{t+1})}{d_o^{t+1}(x_t, y_t)} \right]^{1/2}$$

where $d_o^t(x_{t+1}, y_{t+1})$ represents the distance from the period $t+1$ observation to the period t technology. A value greater than one indicates a positive TFP growth from period t to

period t+1 while a value less than one indicates a TFP decline. The decomposition is as follows:

$$\text{Technical efficiency change} = \frac{d_o^{t+1}(x_{t+1}, y_{t+1})}{d_o^t(x_t, y_t)}$$

$$\text{Technological change} = \left[\frac{d_o^t(x_{t+1}, y_{t+1}) \times d_o^{t+1}(x_{t+1}, y_{t+1})}{d_o^t(x_t, y_t) \times d_o^{t+1}(x_t, y_t)} \right]^{1/2}$$

The Malmquist TFP index can be written as:

$$\text{TFP} = \text{EFFCH} \times \text{TECHCH}$$

EFFCH measures the change in efficiency between current (t) and next (t+1) periods, while the TECHCH (innovation) captures the shift in frontier technology. In addition, the EFFCH can be further decomposed into a pure efficiency change (PECH) and a scale efficiency change (SECH) that reflects the use of sup-optimal scale of operations by firms, as below.

$$\text{TFP} = (\text{PECH} \times \text{SECH}) \times \text{TECHCH}$$

3.1 Input and Output Measures

For the successful application of DEA, careful identification of inputs and outputs is important. Although resources used by DMU can be included as input, only six inputs will be chosen for this study. Inputs identified are number of room nights available, number of employees, book value of the property, total operating expenses, non-operating expenses and food and beverage costs. Six outputs will be selected, including number of room nights occupied, number of guests, average occupancy rate, total operating revenues, other revenues and food and beverage revenues. Table 1 lists both inputs and outputs variables to be incorporated in this study. The number of observations and the variables used will have to adhere to the DEA convention (Raab & Lichty, 2002) that the minimum number of decision making units is greater than three times the total number of inputs and outputs.

Table 1: Inputs and Outputs Measures

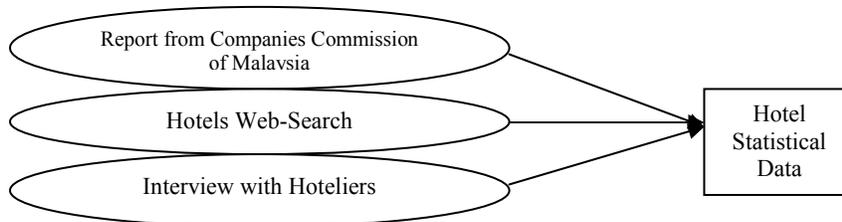
Inputs	Outputs
<ul style="list-style-type: none"> • Number of room nights available • Number of employees (full-time equivalent employees) • Book value of the property • Total operating costs (employee salaries, room costs, utilities, maintenance fees and other relevant operating costs) • Other expenses • Food and beverage costs 	<ul style="list-style-type: none"> • Number of room nights occupied • Number of guests • Average occupancy rate • Total operating revenues • Other revenues • Food and beverage revenues

The variables selected are based on the reviewed literature and the availability of the data. For example, total operating expenses including employee salaries, room costs, utilities

and maintenance fees that affect the profitability of hotels will be viewed as input. While on the output side, total operating revenues that significantly influence the financial efficiency of hotels will be included. As the profit measure alone might not be a good indicator of how efficiently resources were used to provide customer services, the average occupancy rate will also be included as output, because it reflects how efficiently room capacity was utilised as a result of invested expenses.

In order to maintain the homogeneity of the hotels for equitable comparisons, 50 of the hotels registered with the Malaysian Association of Hotels and rated from 1-Star to 5-Star based on the Star-Rating hotel classification schemes and operating for the year 2002 to year 2006 will be chosen for this study. These hotels are geographically dispersed over Peninsular Malaysia and East Malaysia. Panel data covering the observations on the input and output variables for all decision making units in all time period will be obtained from the Companies Commission of Malaysia. The hotels data in the report are commonly deemed valid and reliable. However, some hotels whose data was unavailable from the Companies Commission of Malaysia report will be derived through web-search and interview with the hoteliers. The panel data will be used in this study to determine the Malmquist productivity index of the hotels in Malaysia. The TFP indexes of hotels will be computed using the DEA programme (Coelli, 1996). Figure 1 shows the proposed method for the collection of the hotel statistical data.

Figure 1: Sources of the Hotel Statistical Data



4.0 Managerial Implication

As this research attempts to evaluate the efficiency of the hotel sector, the results of the study could be useful to the hoteliers. This research offers an option for managers looking to accurately assess efficiency or productivity. This research will provide Malaysian's hotel operators with insights into resource allocation and their competitive advantages. The assessment results will assist the hotel management in delivering better and efficient services to the customers.

The results of this study will separate the most efficient hotels from the non-efficient ones and will identify the top performers in the hotel sector. Thus, the study allows managers and researchers to identify hotels that are relatively efficient by comparing a group of hotels. This study also able to segregate the participating hotel into quadrant of efficiency. The findings could benefit hotels management seeking performance improvement in which they could benchmark practices being adapted by the most efficient hotels. The information could potentially served as a guide for other service industry to investigate into performance measurement.

5.0 Conclusion

This paper provides a review of previous literature for the efficiency measurement of hotels. While there has been extensive literature examining the efficiency of United States, European, Taiwan and India hotels over the recent years, the empirical work on Malaysia hotels is still lacking. This preliminary paper merely suggests that efficiency of Malaysian hotels can be estimated by employing a DEA model that take into consideration multiple inputs and outputs. The Malmquist's TFP index which can be decomposed into EFFCH and TECHCH is important in performance measurement as it will help in the determination of the factors contributing to the efficiency of hotels.

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