



Journal of Applied Sciences

ISSN 1812-5654

science
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Influence of Location on Dea Efficiency Measure Case Study from Taiwanese Hotels

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Abstract: In the face of a highly competitive environment, hotel's operational efficiency plays a crucial role in determining a hotel's profitability and competitiveness. Efficiency measures can provide hotel managers with benchmarking information and further insight of how the hotel can improve efficiency with its current resources or through changing resource allocation. This research initially adopted Data Envelopment Analysis (DEA) to measure the relative operational efficiency of 57 international tourist hotels in Taiwan. However, this DEA score only indicated the relative efficiency of all sample hotels and did not consider the role of location. This shortcoming was rectified through the construction of an area adjustment to reflect the effect of location on DEA efficiency. Implications for hotel management arising from this adjustment are discussed.

Key words: Data envelopment analysis, efficiency location, hotel

INTRODUCTION

The hotel industry in Taiwan is encountering a highly competitive environment due to the rapid expansion of hotels. For example, the total number of international tourist hotels has increased from 44 in 1985 to 68 in 2010 (Taiwan Tourism Bureau, 2012). However, due to inappropriate hotel management (Sun and Lu, 2005; Hwang and Chang, 2003), eight international tourist hotels have closed down over the last six years. Average occupancy rate has decreased from 73 to 69% between 2009 and 2010 which is surprising given the surge in new demand entering the market.

Hwang and Chang (2003) noted that Taiwanese hotels have adopted two ways to respond to competition. First, by targeting international travelers and domestic tourists to increase the source of customers. Second, to join franchise-chains, outsourced management and acquired membership in international hotel associations to introduce international management systems and improve their managerial capacities. Even so, it has still been hard for these hotels to improve their performance. According to monthly report on international tourist hotel operations in Taiwan in (2006), the occupancy rate and average room rate of international hotels in (2010) were 69% and US\$ 95, respectively, (Taiwan Tourism Bureau, 2012). Compared with Hong Kong (87%, US\$ 140) (Hong Kong Tourism Board, 2007), the occupancy rate and average room rate in Taiwan is much lower.

Most of the hotel owners were not satisfied with this result. Furthermore, according to Taiwan Tourism Bureau, 43 hotels and approximately 12165 rooms have been scheduled to open between 2010 and 2014. This will make the hotel industry in Taiwan encounter a highly competitive environment.

Facing this situation, the formulation of competition strategy, strengthening operational efficiency and developing corporate advantage are essential for hotel operations. When formulating any strategy, it is necessary to have a sound knowledge of the operating efficiency of a given hotel relative to the entire industry (Hwang and Chang, 2003).

Efficiency was as a measure of how well or how productively resources are used to achieve a goal. Organizations are efficient when managers minimize the amount of input resource or the amount of time needed to produce a given output of goods or service. A manager's responsibility is to ensure that an organization and its members perform as efficiently as possible. The fewer the inputs required to produce a given output, the higher will be the efficiency of the production system. Therefore, it is very important for managers to evaluate organizational efficiency and a number of different approaches and techniques have been employed to conduct such evaluations. However, the often-used mechanisms for measuring and analyzing efficiency of organizations have remained too narrow in their focus to capture the broad spectrum of factors that actually contribute to an

organization's success (Reynolds, 2003). One approach that has been successful is Data Envelopment Analysis (DEA), used in this research as it can integrate multiple input and output variables and remedy this shortcoming.

This paper reports how DEA was used to investigate:

- The relative operational efficiency of international tourist hotels in Taiwan
- Which hotels have good performance and become a benchmark for other hotels and which hotels are inefficient and should improve their operation
- The effect of location on operational efficiency of international tourist hotel as measured by DEA efficiency

Data envelopment analysis (DEA): DEA is a linear programming based method that integrates several relatively disparate input and output variables simultaneously. It then produces a single productivity index that compares all units to the most-efficient units in the sample, helping analysts to identify which unit is most efficient given its own set of variables, which are then compared with others in the set (Reynolds, 2003).

Apart from the measure of the relative efficiency of each unit, DEA also distinguishes the most productive unit or units within the competitive set, describes the relatively less-productive units and calculates the excess resources used by each of those less-productive operations (Anderson *et al.*, 2000). As such DEA has become increasingly popular as a tool for assessing the relative productivity efficiency of companies, including hotels.

Morey and Dittman (1995) were the first researchers to apply the DEA approach in the hotel industry. They employed DEA to analyze the efficiency of 54 hotels in the United States and found that managers were operating at 89% efficiency and the least efficient hotels were 64%. Consequently, the results deemed the lodging market to be operating efficiently in U.S.A. Using the DEA approach Anderson *et al.* (2000) measured the managerial efficiency of 48 hotels in the United States and provided evidence that the hotel industry was operating inefficiently with a mean overall efficiency measure of 42%. Hwang and Chang (2003) also adopted DEA to analyze the efficiency of 45 international tourist hotels in Taiwan in (1998). The results indicated that managers were operating at 79.16% efficiency with only 20 of the 45 hotels improving their managerial efficiency over time. Consequently, the market for lodging services seemed to be operating efficiently in Taiwan.

Although DEA has been used in previous researches to evaluate hotel operational efficiency, the results only indicate the relative efficiency of all sample hotels and do not consider the role of location. As Morey and Dittman (1995) observed, "sometimes one must look past the numbers and take into account qualitative factors". For example a hotel might be scored relatively inefficient if it is located in the area with a difficult competitive environment, whilst another hotel gains a good DEA score because the area this hotel is located in has a favorable environment. If only comparing the relative efficiency of all hotels without considering the factor of the area hotel is located in, inaccurate benchmarks for operational efficiency will be generated.

METHODOLOGY

To understand the operational efficiency of Taiwan international tourist hotels, this paper adopts DEA, developed by Charnes *et al.* (1978), using multiple inputs and outputs to measure the relative operational efficiency of international hotels in Taiwan. This research uses a sample of the 57 international tourist hotels in 2005 to conduct efficiency evaluation via DEA. Each of these hotels was treated as a Decision Making Unit (DMU) in DEA analysis. The 57 hotels were selected for this research because the degree of competitiveness in this marketplace is high and were operating during the period of this investigation.

Calculating hotel DEA: DEA produces a single measure of performance. In contrast to parametric approaches whose purpose is to optimize a single regression plane through the data, DEA optimizes on each individual observation with an objective of calculating a discrete piecewise frontier occupied by the most efficient units. This frontier and the associated measure for each unit, which is generally referred to as relative efficiency or productivity has particular managerial relevance in that it allows for comparison of disparate operating units (Reynolds and Thompson, 2007). The term "relative" is rather important here since an organization identified by the DEA technique as an efficient unit in a given set may become an inefficient one when evaluated in another set of organizations.

There are different mathematical forms of the DEA model. The model used in this study is CCR input-oriented model developed by Charnes, Cooper and Rhodes in (1978). The formulation is based on the following form:

Maximize:

$$E_k = \frac{\sum_{r=1}^s u_r y_{rk}}{\sum_{i=1}^m v_i x_{ik}} \quad (1)$$

Subject to:

$$E_k = \frac{\sum_{r=1}^s u_r y_{rk}}{\sum_{i=1}^m v_i x_{ik}} \leq \frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \quad \text{for } j=1,2,\dots,n$$

$$u_r, v_i \geq \epsilon \geq 0 \quad r=1, \dots, s \quad i=1, \dots, m$$

Where,

- y_{rj} = observed quantity of output r produced by hotel j
- x_{ij} = observed quantity of input i produced by hotel j
- u_r = the weight given to output r by the hotel j
- v_i = the weight given to input i by the hotel j
- ϵ = non-Archimedean quantity, a sufficiently small positive number

This DEA model has the following interpretation within the context of hotels. There are n hotels in the observation set K , each of which producing r different outputs using i different inputs and we are interested in determining the relative efficiency E_k of hotel $k \in K$ with respect to all other hotels in the set K . The relative efficiency E_k is nothing but the ratio of outputs of the hotel k to its inputs. Such a definition of efficiency transforms the multidimensional nature of input and outputs into a single scalar ratio of single output to a single input.

For computational convenience, the efficiency of any hotel, j , can be solved by the dual of (1). The dual of (1) can be written as follows:

Minimize

$$E_k = \theta - \epsilon \left(\sum_{i=1}^m s_i^- + \sum_{r=1}^s s_r^+ \right) \quad (2)$$

Subject to:

$$\sum_{j=1}^n \lambda_j x_{ij} - \theta x_{ik} + s_i^- = 0, \quad i=1, \dots, m$$

$$\sum_{j=1}^n \lambda_j y_{rj} - s_r^+ = y_{rk}, \quad r=1, \dots, s$$

$$\lambda_j, s_i^-, s_r^+ \geq 0, \quad j=1, \dots, n, \quad i=1, \dots, m, \quad r=1, \dots, s$$

θ unconstrained.

An analysis provides the following type of information for decision making purposes:

- Each hotel being evaluated will have a value E_k , $0 < E_k \leq 1$, obtained from the DEA model indicating its efficiency level. If $E_k < 1$, the hotel is inefficient compared to ‘best practice’ units in the observation set K . If $E_k = 1$, this is a relatively ‘best practice’ hotel and therefore is identified as an efficient one
- The DEA model will identify, from the viewpoint of a hotel k , the ‘efficiency reference set’ K_k or ‘efficient frontier’ which is a subset of K that includes only those hotels with $E = 1$ from the observation set K . The hotel k is compared against the hotels in K_k to find the sources of its inefficiency. This allows a hotel manager to locate and understand the nature of the existing inefficiencies by comparing his/her hotel with a select subset of more efficient hotels. It therefore avoids the need to investigate all hotels to understand the existing inefficiencies and consequently helps allocate limited managerial resources to areas where efficiency improvements are most likely to be achieved
- The above model hence produces information with which managerial measures (reducing the inputs used, or increasing the outputs produced) can be formulated to make an inefficient hotel relatively efficient. For example, the necessary and sufficient conditions for any hotel, j , to reach efficiency are $K_j = 1, s_{ij}^- = s_{ij}^+ = 0$; therefore, the efficiency score is 1 and there is no input surpluses or output shortfalls. On the contrary, if a hotel j does not achieve 100% efficiency, then an improvement, $x'_{ij} = \theta x_{ij} - s_{ij}^-, y'_{rj} = y_{rj} + s_{rj}^+$, could be applied so that a 100% efficient hotel can be achieved. That is, the input is decreased by $\Delta x_{ij} = x_{ij} - x'_{ij}$ and the output is increased by $\Delta y_{rj} = y'_{rj} - y_{rj}$

Construction of area correction factor: Hotel operational efficiency is influenced by many factors. Some factors can be controlled by management but others are outside the control of hotel. Location is one of these uncontrolled factors and has great influence on hotel operation. As mentioned above, DEA score only indicates the relative operational efficiency of all hotels but does not consider location factor. Therefore, this paper will adjust a hotel’s DEA score according to its location. The adjustment score is the ratio of original DEA score to average DEA score for all hotels in each area:

$$\text{Adjusted DEA} = \frac{\text{Original DEA score}}{\text{Average DEA for all hotels in each area}}$$

Through this adjustment, the effect of location on DEA efficiency will be found. By comparing each hotel's adjusted score, a more objective operational efficiency, as opposed to overall hotel efficiency, will be determined.

RESULTS

Dea efficiency analysis: Results of DEA analysis are shown in Table 1. Hotel with the value of 1 are relatively 'best practice' hotels and therefore identified as efficient. Those hotels with the value less than one are inefficient compared to 'best practice' hotels. For example the efficiency score of Howard Hotel Taipei is 0.916, which means that Howard Hotel Taipei has only attained about 92% efficiency in relation to the most efficient hotels.

Area adjustment: Table above is a rank-ordered list of the hotels after the area adjustment has been applied. Table reveals that there is a large change in hotel efficiency rank after area adjustment. The rank in most of the hotels located in area with lower average DEA score has been increased after adjustment, including Kaohsiung, Tainan, Taoyuan, Hsinchu and East Coast, Kenting. In the contrary, the rank in most hotels located in area with higher average DEA score has been down, including Taipei Central area. As a result, the hotels from rank 1 to rank 5 are no longer the hotels located in Taipei.

As mentioned above, Taipei is a capital city and financial centre in Taiwan. Most of the multi-national companies' offices are located in Taipei. According to Taiwan Tourism Bureau, 76% of the incoming visitors visit Taipei and living standard in Taipei are higher than other area in Taiwan. All these factors contribute to hotels in Taipei enjoying the highest occupancy rate and room rates. Although there is the highest number of hotels in this area, the strong demand from both inbound travelers and domestic tourists means a large number of rooms continue to be available for visitors to this area. On the other hand, the Central area is originally one of the most popular tourist destinations. In recent years, with the establishment of Taichung Science Park, many international businessmen are attracted to this area. Both factors bring hotels in Central area with good performance. This is the reason why DEA shows that hotels in Taipei and Central area have higher operational efficiency than those in other areas of Taiwan.

The East Coast and Kenting are a popular tourist destinations, with many hotels in this area enjoying high room rates due to the income this area attracts from domestic holidaymakers, with most spending at least one night due to the greater distances involved between this area and Taiwan's major cities. However, this area has a strong emphasis on leisure and is easily influenced by seasonal fluctuations.

Kaohsiung is the largest shipping port in Taiwan and Taiwan's second largest city. This area has the second highest concentration of hotels, however, the number of traveler visiting this area is not much and that causes the accommodation supply to exceed the need. Finally, Tainan, Taoyuan and Hsinchu are famous because the major science park is located in these areas, but most customers in both areas are engineers, not managers as those in Taipei. They would not spend too much in accommodation expenditure. Moreover, Taoyuan and Hsinchu are too close to Taipei. This makes many customers stay in Taipei rather than this area. All these factors influence hotels' operational efficiency in these areas.

It is therefore apparent that location has strong influence on hotel's operational efficiency. Through DEA, we can easily identify the relatively operational efficiency of all hotels in Taiwan but the result may also have errors due to its neglect of location. Therefore, this research further uses area adjustment to reflect the operational efficiency of international tourist hotels in Taiwan.

CONCLUSION AND IMPLICATION

The aim to use DEA to measure hotel's operational efficiency is to provide hotel managers with benchmarking information and further insight of how a hotel can improve efficiency with its current resource, or change resource allocation. There are many factors and resources influencing hotel's operation. Some factors are under hotel's control such as operational expenditures, the number of employees and salaries expenses but some factors such as location and hotel size are outside the control of hotel management. If using DEA to evaluate hotel's efficiency without considering these uncontrolled factors, the result would be inaccurate and cannot provide the real information of operational efficiency. Therefore, based on the DEA result, this paper further divided it by average DEA score for hotels in each area. Through this adjustment, the effect of location on DEA efficiency has been found.

After area adjustment, the rank in most of the hotels located in area with lower average DEA score has risen. Whilst, the rank in most hotels located in area with higher average DEA score has fallen. This result indicates that some hotels in fact have better operational efficiency but are scored relatively inefficient by DEA because these hotels are located in the area with a difficult competitive environment. On the other hand, hotels with a good DEA score do not necessarily have better operational efficiency, just because they are located in favorable areas. Therefore, although Tainan Hotel and the other 11 hotels are ranked at No.1 in DEA, through area adjustment, the rank of Tainan Hotel becomes the

Table 1: DEA efficiency score for Taiwan's international tourist hotel and the score after area adjustment

Hotel	Area	DEA score	DEA rank	Area adjustment	New rank
Tainan Hotel	Tainan	1.000	1	1.376	1
Royal Hotel Chihpen	East Coast, Kengting	1.000	1	1.297	2
Caesar Park Hotel Kenting	East Coast, Kengting	1.000	1	1.297	2
Lalu Hotel	Central area	1.000	1	1.214	4
Grand Formosa Taipei	Taipei	1.000	1	1.160	5
Caesar Park Hotel Taipei	Taipei	1.000	1	1.160	5
Grand Hyatt Hotel	Taipei	1.000	1	1.160	5
Sherwood Hotel	Taipei	1.000	1	1.160	5
Ambassador Hotel Taipei	Taipei	1.000	1	1.160	5
Shangri-La's Hotel	Taipei	1.000	1	1.160	5
Brother Hotel	Taipei	1.000	1	1.160	5
Westin Hotel	Taipei	1.000	1	1.160	5
Sheraton Hotel	Taipei	0.990	13	1.148	13
Gloria Prince Hotel	Taipei	0.987	14	1.145	14
Howard Hotel Kaohsiung	Kaohsiung	0.844	20	1.133	15
Howard Hotel Kenting	East Coast, Kengting	0.871	18	1.130	16
Taoyuan Hotel	Taoyuan, Hsinchu	0.835	23	1.129	17
Landis Hotel Taipei	Taipei	0.960	15	1.114	18
Ambassador Kaohsiung	Kaohsiung	0.818	16	1.098	19
Grand Hi-Lai Hotel	Kaohsiung	0.802	26	1.077	20
Marshal Hotel	East Coast, Kengting	0.821	24	1.064	21
Evergreen Laurel Hotel	Central area	0.876	17	1.063	22
Howard Hotel Taipei	Taipei	0.916	16	1.063	23
Tayih Landis Hotel Tainan	Tainan	0.771	33	1.061	24
Howard Hotel Taichung	Central area	0.860	19	1.044	25
Han-Hsien Hotel	Kaohsiung	0.760	35	1.020	26
Ta Shee Resort	Taoyuan, Hsinchu	0.742	39	0.980	27
China Trust Hotel Hwaleng	East Coast, Kengting	0.750	37	0.973	28
Royal Hotel Taipei	Taipei	0.838	21	0.972	29
Golden China Hotel	Taipei	0.837	22	0.971	30
Farglory Hotel	East Coast, Kengting	0.749	38	0.971	31
Splendor Hotel Kaohsiung	Kaohsiung	0.712	44	0.956	32
Holiday Garden	Kaohsiung	0.708	45	0.950	33
Ambassador Hotel Hsinchu	Taoyuan, Hsinchu	0.716	42	0.946	34
Royal Hotel Hsinchu	Taoyuan, Hsinchu	0.716	42	0.946	35
Plaza Int'l Hotel	Central area	0.776	32	0.942	36
Splendor Hotel Taichung	Central area	0.767	34	0.931	37
Riverview Hotel	Taipei	0.800	27	0.928	38
San Want Hotel	Taipei	0.788	28	0.914	39
Landis Resort Yanminsan	Taipei	0.788	28	0.914	40
United Hotel	Taipei	0.783	30	0.908	41
Evergreen Plaza Hotel	Tainan	0.659	49	0.906	42
Emperor Hotel	Taipei	0.779	31	0.904	43
Kingdom Hotel	Kaohsiung	0.660	48	0.886	44
Grand Hotel Kaohsiung	Kaohsiung	0.658	50	0.883	45
Parkview Hotel	East Coast, Kengting	0.679	46	0.881	46
Grand Hotel	Taipei	0.753	36	0.874	47
Imperial Hotel	Taipei	0.729	40	0.846	48
Holiday Inn Hotel	Taipei	0.719	41	0.834	49
Naruwan Hotel	East Coast, Kengting	0.632	52	0.820	50
Hotel National	Central area	0.665	47	0.807	51
Astar Hotel	East Coast, Kengting	0.621	54	0.805	52
Grand Formosa Taroko	East Coast, Kengting	0.594	56	0.770	53
Fortuna Hotel	Taipei	0.652	51	0.756	54
Crown Plaza Hotel	Taipei	0.627	53	0.727	55
Santos Hotel	Taipei	0.603	55	0.700	56
Hibiscus Resort	Tainan	0.477	57	0.656	57

only Top 1. This implies that managers in Tainan Hotel in fact have better management ability and performance, even though they are given a difficult business environment, they still utilize the hotel's geographical segment and develop its characteristics to capture the customers in this area. Similarly, both Royal Hotel Chihpen and Caesar Park Hotel Kenting are resorts and

located in East Coast and Kengting. Most hotels' DEA score in this area is poor because major market in this area is local customer and is strongly influenced by season. However, after adjustment, both hotels are ranked at 2, meaning both hotels' managers do a better job. On the other hand, Taipei is a capital city and financial centre and enjoys the biggest market in Taiwan.

Therefore, as to those managers working with Taipei's hotels with good DEA score, their ability and performance should be scored poorly because they should be doing even better, given their most favorable environment in Taiwan.

To improve business performance, managers should benchmark themselves against hotels with superior operating efficiency. This paper offers a guide to managers to select suitable benchmark hotels.

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