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Full Length Research Paper

Operational performance and benchmarking: A case study of international tourist hotels in Taipei

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Operational performance evaluation and process improvement in hotels have been the focus of several studies, a number of which have used Data Envelopment Analysis (DEA) to evaluate the operational performance of hotels in different destinations. This study sets out to evaluate the operational efficiency of twenty-three tourist hotels in Taipei over five years (2003 to 2007) using DEA models and the cross-efficiency evaluation method. Efficiency measures are based on four input measures: the total number of hotel rooms, the total number of employees, food and beverage (F&B) capacity, and total operating cost. The three output measures are guest room revenue, F&B revenue, and other revenue. The efficiency scores derived from the DEA models are subject to clustering analysis to identify benchmarks for efficiency improvement in poorly performing hotels. The contributions and managerial implications of the study are discussed.

Key words: Data envelopment analysis (DEA), cluster analysis, hotels, efficiency analysis, benchmarking.

INTRODUCTION

Hotel operational performance is the primary concern of hotel operators. Consequently, increasing numbers of studies have examined the ways in which hotel operational performance can be appropriately measured and assessed with a view to providing useful information for effective decision-making by hotel management. Data Envelopment Analysis (DEA), which has been used to measure the relative efficiency (performance) of decision making units (DMUs) on the basis of their multiple inputs and outputs, has become one of the most frequently used methods for assessing hotel operational performance. A major advantage of DEA is that it does not require any assumptions about the functional form of the model that underpins the relationships between the input and output variables (Hwang and Chang, 2003). It has become a popular efficiency evaluation tool and has been applied in areas such as bank branch activities (Chen and Yeh, 1998), port capacity (Roll and Hayuth, 1993), nations' operational performance at the Olympics (Lozano, Villa and Cortés, 2002), etc. However, as Table 1 shows, despite the increase in research on hotel operational performance, very few studies have investigated the benchmarking of hotels, which is important to ensure their continuing competitiveness.

In this paper, we propose an effective method for evaluating hotel operational performance and identifying useful benchmarks for efficiency improvement in less efficient hotels. The cross-efficiency DEA model is used to examine the efficiency (performance) of the hotels, and the cross-efficiency scores of hotels are calculated. Cluster analysis is then used to select the operational performance targets that will serve as benchmarks for poorly performing hotels.

Hotels with inherently similar inputs and outputs are classified into the same cluster, and the hotel with the highest score in a given cluster is considered to be the primary benchmark for efficiency improvement for the other hotels in the cluster. Further discussion sequentially presents the background to the study and a review of the literature, followed by the theoretical framework, data, results and conclusion.

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Table 1. Published studies on the application of DEA to hotels.

Literature	Model	Sample	Input	Output
Morey and Dittman (1995)	DEA	54 U.S. hotels	Salaries for major room activities Other room-related expenses Energy cost Salaries for property, operation and maintenance (POM) other POM Salaries for variable advertising Other variable advertising expenses Fixed advertising expenses Salaries for administrative and general Other administrative and general expenses	Total room revenue Facilities satisfaction index Services satisfaction index
Anderson, Lewis and Parker (1999)	DEA and stochastic frontier	31 corporate travel departments	Total air expenses Hotel expenses Car expenses Labor expenses Hour expenses Part-time labor Fee expenses Technology costs Building and occupancy expenses	Number of trips
Anderson, Fok and Scott (2000)	DEA (technical efficiency and allocative efficiency)	48 U.S. hotels	Full-time equivalent employees The number of rooms Total gamming-related expenses Total food and leverage expenses Other expenses	Total revenue Other revenue
Hwang and Chang (2003)	DEA-CCR model, super efficiency model and Malmquist	45 Taiwan international hotels	Number of full-time employees Guest rooms Total area of meal department Operating expenses	Room revenue Food and beverages revenue Other revenue
Wang, Huang, and Shang (2006)	DEA (overall efficiency, allocative efficiency, scale efficiency, technical efficiency, and pure technical efficiency)	49 Taiwan international hotels	Number of full-time employees in room department Number of rooms Area of F&B Number of full-time employees in F&B	Revenues from room department Revenues from F&B department Other revenues
Keh, Chu and Xu (2006)	Three-stage DEA model	Asia-Pacific hotel chain	Total expense Number of room	Room revenue F&B revenue

Table 1. Contd.

Tsai (2009)	Cross-efficiency DEA model	Star-rated hotels in 31 Chinese provinces	Number of hotels The amount of fixed assets NUMBER of employees receiving training	Total revenues Occupancy percentage
Yu and Lee (2009)	Hyperbolic network DEA model	57 Taiwan international hotels	Number of employees in department rooms Number of employees in department F&B Number of guest rooms Area of department F&B Total operating expenses	Total revenues of F&B Total revenues of room Other revenues
Hsieh and Lin (2010)	Network DEA model	57 Taiwan international hotels	Costs of accommodations department Employees of accommodations Costs of catering department Employees of catering	Revenues of the accommodations department Revenues of the catering department
Cheng, Lu and Chung (2010)	Slack-based measure (SBM) DEA model	34 Taiwan international hotels	Number of guest rooms Number of employees Area of catering department total operating expenses catering expenses	Total operating revenues Average occupancy rate Average room rate Average production value per employee Occupancy revenues Catering revenues
Chen, Hu and Liao (2010)	CCR and Tobit analysis	All the Taiwan international hotels since 1996 to 2007	Number of guest rooms Number of employees Area of catering departmen	Total revenues of F&B Total revenues of room Other revenue
Hu, Chiu, Shieh and Huang (2010)	SFA and DEA	66 Taiwan international hotels	Price of labor Price of other operations Price of F&B	Room revenues Other operation revenues F&B revenues

LITERATURE REVIEW

Although it is important for hotels to improve their operational efficiency, the issues of efficiency measurement and improvement have attracted little research attention. The literature on hotel efficiency, and in particular the measurement of efficiency and benchmarking, is scant. An over-view of the literature related to these areas is further provided. The summary of previous studies applying DEA technique, whether using the original or derivative models, to measure hotel operational performance is presented in Table 1.

Efficiency analysis of hotels

A number of studies have looked at hotelefficiency issues. Among the earliest is that of Baker and Riley (1994), who used financial ratios to analyze the operational performance of the lodging industry. Wijeysinghe (1993) suggested the use of break-even analysis to discern the effectiveness of tourism manage-ment, and Brotherton and Mooney (1992) and Donaghy, McMahon and McDowell (1995) applied yield manage-ment to analyze hotel management efficiency.

Since Morey and Dittman (1995) first used DEA to measure the operational performance of hotels and provided a useful reference for input/output variable selection, several scholars have used DEA to study hotel operational performance. This suggests that DEA has only recently been recognized as a useful tool by researchers in the area of hospitality management. The focus of most of these published studies is on the hotel industries of Taiwan, the United States, and Portugal.

Several studies have examined hotel operational performance using data from hotels in Taipei, Taiwan. Taipei hotel data are often used because researchers want to compare the operational performance of different DEA models using the same dataset, and because the data are made publicly available by the Taiwan Tourism Bureau.

Since the lifting of martial law in 1985, international tourism in Taiwan has grown substantially, leading to a sharp increase in the demand for international tourist hotels. The rapid increase in international tourist hotels has intensified the competition in the hotel sector in Taiwan. Hotels must aggressively compete through brand development, increased marketing efforts, and improved service quality to stay in the market. In formulating competition strategies, a major problem is how to benchmark the efficiency of a hotel against industry standards, and it is here that methods such as DEA come into play, having been applied in several studies to assess the operational performance of the international tourism hotels in Taiwan. The first such study was that of Tsaur (2001), who evaluated the operational efficiency of fifty-three international tourist hotels in Taiwan during the years of 1996 through 1998. Hwang and Chang (2003) then looked at the efficiency changes in fourty-five Taiwanese hotels from 1994 to 1998, and Chiang et al. (2004) measured operational performance of three types of international tourist hotels (ITHs), namely, independently owned and operated hotels, franchised hotels, and management-contracted hotels. Chiang (2006) further examined the operational performance of 24 ITHs in Taipei according to their operational mode, and Wang, Huang and Shang (2006) evaluated the relative cost efficiency of forty-nine ITHs in Taiwan. Yu and Lee (2009) composed a hyperbolic network DEA model to measure the operational performance of fifty-seven ITHs in Taiwan by dividing the hotel's operation into production process and marketing process, while Hsieh and Lin (2010) proposed another network DEA model to evaluate these same hotels' operational performances by separating hotel activities into accommodations and catering departments. Cheng et al. (2010) improved the slack-based measure (SBM) of efficiency in context-dependent DEA and applied it to measure the operational perfor-mance of thirty-four selected ITHs in Taiwan in order to provide insights on competitive advantage. In order to deal with possible environment variables in the DEA model, Chen et al. (2010) composed a Tobit analysis and Hu et al. (2010) proposed a SFA model for evaluating the operational performance of ITHs in Taiwan.

Other studies have used DEA to compare the productivity of hotels over different periods or efficiency changes over time. Johns et al. (1997) assessed the productivity of fifteen hotels over a twelve-month period, and Hwang and Chang (2003) applied DEA together with the Malmquist index to identify the efficiency changes in forty-five Taiwan international tourist hotels over the period of 1994 to 1998. Again, using DEA, Brown and Ragsdale (2002) evaluated hotel efficiency from the point of view of customer perceptions, which was not considered in the other studies.

These studies indicate that DEA has become an important analytical tool in assessing hotel operational performance. This paper extends this line of research by examining the benchmarking of Taipei international tourist hotels over the period of 2003 to 2007 using a new variant of DEA known as the "cross-efficiency approach."

Benchmarking of hotels

Benchmarking is a technique that was originally proposed by the Japanese manufacturing sector and subsequently popularized by international business practitioners (Camp, 1989). The popularity of benchmarking has increased over the past two decades. Various tools can be employed to carry out a benchmarking exercise, including gap analysis and the hierarchy process using the maturity matrix (Eyrich, 1991; Kleinhans et al., 1995). Although statistical methods can also be utilized for benchmarking purposes (Blumberg, 1994; Schefcyzk, 1993; Moseng, 1995), their use is limited to the simultaneous examination of the correlation or central tendency of the input and output variables; they are not suitable for comparing the operational performance of individual business against best practices. Regression models can be used to identify important relationships and gaps, but are unable to suggest the means by which any efficiency gaps can be closed.

DEA was used in partner selection for benchmarking by Collier and Storbeck (1993) in the telecommunications industry, and by Bell and Morey (1995) to investigate the efficiency of corporate travel management through macro benchmarking. DEA has also been used for benchmarking in the banking and finance industry by Barr and Seiford (1994) and in the grocery industry by Athanassopoulos and Ballantine (1995).

However, the benchmarking of hotels using DEA has attracted little research attention. The few exceptions are the study of Morey and Dittman (1995), which evaluated the operational performance of fifty-four owner-managed hotels and provided benchmarks for less efficient hotels to match. Sigala (2003b) examined best practices in the online marketing strategies of Greek hotels based on DEA and made suggestions for the development of more effective strategies. The issue of benchmarking was also touched on in the studies of Chiang, Tsai and Wang (2004), Barros (2005), Chiang (2006) and Yu and Lee (2009). Although these studies considered different types of hotels, the techniques used to generate benchmarks for poorly performing hotels are the same, in that, they are a linear combination of the hotels in a reference set that serves as a reference for inefficient hotels. However, this traditional form of benchmarking analysis using DEA has a number of limitations. First, the inefficient DMUs and their corresponding benchmarks may not be inherently similar, which may result in inappropriate targets for improvement being set. Second, in most cases an inefficient DMU may have multiple benchmarks as possible targets for improvement. Third, the combination of DMUs results in a virtual DMU that does not really exist, which makes improvements in line with the benchmark difficult. It would greatly benefit hotel efficiency analysis if we could overcome these limitations using a benchmark that closely matches the inherent capabilities of an inefficient DMU.

METHODOLOGY

As suggested by Alam (2011) that a research has to follow a distinct way in nature to carry it out, thus the cross-efficiency evaluation method is an extension of DEA that identifies the best performing DMUs and ranks them using cross-efficiency scores that relate to all of the DMUs in the model (Sexton et al., 1986). The main idea of cross-efficiency evaluation is to use DEA in a peer evaluation mode, rather than in a self-evaluation mode. Cross-efficiency evaluation has been applied in various settings, such as efficiency evaluations of nursing homes (Sexton et al., 1986), R and D project selection (Oral et al., 1991), and preference voting (Green et al., 1996).

Cross efficiency

The conventional nomenclature of DEA is adopted with the assumption of n DMUs that are to be evaluated in terms of m inputs and s outputs. We denote the ith input and rth output for DMU_j $(j=1,2,\ldots,n)$ as x_{ij} (i = 1, …, m) and y_{rj} (r = 1, …, s), respectively. The efficiency rating for any given DMU_d can be computed using the CCR model (Charnes et al., 1978), as follows:

$$\begin{aligned} &\max \sum_{r=1}^{s} \mu_{rd} y_{rd} \\ &\text{s.t.} \ \sum_{i=1}^{m} \omega_{id} x_{ij} - \sum_{r=1}^{s} \mu_{rd} y_{rj} \geq 0, \ j=1,2,..n \\ &\sum_{i=1}^{m} \omega_{id} x_{id} = 1 \\ &\omega_{id} \geq 0, i=1,2,\ldots,m \\ &\mu_{rd} \geq 0, r=1,2,\ldots,s \end{aligned} \quad (1)$$

For each DMU_d (d = 1, …, n) under evaluation, we obtain a set of optimal weights (multipliers) $\omega_{1d}^*,\ldots,\omega_{md}^*,\mu_{1d}^*,\ldots,\mu_{sd}^*$. Using this set, the d-cross efficiency for any DMU_j (j=1,…, n) is then calculated as:

$$E_{dj} = \frac{\sum_{r=1}^{s} \mu_{rd}^* y_{rj}}{\sum_{i=1}^{m} \omega_{id}^* x_{ij}}, d, \ j=1,2,\ldots,n \quad (2)$$

As shown in Table 2, when we move along the dth row of the cross-efficiency matrix (CEM) E of cross efficiencies, each element E_{dj} is the efficiency that DMU_d accords to DMU_j in line with the computed weighting scheme described. The leading diagonal is a special case in which DMU_d rates itself.

Each of the columns of the CEM in Table 2 is then averaged to obtain a mean cross-efficiency measure for each DMU. For $DMU_j \, (j=1,\ldots,n)$, the average of all $E_{dj} \, (d=1,\ldots,n)$ is:

$$\overline{E_j} = \frac{1}{n}\sum_{d=1}^{n} E_{dj}, \quad (3)$$

which can be used as a new efficiency measure for DMU_j and is referred to as the cross-efficiency score for DMU_j.

In general, the weights of the inputs and outputs in model (1) may not be unique. Thus, the evaluation of a DMU in relation to other DMUs may depend on the first of the many alternative optimal solutions reached. To choose the preferred solution among a set of multiple solutions, Sexton et al. (1986) and Doyle and Green (1994) suggested using the aggressive and benevolent cross-evaluation approach. A cross-evaluation is aggressive and benevolent in the sense that it selects a set of weights that not only maximize the efficiency of the particular DMU under evaluation, but also minimizes or maximizes the efficiencies of all of the other DMUs in the same manner.

Where the relative dominance of DMUs is to be evaluated, the aggressive formulation is more appropriate. The corresponding aggressive formulation of (1) developed by Doyle and Green (1994) is:

$$\begin{aligned} &\min \ \sum_{r=1}^{s} (\mu_{rd} \sum_{j \neq d} y_{rj}) \\ &s.t. \ \sum_{i=1}^{m} \omega_{id} x_{ij} - \sum_{r=1}^{s} \mu_{rd} y_{rj} \geq 0, \ j \neq d. \\ &\sum_{i=1}^{m} (\omega_{id} \sum_{j \neq d} x_{ij}) = 1 \\ &\sum_{r=1}^{s} \mu_{rd} y_{rd} - \theta_{dd} \times \sum_{i=1}^{m} \omega_{id} x_{id} = 0 \\ &\omega_{id} \geq 0, i=1,\ldots,m. \\ &\mu_{rd} \geq 0, r=1,\ldots,s. \end{aligned} \quad (4)$$

Table 2. A generalized cross-efficiency matrix (CEM).

Rating DMU	Rated DMU				
	1	**2**	**3**	**…**	**n**
1	E_{11}	E_{12}	E_{13}	⋯	E_{1n}
2	E_{21}	E_{22}	E_{23}	⋯	E_{2n}
3	E_{31}	E_{32}	E_{33}	⋯	E_{3n}
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
n	E_{n1}	E_{n2}	E_{n3}	⋯	E_{nn}
Mean	$\overline{E}_1$	$\overline{E}_2$	$\overline{E}_3$	⋯	$\overline{E}_n$

where θ_{dd} is the efficiency of DMU *d* obtained from (1).

The benevolent formulation is subject to the same set of constraints, except that it is the objective function that is maximized.

Benchmarking

In traditional DEA, a linear combination of the DMUs in the reference set is the target that an inefficient DMU uses to become efficient. According to Doyle and Green (1994), a difficulty with these conventional reference sets is that an inefficient DMU and its reference set may not be inherently similar in their practices, and it is therefore possible that the reference targets are unattainable goals for the inefficient DMU. Cluster analysis, principal component analysis, and multidimensional scaling have all been used in the literature to classify DMUs into similar groups or clusters to avoid this problem.

Cluster analysis is used in this study to identify benchmarks for the inefficient DMUs. Computing the correlation coefficient between a pair of columns in a CEM tells us how similar DMUs are according to the appraisal of their peers. A high positive correlation coefficient indicates that two DMUs are inherently similar with respect to their inputs and outputs, which means that they will display a similar operational performance when evaluated against the optimal weights of other DMUs. Thus, using these correlation coefficients as the elements in a resemblance matrix and carrying out a clustering analysis yields clusters with inherently similar DMUs. The DMU with the highest average cross efficiency in a given cluster can then be used as the primary benchmark for improvement for the other DMUs in that cluster.

RESULTS AND DISCUSSION

Here, we apply the approach presented in the previous discussion to analyze the operational performance and benchmarks of 21 international tourist hotels in Taipei during the period of 2003 to 2007.

Data descriptions

The sample size is determined by the data availability. The data was obtained from *The Operating Report of International Hotels in Taiwan*, which is published annually by the Taiwan Tourism Bureau. The Taiwan Tourism Bureau ranks hotels by "plums," and all of the hotels included in our sample are either four- or five-plum tourist hotels. A list of the hotels in the sample is given in Table 3.

In line with previous studies and the data availability, four input variables and three output variables are included in the empirical analysis. The inputs variables are the total number of hotel rooms (x_1); the total number of employees (x_2); food and beverage (F&B) capacity (x_3) as measured by the total floor area utilized by all of the F&B outlets within the hotel; and total operating cost (x_4), which includes operational costs, advertising costs, and salaries. The output variables include guest room revenue (y_1), F&B revenue (y_2), and other revenue (y_3).

Efficiency analysis

The results of the CCR and average aggressive cross-efficiency scores computed using the aggressive cross-evaluation approach in Doyle and Green (1994) are shown in Table 4. A total of thirteen hotels are considered to be technically efficient (a CCR efficiency score of 1) in at least one out of the five years under consideration. Five hotels are found to be efficient for all the five years – *Brother Hotel* (BRO), *United Hotel* (UNI), *Grand Hyatt Taipei* (GRH), *Grand Formosa Regent Taipei* (GFR) and the *Sherwood Taipei* (SHW). The average efficiencies according to the CCR model are 0.8831, 0.9022, 0.9104, 0.9209 and 0.9144 for the years 2003 to 2007, respectively. These results indicate that there was an upward trend in the average efficiency from 2003 to 2006 and then a slight decline in 2007, with only eight hotels performing efficiently in 2003 but increasing to twelve efficient hotels in 2007. This is likely due to the fact that mainland China, Taiwan, and Hong Kong suffered from the SARS outbreak in 2003, which negatively affected

Table 3. List of hotels.

DMU	Hotel abbreviation	Hotel
1	GRA	The Grand Hotel
2	AMB	The Ambassador Hotel
3	IMP	Imperial Hotel Taipei
4	GLP	Gloria Prince Hotel
5	EMP	Emperor Hotel
6	RIV	Riverview Taipei
7	CAP	Caesar Park Taipei
8	GOC	Golden China Hotel
9	SAW	San Want Hotel
10	BRO	Brother Hotel
11	SAN	Santos Hotel
12	LAN	The Landis Taipei Hotel
13	UNI	United Hotel
14	SHE	Sheraton Taipei Hotel
15	ROY	Hotel Royal Taipei
16	HOP	Howard Plaza Hotel Taipei
17	GRH	Grand Hyatt Taipei
18	GFR	Grand Formosa Regent Taipei
19	SHW	The Sherwood Taipei
20	FEP	Far Eastern Plaza Hotel Taipei
21	WES	The Westin Taipei

Table 4. CCR and aggressive cross-efficiency scores of the hotels for all years.

DMU	Hotel	2003		2004		2005		2006		2007	
		C	A	C	A	C	A	C	A	C	A
1	GRA	0.7342	0.4297	0.7313	0.4250	0.7573	0.4195	0.7751	0.4111	0.7231	0.3919
2	AMB	0.9870	0.6839	1	0.7229	1	0.6946	1	0.7089	1	0.7053
3	IMP	0.7093	0.4286	0.7792	0.4784	0.7298	0.4203	0.6542	0.3729	0.6132	0.3703
4	GLP	0.8036	0.6044	0.7944	0.6163	1	0.5329	1	0.4969	1	0.4414
5	EMP	0.8935	0.3013	0.9754	0.3741	1	0.3539	1	0.3299	1	0.3261
6	RIV	0.7768	0.3811	0.7982	0.4249	0.8019	0.3218	0.8126	0.3105	0.8233	0.3144
7	CAP	0.8882	0.5782	1	0.6556	1	0.5544	1	0.5286	1	0.5441
8	GOC	0.724	0.4305	0.8937	0.5119	0.8379	0.422	0.7932	0.3971	0.7667	0.4000
9	SAW	0.9749	0.6295	0.9213	0.6239	0.78781	0.5949	0.9705	0.6513	1	0.6461
10	BRO	1	0.6221	1	0.5929	1	0.5931	1	0.5904	1	0.5888
11	SAN	0.7146	0.3876	0.8193	0.4284	0.7273	0.3488	0.7677	0.3621	0.6900	0.3504
12	LAN	0.8931	0.6584	0.9128	0.6520	0.9603	0.6694	0.9035	0.6439	0.8565	0.6263
13	UNI	1	0.6162	1	0.5543	1	0.5063	1	0.4268	1	0.4181
14	SHE	0.6026	0.4602	0.5430	0.3901	0.6922	0.4958	0.8774	0.6071	0.9680	0.6535
15	ROY	0.8423	0.6379	0.8940	0.6687	0.9064	0.6212	0.9645	0.626	0.9427	0.6095
16	HOP	1	0.7133	0.9364	0.6739	0.9165	0.6814	0.8678	0.6434	0.8182	0.6207
17	GRH	1	0.7544	1	0.7569	1	0.7526	1	0.7516	1	0.7768
18	GFR	1	0.8879	1	0.8640	1	0.8274	1	0.8051	1	0.7966
19	SHW	1	0.815	1	0.8198	1	0.7834	1	0.7439	1	0.7415
20	FEP	1	0.8863	1	0.7460	1	0.5982	0.9523	0.5659	1	0.6208
21	WES	1	0.6272	0.9472	0.5997	1	0.6576	1	0.7095	1	0.6657
Average		0.8831	0.5968	0.9022	0.5990	0.9104	0.5643	0.9209	0.5563	0.9144	0.5528

"C": CCR efficiency; "A": aggressive cross-efficiency.

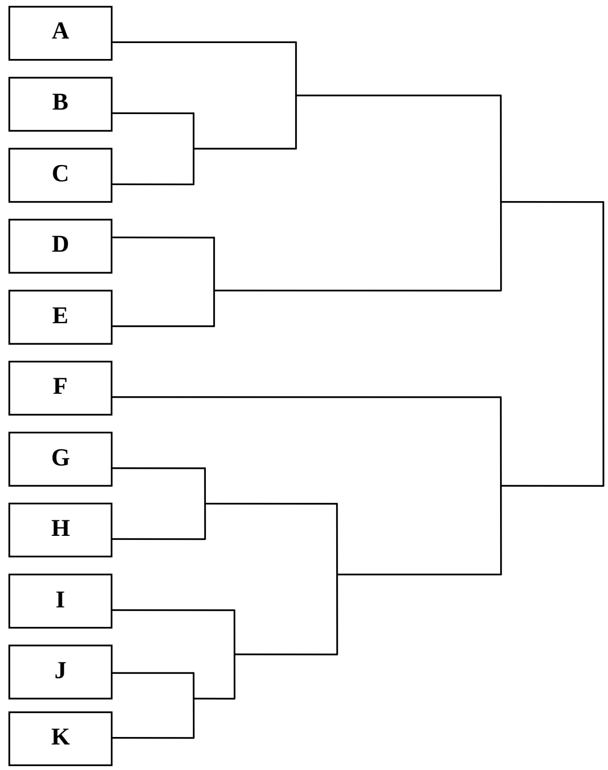

Figure 1. Dendrogram of the hotel clusters for all years.

demand for hotel rooms in these destinations.

As the traditional CCR DEA model fails to differentiate among efficient hotels, we utilize the cross-efficiency analysis (Doyle and Green, 1994) to rank the operational performance of hotels in each of the five years. Using the aggressive cross-efficiency evaluation model, we find that the *Grand Formosa Regent Taipei* (GFR) and the *Sherwood Taipei* (SHW) performed consistently well, with the former ranking first in all five of the years. Their managers and employees should be rewarded because of their stable good-performance and be encouraged to achieve a higher level of operational performance. The least efficient hotels include The *Grand Hotel* (GRA), *Riverview Taipei* (RIV), *Santos Hotel* (SAN), *Imperial Hotel Taipei* (IMP) and *Emperor Hotel* (EMP) (achieving the lowest aggressive cross-efficiency scores). This is a warning sign for management about the low usage of existing input variables selected in our study. A series of measures should be taken for possible improvement, such as monitoring employee work procedures, staffing level, and budget/expense control. After calculating the efficiency scores, we can then group the hotels according to input-out configurations using cluster analysis.

Benchmark analysis

Although the CCR model or model (1) can provide benchmarks for inefficient hotels, it has certain limitations. As has been explained, the main issue is that an inefficient hotel and its benchmarks may not be inherently similar in their practices (Doyle and Green, 1994).

To identify appropriate benchmarks for the poorly performing hotels as a basis for efficiency improvement, we first compute the correlation coefficient between a pair of columns in the cross-efficiency matrix, which tells us how similar the two DMUs are as determined by their peers. We then use these correlation coefficients as the elements in a resemblance matrix and carry out cluster analysis based on a within-groups linkage method. The resulting tree is then truncated to obtain a reasonable level of clustering among the hotels.

This form of cluster analysis is known as hierarchical clustering, and the average linkage method is utilized to derive the clusters (Appendix 1). Figure 1 depicts the dendrogram of the cluster analysis of the hotels over the five-year period, and the corresponding tabulated clusters are shown in Table 5.

Figure 1 and Table 5 show that a total of ten clusters, labeled A to K, are identified. The best performers in each of the clusters can be viewed by the other hotels in the cluster as the primary benchmark for their own efficiency improvements.

For example, in cluster D, GFR 2003, which has an average cross-efficiency score of 0.8879, should be

Table 5. Benchmarks and clusters of the hotels for all years.

Cluster A	Cluster B	Cluster C	Cluster D	Cluster E	Cluster F	Cluster G	Cluster H	Cluster I	Cluster J	Cluster K
AMB 05-07	AMB 03	ROY 03-07	GFR 03	SHW 03	GLP 06	RIV 05-07	EMP 03-07	GRA 03-07	CAP 05	UNI 03-04
BRO 05-07	AMB 04	GLP 03-05	(0.8879)	SHW 04	(0.4969)	SAN 05	UNI 06	IMP 03-07	(0.5544)	CAP 04
LAN 05-07	(0.7229)	SHE 05	GFR 04-07	(0.8198)	GLP 07	SAN 06	(0.4268)	GOC 03	CAP 06-07	(0.6556)
HOP 05-07	BRO 03-04	WES 03-04	FEP 03	SHW 05-07		(0.3621)	UNI 07	GOC 04	UNI 05	
SAW 05-07	SAW 03	LAN 03-04		GRH 03-07		SAN 07		(0.5119)		
SHE 06-07	HOP 03	HOP 04		FEP 04				GOC 05-07		
FEP 05-07		(0.6739)						SHE 03-04		
WES 05		SAW 04						RIV 03-04		
WES 06		CAP 03						SAN 03-04		
(0.7095)										
WES 07										

utilized by GFR 2004, GFR 2005, GFR 2006, GFR 2007 and FEP 2003 as a benchmark for improvement. As an aside, management of other ITHs should observe the operational practices of GFR, especially in the hotel's most efficient year of 2003, and implement these practices in order to become more efficient.

It is evident that in some of the clusters, such as cluster C, the benchmark hotel itself is not a very good performer. It so happens that all of the hotels in Cluster C are relatively poor performers, and thus the most appropriate benchmark for improving their current practices is HOP 2004. Although the benchmark hotel's operational performance is not very good, it is still important for the hotels in this cluster to utilize this hotel as a potential benchmark for achieving an attainable target. Further, it is more reasonable and valuable for the management to set realistic goals rather than radical ones, as such improvements are more easily achieved in an incremental manner. The results for other clusters can be interpreted in the same manner.

The dynamics of the benchmarks may also be examined. Although the benchmarks and clusters of certain hotels change significantly over the five-year period (for example, SAW, HOP, CAP, SHE and FEP, which appear in three different clusters), they remain relatively stable for other hotels (for example, EMP, ROY, GRA, and SHW appear in only one cluster). A possible reason for the drastic changes in some of the hotels may be due to policy and operational changes made over the sample period. An important managerial implication of this is that these hotels can learn best practices from a combination of benchmark hotels over time to improve their operational performance. The dynamic nature of the benchmarks also means that new and more appropriate benchmarks may emerge over time because of operational changes made by the benchmark hotels themselves. The more dynamic the benchmark environment for a given hotel, the more difficult it is to determine a good benchmark. In general, the hotels that easily improve their efficiency are those with stable benchmarks and that tend to stay in the same cluster over time.

Hotels that seek to implement changes may find their benchmarks also striving for change, which means that inefficient hotels may need to choose more than one benchmark. Inefficient hotels also need to observe the directions in which their benchmarks are moving over time so that they can decide the best resource utilization strategy to improve efficiency with minimal input changes. This issue of dynamic benchmarks must be carefully evaluated by inefficient hotels, especially as some of the changes made to improve operational and managerial efficiency may take much longer then one or two years.

CONCLUDING REMARKS

In this paper, we presented a methodology for operational performance evaluation and process improvement in major international tourist hotels in Taipei. We utilized a combination of multi-factor efficiency models, aggressive cross-efficiency DEA, and clustering methods to evaluate the operational performance of selected hotels over the period of 2003 to 2007 and to identify appropriate benchmarks for efficiency improvement in poorly performing hotels. The managerial implications for improving the operational efficiency of hotels through benchmarking are also discussed.

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APPENDIX 1

The cluster technique used in this paper

Multi-dimensional scaling, principal components analysis and cluster analysis can all be used for factor classifications. In this study, computing the correlation coefficient between a pair of columns in Table 4 tells us the similarity of two DMUs as appraised by their peers. A high positive correlation coefficient indicates that the two DMUs are inherently similar with respect to their inputs and outputs, which means that they will display a similar operational performance when they are evaluated against the optimal weights of other DMUs. Thus, using these correlation coefficients as the elements in a resemblance matrix and executing a clustering method yields clusters with inherently similar DMUs.

The cluster analysis technique used in this paper is a hierarchical clustering technique that is based on the correlation coefficients of the columns in the cross-efficiency matrix. The average linkage method is utilized to derive the clusters. The clustering process was completed on a PC version of SPSS. Figure 1 depicts the dendrogram of the analysis of the hotels over the sample period. The clusters are obtained by truncating the dendrogram at a rescaled distance measure of 5 on a scale of 0 to 25, where 0 represents a correlation coefficient of 1.0000. From left to right in the dendrogram, the similarity decreases, and the dissimilarity increases, this means that the benchmarks become less appropriate as we move towards the right of the diagram.

[1] In this method, the distance between two clusters is defined as the average distance between all possible pairs of points within the two clusters. In this way, an average distance is calculated and the two clusters with the smallest average distance between their points are merged at each step.

[1] SPSS defines a dendrogram as a visual representation of the steps in a hierarchical clustering solution that shows the clusters being combined and the values of the distance coefficients at each step. Connected vertical lines designate joined cases. The dendrogram rescales the actual distances to numbers between 0 and 25, preserving the ratio of the distance between steps.