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*IT vs. Marketing: Efficiency and Effectiveness Evaluation

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Abstract: Owing to budget constraints, managers should balance the expenditure requirement of IT and marketing department. This paper offers a new method to evaluate the importance of IT department and marketing department. It introduces the triangular three-stage DEA model to measure the expenditure efficiency and effectiveness. Using the data of the hotel industry of Macao, it shows that IT and marketing effectiveness is both positively correlated to productivity while efficiency is not significantly correlated to effectiveness. That means hotel managers need to more carefully and proactively examine the related budgets to be allocated to IT and marketing. The correlation coefficient of marketing effectiveness (coefficient=0.44) is higher than that of IT effectiveness (coefficient=0.41), which shows that in the sample period marketing expenses are somewhat a little more contributive to the business value than IT. This new way can be a reference for managers to set up the budget.

Keywords: IT, marketing, efficiency, effectiveness, DEA

1. INTRODUCTION

With the fast development of information technology (IT), more and more firms invest a lot on IT. The information technology department becomes important in the firm. When managers decide the financial budget of each department, the IT department shows much more powerful. However, other departments argue for more budgets, such as the marketing department. From the financial perspective IT department is the cost center or expense center, while marketing department is the profit center. When the whole budget is given, the CEO should balance the requirement of each department. What is the decision basis for the CEO? Which one is more important, IT department or marketing department? It has been an interesting topic for both practitioners and academics for a long time. Traditionally, financial ratios of various forms have been commonly applied to assess the importance of IT department or marketing department. Nevertheless, related financial indicators may not reveal the empirical relationship between the use of available resources and the business outcomes. In recent years, more studies have emphasized on the measurement of business efficiency and effectiveness^[1]. In this paper, we use this new way to evaluate the efficiency and effectiveness of IT and marketing. It introduces the triangular three-stage DEA (Data Envelopment Analysis) model to compare the IT and marketing.

2. LITERATURE REVIEW

IT is one of the most important tools to ensure business efficiency and effectiveness. In general, firms invest in IT to meet six strategic business objectives: i) operational excellence; ii) new product, service, and business models; iii) customer and supplier intimacy; iv) decision making; v) competitive advantage; and vi) survival. In absolute and relative terms, IT investments (including hardware, software, and communications equipment) have rapidly grown in the recent 30 years. In 1980, IT investments accounted for 32% of all invested capital of US firms, while this share increased to 52% in 2009^[2]. However, it is also necessary to note that excessive investment may often lead to the “IT productivity paradox”^[3], which means a contradiction

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between the large amount of investment in IT and relatively slow growth of productivity. Sometimes the wide use of IT cannot help firms gain a competitive advantage. As Carr (2003) said, “IT doesn’t matter”^[4]. Traditional marketing department used the “IT productivity paradox” as the reason to strive for more budgets of more advertisements, promotion and other marketing expenses. Keh et al. first offered the triangular DEA model to measure the marketing efficiency and effectiveness using a 49-unit Asia-Pacific hotel chain^[5].

In principle, the DEA is a non-parametric efficiency measurement method of multiple inputs and outputs which was developed by Charnes et al. ^[6]. The DEA is the first approach to establish an “efficient frontier” by using a set of decision making units (DMUs). The efficient frontier shows the best practices or benchmark and shows the distance of the DMUs to an efficient frontier. As the DEA does not require any assumptions to be made about the functional form of the relationship between input and output variables ^[7], it has been widely applied in many fields, including banking, education and the hotel industry. Up to the year 2009, there were approximately 4,500 DEA related papers on the ISI Web of Science database ^[1]. Currently, additional efforts have been devoted to the development of various DEA efficiency models, such as the constant returns to scale (CRS) and variable returns to scale (VRS) models, slacks-based measures, etc. These models are commonly applied to determine the reasons for inefficiency in firms, hence helping them to identify their potential growth points.

A comprehensive review of the existing literature shows that the first application of the DEA that was used to evaluate hotel performance is in a study by Morey and Dittman in 1995. Thereafter, the DEA has been applied in efficiency studies on the hotel industry in different regions and under different motivations. For example, Morey & Dittman (1995) developed benchmarks for a group of hotels, and these benchmarks were then used to score the level of efficiency of the general managers. In 2003, they updated the study by controlling the differences in environmental factors for the general managers to provide a more objective comparison of the efficiency ^[8]. Moreover, Anderson et al. (2000) conducted a comprehensive study of the US hotel industry which measured the overall technical, allocative, pure technical, and scale efficiencies, respectively.

In addition, the application of the DEA has also been extended to examining the efficiency of hotels under different business organizations in different countries/regions. For example, the performance of three operational styles of international tourist hotels in Taiwan (i.e., independently owned and operated, franchise licensed, and managed by international hotel operators) were evaluated ^[9; 10]. Likewise, the DEA was used to assess the efficiency of hotel chains in France and it was found that hotel chains have a higher average efficiency score than franchised and company-owned hotels ^[11].

Moreover, some researchers have given their attention to modifying the methodology of the DEA. For example, the Malmquist productivity index (MPI) and DEA were used to measure managerial performance in 45 Taiwanese hotels in 1998, as well as efficiency changes from 1994 to 1998 ^[7]. Indeed, the MPI is helpful in revealing changes in efficiency. In another study, Wang et al. (2006) introduced the Tobit regression model to the DEA to more accurately measure the relative cost efficiency of 49 international tourist hotels in Taiwan. In considering the effectiveness of the three-stage DEA over the traditional DEA ^[12], Shang et al. (2008b) applied a related procedure to analyze the impact of service outsourcing on the performance of hotels. Also, newly developed DEA methods like the relational network DEA model ^[13], slack-based measure of efficiency ^[14] and the multi-component DEA of global assurance region (GAR) models ^[15] have been recently applied in related studies on the hotel industry.

Thus, an evaluation of the efficiency of IT investment in hotels has become important and seen to be helpful in resolving the “IT productivity paradox” ^[3]. Nevertheless, recent empirical studies may not have arrived at the same results. For example, by applying the DEA to test a dataset of three-star hotels in the United Kingdom, Sigala et al. (2004) found that the adoption of IT does not always increase hotel productivity. In

another study, Shang et al. (2008b) used the three-stage DEA method to point out that the impact of the adoption of e-commerce is not a main determinant of the efficiency of the international tourist hotels in Taiwan. Yet, when Scholochow et al. (2010) proposed a new three-stage DEA approach to investigate IT efficiency and effectiveness in the Austrian hotel sector based on Keh et al.(2006), they found that the impact of IT on productivity gains is positive and significant. The literature review shows that the triangular three-stage DEA model can be used to evaluate both IT and marketing efficiency and effectiveness.

3. RESEARCH HYPOTHESIS AND METHODOLOGY

The DEA framework that examines the business value of IT as proposed by Scholochow et al. (2010) was followed^[16]. In addition, a triangular DEA model was also applied to show the related marketing performance in terms of efficiency and effectiveness^[5]. Following Keh et al.(2006), we selected the hotels industry in Macao as the sample. Since the dawn of the 21st century, the hotel industry in Macao has shown rapid progress, and a tremendous amount of capital investment has shaped the industry. The traditional DEA model provides a robust tool to evaluating the relative efficiency of a set of DMUs with inputs and outputs. Most of the previous studies use firms as the DMUs. Throughout the development of the DEA methodology in the past three decades, it has been noted that the related analyses may not necessarily be restricted to application of firm-level data, but also include industry-level data^[1]. In consideration of the availability of data for the Macao hotel industry, industry-level data will be applied to evaluate the related efficiencies in this study, which is indeed similar to some of the related studies that have been recently released^[17; 18]. To evaluate the efficiency of the hotel industry in Macao, annual data is set as one of the DMUs.

Operation costs are the sum of the operating expenses, purchase of goods and commission paid. In the Macao official statistics, operating expenses include “materials, fuels, electricity, maintenance and repairs, rent of establishment, **computer and information, marketing and publicity**, patents and trademarks, and other contract service” (see Hotels and Similar Establishment Survey, 2000~2011). Thus, the value of “computer & information” is used to represent IT expenses. “Marketing and publicity” is used to represent Marketing expenses. The raw input variables were the total operation cost, number of rooms and employees. The intermediate output and input were IT expenditures/Marketing expenditures. The output variables were the total revenue.

Figure 1 shows IT efficiency in terms of the relationship between IT expenditures and raw inputs. In principle, high IT efficiency means that there are more IT expenditures. On the other hand, IT effectiveness is the relationship between IT expenditures and outputs. It is desirable to have low IT expenditures lead to high outputs. Indeed, an efficient DMU tends to keep inputs low for a given IT budget while simultaneously reaching for maximum output.

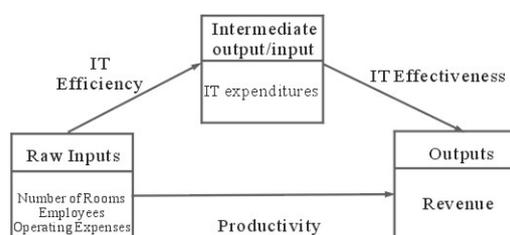


Figure 1. IT efficiency and effectiveness

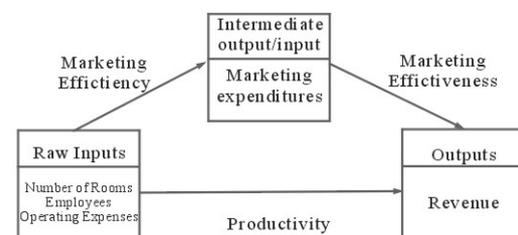


Figure 2. Marketing efficiency and effectiveness

It is possible to compare the efficiency, effectiveness and productivity of IT and marketing expenses. To hotel decision makers, the allocation of budgets between different units is always a challenge. For example, the marketing and the IT departments may both request for a higher budget. Therefore, by applying the same

triangular DEA model as presented in Figure 2, the hypotheses of the efficiency and effectiveness of marketing expenses can also be tested respectively. Marketing efficiency is to measure the efficiency of market expenditures at the given raw inputs. A higher market efficiency means more market expenditures. The market effectiveness is to measure the output of market expenditures. Then, the efficiency and effectiveness of IT, as well as those of marketing, can be compared to reveal which contributes more to productivity. Figures 1 and 2 are similar. However, the intermediates are different. IT and market expenditures are independent expenditures. Generally, IT expenditures are the amount that the DMUs spent on inner management while market expenditures are the amount that the DMUs spent on the outside market. We wanted to see how much the hotels spent on IT or the outside market at a given level of raw inputs. By using the same framework to separately test IT and market expenditures, this can help to compare the contributions by IT and the outside market. The results may help managers to balance their budget.

Based on the previous literature, the following hypotheses are proposed.

H_{1a} : *IT efficiency (DEA1) is negatively correlated to IT effectiveness (DEA2).*

H_{1b} : *IT effectiveness (DEA2) is positively correlated to productivity (DEA3).*

H_{2a} : *Marketing efficiency (DEA1) is negatively correlated to marketing effectiveness (DEA2).*

H_{2b} : *Marketing effectiveness (DEA2) is positively correlated to productivity (DEA3).*

4. DATA ANALYSIS AND RESULTS

To conduct this study, the data of the Macao hotel industry are derived from the Statistics and Census Service of the Macao SAR Government. When constructing the data set for the input and output variables, related data are derived from the *Hotels and Similar Establishment Survey* (Survey) from 2000 to 2011. The data in 2004 and 2005 are omitted by the Survey from the official statistics.

Recently, different approaches have been introduced to capture such effects from the physical environment and statistical noise which could be present in the DEA. For example, the one- and two-stage models have been commonly applied^[19]. Furthermore, Lu & Lian (2010) used a DEA-Tobit regression model to measure the performance of Macao hotels. Nevertheless, the robustness of the empirical results as derived from the one- and two-stage models are still restricted by their deterministic nature. To avoid the potential drawbacks, a three-stage DEA methodology was used^[12], and this method was applied in measuring the performance of hotels and banks in some of the recent studies^[20; 21]. In this study, the three-stage DEA^[12] will be used. In the first stage, we used the traditional DEA model (VRS)^[22]. We only used the input and output quantity data. This can be expressed as a linear programming problem to obtain the efficiency frontier. This is the initial evaluation of producer performance. This evaluation does not account for the operating environment and statistical noise on producer performance. So in the second stage, we used a stochastic frontier analysis (SFA) to adjust for the variation in the first stage, such as from the effects of the environment, managerial inefficiency and statistical noise. In the third stage, we repeated the analysis in the first stage by applying DEA to the amended data. The third stage, the re-evaluation of producer performance improves the measures of managerial efficiency because the data have been processed by second stage SFA regressions with environment effects and statistical noise.

To perform a test on Hypothesis, related data for the input and output variables were first adjusted by using a GDP deflator (base year = 2011) so that the real effect could be revealed. In a related analysis, DEA1 denoted IT efficiency with the assumption of input oriented and variable returns to scale. In principle, this term shows the allocative efficiency related to the intra-organization operation of a hotel, and its decision on the appropriate proportion of total expenses to be allocated to IT expenses (Scholochow et al., 2010). In addition, the input variables comprised the number of rooms and employees, as well as the total operation cost. On the other hand, IT expenses were the output variable.

Then, DEA2 was used to reveal the effectiveness of IT. In this measurement, it is assumed that the behavior of firms are output oriented and VRTS. Besides that, while IT expenses were applied as an input in the hotel business, the total revenue and occupancy rate of hotel rooms were the output variables. Finally, DEA3 was used for the productivity measurement of the raw input and the final output (same assumptions for DEA 2 were applied).

By following Spearman's rho, which is a nonparametric measure of statistical dependence between two variables, the estimated scores (i.e., the Spearman's coefficients) for DEA1, DEA2 and DEA3 are summarized in Table 1. These scores can be used to test Hypothesis 1.

Table 1. Spearman's correlations (IT)

			DEA1	DEA2	DEA3
Spearman's rho	DEA1	Correlation Coefficient	1.00		
		Sig. (2-tailed)	.		
	DEA2	Correlation Coefficient	-0.11	1.00	
		Sig. (2-tailed)	0.57	.	
	DEA3	Correlation Coefficient	0.12	0.41*	1.00
		Sig. (2-tailed)	0.53	0.03	.

* Correlation is significant at the 0.05 level (2-tailed).

The results as presented in Table 1 for the Macao hotel industry may not be the same as those of similar studies on different overseas markets. For example, Scholochow et al. (2010) used data from Austria and found that the negative correlation between DEA1 and DEA2 (H_{1a}) is significant, and the same applied to the positive correlation between DEA2 and DEA3 (H_{1b}).

In principle, the DEA1 of IT efficiency means the allocative expenses of IT, while the DEA2 of IT effectiveness means the outputs of IT. In practice, hotels managers are assumed to maximize outputs with the least amount of IT expenses, hence a negative correlation between DEA1 and DEA2 will be met with little dispute.

In the Macao hotel industry, however, it was found that H_{1a} is not significant. This indicates that the hotel managers may not be minimizing IT expenses when attempting to maximize outputs. One possible explanation could be the lack of proactive IT planning, or that IT capacity is not being fully utilized.

In the hotel business today, while IT expenses are generally required to support the general operations of hotels, marketing expenses are indispensable to sustaining business growth and cultivating new customers. Owing to budget constraints, if more funds are approved for IT purposes, then less will be available for marketing, and vice versa. To be able to effectively allocate the budget between these two kinds of expenses, hotel managers may need an overall picture about the efficiency, effectiveness and productivity of spending in marketing. The Spearman's coefficients of the scores of DEA1, DEA2 and DEA3 for marketing are summarized in Table 2.

Table 2. Spearman's correlations (Marketing)

			DEA1	DEA2	DEA3
Spearman's rho	DEA1	Correlation Coefficient	1.00		
		Sig. (2-tailed)	.		
	DEA2	Correlation Coefficient	-0.24	1.002	
		Sig. (2-tailed)	0.22	.	
	DEA3	Correlation Coefficient	0.25	0.44*	1.002
		Sig. (2-tailed)	0.20	0.02	.

* Correlation is significant at the 0.05 level (2-tailed).

Based on the related test statistics as presented in Table 2, H_{2a} is rejected (the coefficient -0.24 is insignificant), while H_{2b} is not (the coefficient 0.44 is significant). In other words, marketing efficiency (DEA1) is insignificantly correlated to marketing effectiveness (DEA2). However, marketing effectiveness (DEA2) is significantly and positively correlated to productivity (DEA3). Similar to the test results derived for Hypothesis 1, the insignificant relationship between DEA1 and DEA2 (i.e., H_{2a}) may not be in line with some of the other studies on different markets. For example, Keh et al. (2006) explored 49 Asia-Pacific hotel chains and their results support both H_{2a} and H_{2b} .

5. CONCLUSIONS AND DISCUSSION

It shows that IT and marketing effectiveness is both positively correlated to productivity while efficiency is not significantly correlated to effectiveness. That means it is helpful to productivity by how to use the expenditures of IT and marketing. The usage of resources is more important than the allocation. In the budget building, the managers should pay more attention to the effectiveness but not the efficiency. It is not about the amount of expenditures but the usage of the budget, which have direct relation to performance.

A simple comparison between related Spearman's correlation coefficients of DEA scores of IT and marketing may further provide some meaningful implications for the management of hotels. We summarized the hypotheses and correlation coefficients as table 3. Since the correlation coefficient of marketing effectiveness (i.e., positive correlation between marketing expenses and the industry's productivity) is higher than that of IT effectiveness (0.44 versus 0.41), this shows that in the sample period, marketing expenses are somewhat more contributive to the business value than IT.

Table 3. Hypotheses and Correlation Coefficients

Hypothesis	Content	Correlation Coefficient	Significant
1a(IT)	DEA1 and DEA2	-0.11	No
1b(IT)	DEA2 and DEA3	0.41	Yes
2a(Marketing)	DEA1 and DEA2	-0.24	No
2b(Marketing)	DEA2 and DEA3	0.44	Yes

Nevertheless, in view of the small differences in absolute value between IT and marketing effectiveness, and the anticipated importance of IT in the global hotel industry, hotel managers need to more carefully and proactively examine the related budgets to be allocated to IT and marketing in the future. Indeed, this is in line with the fact that Hypotheses 1a and 2a are not significant in this study, which is not the case as compared to evidence derived from other markets. Finally, it is worthwhile to underline that compared to other existing studies like those by Keh et al. (2006) and Scholochow et al. (2010) at the industry level, the performance evaluation method in the Macao hotel industry may also be applied to the firm level.

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