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MEASURING PERFORMANCE EFFICIENCY OF HOTEL SERI MALAYSIA USING DATA ENVELOPMENT ANALYSIS MODELS

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ABSTRACT

A hotel is a place that offers paid lodging, typically for a brief period of time. Hotels frequently offer a variety of extra services to its guests, including dining establishments, bars, swimming pools, medical facilities, retail stores, meeting spaces like boardrooms and banquet halls, and areas for private events like birthdays and weddings. This research study was conducted at Hotel Seri Malaysia(HSM) in each state in Malaysia. The research objectives is to measure performance efficiency of Hotel Seri Malaysia using the Charnes, Cooper, Rhodes(CCR) and Banker, Charnes, Cooper(BCC) Data Envelopment Analysis(DEA) models. Then, to identify the best performance efficiency of Hotel Seri Malaysia by comparing CCR and BCC DEA models. This project will use data from Hotel Seri Malaysia and the approach of (DEA) will be used in this study. Several models found in the DEA method are used to obtain relative efficiency scores such as the CCR model and the BCC model by using DEAFrontier software. The BCC model outperforms the CCR model in terms of effectiveness, according to a comparison between the two models. This is due to the BCC model having more efficient decision making units (DMUs) than the CCR model. Out of 11 DMUs, HSM Temerloh, HSM Kepala Batas, HSM Kangar, and HSM Mersing are the most effective.

1 INTRODUCTION

1.1 Research Backgroud

Malaysia is one of the most popular tourist destinations in the world, largely because of its exceptional natural setting and rich cultural legacy. The services sector has been a major contributor to Malaysia's economic growth, accounting for over half of the country's real GDP. The hotel business is one of Malaysia's most promising industries, but it requires a few essential measures to match it with the country's economic plan. The hotel industry makes numerous contributions to the national economy, including providing employment opportunities, alternative and additional income for rural residents, supporting the growth of secondary industries such as material and equipment suppliers, and complementing the expansion of both domestic and international tourism. The performance of the industrial sector and other service sectors, particularly the financial sector, is, nonetheless, critical to the industry's success.

In 2019, based on website the total revenue of the hotel industry sector in Malaysia surpassed USD1.13bn, while the total number of employees was more than 208.5 thousand people. Based on 2019 statistics, 26.1 million tourists came to Malaysia before the COVID-19 pandemic began to spread in the country. However, many tourists like to come to Malaysia because of its beautiful and clean country. It also has delicious traditional Malay food and various interesting places to visit.

The purpose of this paper is to analyze the efficiency of Hotel Seri Malaysia in eleven states in Malaysia using Data Envelopment Analysis (DEA) as the research instrument. The primary goal of the study is to analyze the tourist's competitiveness and efficiency of several Hotel Seri Malaysia in eleven states in Malaysia and to identify the root causes of inefficiency. Hotel Seri Malaysia is available in all states in Malaysia except Kelantan and Sabah.

The Charnes et al.-developed Data Envelopment Analysis (DEA) is a method based on mathematical programming that assesses the relative effectiveness of a collection of decision-making units (DMUs) that share inputs and outputs. The DMU is the homogeneous entity responsible for the conversion of inputs into outputs. A matrix made up of the inputs, outputs, and complementary components of the sample of DMUs is necessary to conduct a DEA analysis. The matrix is implemented in the model to be solved once the DEA model has been developed in accordance with a set of features including metrics and orientation. As a result, the major outcomes are relative efficiency scores and operational benchmarks for each DMU.

The Charnes–Cooper–Rhodes (CCR) DEA model and the Banker–Charnes–Cooper (BCC) DEA model are two standard DEA models. The CCR DEA model is a model of constant returns to scale. The BCC DEA model is a model of variable returns of scale. This study will use the CCR DEA model and BCC DEA model to evaluate Hotel Seri Malaysia, one of the few empirical studies to do so for the hotel industry sector. Next, the DEA CCR model and the DEA BCC model will be compared to determine which model has the best efficiency performance of Hotel Seri Malaysia.

1.2 Problem Statement

This study will be focusing on Hotel Seri Malaysia in eleven states in Malaysia to measure efficiency using data envelopment analysis (DEA). The reason why this study will be focusing on Hotel Seri Malaysia is because there are eleven states that have Hotel Seri Malaysia except Kelantan and Sabah, which is why this study will concentrate on them. Penang, Terengganu, Pahang, Selangor, Negeri Sembilan, Melaka, Perak, Johor, Kedah, Perlis and Sarawak are where Hotel Seri Malaysia may be found. This hotel has a lot of branches, due to this, Hotel Seri Malaysia has become one of Malaysia's most well-known hotels. Many tourists traveling in Malaysia whether from inside Malaysia or outside Malaysia will stay at this hotel because it has many branches located everywhere. Hence, when the vacation season rolls around, Hotel Seri Malaysia is also one of the busiest hotels.

Hotel Seri Malaysia is open every year, twenty-four hours a day, seven days a week. The increase in the number of guests during the holidays causes busyness at Hotel Seri Malaysia. The smaller number of employees causes the service that can be provided to be less satisfactory. Thus, causing the number of rooms that can be opened to hotel guests to decrease. This is because the workers are not able to clean the rooms that have been left by the guests in a short time. Therefore, the hotel does not want to take the risk of opening a large number of rooms because it does not want the service provided to not reach the standard of the guests.

1.3 Research Objective

The research study was conducted at Hotel Seri Malaysia in each state in Malaysia. The following is a list of the study's research objectives:

1. To measure performance efficiency of Hotel Seri Malaysia using the CCR and BCC DEA models.

2. To identify the best performance efficiency of Hotel Seri Malaysia by comparing CCR and BCC DEA models.

1.4 Significant Of Project

The significance of this project is to measure performance of several branches of Hotel Seri Malaysia using the CCR and BCC DEA model. For this project, the CCR and BCC DEA models will be compared to identify which model has the best hotel performance efficiency. This research is expected to be beneficial to the management of hotels in Malaysia as a guide to reduce their cost and increase service quality of hotels. There is a lot of research about the efficiency of hotels so future studies will profit from these findings because the effectiveness of this mathematical technique has been established.

1.5 Scope Of Project

This study will use the data from Hotel Seri Malaysia and the approach of Data Envelopment Analysis (DEA) will be used in this study, which will include a CCR input-oriented model and BCC input-oriented model. The CCR input-oriented model and BCC input-oriented model will be used to measure the performance efficiency between Hotel Seri Malaysia branches. Then the results will be compared to identify which model has the best performance efficiency in Hotel Seri Malaysia branches.

1.6 Definition of Terms and Concepts

The following are the definition of terms and concepts used in this project:

Data Envelopment Analysis (DEA)	Data Envelopment Analysis (DEA) is a non-parametric technique for determining the efficiency of Decision Making Units (DMUs) with many inputs and outputs. This is the most widely used method for estimating frontiers in productivity and efficiency assessments in all domains of economic activity.
Charnes, Cooper, Rhodes (CCR)	The first DEA model is known as CCR model developed by Charnes, Cooper and Rhodes in 1978 under the assumption of a Constant Returns to Scale production technology.
Banker, Charnes, Cooper (BCC)	The BCC model, named after the names Banker, Charnes and Cooper, is the second DEA model. The model is built on the Technology assumption of Variable Return to Scale (VRS).
Hotel Seri Malaysia (HSM)	Hotel Seri Malaysia is one of the leading hotels in Malaysia. It has branches in almost every state in Malaysia.
Decisions-making units (DMUs)	The homogeneous entity responsible for the conversion of inputs into outputs.

2 LITERATURE REVIEW

2.1 Introduction

This section establishes our research theme and identifies various studies that use DEA to assess the efficiency of the hotel. The types of inputs and outputs used, the samples considered, and the methodologies used are the key differences between this research. The data envelope analysis (DEA), developed by Charnes et al., is a mathematical programming approach for measuring the efficiency of a set of decision-making units (DMUs) with similar inputs and outputs in a relative way. The constant returns to scale (CCR) model, developed by Charnes et al., and the variable returns to scale (BCC) model, developed by Banker, Charnes, and Cooper, allows each DMU under assessment to determine its own weights for inputs and outputs, resulting in the highest possible efficiency score.

2.2 Research on Effectiveness of the Hotel

According to Gombu (2021) effective resource planning and management are key to the hotel industry's success and survival in the tourism sector. The current research examines the effectiveness of the hotels in the Bomdila-Tawang tourism circuit using the data envelopment analysis (DEA) BCC and CCR models. In tourism and hospitality, the DEA technique is commonly used to assess performance and efficiency, which aids in decision-making. Technical efficiency examines the measure of comparative effectiveness with which a set of inputs and outputs is used in the regional hotel sector (Yinghua, Hani Maxwell, 2011). The DEA model is effective for measuring the overall organisational efficiency of hotels because it considers various inputs and outputs (Yen Othman, 2011).

Higuerey et al. (2020) measured the efficiency of the hotel industry in Ecuador during the period 2013-2017. They applied DEA the constant returns to scale (CCR) models. The input variables considered were the number of employees, fixed assets and consumption cost. The output was total revenue. The main results indicate that the most efficient provinces were

Galapagos and Chimborazo while the provinces of Manabi and Guayas had a low efficiency. In conclusion, the hotel business in Ecuador has a poor efficiency on average, with a high level of hotels that, due to their flood of customers and the locations in which they are located, have a large influx of consumers, as evidenced by income, allowing them to enhance their resource utilization.

The effectiveness of 400 Spanish hotels is examined in this article, which takes into account the tourist destination's characteristics as well as internal firm aspects. According to Lado-Sestayo & Fernández-Castro (2019) data envelopment analysis (DEA) is used to provide a synthetic indicator of efficiency, with sales revenue as the output variable and depreciation, labour costs, and operational costs as the input variables. Two major methodological contributions are made in this study. First, it presents a four-stage DEA model that uses CCR to separate efficiency into characteristics related to tourism destinations and hotel management. The second addition is in the area of measuring efficiency through "super efficiencies," which expands the efficiency rankings to include efficient units. The findings support the utility of the proposed disaggregated model and the necessity of factoring in tourist destination factors.

Between 2011 and 2015, Bayrak & Bahar (2018) used DEA to measure the tourism activities of 34 OECD member nations. Three inputs were employed in the study: the number of arriving passengers, tourism expenditures, and the logistics performance index, as well as one outcome, tourism income. By applied CCR model, eight nations (the United States, Australia, Spain, Luxembourg, Portugal, Turkey, New Zealand, and Greece) are efficient DMUs as a consequence of a dynamic study examining the five-year period concurrently. But by applied the BCC model indicated that nine countries (Estonia, Israel, Iceland, Hungary, Mexico, Poland, Slovenia, Slovakia, and Chile) were efficient. As a result, New Zealand appeared to be in first place when the ranking of efficient countries was evaluated. Following it were Greece and Portugal.

Soysal-Kurt (2017) used variables obtained from studies in the literature (Hwang Chang, 2003; Oukil et al., 2016; Hadad et al., 2012; Assaf, 2012). to apply to 29 European countries with high and upper-middle incomes .The application is performed using constant returns to scale (CRS) and input-oriented (CCR) DEA. Three input (number of employees,tourism expenses and number of beds) and three output (tourist arrivals, tourist receipts and number of nights spent) factors that are expected to affect tourism efficiency and are commonly utilised in the literature are used in the analysis.

Poldrugovac et al. (2016) two approaches were used in this study to explore the influence of scale on efficiencies of 25 hotels in Croatian. To generate efficiency scores, CCR output-oriented DEA model was applied was employed first, followed by an analysis of variance to see if there were any differences in efficiency between hotels of various sizes and star ratings. The 5 inputs were energy expenses, room expenses, FB expenses, expenses associated with other services and labor expenses.The output were total revenue and occupancy rate. Overall, because the average efficiency of a hotel within the group is 73 percent, the data imply that hotels run at a pretty high degree of efficiency.

During the years 2002–2006, Tsai (2009) used the DEA technique based on the Banker-Charnes-Cooper (BCC) model to measure star-rated hotel productivity/efficiency in China. The number of hotels, the amount of fixed assets, and the number of hotel staff undergoing training were chosen as the three inputs. Total revenue and occupancy percentage were the two outputs employed.Their findings revealed that the hotel industry in major provinces/cities such as Beijing, Tianjin, Shanghai, and Zhejiang was efficient, which is logical given their status as major metropolitan destinations, whereas hotels in provinces such as Hainan, Heilongjiang, and Liaoning were the least efficient. The slack in the BCC model shows that the number of hotels in these latter areas might be lowered in order to achieve maximum outputs of total sales income and occupancy percentage. There is also evidence that the ranking produced by The Yearbook (Shao, 2002–2007) using traditional productivity metrics differs significantly from that produced by the DEA cross-efficiency measurement.

2.3 Research on CCR and BCC Models

In the thirteen regions of Greece between the years of 2002 and 2013, Karakitsiou et al. (2020) examined the effectiveness of the restaurant and hotel industries. They applied DEA with the CCR and BBC models. The number of local units, personnel, and investments were all taken into account as input variables. Invoices were the result. The major findings showed that Attica, the North Aegean, and the South Aegean were the most effective locations, whereas Eastern Macedonia and Thrace, Thessaly, and Central Greece were less effective. Many Greek regions' performance might be significantly improved overall. By balancing inputs and outputs, local destination management organisations must make a significant effort to improve the tourist performance of Greek locations.

Additionally, according to Grmanová & Strunz (2017), their study's objective is to ascertain the link between insurance businesses' financial success and technical efficiency. Two models, the output-oriented BCC model and the input-oriented CCR model, were used to express the technical efficiency score. The inputs were operating costs and claims incurred. Earned premiums and investment income were the outputs.

In 2019, Mazumdar (2019) investigated the effectiveness of the Selected Indian banks from 2000-2001 to 2014-15 by way of DEA. According to the findings, foreign banks, as a collective, are the most effective. Using CCR DEA model, Maity & Ganguly (2019) examined the efficiency level trend throughout the pre- and post-demonetization phase from April 2014 to March 2018. Total assets, total expenses, and net non-performing assets were taken into account as input factors to analyse the TE of the banking sector, while total revenue, which comprises interest income and non-interest income, was evaluated as an output variable.

On the basis of sales, profit, the number of stores, the number of employees, and the total sales area, Takouda & Dia (2019) used DEA to assess the effectiveness of 33 outlets of three hardware retail corporations in Canada during the years 2000–2010. The relevance between the

CCR, BCC, and SC DEA models was further examined by the authors using bootstrapping.

3 METHODOLOGY

According to Taboada & Han (2020), DEA measures the performance of entities known as Decision-Making Units (DMUs) in a non-parametric way. A DMU can be a restaurant, a hospital, a factory, a bank branch and as in this research, a hotel. The objective of DEA is to identify the hotels that most effectively transform their inputs to outputs. Thore & Tarverdyan (2021), these units are located on the effectiveness frontier. The remaining units falling behind the frontier are deemed ineffective.The efficiency score of DEA is 1.00 for frontier points and less than one for sub-efficient points located behind the frontier. Benchmarks are the terms used to describe frontier points. Any benchmark point can be expressed as the linear combination of its "reference" units or "peers."

There are two standards of the DEA model which are the CCR (Charnes,Cooper,Rhodes) DEA model and the BCC (Banker,Charnes,Cooper) DEA model. There are three different types of model orientation: input-oriented, output-oriented, and non-oriented Cooper et al. (2007). According to Martín-Gamboa & Iribarren (2021) an input-oriented model, an inefficient entity can become efficient by lowering its inputs while maintaining at least the same level of outputs. However, under an output-oriented model, the DMU is transformed into an efficient entity by increasing outputs while maintaining the same level of inputs. The goals of a non-oriented model are raising outputs while lowering inputs.

3.1 Data Collection

3.1 (a) Hotel Seri Malaysia

Every year, Hotel Seri Malaysia is open twenty-four hours per day, seven days a week. The hotel has many branches throughout Malaysia. Inside a hotel room, facilities provided by Hotel Seri Malaysia can range from a small room with a low-quality mattress to a spacious suite with larger, higher-quality beds, a wardrobe, a refrigerator and other kitchen appliances, upholstered chairs, a flat-screen television, and suite bathrooms. For registration time, guests can start check-in at 3 PM and check-out at 12 PM. Even though the hotel doesn't get much business during the weekdays and few rooms are filled, this figure somewhat increases on weekends. However, hotel rooms will be completely filled at some seasonal times of the year, such as school breaks and festive holidays.

The data below is from Hotel Seri Malaysia which has 11 branches in Malaysia. Thus, there are 11 hotels considered as decision making units (DMU) as shown in Table 3.1.

Table 3.1: Data collection

No.	Hotel Seri Malaysia	Number of room	Number of employee	Total Revenue (USD)
H1	Kepala Batas	100	141	26,000,000
H2	Temerloh	50	84	15,000,000
H3	Kuala Terengganu	133	165	21,000,000
H4	Alor Setar	100	135	22,000,000
H5	Mersing	50	76	13,200,000
H6	Port Dick-son	90	122	18,700,000
H7	Melaka	100	140	24,000,000
H8	Ipoh	100	137	20,000,000
H9	Kangar	143	180	34,000,000
H10	Lawas	104	150	25,000,000
H11	Bagan Lalang	91	125	17,800,000

3.2 Input and Output

Before the efficiency analysis for each DMU is measured,The first step is to choose the suitable inputs and outputs to measure the performance of each DEA model used. The inputs and output in this research are based on previous studies by Honma & Hu (2012). They used the same inputs and output with this research as it is the best factor involved in measuring the efficiency of a hotel. This research only focuses on 2 inputs and 1 output. As Table 3.2 indicates, the inputs are number of rooms and number of employees while revenue of a hotel is considered as output.

Table 3.2: Input and Output

Input	Output
1. Number of room 2. Number of employee	Total revenue

3.3 Methodology Phases

The CCR input-oriented model and the BCC input-oriented model are the Data Envelopment Analysis (DEA) models instruments used in this study. This study is divided into three phases. Phase one is to measure performance efficiency of Hotel Seri Malaysia using the CCR DEA models, phase two is to measure performance efficiency of Hotel Seri Malaysia using the BCC DEA models and the last phase is to identify the best performance efficiency of Hotel Seri Malaysia by comparing CCR and BCC DEA models.

3.3 (a) ***Phase 1: To measure performance efficiency of Hotel Seri Malaysia using the CCR DEA models***

The first model (Charnes, Cooper, and Rhodes, 1978) is a constant returns to scale (CRS model or also known as CCR model - named after its authors) model that implies the change in outputs will be the same as the change in inputs or the change in inputs will be the same as the change in output.This approach provides an unbiased assessment of overall effectiveness based on the population under consideration and identifies values linked to the variables relating to the inefficient units.The key assumption of the CCR model is that the associated frontiers have constant return-to-scale characteristics. As a result, where this assumption is reasonable given the variable specifications, a model of this kind would be most useful. The input-oriented model and the output-oriented model are two DEA models that can be used to calculate the efficiency score. The input-oriented model is used to lower the amount of input used to produce a given output, whereas the output-oriented model is used to maximize the amount of product produced from a given input. In this study, the input-oriented paradigm is more appropriate than the output-oriented model for providing high-quality services to customers with limited resources.

Karakitsiou et al. (2020) uses an input-oriented CCR model, they conclude that some regions of Greek will be more efficient if they reduce the level of inputs with non-zero slacks. Below are the CCR input-oriented and output-oriented models :

(i) CCR input-oriented model:

$$Maximize: \sum_{i=1}^{r} u_i y_{i0}, \tag{1}$$

$$Subjectto: \sum_{j=1}^{m} v_j x_{j0} = 1, \tag{2}$$

$$\sum_{i=1}^{r} u_i y_{ik} \leq \sum_{j=1}^{m} v_j x_{jk}, \tag{3}$$

$$u_i \geq \varepsilon, \tag{4}$$

$$v_j \geq \varepsilon, \tag{5}$$

$$k = 1, 2, .., n$$

$$i = 1, 2, ..., r$$

$$j = 1, 2, ..., m$$

u_i=The weight representing the output (*i* represented as the types of output),

y_{i0}=The actual value of the output *i* for DMU_0

v_j=The weight representing the input of DMU_0,

x_{j0}=The vector input of DMU_o,

j=1,2 (represented as 2 types of input).

y_{ik}=The actual value of the output i for DMU_k

x_{jk}=The actual value of the input i for DMU_k

u_i=The weight representing the output(i represented as the types of output),

v_j=The weight representing the input(j represented as the types of input)

(ii) CCR output-oriented model:

$$Minimize: \sum_{j=1}^{m} v_j x_{jq}, \quad (6)$$

$$Subjectto: \sum_{i=1}^{r} u_i y_{iq} = 1, \quad (7)$$

$$\sum_{i=1}^{r} u_i y_{ik} \leq \sum_{j=1}^{m} v_j x_{jk}, \quad (8)$$

$$u_i \geq \varepsilon, \quad (9)$$

$$v_j \geq \varepsilon, \quad (10)$$

$$k = 1,2,..,n$$

$$i = 1,2,...,r$$

$$j = 1,2,...,m$$

*3.3 (b) **Phase 2: To measure performance efficiency of Hotel Seri Malaysia using the BCC DEA models***

The CRS assumption is only appropriate when the values of n are operating at an optimal scale. Banker, Charnes and Cooper (1984) suggested an extension of the CRS model to account for variable returns to scale (VRS).They proposed a BCC model which has variable returns to scale (VRS). The BCC model distinguishes between technical and scale inefficiencies by estimating pure technical efficiency given the various scale inefficiencies. The BCC DEA model also have two varians oriented which input-oriented and output oriented.The level of outputs/inputs in this model can increase, remain constant, or decrease; it does not have to change in proportion to the level of inputs/outputs.In contrast to the CCR model, the BCC model is appropriate when output maximization is achieved through a proportional (but not necessarily constant) reduction in inputs. Other basic models also included the cone ratio model, the assurance region model, the multiplicative model, the additive model, and the super efficiency model. Therefore, this method requires mathematical constructs not present in the CCR model. Below are the BCC input-oriented and output-oriented models:

(i) BCC input-oriented model:

$$Maximize: \sum_{i=1}^{r} u_i y_{i0} + \mu, \tag{11}$$

$$Subjectto: \sum_{j=1}^{m} v_j x_{j0} = 1, \tag{12}$$

$$\sum_{i=1}^{r} u_i y_{ik} + \mu \leq \sum_{j=1}^{m} v_j x_{jk}, \tag{13}$$

$$u_i \geq \varepsilon, \tag{14}$$

$$v_j \geq \varepsilon, \tag{15}$$

$$\mu random \tag{16}$$

$$k = 1, 2, .., n$$

$$i = 1, 2, ..., r$$

$$j = 1, 2, ..., m$$

u_i=The weight representing the output (i represented as the types of output),

y_{i0}=The actual value of the output i for DMU_0

μ_0=The constant label with c.

v_j=The weight representing the input of DMU_0,

x_{j0}=The vector input of DMU_o,

j=1,2 (represented as 2 types of input).

y_{ik}=The actual value of the output i for DMU_k

x_{jk}=The actual value of the input i for DMU_k

(ii) BCC output-oriented model:

$$Minimize : \sum_{j=1}^{m} v_j x_{jq} + v, \tag{17}$$

$$Subjectto : \sum_{i=1}^{r} u_i y_{iq} = 1, \tag{18}$$

$$\sum_{i=1}^{r} u_i y_{ik} \leq \sum_{j=1}^{m} v_j x_{jk} + v, \tag{19}$$

$$u_i \geq \varepsilon, \tag{20}$$

$$v_j \geq \varepsilon, \tag{21}$$

$$k = 1, 2, .., n$$

$$i = 1, 2, ..., r$$

$$j = 1, 2, ..., m$$

3.3 (c) Phase 3: To identify the best performance efficiency of Hotel Seri Malaysia by comparing CCR and BCC DEA models

This study will compare the results to identify the 11 Hotel Seri Malaysia that have the best efficiency performance after evaluating the data using different models. Based on the results of this study, the model with the most number of efficient improvements between the two models will be selected as the optimal model.

3.4 Software Used

3.4 (a) Microsoft Excel and DEAFrontier Software

DEAFrontier software developed by Professor Joe Zhu is a Microsoft® Excel Add-In for solving Data Envelopment Analysis (DEA) models. DEAFrontier includes the Envelopment Models , Multiplier Models, Slack-based Models (CRS additive model) and Measure-specific Models. DEAFrontier software requires Excel 2007–2013 9 (under Windows) and can solve up to 50 DMUs with an unlimited number of inputs and outputs (subject to the capacity of the standard Excel Solver). Figure 3.5 portrays the Microsoft Excel for DEAFrontier Software.

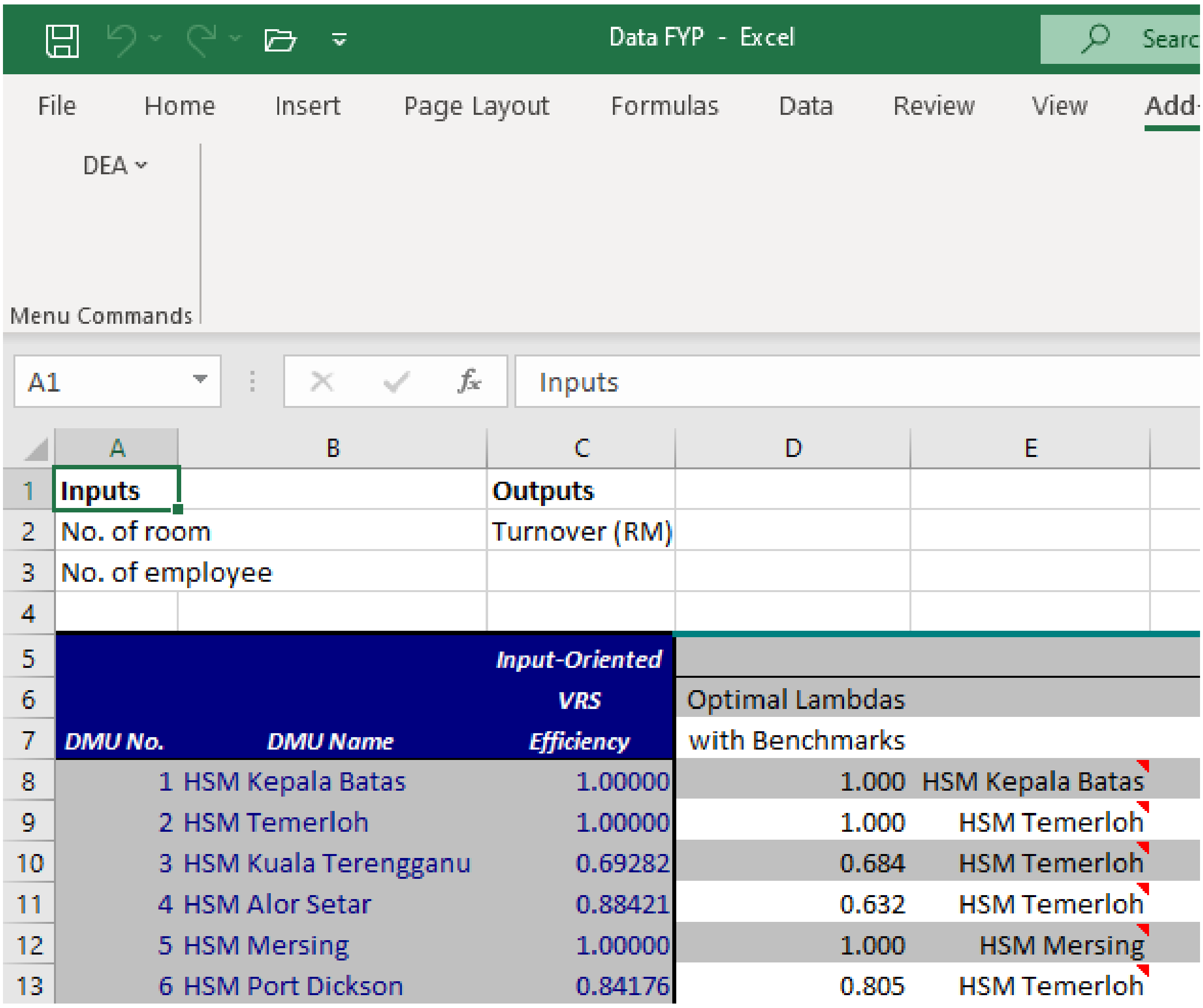

Figure 3.1: Example of DEAFrontier interface

4 IMPLEMENTATION

4.1 Introduction

This section explains the data collection procedures used to carry out this study. The data of Hotel Seri Malaysia are from 11 different states which is obtained by searching for information on the hotel's website. The input-oriented model version is considered suitable for this research since the hotel intends to provide their guests with high quality service while using fewer resources. Therefore, to determine the best efficiency performance of hotels, the input-oriented CCR and BCC model was applied. The subdivisions in this chapter can be divided into the following sections; (i) Evaluate the best performance efficiency of hotels using CCR-input oriented model; (ii) Evaluate the best performance efficiency of hotels using BCC-input oriented model.

4.2 To measure performance efficiency of Hotel Seri Malaysia using the CCR DEA models

Step 1: Normalise decision matrices by find the denominator of formula below.

$$N_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{r} x_{ij}{}^{2}}} \tag{22}$$

DMU	Hotel	No. of room, P	No. of employee, Q	Revenue (USD), R
1	HSM Kepala Batas	100	141	26,000,000
2	HSM Temerloh	50	84	15,000,000
3	HSM Kuala Terengganu	133	165	21,000,000
4	HSM Alor Setar	100	135	22,000,000
5	HSM Mersing	50	76	13,200,000
6	HSM Port Dickson	90	122	18,700,000
7	HSM Melaka	100	140	24,000,000
8	HSM Ipoh	100	137	20,000,000
9	HSM Kangar	143	180	34,000,000
10	HSM Lawas	104	150	25,000,000
11	HSM Bagan Lalang	91	125	17,800,000
	$\sum_{i=1}^{r} x_{ij}^2$	110335	201941	5,423,770,000,000,000
	$\sqrt{\sum_{i=1}^{r} x_{ij}^2}$	332.17	449.38	73646249.06

Figure 4.1: Denominator value of data

Calculation work:

1) Number of room, P

$\sum_{i=1}^{r} x_{ij}^2 = 100^2 + 50^2 + 133^2 + 100^2 + 50^2 + 90^2 + 100^2 + 100^2 + 143^2 + 104^2 + 91^2$

$= 110335$

$\sqrt{\sum_{i=1}^{r} x_{ij}^2} = \sqrt{110335} = 332.17$

2) Number of employee, Q

$\sum_{i=1}^{r} x_{ij}^2 = 141^2 + 84^2 + 165^2 + 135^2 + 76^2 + 122^2 + 140^2 + 137^2 + 180^2 + 150^2 + 125^2$

$= 201941$

$\sqrt{\sum_{i=1}^{r} x_{ij}^2} = \sqrt{201941} = 449.38$

3) Total revenue (USD), R

$\sum_{i=1}^{r} x_{ij}^2 = 26,000,000^2 + 15,000,000^2 + 21,000,000^2 + 22,000,000^2 + 13,200,000^2 + 18,700,000^2 + 24,000,000^2 + 20,000,000^2 + 34,000,000^2 + 25,000,000^2 + 17,800,000^2$

$= 5,423,770,000,000,000$

$\sqrt{\sum_{i=1}^{r} x_{ij}^2} = \sqrt{5,423,770,000,000,000} = 73646249.06$

Step 2: Enter the answer to the formula below:

$$N_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{r} {x_{ij}}^2}} \tag{23}$$

DMU	Hotel	No. of room	No. of employee	Revenue (USD)
1	HSM Kepala Batas	$\frac{100}{332.17} = 0.3011$	$\frac{141}{449.38} = 0.3138$	$\frac{26000000}{73646249.06} = 0.3530$
2	HSM Temerloh	0.1505	0.1869	0.2037
3	HSM Kuala Terengganu	0.4004	0.3672	0.2851
4	HSM Alor Setar	0.3011	0.3004	0.2987
5	HSM Mersing	0.1505	0.1691	0.1792
6	HSM Port Dickson	0.2709	0.2715	0.2539
7	HSM Melaka	0.3011	0.3115	0.3259
8	HSM Ipoh	0.3011	0.3049	0.2716
9	HSM Kangar	0.4305	0.4006	0.4617
10	HSM Lawas	0.3131	0.3338	0.3395
11	HSM Bagan Lalang	0.2740	0.2782	0.2417

Figure 4.2: The value of normalise decision matrices

Step 3: Enter the revenue(output) of hotel from the Figure 4.1 to the linear programming of CCR input oriented:

A linear programming approach is used to solve the problem in this project. The goal of the programming problem is to maximize the amount of output which is the total revenue of the hotel by using the quantity not greater than the input source provided which is the number of rooms and the number of employees. The aim of this project is to provide quality services to customers by minimize the number of room and the number of employee.

$$Max\theta_0 = \sum_{i=1}^{r} u_i y_{i0} \tag{24}$$

θ_0=The efficiency score for DMU_0,

u_i=The weight representing the output (i represented as the types of output),

y_{i0}=The actual value of the output i for DMU_0

$Max = 0.3530u_1$

The answer above is for DMU_1,

The expansion is continued on until the DMU_{11}

Step 4: Enter the inputs which are the number of room and the number of employee from the Figure 4.1 to the modelling constraints of CCR input oriented:

The expansions for all contraints are shown below:

Constraint (1):

$$\sum_{i=1}^{m} v_j x_{j0} = 1 \tag{25}$$

From the given information:

v_j=The weight representing the input of DMU_0,

x_{j0}=The vector input of DMU_o,

j=1,2 (represented as 2 types of input).

Constraint (1) must assign as equal to 1 to get the efficient DMU only.

For $DMU1 : 0.3011v_1 + 0.3138v_2 = 1$

For $DMU2 : 0.1505v_1 + 0.1869v_2 = 1$

For $DMU3 : 0.4004v_1 + 0.3672v_2 = 1$

The expansion is continued on until the DMU_{11}.

Constraint (2):

$$\sum_{i=1}^{r} u_i y_{ik} - \sum_{j=1}^{m} v_j x_{jk} \leq 0, k = 1, 2, ..., n, k \neq 0 \tag{26}$$

From the given information,

u_i=The weight representing the output,

y_{ik}=The actual value of the output i for DMU_k

v_j=The weight representing the input,

x_{jk}=The actual value of the input i for DMU_k

DMU1=$-0.3011v_1 - 0.3138v_2 + 0.3530u_1 \leq 0$

DMU2=$-0.1505v_1 - 0.1869v_2 + 0.2037u_1 \leq 0$

DMU3=$-0.4004v_1 - 0.3672v_2 + 0.2851u_1 \leq 0$

The expansion is continued on until the DMU_{11}.

Constraint (3):

$$v_j, u_i \geq 0 \tag{27}$$

From the given information,

u_i=The weight representing the output(i represented as the types of output),

v_j=The weight representing the input(j represented as the types of input)

The value must be a non-negative value.

4.3 To measure performance efficiency of Hotel Seri Malaysia using the BCC DEA models

$$N_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{r} x_{ij}^2}} \tag{28}$$

Calculation work:

1) Number of room, P

$\sum_{i=1}^{r} x_{ij}^2 = 100^2 + 50^2 + 133^2 + 100^2 + 50^2 + 90^2 + 100^2 + 100^2 + 143^2 + 104^2 + 91^2$

$= 110335$

$\sqrt{\sum_{i=1}^{r} x_{ij}^2} = \sqrt{110335} = 332.17$

DMU	Hotel	No. of room, P	No. of employee, Q	Revenue (USD), R
1	HSM Kepala Batas	100	141	26,000,000
2	HSM Temerloh	50	84	15,000,000
3	HSM Kuala Terengganu	133	165	21,000,000
4	HSM Alor Setar	100	135	22,000,000
5	HSM Mersing	50	76	13,200,000
6	HSM Port Dickson	90	122	18,700,000
7	HSM Melaka	100	140	24,000,000
8	HSM Ipoh	100	137	20,000,000
9	HSM Kangar	143	180	34,000,000
10	HSM Lawas	104	150	25,000,000
11	HSM Bagan Lalang	91	125	17,800,000
	$\sum_{i=1}^{r} x_{ij}^2$	110335	201941	5,423,770,000,000,000
	$\sqrt{\sum_{i=1}^{r} x_{ij}^2}$	332.17	449.38	73646249.06

Figure 4.3: Denominator value of data

2) Number of employee, Q

$\sum_{i=1}^{r} x_{ij}^2 = 141^2 + 84^2 + 165^2 + 135^2 + 76^2 + 122^2 + 140^2 + 137^2 + 180^2 + 150^2 + 125^2$

$= 201941$

$\sqrt{\sum_{i=1}^{r} x_{ij}^2} = \sqrt{201941} = 449.38$

3) Total revenue (USD), R

$\sum_{i=1}^{r} x_{ij}^2 = 26,000,000^2 + 15,000,000^2 + 21,000,000^2 + 22,000,000^2 + 13,200,000^2 + 18,700,000^2 + 24,000,000^2 + 20,000,000^2 + 34,000,000^2 + 25,000,000^2 + 17,800,000^2$

$= 5,423,770,000,000,000$

$\sqrt{\sum_{i=1}^{r} x_{ij}^2} = \sqrt{5,423,770,000,000,000} = 73646249.06$

Step 2: Enter the answer to the formula below:

$$N_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{r} {x_{ij}}^2}} \tag{29}$$

DMU	Hotel	No. of room	No. of employee	Revenue (USD)
1	HSM Kepala Batas	$\frac{100}{332.17} = 0.3011$	$\frac{141}{449.38} = 0.3138$	$\frac{26000000}{73646249.06} = 0.3530$
2	HSM Temerloh	0.1505	0.1869	0.2037
3	HSM Kuala Terengganu	0.4004	0.3672	0.2851
4	HSM Alor Setar	0.3011	0.3004	0.2987
5	HSM Mersing	0.1505	0.1691	0.1792
6	HSM Port Dickson	0.2709	0.2715	0.2539
7	HSM Melaka	0.3011	0.3115	0.3259
8	HSM Ipoh	0.3011	0.3049	0.2716
9	HSM Kangar	0.4305	0.4006	0.4617
10	HSM Lawas	0.3131	0.3338	0.3395
11	HSM Bagan Lalang	0.2740	0.2782	0.2417

Figure 4.4: The value of normalise decision matrices

Step 3: Enter the revenue(output) of hotel from the Figure 4.1 to the linear programming of CCR input oriented:

A linear programming approach is used to solve the problem in this project. The goal of the programming problem is to maximize the amount of output which is the total revenue of the hotel by using the quantity not greater than the input source provided which is the number of rooms and the number of employees. The aim of this project is to provide quality services to customers by minimize the number of room and the number of employee.

$$Max\theta_0 = \sum_{i=1}^{r} u_i y_{i0} + \mu_0 \tag{30}$$

θ_0=The efficiency score for DMU_0,

u_i=The weight representing the output (i represented as the types of output),

y_{i0}=The actual value of the output i for DMU_0

μ_0=The constant label with c.

$Max = 0.3530u_1 + c$

The answer above is for DMU_1,

The expansion is continued on until the DMU_{11}

Step 4: Enter the inputs which are the number of room and the number of employee from the Figure 4.1 to the modelling constraints of CCR input oriented:

The expansions for all contraints are shown below:

Constraint (1):

$$\sum_{i=1}^{m} v_j x_{j0} = 1 \tag{31}$$

From the given information:

v_j=The weight representing the input of DMU_0,

x_{j0}=The vector input of DMU_o,

j=1,2 (represented as 2 types of input).

Constraint (1) must assign as equal to 1 to get the efficient DMU only.

For $DMU1 : 0.3011v_1 + 0.3138v_2 = 1$

For $DMU2 : 0.1505v_1 + 0.1869v_2 = 1$

For $DMU3 : 0.4004v_1 + 0.3672v_2 = 1$

The expansion is continued on until the DMU_{11}.

Constraint (2):

$$\sum_{i=1}^{r} u_i y_{ik} - \sum_{j=1}^{m} v_j x_{jk} \leq 0, k = 1, 2, ..., n, k \neq 0 \tag{32}$$

From the given information,

u_i=The weight representing the output,

y_{ik}=The actual value of the output i for DMU_k

v_j=The weight representing the input,

x_{jk}=The actual value of the input i for DMU_k

DMU1=$-0.3011v_1 - 0.3138v_2 + 0.3530u_1 \leq 0$

DMU2=$-0.1505v_1 - 0.1869v_2 + 0.2037u_1 \leq 0$

DMU3=$-0.4004v_1 - 0.3672v_2 + 0.2851u_1 \leq 0$

The expansion is continued on until the DMU_{11}.

Constraint (3):

$$v_j, u_i \geq 0 \quad (33)$$

From the given information,

u_i=The weight representing the output(i represented as the types of output),

v_j=The weight representing the input(j represented as the types of input)

The value must be a non-negative value.

5 RESULTS AND DISCUSSION

5.1 Introduction

The findings and a thorough analysis of these studies are presented in this section. It explains how each DMU (hotel)'s level was calculated using models from Data Envelopment Analysis (DEA). The most effective hotels will be compared with one another by comparing the numbers of rooms and employees. The results of the analysis of all the models applied will produce the most effective hotel.

5.2 CCR DEA Model

The amount of efficiency of service operations and manufacturing can be shown through relative efficiency score analysis. The CCR input-oriented model was used to calculate the efficiency score measures for each DMU in this study. The hotels with the most efficiency value are DMU 2 and DMU 9 which are HSM Temerloh and HSM Kangar.

5–7	DMU No.	DMU Name	Input-Oriented CRS Efficiency	Sum of lambdas	RTS	Optimal Lambdas with Benchmarks			
8	1	HSM Kepala Batas	0.99958	1.166	Decreasing	0.718	HSM Temerloh	0.448	HSM Kangar
9	2	HSM Temerloh	1.00000	1.000	Constant	1.000	HSM Temerloh		
10	3	HSM Kuala Terengganu	0.67380	0.618	Increasing	0.618	HSM Kangar		
11	4	HSM Alor Setar	0.87564	0.859	Increasing	0.379	HSM Temerloh	0.480	HSM Kangar
12	5	HSM Mersing	0.95527	0.719	Increasing	0.592	HSM Temerloh	0.127	HSM Kangar
13	6	HSM Port Dickson	0.82430	0.741	Increasing	0.341	HSM Temerloh	0.400	HSM Kangar
14	7	HSM Melaka	0.92796	1.054	Decreasing	0.622	HSM Temerloh	0.431	HSM Kangar
15	8	HSM Ipoh	0.78678	0.820	Increasing	0.416	HSM Temerloh	0.405	HSM Kangar
16	9	HSM Kangar	1.00000	1.000	Constant	1.000	HSM Kangar		
17	10	HSM Lawas	0.90751	1.195	Decreasing	0.823	HSM Temerloh	0.372	HSM Kangar
18	11	HSM Bagan Lalang	0.76787	0.737	Increasing	0.381	HSM Temerloh	0.355	HSM Kangar

Figure 5.1: Results obtained by using CCR-input oriented model

5.3 BCC DEA Model

The BCC Model is used to determine each DMU's efficiency score. The DEAFrontier programme is used in this model to include the data gathered in Table 3.1. For each DMU, the programme has produced efficiency scores, which are displayed in Figure 5.2.

	DMU No.	DMU Name	Input-Oriented VRS Efficiency	Optimal Lambdas with Benchmarks					
8	1	HSM Kepala Batas	1.00000	1.000	HSM Kepala Batas				
9	2	HSM Temerloh	1.00000	1.000	HSM Temerloh				
10	3	HSM Kuala Terengganu	0.69282	0.684	HSM Temerloh	0.316	HSM Kangar		
11	4	HSM Alor Setar	0.88421	0.632	HSM Temerloh	0.368	HSM Kangar		
12	5	HSM Mersing	1.00000	1.000	HSM Mersing				
13	6	HSM Port Dickson	0.84176	0.805	HSM Temerloh	0.195	HSM Kangar		
14	7	HSM Melaka	0.92810	0.324	HSM Kepala Batas	0.390	HSM Temerloh	0.286	HSM Kangar
15	8	HSM Ipoh	0.79754	0.737	HSM Temerloh	0.263	HSM Kangar		
16	9	HSM Kangar	1.00000	1.000	HSM Kangar				
17	10	HSM Lawas	0.91783	0.909	HSM Kepala Batas	0.091	HSM Temerloh		
18	11	HSM Bagan Lalang	0.78518	0.853	HSM Temerloh	0.147	HSM Kangar		

Figure 5.2: Results obtained by using BCC-input oriented model

As a result, 4 out of 11 DMUs are considered to be efficient. DMUs 1, 2, 5, and 9 form up the group.

5.4 Comparison and Suggestion of The Best Performance Efficiency Between The Two Models Used

Table 5.1 and Table 5.2 displays a summary of the computations made in the previous section's results. The end result reveals that each model has suggested various DMUs that are thought to be efficient. According to the findings, the CCR DEA model only measures 2 DMUs as efficient, whereas the BCC DEA model only measures 4 DMUs.

Table 5.1: CCR DEA Model

Hotel Seri Malaysia	Temerloh	Kangar
Number of room	50	143
Number of employee	84	180
Total revenue (USD)	15,000,000	34,000,000

Table 5.2: BCC DEA Model

Hotel Seri Malaysia	Temerloh	Kangar	Mersing	Kepala Batas
Number of room	50	143	50	100
Number of employee	84	180	76	141
Total revenue (USD)	15,000,000	34,000,000	13,200,000	26,000,000

		Efficiency Scores		Average Ranking	
DMU	Hotel	**CCR-I**	**BCC-I**	**CCR-I**	**BCC-I**
1	HSM Kepala Batas	0.99958	1.00000	3	1
2	HSM Temerloh	1.00000	1.00000	1	1
3	HSM Kuala Terengganu	0.67380	0.69282	11	11
4	HSM Alor Setar	0.87564	0.88421	7	7
5	HSM Mersing	0.95527	1.00000	4	1
6	HSM Port Dickson	0.82430	0.84176	8	8
7	HSM Melaka	0.92796	0.92810	5	5
8	HSM Ipoh	0.78678	0.79754	9	9
9	HSM Kangar	1.00000	1.00000	1	1
10	HSM Lawas	0.90751	0.91783	6	6
11	HSM Bagan Lalang	0.76787	0.78518	10	10

Figure 5.3: Average ranking of BCC input and CCR input model

The CCR model and the BBC model have been compared. This comparison was done to determine the most effective DMU so that Hotel Seri Malaysia could operate more effectively and eliminate the issue of shortages. Based on the number of employees, rooms, and overall revenue, the DMUs are compared. Hence, the BCC model is more efficient because it has more efficient DMUs than the efficient DMUs in the BCC model.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The hotel needs to pay special attention to the problems faced by the hotel. If this is the case, a solution can be achieved through the development of systematic and effective methods. If the DMU obtained can accomplish the goals of this study, the approach, known as DEA, is appropriate to apply. If this approach is effectively established, it can improve Hotel Seri Malaysia's efficiency and reduce the problem of a staffing and rooms shortage, which plagues many hotels today.

6.2 Conclusion

In general, the aim of this study is to assess Hotel Seri Malaysia's effectiveness, with a particular emphasis on addressing the shortage of staff members and hotel rooms. Finding the best DMUs and converting their inputs into outputs are the goals of data envelopment analysis (DEA). In order to address the issue of busyness over the holidays, numerous DEA models use data as input and output. Several models found in the DEA method are used to obtain relative efficiency scores such as the CCR model and the BCC model. So, by achieving the maximum efficiency score value, one can identify the most effective hotel. The goals of this study, which were to determine Hotel Seri Malaysia's highest performance efficiency, were met by the application of the BCC input-oriented and CCR input-oriented models. As a result, the BCC model shows the most number of efficiencies. In conclusion, the BCC model is the most effective model compared to the CCR model. The most effective hotels in the BCC model are HSM Temerloh, HSM Kangar, HSM Mersing and HSM Kepala Batas.

6.3 Recommendations

Based on the research conducted, the purpose of this study is to see the difference in hotel efficiency between the BCC and CCR methods. Thus, based on the result of the research, the BCC input-oriented method showed the lowest average value. Therefore, it is recommended to use BCC input-oriented. However, it would be preferable if more research into hotels could be conducted in order to identify and determine all of the issues and problems of the hospitality industry. This might help to increase our nation's tourism industry, which also would indirectly improve our economy.

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APPENDIX A

Manual calculation by using the CCR-input oriented model.

$$Max = 0.3866u_1,$$

$$0.3197v_1 + 0.3371v_2 = 1$$

$$DMU\ 1 = \ -0.3197v_1 - 0.3371v_2 + 0.3866u_1 \leq 0$$

$$DMU\ 2 = \ -0.1599v_1 - 0.2008v_2 + 0.2230u_1 \leq 0$$

$$DMU\ 3 = \ -0.4252v_1 - 0.3944v_2 + 0.3123u_1 \leq 0$$

$$DMU\ 4 = \ -0.3197v_1 - 0.3227v_2 + 0.3271u_1 \leq 0$$

$$DMU\ 5 = \ -0.1599v_1 - 0.1817v_2 + 0.1963u_1 \leq 0$$

$$DMU\ 6 = \ -0.2877v_1 - 0.2916v_2 + 0.2781u_1 \leq 0$$

$$DMU\ 7 = \ -0.3197v_1 - 0.3347v_2 + 0.3569u_1 \leq 0$$

$$DMU\ 8 = \ -0.3197v_1 - 0.3275v_2 + 0.2974u_1 \leq 0$$

$$DMU\ 9 = \ -0.4572v_1 - 0.4303v_2 + 0.5056u_1 \leq 0$$

$$DMU\ 10 = \ -0.3325v_1 - 0.3586v_2 + 0.3717u_1 \leq 0$$

$$DMU\ 11 = \ -0.2909v_1 - 0.2988v_2 + 0.2647u_1 \leq 0$$

$$v_1, v_2, u_1 \geq 0$$

APPENDIX B

Manual calculation by using BCC-input oriented model.

$$Max = 0.3866u_1 + c,$$

$$0.3197v_1 + 0.3371v_2 = 1$$

$$DMU\ 1 = -0.3197v_1 - 0.3371v_2 + 0.3866u_1 + c \leq 0$$

$$DMU\ 2 = -0.1599v_1 - 0.2008v_2 + 0.2230u_1 + c \leq 0$$

$$DMU\ 3 = -0.4252v_1 - 0.3944v_2 + 0.3123u_1 + c \leq 0$$

$$DMU\ 4 = -0.3197v_1 - 0.3227v_2 + 0.3271u_1 + c \leq 0$$

$$DMU\ 5 = -0.1599v_1 - 0.1817v_2 + 0.1963u_1 + c \leq 0$$

$$DMU\ 6 = -0.2877v_1 - 0.2916v_2 + 0.2781u_1 + c \leq 0$$

$$DMU\ 7 = -0.3197v_1 - 0.3347v_2 + 0.3569u_1 + c \leq 0$$

$$DMU\ 8 = -0.3197v_1 - 0.3275v_2 + 0.2974u_1 + c \leq 0$$

$$DMU\ 9 = -0.4572v_1 - 0.4303v_2 + 0.5056u_1 + c \leq 0$$

$$DMU\ 10 = -0.3325v_1 - 0.3586v_2 + 0.3717u_1 + c \leq 0$$

$$DMU\ 11 = -0.2909v_1 - 0.2988v_2 + 0.2647u_1 + c \leq 0$$

$$v_1, v_2, u_1 \geq 0$$

APPENDIX C

DEAFrontier Software by using CCR Model

DMU No.	DMU Name	Efficient Input Target: No. of room	Efficient Input Target: No. of employee	Efficient Output Target: Revenue (RM)
1	HSM Kepala Batas	99.95788	140.94061	26000000.00000
2	HSM Temerloh	50.00000	84.00000	15000000.00000
3	HSM Kuala Terengganu	88.32353	111.17647	21000000.00000
4	HSM Alor Setar	87.56392	118.21130	22000000.00000
5	HSM Mersing	47.76358	72.60063	13200000.00000
6	HSM Port Dickson	74.18697	100.56457	18700000.00000
7	HSM Melaka	92.79589	129.91425	24000000.00000
8	HSM Ipoh	78.67825	107.78920	20000000.00000
9	HSM Kangar	143.00000	180.00000	34000000.00000
10	HSM Lawas	94.38137	136.12698	25000000.00000
11	HSM Bagan Lalang	69.87636	95.98402	17800000.00000

DMU No.	DMU Name	Input Slacks: No. of room	Input Slacks: No. of employee	Output Slacks: Revenue (RM)
1	HSM Kepala Batas	0.00000	0.00000	0.00000
2	HSM Temerloh	0.00000	0.00000	0.00000
3	HSM Kuala Terengganu	1.29144	0.00000	0.00000
4	HSM Alor Setar	0.00000	0.00000	0.00000
5	HSM Mersing	0.00000	0.00000	0.00000
6	HSM Port Dickson	0.00000	0.00000	0.00000
7	HSM Melaka	0.00000	0.00000	0.00000
8	HSM Ipoh	0.00000	0.00000	0.00000
9	HSM Kangar	0.00000	0.00000	0.00000
10	HSM Lawas	0.00000	0.00000	0.00000
11	HSM Bagan Lalang	0.00000	0.00000	0.00000

APPENDIX D

DEAFrontier Software by using BCC Model

			Efficient Input Target		Efficient Output Target
8	DMU No.	DMU Name	No. of room	No. of employee	Revenue (RM)
9	1	HSM Kepala Batas	100.00000	141.00000	26000000.00000
10	2	HSM Temerloh	50.00000	84.00000	15000000.00000
11	3	HSM Kuala Terengganu	79.36842	114.31579	21000000.00000
12	4	HSM Alor Setar	84.26316	119.36842	22000000.00000
13	5	HSM Mersing	50.00000	76.00000	13200000.00000
14	6	HSM Port Dickson	68.11053	102.69474	18700000.00000
15	7	HSM Melaka	92.80960	129.93344	24000000.00000
16	8	HSM Ipoh	74.47368	109.26316	20000000.00000
17	9	HSM Kangar	143.00000	180.00000	34000000.00000
18	10	HSM Lawas	95.45455	135.81818	25000000.00000
19	11	HSM Bagan Lalang	63.70526	98.14737	17800000.00000

7			Input Slacks		Output Slacks
8	DMU No.	DMU Name	No. of room	No. of employee	Revenue (RM)
9	1	HSM Kepala Batas	0.00000	0.00000	0.00000
10	2	HSM Temerloh	0.00000	0.00000	0.00000
11	3	HSM Kuala Terengganu	12.77703	0.00000	0.00000
12	4	HSM Alor Setar	4.15789	0.00000	0.00000
13	5	HSM Mersing	0.00000	0.00000	0.00000
14	6	HSM Port Dickson	7.64789	0.00000	0.00000
15	7	HSM Melaka	0.00000	0.00000	0.00000
16	8	HSM Ipoh	5.28045	0.00000	0.00000
17	9	HSM Kangar	0.00000	0.00000	0.00000
18	10	HSM Lawas	0.00000	1.85664	0.00000
19	11	HSM Bagan Lalang	7.74602	0.00000	0.00000