A Comparative Analysis for Hotel Location Selection: A Case Study for Turkey

Nazli Goker[1], Mehtap Dursun[2]

Abstract: This work introduces DEA-based approaches to hotel location selection problem for Turkey, by improving the decision making approach of Uygurtürk and Uygurtürk [1]. Three different programming models such as CCR, minsum efficiency, and the common-weight DEA-based approach of Sun et al. [4], are solved. Efficiency values and ranking results of these models are determined, a comparative analysis is provided.

Keywords: Business and Economics, Hotel Location Selection. Data Envelopment Analysis.

I. INTRODUCTION

Uygurtürk and Uygurtürk [1] employed an integrated approach for hotel location selection problem and applied it in Kemer, Antalya. They employed analytic hierarchical process (AHP) to weight the criteria influencing hotel location selection, and utilized VIKOR methodology to select the most appropriate hotel alternative for Kemer, Antalya, Turkey.

Location selection problems are generally solved by integrating multiple criteria decision making tools into the decision framework. Therefore, an expert system is required in which decision makers' opinions are collected and incorporated into the data. For that reason, results depend on experts' knowledge and opinions, and a subjective assessment is provided.

Location selection, an irreversible decision because of the huge amount of investment cost, is a crucial decision for companies in order to obtain a sustainable financial success. Hence, subjective assessment is not thought to be suitable for such a decision making problem, an objective evaluation is required. For that purpose, a mathematical programming approach namely data envelopment analysis (DEA) is considered as an appropriate methodology to identify the best performing hotel alternative.

The objective of this study is to improve Uygurtürk and Uygurtürk [1] approach by solving their problem without using experts' opinions. Two different programming models that are solved are called as CCR and minsum efficiency. Finally the approach of Sun et al. [4] which is a common-weight DEA-based model, is applied. Efficiency values and ranking results of these models are indicated, a comparative analysis is provided.

The authors are with Galatasaray University, Industrial Engineering Department, 34349 Istanbul, Turkey
mdursun@gsu.edu.tr

The rest of the paper is organized as follows. Section 2 explains DEA methodology and DEA-based models. Section 3 illustrates three different models via a numerical example of hotel location selection for Kemer, Antalya, Turkey. Concluding remarks are delineated in the last section.

II. DATA ENVELOPMENT ANALYSIS (DEA)

The original DEA model, also named as the CCR model, proposed by Charnes et al. [2], computes the relative efficiency of a DMU by maximizing the ratio of its total weighted outputs to its total weighted inputs subject to the condition that the output to input ratio of every DMU be less than or equal to unity. The traditional DEA formulation can be represented as follows:

$$\max E_{j_0} = \frac{\sum_{r=1}^{s} u_r y_{rj_0}}{\sum_{i=1}^{m} v_i x_{ij_0}}$$

subject to (1)

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \le 1, \quad \forall j,$$

$$u_r, v_i \ge \varepsilon, \quad \forall r, i.$$

where E_{j_0} is the efficiency score of the evaluated DMU, u_r is the weight assigned to output r, v_i is the weight assigned to input i, y_{rj} is the quantity of output r generated and x_{ij} is the amount of input i consumed by DMU j, respectively, and ϵ is a small positive scalar.

Formulation (1) has non-linear and non-convex properties, however, it can be transformed into a linear programming model via a transformation. The linear programming model for calculating the relative efficiency of a DMU is given in the following set of equations.

$$\max E_{j_0} = \sum_r u_r y_{rj_0}$$

subject to (2)

$$\sum_i v_i x_{ij_0} = 1$$
$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \le 0, \quad \forall j,$$
$$u_r, v_i \ge \varepsilon, \quad \forall r, i.$$

Alternatively, minsum efficiency measure does not give favorable consideration to the evaluated DMU unlike the traditional DEA model. Minsum efficiency aims to minimize the total deviation from efficiency [2]. The programming model is as follows:

$$\min \sum_{j=1}^{n} d_j$$

subject to (3)

$$\sum_{i=1}^{m} v_i x_{ij_0} = 1,$$
$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} + d_j = 0, \quad \forall j,$$
$$u_r, v_i, d_j \ge 0, \quad \forall r, i, j.$$

Over the literature, common-weight DEA-based models have been proposed in order to avoid the shortcomings of classical DEA models. These models provide a common evaluation for all DMUs and do not require subjective assessment to determine input and output weights. Hence, the discriminating power is improved that restricts the selection of input and output weights in favor of respective DMUs [3].

Sun et al. [4] developed a common-weight DEA-based model for obtaining the efficiency values of the alternatives and ranking them. Initially, they proposed the following linear programming model.

$$\min \sum_{j=1}^{n} d_j$$

subject to (4)

$$\sum_{i=1}^{m} v_i x_{ij} - d_j = \sum_{r=1}^{s} u_r y_{rj}, \quad \forall j,$$
$$\sum_{i=1}^{m} v_i x_{\min} = 1,$$
$$\sum_{r=1}^{s} u_r y_{\max} = 1,$$
$$u_r, v_i \ge \varepsilon, \quad \forall r, i,$$
$$d_j \ge 0, \quad \forall j.$$

Second, they developed the non-linear programming model as

$$\max \sum_{i=1}^{m} v_i^2 + \sum_{r=1}^{s} u_r^2$$

subject to (5)

$$\sum_{j=1}^{n} \left(\sum_{i=1}^{m} v_i x_{ij} - \sum_{r=1}^{s} u_r y_{rj} \right) = D^*,$$
$$\sum_{i=1}^{m} v_i x_{ij} - \sum_{r=1}^{s} u_r y_{rj} \ge 0, \quad \forall j,$$
$$\sum_{i=1}^{m} v_i x_{\min} = 1,$$
$$\sum_{r=1}^{s} u_r y_{\max} = 1,$$
$$u_r, v_i \ge \varepsilon, \quad \forall r, i.$$

where D^* is the optimal objective function value of Formulation (4).

III. CASE STUDY

Uygurtürk and Uygurtürk [1] provided a numerical example that is to locate a hotel in an appropriate land in Kemer, Antalya, Turkey. There are 5 different alternative lands on which a hotel will be built. For that reason, 5 different projects were prepared and the best performing hotel alternative is selected using MCDM methods. First, criteria affecting hotel location are weighted via AHP method which requires experts' opinions. Second, the most suitable hotel alternative is identified by applying VIKOR methodology.

This study improves this approach by employing DEA approaches which does not require decision makers' knowledge. In this section, illustration of the application of the three DEA approaches is given. The numerical example involves 3 inputs such as "distance to the airport (km)", "distance to the sea (m)", "distance to the city center (km) "; and 3 outputs namely "number of restaurants", "number of swimming pools", "length of the beach (m)". Input and output data regarding hotel location selection are given in Table 1. Equations should be centred and should be numbered with the number on the right-hand side.

Table 1. Input and output data regarding hotel alternatives.

DMU (*j*)	Data					
	Input 1	Input 2	Input 3	Output 1	Output 2	Output 3
1	56	75	38	3	2	50
2	75	300	60	1	3	100
3	65	0	45	2	3	120
4	60	150	45	3	2	168
5	65	0	60	3	4	215

Efficiency scores and ranking results of CCR, minsum and the model of Sun et al. [4] are provided in Tables 2, 3 and 4, respectively.

Table 2. Efficiency scores and ranking results of CCR model.

DMU (*j*)	Efficiency	DEA ranking
1	1	1
2	0.749705	5
3	0.999942	4
4	1	1
5	1	1

Table 3. Efficiency scores and ranking results of minsum efficiency model.

DMU (*j*)	Efficiency	Minsum ranking
1	1	1
2	0.638889	5
3	0.97037	3
4	0.844444	4
5	1	1

Table 4. Efficiency scores and ranking results of the model developed by Sun et al. [4].

DMU (*j*)	Efficiency	Ranking
1	0.999783	1
2	0.24886	5
3	0.574353	4
4	0.933177	2
5	0.861548	3

The ranking results of Uygurtürk and Uygurtürk [1] are given in Table 5.

Table 5. Ranking results of the approach of Uygurtürk and Uygurtürk [1].

Hotel	Ranking
1	4
2	5
3	2
4	3
5	1

IV CONCLUDING REMARKS

In this study, three different DEA-based approaches are employed to hotel location selection problem, a case study that is conducted by Uygurtürk and Uygurtürk [1] is illustrated by using the same numerical example. According to CCR model, hotel 1, 2 and 5 are thought to be the best performing hotels, hotel 1 and 5 are the most efficient hotels according to minsum efficiency model. Since common weight DEA-based models improve the discriminating power of traditional DEA models, a non-linear programming model of Sun et al. [4] is applied and hotel 1 is identified as the best hotel alternative. On the other hand, Uygurtürk and Uygurtürk [1] considered hotel 5 as the best performing hotel. One shall note that the use of experts' opinions change the ranking results.

Acknowledgment

This work has been financially supported by Galatasaray University Research Fund Project 16.402.010.

References

1. H. Uygurtürk, H. Uygurtürk, Int. J. Econ. Soc. Res. 10, 2 (2014)
2. A. Charnes, W.W. Cooper, E. Rhodes, Eur. J. Oper. Res. 2 (1978)
3. E.E. Karsak, S.S. Ahiska, Int. J. Prod. Res. 43, 8 (2005)
4. J. Sun, J. Wu, D. Guo, Appl. Math. Model. 37 (2013)