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Discussion paper

Quantitative Approaches for Location Decision Strategies of a Hotel Chain Network

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ABSTRACT

Accommodation revenue and demand are affected by hotel location, leading a lot of research to perform theoretical, empirical and operational approaches to analyze and determine the ideal location of hotels. However, operational approaches such as mathematical modeling based optimization have not received sufficient interest in hotel location research while it has been widely used for various kinds of facility locations. Therefore, two mathematical models for opening of new hotels and the closing of existing hotels to a manage hotel chain network are developed using the demand estimation and existing hotel information. In this research, hotel demand is estimated based on the accessibilities to sightseeing, transportation, business points, and market share. Gaining and/or losing of demand and the agglomeration effect are introduced as the objective of two models. Proposed mathematical models are tested to design a hotel chain network with the real data in Seoul, Korea.

1. Introduction

The establishment of a hotel requires a long–term fixed investment and a huge amount of capital. Successful investment in the hotel industry hinges greatly on location factors because ideal location tends to associate with demand of accommodation, revenue per available room, better performance and lower failure rate. Furthermore, it is very difficult to rectify the failure of a hotel location. Therefore, many researchers recognize the importance of location strategy in the hotel industry. Newell and Seabrook (2006) identified hotel location as one of the five key factors for hotel investment. Lado-Sestayo et al. (2016) argues the importance of hotel location for its profitability. Rivers et al. (1991) and Lewis and Chambers (1989) showed the influence of hotel location for tourists and business people. Thus, there is a great deal of research identifying and determining the key factors of ideal location for a newly constructed hotel. Yang et al. (2014) reviewed the past literature on hotel location models during the last several decades and categorized them into three major parts, theoretical, empirical and operational models. However, while there are numerous research papers about both theoretical and empirical models, researchers who focus on operation models, such as application of operations research do not receive sufficient interests as described in Yang et al. (2014). Operational models can help to provide optimal strategic decision via analytical methodology such as the mathematical modeling approach with the consideration of the various systemic elements and factors derived from both theoretical and empirical models. That is, operational models can generate exact solutions about given decision making issues by using certain scientific methodologies reflecting insights from both theoretical and empirical models. Without applying operational models, decision makers should make some decisions based on their intuitions or own ways even though they know certain insights. Therefore, mathematical modeling based optimization, which is one of the well-known operations research methodologies, is applied in this study to decide ideal hotel location and size to design hotel networks. To construct the models, many important factors affecting hotel location are included such as the accessibilities to sightseeing, transportation and business points, the market share of that hotel, and the agglomeration effect with nearby hotels.

Although the mathematical modeling approach is not familiar in research in the hotel industry, mathematical modeling for various kinds of facility locations have been widely used and developed since 1929, when Alfred Weber considered how to position a single warehouse so as to minimize the total distance between it and customers (Weber, 1929). With the successful development of mathematical modeling based optimization, many researchers found the optimal locations of both public and private facilities such as fire stations, emergency medical centers, department stores, retail stores, factories, distribution centers, and so on, considering their own purposes. In addition, the actual applications of location decisions with mathematical modeling approaches by governments and private sectors can be easily found in the real world

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(Zekavat and Buehrer, 2011). The enormous history of theory and application of location mathematical models provides the possibility of successful use in the hotel industry. The location of hotels can be optimized by reflecting the nature of the hotel industry and developing proper mathematical models with suitable purposes.

In this study, mathematical models to design hotel networks are suggested. Specifically, the optimal location of new opening hotels and hotels to be closed is determined using two mathematical models. To develop mathematical models, the demand functions when locating new hotels and closing existing hotels are estimated based on the accessibility to major sightseeing, transportation and business points and the market share of the hotels. In addition, the agglomeration effect with nearby hotels is considered as one of the important elements for hotel network strategy. The contributions of this paper are as follows.

- Examination of the mathematical modeling based optimization approaches at the location researches in hotel industry.
- Development of mathematical models with the considerations on important factors that affects location of hotels, such as the accessibility to several city points, market share and agglomeration effect.
- Deriving the optimal hotel chain network strategies of both new hotel openings and existing hotel closings with real data in Seoul metropolitan city, Korea.
- Providing quantitative insights about hotel chain networks through numerical examples, and this is expected to facilitate the operations research methodology in the research of various areas in the hotel industry.

The remaining parts of this paper are organized as follows. In Section 2, the types of mathematical models for location decisions and its applications are introduced. Section 3 describes the problem nature and presents the estimation of demand functions and the agglomeration effect. By using the functions developed in Section 3, mathematical models are proposed in Section 4. Developed mathematical models are tested with real data of Seoul metropolitan city of Korea in Section 5. Also, sensitivity analysis on the systemic parameters is conducted in Section 5. Finally, the conclusion of this study is given in Section 6.

2. Literature review

Hotel location problems have been studied by several researchers mainly in qualitative ways. Yang et al. (2014) reviewed the past literature on hotel location models. In the study, authors divided hotel location models into three categories – theoretical, empirical and operational – and provided detailed descriptions, advantages, and limitations based on 13 specific models. The goal of the theoretical model is to establish the theoretical foundations for the spatial location choice of hotels using geographical (Egan and Nield, 2000), economic (Kalnins and Chung, 2004) and marketing (Urtasun and Gutiérrez, 2006) theories. Especially, some researchers developed theories on the agglomeration effect, which refers to benefits that the hotel can receive from clustering (Ingram and Inman, 1996; Kalnins and Chung, 2004). In empirical studies, researchers provide the factors behind the hotel location decision. Most researchers use qualitative descriptions, choropleth mapping and inequity indices to describe hotel location distribution and possible factors shaping the pattern (Bull and Church, 1994; Rogerson, 2013). On the other hand, the operational hotel location model applies location decision rules to determine suitable locations for new entrants. Yang et al. (2014) pointed out that few have been concerned with operation models, however, it transfers knowledge from scholarly models to knowledge with greater practical values to practitioners. The checklist method (Lin and Juan, 2010), statistical prediction (Biemer and Kimes, 1991) and the geographic information system based operational model (Crecente et al., 2012) are developed to determine the idle location of hotels. This study focused on the operational models, which do not receive sufficient interest in the hotel industry. Optimization theory is adopted and developed to discover the idle location of hotels to newly open or close.

Mainly from the 1960s, the studies about location theories using mathematical models have flourished, and many research articles have appeared in the literature. According to Owen and Daskin (1998), location models can be classified into four categories. The first category is the covering problem. A well-known covering problem is to locate emergency service centers such as fire stations or ambulances to provide a wide service range for people. The set covering and maximal covering problems are two different types of covering problems. The objective of the set covering problem is to find the minimum number of facilities and their locations while each demand group has at least one facility located within an acceptable service distance. Walker (1974) developed a set covering formulation to locate two types of ladder truck used by the New York City Fire Department. Gleason (1975) suggested the set covering approach to locate bus stops. Recently, Farahani et al. (2012) reviewed the past covering problems in facility location and someone can find more recent research about the covering problem. The maximal covering problem occurs when it is required to maximize the amount of demand covered by locating a predetermined number of facilities. Shariff et al. (2012) reported a location and allocation model for healthcare facilities in one district in Malaysia. Yin and Mu (2012) suggested the modular capacitated maximal covering location problem for emergency vehicles. In the usual capacitated maximal covering location problem, only one fixed capacity level is assumed for each potential facility site. However, the proposed model could consider various kinds of capacity levels for each facility to choose. That is, different capacities can be assigned for all facilities.

The second category of the location problem is the *P*-center problem. It is a minimax problem with the objective of minimizing the maximum distance from any demand node to the nearest facility among p facilities by choosing p facilities among a set of possible locations. Unlike the covering problem, allocation of the demand nodes to facilities also becomes a decision variable. Averbakh and Berman (1997) also solved the *P*-center location problem under demand uncertainty to construct a transportation network. Their goal is to minimize the worst-case loss. Huang et al. (2010) suggested the *P*-center facility location problem for large scale emergencies and developed a solution approach for the problem on a general network. In terms of the mathematical formulation, the same problem can be formulated in different ways. Elloumi et al. (2004) presented a new type of formulation for the *P*-center problem. Newly developed mathematical formulation outperforms existing *P*-center formulation and extends the size of solvable problems.

The third category of the location problem is the *P*-median problem where the traveling distance is measured as a goal of the location problem. In this problem, a decision maker has to determine the location of p facilities and allocation of the customers to the facilities. Hakimi (1965) studied the optimum distribution of switching centers in a communication network. Jarvinen et al. (1972) developed an optimal solution algorithm, a branch and bound algorithm for solving a general *P*-median problem. Campbell (1996) developed the *P*-median problem to locate hub facilities that serve as switching and transshipment points in a transportation and communication network. Dantrakul et al. (2014) suggested *P*-median *P*-center algorithms for a capacitated facility location problem. The objective of the research was to minimize the sum of setup cost and transportation cost. The setup cost included the land and facility setup costs that were stochastic since land value varies by the economic condition. Also, the transportation cost depended on the fuel consumption rate, which was stochastic.

The last one is the fixed charge location problem. Fixed charge is the cost associated with locating facilities at each potential candidate site. The objective of the fixed charge location problem is to minimize the total transportation cost and fixed cost. Like the previous problems, location variables and allocation variables are considered as decision variables. Sankaran and Raghavan (1997) designed the location and