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A fuzzy multi-criteria decision model for international tourist hotels location selection

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Abstract

The main purpose of this paper is to present a fuzzy multi-criteria decision making (FMCDM) model for international tourist hotel location selection. In this article we created 21 criteria for selecting the international tourist hotel location acquired from literatures review and practical investigations. And the methods of fuzzy set theory, linguistic value, hierarchical structure analysis, and fuzzy analytic hierarchy process are used to consolidate decision-makers' assessments about criteria weightings. Finally, an empirical study for identifying the international tourist hotel location selection in Taiwan is conducted to demonstrate the computational process and effectiveness of FMCDM proposed by this paper.

Keywords: International tourist hotel; Location choice; Linguistic value; Fuzzy multi-criteria decision

1. Introduction

In order to reduce passengers' cost of seeking accommodations, enforce the return ratio efficiency of guest rooms and enhance total operating performance, evaluating and selecting a suitable hotel location has become one of the most critical issues for the hotel industry. Location decision has drawn increasing attention from academic and business communities in the past two decades. It has been well recognized that selection of a facility location has important strategic implications because a location decision will normally involve a long-term commitment of resources. From the practical operating situation of a hotel, we can gather that the influential factors for hotels to achieve success are reputation, building style, financial structure, marketing, staffs' quality, and initial location selection. But location is the significant factor influencing operation performance in the future (Yang and Lee, 1997). So, good hotel location cannot only help increase market share and profitability but can also enhance the convenience of customer lodging because establishing a fine location will shorten the payoff period for fixed capital investments. Moreover, in the age of customer-based service, satisfying customer requirements or enhancing the convenience of customer lodging will directly raise customer loyalty.

Many methods for location selection have been developed. Aikens (1985) utilized mathematical programming to develop the facility location models for distribution planning. Cheng and Li (2004) also used mathematical programming to identify the location selection of factory and retail store. Chen (1996) applied mathematical programming to build a location choice model for distribution centers. In exploring the choice location of factory or retail store, Chen (1999) presented a fuzzy group decision model for the allocation of a distribution center. Chen et al. (1997) adopted fuzzy multi-objectives facility location programming to search for an airport fire station. Nicolau (2002) used regression analysis method to assess new hotel opening through an event study. Teng (2000) applied multi-criteria decision-making method to deal with

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the site selection of restaurants. Tzeng et al. (2002) developed the multi-criteria selection for a restaurant location in Taipei. Other scholars applied the same method in the aviation industry (Chang et al., 1997), retail business (Kuo et al., 2002), distribution center (Chen, 2001), and sales-delivery facility location (Aberbakh and Berman, 1995).

Almost every evaluation method has its strong points or defects and issues about the suitability for different situations. AHP (analytic hierarchy process) is a popular method used in finding a solution to the problem of location selection. Tzeng et al. (2002) evaluated the alternative locations to the restaurant using AHP. Aras et al. (2004) tried to select the best location of wind observation station by AHP. Barbarosoglu and Yazgac (1997), Xia and Wu (2007) and Wu et al. (2007) proposed the use of the AHP to deal with location selection or supplier selection. In short, AHP circumvents the difficulty of having to provide point estimates for criteria weights as well as performance scores in the basic linear weighting models. Instead, using AHP the managers or decision makers are only required to give verbal, qualitative statements regarding the relative importance of one criterion over another and similarly regarding the relative preference of one location to another on a criterion. This approach is more accurate than the other scoring methods. Some methods apply to the evaluation of qualitative criteria evaluation while others are suitable for quantitative criteria. But in reality, sometimes both qualitative and quantitative criteria exist simultaneously. In order to confront this situation, we can adopt the AHP method to build a systemic evaluation structure integrating all of the criteria and allowing easier operation based on consistence test approving. Moreover, due to the availability and uncertainty of information in our decision process as well as the vagueness of human feeling and recognition, it is difficult to make an exact evaluation and convey the feeling and recognition of objects for decision makers. Fuzzy set theory (Zadeh, 1965) can play a significant role in this kind of decision situation.

Generally, it is difficult to express the character and significance of criteria exactly or clearly through traditional methods. Using the concept of fuzzy sets theory and natural language to evaluate the site selection criteria is more convenient, allowing decision makers to express their ideas freely and adequately. Therefore, we combine fuzzy sets theory and linguistic value concept to establish a model that can provide decision makers with the tool to deal with complex issues in a fuzzy environment. Thus, a fuzzy-based decision model for tourist hotel location selection is more appropriate and effective than traditional precision-based models. In addition, by establishing an ideal to stimulate the creativity and invention of a new alternative, the direction to the process of generating alternatives becomes clear and definite. Based on the reasons stated above, by combining the concepts of fuzzy set theory, hierarchical structure analysis, ideal and anti-ideal, and analytic hierarchy process, a fuzzy multi-criteria decision-making model is developed to tackle international tourist hotel location selection in a fuzzy decision environment.

In order to develop the fuzzy decision-making model for tourist hotel location selection, the paper is organized as follows. In Section 2, we introduce the criteria of tourist hotel location selection under development in Taiwan. In Section 3, the basic concepts of Research methods are introduced. Section 4 presents the empirical study by the decision model presented in this article. Finally, some conclusions are highlighted at the end of this paper.

2. Tourist hotel

2.1. The criteria of international tourist hotel location selection

Location selection involves the provision of an overall distribution blueprint for the region, and traffic and transportation conditions are also very important (Coltman, 1989). During the decision-making process of selecting the tourist hotel location, the objective of synergy can be accomplished if facilities such as commercial areas, conventional centers, and airports can be taken into consideration. Gray and Liguori (1998), in a feasibility study of hotel establishment, suggested several considerations for location selection: local economic environment, regional or zone regulations, height limit of buildings, car park facilities, public facilities, traffic convenience and accessibility, geographic factors, natural resources, and the size of the location. Also, Pan (2002) categorized tourist hotel location selection factors according to base station suitability, traffic convenience and fine visual perception, public facilities and other services, application of certain regulations, and flexible space. The basis of these discussions is focused on the overall facilities surrounding the hotel, traffic conditions, and future considerations for expandability.

On the other hand, some scholars have also utilized the issues of location theory such as central place theory, principle of minimum differentiation, and bid rent theory as the basis for making decisions on tourist hotel locations (Wey and Liao, 2004, Hsieh and Huang, 1998, Lee et al., 2000). From the standpoint of the central place theory, two primary concepts of service scope and demand threshold are survived for the hotel operator. Given these two concepts, we can theorize that the consumer characteristics and scope covered under the overall market conditions include factors such as consumption standard and number of consumers.

Factors attributed to the principle of minimum differentiation mainly emphasized on the concept of cluster effect, which is a result of the consumer behavior of asking for quotations. In order to minimize the cost of transportation during the process in which consumers are seeking price information, companies will engage in cluster activities. According to Lee et al. (2000) and Hsieh and Huang (1998), the number of competitive store locations is an important factor for location selection, where competitiveness is demonstrated by market share in commercial circles. The degree of proximity to competitor locations is also an indicator of competitiveness. Therefore, when businesses are making location selection decisions, future development potential is an important consideration in addition to projecting the competitiveness of the new location. From the perspective of surrounding environment, public order issues such as the outbreak of theft, fire, and robbery are also major concerns in location selection. Through the viewpoints of cluster economy effect, this paper discusses the competitive situation, developmental potential, and surrounding environment given certain market and geographic conditions.

Factors attributed to the bid rent theory involve an important location concept: the nature of land use is determined by the ability to pay the rent; the higher the rent-paying ability, the closer the location is to the city center. We can use this view to discuss the aspects of base station characteristics, surrounding environment, accessibility, traffic volume, and financial conditions associated with geographic, traffic, and management considerations. Lee et al. (2000) has indicated that the base station area is a major factor of location selection; operating area is positively related to sales. Teng (2000) and Tzeng et al. (2002) noted that car parking conditions should also be included into location selection factors, as additional numbers of parking spaces will attract more customers. Meanwhile, other base station traffic accessibility or convenience is one of consumers' primary concerns in selecting a tourist hotel location.

Hotels' unique core ability is also one of customers' main consideration for selecting a tourist hotel. Entertainment facilities, food and beverage services, and environmental conditions are major attributes in hotel selection. Also, developing hotel genre, amalgamating with local culture, and using decorative styles to create competitive advantage are all prime components influencing customers' choice of hotels. Furthermore, the quantity and quality of local human resources is also a focal point for enterprises when making decisions on the establishment of international tourist hotels.

Combining the criteria of selecting the hotel location reported in the above literature review and considering the characteristics of Taiwan's hotel industry and comments from expert academics as well as known hotel managers in Taiwan, 21 criteria were selected to assess the superiority of an international tourist hotel location. The results are shown in Table 3.

2.2. The development of the international tourist hotel industry in Taiwan

Because the national income and level of education is improving in Taiwan, people are gradually paying more attention to their leisure activities. This will benefit the tourist industry. According to a Taiwan government report (http://www.dgbas.gov.tw, 2004), the tourism industry represented 2.77% of gross domestic product (GDP) in 2003. The GDP of tourism had surpassed that of agriculture, making it an important industry for Taiwan.

The 2006 annual report on tourism (http://202.39.225.136/indexc.asp, 2007) noted that at the end of December 2006, Taiwan had 29 tourist hotels with a total of 3298 rooms and 60 international tourist hotels with a total of 17,832 rooms. It is obvious that the number of hotels is not enough to meet the tourist demand of a developed country. Therefore, a tourist hotel development plan was drafted with the objective of developing hotels in suitable agricultural lands, which are to be conducted in an orderly manner and without damage to agricultural production. By 2008, the target year of the plan, it is estimated that Taiwan will require 15,100 additional tourist hotel rooms.

Furthermore, by executing the policy for Asia–Pacific Region Operations Center (APROC), the administration actively promotes tourism industry education and personnel training, such as tour guide and tour manager testing and assessment, qualification program for travel industry managers, on-the-job training for travel agency employees, and revision of basic materials for tourism personnel. All of these policies demonstrate the government's promise for the tourism industry.

3. Research method

3.1. Fuzzy analytic hierarchy process

Herein, the AHP (Saaty, 1980) is used to solve multiple criteria decision problems. By means of a systematic hierarchy structure, complex estimation criteria can be clearly and distinctly presented. Ratio scales are utilized to make reciprocal comparisons for each element and layer. After completing the reciprocal matrix, the comparative weights for each element can be obtained. The AHP is widely used for tackling multi-criteria decision-making problems in real situations. In spite of its popularity and simplicity in concept, this method is often criticized for its inability to adequately handle the inherent uncertainty and imprecision associated with the mapping of the decision-maker's perception to crisp values. In the traditional formulation of the AHP, human judgments are represented as crisp values. However, in many practical cases the human preference model is uncertain and decision makers might be reluctant or unable to assign crisp values to the comparison judgments (Chan and Kumar, 2007).

The use of fuzzy set theory allows the decision-makers to incorporate unquantifiable information, incomplete information, non-obtainable information, and partial facts into the decision model (Kroemer et al., 1999). Although fuzzy AHP requires tedious computations, it is capable of capturing a human's appraisal of ambiguity when complex multi-criteria decision-making problems are considered (Erensal et al., 2006).

3.2. Fuzzy set theory

The fuzzy set theory introduced by Zadeh (1965) is suitable for handling problems involving the absence of sharply defined criteria. In a universal set of discourse X, a fuzzy subset A of X is defined by a membership function $f_A(x)$ which maps each element x in A to a real number in the interval [0, 1]. The function value $f_A(x)$ represents the grade of membership of x in A. The larger the $f_A(x)$, the stronger is the grade of membership for x in A.

3.3. Triangular fuzzy number

A fuzzy number A in $\Re$ (real line) is a triangular fuzzy number if its membership function $f_A : \Re \to [0,1]$ is

$$f_A(x) = \begin{cases} (x-c)/(a-c) & c \leqslant x \leq a, \\ (x-b)/(a-b) & a \leqslant x \leqslant b, \\ 0 & \text{otherwise} \end{cases}$$

with $-\infty < c \leqslant a \leqslant b < \infty$. The triangular fuzzy number A can be denoted by (c, a, b).

The parameter a gives the maximal grade of $f_A(x)$, i.e. $f_A(a) = 1$ and it is the most possible value of the evaluated data. c and b are the lower and upper bounds of the available area for the evaluated data. They are used to reflect the fuzziness of the evaluation data. The narrower the interval $[c, b]$, the lower is the fuzziness of the evaluated data.

By the extension principle (Zadeh, 1965) the fuzzy addition, $\oplus$, of any two triangular fuzzy numbers is also triangular fuzzy numbers. But the fuzzy multiplication, $\otimes$, of any two triangular fuzzy numbers is only approximate triangular fuzzy numbers. That is, if $A_1 = (c_1, a_1, b_1)$ and $A_2 = (c_2, a_2, b_2)$ then

$$A_1 \oplus A_2 = (c_1 + c_2, a_1 + a_2, b_1 + b_2), \tag{1}$$

$$k \otimes A_1 = (kc_1, ka_1, kb_1), \quad k \geqslant 0, \ k \in \Re, \tag{2}$$

$$A_1 \oslash A_2 \approx (c_1/b_2, a_1/a_2, b_1/c_2) \quad \text{if } c_1 \geqslant 0, \ c_2 > 0, \tag{3}$$

$$A_1 \otimes A_2 \approx (c_1c_2, a_1a_2, b_1b_2) \quad \text{if } c_1 \geqslant 0, \ c_2 \geqslant 0. \tag{4}$$

3.4. Linguistic value

The concept of linguistic values (Zadeh, 1975/1976) is very useful in handling situations that are too complex or ill-defined to be reasonably described in conventional quantitative expressions. In this paper, the triangular fuzzy numbers defined on [0,1] and/or the linguistic values characterized by triangular fuzzy numbers defined on [0,1] are utilized to convey the suitability evaluation of alternatives versus criteria. For example, S = {VG, G, M, B, VB}. The membership functions of those linguistic values are VB (very bad) = (0, 0, 0.2), B (bad) = (0, 0.2, 0.4), M (medium) = (0.3, 0.5, 0.7), G (good) = (0.6, 0.8, 1), VG (very good) = (0.8, 1, 1).

Determine the weights of the criteria and sub-criteria by using pair-wise comparison matrices. The fuzzy scale regarding relative importance to measure the relative weights is given in Fig. 1 and Table 1. This scale is proposed by Kahraman et al. (2006) and used for solving fuzzy decision-making problems.

3.5. Ranking of triangular fuzzy numbers

Obtaining the ideal and anti-ideal values is important and essential, and the ranking method plays a key role. Many fuzzy ranking methods have been developed (Chen, 1985; Chen and Hsieh, 2000; Cheng, 1998; Kim and Park, 1991). Because the graded mean integration representation (Chen and Hsieh, 2000) not only improves some drawbacks of existing ranking methods but also possesses the advantage of easy implementation and powerfulness of problem solving, it is adopted by this study to find the ideal and anti-ideal solutions.

Based on the graded mean integration representation method, we can obtain the presented and ranking value of triangular fuzzy number $A_i = (c_i, a_i, b_i)$ as

$$R(A_i) = \frac{c_i + 4a_i + b_i}{6}. \tag{5}$$

Using $R(A_i)$, $i = 1,2,\ldots,n$, we can rank the n triangular fuzzy numbers, $A_1, A_2, \ldots, A_n$. Let A_i and A_j be two fuzzy

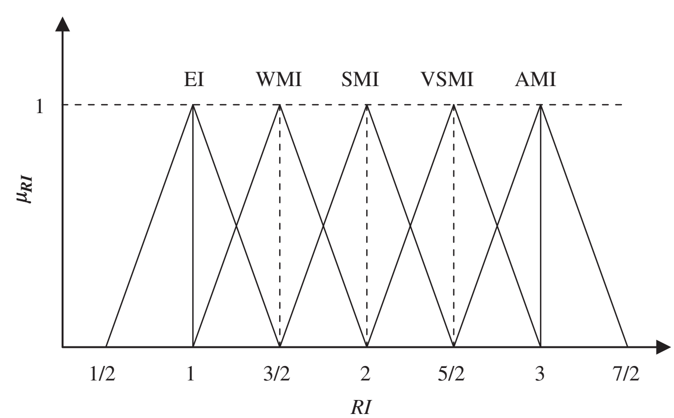

Fig. 1. Linguistic scale for relative importance.

Table 1
Linguistic scales for importance

Linguistic scale for importance	Triangular fuzzy scale	Triangular fuzzy reciprocal scale
Just equal	(1, 1, 1)	(1, 1, 1)
Equally important (EI)	(1/2, 1, 3/2)	(2/3, 1, 2)
Weakly more important (WMI)	(1, 3/2, 2)	(1/2, 2/3, 1)
Strongly more important (SMI)	(3/2, 2, 5/2)	(2/5, 1/2, 2/3)
Very strongly more important (VSMI)	(2, 5/2, 3)	(1/3, 2/5, 1/2)
Absolutely more important (AMI)	(5/2, 3, 7/2)	(2/7, 1/3, 2/5)

numbers and define: $A_i > A_j \Leftrightarrow R(A_i) > R(A_j)$; $A_i = A_j \Leftrightarrow R(A_i) = R(A_j)$; $A_i < A_j \Leftrightarrow R(A_i) < R(A_j)$.

3.6. Distance between two triangular fuzzy numbers

There are three distance formulae constructed on trapezoidal fuzzy numbers (Chen, 1985; Chen and Hsieh, 2000; Kaufmann and Gupta, 1991; Kim and Park, 1991). In 1999, Chen and Hsieh studied the Heilpern's (1997) geometrical distance based on the geometrical operation of trapezoidal fuzzy numbers, and proposed the modified geometrical distance method. Based on this method, the distance between A_i and A_k, denoted by $d_p(A_i, A_k)$, is

$$d_p(A_i, A_k) = \begin{cases} [0.25(|c_i - c_k|^p + |a_i - a_k|^p + |b_i - b_k|^p + |d_i - d_k|^p)]^{1/p} \\ \quad \text{for } 1 \leqslant p < \infty, \\ \max\{|c_i - c_k|, |a_i - a_k|, |b_i - b_k|, |d_i - d_k|\} \\ \quad \text{for } p = \infty. \end{cases}$$

We utilized this modified geometrical distance with parameter $p = 2$ that can meet the concept of the classical distance in order to solve the distance between two triangular fuzzy numbers mentioned in this paper. Based on the concept, the distance between two triangular fuzzy numbers $A_i = (c_i, a_i, b_i)$ and $A_k = (c_k, a_k, b_k)$ with distance parameter $p = 2$ can be denoted as $D(A_i, A_k)$,

$$D(A_i, A_k) = \{\tfrac{1}{4}[(c_i - c_k)^2 + 2(a_i - a_k)^2 + (b_i - b_k)^2]\}^{1/2}. \quad (6)$$

3.7. Ideal and anti-ideal concepts

The ideal point represents a point at which all criteria would be optimized. It provides an anchor for human adaptivity, intransitivity, and dynamic adjustment of preferences, and can also be as close as possible to the perceived ideal that is rational of human choice (Zaleny, 1982). The operation method of ideal and anti-ideal concepts can be summarized as follows.

Assume that there are m alternatives versus n evaluation criteria. Let x_i^k, $i = 1, 2, \ldots, n$; $k = 1, 2, \ldots, m$, be the linguistic rating assigned to alternative k for criteria i.

Let x_i^* and $x_i^\sim$ be the ideal value and anti-ideal value, respectively of criterion i. Then, (1) For the positive criterion i, $x_i^* = \max_k\{x_i^k\}$, $x_i^\sim = \min_k\{x_i^k\}$; (2) For negative criterion i $x_i^* = \min_k\{x_i^k\}$, $x_i^\sim = \max_k\{x_i^k\}$.

Let λ_i, $i = 1, 2, \ldots, n$, be the integrated weight of criterion i. And let $x^* = (x_1^*, x_2^*, \ldots x_i^*, \ldots, x_n^*)$and $x^\sim = (x_1^\sim, x_2^\sim, \ldots, x_i^\sim, \ldots, x_n^\sim)$ be the ideal and anti-ideal solutions, respectively. Define

$$D_k^* = \sqrt{\sum_{i=1}^{n} \lambda_i^2 D(x_i^*, x_i^k)^2}, \quad (7)$$

and

$$D_k^\sim = \sqrt{\sum_{i=1}^{n} \lambda_i^2 D(x_i^\sim, x_i^k)^2}. \quad (8)$$

Then, D_k^* and $D_k^\sim$ can be utilized to denote the distance of alternative k versus ideal and anti-ideal solutions, respectively.

Allow C_k^*, $k = 1, 2, \ldots, m$, to denote the relative approximation value of alternative k versus the ideal solution. Define

$$C_k^* = \frac{D_k^\sim}{D_k^* + D_k^\sim}, \quad (9)$$

where $0 \leqslant C_k^* \leqslant 1$. Then the value of C_k^* close to 1 implies a closer alternative k approach to the positive ideal solution.

4. Empirical study

One hotel was established in Taipei in 1952. In 1973, a new hotel was opened in Kaohsiung. Owing to the rapid central Taiwan development in recent years, hotel investors were prepared to launch a new hotel. At first, the investors asked two academic experts and three professional hotel managers to form a committee and make a recommendation on the location selection. The evaluation processes of this model are described as follows.

Three alternatives are available to this empirical study and the details of these alternatives are described as follows:

1. Alternative 1: This case concerns Taichung's business district, which is next to the National Museum of Natural Science, National Taiwan Museum of Fine Arts, and the Botanical Garden. It is located about 50 min away from the airport, 25 min away from the train station and freeway. The surrounding land has almost been fully developed and there are five competitors within close proximity of this location.
2. Alternative 2: The site is located on the north of Taichung's business district, which is close to the Da-Ken scenic area. Tourists can go to the famous night market, which is within walking distance, but public security is not ideal. It is located just 30 min away from the airport and 25 min away from the train station and freeway. The surrounding land has almost been fully developed. No competitor is within close proximity to this location.
3. Alternative 3: This location is on the border of the Da-Du scenic area, which is considered a remote district. However, the landscape and scenic view are very good, although the public security is of medium quality. It is located just 20 min away from the airport and 10 min away from the freeway. The surrounding land has not been fully developed. No competitor is within close proximity of this location.

4.1. Hierarchical structure of criteria

The systemic hierarchical structure of criteria is adopted to select the international tourist hotel location. The first level reveals the objective of this study and the second level describes four perspectives taken into consideration for selecting the location. The third and fourth levels illustrate the factors and criteria determined for each perspective. The last level, the alternatives of decision-making, demonstrates three locations for consideration. The details are presented in Table 2.

4.2. Fuzzy weight of criteria for each level

In this study, on the basis of the concept of Kahraman et al., we measure the relative weights scale of each criteria or sub-criteria. And then we employ the method presented by Buckley (1985) to use the geometric mean method to calculate the fuzzy weights for each fuzzy matrix.

Given a positive reciprocal matrix $A = [a_{ij}]$, first compute the geometric mean of each row as $r_i = (\prod_{j=1}^{m} a_{ij})^{1/m}$, then $w_i = r_i \varnothing (r_1 \oplus \cdots \oplus r_m)$. The fuzzy weight and integrated weight are presented in Table 3.

4.3. Tabulate the evaluation ratings of alternatives versus criteria by fuzzy numbers

The preponderances of alternatives versus criteria could be obtained by using the linguistic values and these values could be transferred into triangular fuzzy numbers as defined in Section 3.2.2 (shown in Table 4). After obtaining all the triangular fuzzy numbers by committee, we can adopt the average method to get the average evaluation rating of each criterion.

4.4. Calculate the ideal value x_i^* and anti-ideal value $x_i^{\sim}$ of alternatives versus evaluation criteria

To utilize the ranking of triangular fuzzy numbers method (presented in Section 3.2.3) and the concept of ideal and anti-ideal solution, we could obtain the idea solution and anti-ideal solution of alternatives versus criteria.

At this point, we could determine whether or not the performance of each criterion is excellent, meaning that managers will be able to know the gap between the location criteria rating and the ideal target as well as the strength or weakness of the location.

4.5. To solve the distance between alternatives and the ideal and anti-ideal solution.

Eqs. (7) and (8) shown in Section 3.3 were used to obtain the distance between two triangular fuzzy numbers and to

Table 2
The hierarchical structure of location selection model

Perspectives	Factors	Criteria	Description
C_1 Geographical Conditions	C_{11} Surrounding environment	C_{111} Proximity to public facilities	Distance to the public facilities such as theatre or large park
		C_{112} The distance to existing competitors	Regional competitiveness
		C_{113} Public security	Whether the regional public security is good or not
	C_{12} Rest resources	C_{121} Natural resources characteristic	Where has nature resource like as hot spring or landscape
		C_{122} Nearby rest facilities	The access of rest facilities
C_2 Traffic Conditions	C_{21} Access	C_{211} The distance to airport or freeway	The spend time from hotel to traffic facilities or not
		C_{212} The distance to downtown area	The area is prosperous or not
		C_{213} The distance to tourism scenic spots	Distance near by the tourism scenic spots or not
		C_{214} Parking area	Easy for parking or not
	C_{22} Convenience	C_{221} Convenience of airport or freeway communication	Easy to arrive main traffic facilities
		C_{222} Extensiveness of traffic routes	Perfect routes planning
		C_{223} Convenience of traffic to tourism scenic spots	Have many alternative of transportation tool to reach scenic spots or not
C_3 Hotel Characteristic	C_{31} Internal development	C_{311} Indoor leisure facilities	Many facilities such as fitness center or play area
		C_{312} The diversity of restaurants in the hotel	Have local character to combine with restaurant
	C_{32} External development	C_{321} Amalgamation with local culture	Have local characteristic to combine with hotel design or not
		C_{322} Outside leisure facilities area	Many facilities such as golf ground or swimming pool
		C_{323} Convenience of obtaining nearby land	Facilities establishing or developing is easy or not
C_4 Operation Management	C_{41} Human resource	C_{411} Sufficient human resources	Human resource is enough or not in the area
		C_{412} Quality of manpower	Human ability is enough or not, such as university support or not.
	C_{42} Operating conditions	C_{421} Land cost	Land cost is good for hotel developing or not
		C_{422} Regulation restrictions	Legal rules is good for hotel developing or not

Table 3
The integrated fuzzy weight and weight in each level

Item	Integrated fuzzy weight	Weight
C_1	(0.1133, 0.2326, 0.3870)	0.23842
C_2	(0.1336, 0.2473, 0.4285)	0.25855
C_3	(0.1524, 0.2648, 0.4855)	0.28283
C_4	(0.1488, 0.2554, 0.4764)	0.27445
C_{11}	(0.0357, 0.1083, 0.2515)	0.12008
C_{12}	(0.0417, 0.1243, 0.3149)	0.14226
C_{21}	(0.0488, 0.1282, 0.2997)	0.14354
C_{22}	(0.0479, 0.1191, 0.2924)	0.13612
C_{31}	(0.0581, 0.1471, 0.3785)	0.17088
C_{32}	(0.0500, 0.1176, 0.3060)	0.13773
C_{41}	(0.0512, 0.1295, 0.3344)	0.15058
C_{42}	(0.0527, 0.1259, 0.3481)	0.15074
C_{111}	(0.0073, 0.0353, 0.1256)	0.04569
C_{112}	(0.0116, 0.0484, 0.2227)	0.07135
C_{113}	(0.00220, 0.1083, 0.4092)	0.14406
C_{121}	(0.0159, 0.0682, 0.2374)	0.08768
C_{122}	(0.0141, 0.0561, 0.2002)	0.07308
C_{211}	(0.0061, 0.0262, 0.0989)	0.03499
C_{212}	(0.0069, 0.0312, 0.1206)	0.04203
C_{213}	(0.0079, 0.0356, 0.1438)	0.04899
C_{214}	(0.0080, 0.0352, 0.1423)	0.04854
C_{221}	(0.0100, 0.0418, 0.1726)	0.05833
C_{222}	(0.0147, 0.0655, 0.2792)	0.09263
C_{223}	(0.0302, 0.1321, 0.5684)	0.18785
C_{311}	(0.0202, 0.0630, 0.2269)	0.05681
C_{312}	(0.0202, 0.0630, 0.2269)	0.08911
C_{321}	(0.0103, 0.0414, 0.1649)	0.17763
C_{322}	(0.0160, 0.0641, 0.2624)	0.08315
C_{323}	(0.0333, 0.1295, 0.5146)	0.08315
C_{411}	(0.0206, 0.0741, 0.2673)	0.09734
C_{412}	(0.0206, 0.0741, 0.2673)	0.09675
C_{421}	(0.0158, 0.0471, 0.1578)	0.06035
C_{422}	(0.0222, 0.0705, 0.2449)	0.09151

get the distance of alternatives versus the ideal and anti-ideal solutions (D_k^* and $D_k^{\sim}$, shown in Table 5).

4.6. To obtain the close index of alternative k versus the ideal solution and select the best alternative

Using Eq. (9) (Section 3.3), the close index (C_k^*) of three alternatives was obtained (shown in Table 6), which expressed the final results clearly. Moreover, managers will be able to know the criteria gap between location characteristics and the ideal target and devise the operation strategies for the location they selected.

Using Eq. (9) in Section 3.3, the relative approximation value of each alternative k versus ideal solution (C_k^*) could be obtained. As Table 6 demonstrated, alternative 1 was the best location. As the final result was integrated by the weight of each criterion, managers can therefore trace each

Table 5
The distance between alternatives and the ideal and anti-ideal solution

	Alternative 1	Alternative 2	Alternative 3
D_k^*	0.08129	0.08419	0.1112
$D_k^{\sim}$	0.04240	0.03919	0.04558

Table 6
The close index of alternatives versus the ideal solution

	Alternative 1	Alternative 2	Alternative 3
C_k^*	0.3428	0.3176	0.2907

Table 4
The average evaluation ratings of each criterion

	Alternative1	Alternative2	Alternative3	Ideal solution	Anti-ideal solution
C_{111}	(0.7, 0.7, 0.7)	(0.5, 0.7, 0.9)	(0.7, 0.9, 1.0)	(0.7, 0.9, 1.0)	(0.5, 0.7, 0.9)
C_{112}	(0.6, 0.8, 1.0)	(0.7, 0.9, 1.0)	(0.4, 0.6, 0.8)	(0.7, 0.9, 1.0)	(0.4, 0.6, 0.8)
C_{113}	(0.6, 0.8, 1.0)	(0.6, 0.8, 1.0)	(0.4, 0.6, 0.8)	(0.6, 0.8, 1.0)	(0.4, 0.6, 0.8)
C_{121}	(0.5, 0.7, 0.9)	(0.5, 0.7, 0.9)	(0.4, 0.6, 0.8)	(0.5, 0.7, 0.9)	(0.4, 0.6, 0.8)
C_{122}	(0.6, 0.8, 0.9)	(0.4, 0.6, 0.8)	(0.5, 0.7, 0.8)	(0.6, 0.8, 0.9)	(0.4, 0.6, 0.8)
C_{211}	(0.5, 0.7, 0.9)	(0.6, 0.8, 0.8)	(0.7, 0.9, 1.0)	(0.7, 0.9, 1.0)	(0.5, 0.7, 0.9)
C_{212}	(0.6, 0.8, 1.0)	(0.5, 0.7, 0.9)	(0.7, 0.9, 1.0)	(0.7, 0.9, 1.0)	(0.5, 0.7, 0.9)
C_{213}	(0.5, 0.7, 0.9)	(0.3, 0.5, 0.7)	(0.4, 0.6, 0.8)	(0.5, 0.7, 0.9)	(0.3, 0.5, 0.7)
C_{214}	(0.5, 0.7, 0.9)	(0.6, 0.8, 0.9)	(0.4, 0.6, 0.8)	(0.6, 0.8, 0.9)	(0.4, 0.6, 0.8)
C_{221}	(0.6, 0.8, 1.0)	(0.5, 0.7, 0.9)	(0.4, 0.6, 0.8)	(0.6, 0.8, 1.0)	(0.4, 0.6, 0.8)
C_{222}	(0.4, 0.6, 0.8)	(0.6, 0.8, 0.9)	(0.5, 0.7, 0.9)	(0.6, 0.8, 0.9)	(0.4, 0.6, 0.8)
C_{223}	(0.4, 0.6, 0.8)	(0.5, 0.7, 0.9)	(0.4, 0.6, 0.8)	(0.5, 0.7, 0.9)	(0.4, 0.6, 0.8)
C_{311}	(0.6, 0.8, 0.9)	(0.4, 0.6, 0.8)	(0.4, 0.6, 0.8)	(0.6, 0.8, 0.9)	(0.4, 0.6, 0.8)
C_{312}	(0.7, 0.9, 1.0)	(0.6, 0.8, 1)	(0.4, 0.6, 0.8)	(0.7, 0.9, 1.0)	(0.4, 0.6, 0.8)
C_{321}	(0.5, 0.7, 0.9)	(0.6, 0.8, 0.9)	(0.4, 0.6, 0.8)	(0.6, 0.8, 0.9)	(0.4, 0.6, 0.8)
C_{322}	(0.7, 0.9, 1.0)	(0.6, 0.8, 1)	(0.5, 0.7, 0.9)	(0.7, 0.9, 1.0)	(0.5, 0.7, 0.9)
C_{323}	(0.5, 0.7, 0.9)	(0.6, 0.8, 0.9)	(0.3, 0.5, 0.7)	(0.6, 0.8, 0.9)	(0.3, 0.5, 0.7)
C_{411}	(0.5, 0.7, 0.7)	(0.6, 0.8, 0.9)	(0.5, 0.7, 0.8)	(0.6, 0.8, 0.9)	(0.5, 0.7, 0.8)
C_{412}	(0.5, 0.7, 0.7)	(0.3, 0.5, 0.7)	(0.4, 0.6, 0.8)	(0.5, 0.7, 0.7)	(0.3, 0.5, 0.7)
C_{421}	(0.5, 0.7, 0.9)	(0.4, 0.6, 0.8)	(0.4, 0.6, 0.8)	(0.5, 0.7, 0.9)	(0.4, 0.6, 0.8)
C_{422}	(0.7, 0.9, 1.0)	(0.7, 0.9, 1.0)	(0.7, 0.9, 1.0)	(0.7, 0.9, 1.0)	(0.7, 0.9, 1.0)

criterion in order to understand the superiority or inferiority of the strategies established. For instance, empirical results of this study indicated that the criterion of "public security," alternative 3 versus $C_{113,}$ is quite distant from the ideal solution and the weight of C_{113} was substantial. Therefore managers could make operation strategies for this criterion, public security, in advance.

5. Conclusion

Because hotel location is directly related to the level of hotel business activity, the hotel budget plan, when settled, will affect future hotel customer quantity as well as access of foreign independent tourists. Therefore, developing a set of integrated tourist hotel location selection system and comparing its suitability to major alternatives are needed for managers to sharpen their competitive edge. This article presents a fuzzy multi-criteria decision model for selecting a location for a tourist hotel. The process of deriving the solution is illustrated through an easy-to-understand empirical study. Results demonstrate that the model can provide a framework to assist decision makers in analyzing location factors and making a dispassionate and objective location selection.

At the process of model building, the weights of four perspectives, four factors, and 21 criteria are presented. From the result of weights of perspectives, the C_3 (hotel characteristic) and C_4 (operation management) are the first and second important perspectives in the four perspectives. And the C_{31} (internal development) is the most important factor in all factors. In the 21 criteria, we know that criteria C_{113} (public security), C_{223} (convenience of traffic to tourism scenic spots), and C_{321} (amalgamation with local culture) are more important in the evaluation model. From the above results, the managers focus on whether the characteristic of a hotel can combine with the local culture characteristic when they survey location. The managers pay more attention to other criteria such as public security, modes of transportation to reach scenic spots and to combine these with the local character when a hotel is being designed. Since these criteria provide relief, convenience and a good experience to the customers, an experiential marketing strategy can also be developed for the hotel.

In real life, due to the uncertainty of information as well as the vagueness of human feeling and recognition, it is difficult to exactly evaluate and convey the feeling and recognition of objects. Hence, the authors, based on the AHP method, combine fuzzy sets theory with linguistic value concept in setting up a model that can help decision-makers deal with complex issues under the fuzzy environment. Thus, this paper proposes a simple and practical decision model that will provide significant managerial insights to evaluation committees when making location selection decisions. Also, the committee members can understand the organizational goal and decision process. The model will further enhance organizational communication ability. Meanwhile, tourist hotel managers and investors should decide on the strength of each location in an effort to enhance their understanding of the new hotel's competitiveness. The paper also demonstrates how comparisons could be made while selecting the model, which gives a clear direction for hotel managers and investors when devising operating strategies and activities.

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