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A Hybrid MCDM Model with Interval Weights and Data for Convention Site Selection

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Abstract: In this study, we present a hybrid Multi-Criteria Decision Making (MCDM) model to solve convention site selection. In the proposed model, interval comparison matrix which has been inspired by Analytical Hierarchy Process (AHP) is employed to compare the criteria against each other. Furthermore, to calculate the interval weights of criteria, we make use of Goal Programming (GP). Moreover, interval data is utilized to evaluate the alternatives with respect to the criteria. In order to rank the alternatives with respect to criteria, technique for order preference by similarity to an ideal solution (TOPSIS) with interval data and weights is used. In the conditions where there exist uncertainties for both the comparison of criteria against each other and alternatives evaluation with respect to influential criteria in the process of decision making, using this model facilitates the decision making process and causes the quality of decision will be enhance.

Key words: Analytical hierarchy process (AHP), multiple criteria decision making (MCDM), interval comparison matrix, technique for order preference by similarity to an ideal solution (TOPSIS), interval data

INTRODUCTION

To select a convention site, a variety of influential decision variable should be simultaneously assimilated in the process of decision making and this has made the subject potentially complex (Clark and McCleary, 1995). According to the exhaustive review of the site selection papers in the literature, a 5-step conceptual model of the site selection process was proposed by Crouch and Ritchie (1998) and they discovered several categories of site selection factors, coupled with various antecedent conditions and competing sites influences. Convention preplanning, site selection analysis and recommendations, site selection decision, convention held and post convention evaluation are the five steps the have to be taken in convention site selection process. The site selection decision are influenced by several factors and can be broadly separated into site-specific and association factors (Weber and Chon, 2002). The majority of previous studies have endeavored to recognize many of this topic's selection contributive factors (e.g., Oppermann, 1996; Go and Zang, 1997; Crouch and Ritchie, 1998; Chacko and Fenich, 2000; Kim and Kim, 2003; Crouch and Louviere, 2004). Go and Zang (1997) classified the convention site selection criteria into two primary categories: 1 the convention destination site's environment addressing a city's capacity to host an international convention and 2 the meeting facilities. The proposed conceptual model of convention site selection by Crouch and Ritchie (1998) investigates eight primary factors together with several aspects, culminating in the recognition of 36 attributes that affect the choice of a convention site. With reference to the summary review of Kim and Kim (2003) the prominent criteria for convention site selection can be characterize as follows: meeting room facilities, service quality, restaurants, transportation and attractiveness of the destination are the major attributes. Several contributive and worthwhile studies have been conducted regarding site attributes which among them the study of Chacko and Fenich (2000) and Crouch and Louviere (2004) are of vital importance. A regression analysis was performed by Chacko and Fenich (2000) to explore the significance of US convention destination attributes. Crouch and Louviere (2004) applied the logistic choice model using designed experimental data to explore the determinants of convention site selection.

As mentioned before there are various criteria that affect decision making process in a convention site

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selection problem. Therefore, offering a method for choosing a suitable place, entails applying MCDM methods. In general, we face with MCDM methods when for making decision between different alternatives, we encounter with more than one criteria or objectives. So decision making problems can be categorized into two groups of multiple attribute decision making (MADM) and Multiple Objective Decision Making (MODM).

MADM is ranking multiple alternatives subject to different attributes. In fact it is, choosing the best alternative among available alternatives based on given criteria and attributes. Optimum performance of ranking alternatives strictly depends on choosing suitable weights for these criteria. To calculate these weights, the criteria should be compared with each other in advance. Pair wise comparison matrix which is used in AHP method is a good method for this purpose.

AHP, as a Multiple Criteria Decision Making (MCDM) tool and a weight estimation technique, has been extensively applied in many areas such as selection, evaluation, planning and development, decision making, forecasting and so on (Vaidya and Kumar, 2006). The conventional AHP requires exact judgments and crisp comparison matrices. However, due to the complexity and uncertainty involved in real world decision problems, it is sometimes unrealistic or impossible to acquire exact judgments. It is more natural or easier to provide interval judgments for part or all of the judgments in a pair wise comparison matrix. In this study first with the help of interval comparison matrices and applying goal programming model, the weights of efficient criteria are obtained in the form of interval weights. Then, alternatives are ranked through interval TOPSIS method.

Interval comparison matrix: In an interval comparison matrix we face with interval judgments instead of precise judgments. In other words, the relative importance of criterion i and j can be expressed as a number between l_{ij} and u_{ij}. Where, l_{ij} and u_{ij} are non-negative real numbers and $l_{ij} \le u_{ij}$. General form of an interval comparison matrix is presented in matrix A.

$$A = \begin{bmatrix} 1 & [l_{12}, u_{12}] & \cdots & [l_{1n}, u_{1n}] \\ [l_{21}, u_{21}] & 1 & \cdots & [l_{2n}, u_{2n}] \\ \vdots & \vdots & \vdots & \vdots \\ [l_{n1}, u_{n1}] & [l_{n2}, u_{n2}] & \cdots & 1 \end{bmatrix} \quad (1)$$

where, $l_{ij} = 1/u_{ij}$ and $u_{ij} = 1/l_{ij}$ for all I, j = 1,..., n; i ≠ j. The above interval comparison matrix can be divided into two crisp nonnegative matrices as follows:

$$A_L = \begin{bmatrix} 1 & l_{12} & \cdots & l_{1n} \\ l_{21} & 1 & \cdots & l_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ l_{n1} & l_{n2} & \cdots & 1 \end{bmatrix} \text{ and } A_U = \begin{bmatrix} 1 & u_{12} & \cdots & u_{1n} \\ u_{21} & 1 & \cdots & u_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ u_{n1} & u_{n2} & \cdots & 1 \end{bmatrix} \quad (2)$$

where, $A_L \le A \le A_U$. Note that, A_l and A_u are no longer reciprocal matrices.

For the interval comparison matrix A, there should exist a normalized interval weight vector, $W = ([w_1^l, w_1^u], ..., [w_n^l, w_n^u])^T$, which is close to A in the sense that $a_{ij} = [l_{ij}, u_{ij}] \approx [w_i^l, w_i^u]/[w_j^l, w_j^u]$ for all i, j = 1,..., n; i ≠ j.

Consistency of the pair wise comparison matrices is another factor which should be considered. In this study to examine the consistency of matrices with interval data, here used the proposed method by Wang *et al.* (2005a) which is described as follow.

$A = (a_{ij})_{n\times n}$ is a consistent interval comparison matrix if and only if it satisfies the following inequality constraints:

$$\max_k \left(l_{ik} l_{kj}\right) \le \min_k (u_{ik} u_{kj}), \quad \text{for all} \quad i, j, k = 1, ..., n \quad (3)$$

GP model for obtaining interval weights from an interval comparison matrix: Weight calculation techniques from interval comparison matrices are classified into two groups of point estimation and interval estimation. Extensive researches have been done regarding these two techniques to come up with the weights from interval comparison matrix. matrix (e.g., Saaty and Vargas, 1987; Arbel, 1989; Kress, 1991; Arbel and Vargas, 1993; Islam *et al.*, 1997; Mikhailov, 2002, 2004; Sugihara *et al.*, 2004; Wang *et al.*, 2005a,b; Wang and Elhag, 2007). It is more natural and logical that an interval comparison matrix should give an interval weight estimate rather than an exact point estimate. GP model that was proposed by Wang and Elhag (2007), is one of the methods for calculating interval weights from interval comparison matrices. This model is shown in Eq. 4.

$$\text{Minimize } J = \sum_{i=1}^{n} (\varepsilon_i^+ + \varepsilon_i^- + \gamma_i^+ + \gamma_i^-) = e^T(E^+ + E^- + \Gamma^+ + \Gamma^-)$$

$$\text{S.t.} \begin{cases} (A_L - I) \; W_u - (n-1) \; W_L - E^+ + E^- = 0, \\ (A_U - I) \; W_l - (n-1) \; W_U - \Gamma^+ + \Gamma^- = 0, \\ w_i^L + \sum_{j=1, j\ne i}^{n} W_j^U \ge 1, \; i = 1, ..., n, \\ w_i^u + \sum_{j=1, j\ne i}^{n} W_j^L \le 1, \; i = 1, ..., n, \\ W_U - W_L \ge 0, \\ W_L, W_U, E^+, E^-, \Gamma^+, \Gamma^- \ge 0, \end{cases} \quad (4)$$

where, $E^+ = (\varepsilon_1^+,...,\varepsilon_n^+)^T \geq 0$, $E^- = (\varepsilon_1^-,...,\varepsilon_n^-)^T \geq 0$, $\Gamma^+ = (\gamma_1^+,...,\gamma_n^+)^T \geq 0$, $\Gamma^- = (\gamma_1^-,...,\gamma_n^-)^T \geq 0$, $W_L = (W_1^L,....,W_n^L)^T$ and $W_U = (W_1^U,....,W_n^U)^T$ and $e^t = (1,..., 1)$.

Note that ε_i^+ and ε_i^+ as well as γ_i^+ and γ_i^+ can not be simultaneously selected as basic variables in a simplex method. In following here's used this method to obtain interval weights of criteria and sub criteria of our case study.

Interval arithmetic: If upper and lower bounds for the uncertain parameters can be determined, these can be interpreted as the endpoints $\underline{x},\overline{x}$ of a closed interval $[\underline{x},\overline{x}] \subseteq \Re$. This interval is usually denoted by [x]. The principles of interval arithmetic are quite simple: during evaluation any expression is constructed by subsequent calls of elementary binary operations $\{+,-,\div,\times\}$, where the internalization of binary operators is:

$$[\underline{x},\overline{x}] \ \Diamond \ [\underline{y},\overline{y}] = [\underline{z},\overline{z}], \qquad \text{for } \Diamond \in \{+,-,\times,\div\}, \tag{5}$$

$$\text{with } \underline{z} = \min\{\underline{x}\Diamond\underline{y}, \underline{x}\Diamond\overline{y}, \overline{x}\Diamond\underline{y}, \overline{x}\Diamond\overline{y}\}$$
$$\text{and } \overline{z} = \max\{\underline{x}\Diamond\underline{y}, \underline{x}\Diamond\overline{y}, \overline{x}\Diamond\underline{y}, \overline{x}\Diamond\overline{y}\}.$$

TOPSIS method with interval weight and data: TOPSIS (technique for order preference by similarity to an ideal solution) method is presented in Chen and Hwang (1992), with reference to Hwang and Yoon (1981). TOPSIS is a multiple criteria method to identify solutions from a finite set of alternatives. The basic principle is that the chosen alternative should have the shortest distance from the positive ideal solution and the farthest distance from the negative ideal solution. A similar concept has also been pointed out by Zeleny (1982).

Considering the fact that, in some cases, determining precisely the exact value of the attributes is difficult and that, as a result of this, their values are considered as intervals, TOPSIS method with interval data was proposed by Jahanshahloo *et al.* (2006), such that in it, data were considered as interval and the weights of criteria were deterministic. The proposed TOPSIS method of this paper apart from including interval data, considers the weights as intervals. This method is described as follow:

Suppose, A_1, A_2,..., A_m are m possible alternatives among which decision makers have to choose, $C_1, C_2,..., C_n$ are criteria with which alternative performance are measured, x_{ij} is the rating of alternative A_i with respect to criterion C_j and is not known exactly and only we know $x_{ij} \in [x_{ij}^L, x_{ij}^U]$. A MCDM problem with interval weight and data can be concisely expressed in format of one matrix as Table 1.

Table 1: MCDM problem with interval weight and data

	C_1	C_2	...	C_1
	-----------	-----------	------	----------
Alternatives	$[w_1^L, w_1^U]$	$[w_2^L, w_2^U]$		$[w_n^L, w_n^U]$
A_1	$[x_{11}^L, x_{11}^U]$	$[x_{12}^L, x_{12}^U]$	...	$[x_{1n}^L, x_{1n}^U]$
A_2	$[x_{21}^L, x_{21}^U]$	$[x_{22}^L, x_{22}^U]$	...	$[x_{1n}^L, x_{1n}^U]$
⋮	⋮	⋮	⋮	⋮
A_m	$[x_{m1}^L, x_{m1}^U]$	$[x_{m1}^L, x_{m1}^U]$	...	$[x_{mn}^L, x_{mn}^U]$

Where, $[w_i^L, w_i^U]$ is the weight of criterion C_j

The algorithmic method: A systematic approach to extend the TOPSIS to the interval data is proposed in this section. First, we calculate the normalized decision matrix as follows:

The normalized values $\overline{n}_{ij}^L$ and $\overline{n}_{ij}^U$ are calculated as:

$$\overline{n}_{ij}^L = \frac{x_{ij}^L}{\sqrt{\sum_{j=1}^{m}(x_{ij}^L)^2 + (x_{ij}^U)^2}}, \qquad j=1,2,...,m. \quad i=1,2,...,n, \tag{6}$$

$$\overline{n}_{ij}^U = \frac{x_{ij}^U}{\sqrt{\sum_{j=1}^{m}(x_{ij}^L)^2 + (x_{ij}^U)^2}}, \qquad j=1,2,...,m. \quad i=1,2,...,n. \tag{7}$$

Now, interval $[\overline{n}_{ij}^L, \overline{n}_{ij}^U]$ is normalized of interval $[x_{ij}^L, x_{ij}^U]$. The normalization method mentioned above is to preserve the property that the ranges of normalized interval numbers belong to (0,1).

Referring to the Eq. 5 with regard to $w_i^l \geq 0$, We can construct the weighted normalized interval decision matrix as:

$$\overline{v}_{ij}^L = w_i^l \overline{n}_{ij}^L, \qquad j=1,2,...,m, \quad i=1,2,...,n, \tag{8}$$

$$\overline{v}_{ij}^U = w_i^u \overline{n}_{ij}^U, \qquad j=1,2,...,m, \quad i=1,2,...,n, \tag{9}$$

where, w_i^L, w_i^U are the lower and upper weight of the ith attribute or criterion and

$$\frac{\sum_{j=1}^{n}[w_j^l, w_j^u]}{2} = 1.$$

Then, we can identify positive ideal solution and negative ideal solution as:

$$\overline{A}^+ = \{\overline{v}_1^+,...,\overline{v}_n^+\} = \left\{\left(\max_j \overline{v}_{ij}^U \mid i \in I\right), \left(\min_j \overline{v}_{ij}^L \mid i \in J\right)\right\}, \tag{10}$$

$$\overline{A}^- = \{\overline{v}_1^-,...,\overline{v}_n^-\} = \left\{\left(\min_j \overline{v}_{ij}^L \mid i \in I\right), \left(\max_j \overline{v}_{ij}^U \mid i \in J\right)\right\}, \tag{11}$$

where, I is associated with benefit criteria and J is associated with cost criteria. The separation of each alternative from the positive ideal solution, using the n-dimensional Euclidean distance, can be currently calculated as:

$$\bar{d}_j^+ = \left\{\sum_{i\in I}(\bar{v}_{ij}^L - \bar{v}_i^+)^2 + \sum_{i\in J}(\bar{v}_{ij}^U - \bar{v}_i^+)^2\right\}^{\frac{1}{2}}, \qquad j=1,2,\ldots,m \quad (12)$$

Similarly, the separation from the negative ideal solution can be calculated as:

$$\bar{d}_j^- = \left\{\sum_{i\in I}(\bar{v}_{ij}^U - \bar{v}_i^-)^2 + \sum_{i\in J}(\bar{v}_{ij}^L - \bar{v}_i^-)^2\right\}^{\frac{1}{2}}, \qquad j=1,2,\ldots,m \quad (13)$$

A closeness coefficient is defined to determine the ranking order of all alternatives once the $\bar{d}_j^+$ and $\bar{d}_j^-$ of each alternative A_j has been calculated. The relative closeness of the alternative A_j with respect to $\bar{A}^+$ is defined as:

$$\bar{R}_j = \frac{\bar{d}_j^-}{\bar{d}_j^- + \bar{d}_j^+}, \qquad j=1,2,\ldots,m \quad (14)$$

Obviously, an alternative A_j is closer to the $\bar{A}^+$ and farther from $\bar{A}^-$ as $\bar{R}_j$ approaches to 1. Therefore, according to the closeness coefficient, we can determine the ranking order of all alternatives and select the best one among a set of feasible alternatives.

Case study: To clarify the proposed method a numerical example is illustrated. The hierarchical structure of this example was proposed by Chen (2006). In this case study we consider five alternatives and try to assess their performance by proposed method. The highest level of the hierarchy is the overall goal: to construct an evaluation structure for convention site selection with weights corresponding to criteria. Under the overall goal, the second level represents the criteria affecting convention site selection, including meeting and accommodation facilities, costs, site environment, local support and extra conference opportunities. Various sets of subcriteria associated with each factor in the second level are linked to the third level. As seen in Fig. 1 there are 17 attributes in total in the third level. The meeting and accommodation facilities factor consists of 4 attributes which are space, variety of meeting and accommodation properties, suitability of convention facilities and quality of food and beverage.

The cost factor is subdivided into 4 attributes named transport expense, accommodation expense, food and beverage expense and commodity prices. The site environment factor is made of three attributes called city image, site accessibility and suitability and quality of local infrastructure. The local support factor includes three attributes such as government support, quality of convention personnel and efficiency of convention personnel. Finally, the extra conference opportunities factor includes three attributes that are climate, entertainment opportunities and sightseeing and cultural attractions. The hierarchical structure of this decision problem is shown in Fig. 1.

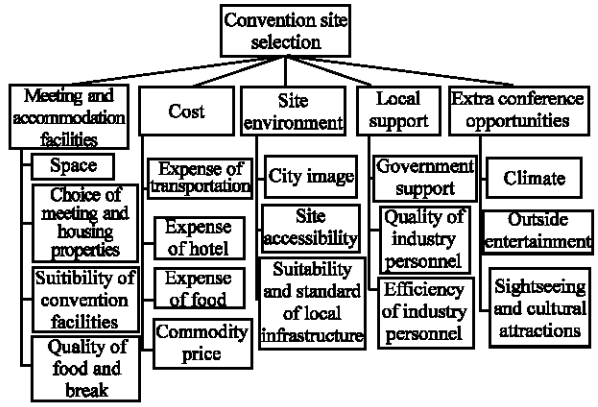

Fig. 1: The hierarchical structure for convention site selection

Interval comparison matrices of criteria and sub-criteria prepared by experts are presented in Table 2-7.

The consistency of each mentioned pair wise comparison matrices are examined through Eq. 3. For instance the consistency of each level-one comparison matrices is shown in Table 8.

The consistency of each remaining matrices are examined in the way of level-one matrices. Regarding the yield results from studying the consistency of comparison matrices, being consistent for all matrices is proved. In the next step interval weights of each criteria and sub-criteria are calculated via goal programming model which is shown in Eq. 4 and its results are presented in Table 9.

Then applying interval TOPSIS method, the five cited alternatives are ranked regarding with the obtained interval weights shown in Table 8. Initially each alternative is evaluated against each criterion by an expert who expresses his/her opinion in the form of interval data that are presented in Table 10. In the next step these data are normalized through Eq. 6 and 7, their results are shown in Table 11. Then considering the Eq. 7 and 8 and the normalized data of Table 11, the normalized weights are obtained and their results are shown in Table 12.

Then the values of $\bar{d}_j^+$ and $\bar{d}_j^-$ are calculated through Eq. 12 and 13 that their results are presented in Table 13 and Table 14. In the end with the help of Eq. 5 and the

Table 2: Interval comparison matrix for the four criteria

Criteria	Meeting and accommodation facilities	Costs	Site environment	Local support	Extra conference opportunities
Meeting and accommodation facilities	1	[3,5]	[1/2,1]	[2,3]	[2,4]
Costs		1	[1/6,1/4]	[1/2,1]	[1/3,1]
Site environment			1	[2,3]	[3,5]
Local support				1	[1,2]
Extra conference opportunities					1

Table 3: Interval comparison matrix for the four sub-criteria with respect to meeting and accommodation facilities

Meeting and accommodation facilities	Space	Choice of meeting and housing properties	Suitability of convention facilities	Quality of food and break
Space	1	[1,3]	[1/5,1/3]	[1,2]
Choice of meeting and housing properties		1	[1/6,1/5]	[1,3]
Suitability of convention facilities			1	[4,5]
Quality of food and break				1

Table 4: Interval comparison matrix for the four sub-criteria with respect to costs

Costs	Expense of transportation	Expense of transportation	Expense of transportation	Expense of transportation
Expense of transportation	1	[1,3]	[2,4]	[7,9]
Expense of hotel		1	[2,3]	[5,7]
Expense of food			1	[2,4]
Commodity prices				1

Table 5: Interval comparison matrix for the four sub-criteria with respect to site environment

Site environment	City image	Site accessibility	Suitability and standard of local infrastructure
City image	1	[1,3]	[1/5,1/2]
Site accessibility		1	[1/4,1/2]
Suitability and standard of local infrastructure			1

Table 6: Interval comparison matrix for the four sub-criteria with respect to local support

Local Support	Government support	Quality of industry personnel	Efficiency of industry personnel
Government support	1	[1,3]	[1/4,1/2]
Quality of industry personnel		1	[1/5,1/3]
Efficiency of industry personnel			1

Table 7: Interval comparison matrix for the four sub-criteria with respect to extra conference opportunities

Extra conference opportunities	Climate	Outside Entertainment	Sightseeing and cultural attractions
Climate	1	[2,4]	[4,7]
Outside entertainment		1	[1,3]
Sightseeing and cultural attractions			1

Table 8: Consistency test for level-one comparison matrices

Judgment element	i	j	k	$l_{ik}\, l_{kj}$	$u_{ik}\, u_{kj}$	Consistency test
a_{12}	1	2	1	3	5	Max $(l_{ik}\, l_{kj}) = 3$
	1	2	3	2	6	Min $(u_{ik}\, u_{kj})$ 5
	1	2	4	2	6	
	1	2	5	2	12	Passed
a_{13}	1	3	1	1/2	1	Max $(l_{ik}\, l_{kj}) = 2/3$
	1	3	2	1/2	5/4	Min $(u_{ik}\, u_{kj}) = 1$
	1	3	4	2/3	3/2	
	1	3	5	2/5	4/3	Passed
a_{14}	1	4	1	2	3	Max $(l_{ik}\, l_{kj}) = 2$
	1	4	2	3/2	5	Min $(u_{ik}\, u_{kj}) = 3$
	1	4	3	1	3	
	1	4	5	1	4	Passed
a_{15}	1	5	1	2	4	Max $(l_{ik}\, l_{kj}) = 2$
	1	5	2	1	5	Min $(u_{ik}\, u_{kj}) = 4$
	1	5	3	3/2	5	
	1	5	4	2	6	Passed
a_{23}	2	3	1	1/10	1/3	Max $(l_{ik}\, l_{kj}) = 1/6$
	2	3	2	1/6	1/4	Min $(u_{ik}\, u_{kj}) = 1/4$
	2	3	4	1/6	1/2	
	2	3	5	1/15	1/3	Passed
a_{24}	2	4	1	2/5	1	Max $(l_{ik}\, l_{kj}) = 1/2$
	2	4	2	1/2	1	Min $(u_{ik}\, u_{kj}) = 3/4$
	2	4	3	1/3	3/4	
	2	4	5	1/6	1	Passed

Table 8: Continued

Judgment element	i	j	k	l_{ik} l_{kj}	u_{ik} u_{kj}	Consistency test
a_{25}	2	5	1	2/5	4/3	Max (l_{ik} l_{kj}) = 1/2
	2	5	2	1/3	1	Min (u_{ik} u_{kj}) = 1
	2	5	3	1/2	5/4	
	2	5	4	1/2	2	Passed
a_{34}	3	4	1	2	6	Max (l_{ik} l_{kj}) = 2
	3	4	2	2	6	Min (u_{ik} u_{kj}) = 3
	3	4	3	2	3	
	3	4	5	3/2	5	Passed
a_{35}	3	5	1	2	8	Max (l_{ik} l_{kj}) = 3
	3	5	2	4/3	6	Min (u_{ik} u_{kj}) = 5
	3	5	3	3	5	
	3	5	4	2	6	Passed
a_{45}	4	5	1	2/3	2	Max (l_{ik} l_{kj}) = 1
	4	5	2	1/3	2	Min (u_{ik} u_{kj}) = 2
	4	5	3	1	5/2	
	4	5	4	1	2	Passed

Table 9: Interval weights for a consistent interval comparison matrix generated GPM method

Criteria	Interval weight resulted from comparative tables	Compound weights of sub-criteria
Meeting and accommodation facilities	[0.2348,0.3781]	
Space (C_1)	[0.1475,0.2135]	[0.0346,0.0807]
Choice of meeting and housing properties (C_2)	[0.1010,0.1237]	[0.0237,0.0468]
Suitability of Convention facilities (C_3)	0.5963	[0.1400,0.2255]
Quality of food and break (C_4)	[0.0891,0.1325]	[0.0209,0.0501]
Costs	[0.0996,0.1005]	
Expense of transportation (C_5)	[0.3819,0.5759]	[0.0380,0.0579]
Expense of hotel (C_6)	[0.2402,0.3835]	[0.0239,0.0385]
Expense of food (C_7)	[0.1297,0.1760]	[0.0129,0.0177]
Commodity prices (C_8)	[0.0543,0.0586]	[0.0054,0.0059]
Site Environment	[0.3182,0.4624]	
City image (C_9)	[0.1691,0.2904]	[0.0538,0.1343]
Site accessibility (C_{10})	[0.1103,0.2096]	[0.0351,0.0969]
Suitability and standard of local structure (C_{11})	[0.5000,0.6434]	[0.1591,0.2976]
Local support	0.1168	
Government support (C_{12})	[0.1762,0.3040]	[0.0206,0.0355]
Quality of industry personnel (C_{13})	[0.1145,0.1850]	[0.0134,0.0216]
Efficiency of industry personnel (C_{14})	[0.5815,0.6388]	[0.0679,0.0746]
Extra conference opportunities	0.0865	
Climate (C_{15})	[0.6118,0.6727]	[0.0529,0.0582]
Outside entertainment (C_{16})	[0.1672,0.2916]	[0.0145,0.0252]
Sightseeing and cultural attractions (C_{17})	[0.0967,0.1601]	[0.0084,0.0138]

Table 10: The interval decision matrix of five alternatives

	Alternatives									
	A_1		A_2		A_3		A_4		A_5	
Criteria	$x^L_{1,j}$	$x^U_{1,j}$	$x^L_{2,j}$	$x^U_{2,j}$	$x^L_{3,j}$	$x^U_{3,j}$	$x^L_{4,j}$	$x^U_{4,j}$	$x^L_{5,j}$	$x^U_{5,j}$
C_1	2	4	3	5	6	7	4	6	6	8
C_2	5	6	7	8	6	7	5	7	6	8
C_3	7	8	8	9	6	8	7	8	7	8
C_4	7	8	8	9	7	9	7	8	7	8
C_5	5000	7000	3500	6300	4200	5900	3000	4000	5500	6800
C_6	100000	260000	82000	125000	75000	100000	90000	186000	112000	230000
C_7	45000	70000	40000	68000	58000	85000	67000	92000	80000	100000
C_8	50000	250000	45000	220000	35000	197000	66000	360000	40000	200000
C_9	7	9	6	8	6	9	6	8	7	8
C_{10}	5	6	6	7	6	8	5	7	7	8
C_{11}	6	7	7	8	7	9	6	8	7	9
C_{12}	7	8	7	8	6	8	7	9	6	9
C_{13}	7	9	7	8	6	8	7	8	7	8
C_{14}	5	7	6	7	6	7	5	6	6	7
C_{15}	5	7	4	6	5	6	6	8	6	7
C_{16}	7	8	6	7	6	8	7	9	6	7
C_{17}	4	6	8	9	6	7	5	7	5	6

Table 11: The interval normalized decision matrix

	Alternatives									
	A$_1$		A$_2$		A$_3$		A$_4$		A$_5$	
Criteria	$n^L_{1,j}$	$n^U_{1,j}$	$n^L_{2,j}$	$n^U_{2,j}$	$n^L_{3,j}$	$n^U_{3,j}$	$n^L_{4,j}$	$n^U_{4,j}$	$n^L_{5,j}$	$n^U_{5,j}$
C_1	0.1172	0.2344	0.1758	0.2931	0.3517	0.4103	0.2344	0.3517	0.3517	0.4689
C_2	0.2402	0.2883	0.3363	0.3844	0.2883	0.3363	0.2402	0.3363	0.2883	0.3844
C_3	0.2896	0.3310	0.3310	0.3724	0.2482	0.3310	0.2896	0.3310	0.2896	0.3310
C_4	0.2824	0.3228	0.3228	0.3632	0.2824	0.3632	0.2824	0.3228	0.2824	0.3228
C_5	0.2988	0.4184	0.2092	0.3765	0.2510	0.3526	0.1793	0.2390	0.3287	0.4064
C_6	0.2114	0.5497	0.1733	0.2642	0.1585	0.2114	0.1902	0.3932	0.2367	0.4862
C_7	0.1953	0.3038	0.1736	0.2951	0.2517	0.3689	0.2907	0.3992	0.3472	0.4340
C_8	0.0869	0.4345	0.0782	0.3823	0.0608	0.3424	0.1147	0.6257	0.0695	0.3476
C_9	0.2958	0.3803	0.2535	0.3380	0.2535	0.3803	0.2535	0.3380	0.2958	0.3380
C_{10}	0.2402	0.2883	0.2883	0.3363	0.2883	0.3844	0.2402	0.3363	0.3363	0.3844
C_{11}	0.2540	0.2963	0.2963	0.3386	0.2963	0.3810	0.2540	0.3386	0.2963	0.3810
C_{12}	0.2924	0.3342	0.2924	0.3342	0.2506	0.3342	0.2924	0.3759	0.2506	0.3759
C_{13}	0.2934	0.3773	0.2934	0.3353	0.2515	0.3353	0.2934	0.3353	0.2934	0.3353
C_{14}	0.2531	0.3544	0.3038	0.3544	0.3038	0.3544	0.2531	0.3038	0.3038	0.3544
C_{15}	0.2592	0.3629	0.2073	0.3110	0.2592	0.3110	0.3110	0.4147	0.3110	0.3629
C_{16}	0.3090	0.3532	0.2649	0.3090	0.2649	0.3532	0.3090	0.3973	0.2649	0.3090
C_{17}	0.1958	0.2938	0.3917	0.4407	0.2938	0.3427	0.2448	0.3427	0.2448	0.2938

Table 12: The interval weighted normalized decision matrix

	Alternatives									
	A$_1$		A$_2$		A$_3$		A$_4$		A$_5$	
Criteria	$\bar{v}^L_{1,j}$	$\bar{v}^U_{1,j}$	$\bar{v}^L_{2,j}$	$\bar{v}^U_{2,j}$	$\bar{v}^L_{3,j}$	$\bar{v}^U_{3,j}$	$\bar{v}^L_{4,j}$	$\bar{v}^U_{4,j}$	$\bar{v}^L_{5,j}$	$\bar{v}^U_{5,j}$
C_1	0.0040	0.0189	0.0060	0.0236	0.0121	0.0331	0.0081	0.0283	0.0121	0.0378
C_2	0.0056	0.0134	0.0079	0.0179	0.0068	0.0157	0.0056	0.0157	0.0068	0.0179
C_3	0.0405	0.0746	0.0463	0.0839	0.0347	0.0746	0.0405	0.0746	0.0405	0.0746
C_4	0.0059	0.0161	0.0067	0.0181	0.0059	0.0181	0.0059	0.0161	0.0059	0.0161
C_5	0.0113	0.0242	0.0079	0.0218	0.0095	0.0204	0.0068	0.0138	0.0124	0.0235
C_6	0.0050	0.0211	0.0041	0.0101	0.0037	0.0081	0.0045	0.0151	0.0056	0.0187
C_7	0.0025	0.0053	0.0022	0.0052	0.0032	0.0065	0.0037	0.0070	0.0044	0.0076
C_8	0.0005	0.0025	0.0004	0.0022	0.0003	0.0020	0.0006	0.0036	0.0003	0.0020
C_9	0.0159	0.0510	0.0136	0.0454	0.0136	0.0510	0.0136	0.0454	0.0159	0.0454
C_{10}	0.0084	0.0279	0.0101	0.0325	0.0101	0.0372	0.0084	0.0325	0.0118	0.0372
C_{11}	0.0404	0.0881	0.0471	0.1007	0.0471	0.1133	0.0404	0.1007	0.0471	0.1133
C_{12}	0.0060	0.0118	0.0060	0.0118	0.0051	0.0118	0.0060	0.0133	0.0051	0.0133
C_{13}	0.0039	0.0081	0.0039	0.0072	0.0033	0.0072	0.0039	0.0072	0.0039	0.0072
C_{14}	0.0171	0.0264	0.0206	0.0264	0.0206	0.0264	0.0171	0.0226	0.0206	0.0264
C_{15}	0.0137	0.0211	0.0109	0.0181	0.0137	0.0181	0.0164	0.0241	0.0164	0.0211
C_{16}	0.0044	0.0089	0.0038	0.0077	0.0038	0.0089	0.0044	0.0100	0.0038	0.0077
C_{17}	0.0016	0.0040	0.0032	0.0060	0.0024	0.0047	0.0020	0.0047	0.0020	0.0040

Table 13: Distance of each alternative from the positive ideal solution

$\bar{d}_1^+$	$\bar{d}_2^+$	$\bar{d}_3^+$	$\bar{d}_4^+$	$\bar{d}_5^+$
0.1050	0.0974	0.1007	0.1043	0.0966

Table 14: Distance of each alternative from the negative ideal solution

$\bar{d}_1^-$	$\bar{d}_2^-$	$\bar{d}_3^-$	$\bar{d}_4^-$	$\bar{d}_5^-$
0.0794	0.0932	0.1031	0.0899	0.1021

Table 15: Closeness coefficient

$\bar{R}_1$	$\bar{R}_2$	$\bar{R}_3$	$\bar{R}_4$	$\bar{R}_5$
0.4305	0.4891	0.5059	0.4630	0.5138

results of closeness coefficient shown in Table 15, the final ranks are obtained.

General representation of proposed model to obtain the final rank is as follows:

Stage 1: Constructing interval comparison matrix of Table 2-7 for criteria and sub-criteria with regard to the AHP which has been presented in Fig. 1.

Stage 2: Examining the consistencies of interval comparison matrix obtained from stage 1 with respect to the Eq. 3 which its results have been reported in Table 8.

Stage 3: Calculating the interval weights of criteria and sub criteria with the use of goal programming model with respect to the Eq. 4 which its results have been presented in Table 9.

Stage 4: With regard to the weights obtained from stage 3, evaluation of considered five alternatives with respect to the criteria determined by experts are summarized in Table 10 in the form of interval decision making matrix. In order to rank the alternatives, we first normalize the interval decision making matrix with the use of Eq. 6 and 7 which its results have been presented in Table 11.

Stage 5: Having obtained the interval normalized decision matrix, with the consideration of weights obtained from Table 4 and utilization of Eq. 8 and 9, we construct the interval weighted normalized matrix which its results have been presented in Table 12.

Stage 6: Determine positive ideal solution and negative ideal solution (identification of $\bar{A}^+$ and $\bar{A}^-$, using the Eq. 10 and 11.

Stage 7: In this state with regard to the reported results in Table 12 and utilization of Eq. 12 and 13, the distance of each alternative from the positive and negative ideal solution is calculated which its results have been presented in Table 13 and 14.

Stage 8: With utilizing the Eq. 14 and the obtained results in Table 13 and 14, the Closeness coefficient is calculated which its results have been presented in Table 15.

Stage 9: finally, with respect to the closeness coefficient presented in Table 15, final ranking of alternatives is obtained.

Considering the acquired results of Table 15, 5th alternative is placed in the 1st rank and the 3rd; 2nd, 4th and 1st alternatives are placed in the 2nd, 3rd, 4th and 5th rank, respectively.

CONCLUSIONS

In this study, an effective hybrid model was presented for decision making. In the proposed model, interval comparison matrix which has been inspired by Analytical Hierarchy Process (AHP) was employed to compare the criteria against each other. Furthermore, to calculate the interval weights of criteria, we made use of goal programming method. Moreover, interval data was utilized to evaluate the alternatives with respect to the criteria. In order to rank the alternatives with respect to criteria, Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) with interval data and weights is used. It is very obvious that the proposed model can be generalized to other cases and in the conditions of uncertainty for both the comparison of criteria against each other and alternatives evaluation with respect to influential criteria in the process of decision making, the model can create the possibility for decision makers to use interval data instead of deterministic values so that he can adopt a high quality and more appropriate decisions.

REFERENCES

Arbel, A., 1989. Approximate articulation of preference and priority derivation. Eur. J. Operat. Res., 43: 317-326.

Arbel, A. and L.G. Vargas, 1993. Preference simulation and preference programming: Robustness issues in priority deviation. Eur. J. Operat. Res., 69: 200-209.

Chacko, H.E. and G.G. Fenich, 2000. Determining the importance of US convention destination attributes. J. Vacation Market., 6: 211-220.

Chen, C.F., 2006. Applying the Analytical Hierarchy Process (AHP) approach to convention site selection. J. Trav. Res., 45: 167-174.

Chen, S.J. and C.L. Hwang, 1992. Fuzzy Multiple Attribute Decision Making: Methods and Applications. 1st Edn. Springer, Berlin. .

Clark, J.D. and K.M. McCleary, 1995. Influencing associations' site selection process. Cornell Hotel Restaurant Administration Quart., 36: 61-68.

Crouch, G. and J.R. Ritchie, 1998. Convention site selection research: A review, conceptual model and preposition Framework. J. Convention Exhibition Manage., 1: 49-69.

Crouch, G. and J. Louviere, 2004. The determinants of convention site selection: A Logistic choice model from experimental data. J. Trav. Res., 43: 118-130.

Go, F. and W. Zang, 1997. Applying importance-performance analysis to Beijing as an international meeting destination. J. Trav. Res., 35: 42-49.

Hwang, C.L. and K. Yoon, 1981. Multiple Attribute Decision Making Methods and Applications. 1st Edn. Springer, Heidelberg, Berlin.

Islam, R., M.P. Biswal and S.S. Alam, 1997. Preference programming and inconsistent interval judgments. Eur. J. Operat. Res., 97: 53-62.

Jahanshahloo, G.R., F. Hosseinzadeh Lotfi and M. Izadikhah, 2006. An algorithmic method to extend TOPSIS for decision-making problems with interval data. Applied Math. Comput., 175: 1375-1384.

Kim, W.G. and H.C. Kim, 2003. The analysis of Seoul as an international convention destination. J. Convention Exhibition Manage., 5: 69-87.

Kress, M., 1991. Approximate articulation of preference and priority derivational comment. Eur. J. Operat. Res., 52: 382-383.

Mikhailov, L., 2002. Fuzzy analytical approach to partnership selection in formation of virtual enterprises. Omega, 30: 393-401.

Mikhailov, L., 2004. A fuzzy approach to deriving priorities from interval pairwise comparison judgements. Eur. J. Operat. Res., 159: 687-704.

Oppermann, M., 1996. Convention destination images: Analysis of association meeting Planners' Perceptions. Tourism Manage., 17: 175-182.

Saaty, T.L. and L.G. Vargas, 1987. Uncertainty and rank order in the analytic hierarchy process. Eur. J. Operat. Res., 32: 107-117.

Sugihara, K., H. Ishii and H. Tanaka, 2004. Interval priorities in AHP by interval regression analysis. Eur. J. Operat. Res., 158: 745-754.

Vaidya, O.S. and S. Kumar, 2006. Analytic hierarchy process: An overview of applications. Eur. J. Operat. Res., 169: 1-29.

Wang, Y.M., J.B. Yang and D.L. Xu, 2005. Interval weight generation approaches based on consistency test and interval comparison matrices. Applied Math. Comput., 167: 252-273.

Wang, Y.M., J.B. Yang and D.L. Xu, 2005. A two-stage logarithmic goal programming method for generating weights from interval comparison matrices. Fuzzy Sets Syst., 152: 475-498.

Wang, Y.M. and T.M.S. Elhag, 2007. A goal programming method for obtaining interval weights from an interval comparison matrix. Eur. J. Operat. Res., 177: 458-471.

Weber, K. and K. Chon, 2002. Convention Tourism: International Research and Industry Perspectives Haworth, New York

Zeleny, M., 1982. Multiple Criteria Decision Making. 1st Edn. McGraw-Hill, New York.