Pergamon

Annals of Tourism Research, Vol. 24, No. 4, pp. 796–812, 1997

0160-7383/97 $17.00+0.00

PII: S0160-7383(97)00059-5

EVALUATING TOURIST RISKS FROM FUZZY PERSPECTIVES

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Abstract: Since little effort has been devoted to measuring tourist risk from epistemology perspectives, this study develops a scientific framework for its evaluation. Tourist risk is defined as what is perceived by the tourists during the process of a group package tour. This in turn depends on the traveling service conditions experienced during the process and at the destination. The study uses an Analytic Hierarchy Process method to determine the weighting of various risk evaluation criteria. It further considers the possibility of "fuzzy logic" in making subjective judgments, and applies a Fuzzy Multiple Criteria Decision-Making method to conduct the evaluation of tourist risk. **Keywords:** AHP, fuzzy MCDM, tourist risk. © 1997 Elsevier Science Ltd

Résumé: L'évaluation des risques touristiques dans un contexte d'ambiguïté. Puisque peu d'effort a été consacré au mesurage du risque touristique, cette étude développe un cadre scientifique pour son évaluation. Le risque touristique se définit comme le risque qui est éprouvé par les touristes pendant un voyage organisé en groupe, ce qui dépend des conditions de services touristiques dont on fait l'expérience au cours du voyage et à la destination. L'étude utilise une méthode de Processus d'Hiérarchie Analytique (PHA) pour déterminer les coefficients des différents critères pour évaluer les risques. On considère aussi la possibilité d'une logique d'ambiguïté pour formuler des jugements subjectifs, et on applique une méthode de Prise de Décisions à Critères Multipes (PDCM) avec Ambiguïté afin d'évaluer le risque touristique. **Mots-clés:** PHA, ambiguïté avec PDCM, risque touristique. © 1997 Elsevier Science Ltd

INTRODUCTION

In 1979 the restriction on overseas travel by the residents of Taiwan was lifted, and the number of individuals going international increased from 321,446 in that year to 4,744,434 in 1994 (an annual growth rate of 21.3%). This increase has naturally entailed increases in travel-related misfortunes. Taiwanese tourists abroad have experienced robbery and petty theft, car accidents, and infectious diseases more frequently in recent years. For the benefit of public policymakers,

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travel agents, and the travelers themselves, it is necessary to devise better ways to measure tourist risk.

According to Taylor (1974), risk can be defined in terms of possible loss, and in human life all activities entail possible losses. Travel is no exception; its degree of risk depends on several factors including the means of transportation used, the facilities and activities offered at the destination, the customs and environment of the sightseeing areas, and so on. Since it is impossible to eliminate the risk, it may be hoped that perceived tourist risk can be reduced if advance warning can be obtained through risk evaluation. The criteria found in this study are obtained both from the integration of expert consultation and literature review. Altogether seven distinct aspects of tourist risk and 16 evaluation criteria are considered. Since the criteria of risk evaluation are endowed with diverse connotations and meanings, there is no logical reason to treat them as if they are each of equal importance. Therefore, it is necessary to develop a less arbitrary method for assigning relative weight to the evaluation criteria, such as the AHP method. For empirical study, six representative group package tour itineraries were selected, including tours of Singapore, Thailand, Japan, the west coast of the United States and two alternative itineraries in Mainland China.

Risk has been successfully used in theories of decision-making in economics, finance, and the decision sciences (Dowling and Staelin 1994). When faced with a purchasing situation such as choosing a group package tour, a tourist has a certain degree of risk involved in the decision to be made. The concept of perceived risk most often used by consumer researchers defines risk in terms of the consumer's perceptions both of the uncertainty and the magnitude of the possible adverse consequences (Cox 1967; Cox and Rich 1964; Dowling and Staelin 1994). Since the degree of risk itself is not known with certainty, its evaluation must therefore be conducted in an uncertain, fuzzy environment. During the process of evaluation, criteria measurement indices can not be clarified while the evaluators are unclear about criteria measurement, since this could make the values imprecise with too large an allowance for error. Therefore, this study includes Fuzzy MCDM theory to strengthen the comprehensiveness and reasonableness of the decision-making process.

TOURIST RISK EVALUATION

Selection of Criteria

Traditional evaluation methods usually take the minimum cost or the maximum benefit as their single index of measurement criterion (Tzeng and Tsaur 1993), but in an increasingly complex and diversified decision-making environment, this approach may sacrifice too much valuable information in the process. Thus, this study uses a multiple criteria decision-making method to conduct group package tourist risk evaluation.

Multiple Criteria Decision-Making (MCDM) is the scientific analysis method to evaluate the gain and loss of alternatives under the consideration of multiple criteria. Generally speaking, MCDM problems can be broadly classified into two categories: multiple objective programming and multiple criteria evaluation. Since this study places its focus mainly on the evaluation problem, the second category is emphasized. The typical multiple criteria evaluation problem focuses on a set of feasible alternatives and considers more than one criterion to determine a priority ranking for alternative implementation. Keeney and Raiffa (1976) suggest that five principles be considered when criteria are being formulated: completeness (the criteria must embrace all of the important characteristics of the decision-making problems), operational (the criteria will have to be meaningful for decision-makers and available for open study), decomposable (the criteria can be decomposed from higher hierarchy to lower hierarchy so that the evaluation processes can be simplified), nonredundancy (the criteria must avoid duplicate measurement of the same performance), and minimum size (the number of criteria should be as small as possible so as to reduce the needed manpower, time, and cost).

In the field of marketing research, Cunningham (1967) and Bettman (1973) have developed schema for specifying the components of risk. Cunningham specified these components as certainty and consequences. Bettman built a theoretical model and measurement system for perceived risk, including inherent risk and handled risk, and its components are developed. Moutinho (1987) reviewed marketing literature and divided tourist perceived risks into five categories: functional risk, physical risk, financial risk, social risk, and psychological risk. Roselius (1971), in consumer's behavior research, defines the types of consumer (tourist) loss as time loss, hazard loss, ego loss, and money loss. In the attempt to investigate the relationship between the risk perceptions of tourist and pleasure travel, Roehl and Fesenmaier (1992) have categorized tourist risk into seven items: equipment risk, financial risk, physical risk, psychological risk, satisfaction risk, social risk, and time risk. Pinhey and Iverson (1994) explored safety concerns centering on typical vacation activities among Japanese visitors to Guam. The authors divided the evaluation aspects of traveling safety concern into seven items: the perception of the described safety, the perception of sightseeing safety, the perception of water sports safety, the perception of beach activity safety, the perception of night life safety, the perception of in-car safety, and the perception of road safety. The nature of the study is a exploratory research, focused on seven items of safety concern relevant to the typical Japanese tourists, while the aspects of other related activities such as food, catering, accommodation, and so on have not been taken into consideration.

Synthesizing the studies just mentioned above with the goal of this study, "tourist risk" is defined as the possibility of various misfortunes which might befall a group package tourist in the process of traveling or at its destination. According to this definition, the tourist risk cited in this study intends to cover two main categories: physical risk, which refers to the possibility that an individual's health is likely to be exposed to risk, injury, and sickness because of conditions like law

Table 1. The Evaluation Criteria for Tourist Risks

Objective	Attribute
Transportation	Safety of transportation Convenience of telecommunication facilities Safety of driving
Law and Order	Political stability Possibility of criminal attack Attitude of inhabitants towards tourist
Hygiene	Possibility of contracting infectious diseases Hygiene of catering conditions
Accommodation	Hotel fire control system Hotel security system
Weather	Difference of weather change Possibility of natural disasters
Sightseeing Spot	Safety of recreational facilities Quality of the management staff
Medical Support	Degree of assistance available in case of accident Completeness of medical service system

and order, weather, and hygiene problems found during the tour; and equipment risk, which refers to the dangers arising from the unavailability of equipment or its malfunctioning, such as insufficient telecommunication facilities, unsafe transportation, and break-down of vehicles, etc. In view of such settings, expert consultation, literature review, and the five criterion selection principles suggested by Keeney and Raiffa have been employed to formulate the risk evaluation criteria in this study. These evaluation criteria include seven aspects as transportation, law and order, hygiene, accommodation, weather, sightseeing spot, and 16 risk evaluation criteria, the details of which can be found in Table 1.

Determination of the Evaluation Criteria Weights

Since the criteria of risk evaluation entail diverse significances and meanings, we cannot assume that each evaluation criterion is of equal importance. There are many methods that can be employed to determine weights (Hwang and Yoon 1981), such as the eigenvector method, weighted least square method, entropy method, AHP, LINMAP (linear programming techniques for Multidimensional of Analysis Preference). The selection of method depends on the nature of the problem. To evaluate tourist risk is both a complex and wide-ranging problem, so solution requires the most inclusive and flexible method. Since AHP method has the characteristics that it systematizes complicated problems, is easy to operate, and integrates most of the experts' and evaluators' opinions, this study selected AHP for the contrivance of weights.

AHP was first proposed by Thomas L. Saaty in 1971 (Saaty 1977, 1980, 1982). For years it has been used in economic planning, and in several areas of social management sciences. This method decomposes complicated problems from higher hierarchies to lower ones. Furthermore, it also systematizes the problem by employing the subsystem perspective endowed in the system. Based on the hierarchical structure of AHP, this study then establishes the evaluation structure for the tourist risk in this way (Figure 1). The resulting structure is tri-tiered. The first hierarchy is the goal level, with tourist risk evaluation as its ultimate objective; the second hierarchy is the objective level, with its seven-risk evaluation aspects; the third hierarchy is the attribute level, with its 16 evaluation criteria.

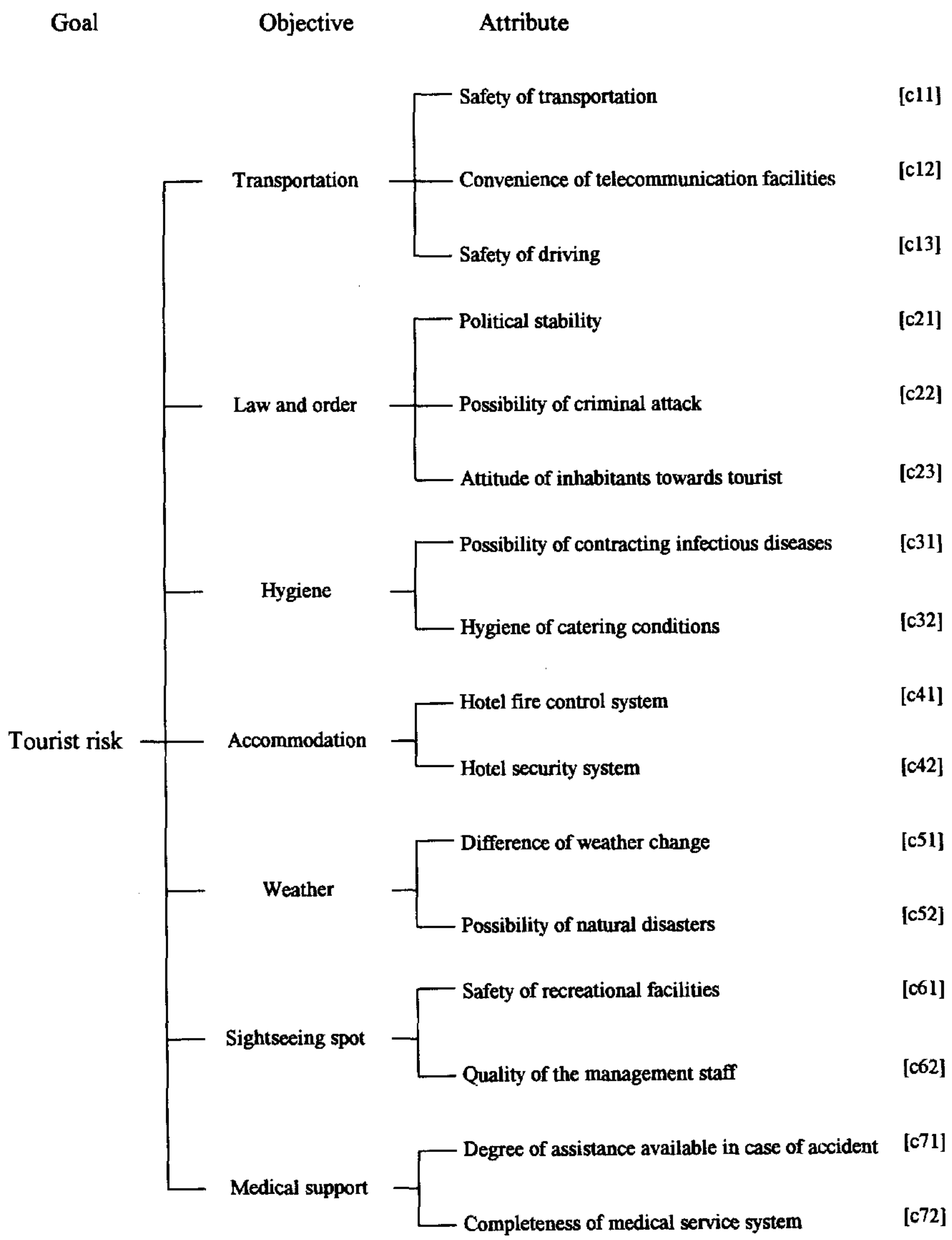

Figure 1. The Hierarchical Structure of Tourist Risk Evaluation. [] Represents the Sign of Each Criterion

The AHP weighting is mainly determined by the decision-makers who conduct the pairwise comparisons, so as to reveal the comparative importance between two criteria. If there are n evaluation criteria, then while deciding the decision-making the decision-makers have to conduct $C(n, 2)=n(n-1)/2$ pairwise comparisons. Furthermore, the comparative importance derived from the pairwise comparisons allows a certain degree of inconsistency within a domain. Saaty used the principal eigenvector of the pairwise comparison matrix contrived by scaling ratio to find the comparative weight among the criteria.

Fuzzy Theory

"Not very clear", "probably so", "very likely", "rather dangerous", these terms of expression can be heard very often in daily life, and their commonality is that they are more or less tainted with uncertainty. With different daily decision-making problems of diverse intensity, the results can be misleading if the fuzziness (uncertainty) of human decision-making is not taken into account. However, since Zadeh put forward fuzzy set theory (Zadeh 1965), and Bellman and Zadeh (1970) described the decision-making method in fuzzy environments, an increasing number of studies have dealt with uncertain fuzzy problems by applying fuzzy set theory. With such an idea in mind, this study includes fuzzy decision-making theory, considering the possible fuzzy subjective judgment of the evaluators during tourist risk evaluation. This way the methodology for establishing tourist risk can be made more objective. The applications of fuzzy theory in this study are elaborated as follows.

Fuzzy Number. Fuzzy numbers are a fuzzy subset of real numbers, and they represent the expansion of the idea of confidence interval. According to the definition made by Dubois and Prade (1978), fuzzy numbers should possess the following basic features.

Fuzzy number A is of a fuzzy set, and its membership function is $\mu_{\tilde{A}}(x): R \rightarrow (0, 1)$ and it is enshrined with the following characteristics.

1. $\mu_{\tilde{A}}(x)$ is a continuous mapping from R to the closed interval 0, 1.
2. $\mu_{\tilde{A}}(x)$ is of a convex fuzzy subset.
3. $\mu_{\tilde{A}}(x)$ is the normality of a fuzzy subset, which means that there exists a number x_0 that makes $\mu_{\tilde{A}}(x_0)=1$.

Those numbers that can satisfy these three requirements will then be called fuzzy numbers, and the following is the explanation for the features and calculation of the triangular fuzzy number. For such a number $\mu_{\tilde{A}}(x)=(L,M,U)$, its chart and mathematical equation, according to the foregoing definition made for a fuzzy number, are as shown in Figure 2.

$$\mu_{\tilde{A}}(x)=\begin{cases}(X-L)/(M-L), & L\leq X\leq M\\ (X-U)/(M-U), & M\leq X\leq U\\ 0, & \text{otherwise}\end{cases} \tag{1}$$

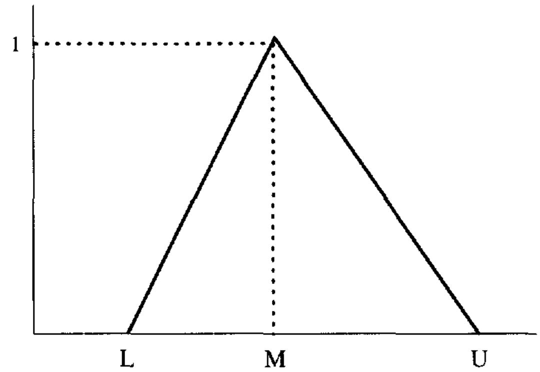

Figure 2. The Membership Function of the Triangular Fuzzy Number

According to the nature of triangular fuzzy numbers and the extension principle put forward by Zadeh (1965), the algebraic calculation of the triangular fuzzy number $\mu_{\tilde{A}1}(x)=(L_1,M_1,U_1)$ and $\mu_{\tilde{A}2}(x)=(L_2,M_2,U_2)$ can be displayed as follows:

Addition of a fuzzy number $\oplus$

$$(L_1,M_1,U_1)\oplus(L_2,M_2,U_2)=(L_1+L_2,M_1+M_2,U_1+U_2) \quad (2)$$

Multiplication of a fuzzy number $\odot$

A. $(L_1,M_1,U_1)\odot(L_2,M_2,U_2)\fallingdotseq(L_1L_2,M_1M_2,U_1U_2) \quad L_1\geq 0,L_2\geq 0$ (3)

B. Any real number k,

$$K\odot\mu_{\tilde{A}}(x)=(K,K,K)\odot(L,M,U)=(KL,KM,KU) \quad (4)$$

Subtraction of a fuzzy number $\ominus$

$$(L_1,M_1,U_1)\ominus(L_2,M_2,U_2)=(L_1-U_2,M_1-M_2,U_1-L_2) \quad (5)$$

Division of a fuzzy number $\varnothing$

$$(L_1,M_1,U_1)\varnothing(L_2,M_2,U_2)\fallingdotseq(L_1/U_2,M_1/M_2,U_1/L_2) \quad L_1\geq 0,L_2>0 \quad (6)$$

Linguistic Variable. According to Zadeh (1975), it is very difficult for conventional quantification to express reasonably those situations that are overtly complex or hard to define; thus, the notion of a linguistic variable is necessary in such situations. A linguistic variable is a variable whose values are words or sentences in a natural or artificial language. For example, the expression "tourist risk" represents a linguistic variable in the context of this study. It may take on values such as "very dissatisfied" (or very likely), "not satisfied" (or likely), "fair", "satisfied" (or not likely), "very satisfied" (or very unlikely). The membership functions of the expression values can be indicated by triangular fuzzy numbers, which are as shown in Figure

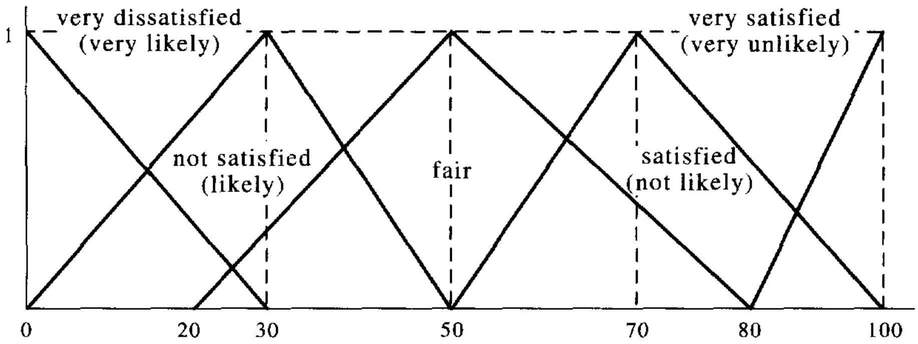

Figure 3. The Membership Function of the Five Levels of Linguistic Variables

3. The utilization of linguistic variables is rather widespread at the present time, and the linguistic values found in this study are primarily used to assess the linguistic ratings given by the evaluators. Furthermore, linguistic variables are used as a way to measure the achievement of the performance value for each criterion.

Fuzzy Multiple Criteria Decision-Making

Bellman and Zadeh (1970) were the first to probe into the decision-making problem under a fuzzy environment, and they heralded the initiation of Fuzzy MCDM. This study uses this method to evaluate tourist risk, and ranks it for each alternative accordingly. The following will be the method and procedures of the Fuzzy MCDM theory. One is management of the evaluation criteria. Using the measurement of linguistic variables to demonstrate the criteria performance by expressions such as "very dissatisfied" (very likely), "not satisfied" (likely), "fair", "satisfied" (not likely), "very satisfied" (very unlikely), the evaluators were asked to conduct their judgments, and each linguistic variable can be indicated by a triangular fuzzy number (TFN) within the scale range of 0–100. Also the evaluators can subjectively assume their personal range of the linguistic variable.

Take E_{ij}^{k} to indicate the fuzzy performance value of evaluator k towards alternative i under criterion j, and all of the evaluation criteria will be indicated by set S, that is,

$$E_{ij}^{k} = (LE_{ij}^{k}, ME_{ij}^{k}, UE_{ij}^{k}),\ j \in S \tag{7}$$

Since the cognition and stance of each evaluator varies, and the definition ranges of the linguistic variables vary as well, this study has employed the notion of average value so as to integrate the fuzzy judgment values of m evaluators, that is,

$$E_{ij} = (1/m) \odot (E_{ij}^{1} \oplus E_{ij}^{2} \oplus, \ldots, \oplus E_{ij}^{m}) \tag{8}$$

The sign $\odot$ indicates fuzzy multiplication, the sign $\oplus$ denotes fuzzy addition, E_{ij} tells the average fuzzy number of the judgment of the decision-maker, and it can be displayed by a triangular fuzzy number as follows:

$$E_{ij} = (LE_{ij}, ME_{ij}, UE_{ij}) \tag{9}$$

The preceding end-point values LE_{ij}, ME_{ij}, and UE_{ij} can be solved by the method put forward by Buckley (1985), that is,

$$LE_{ij}=\left(\sum_{k=1}^{m} LE_{ij}^{k}\right)\Big/ m \tag{10}$$

$$ME_{ij}=\left(\sum_{k=1}^{m} ME_{ij}^{k}\right)\Big/ m \tag{11}$$

$$UE_{ij}=\left(\sum_{k=1}^{m} UE_{ij}^{k}\right)\Big/ m \tag{12}$$

Second is the fuzzy synthetic decision. The weights of each criterion of tourist risk evaluation as well as the fuzzy performance values have to be integrated by the calculation of fuzzy numbers so as to be located at the fuzzy performance value of the integral evaluation, which is of the procedures of fuzzy synthetic decision. According to the weight w_j derived by AHP, the weight vector can be obtained, while the fuzzy performance matrix $\boldsymbol{E}$ of each of the alternatives can as well be obtained from the fuzzy performance value of each alternative under n criteria, that is,

$$W=(w_1,\ldots,w_j,\ldots,w_n)^t \tag{13}$$

$$E=(E_{ij}),\ \forall i,j \tag{14}$$

From the weight vector $\boldsymbol{W}$ and fuzzy performance matrix $\boldsymbol{E}$, the final fuzzy synthetic decision can be conducted, and the derived result will be the fuzzy synthetic decision matrix $\boldsymbol{R}$, that is,

$$\boldsymbol{R}=\boldsymbol{E}\circ\boldsymbol{W} \tag{15}$$

The sign "$\circ$" indicates the calculation of the fuzzy numbers, including fuzzy addition and fuzzy multiplication; since the calculation of fuzzy multiplication is rather complex, usually it is denoted by the approximate multiplied result of the fuzzy multiplication, and the approximate fuzzy number R_i of the fuzzy synthetic decision of each alternative can be shown as follows:

$$R_i=(LR_i, MR_i, UR_i),\ \forall i \tag{16}$$

$$LR_i=\sum_{j=1}^{n} LE_{ij}^{*}w_j \tag{17}$$

$$MR_i=\sum_{j=1}^{n} ME_{ij}^{*}w_j \tag{18}$$

$$UR_i=\sum_{j=1}^{n} UE_{ij}^{*}w_j \tag{19}$$

Third is the ranking of fuzzy numbers. The result of fuzzy synthetic decision of each alternative is a fuzzy number. Therefore, it is necessary that the nonfuzzy ranking method for fuzzy numbers be employed during risk comparison for each alternative. In other words, the procedure of defuzzification is to locate the Best Nonfuzzy Performance value (BNP). Methods of such defuzzified fuzzy ranking generally include mean of maximal (MOM), center of area (COA), and α-cut, three kinds of method (Zhao and Govind 1991). To utilize the COA method to find out the BNP is a simple and practical method and there is no need to bring in the preferences of any evaluators. For those reasons, the COA method is used in this study.

The BNP value of the fuzzy number R_i can be found by the following equation,

$$BNP_i = [(UR_i - LR_i) + (MR_i - LR_i)]/3 + LR_i, \ \forall i \qquad (20)$$

According to the value of the derived BNP for each of the alternatives, the ranking of the tourist risk intensity of each of the alternatives can then proceed.

Empirical Study

This study selected the destinations most frequented by Taiwanese group package tours as its evaluation object of tourist risk. These include five different country destinations that together account for 65% of the traveling population of Taiwan in 1994. Six representative group package tour itineraries were constructed to conduct the empirical portion of the study, including a 12-day itinerary of East-China (I1), a 12-day itinerary of Three Gorges and Hwang-Shan China (I2), a 4-day itinerary of Singapore (I3), an 8-day itinerary of Bangkok and Phuket island (I4), a 7-day itinerary of Japan (I5), and a west coast 12-day itinerary of the United States (I6).

The questionnaire of tourist risk evaluation mainly was divided into two parts. In the first part, the evaluators conducted pairwise comparisons of the importance of various tourist risk evaluation criteria. In the second part, the evaluators employed five linguistic variables as "very dissatisfied" (very likely), "dissatisfied" (likely), "fair", "satisfied" (not likely), "very satisfied" (very unlikely) to evaluate the risks of the test itineraries. The values of the scale range from 0–100, with larger scale values denoting more satisfactory expected performances and a lower likelihood of occurrence of any negative event, hence lower intensity of risk. Due to the fact that the range of scale value of linguistic variables of individual subjective cognition varies, the ranges of these five linguistic variables have to be defined before the evaluation of the alternatives can be conducted. As for the selection of evaluators, both the objectivity and correctness of risk evaluation have to be considered; thus, only those who have led group package tours to the above-mentioned six itineraries were selected. Altogether 20 evaluators have been selected in this study, all senior tour leaders with an average of 9.3 years' job experience in the trade.

The Weight Calculation of the Evaluation Criteria. According to the formulated structure of tourist risk evaluation, the weights of the objective hierarchy and attribute hierarchy can be analyzed. Weights

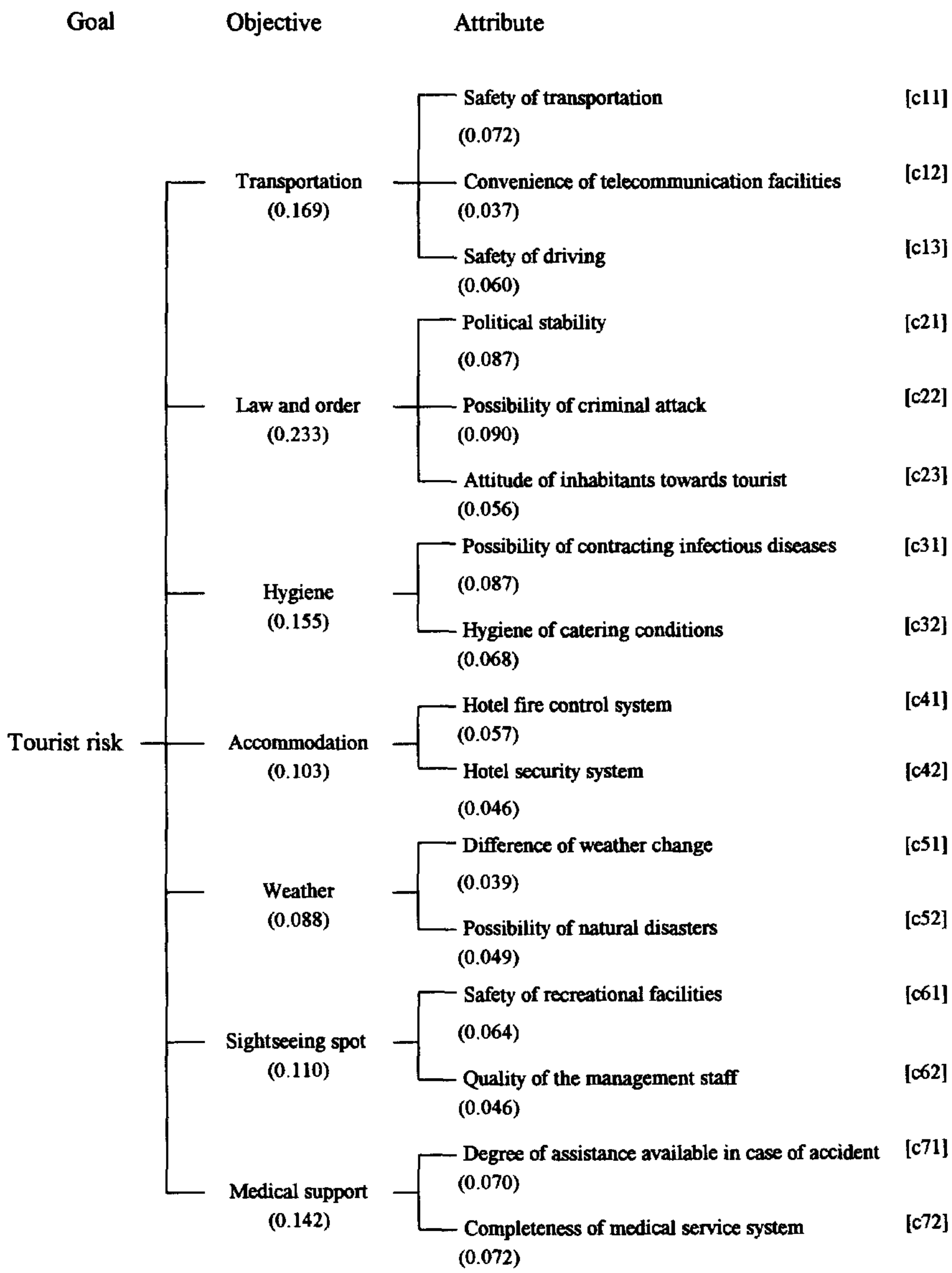

Figure 4. The Weight Structure of the Tourist Risk Evaluation. () The Number in it Represents the Weight of Each Hierarchy, [] Represents the Sign of Each Criterion

were obtained by using AHP, then the average weights (Figure 4) were derived and the weights of all the evaluators evened out after the consistency verification. Evaluators consider law and order (0.233) to be most important in the tourist risk evaluation, then transportation (0.169), hygiene (0.155), medical support (0.142), sightseeing spot (0.110), accommodation (0.103), and weather (0.088). The results indicate that with improved law and order the tourists can be better secured in terms of their life (physical) and property during

Table 2. The Subjective Cognition Results of Evaluators Towards the Five Levels of Linguistic Variables

Evaluator	Very Dissatisfied (very likely)	Dissatisfied (likely)	Fair	Satisfied (not likely)	Very satisfied (very unlikely)
1	(0,0,25)	(20,30,40)	(35,40,45)	(50,60,70)	(80,100,100)
2	(0,0,20)	(21,31,40)	(41,51,60)	(61,71,80)	(81,100,100)
3	(0,0,30)	(30,43,55)	(60,65,70)	(70,75,80)	(80,100,100)
4	(0,0,20)	(20,30,40)	(40,50,60)	(60,70,80)	(80,100,100)
5	(0,0,23)	(24,33,42)	(43,51,59)	(60,70,80)	(80,100,100)
6	(0,0,20)	(20,22,24)	(24,37,50)	(50,65,80)	(80,100,100)
7	(0,0,21)	(18,31,44)	(40,48,56)	(55,69,82)	(80,100,100)
8	(0,0,40)	(40,50,60)	(60,65,70)	(70,80,90)	(90,100,100)
9	(0,0,20)	(21,33,45)	(45,53,60)	(60,70,80)	(80,100,100)
10	(0,0,20)	(21,31,40)	(41,51,60)	(61,71,80)	(81,100,100)
11	(0,0,20)	(21,31,40)	(41,51,60)	(61,71,80)	(81,100,100)
12	(0,0,20)	(18,32,45)	(40,49,58)	(60,73,85)	(86,100,100)
13	(0,0,20)	(20,30,40)	(40,50,60)	(60,70,80)	(80,100,100)
14	(0,0,40)	(40,45,50)	(50,55,60)	(60,70,80)	(80,100,100)
15	(0,0,20)	(21,31,40)	(41,51,60)	(61,71,80)	(81,100,100)
16	(0,0,20)	(21,31,40)	(41,51,60)	(61,71,80)	(81,100,100)
17	(0,0,50)	(50,55,60)	(60,65,70)	(70,75,80)	(80,100,100)
18	(0,0,22)	(20,32,44)	(40,53,66)	(60,74,88)	(81,100,100)
19	(0,0,20)	(21,31,40)	(41,51,60)	(61,71,80)	(90,100,100)
20	(0,0,49)	(50,55,59)	(60,65,69)	(70,80,89)	(81,100,100)

the processes of traveling, and there will be less threat of exposure to physical injury and property damage. As for the attribute hierarchy, what is deemed most important by evaluators is the possibility of criminal attack (0.090). This may reflect the fact that Taiwanese tourists have recently been robbed, pilfered, and even murdered overseas, to a greater and more publicized extent than before. Criminal attack was followed in importance by political stability (0.087), possibility of contracting infectious diseases (0.087), safety of transportation (0.072), and the completeness of medical service system (0.072). The less important criteria are the convenience of telecommunication facilities (0.037), difference of weather change (0.039), hotel security system (0.046), and the quality of the management staff (0.046).

The Risk Evaluation of Tour Itinerary. The evaluators defined their own individual range for the linguistic variables employed in this study according to their subjective judgments within a scale of 0–100. Table 2 reveals a degree of variation in their definitions of the linguistic variables, as can be seen in Figure 5 which contrasts the divergent understandings of the 7th and 8th evaluator with respect to the same linguistic variable. Thus, this study has employed the method of average value to integrate the fuzzy judgment values of different evaluators towards the same risk evaluation criteria. In other words, fuzzy addition and fuzzy multiplication are used to solve for the

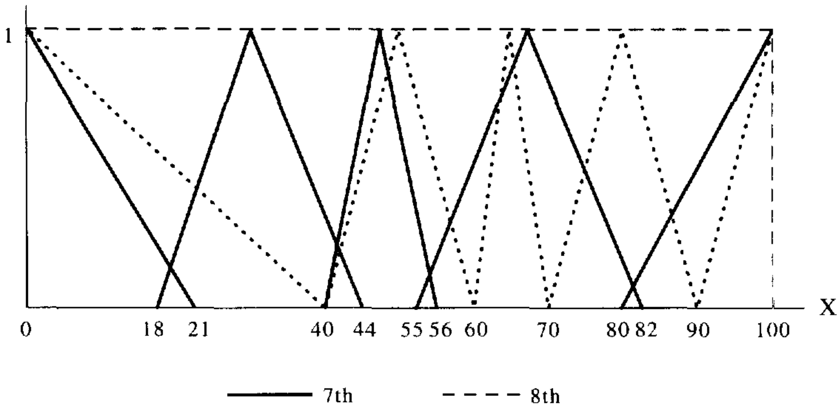

Figure 5. Divergent Understandings of the 7th and 8th Evaluator with Respect to the Same Linguistic Variable

average fuzzy numbers of the performance values under every evaluation criterion shared by the evaluators for the six tour itineraries (Table 3).

From the criteria weights obtained from AHP (Figure 4) and the fuzzy performance values of each criterion (Table 3), the final fuzzy synthetic decision can then be conducted. After the fuzzy synthetic decision was conducted and subsequently the nonfuzzy ranking method was employed, at the end the fuzzy numbers were changed into nonfuzzy values. Though there are methods to rank these fuzzy numbers, this study has employed COA to find out the BNP value which is used to rank the risks of each of the tour itineraries; details of the result are presented in Table 4.

As can be seen from the tourist risk evaluation results in Table 4,

Table 3. The Fuzzy Performance Values of Each Criterion

	Itinerary					
Criterion	I1	I2	I3	I4	I5	I6
Safety of Transportation	(34,42,55)	(37,45,55)	(60,72,78)	(47,56,65)	(60,71,79)	(63,74,81)
Convenience of Telecommunication Facilities	(29,37,47)	(27,35,46)	(69,82,87)	(45,53,63)	(71,86,91)	(73,89,93)
Safety of Driving	(30,38,49)	(28,36,46)	(65,78,85)	(44,52,61)	(70,84,89)	(73,88,92)
Political Stability	(28,35,47)	(23,30,45)	(67,82,88)	(47,56,64)	(69,84,89)	(72,87,92)
Possibility of Criminal Attack	(19,25,40)	(20,27,41)	(60,71,79)	(33,41,50)	(67,81,87)	(58,69,76)
Attitude of Inhabitants Towards Tourist	(29,37,50)	(30,38,51)	(53,63,72)	(46,55,64)	(58,68,77)	(55,66,74)
Possibility of Contracting Infectious Diseases	(19,24,38)	(15,20,36)	(58,69,78)	(25,33,44)	(70,85,90)	(66,80,86)
Hygiene of Catering Conditions	(26,33,47)	(26,32,46)	(59,70,79)	(39,48,56)	(66,79,86)	(62,75,82)
Hotel Fire Control System	(34,43,55)	(30,39,50)	(61,72,80)	(44,53,62)	(68,82,88)	(68,81,88)
Hotel Security System	(34,41,54)	(29,36,49)	(55,65,74)	(41,49,59)	(66,79,85)	(60,71,78)
Difference of Weather Change	(35,44,53)	(33,41,51)	(56,66,75)	(48,58,67)	(54,63,73)	(59,70,78)
Possibility of Natural Disasters	(24,30,44)	(22,28,43)	(53,64,72)	(38,45,56)	(45,55,63)	(51,61,70)
Safety of Recreational Facilities	(29,37,47)	(23,29,43)	(57,69,77)	(34,43,52)	(66,79,85)	(67,81,86)
Quality of the Management Staff	(17,23,39)	(16,21,38)	(53,64,73)	(37,46,56)	(68,81,88)	(66,80,86)
Degree of Assistance Available in case of Accident	(17,21,38)	(17,21,38)	(50,60,69)	(38,47,57)	(57,68,76)	(56,67,75)
Completeness of Medical Service System	(22,28,43)	(20,25,41)	(59,70,77)	(39,48,57)	(67,81,86)	(64,77,83)

Table 4. The Evaluation Results of Each Itinerary

Itinerary	R_i	BNP_i
12-day itinerary of East-China (I1)	(25.967,32.807,46.030)	34.935
12-day itinerary of Three Gorges and Hwang-Shan China (I2)	(24.144,30.721,44.455)	33.107
4-day itinerary of Singapore (I3)	(58.650,70.117,77.968)	68.912
8-day itinerary of Bangkok and Phuket island (I4)	(39.625,48.246,57.562)	48.478
7-day itinerary of Japan (I5)	(64.395,77.341,83.818)	75.185
West coast 12-day itinerary of the United States (I6)	(63.427,76.136,82.601)	74.055

the ranking of risk can be conducted from a higher risk itinerary to lower risk:

$$I2 \succ I1 \succ I4 \succ I3 \succ I6 \succ I5$$

CONCLUSION

The purpose of this study was to develop a scientific framework for the evaluation of tourist risk. Previous studies were mainly from the consumers' behavior (buyer), travel risk (attitude), or safety perspective to discuss the perceived risks with other associated constructs. But Roehl and Fesenmaier (1992) mentioned that the studies for the last 50 years of the concept of risk have proved to be difficult to operationalize. In this study the authors attempted to employ AHP and Fuzzy MCDM from the two important categories of tourist risk—physical and equipment—to operationalize and evaluate tourist risks. The use of AHP was to find out the weights for the tourist risk evaluation criteria. The comparative importance of the criteria can be measured accurately through pairwise comparison among criteria. The results pointed out that in the cognition of importance of tourist risks, law and order, transportation, and hygiene are the more important aspects in the evaluation of tourist risk, while law and order are given the highest attention by evaluators. As for the evaluation criteria, possibility of criminal attack, political stability, and possibility of contracting infectious diseases are the most important criteria in the evaluation.

Since tourist risk itself represents certain degrees of uncertainty, risk evaluation should be conducted under a fuzzy environment. From the application of the Fuzzy MCDM method, the tourist risk evaluation done in this study has then been rendered more objective and practicable. The result of the empirical study is that six selected itineraries were ranked according to the experts' evaluation. The 7-day itinerary of Japan is considered to have the least risk, followed by the west coast 12-day itinerary of the United States and 4-day itinerary of Singapore. It is interesting to find that among 16 criteria in this study, there are only two criteria—possibility of criminal attack and possibility of natural disasters—which the fuzzy performance values of 4-day itinerary of Singapore are higher than the west coast 12-day itinerary of the United States (Table 3). It may reflect the facts and influences of the criminals attacking tourists in Miami and the earthquakes on the west coast of the United States. Generally speaking, the risk of these three itineraries are rather low.

As for the 12-day itinerary of Three Gorges and Hwang-Shan China, it reveals the highest risk among the six itineraries, followed by the 12-day itinerary of East-China, and 8-day itinerary of Bangkok and Phuket island. From Table 3, one could extract four main factors from the 16 criteria to further explain why the BNP values of these three itineraries are quite low. The four main factors are possibility of criminal attack, possibility of contracting infectious diseases, quality of the management staff, and the degree of assistance available in case of accident. In the AHP analysis, law and order was perceived as the most important risk aspect. However, according to Table 3, the possibility of contracting infectious diseases is the most serious problem that the group package tour would confront during the traveling of these three itineraries. It indicates that those two countries, China and Thailand, need better control of the preventive epidemic system, in order to diminish the possibility of contracting infectious diseases.

Understanding tourist risk has a number of benefits for the practitioners and government, including providing a useful reference for marketing and government policy-making. For example, the AHP analysis in this study reveals that law and order is the most important aspect of tourist risk. In 1994, some travel agencies in Taiwan whose main group package tours focused on Mainland China experienced severe drops in business as a result of the Thousand Island Lake massacre. Had they been better informed about the seriousness of public concern about law and order, they might have reduced overall business risk by diversifying their tour offerings. In addition, managers could use the approaches presented in this paper to build internal risk evaluation models for their own itineraries based on the experiences of their senior tour leaders. Risk information can play an important role in risk reduction. The obligation and responsibility of government is to make accurate tourist risk information available to the public. Then tourists can use the information to take some precautions in advance. The degree of tourist risk in specific locales will vary with the passage of time. Both the practitioners and the government should evaluate the risks at intervals in order to obtain the latest information.

It appears that this is one of the first tourism studies to empirically evaluate tourist risk. Its selection and weighting of evaluation criteria is fully customized in order to make the most efficient possible use of expert opinion according to the purpose, objective, and domain of the study. Future studies can use the same techniques to alter or adjust the criteria in order to pursue different aims, or they may even wish to further expand the application of fuzzy set theory by combining it with the AHP method for the determination of the criteria weights. The desire for objectivity and accuracy let one survey the opinions of acknowledged experts (i.e., the 20 senior group package tour leaders who answered the questionnaire). Their rich experience contributes strongly to the internal validity of the study.

Future research may wish to use actual tourists as the respondents, but one thing should be taken into consideration: if it tries to compare different itineraries as done here, it may confront the problem of finding tourist respondents who are qualified to make comparisons across the full set of alternatives. Likewise, future research is needed to broaden the conception of risk to be evaluated. This study has focused mainly on "physical risk" and "equipment risk" as the basis for defining and selecting its tourist risk evaluation criteria. However, if a foreign independent tour itinerary is taken as the object of risk evaluation, other risk conceptions such as time risk, satisfaction risk, and financial risk can be incorporated into the domain of tourist risk evaluation in future research. □ □

Acknowledgments—The authors wish to thank Peter Morton of the Graduate Institute of International Business Administration, Chinese Culture University, for his great help in the development of this paper. This research was supported by the National Science Council of ROC under grant NSC 85-2415-H034-001.

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Submitted 20 June 1995
Resubmitted 28 May 1996
Accepted 31 January 1997
Refereed anonymously
Coordinating Editor: Abraham Pizam