Determination of a Cause and Effect Decision Making Model for Leisure Farm's Service Quality in Taiwan

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Abstract: - Causal and effect analysis influences the effectiveness of decision-making and the consumer behaviour. The complex relationship between cause and effect as well as the fuzzy nature of human life make the casual and effect analysis difficult. This research applies a fuzzy DEMATEL method for group decision-making to gather group ideas and analyze the cause and effect relationship of complex problems in fuzzy environments. Procedures of the fuzzy DEMATEL method are presented. Using the fuzzy DEMATEL procedures, a set of service quality criteria involved are separated into the cause and effect groups for helping decision-makers focus on those criteria that provide great influence. An empirical study applies the fuzzy DEMATEL method to the service quality expectation of Taiwanese leisure farms. This study used purpose sampling, a total of 215 valid instruments collected from Beijing tourists' perception on service quality. The result and contribution are discussed.

Key-Words:-service quality expectation, fuzzy logic, Decision Making Trial and Evaluation Laboratory (DEMATEL)

1 Introduction

The leisure farm wishes to maintain their continued competitiveness in terms of service quality expectation from customers in order to cope with the new challenges from government new tourism policy for mainland China tourists. The leisure farms are intending to rebuild an evaluation service quality model for the new coming challenges. Therefore, understanding, building and integrating service quality expectation are the main concerns. It is now a leading firm strategy to develop a model from customer expectation. The service quality affects all leisure farm service activities and accelerates the development of leisure farm growth. The performances are usually with multiple criteria for many customers' expectation to judge by the best service quality performance. The leisure farm can be acquired the competitive advantage thereby service quality buildup. Improving service quality, increasing assessment and reliability are while competition ever increases and try to retain customers. Service quality conditions might influence a firm's competitive advantage by retaining customer patronage and with this comes market share, and ultimately profitability [25].

Service quality has been developing for several years, evaluating the expectation is critical to whether the leisure farms are aware of the importance of customer expectation. Service quality is measured to assess service performance, diagnose service problems, and manage service delivery. The criteria used for service quality effectiveness evaluation are numerous and influence one another [29] [30] [27][28]. In recent years, numerous studies have focused on service quality in the leisure farm development [24][39][13][21]. The outcomes of these studies have produced several contributions in relation to understanding the dimensional structure of service quality of hotels. This study arises the imperative issue of how enhance the leisure farm competitiveness in terms of a set of service quality

criteria with interdependency relationships from customer expectation in uncertainty. And how to improve decision- making in service quality expectation into a set of cause and effect model is the major issue of this study objective. Unfortunately, there is none study presented the cause and effect model in aiming decision making process of leisure farm in uncertainty. Though, this social science problem is always controversy.

To solve uncertainty issue, it is generally understood that customer expectation is usually judged by human perception measurement. Human judgment in social science is always represented as exact numbers. In many practical cases, the human preference model is uncertain and customer expectation might be reluctant or unable to assign exact numerical values to describe the preferences [10][41]. Since some of the evaluation criteria are subjective and qualitative in nature described in linguistic information, it is very hard for the respondents to express the preferences using exact numerical values and this result more desirable for the researchers to use fuzzy logic evaluation. The fuzzy logic resembles human reasoning in its use of approximate information and uncertainty to generate the research result. It has the advantage of mathematically representing uncertainty and vagueness, and it provides formalized tools for dealing with the imprecision intrinsic to many social science problems.

To address these interrelationships issues, the Decision Making Trial and Evaluation Laboratory (DEMATEL), a mathematical computation method, not only can convert the relations between cause and effect of criteria into a visual structural model [19][44], but also can be utilized as a wise way to handle the inner dependences within a set of criteria. The main advantages of DEMATEL are involving indirect relations into a compromised cause and effect model. The DEMATEL method is an effective procedure for analyzing structure and relationships between components of a system or a number of available alternatives. The DEMATEL can be priorities the criteria based on the type of relationships and severity of influences of them on another. The criteria having more effect to another are assumed to have higher priority and called cause criteria. And those receiving more influence from another are assumed to have lower priority and called effect criteria [35]. With these advantages, this study is utilized DEMATEL method to determine the cause and effect of criteria. The linguistic terms parameterized with triangular fuzzy numbers, and defuzzification into a crisp value for DEMATEL analysis.

Since the combination of fuzzy logic and DEMATEL can be solved this interrelationships in fuzzy environment and this combination method has success evaluated in many fields [19][34][35][23][22], the service quality of leisure farm needs to be developed a full understanding in cause- effect relationships. The following section is presenting the combined research method triangular numbers and defuzzification applied in this study and the DEMATEL method. The rest of this paper is organized as follows. Section 2, literature review discussed. In Section 3, evaluation methods are presented. In Section 4, an empirical study is illustrated. Finally, according to the findings of this research, post survey, conclusions and suggestions are presented in Section 5.

2 Literature Review

To success managing the challenges of globalization and intensive competition, firms need to notify the service quality expectation. The service quality perceptions have been received extensive attention from researchers and practitioners. Service quality criteria need specific definitions in the evaluation of the quality of a service. Numerous studies attempt to establish which criteria or factors to consider when evaluating service quality. Among these, the research by Parasuraman et al.[29] bears greater impact, and identifies ten dimensions, which were subsequently reduced to five, namely, tangible, reliability, response, assurance, and empathy. At present, no consensus exists on the number of dimensions or their applicability to which services. For example, the study of Carman et al.[6] investigates different types of services and suggests that the dimensions proposed by [30] are not applicable to every type of service and that other dimensions exist, such as convenience and cost. They also disagree with the way that the initial dimensions were combined into five. This shows the difficulty of quantifying service quality because of the very nature of service itself. An important advantage of the SERVQUAL instrument is that it has been proven valid and reliable across a large range of service contexts. Furthermore, PBZ Parasuraman et al. [27] indicated that the SERVQUAL instrument could be revised and refined slightly to fit a wide range of contexts with its intact basic content, structure, and length.

In recent decades, substantial literature examines the concept of service quality, most research on accommodation services focus on hotels, without particular reference to the perception comparison between customers and employees

[32][33][16][31][37][5].The term service quality has been used to explain by the customers evaluated the service quality and numerous contributions in the literatures have attempted to establish the criteria to evaluate the service quality for difference fields [4][12][38][7][5]. Researchers have been described it into strategic, inter-organization and internal service quality perspective in order to improve firm's competitiveness [15][17][36].

However, most evaluators cannot give exact numerical values to represent opinions, based on human perception on service quality criteria; more realistic evaluation uses linguistic assessments rather than numerical values [18][43]. After Zadeh [48] introduced fuzzy set theory to deal with vague problems, linguistic terms have been used for approximate reasoning within the framework of fuzzy set theory to handle the ambiguity of evaluating data and the vagueness of linguistic expression [49]. The linguistic variable is useful method in dealing with situations which are described in quantitative expressions [2][43]. Especially, linguistic variables are used as variables whose values are not numbers but linguistic term. The fuzzy set theory finds various applications in the field of management science [20][46], and begins to gain acceptance in the field of service quality [40][47].

The combination of fuzzy and DEMATEL has applied in many field recent years. Liou et al. [23] uses fuzzy DEMATEL to address dependent relationships among criteria and the results showing inter-dependence and feedback of airline safety criteria. And conduct an empirical study on airline safety measurement, safety is affected by many factors such as management, operations, maintenance, environment, aircraft design, and air traffic control. The measure aviation safety has assumed that there are complex relationships among criteria. Wu & Lee [45] studied modern global managers are required to possess a set of competencies or multiple intelligences in order to meet pressing business challenges. Hence, expanding global managers' competencies is becoming an important issue. This study arises to enrich global managers' competencies by segmenting a set of competencies into some portions of facilitate competency development model.

They proposed an effective method combining fuzzy logic and DEMATEL to segment required competencies for better promoting the competency development of global managers.

Table 1. Measurement leisure farm service quality perception criteria

Measurement criteria
The employees are courteous, polite, and respectful (C1)
The physical facilities and employees are neat and clean(C2)
The employees are trustworthy, believable, and honest (C3)
The leisure farm provides additional service information. Eg., travel information, shuttle service, message, physical therapy , accommodation, food service etc (C4)
The employees provide service reliably, consistently and dependably(C5)
The service information and price list are always clear provided (C6)
The employees are willing and able to provide service in a timely manner (C7)
The employees are competent (i.e. leisure farm knowledgeable and skillful) (C8)
The leisure farm information is accessible on website. (C9)
This leisure farm provides a safety environment (C10)
The leisure farm is in an easily accessible location and parking lots (C11)
The leisure farm is offering enough information for facilities indications/ directions (C12)
The leisure farm is always update the service information to customers (C13)
The employees make their effort to understand my needs (C14)
The employees listen to me and speak in a language that I can understand (C15)
The employee are approachable and easy to contact (C16)
Customers feel safe and privacy in the service process (C17)
The operating hours are always convenient to all customers. (C18)
The leisure farm is providing their services at the times they promise to do so (C19)
Brochures and other communication materials are visually appealing(C20)
The leisure farm provides speedy check in/out process (C21)
When a customer has a problem, the employee shows a sincere interest in solving it (C22)

Lin and Wu[22] uses the fuzzy DEMATEL to present an empirical study on the R&D project selection of a Taiwanese company, the result shows that, within the cause group, the criterion of probability of technical success is the most

important factor for R&D project selection, whereas the strategic fit and potential size of market have the best effect on the other criteria. By contrast, the net present value is the most easily improved of the effect group criteria. Moreover, a considerable number of studies have been conducted emphasizing the criteria to be considered for the evaluation[40][42].

This preliminary literature reviewed illustrates the fact that customer perception of service quality is critically important for the success of leisure farms. However, the criteria of service quality is lacking of interacted with environmental uncertainty and there is none study presents such a causal and effect relationships in prior researches. With this background, this study extrapolate prior results related to marketing research in the new context of leisure farms and act on modified SERVQUAL in uncertainty for developing causal and effect relationship of service quality perceptions described in linguistic information. In conclude of prior literatures, the study criteria are presented in Table 1.

3 The Method

The research method can be justified using linguistic information in complex evaluation systems. Many social science problems are involving imprecision, constraints, and possible actions are not precisely in description [3]. The research result in uncertain environment is highly affected by subjective judgments that are vague and imprecise. The sources of imprecision include: unquantifiable information, incomplete information, non-obtainable information, and partial ignorance [9].

To solve this kind of imprecision problem, fuzzy logic was first introduced by Zadeh [48] as a mathematical way to represent and handle vagueness in decision-making. In fuzzy logic, each number between 0 and 1 indicates a partial truth, whereas crisp sets correspond to binary logic [0, 1]. Hence, fuzzy logic can express and handle vague or imprecise judgments mathematically [1]. To deal with the vagueness of human thought and expression in making decisions, fuzzy logic is very helpful. In particular, to tackle the ambiguities involved in the process of linguistic estimation, it is a beneficial way to convert these linguistic terms into fuzzy numbers. In practice, linguistic values can be represented by fuzzy numbers, and the TFN is commonly used. The linguistic information is dealing with situations which are described in quantitative expressions [2]. Especially, linguistic information is used as variables whose values are not numbers but linguistic terms [49]. The linguistic term approach is a way for decision makers to express their perception's assessment. In practice, linguistic values can be represented by TFN that is commonly used in natural perceptions. In the following, this research briefly reviews some essential definitions of fuzzy logic and application of defuzzification method in this research.

3.1 Fuzzy logic

Some important definitions and notations of fuzzy set theory from [8][11] were reviewed. Let X be the universe of discourse, X={x_1, x_2, x_3,….x_n}. A fuzzy set $\widetilde{A}$ of X is a set of order pairs $\{(x_1, f_{\widetilde{A}}(x_1)),(x_2, f_{\widetilde{A}}(x_2)),.....(x_n, f_{\widetilde{A}}(x_n))\}$, where $f_{\widetilde{A}} : X \to [0,1]$, is the membership function of $\widetilde{A}$, and $f_{\widetilde{A}}(x_i)$ stand for the membership degree of x_i in $\widetilde{A}$.

Definition 1. When X is continuous rather than a countable or finite set, the fuzzy set $\widetilde{A}$ is denoted as: $\widetilde{A} = \int_X f_{\widetilde{A}}(x_i)/(x)$, where $x \in X$.

Definition 2. When X is a countable or finite set, the fuzzy set $\widetilde{A}$ is represent as $\widetilde{A} = \sum_i f_{\widetilde{A}}(x_i)/(x_i)$, where $x_i \in X$

Definition 3. A fuzzy set $\widetilde{A}$ of the universe of discourse X is normal when its membership function $f_{\widetilde{A}}(x)$ satisfies $\max f_{\widetilde{A}}(x) = 1$

Definition 4. A fuzzy number is a fuzzy subset in the universe of discourse X that is not convex but also normal

Definition 5. The fuzzy α-cut $\widetilde{A}_\alpha$ and strong α-cut $\widetilde{A}_{\alpha+}$ of the fuzzy set $\widetilde{A}$ in the universe of discourse X is defined by

$$\widetilde{A}_\alpha = \{x_i | f_{\widetilde{A}}(x_i) \geq \alpha, x_i \in X\}, \quad where \quad \alpha \in [0,1] \quad (1)$$
$$\widetilde{A}_{\alpha+} = \{x_i | f_{\widetilde{A}}(x_i) \geq \alpha, x_i \in X\}, \quad where \quad \alpha \in [0,1]$$

Definition 6. A fuzzy set $\widetilde{A}$ of the universe of discourse X is convex if and only if every $\widetilde{A}_\alpha$ is convex, that is $\widetilde{A}_\alpha$ is a close interval of R. It can be written as

$$\widetilde{A}_\alpha = [P_1^{(\alpha)}, P_2^{(\alpha)}], \quad where \quad \alpha \in [0,1] \quad (2)$$

Definition 7. A triangular fuzzy number (TFN) can be defined as a triplet (a_1, a_2, a_3); the membership function of the fuzzy number $\widetilde{A}$ is defined.

$$f_{\tilde{A}}(x)=\begin{cases}0, & x \prec a_1\\ (x-a_1)/(a_2-a_1), & a_1 \le x \le a_2,\\ (a_3-x)/(a_3-a_2), & a_2 \le x \le a_3,\\ 0, & x \succ a_3\end{cases} \quad (3)$$

Let $\tilde{A}$ and $\tilde{B}$ be two TFN parameterized by the triplet (a_1, a_2, a_3) and (b_1, b_2, b_3) respectively, then the operational laws of these two TFN are as follows:

$$\begin{aligned}&\tilde{A}(+)\tilde{B}=(a_1,a_2,a_3)(+)(b_1,b_2,b_3)=(a_1+b_1,a_2+b_2,a_3+b_3)\\ &\tilde{A}(-)\tilde{B}=(a_1,a_2,a_3)(-)(b_1,b_2,b_3)=(a_1-b_1,a_2-b_2,a_3-b_3)\\ &\tilde{A}(\times)\tilde{B}=(a_1,a_2,a_3)(\times)(b_1,b_2,b_3)=(a_1b_1,a_2b_2,a_3b_3)\\ &\tilde{A}(\div)\tilde{B}=(a_1,a_2,a_3)(\div)(b_1,b_2,b_3)=(a_1/b_3,a_2/b_2,a_3/b_1)\end{aligned} \quad (4)$$

Where *a1*, *a2*, and *a3* are real numbers and $a1 \le a2 \le a3$

Further, in achieving a favorable solution, the group decision-making is usually important to any organization. This is because that the process of arriving at a consensus based upon the reaction of multiple individuals, whereby an acceptable judgment may be obtained. To deal with the research problems in uncertainty, an effective fuzzy aggregation method is required. Any fuzzy aggregation method always needs to contain a defuzzification method because the results of human judgments with fuzzy linguistic variables are fuzzy numbers. The term defuzzification refers to the selection of a specific crisp element based on the output fuzzy set, which convert fuzzy numbers into crisp may score. This study is applying the converting fuzzy data into crisp scores developed by [26], the main procedure of determining the left and right scores by fuzzy minimum and maximum, the total score is determined as a weighted average according to the membership functions. Here adopts the CFCS (Converting Fuzzy data into Crisp Scores) defuzzification method for fuzzy aggregation procedure. This is because the CFCS method can give a better crisp value than the Centroid method. Lets $\tilde{w}_{ij}^k=(a_{1ij}^k,a_{2ij}^k,a_{3ij}^k)$, suppose that a decision group has *k* members; take $\tilde{w}_{ij}^k$ to present the fuzzy weight of *i*th criteria affects the *j*th criteria assessed by *k*th evaluators Normalization:

$$\begin{aligned}xa_{1ij}^k&=(a_{1ij}^k-\min a_{1ij}^k)/\Delta_{\min}^{\max}\\ xa_{2ij}^k&=(a_{2ij}^k-\min a_{1ij}^k)/\Delta_{\min}^{\max}\\ xa_{3ij}^k&=(a_{3ij}^k-\min a_{1ij}^k)/\Delta_{\min}^{\max}\end{aligned} \quad (5)$$

Where $\Delta_{\min}^{\max}=\max a_{3ij}^k-\min a_{1ij}^k$

Compute left (*ls*) and right (*rs*) normalized value:

$$\begin{aligned}xls_{ij}^k&=xa_{2ij}^k/(1+xa_{2ij}^k-xa_{1ij}^k)\\ xrs_{ij}^k&=xa_{3ij}^k/(1+xa_{3ij}^k-xa_{2ij}^k)\end{aligned} \quad (6)$$

Compute total normalized crisp value

$$x_{ij}^k=\left[xls_{ij}^k\left(1-xls_{ij}^k\right)+xrs_{ij}^k xrs_{ij}^k\right]/\left[1-xls_{ij}^k+xrs_{ij}^k\right] \quad (7)$$

Compute crisp values:

$$w_{ij}^k=\min a_{1ij}^k+x_{ij}^k\Delta_{\min}^{\max} \quad (8)$$

To integrate the different opinions of evaluators, this research adopted the synthetic value notation to aggregate the subjective judgment for k evaluators, given by

$$\tilde{w}_j=\frac{1}{k}(\tilde{w}_{ij}^1+\tilde{w}_{ij}^2+\tilde{w}_{ij}^3+.....+\tilde{w}_{ij}^k) \quad (9)$$

3.2 DEMATEL

The DEMATEL method originated from the Geneva Research Centre of the Battelle Memorial Institute [14]. It is especially practical and useful for visualizing the structure of complicated causal relationships with matrices or digraphs. The matrices or digraphs portray a contextual relation between the elements of the system, in which a numeral represents the strength of influence. Hence, the DEMATEL method can convert the relationship between the causes and effects of criteria into an intelligible structural model of the system. The DEMATEL method has been successfully applied in many fields [19][34][35][41]. The essentials of the DEMATEL method suppose that a system contains a set of criteria C = {C_1,C_2, . . .,C_n}, and the particular pairwise relations are determined for modeling with respect to a mathematical relation. The solving steps are as follows:

Definition 8: Generating the direct relation matrix. Measuring the relationship between criteria requires that the comparison scale be designed as four levels: 0(no influence), 1(very low influence), 2(low influence), 3(high influence), 4(very high influence). Experts make sets of the pairwise comparisons in terms of influence and direction between criteria, the initial data can be obtained as the direct-relation matrix that is a *n x n* matrix A, in which a_{ij} is denoted as the degree to which the criteria *i* affects the criteria *j*.

Definition 9: Normalizing the direct relation matrix. On the base of the direct – relation matrix A, the normalized direct-relation matrix X can be obtained through the following formulas:

$$X = k \cdot A \tag{10}$$

$$k = \frac{1}{\max_{1 \le i \le n} \sum_{j=1}^{n} a_{ij}}, \quad i, j = 1,2,.....,n \tag{11}$$

Definition 10: *Attaining the total relation matrix.* Once the normalized direct-relation matrix X is obtained, the total relation matrix T can be acquired by using formula (3), in which I is denoted as the identity matrix:

$$T = X(I - X)^{-1} \tag{12}$$

Definition 11: Definition 8:: *Producing a causal diagram.* The sum of rows and the sum of columns are separately denotes as vectors D and vector R through formula (4)-(6). The horizontal axis vector (D+R) named "Prominence" is made by adding D to R, which reveals how much importance the criterion has. Similarly, the vertical axis (D-R) named "Relation" is made by substracting D from R, which may group criteria into a cause group. Or, if the (D-R) is negative, the criterion is grouped into the effect group. Therefore, the causal diagram can be acquired by mapping the dataset of the **(**D + R**,**D − R**),** providing valuable insight for making decisions.

$$T = [t_{ij}]_{nxn}, \quad i, j = 1,2,.....,n \tag{13}$$

$$D = \left[\sum_{j=1}^{n} t_{ij} \right]_{nx1} = [t_i]_{nx1} \tag{14}$$

$$R = \left[\sum_{j=1}^{n} t_{ij} \right]_{1xn} = [t_j]_{nx1} \tag{15}$$

In these equations, vector D and vector R denote the sum of rows and the sum of columns from total-relation matrix $T = [t_{ij}]_{n \times n}$, respectively,

Definition 12: Obtaining the inner dependence matrix. In this step, the sum of each column in total-relation matrix is equal to 1 by the normalization method, and then the inner dependence matrix can be acquired.

3.3 Application steps

To further explore the DEMATEL research method in uncertainty, the analysis procedures is explained as follows:

Step 1. Identifying decision goal- gathering the relevant information to evaluate the advantages and disadvantages and monitoring the results to ensure the goals is able to achieve. This is necessary to form two expert committees for group knowledge to achieve the goals.

Step 2. Developing evaluation criteria and survey instrument- This is important to establish a set of criteria for evaluation. However, the criteria have the nature of complicated relationships within the cluster of criteria. To gain a structural model dividing evaluation criteria into the cause and effect groups, the DAMATEL is an appropriateness to be applied in this study. Acquiring the responded instrument - to make sure the relationships among the evaluation criteria, it is necessary to consult two groups of experts to confirm reliable information of the criteria influences and directions.

Step 3. Interpret the linguistic information into fuzzy linguistic scale- using linguistic information to convert fuzzy numbers into crisp may score, the fuzzy assessments applying in equations (5)~(8) are defuzziffied and aggregated as a crisp value ($\widetilde{w}_j$) . Using equation (9) , the integration of the different opinions of evaluators, this research adopted the synthetic value notation to aggregate the subjective judgment for evaluators

Step 4. Analyze the criteria into causal and effect diagram- the crisp value is composed the initial direct-relation matrix. The normalized direct relation matrix can be obtained through Eq. (10). According to Eqs. (11)~(15), a causal and effect diagram can be constructed.

4 Empirical Results

This study distributed the survey instrument in F.C. leisure farm with purpose sampling method. F.C. farm provides various livestock commodities, with farming scenery, ecological environment and resources, combined with farming, forestry, fishing, barbeque, conference site, accommodation and rural culture to enhance the customer expectation and countryside life style. F.C leisure farm wishes to maintain their continued competitiveness in service quality expectation to cope with the new challenges from government new tourism policy for mainland China tourists. The empirical study steps are as follows:

4.1 Application of fuzzy DEMATEL

This study attempts to apply the DEMATEL to the service quality expectation to build up a cause an effect model. This research follows the four proposed steps to study on the empirical data from a total of 215 instrument sets are collected.

Prior to data collection, the survey instrument was pre-tested for content validity in two stages. In the first stage, six experienced researchers were asked to critique the questionnaire for the ambiguity, clarity and appropriateness based on feedback received from these researchers, the instrument was modified to enhance clarity and

appropriateness of the measures purporting to tap the constructs. In the second stage, the survey instrument was mailed to five management executives affiliated with the leisure farms. These executives were asked to review the questionnaire for structure, readability, ambiguity and completeness. This process yielded a survey instrument that was judged to exhibit high content validity. The empirical application analytical method steps are as follows.

Step 1. Identifying decision goal- gathering the relevant information and defined the goals for further developing the 22 service quality criteria in order to study the interrelationships of criteria in uncertainty.

Step 2. Developing evaluation criteria and survey instrument- This is important to establish a set of criteria for evaluation (Table 1). However, the criteria have the nature of complicated relationships within the cluster of criteria. The measurement linguistic terms are identified as No influence, Very low influence, Low influence, High influence and Very high influence and follows with the corresponding TFNs. To make sure the relationships among the evaluation criteria, it is necessary to consult the study group to confirm reliable information of the criteria influences and directions using a survey instrument. The initial direct-relation matrix is as follows:

Step 3. Interpret the linguistic information into fuzzy linguistic scale. The empirical data is obtained from each individual customer assessment. Using Eq. (5) to normalize the assessment data. And the linguistic information to convert the TFNs into crisp value by using Eqs. (6)~(8), w_{ij}^k is the computed crisp values, and yet the synthetic value notation to aggregate the subjective judgment for thirty evaluators is using Eq.(9) to acquire the as a crisp value ($\widetilde{w}_j$), the result showed in Table 4. For example, through Eq.(6) the left (*ls*) and right (*rs*) normalized value are xls_{ij}^k = 0.889 /(1+0.889-0.667)=0.727; xrs_{ij}^k =1.00/(1+1.00-0.889)=0.900; From Eq. (7) the total normalized crisp value is x_{ij}^k = [0.727 *(1-0.727)+(0.900 *0.900)]/(1-0.727+0.900)=0.889; Using Eq.(8) the crisp values is w_{ij}^k = 0.1+0.889*0.9=0.535 ($\Delta_{\min}^{\max}$ = 0.9; $\min a_{1ij}^k$ =0.1); Using Eq.(9) the synthetic value is $\widetilde{w}_j$ = (0.900+0.900 +0.401+0.586+0.726+0.796+0.649+0.586+0.401+0.726 +0.726+0.535+0.649+0.401+0.586+0.649+0.649+0.730+0.649+0.666+0.666)/21=0.647. Repeated the Eqs. (5)~(8) in above computational procedures can obtain the EDEMATEL initial direct-relation matrix, and using equation (9) to integrate the different opinions of 215 evaluators, this research adopted the synthetic value notation to aggregate the subjective judgment for evaluators the results are showed in Table 2.

Step 4. The crisp value of service quality expectation from the fuzzy linguistics assessment is composed the initial direct-relation matrix. The normalized direct relation matrix can be obtained through Eqs. (10) and (11) Following the Eq.(12), the total relation matrix can be acquired, presented in Table 3. Then, using Eqs.(13)~(15), the horizontal axis vector (D+R) named "Prominence" is made by adding D to R, which reveals the importance of criterion. Similarly, the vertical axis (D-R) named "Relation" is made by subtracting D from R, which may group criteria into a cause group (Table 4). If the (D-R) is negative, the criteria are grouped into the effect group. Therefore, the causal and effect diagram can be acquired by mapping the dataset of the (D + R**,** D − R)**,** providing valuable insight for problem solving (Figure 1).

As shown in the causal diagram (Fig. 1), the evaluation criteria are visually divided into the cause service quality criteria group (C4, C7, C9, C10, C11, C12, C13, C16, C19, C21, C22) can be improved, while the effect criteria group is including C1,C2, C3, C5, C6, C8, C14, C15, C17, C18 and C20. From the causal diagram, valuable cues are obtained for making profound decisions. These two cause and effect groups may be further used to, respectively, serve as causal criteria and effective criteria clusters in a service quality expectation model.

5 Conclusions

This empirical study plans to enhance the service quality expectation from Beijing tourists contains with twenty two required criteria from definition [30]. As service quality is taking on an important strategic role, this study integrates service quality expectation from customers analyzing into a cause and effect model. It is measured the service quality expectation to be performed effectively in order to transform the service quality expectation as benchmark model. More importantly, the successful service quality starts with service quality expectations that are produced through a robust evaluation method.

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Table 2. The DEMATEL initial direct-relation matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22
C1	0.000	0.657	0.685	0.532	0.528	0.478	0.887	0.564	0.467	0.564	0.673	0.490	0.488	0.521	0.432	0.569	0.488	0.487	0.468	0.498	0.521	0.521
C2	0.647	0.000	0.576	0.487	0.435	0.209	0.145	0.197	0.180	0.367	0.408	0.467	0.812	0.986	0.200	0.658	0.760	0.162	0.477	0.418	0.719	0.719
C3	0.656	0.428	0.000	0.482	0.410	0.327	0.410	0.194	0.202	0.317	0.295	0.202	0.887	0.324	0.417	0.450	0.229	0.486	0.503	0.284	0.450	0.450
C4	0.694	0.677	0.439	0.000	0.578	0.590	0.634	0.890	0.923	0.863	0.771	0.700	0.794	0.836	0.815	0.475	0.882	0.102	0.523	0.764	0.418	0.418
C5	0.642	0.455	0.482	0.485	0.000	0.708	0.640	0.362	0.275	0.388	0.391	0.682	0.546	0.395	0.351	0.504	0.351	0.290	0.361	0.304	0.402	0.402
C6	0.683	0.368	0.488	0.368	0.455	0.000	0.198	0.298	0.648	0.419	0.313	0.102	0.691	0.420	0.291	0.638	0.427	0.555	0.460	0.520	0.668	0.668
C7	0.669	0.784	0.657	0.412	0.498	0.390	0.000	0.781	0.281	0.844	0.588	0.289	0.654	0.853	0.837	0.552	0.671	0.812	0.634	0.564	0.694	0.694
C8	0.646	0.576	0.422	0.668	0.512	0.207	0.757	0.000	0.676	0.293	0.733	0.802	0.162	0.352	0.311	0.152	0.360	0.075	0.548	0.418	0.297	0.297
C9	0.617	0.478	0.489	0.698	0.543	0.882	0.492	0.781	0.000	0.209	0.164	0.456	0.487	0.267	0.289	0.118	0.398	0.602	0.399	0.460	0.711	0.711
C10	0.671	0.484	0.477	0.701	0.546	0.238	0.543	0.783	0.855	0.000	0.399	0.815	0.573	0.764	0.573	0.389	0.298	0.459	0.382	0.642	0.270	0.270
C11	0.660	0.482	0.533	0.621	0.578	0.775	0.391	0.765	0.481	0.375	0.000	0.522	0.504	0.289	0.504	0.683	0.515	0.532	0.302	0.313	0.230	0.230
C12	0.571	0.578	0.678	0.605	0.598	0.433	0.207	0.633	0.236	0.284	0.342	0.000	0.624	0.598	0.624	0.264	0.770	0.540	0.944	0.588	0.931	0.931
C13	0.682	0.601	0.477	0.587	0.623	0.570	0.882	0.629	0.332	0.852	0.347	0.162	0.000	0.553	0.568	0.559	0.620	0.464	0.503	0.733	0.274	0.274
C14	0.632	0.562	0.510	0.542	0.634	0.433	0.358	0.455	0.393	0.268	0.159	0.394	0.234	0.000	0.093	0.548	0.559	0.394	0.234	0.602	0.275	0.275
C15	0.662	0.451	0.539	0.210	0.564	0.390	0.638	0.375	0.206	0.884	0.523	0.214	0.127	0.375	0.000	0.884	0.523	0.449	0.127	0.586	0.267	0.267
C16	0.605	0.481	0.536	0.632	0.602	0.783	0.230	0.540	0.297	0.374	0.221	0.880	0.521	0.540	0.297	0.000	0.423	0.880	0.521	0.314	0.143	0.143
C17	0.638	0.495	0.492	0.345	0.612	0.626	0.642	0.734	0.404	0.165	0.498	0.200	0.844	0.734	0.404	0.556	0.000	0.200	0.119	0.689	0.314	0.314
C18	0.663	0.512	0.482	0.555	0.630	0.396	0.238	0.128	0.276	0.248	0.219	0.334	0.187	0.300	0.555	0.472	0.442	0.000	0.508	0.597	0.165	0.165
C19	0.605	0.540	0.567	0.518	0.651	0.513	0.400	0.605	0.360	0.745	0.358	0.817	0.458	0.238	0.812	0.397	0.313	0.576	0.000	0.379	0.391	0.391
C20	0.631	0.476	0.555	0.512	0.633	0.765	0.709	0.183	0.109	0.596	0.287	0.426	0.239	0.126	0.475	0.237	0.588	0.331	0.461	0.000	0.207	0.207
C21	0.612	0.699	0.690	0.407	0.452	0.626	0.531	0.765	0.455	0.490	0.236	0.207	0.216	0.536	0.602	0.294	0.733	0.413	0.090	0.353	0.000	0.534
C22	0.827	0.699	0.690	0.458	0.546	0.627	0.590	0.772	0.523	0.442	0.209	0.298	0.319	0.456	0.666	0.385	0.810	0.510	0.121	0.457	0.621	0.000

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Table 3. Total DEMATEL relation matrix

	C 1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C 9	C 10	C 11	C 12	C 13	C 14	C 15	C 16	C 17	C 18	C 19	C 20	C 21	C 22
C 1	0.175	0.195	0.196	0.177	0.187	0.173	0.200	0.186	0.145	0.170	0.157	0.158	0.172	0.175	0.161	0.169	0.178	0.155	0.148	0.171	0.154	0.153
C 2	0.198	0.129	0.170	0.156	0.161	0.138	0.132	0.142	0.110	0.139	0.122	0.139	0.176	0.190	0.127	0.158	0.180	0.115	0.132	0.149	0.152	0.151
C 3	0.177	0.141	0.109	0.137	0.140	0.127	0.133	0.122	0.097	0.121	0.102	0.105	0.163	0.125	0.127	0.128	0.123	0.124	0.120	0.122	0.118	0.117
C 4	0.257	0.224	0.206	0.166	0.219	0.208	0.211	0.237	0.199	0.215	0.184	0.196	0.218	0.222	0.210	0.186	0.232	0.149	0.172	0.216	0.169	0.168
C 5	0.191	0.156	0.157	0.150	0.123	0.166	0.160	0.147	0.113	0.136	0.119	0.150	0.153	0.143	0.133	0.143	0.145	0.121	0.122	0.135	0.127	0.127
C 6	0.195	0.150	0.158	0.143	0.157	0.118	0.131	0.143	0.139	0.138	0.112	0.110	0.162	0.143	0.129	0.152	0.150	0.140	0.127	0.150	0.144	0.143
C 7	0.244	0.221	0.212	0.185	0.202	0.183	0.154	0.217	0.145	0.205	0.163	0.158	0.197	0.214	0.203	0.183	0.207	0.190	0.171	0.192	0.178	0.177
C 8	0.191	0.164	0.153	0.163	0.160	0.131	0.168	0.122	0.141	0.129	0.143	0.159	0.126	0.140	0.131	0.117	0.146	0.105	0.135	0.142	0.121	0.120
C 9	0.201	0.167	0.167	0.173	0.171	0.187	0.159	0.185	0.101	0.131	0.110	0.141	0.156	0.142	0.137	0.122	0.158	0.148	0.131	0.154	0.157	0.156
C 10	0.217	0.178	0.177	0.186	0.184	0.153	0.173	0.197	0.169	0.125	0.135	0.178	0.172	0.187	0.166	0.151	0.161	0.148	0.140	0.178	0.134	0.133
C 11	0.203	0.166	0.169	0.169	0.174	0.179	0.151	0.183	0.135	0.142	0.098	0.147	0.158	0.143	0.151	0.163	0.164	0.144	0.125	0.144	0.121	0.120
C 12	0.221	0.194	0.200	0.185	0.196	0.174	0.158	0.194	0.132	0.154	0.136	0.124	0.183	0.182	0.178	0.150	0.203	0.159	0.182	0.181	0.186	0.184
C 13	0.220	0.188	0.178	0.178	0.190	0.176	0.199	0.187	0.134	0.189	0.133	0.133	0.133	0.175	0.167	0.166	0.184	0.150	0.148	0.186	0.133	0.132
C 14	0.175	0.150	0.146	0.143	0.156	0.136	0.129	0.140	0.111	0.115	0.093	0.120	0.120	0.102	0.103	0.134	0.147	0.116	0.103	0.144	0.107	0.107
C 15	0.187	0.150	0.157	0.127	0.159	0.140	0.155	0.143	0.104	0.166	0.124	0.115	0.119	0.137	0.102	0.166	0.151	0.129	0.101	0.150	0.111	0.111
C 16	0.194	0.161	0.165	0.165	0.172	0.175	0.134	0.162	0.118	0.138	0.110	0.169	0.155	0.157	0.133	0.110	0.154	0.165	0.138	0.141	0.112	0.111
C 17	0.197	0.163	0.163	0.145	0.172	0.166	0.167	0.177	0.125	0.125	0.130	0.120	0.177	0.170	0.139	0.151	0.124	0.118	0.108	0.166	0.123	0.122
C 18	0.170	0.140	0.138	0.137	0.150	0.127	0.114	0.110	0.097	0.110	0.093	0.111	0.110	0.118	0.130	0.125	0.132	0.083	0.117	0.138	0.094	0.093
C 19	0.205	0.175	0.177	0.166	0.184	0.164	0.156	0.177	0.129	0.173	0.127	0.172	0.158	0.144	0.178	0.147	0.155	0.151	0.106	0.153	0.137	0.136
C 20	0.180	0.148	0.154	0.143	0.160	0.161	0.157	0.125	0.095	0.144	0.106	0.125	0.125	0.117	0.135	0.118	0.152	0.116	0.122	0.105	0.106	0.106
C 21	0.193	0.176	0.175	0.147	0.159	0.162	0.156	0.178	0.129	0.145	0.111	0.119	0.133	0.157	0.152	0.131	0.174	0.130	0.103	0.142	0.100	0.138
C 22	0.224	0.190	0.189	0.164	0.179	0.176	0.174	0.191	0.143	0.154	0.119	0.136	0.152	0.164	0.168	0.149	0.193	0.148	0.116	0.162	0.155	0.110

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Table 4. The prominence and relation axis for cause and effect group

	D (Sum)	R(Sum)	(D+R)	(D-R)
C 1	3.754	4.414	3.754	0.660
C 2	3.267	3.726	3.267	0.460
C 3	2.780	3.716	2.780	0.936
C 4	4.463	3.506	4.463	0.957
C 5	3.118	3.756	3.118	0.638
C 6	3.135	3.520	3.135	0.386
C 7	4.201	3.472	4.201	0.729
C 8	3.107	3.665	3.107	0.558
C 9	3.353	2.810	3.353	0.543
C 10	3.637	3.265	3.637	0.372
C 11	3.352	2.727	3.352	0.626
C 12	3.855	3.085	3.855	0.769
C 13	3.679	3.420	3.679	0.259
C 14	2.797	3.448	2.797	0.651
C 15	3.006	3.258	3.006	0.252
C 16	3.239	3.219	3.239	0.020
C 17	3.249	3.613	3.249	0.364
C 18	2.639	3.002	2.639	0.363
C 19	3.469	2.864	3.469	0.605
C 20	2.900	3.421	2.900	0.521
C 21	3.209	2.941	3.209	0.268
C 22	3.557	2.917	3.557	0.640

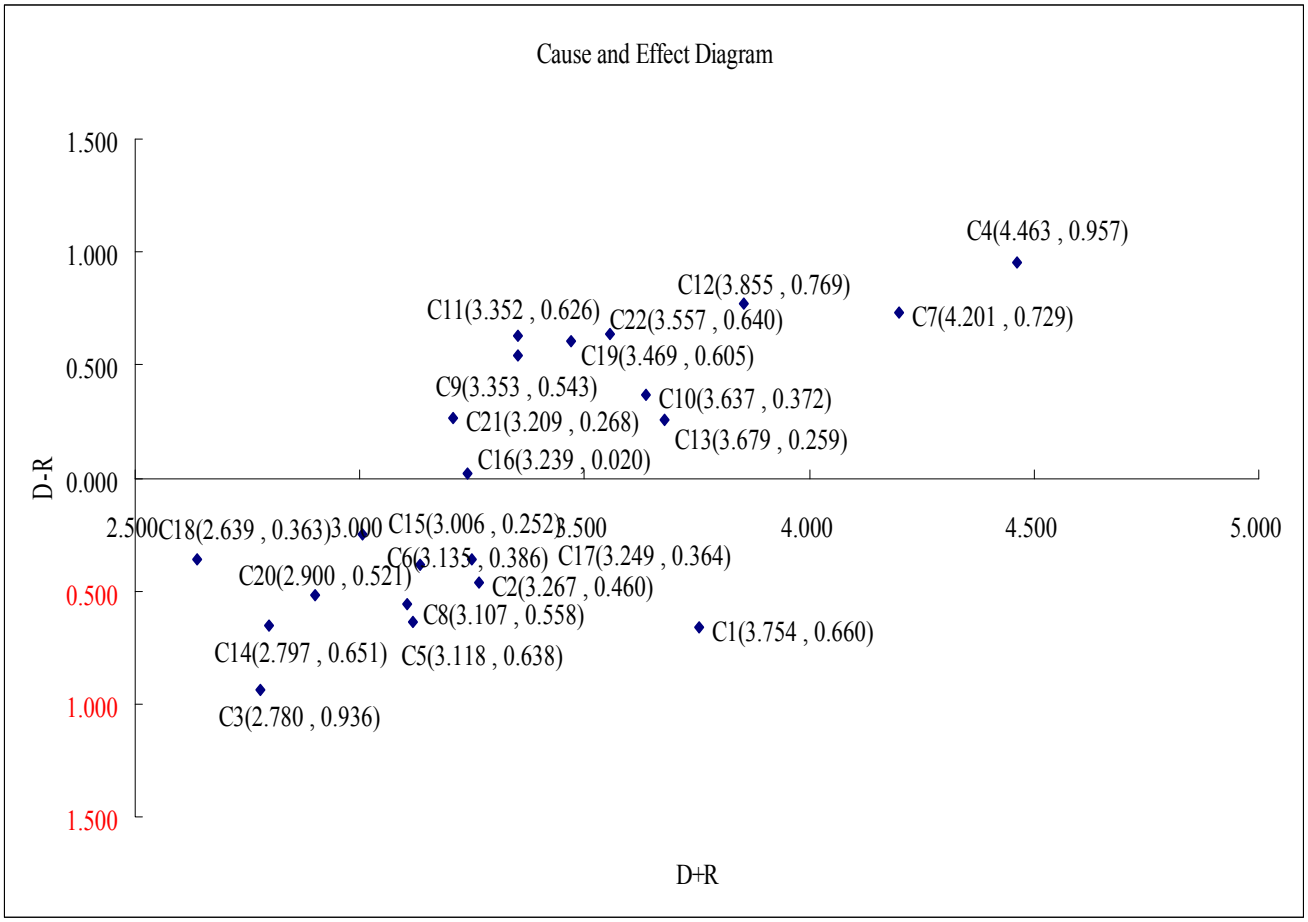

Figure 1. Cause and effect diagram

Especially, the new challenge from Taiwan government implements the new tourism policy for mainland China tourists to Taiwan. According to the evaluation results, this study derives some implications about business management as follows:

The valuable cues can be obtained for making profound decisions from the causal diagram (Fig. 1). For example, if the leisure farm wants to obtain high performances in terms of the effect group criteria, it would be necessary to control and pay attention to the cause group criteria beforehand. This is because the cause group criteria imply the meaning of the influencing criteria, whereas the effect group criteria denote the meaning of the influenced criteria [14]**.** In other words, the cause group criteria are difficult to move, while the effect group criteria are easily moved. Hence, the C4 is the most important criteria and most influencing criteria among these twenty-two criteria because it has the highest intensity of relation to other criteria (Table4). C3 effect criteria attempts to increase cause criteria C4 in order to make the leisure farm work better with high performances. However, C4 is presenting a most importance cause criteria and C3 is playing as important effect criteria. This implies that the effect criteria (C4, C7, C9, C10, C11, C12, C13, C16, C19, C21, and C22) are difficult to be changed. And there is an effective way to expand service quality perceptions by the causal criteria group (C1, C2, C3, C5, C6, C8, C14, C15, C17, C18 and C20). Further, these criteria can be regarded as the critical criteria in guiding the right benchmark for other leisure farm service providers and customer expectations.

Although numerous creditable works are devoted to the study of how to build a service quality cause and effect model and to execute the leisure farm service quality successfully, few of those can systematically evaluate and model complex characteristics criteria of the service quality measurement in uncertainty and using linguistic information terms. Moreover, in order to promote and deepen continuing research in future, it is worthwhile to investigate more studies to uncover invaluable new study issues. The proposed method using fuzzy DEMATEL can be applied to other applications in manufacturing, financial investment, social science and other multi-criteria decision making problems.

This research contributes to literature by filling in the gap in perceptions of service quality in uncertainty. Since the overall service quality indicator can be analyzed dynamically, once a lower effect performance level appears, management can recognize, prioritize and improve operational areas where important weaknesses are presented. This study provides a number of directions for future research. The possibility of developing a richer, multi-hierarchical structure that incorporates other constructs such as customer satisfaction and customer loyalty and others, and consider their interactive effects appears to be attainable. As in the study of Caruana[7], the statistical method used confirms that certain relationships exist among the three constructs in the study. However, the fuzzy analytical network process might be the best research method to explore its inter-effects among all constructs and combined with DEMATEL analysis [44].

References:

[1] B., Al-Najjar and I., Alsyouf, Selecting the most efficient maintenance approach using fuzzy multiple criteria decision making, International Journal of Production Economics. Vol.84, No.1, 2003, pp. 85-100.

[2] U., Asan, C., Erhan Bozdag, and S., Polat, A fuzzy approach to qualitative cross impact analysis. Omega, International Journal of Management Science, Vol. 32, No. 6., 2004, pp.443-458.

[3] R.E., Bellman, and L.A., Zadeh, Decision making in a fuzzy environment, Management science, Vol. 17, No.4, 1970, pp.141-164.

[4] E., Babakus, G.W., Boller, An empirical assessment of the SERVQUAL scale. Journal of Business Research, Vol, 24, 1992, pp.253–268.

[5] J.M., Benitez, J.C., Martin, and C., Roman, Using fuzzy number for measuring quality of service in hotel industry. Tourism management, Vol.28, 2007, pp.544-555.

[6] J., Carman, Consumer perceptions of service quality: An Assessment of the SERVQUAL Dimensions. Journal of retailing, Vol. 66, 1990, pp.33–55.

[7] A., Caruana, Service quality: the effects of service quality and the mediating role of customer satisfaction. European journal of marketing, Vol.36, 2002, pp.7-8.

[8] S.M., Chen, Evaluating weapon systems using fuzzy arithmetic operation. Fuzzy Sets and Systems, Vol.77, 1996, pp.265-276.

[9] S.J., Chen, C.L., Hwang, & F.P., Hwang, Fuzzy multiple attribute decision making methods and applications. New York: Springer, 1992.

[10] Y.W, Chen, and G.H., Tzeng, Using fuzzy integral for evaluating subjectively perceived travel costs in a traffic assignment model,

European journal of operational research, Vol.130, 2001, pp.653-664

[11] C.H., Cheng, and Y., Lin, Evaluating the best main battle tank using fuzzy decision theory with linguistic criteria evaluation. European Journal of Operational Research, Vol.142, No. 1, 2002, pp.174-186. .

[12] P.A., Dabholkar, D.T., Thorpe, and J.0., Rentz, A measure of service quality for retail stores: scale development and validation. Journal of Academic Marketing science, Vol.24, No.1, 1996, pp.3-16.

[13] Y., Ekinci, P., Prokopaki, and C., Cobanoglu, Service quality in Cretan accommodations: marketing strategies for the UK holiday market. International Journal of Hospitality Management, Vol. 22, 2003, pp.47–66.

[14] E., Fontela, and A., Gabus, The DEMATEL Observer, DEMATEL 1976 Report. Switzerland, Geneva, Battelle Geneva Research Center, 1976.

[15] D., Farmer, Purchasing myopia revisited. European journal of purchasing and supply management, Vol. 3, No.1, 1997, pp.1-8.

[16] J., Getty, and K.A., Thompson, Procedure for Scaling Perceptions of Lodging Quality. Hospitality research journal, Vol.18, No.2, 1994, pp.75–96.

[17] C.M., Harland, R.C., Lamming, P.D., Cousin, Developing the concept of supply strategy. International journal of operation and production management, Vol.19, No.7, 1999, pp.650-673

[18] F., Herrera, E., Herrera-Viedma, L., and Martinez, A fusion approach for managing multi-granularity linguistic term sets in decision making. Fuzzy Sets and Systems, Vol. 114, 2000, pp.43-58

[19] S., Hori, and Y., Shimizu, Designing methods of human interfaces for supervisory control systems. Control Engineering Practice, Vol. 7, No.11, 1999, pp.1413-1419.

[20] M.O., Hutchinson, "The use of fuzzy logic in business decision making". Derivatives quarterly, Vol. 4, No.4, 1998, pp.53-67.

[21] T.D., Juwaheer, Exploring international tourists' perceptions of leisure farm operations by using a modified SERVQUAL approach: a case study of Mauritius. Managing Service Quality, Vol.14, No.5, 2004, pp.350–364.

[22] C.J., Lin, W.W., Wu, A causal analytical method for group decision-making under fuzzy environment. Expert Systems with Applications, Vol. 34, 2008, pp.205-213

[23] J.J., Liou, and G.H., Tzeng, A non-additive model for evaluating airline service quality. Journal of Air Transportation Management, Vol. 13, 2007, pp.131-138.

[24] A.W., Mei, A.D., Dean, C.J., White, Analyzing service quality in the hospitality industry. Managing Service Quality, Vol.9, No. 2, 1999, pp.136–143.

[25] E.A., Morash, J., Ozment, Toward management of transportation service quality. Logistics and Transportation Review, Vol.30, 1994, pp.115–140.

[26] S., Opricovic, and G.H., Tzeng, Defuzzification within a multi-criteria decision model, International Journal of Uncertainty. Fuzziness and Knowledge-Based Systems, Vol.11, No.5, 2003, pp.635–652.

[27] A., Parasuraman, L.L., Berry, and V.A., Zeithaml, A refinement and reassessment of the SERVQUAL scale. Journal of retailing, Vol.67, No.4, 1991, pp.420-450.

[28] A. Parasuraman, L.L., Berry, V.A., and Zeithaml, Research note: more on improving quality measurement. Journal of Retailing, Vol. 69, 1993, pp.140-147.

[29] A., Parasuraman, and V.A., Zeithaml, and L.L., Berry, A conceptual model of service quality and its implications for future research. Journal of marketing, Vol.49, 1985, pp. 41-50.

[30] A., Parasuraman, V.A., Zeithaml, L.L., Berry, SERVQUAL: a multiple-item scale for measuring consumer perceptions of service quality. Journal of retailing, Vol. 64, 1988, pp.12-37.

[31] M., Patton, P., Stevens, and B., Knutson, Internationalizing LODSERV as a Measurement Tool: A Pilot Study. Journal of hospitality and leisure marketing, Vol. 2, No.2, 1994, pp. 39–55.

[32] F., Saleh, and C., Ryan, Analyzing Service Quality in the Hospitality Industry Using the SERVQUAL Model. The service industries journal, Vol.11, 1991, pp. 324–343.

[33] F., Saleh, and C., Ryan, Client Perceptions of Hotels: A Multi-attribute Approach". Tourism management, Vol.13, 1992, pp.163–168.

[34] N.R., Sankar, and B.S., Prabhu, Modified approach for prioritization of failures in a system failure mode and effects analysis. International Journal of Quality Reliability Management, Vol. 18, No.3, 2001, pp.324-35.

[35] S.M., Seyed-Hosseini, N., Safaei, and M.J., Asgharpour, Reprioritization of failures in a system failure mode and effects analysis by decision making trial and evaluation laboratory

technique. Reliability Engineering & System Safety, Vol. 91, No.8, 2006, pp. 872-881

[36] L.L., Stanley, and J.D., Wisner, Service quality along the supply chain: implications for purchasing, Journal of operations management, Vol. 19, No. 3, 2001, pp. 287–306

[37] S., Suh, Y., Lee, Y., Park, and G., Shin, The Impact of Consumer Involvement on the Consumers' Perception of Service Quality-Focusing on the Korean Hotel Industry. Journal of Travel and Tourism marketing, Vol.6, No.2., 1997, pp.33–52.

[38] F., Sultan, and M.C., Simpson, International service variants: airline passenger expectations and perceptions of service quality. Journal of service marketing, Vol.14, 2000, pp. 188-216.

[39] N., Tsang, and H., Qu, Service quality in China's leisure farm industry: a perspective from tourists and leisure farm managers. International Journal of Contemporary Hospitality Management, Vol. 12, No.5, 2000, pp.316–326.

[40] S.H., Tsaur, T.Y., Chang, and C.H., Yen, The evaluation of airline service quality by fuzzy MCDM. Tourism Management, Vol.23, No.2, 2002, pp.107-115.

[41] M.L., Tseng, Y.H., Lin, A.S., Chiu, and C.H., Liao, Using FANP approach on selection of competitive priorities based on cleaner production implementation: a case study in PCB manufacturer, Taiwan. Clean Technology and Environmental Policy, Vol.10, No.1, 2008, pp.17-29.

[42] G.H., Tzeng, C.H., Chiang, and C.W., Li, Evaluation intertwined affect in –e-learning programs: A novel hybrid MCDM model based on factor analysis and EDEMATEL. Expert systems with applications, Vol. 32, 2007, pp. 1028-1044.

[43] R.C., Wang, and S. J. Chu, Group decision-making using a fuzzy linguistic approach for evaluating the flexibility in a manufacturing system. European Journal of Operational Research, Vol. 154, 2004, pp. 363-572.

[44] W.W., Wu, (in press) Choosing knowledge management strategies by using a combined ANP and EDEMATEL approach. Expert systems with applications, 2007.

[45] W.W., Wu, and Y.T., Lee, Developing global managers' competencies using the fuzzy DEMATEL method. Expert systems with applications, Vol. 32, 2007, pp. 499-507.

[46] X., Xia, Z., Wang, and Y., Gao, Estimation of non-statistical uncertainty using fuzzy-set theory. Measurement Science and Technology, Vol.11, No.4, 2000, pp.430-435.

[47] C.H., Yeh, and Y.L., Kuo, "Evaluating passenger services of Asia-Pacific international airports". Transportation Research E, Vol. 39, No.1, 2003, pp.35-48.

[48] L.A., Zadeh, Fuzzy set. Information and Control , Vol. l8, 1965, pp. 338-353.

[49] L.A., Zadeh, The concept of a linguistic variable and its application to approximate reasoning. Information Sciences, Vol. 9, 1975, pp. 43-80.