Using VIKOR Method for Evaluating Service Quality of Online Auction under Fuzzy Environment

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***Abstract*— Most decision making problems can be considered as multiple criteria decision making (MCDM) problems, and should be solved by MCDM method. The main advantage of MCDM is that it can give managers many dimensions to consider related elements, and evaluate all possible options under variable degrees. This paper applied fuzzy set theory and a compromised MCDM method - VIKOR method to evaluate the service quality of online auction. However, service quality is a composite of various attributes, among them many intangible attributes are difficult to measure. Thus, we invite fuzzy set theory into the measurement of performance. By applying AHP in obtaining criteria weight and VIKOR in ranking, we found the most concerned dimension of service quality is Transaction Safety Mechanism and the least is Charge Item. Other criteria such as information security, accuracy and information are too vital. And the online auction A is the best of the three online auctions.**

***Keywords*— MCDM, Fuzzy Set Theory, VIKOR, Online auction, Service quality**

I. INTRODUCTION

The online auction business model has developed and thrived in a short time and become one of the most outstanding electronic commerce models. Some of the online auction sites are Yahoo, Ruten, Taobao, Eachnet, and eBay, to name but a few. The success factors of auction sites are considered to be many. One of the main factors is that sellers and purchasers can have direct contacts with no time and geographical constraints. In this kind of setting, not only can sellers sell items for relatively high prices, but purchasers can transact satisfactorily [12]. In other words, both parties acquire best mutual economical benefits. Another factor is that auction sites bring intense network flow since bidders have to check newest prices offered by sellers while updating their bids when necessary. This intensity becomes the niche itself as well. Owing to these advantages, there is no doubt why auction business model is instantaneously popular and prosperous nowadays. With a plethora of auction sites available online, the good service quality offered turns out to be the key reason affecting consumer behavior and consumer loyalty. Thus, learning to evaluate the quality and upgrade it are our focus here.

In order to measure the service quality, we tend to adopt the well-known SERVQUAL model [16] to investigate, extract, adjust, and evaluate information found in both production business and service business. However, in our study [26], the SERVQUAL model modified by Parasuraman, Zeithaml and Berry (PZB) is not an appropriate management tool for on-line business at all. Another thing to note here is that advanced technology contributes to ever-growing demands from consumers. And using single evaluative criterion to measure appears to be inadequate, not to mention different evaluators hold subjective views and different results. In short, there are much uncertainty and fuzziness in this kind of analysis and the problems mentioned above are just too hard to tackle.

To solve the problems we enumerated earlier, we use Multiple Criteria Decision Making (MCDM) method to assist decision makers in quality and quantification evaluation. We then choose a group to demonstrate an alternative to assess and then measure pros and cons and decide execute priorities [4]. Additionally, the analytic hierarchy process (AHP) [19], fuzzy integral [22], Grey relation analysis (GRA) [5], VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) [15] and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) [9] and so on proposed in this method are widely used and proved successful in great many fields.

As for the cognitive uncertainty generated from users' subjective judgments, we then use fuzzy set theory [30] to deal with linguistic variables and linguistic values [29, 31-33]. We are convinced this will empower decision makers' ability in decision analysis.

This study approaches the problem by applying MCDM in the hope to evaluate online auctions with good service quality. Through the presentation of literature reviews, we then will use the AHP to establish a hierarchical structure of online auctions based on the goal, the objectives and the criteria for evaluation. We also will implement experts' opinions and consider measured weights.

Lastly, we will take VIKOR method to generate a list of ranking order based on online auctions service quality so that e-sellers can take this model as their managerial strategy in business.

II. EVALUATION FRAMEWORK AND METHODS OF ONLINE AUCTION SERVICE QUALITY

The evaluation procedure of this study consists of several steps shown in Fig. 1. First, we identify the service quality dimensions and criteria that customers consider the most

important. After constructing the evaluation criteria hierarchy, we calculate the criteria weights by applying AHP method. The measurement of performance corresponding to each criterion is conducted under the setting of fuzzy set theory. Finally, we conduct VIKOR to achieve the final ranking results. The detailed descriptions of each step are elaborated in each of the following sub-section.

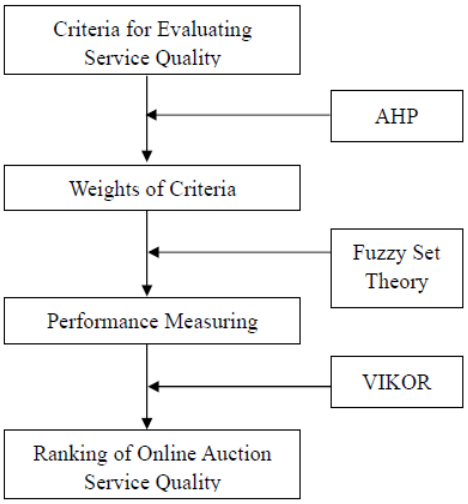

Fig. 1 Evaluation framework of online auction service quality

A. Online auction service quality

SERVQUAL was proposed by PZB in 1988, which is the most evaluative tool in the service quality domain. In SERVQUAL, there are five dimensions: tangibles, reliability, responsiveness, assurance, and empathy. In the service quality evaluation of information service industry [7,14] there are still some debate about using the evaluative tools by the five dimensions of SERVQUAL despite many papers praise their achievement. In fact, the most important problem is whether it could be measured by the five dimensions. Xie et al. [26], for example, utilized the five dimensions to estimate the service quality of search websites and found they could not be used to describe the users' needs. Besides, some papers suggest that they have to be modified to adapt for different information service industries. Kettinger and Lee [11], for instance, deleted the dimension of Tangibles in their research. Pitt et al.[17] separated Tangibles and Empathy into another two dimensions through factor analysis. Such other related literatures are shown in TABLE I. Through these literatures in Table I, we establish a hierarchical framework by AHP method.

B. Analytic hierarchy process (AHP)

The AHP proposed by Saaty [19] has been a tool at the hands of decision makers and researchers, and it is one of the most widely used MCDM tools. Its validity is based on thousands of actual applications in which the AHP results were accepted and used by decision makers [23, 27]. It provides a methodology to calibrate the numeric scale for the measurement of quantitative as well as qualitative performance. It involves decomposing a complex decision into a hierarchy with goals at the levels and sublevels of the hierarchy. Therefore, the AHP can be considered as both a descriptive tool and a prescriptive model for decision making. Additionally, one of the major advantages of the AHP is that it calculates the inconsistency criteria as a ratio of the decision maker's inconsistency and randomly generated criteria. Although a higher value of inconsistency criteria requires revaluation of pairwise comparisons, decisions obtained in certain cases can also be taken as the best alternative [18].

C. Fuzzy set theory

Some expressions, such as ``not very clear" and ``very likely", can be heard very often in daily life. 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 of human decision-making is not taken into account. However, since Zadeh [30] developed fuzzy set theory, and Bellman and Zadeh [2] described the decision-making method in fuzzy environments. An increasing number of studies have also dealt with fuzzy problems by applying fuzzy set theory. With such an idea in mind, this paper includes fuzzy decision-making theory, considering the possible fuzzy subjective judgment of the evaluators during online auction service quality evaluation. This method for establishing online auction service quality can be made more objectively. The applications of fuzzy set theory in this paper are elaborated as follows.

1) Fuzzy numbers: 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 [6], 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 numbers.

For example, the expression ``online auction service quality" represents a linguistic variable in the context of this paper. It may take on values such as ``fair", and the membership functions of expression values can be indicated by triangular fuzzy numbers (TFN) $\mu_A \times (X) = (L, M, U)$ within the scale range of 0 - 100. The evaluators can subjectively assume their personal range of the linguistic variable μ_A (fair) = (30, 55, 85), which are shown in Fig. 2. Comparing with the traditional investigative research, the importance degree for the serving attribute used 5-points of Likert Scale, and TFN is rather widespread at the present time. The linguistic values found in this paper are primarily used to assess the linguistic ratings given by the evaluators.

According to the nature of TFN and the extension principle put forward by Zadeh [30], the algebraic calculation of the triangular fuzzy numbers are shown as follows.

TABLE I
SERVICE QUALITY MEASUREMENT IN PRIOR STUDIES

Study	Context	Dimensions
Shohreh & Christine [21]	Service quality of online travel agencies	Content and purpose, accessibility, navigation, design and presentation, responsiveness background, personalization and customization
Branes and Vidgen [1]	Website quality of online shopping	Tangibles, reliability, responsiveness, assurance, empathy
Loiacono et al. [13]	Website quality of website usage	Information quality, tailored communications, trust, response time, ease of understanding, intuitive operations, visual appeal, innovativeness, emotional appeal, consistent image, on-line completeness, relative advantage
Wolfinbarger and Gilly [24]	E-service quality of B2C commerce	Efficiency, system availability, fulfilment, privacy, responsiveness, compensation, contact
Shih T. L. [20]	Decision making factors of C2C online auction	Transaction, safety mechanism, website promotion, operation convenience, charge item, customer service
Hsieh T. Y. [8]	E-service quality of online auction	Efficiency, system availability, privacy/security, compensation, personalization, reputation, playfulness

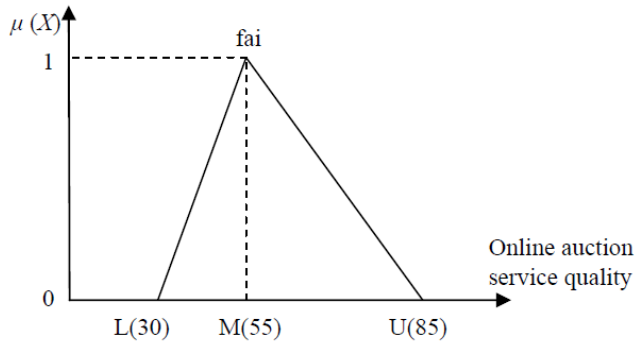

Fig. 2 Triangular membership function of fuzzy numbers

Addition of triangular fuzzy numbers $\oplus$:

$$(L_1, M_1, U_1) \oplus (L_2, M_2, U_2) = (L_1+L_2, M_1+M_2, U_1+U_2). \quad (1)$$

Multiplication of triangular fuzzy numbers $\otimes$:

(a)

$$(L_1, M_1, U_1) \otimes (L_2, M_2, U_2) = (L_1L_2, M_1M_2, U_1U_2). \quad (2)$$

(b) Any real number K,

$$K \otimes \mu_A (X) = (KL, KM, KU) \quad (3)$$

Subtraction of triangular fuzzy numbers $\ominus$:

$$(L_1, M_1, U_1) \ominus (L_2, M_2, U_2) = (L_1 - U_2, M_1 - M_2, U_1 - L_2). \quad (4)$$

2) *Linguistic variables:* According to Zadeh [31-33], it is very difficult for conventional quantification to reasonably express 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 with lingual expression as its values. One example for the linguistic variable is ``online auction service quality". It means service quality that customer experiences during consumption of the online auction. The possible values for this variable could be ``very dissatisfied", ``not satisfied", ``fair", ``satisfied" or ``very satisfied". The evaluators were asked to conduct their judgments, and each linguistic variable can be indicated by a triangular fuzzy number within the scale range of 0-100. Also the evaluators can subjectively assume their personal range of the linguistic variable.

3) *The overall valuation of the fuzzy judgement*: The overall valuation of the fuzzy judgment copes with the fact that every respondent perceives differently toward every criterion. The subsequent valuation of the linguistic variable certainly varies among individuals. We integrate the overall fuzzy judgment by Eq. (5).

$$E_{ij} = (1/m) \otimes (E_{ij}^1 \oplus E_{ij}^2 \oplus \ldots E_{ij}^m) \quad (5)$$

where $\otimes$ is the multiplication of fuzzy numbers, $\oplus$ is the add operation of fuzzy numbers, and E_{ij} the overall average performance valuation of online auction i under criterion j over m assessors.

E_{ij} as a fuzzy number can be represented by triangular membership function as Eq. (6) shows

$$E_{ij} = (LE_{ij}, ME_{ij}, UE_{ij}) \quad (6)$$

Buckley [3] stated that the three end points can be calculated by the method proposed as:

$$LE_{ij} = \left(\sum_{k=1}^{m} LE_{ij}^k \right) / m, \quad (7)$$

$$ME_{ij} = \left(\sum_{k=1}^{m} ME_{ij}^{k} \right) / m, \quad (8)$$

$$UE_{ij} = \left(\sum_{k=1}^{m} UE_{ij}^{k} \right) / m. \quad (9)$$

4) *Defuzzification:* 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 service quality comparison for each alternative. In other words, defuzzification is a technique to convert the fuzzy number into crisp real numbers, and the procedure of defuzzification is to locate the Best Nonfuzzy Performance (BNP) value. There are several available methods that serve this purpose. Mean-of-Maximum, Center-of-Area, and α-cut Method [34] are the most common approaches. This paper utilizes the Center-of-Area method due to its simplicity and doesn't require analysts' personal judgment.

The defuzzified value of fuzzy numbers can be obtained from Eq. (10).

$$\begin{aligned} BNP_{ij} = & [(UE_{ij} - LE_{ij})] \\ & + (ME_{ij} - LE_{ij})] \diagup 3 \\ & + LE_{ij}, \qquad 1 \le i, j \le m \end{aligned} \quad (10)$$

We use the fuzzy approach on vague objects such as the satisfaction of online auction service quality. Because the evaluation is from the views of linguistic variables of different evaluators, it speaks discrepancies and ambiguity. Furthermore, the traditional evaluation method required the evaluators to make the choice among ``very dissatisfied", ``not satisfied", ``fair", ``satisfied", and ``very satisfied". That would force the evaluators to do an over-high or over-low appraisal. Consequently, it would influence the accuracy of the evaluation. As a result, in this paper, we use the membership function to measure the linguistic variables to achieve a better result, which can fairly and exactly reflect different service quality of each online auction. Therefore, the fuzzy logic and results of the fuzzy approach are better than that of the traditional statistics approach.

5) *VIKOR:* VIKOR was proposed by Opricovic and Tzeng [15], based on the concept of the compromised programming of MCDM by comparing the measure of ``closeness" to the ``ideal" alternative. The multi-criteria measure for the compromised ranking is developed from the L_P-metric, used as an aggregating function in the compromised programming [28, 34]. This method focuses on ranking and selecting from a set of alternatives, and determines compromised solutions for a problem with conflicting criteria, which can help the decision makers to reach a final decision. The compromised ranking method of VIKOR consists of the following steps [15]:

Step 1: Determine the best (aspired/desired levels) and worst (tolerable/worse levels) values. Assuming the jth criterion represents a benefit, then the best values for setting all the criteria functions (aspired/desired levels) are $\{ x_j^* \mid j=1,2,\ldots,n\}$ and the worst values (tolerable/worse levels) are $\{ x_j^- \mid j=1,2,\ldots,n\}$, respectively.

Step 2: Compute the gaps $S_i \mid i = 1,2,...,m$ and $R_i \mid i = 1,2,...,m$ form the L_P-metric referring to Eq. (11) with normalization. The relationships are presented in Eqs. (12) and (13)

$$L_{pi} = \{ \sum_{j=1}^{n} [w_j (x_j^* - x_{ij}) / (x_j^* - x_j^-)]^p \}^{1/p}, \quad 1 \le p \le \infty, \ \ i = 1,2,...,m \quad (11)$$

$$S_i = \sum_{j=1}^{n} w_j (x_j^* - x_{ij}) / (x_j^* - x_j^-), \ \ i = 1,2,..,m \quad (12)$$

$$R_i = \max_j [w_j (x_j^* - x_{ij}) / (x_j^* - x_j^-)], \ \ i = 1,2,..,m \quad (13)$$

where S_i, $R_i \in [0,1]$ and 0 denotes the best (i.e., achieving aspired/desired level situations) and 1 denotes the worst ones.

Step 3: Compute the gaps $Q_i \mid i = 1,2,...,m$ for ranking. The relation is defined as Eq.(14), where $S^* = \min_i S_i$ (the best S^* can be set to equal zero), $S^- = \max_i S_i$ (the worst S^- can be set to equal zero), $v \in [0,1]$ is introduced as the weight of the strategy of the "the majority of the criteria" (or "maximum group utility"), and $v = 0.5$. In this research, the value of v is set to equal 0, 0.5 and 1 for sensitive analyse.

$$Q_i = v[\frac{(S_i - S^*)}{(S^- - S^*)}] + (1-v)[\frac{(R_i - R^*)}{(R^- - R^*)}], \ \ i = 1,2,..,m \quad (14)$$

Step 4: Rank and improve the alternatives, sorted by the values S, R and Q, in decreasing order and reduce the gaps in the criteria. The results are three ranking lists, with the best alternatives having the lowest value.

Step 5: Propose a compromised solution. For a given criteria weight, the alternatives (a'), are best ranked by measure Q (minimum). If the following two conditions are satisfied:

C1. "Acceptable advantage": $Q(a'') - Q(a') \ge DQ$, where a'' is the alternative with second position in the ranking list by Q; $DQ = 1 / (J - 1)$; J is the number of alternatives. **C2**. "Acceptable stability in decision making" : Alternative a′ must also be the best ranked by S or/and R. This compromised solution is stable within a decision making process, which could be: "voting by majority rule" (when $v > 0.5$ is needed), or "by consensus" $v \approx 0.5$, or "with veto" ($v < 0.5$). Here, v is the weight of decision making strategy "majority of criteria" (or "the maximum group utility").

If one of the conditions is not satisfied, then a set of compromised solutions is proposed, consisting of:

• Alternatives a' and a'' if only condition **C2** is not satisfied, or

• Alternatives a', a'',…,$a^{(M)}$ if condition **C1** is not satisfied, and $a^{(M)}$ is determined by the relation $Q(a'')-Q(a') < DQ$ for maximum M (the positions of these alternatives are "in closeness").

The compromised solution obtained by VIKOR can be accepted by the decision makers because if provides a maximum" group utility" of the "majority" (with measure *S*, representing "concordance"), and a minimum individual regret of an "opponent" (with measure *R*, representing "discordance"). The compromised solutions can be the basis for negotiations, by involving the criteria weights of the decision makers' preference [25].

III. An Empirical Study for Online Auction

A. Survey

Thanks to the growth of online action market in Taiwan, slotting and bidding process is now increasingly common for online auction. InsightXplorer[10] indicated that there are 80% of people buying items and more than 40% of people selling items. The online auction does not need a physical transaction place. As long as you can get online, you can carry out transactions any time or any places. Besides, buyers are not equal to traders, anyone would like to sell items and find buyers through online auction.

Three domestic online auctions, which provide relative auction services including Website Design, Operation Convenience, Website Promotion, Charge Item, Customer Service and Transaction Safety Mechanism, are selected to identify the critical criteria of evaluating e-service quality for online auction. The above online auctions were the most natural choices due to consumers' frequent uses. Among 168 surveys, 64 were invalid for a return rate of 38%. The demographic statistics indicate that 72% of respondents belong to the age group of 21-30 years, and 85% of received at least college education.

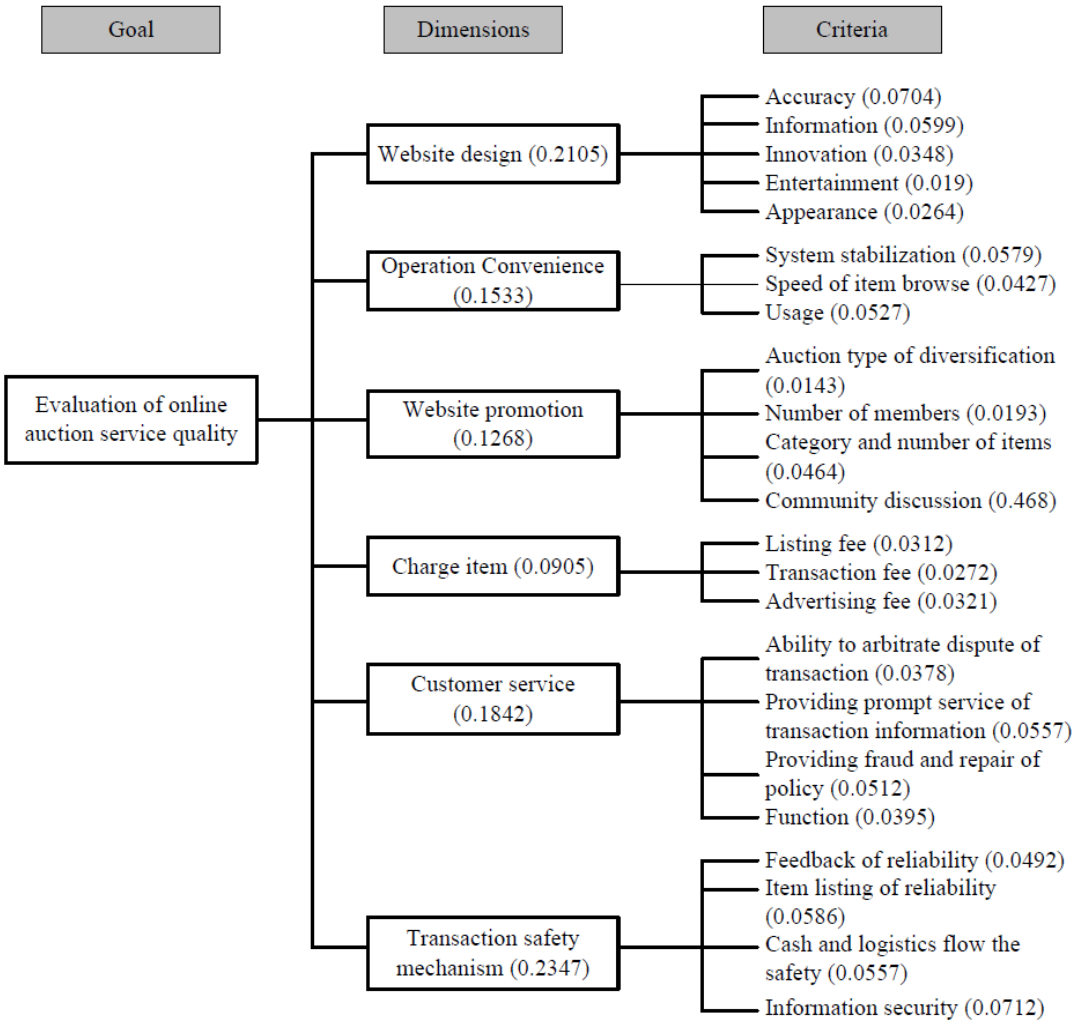

Fig. 3 Weights of the twenty-three criteria

The questionnaire of service quality evaluation mainly was composed of two parts: questions for evaluating the relative importance of criteria and online auction performance corresponding to each criterion. AHP method was used in obtaining the relative weight of criteria. As for the performance corresponding to criteria of every online auction, we used linguistic expression to measure the expressed performance. In order to establish the membership function associated with each linguistic expression term, we asked respondents to specify the range from 1 to 100 corresponding to linguistic term "very dissatisfied", "dissatisfied", "fair", "satisfied" and "very satisfied". These scores were later pooled to calibrate the membership functions.

We picked three major online auctions in Taiwan as the objects of this empirical study. Online auction A, the oldest online auction in Taiwan, with more than 8 years of history, gains the highest market share by nearly 75%. The online auction B, although the market share is only 40% currently, it is rapidly growing because it does not require any fees. The online auction C, the market share is nearly 32%, whose goal must be established to conform to the localization, and has the internationalization service level of the auction platform.

TABLE II
THE PERFORMANCE MATRIX $[x_{ij}]_{m\times n}$ WITH THE BEST VALUE x_j^* AND THE WORST VALUE x_j^- BY VIKOR

Evaluation criteria	Online auction A	Online auction B	Online auction C	x_j^*	x_j^-
Accuracy[a]	79.06	72.58	63.11	79.06	63.11
Information[a]	73.15	66.78	53.49	73.15	53.49
Innovatin[a]	73.51	70.51	58.55	73.51	58.55
Entertainment[a]	68.14	58.85	73.68	73.68	58.85
Appearance[a]	79.19	73.41	55.42	79.19	55.42
System Stabilization[a]	66.18	58.19	55.98	66.18	55.98
Speed of Items Browse[a]	82.57	79.95	64.53	82.57	64.53
Usage[a]	73.50	65.43	69.63	73.50	65.43
Auction Type of Diversification[a]	82.14	78.56	70.14	82.14	70.14
Number of Members[a]	72.18	67.75	55.18	72.18	55.18
Category and Number of Items[a]	78.04	65.81	52.11	78.04	52.11
Community Discussion[a]	71.01	68.51	62.21	71.01	62.21
Listing Fee[b]	80.51	75.86	62.49	62.49	80.51
Transaction Fee[b]	79.55	71.08	70.20	70.20	79.55
Advertising Fee[b]	83.33	75.65	62.27	62.27	83.33
Ability to Arbitrate Dispute of Transaction[a]	71.66	63.85	70.71	71.66	63.85
Providing Prompt Service of Transaction Information[a]	73.49	65.22	46.01	73.49	46.01
Providing Fraud and Repair of Policy[a]	64.56	55.15	55.00	64.56	55.00
Function[a]	65.51	58.81	44.45	65.51	44.45
Feedback of Reliability[a]	71.56	65.80	53.00	71.56	53.00
Item Listing of Reliability[a]	73.12	65.07	53.08	73.12	53.08
Cash and Logistics Flow the Safety[a]	76.48	70.35	55.35	76.48	55.35
Information Security[a]	83.44	78.61	72.18	83.44	72.18

x_j^* indicates the best values for setting all the criteria functions (aspired/desired levels) and x_j^- indicates the worst values (tolerable/worst level).

[a] indicates the valuation criteria is associated with benefit criteria and maximum is the ideal solution.
[b] indicates the valuation criteria is associated with cost criteria and minimum is the ideal solution.

B. The weights of evaluation criteria

Fig. 3 shows the relative weights of the six dimensions of service quality, which are obtained by applying AHP. The weights for each of the dimension are: Website Design was 0.2105, Operation Convenience was 0.1533, Website Promotion was 0.1268, Charge Item was 0.0905, Customer Service was 0.01842 and Transaction Safety Mechanism was 0.2347. The weights described in general that consumers concern the most was Transaction Safety Mechanism, the second was Website Design, and the most unconcerned was Charge Item.

Ranked by the weights, the top eight evaluation criteria are information security which was 0.0712, accuracy which was 0.0704, information which was 0.0599, item listing of reliability which was 0.0586, system stabilization which was 0.0579, providing prompt service of transaction information which was 0.0557, cash and logistics flow the safety which was 0.0577 and usage which was 0.0527. Apparently, consumers concern how well they are treated and served during auction process. Information security and accuracy tend to allow consumers to feel relieved when using online auction.

The ranks of criteria also reflect why information security or transaction safety mechanism are prominently concerned by consumers, particularly for the items listed of reliability, since they usually are not the items that consumers see online, and feedback of reliability is the substantial need for consumers. In addition, cash and logistics flow safety becomes a public distress due to several serious fraud events occurred in recent years. Consumers are more aware of the transaction safety mechanism and turns into an essential requirement of any online auction.

C. Performance measure of service quality and ranking

From the criteria weights obtained from AHP (Fig. 3.), the performance of alternatives corresponding to each evaluation criterion evaluated by respondents is measured as fuzzy numbers with triangular membership function. The performance of each respondent is then calculated by Eqs. (5)-(9) to obtain the overall performance measure for each online auction. Next, we use Center-of-Area method (as Eq.(10)) to defuzzify the fuzzy numbers, which are shown in Table II. Table II shows the performance matrix with the best value x_j^* (aspired/desired levels) and the worst value x_j^- (tolerable/ worst levels).

The values of S_i and R_i computed by Eqs. (11)-(13) are shown in Table III, while the computed value Q_i (with v = 0, 0.5, 1) by Eq. (14) and the preference order ranking is given in Table IV. The performance ranking order of the three online auction by VIKOR is Online auction A (Q_i = 0.0000) $\succ$ Online auction B (Q_i = 0.5234) $\succ$ Online auction C (Q_i = 1.0000).

TABLE III
THE VALUES S_i AND R_i BY VIKOR

Online auctions	S_i	R_i
Online auction A	0.0976 (1)	0.0321 (1)
Online auction B	0.4883 (2)	0.0527 (2)
Online auction C	0.8299 (3)	0.0712 (3)

Note:() indicates ranking order

TABLE IV
THE VALUES Q_i WITH V = 0, 0.5, 1 AND PREFERENCE ORDER RANKING BY VIKOR FOR SENSITIVE ANALYSIS

Online auctions	Q_i [v = 0]	Q_i [v = 0.5]	Q_i [v = 1]
Online auction A	0.0000 (1)	0.0000 (1)	0.0000 (1)
Online auction B	0.5269 (2)	0.5234 (2)	0.5199 (2)
Online auction C	1.0000 (3)	1.0000 (3)	1.0000 (3)

D. Discussion

This paper conducted a performance analysis on three online auctions using fuzzy set theory and MCDM method based on online auction transactions. The AHP and the VIKOR method were employed in the performance analysis for computing the weights of the criteria, ranking the online auction performance and improving the gaps of the three online auctions, respectively. Based on the results of the analysis, some essential findings were discussed as follows.

The AHP adopted in this paper focuses on the relative importance of the evaluation criteria of the online auction performance. As shown in Fig. 3, the result of the AHP analysis reveals that the ``transaction safety mechanism'' is the primary focus of the service quality and ``Information security'' is the most important evaluation criterion. This is because online auction is a service industry, and online auction performance is strongly connected to transaction safety mechanism. Therefore, in order to encourage more buyers, every online auction has to handle these concerns carefully.

In addition, the VIKOR method is used to provide information on how to focus on ranking and selecting from a set of alternatives, and determines compromised solutions for problems with conflicting criteria, which can help decision makers to reach a final decision. Here, based on the weights of the evaluation criteria calculated by AHP, the performance ranking order the three online auction using is Online auction A $\succ$ Online auction B $\succ$ Online auction C.

IV. CONCLUSIONS

In the past, many auction sites all targeted at providing best service quality. It is not hard for us to see some tangible service approaches dominating the market, such as the functionality of website designs, abundant information values, customer service skills … etc. However, we tend to neglect the fact that good service lies in whether consumers' expectations have been met, and we are aware that this can never be solved by looking at one single layer. This paper aims to look at this problem in every aspect and determines to offer a solution with multiple criteria of evaluation.

In investigating both concerns, we establish the procedures for identifying the most important criteria of service qualify for three online auctions based on these criteria. The evaluation procedures consist of the following steps:

1) Identify the evaluation criteria for online auction service quality;
2) Assess the average important of each criterion by Analytic Hierarchical Process over all the respondents;
3) Represent the performance assessment of online auctions for each criterion by fuzzy numbers, which explicitly attempts to accurately capture the real preference of assessors;
4) Use VIKOR as the main device in ranking the service quality of the three online auctions.

The result indicates that ``transaction safety mechanism'' outweighs all other dimensions. This shows that consumers care for the Feedback of Reliability, Cash and Logistics Flow the Safety and Information Security on any online auction sites. Therefore, in order to encourage more buyers, every online auction site has to attend to these concerns carefully. The second rank following ``transaction safety mechanism'' is ``website design'', which implies adequate information included on one auction site will influence buyers' willingness to visit that site again. Thus, paying attention to designs is also another success factor. As for the attributes, ``Information Security'' and ``Accuracy'' are all prominent. All these figures demonstrate consumers' privacy concern and accurate transaction wishes.

The final ranking results show that online auction A is the best of the three online auctions in terms of service quality, followed by online auction B and C. It is interesting to note that assessment of the service quality is not strongly reflected in the market share. This suggests that even though consumer service has a vital impact on electronic commerce, other

factors such as H & S fees also play an important role. Furthermore, the consumer perception of service quality is also dynamic and sensitive to some major incidents such as transaction fraud or payment failure, which are not necessarily promptly reflected in the market share.

Finally, this paper emphasizes the method application, and the alternative method we adopted may not all-inclusively meet each standard. Therefore, we believe the Multi-Objective Decision Method (MODM) can be applied in the near future to withdraw a fairer and more accurate principle.

REFERENCES

[1] Barnes, S. J. and Vidgen, R., "An evaluation of cyber-bookshops: the WebQual method," International Journal of Electronic Commerce, Vol. 6, No. 1, pp. 11-30, 2000.

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

[3] Buckley, J. J, "Ranking alternatives using fuzzy numbers," Fuzzy Sets and Systems, Vol. 15, pp. 21-31, 1985.

[4] Cheng, C. C. and Shyn J. Z., "An evaluation on light rail route alternative in the metropolitan Hsin-Chu area," Chung Hua Journal of Management, Vol. 6, No. 1, pp. 75-104, 2005.

[5] Deng, J., "Introduction to Grey system theory," The Journal of Grey Systems, Vol. 1, pp. 288-294, 1989.

[6] Dubois, D. and Prade, H., "Operations on fuzzy number," International Journal of System Science, Vol. 9, No. 6, pp. 613-626, 1978.

[7] Huang, M. H., "Weg Performance Scale," Information and Management, Vol. 2, No. 1, pp. 841-852, 2005.

[8] Hsieh T. H., "Research on developing an instrument of measuring service quality on online auction," Master thesis, Dept. of Business Administration, Soochow University, Taipei, 2006.

[9] Hwang, C. L. and Yoon, K., Multiple attribute decision making methods and applications, New York: Springer-Verlag, 1981.

[10] InsightXplorer Limited. (2009, Jul.) Survey of behaviors for online auction in Taiwan. <http://www.insightxplorer.com/specialtopic/2009 7 auction.htm>.

[11] Kettinger, W. J. and Lee, C. C., "Perceived service quality and user satisfaction with the information services function," Decision Science, Vol. 25, No. 5, pp, 737-766, 1994.

[12] L. Pin, Electronic Commerce, Taichung: Tsang Hai Book Publishing Co., 2007, ch 5.

[13] Loiacono, E. T., Waston, R. T. and Goodhue, D. L., "WEBQUALTM: a measure of web site quality," in Evans, K. and Scheer, L. (Eds), Marketing Educators' Conference: Marketing Theory and Applications, Vol. 13, American Marketing Association, New York, NO, pp. 432-437, 2002.

[14] Novak. T. P., Hoffman, D. L., and Yung, Y. F., "Measuring the customer experience in online environments: a structural modeling approach," Marketing Science, Vol. 19, No. 1, pp. 22-42, 2000.

[15] Opricovic, S., Tzeng, G. H., "Compromise solution by MCDM methods: A comparative analysis of VIKOR and TOPSIS," European Journal of Operational research, Vol. 156, No. 2, pp. 445-455, 2004.

[16] Parasuraman, A., Zeithaml, V. A., and Berry, L. L., "SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality," Journal of Retailing, Vol. 64, NO. 1, pp.12-40, 1988.

[17] Pitt, L. F., Waston, R. T., and Kavan, C. B., "Service quality: a measure of information systems effectiveness," MIS Quarterly, Vol. 19, No. 2, pp.173-187, 1995.

[18] Pohekar, S. and Ramachandran, M., "Application of multi-criteria decision making to sustainable energy planning - A view," Renewable and Sustainable Energy Review, Vol. 8, pp. 365-381, 2004.

[19] Saaty, T. L., The analytic hierarchy process: planning, priority setting, New York: McGraw Hill International Book Co, 1980.

[20] Shih. T. L., "Decision-making factors of C2C online auction: a case study of main online auction website in the cross-straits," Master thesis, Dept. of Business Administration in International Commerce, Tamkang University, Taipei, 2004.

[21] Shohreh, A. K., and Christine, B. I., "A proposal to assess the service quality of online travel agencies: an exploratory study," Journal of Professional Services Marketing, Vol. 21, No. 1, pp. 63-88, 2000.

[22] Sugeno, M., "Theory of fuzzy integral and its applications," Ph.D. Dissertation, Tokyo Institute of Technology, Japan.

[23] Tzeng, G. H, Teng, M. H., Chen, J. J. and Opricovic, S., "Multi-criteria selection for a restaurant location in Taipei," International Journal of Hospitality Management, Vol. 21, pp. 171-187, 2002.

[24] Wolfinbarger, M. and Gilly, M. C., "eTailQ: Dimensionalizing, measuring and predicting retail quality," Journal of Retailing, Vol. 79, pp. 183-198, 2003.

[25] Wu, H. Y., Tzeng, G. H. and Chen, Y. H., "A fuzzy MCDM approach for evaluating banking performance based on Balanced Scorecard," Expert Systems with Applications, Vol. 36, pp. 10135-10147, 2009.

[26] Xie, M., Wang H., and Goh, T. N., "Quality dimensions of internet search engines," Journal of Information Science, Vol. 24, No. 5, pp. 365-372, 1998.

[27] Yang, L. and Lee, H., "An AHP decision model for facility location selection," Facilities, Vol. 15, pp. 241-254, 1997.

[28] Yu, P. L., "A class of solutions for group decision problems," Management Science, Vol. 19, No. 8, pp. 936-946, 1973.

[29] Yuan Y. and Shaw, M. J., "Induction of fuzzy decision trees," Fuzzy Sets and Systems, Vol. 69, pp. 125-139, 1995.

[30] Zadeh, L. A., "Fuzzy sets," Information Control, Vol. 8, No. 3, pp. 338-353, 1965.

[31] Zadeh, L. A., "The concept of a linguistic variable and its application to approximate reasoning," Information Science (part I), Vol. 8, No. 3, pp. 199-249, 1975.

[32] Zadeh, L. A., "The concept of a linguistic variable and its application to approximate reasoning," Information Science (part II), Vol. 8, NO. 4, pp. 301-357, 1975.

[33] Zadeh, L. A., "The concept of a linguistic variable and its application to approximate reasoning," Information Science (part III), Vol. 9, No. 1, pp. 43-80, 1976.

[34] Zeleny, M., "Multiple criteria decision making," New York: McGraw-Hill, 1982.