Applying Fuzzy MCDM Methods to the Evaluation on Portal Website Service Quality

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Received : 12.02.2019 **Revised : 14.05.2019** **Accepted :12.08.2019**

***Abstract*—**In recent years, the Internet has been developed rapidly and brought great impact to various industries. In which, the portal website is the gate for the Internet access. In the progress of development, the portal website has been reformed from single to multi-functional and categorized services which stand out of the site. However, the quality of each site that users conceive differs from person to person. Among them, many intangible attributes are difficult to measure. Therefore, to overcome the obstacles of subjective respondents, we adopt the fuzzy set theory as the measurement of performance and obtain criteria's weights by using AHP. Furthermore, we rank each performance of service quality in VIKOR. In empirical application, the results are used for managerial reference in the four selected portal websites domestically.

***Keywords*—**AHP; Fuzzy Set Theory; Portal Website; Service Quality; VIKOR.

***Abbreviations*—**Analytic Hierarchy Process (AHP); Best Nonfuzzy Performance (BNP); Center-of-Area (COA); Multi-Criteria Decision Making (MCDM); Triangular Fuzzy Number (TFN); VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR); World Wide Web (WWW).

I. INTRODUCTION

WORLD Wide Web (WWW) has grown drastically which brings the user population new record high. Until the end of 2012, the statistics show that the online users has been over 10 millions whereas the prevalence of the Internet hits 48%, the TANet users to be 6.3 millions, and the mobile net users are 21 millions [Find, 7]. It shows the Internet has largely changed people's lifestyles in terms of entertainment, ways to obtain information, and receiving commercial messages.

An individual can experience all activities online; however, due to the diversification of the Internet, users must enter the Internet via portal websites. Namely, portal websites are the gateway of the Internet [Cohan, 5]. From the development of portal websites, most of sites are started by providing search engines. Furthermore, they are followed by other user-orientated services in a greater scale. Such as, e-mail, maps, forums, news services, etc. Nevertheless, with more and more portal websites, the variety of services and service quality influence the perception of users entering the sites. Thus, the evaluation of service quality of portal websites is an important issue.

The well-known for SERVQUAL scale [Parasuraman et al., 14] is an important tool which examine, extract, evaluate and analyze items of service quality for service and manufacturing industries. However, many scholars [Xie et al., 22] consider that the SERVQUAL scale must adapt moderately, so that it can be applied on related issues of online service quality. In addition, along with the progress of information technology, requirements for service quality of the Internet are constantly enhancing. This phenomenon is hard to be evaluated and explained by a single criterion, since it has become a decision problem of multiple criteria. And the further concerns are the subjective cognition which may be varied from evaluators to evaluators, including the unavoidable of uncertainty and fuzziness.

Multi-criteria decision making (MCDM) has been widely applied on the study of decision making for many years. Among which, the analysis of analytic hierarchy process (AHP) and VIKOR have been widely applied on various fields [Tzeng & Huang, 19]. Along with the introduction and

DOI: 10.9756/SIJCSEA/V7I4/03010020401
ISSN: 2321-2381

development of the fuzzy set theory [Zadeh et al., 27], many management and decision making problems can also be facilitated with the methods. In addition to avoiding uncertainty and ambiguity, the methods also obtain data more objectively.

This paper hopes to assess portal websites with good service quality by applying the fuzzy MCDM. Through the presentation of literature reviews, we then use AHP to establish a hierarchical structure of portal websites based on the goals, the dimension and the criteria for evaluation. We also implement experts' opinions and consider measured weights. Lastly, we take VIKOR to generate a list of rating order on portal websites service quality so that e-sellers can take this model as their managerial strategy into business.

II. Evaluation Framework and Methods of Portal Website Service Quality

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

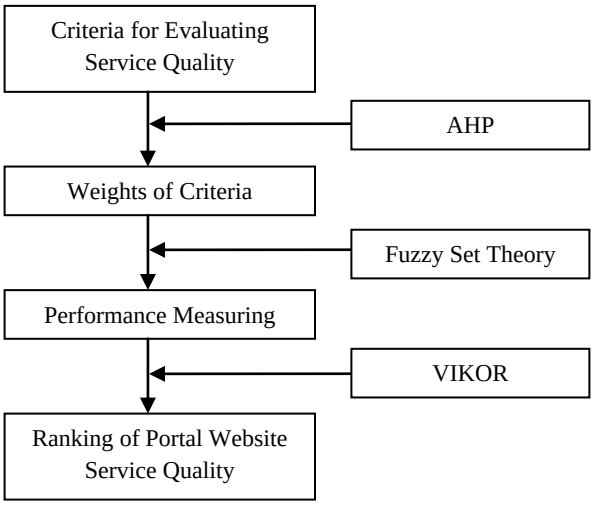

Figure 1: Evaluation Framework of Portal Website Service Quality

2.1. Portal Website Service Quality

Clarke & Flaherty [4] indicated that portal website is the entry point for Internet users to search information and also offers customizable service to enable Internet users to access to the needed information easily. Thus, portal website is used for any site that serves as an entry point to other content on the Internet. The so-called portal website refers to the website with which the internet users contact after starting web browser software and can link to other websites via this portal website or use the functions provided by this portal website.

Although service quality plays an increasingly important role in service marketing, it is difficult to reasonably quantify it because of the very nature of service itself. SERVQUAL was proposed by Parasuraman et al., [14] 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 [Huang, 8; Novak et al., 12] there is still some debate about using the evaluative tools by the five dimensions of SERVQUAL. Various papers praise its achievement of prevalence. In fact, the most important problem is whether it could be measured by the five dimensions. Xie et al., [22], 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. Such other related literatures are shown in Table 1. Through these literatures in Table 1, we establish a hierarchical framework by AHP method.

Table 1: Website Service Quality Dimensions as Articulated in Prior Studies

Authors / Dimensions	A	B	C	D	E	F	G	H
Responsiveness	●				●			●
Personalization	●	●	●			●		●
Site features	●							
Security	●		●			●		
Search engine and website catalog		●						
Electronic commerce		●						●
Tangible			●		●		●	
Reliable			●		●	●	●	●
Convenience			●				●	
Ease of use				●		●	●	●
Accessibility				●		●		
Empathy				●	●			

A: Chiang et al., [3]; B: Wang & Liu [20]; C: Ye et al., [25]; D: Kuo et al., [9]; E: Li et al., [10]; F: Yang & Jun [24]; G: Liu & Arnet [11]; H: Swaid & Wigand [17]

2.2. Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) was proposed by Thomas L. Saaty [16] 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 [Tzeng et al., 18; Yang & Lee, 23]. 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

DOI: 10.9756/SIJCSEA/V7I4/03010020401
ISSN: 2321-2381

hierarchy. Therefore, the AHP can be considered as both a descriptive tool and a prescriptive model for decision making.

The weighting of AHP is mainly determined by the decision-makers who conduct the pairwise comparisons, in order 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 condusect $C(n, 2)=n(n-1)/2$, pairwise comparisons. Moreover, 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.

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 reevaluation of pairwise comparisons, decisions obtained in certain cases can also be taken as the best alternative [Pohekar & Ramachandran, 15].

2.3. 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 [27] developed the fuzzy set theory, and Bellman & Zadeh [1] described the decision-making method in fuzzy environments. An increasing number of studies have also dealt with fuzzy problems by applying the 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 portal website service quality evaluation. This method for establishing portal website service quality can be made more objectively. The application of fuzzy set theory in this paper is elaborated as follows.

2.3.1. 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 & 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 "portal website 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 Figure 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.

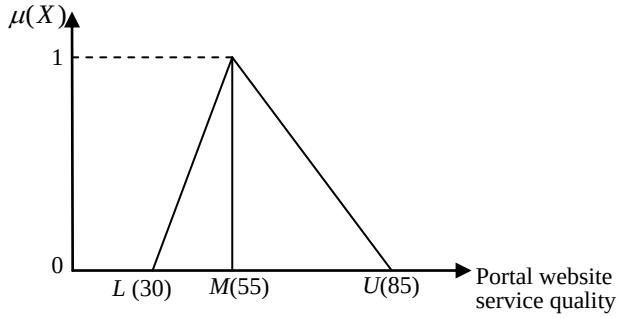

Figure 2: Triangular Membership Function of Fuzzy Numbers

According to the nature of TFN and the extension principle put forward by Zadeh [27], the algebraic calculation of the triangular fuzzy numbers are shown as follows.

The addition of triangular fuzzy numbers $\oplus$:

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

The multiplication of a 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*,

$$k \otimes \mu_A(X) = (k, k, k) \otimes (L, M, U) = (kL, kM, kU) \quad (3)$$

2.3.2. Linguistic Variables

According to Zadeh [28-30], 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 "portal website service quality". It means service quality that user experiences during use of the portal website. 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.

2.3.3. 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 (COA),

DOI: 10.9756/SIJCSEA/V7I4/03010020401
ISSN: 2321-2381

and α-cut Method [Zeleny, 31] 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. (4)

$$BNP_{ij} = [(U_{ij} - L_{ij}) + (M_{ij} - L_{ij})] / 3 + L_{ij},\ 1 \leq i, j \leq m \qquad (4)$$

2.4. VIKOR

VIKOR was proposed by Opricovic & Tzeng [13], 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 [Opricovic & Tzeng, 13; Yu, 26]. 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:

Step 1: Determine the best (aspired/desired levels) and worst (tolerable/worse levels) values. Assuming that *j*th 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 $S_i | i = 1, 2, \ldots, m$ and $R_i | i = 1, 2, \ldots, m$ from the L_P -metric referring to Eq. (5) with normalization. The relationships are presented in Eqs. (6) and (7).

$$L_{pi} = \{\sum_{j=1}^{n} [w_j (x_j^* - x_{ij}) / (x_j^* - x_j^-)]^p\}^{1/p}, \quad 1 \leq p \leq \infty, i = 1,2,\ldots,m \qquad (5)$$

$$S_i = \sum_{j=1}^{n} [w_j (x_j^* - x_{ij}) / (x_j^* - x_j^-)],\ \ i = 1,2,\ldots,m \qquad (6)$$

$$R_i = \max_j [w_j (x_j^* - x_{ij}) / (x_j^* - x_j^-)],\ \ i = 1,2,\ldots,m \qquad (7)$$

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 $Q_i | i = 1, 2, \ldots, m$ for ranking. The relation is defined as Eq.(8), where $S^* = \min_i S_i$ (the best S^* can be set equal zero), $S^- = \max_i S_i$ (the worst S^- can be set to equal one), $v \in [0,1]$ is introduced as the weight of the strategy of the "the majority of the criteria" (or "maximum group utility"), and usually $v = 0.5$. In this research, the value of v is set to equal 0, 0.5 and 1 for sensitive analyze.

$$Q_i = v[(S_i - S^*) / (S^- - S^*)] + (1 - v)[(R_i - R^*) / (R^- - R^*)],\ \ i = 1,2,\ldots,m \qquad (8)$$

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 the measure *Q* (minimum). If the following two conditions are satisfied:

C1. "Acceptable advantage": $Q(a'') - Q(a') \geq DQ$, 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, as the following:

- 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 it provides a maximum "group utility" of the "majority" (with the measure *S*, representing "concordance"), and a minimum individual regret of an "opponent" (with the measure *R*, representing "discordance"). The compromised solutions can be the basis for negotiations, by involving the criteria weights of the decision makers' preference [Wu et al., 21].

III. AN EMPIRICAL STUDY FOR ONLINE AUCTION

3.1. Survey

This study is surveyed on the basis of the population who are experienced in using portal websites. According to the magazine, Business Next, it indicates that there are 4 portal websites are ranked top 30 in Taiwan [Business Next, 2]; thus, this study is based on the 4 portal websites as the performance rating.

Four portal websites, which provide relative service including Responsiveness, Personalization, Site features, Security and Effectiveness, are selected to identify the critical criteria of evaluating e-service quality for portal websites. The above portal websites were the most natural choices from users' frequent uses. Among 286 surveys, 49 were invalid for a return rate of 38%. The demographic statistics indicate that 33% of respondents belong to the age groups of 21-25 and 31-35 years, and 72% received at least college education.

The questionnaire of service quality evaluation mainly was composed of two parts: questions for evaluating the relative importance of criteria and portal website 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 portal website,

DOI: 10.9756/SIJCSEA/V7I4/03010020401
ISSN: 2321-2381

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 selected four major portal websites as the objects of this empirical study. Take Portal Website A as a transnational corporation in America, which provides a series of Internet services, has a large group of users and the highest market share in this research. Portal Website B is the largest ISP in Taiwan and its main services include mobile communication, fixed communication and the Internet, holding the market share of 25% domestically. Portal Website C is the first website database in Taiwan. It owns its team of R&D and service experiences, providing capabilities of platform and technique integration for meeting the needs of enterprise e. The market share of Portal Website C is about 15%. Portal Website D is an ISP established by Microsoft. It provides multi services such as mail and news, and has even been the world second largest ISP. Although it does not take large market share in Taiwan, it owns its brand value.

3.2. The Weights of Evaluation Criteria

Figure 3 shows the relative weights of the five dimensions of service quality, which are obtained by applying AHP. The weights for each of the dimensions are: Responsiveness was 0.091, Personalization was 0.053, Site features was 0.066, Security was 0.524 and Effectiveness was 0.267. The weights described in general that users concern the most was Security, the second was Effectiveness, and the most unconcerned was Personalization.

Ranked by the weights, the top four evaluation criteria are system stability which was 0.157, credit card payment security which was 0.128, data transmission security which was 0.125 and shopping information security which was 0.113. These four criteria are over 50% summing. Apparently, users concern how well they are treated and served while using the process. System stability and security tend to allow users to feel relieved when using portal websites.

System stability can provide innovative service, and it also attracts more opportunities for users' visit. When the number of users increases, the value of the website increases as well as forming a competitive advantage. As for relative issues of security, if portal website is well secured for users, portal websites could promote utility rate and further create profits.

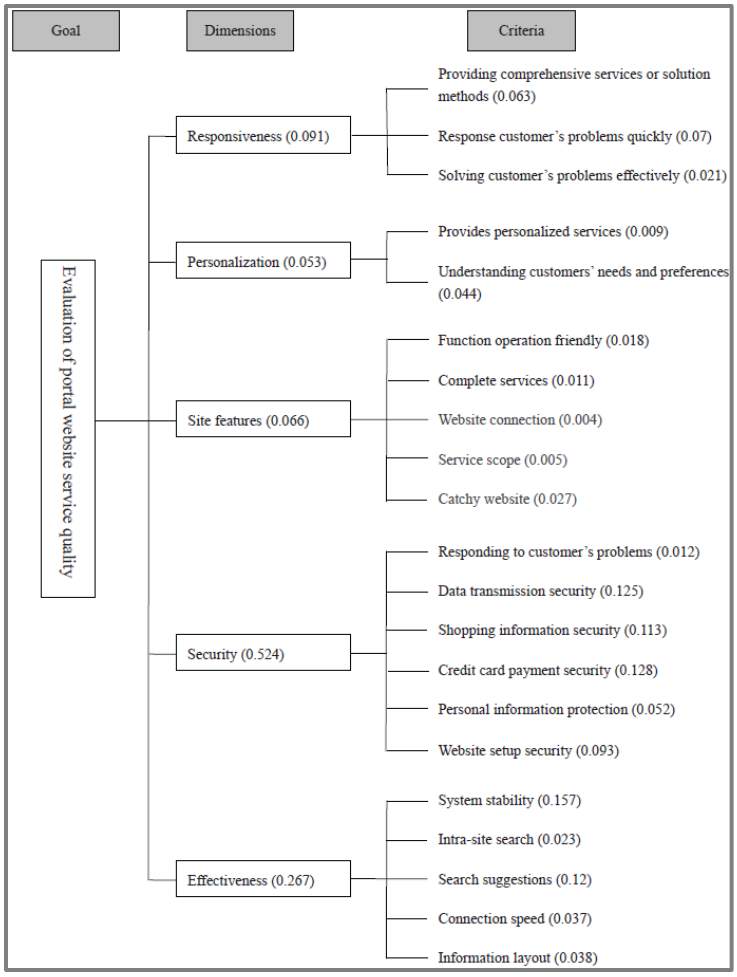

Figure 3: Weights of the twenty-one criteria

DOI: 10.9756/SIJCSEA/V7I4/03010020401
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Table 2: The Performance Matrix $[x_{ij}]_{m\times n}$ with the Best Value x_j^* and the Worst Value x_j^- by VIKOR

Evaluation criteria	Portal website A	Portal website B	Portal website C	Portal website D	x_j^*	x_j^-
Providing comprehensive services or solution methods[a]	80.65	85.13	86.22	90.24	90.24	80.65
Response customer's problems quickly[b]	84.96	85.91	84.04	85.35	84.04	75.91
Solving customer's problems effectively[a]	75.35	74.04	77.13	73.60	77.13	73.60
Provides personalized services[a]	70.53	72.23	73.57	70.09	73.57	70.09
Understanding customers' needs and preferences[a]	71.84	71.42	71.26	71.16	71.84	71.16
Function operation friendly[a]	88.42	89.98	88.10	87.84	89.10	87.84
Complete services[a]	70.60	71.61	7.24	72.57	72.57	70.60
Website connection[a]	68.42	68.42	66.52	67.19	68.42	66.52
Service scope[a]	80.09	82.72	83.13	81.84	83.13	80.09
Catchy website[a]	88.77	91.40	90.65	85.96	91.40	85.96
Responding to customer's problems[a]	77.89	80.09	83.13	78.40	83.13	77.89
Data transmission security[a]	82.28	79.21	83.22	81.89	83.22	79.21
Shopping information security[a]	81.40	81.40	78.27	79.21	81.40	78.27
Credit card payment security[a]	85.54	87.40	88.32	84.47	88.32	84.47
Personal information protection[a]	74.91	73.30	72.17	70.53	74.91	70.53
Website setup security[a]	85.91	85.79	85.21	85.09	85.91	85.09
System stability[a]	82.96	82.28	81.57	84.65	85.65	81.57
Intra-site search[a]	54.82	67.98	56.51	50.88	67.98	50.88
Search suggestions[a]	73.68	70.52	67.30	69.24	73.68	67.30
Connection speed[a]	73.23	69.52	70.39	71.59	73.23	69.52
Information layout[a]	85.62	90.57	84.69	85.75	90.57	84.69

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

[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.

3.3. Performance Measure of Service Quality and Ranking

From the criteria weights obtained from AHP (Figure 3.), the performance of alternatives corresponding to each evaluation criterion evaluated by respondents is measured as fuzzy numbers with the TFN. The performance of each respondent is calculated and obtains the overall performance measure for each portal website. Next, we use Center-of-Area method (as Eq.(4)) to defuzzify the fuzzy numbers, which are shown in Table 2, a table shows the performance matrix with the best value x_j^* (desired levels) and the worst value x_j^- (worst levels).

The values of S_i and R_i computed by Eqs. (6) - (7) are shown in Table 3, while the computed value Q_i (with v = 0, 0.5 and 1) by Eq. (8) and the preference order ranking is given in Table 4. The performance ranking order of the four portal website by VIKOR is Portal website A (Q_i = 0.0000) $\succ$ Portal website B (Q_i = 0.4388) $\succ$ Portal website C (Q_i = 0.7703) $\approx$ Portal website D (Q_i = 0.7791).

Table 3: The Values S_i and R_i by VIKOR

Portal websites	S_i	R_i
Portal website A	0.3699 (1)	0.0928 (1)
Portal website B	0.4544 (2)	0.1246 (2)
Portal website C	0.4788 (3)	0.1568 (4)
Portal website D	0.5487 (4)	0.1285 (3)
Note: ()indicates ranking order		

Table 4: The Value Q_i with v = 0, 0.5, 1 and Preference order Ranking by VIKOR for Sensitive Analysis

Portal websites	Q_i [v = 0]	Q_i [v = 0.5]	Q_i [v = 1]
Portal website A	0.0000 (1)	0.0000 (1)	0.0000 (1)
Portal website B	0.4977 (2)	0.4833 (2)	0.3799 (2)
Portal website C	1.0000 (4)	0.7703 (3)	0.5406 (3)
Portal website D	0.5582 (3)	0.7791 (4)	1.0000 (4)
Note: () indicates ranking order			

3.4. Discussion

This paper is conducted a performance analysis on four portal websites using fuzzy set theory and MCDM method based on evaluation of portal website. The AHP and the VIKOR method were employed in the performance analysis for computing the weights of the criteria, ranking the portal website performance and improving the gaps of the four

DOI: 10.9756/SIJCSEA/V7I4/03010020401
ISSN: 2321-2381

portal websites, 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 portal website performance. As shown in Figure 3, the result of the AHP analysis reveals that the "Security" is the primary focus of the service quality and "System stability" is the most important evaluation criterion. This is because portal websites are of a service industry, and the portal website performance is strongly connected to stability and security. Therefore, in order to encourage more users, every portal website has to protect and 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 helps decision makers to reach a final decision. Here, based on the weights of the evaluation criteria calculated by AHP, the performance ranking order the four portal website using are portal website A $\succ$ portal website B $\succ$ portal website C $\approx$ portal website D.

IV. CONCLUSIONS

The portal website is the first connection to enter the gate of the Internet for users, which is not only the origin of information access, but also the entrance to businesses and operations. However, the measure of service quality of portal websites is often a multiple-layer problem rather than a single dimension issue. Thus, this paper aims to look at the problem in every aspect and determines to offer a solution with multiple criteria of evaluation for advancing service quality-the key to influence users' preference when using a portal website.

In investigating both concerns, we establish the procedures to identify the most important criteria of service qualify for four portal websites based on the above criteria. The evaluation procedures consist of the following steps:

1) Identify the evaluation criteria for portal website service quality;
2) Assess the average importance of each criterion by AHP over all the respondents;
3) Represents the performance assessment of portal websites 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 four portal websites and compare with the result of Business Next.

The result indicates that "Security" outweighs all other dimensions. This shows that users care for the "Credit Card Payment Security", "Data Transmission Security" and "Shopping Information Security" on any portal website. Therefore, in order to encourage more uses, every portal website has to address to these concerns carefully. The second rank is "Effectiveness", which implies adequate information, including one portal website which will influence users' willingness to visit that website again. As for the dimensions, "Responsiveness", "Site Features" and "Personalization" must be intensive, so that the portal website will be subject to the users' preferences.

The final ranking results show that Portal Website A is the best of the four portal websites in terms of service quality, followed by Portal Website B, C and D. It is interesting to note that assessment of the service quality is not strongly reflected in the market share. This suggests that every portal website has a vital impact. As to the whole evaluation, if it is positive, it will promote users' willingness. Users' circles of friends and relatives are likely to be told of their good experience. The process will be a positive assistance for portal websites.

Finally, this paper emphasizes the method application, and the alternative methods 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.

ACKNOWLEDGEMENTS

This work was supported in part by the National Science Council of the Republic of China.

REFERENCES

[1] R.E. Bellman & L.A. Zadeh (1970), "Decision Making in a Fuzzy Environment", *Management Science*, Vol. 17, No. 4, Pp. 141–164.

[2] Business Next (2013), "2013 Top 100 in Taiwan", http://www.bnext.com.tw/article/view/id/26755, Retrieved June 2013.

[3] C. Chiang, C.C. Lee & G.H. Tzeng (2009), "A Non-Additive Model for the Evaluation on Portal Website Service Quality", *Journal of the Chinese Institute of Industrial Engineers*, Vol. 26, No. 5, Pp. 355–366.

[4] I. Clarke & T.B. Flaherty (2003), "Web-based B2B Portals", *Industrial Marketing Management*, Vol. 32, Pp. 15–23.

[5] P.S. Cohan (1999), "Net Profit: How to Invest and Compete in the Real World of Internet Business", *John Wiley & Sons, Inc*. New York, USA.

[6] D. Dubois & H. Prade (1978), "Operations on Fuzzy Number", *International Journal of System Science*, Vol. 9, Pp. 613–626.

[7] Find (2013), "2012 Q4 Internet Subscribers in Taiwan", http://www.find.org.tw/eng/news.asp?pos=0&subjectid=4&msgid=552, Retrieved Dec. 2013.

[8] M.H. Huang (2005), "Web Performance Scale", *Information and Management*, Vol. 42, Pp. 841–852.

[9] T. Kuo, I.Y. Lu, C.H. Huang & G.C. Wu (2005), "Measuring User's Perceived Portal Service Quality: An Empirical Study", *Total Quality Management*, Vol. 16, Pp. 309–320.

[10] Y.N. Li, K.C, Tan & M. Xie (2002), "Measuring Web-based Service Quality", *Total Quality Management*, Vol. 13, Pp. 685–700.

[11] C. Liu & K.P. Arnett (2000), "Exploring the factors Associated with Web Site Success in the Context of Electronic Commerce", *Information and Management*, Vol. 38, Pp. 23–33

[12] T.P. Novak, D.L. Hoffman & Y.F. Yung (2000), "Measuring the Customer Experience in Online Environments: A Structural Modeling Approach", *Marketing Science*, Vol. 19, Pp. 22–42.

[13] S. Opricovic & G.H. Tzeng (2004), "Compromise Solution by MCDM Methods: A Comparative Analysis of VIKOR and TOPSIS", *European Journal of Operational Research*, Vol. 156, Pp. 445–455.

DOI: 10.9756/SIJCSEA/V7I4/03010020401
ISSN: 2321-2381

[14] A. Parasuraman, V.A. Zeithaml & L.L. Berry (1988), "SERVQUAL: A Multiple-Item Scale for Measuring Consumer Perceptions of Service Quality", *Journal of Retailing*, Vol. 64, No. 1, Pp. 12–40.
[15] S. Pohekar & M. Ramachandran (2004), "Application of Multi-Criteria Decision Making to Sustainable Energy Planning - A View", *Renewable & Sustainable Energy Review*, Vol. 8, Pp. 365–381.
[16] T.L. Saaty (1980), "The Analytic Hierarchy Process: Planning, Priority Setting", *McGraw Hill International Book Co*, New York, USA.
[17] I.S. Swaid & R.T. Wigand (2009), "Measuring the Quality of e-Service: Scale Development and Initial Validation", *Journal of Electronic Commerce Research*, Vol. 10, No. 1, Pp. 13–28.
[18] G.H. Tzeng, M.H. Teng, J.J. Chen & S. Opricovic (2002), "Multicriteria Selection for a Restaurant Location in Taipei", *International Journal of Hospitality Management*, Vol. 21, Pp. 171–187.
[19] G.H. Tzeng & J.J. Huang (2011), "Multiple Attribute Decision Making: Methods and Applications", *CRC Press*, New York, USA.
[20] T.C. Wang & S.L. Liu (2004), "An Application of Fuzzy MCDM in Portal's Service Performance", *Electronic Commerce Studies*, Vol. 2, No. 3, Pp. 235–258.
[21] H.Y. Wu, G.H. Tzeng & Y.H. Chen (2009), "A Fuzzy MCDM Approach for Evaluating Banking Performance based on Balanced Scorecard", *Expert Systems with Applications*, Vol. 36, Pp. 10135–10147.
[22] M. Xie, H. Wang & T.H. Goh (1998), "Quality Dimensions of Internet Search Engines", *Journal of Information Science*, Vol. 24, No. 5, Pp. 365–372.
[23] L. Yang & H. Lee (1997), "An AHP Decision Model for Facility Location Selection", *Facilities*, Vol. 15, Pp. 241–254.
[24] Z. Yang & M. Jun (2002), "Consumer Perception of e-Service Quality: From Internet Purchaser and Non-Purchaser Perspectives", *Journal of Business Strategy*, Vol. 19, No. 1, Pp. 19–41.
[25] D.Y. Ye, C.H. Cheng & K.C. Huan (2008), "Applying Fuzzy Hierarchical TOPSIS to Evaluate Portal Site Service Quality", *Journal of Management & Systems*, Vol. 15, No. 3, Pp.439–466.
[26] P.L. Yu (1973), "A Class of Solutions for Group Decision Problems", *Management Science*, Vol. 19, No. 8, Pp. 936–946.
[27] L.A. Zadeh (1965), "Fuzzy Sets", *Information Control*, Vol. 8, Pp. 338–353.
[28] L.A. Zadeh (1975), "The Concept of a Linguistic Variable and its Application to Approximate Reasoning, Information Science －I", *Information Science*, Vol. 8, Pp. 199–249.
[29] L.A. Zadeh (1975), "The Concept of a Linguistic Variable and its Application to Approximate Reasoning, Information Science －II", *Information Science*, Vol. 8, Pp. 301–357.
[30] L.A. Zadeh (1976), "The Concept of a Linguistic Variable and its Application to Approximate Reasoning, Information Science －III", *Information Science*, Vol. 9, Pp. 43–80.
[31] M. Zeleny (1982), "Multiple Criteria Decision Making", *McGraw-Hill*, New York.

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DOI: 10.9756/SIJCSEA/V7I4/03010020401
ISSN: 2321-2381