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An e-service quality assessment of house rental websites based on the Kano model and Multiple Criteria Decision Making method (MCDM) in Taiwan

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Amidst the advanced Internet and mounting popularity in network users, information transmission has become easily accessible to all. As a natural result, house leasehold websites have been mushrooming exactly like bamboo shoots after a spring rain. How can these websites better strengthen services to create more competitive edge? This is exactly the very motive behind the present study. According to the study results, it is concluded that (i) an electronic service quality (e-SQ) scale proposed by ZPM (2005) is highly applicable to the e-SQ assessment of house rental websites; (ii) the three criteria of greatest importance are contact, responsiveness and compensation, which all belong to restored dimensions; (iii) compared with DEMATEL graphics, Kano graphics can present a more authentic world and provide more precise information concerning decision making.

Key words: ANP, e-service quality, house rental website, Kano model, multiple criteria decision making method (MCDM).

INTRODUCTION

With the trend of growing aging population with low birthrate (Ministry of the Interior Website, 2011), the aging population problem will become more serious in the future and the younger generation will have to spend more to take care of the older generation. The older generation would otherwise choose a mortgage to support themselves and reduce their children's burden.

The Financial Supervisory Commission in Taiwan is discussing a policy whereby the older people sell their house in instalments in order to support themselves. Nevertheless, house prices may rise because of extensions to mortgage years. Consequently, developing the house rental market ought to be an effective way of restraining the rise in house prices [DGBAS, 2008; Institute for Physical Planning and Information, 2009]. The Institute for Physical Planning & Information pointed out the housing need in Taiwan in the first half, 2009 through its studies that up to 67% of the new house tenants believe that they could not at all pay for buying a house. In the five major metropolis regions (Taipei City, Taipei County, Taoyuan/Hsinchu County/City, Taichung County/City and Kaohsiung County/City), the house price and income ratio is 6.65 times. The house loan burden eats out 27.69% of their income. Among those regions, Taipei City citizens shoulder the heaviest house price ratio, at 8.89 times of their income, with loan percentages of up to 33.56%. Further, as indicated by the household revenues and expenditures reports officially revealed by

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the Directorate-General of Budget, Accounting and Statistics, Executive Yuan, Republic of China in 2008, the house ownership ratio has reduced from 88.14 to 87.36% and house leasehold ratio from 7.89 to 8.37%. Nobody would be wealthy enough unless he or she owns land. That very firm concept makes the house prices consistently going high, bringing heavy burden to house buyers, especially in the metropolis area, making the house dwellers to use their houses by only leasehold. The report on wideband network use revealed by the Taiwan Network Information Center 2010 suggests that in Taiwan, up to 16.22 million of the total population use wideband, as popular as 67.21% to the total population. Market Intelligence & Consulting Institute anticipated that in 2009, the Internet shopping values in the online markets came to NT$31.16 billion, growing by 30.4% over the preceding year. The computer use statistics conducted by Directorate-General of Budget, Accounting and Statistics, Executive Yuan, Republic of China 2008 indicate that up to 56,500 households use computers rendering selling or services, selling up to 12.91% which would account for more than 25% of the total sales values. These figures suggest that e-commerce must inevitably become next stellar industry. The ones who own and operate a superior electronic quality services commercial website will gain strengthened advantage in boosting their enterprises.

In recent years, the popularity of the Internet and the e-commerce on the rise [DGBAS, 2008; 23] will help firms to enhance their competitive advantage. The major motive of this research is to determine how to improve service quality of house rental websites in order to obtain their best competitive advantage. Based on the research background and motivation, this study intends to achieve the following goals: to build up the criteria of an e-service quality assessment questionnaire on house rental websites; to study the relational influences of these criteria; and to explore the degree of importance of these criteria, as well as the performance of the assessment plan.

Literature review

P.Z.B Model

Gronroos (1982) defined service quality as the comparison result between customers' expectations and their perception toward services. Later, Parasuraman et al. (1985), extended Gronroos's definition, and they suggested that service quality should be based on a customer's perception, which is the gap between perceived quality and expected quality. The PZB Model and SERVQUAL, also proposed by them, are widely accepted and applied. Moreover, after Parasuraman et al. 1988, added external communication as an additional influential factor of customers' expected service, Yang (2009), a domestic scholar of quality management, added service price as a new factor. Therefore, there are five factors, namely, word of mouth, personal needs, past experience, external communication and service price.

Parasuraman et al. (1990) integrated the ten factors of measuring service quality, concluded before, into five major factors of SERVQUAL. These are formality, reliability, responsiveness, guaranty and empathy (Parasuraman et al., 1985). By connecting these factors with the gap-causing problems, they came up with an expanded model of service quality. Electronic Service Quality (e-SQ) may be understood by other scholars to be website service quality or online service quality. In this study, it was understood to be e-SQ for the sake of consistency. Zeithaml et al. (2005) defined e-SQ as the increased level of effectiveness of products and services, which are delivered via a website. Additionally, the conceptual model of e-SQ was proposed by the three scholars in 2002, and has been used to teach the differences between customers' perceptions and those of practitioners' with regard to the service quality of an e-commerce website (Zeithaml et al., 2005). According to the three scholars, when a service is provided for customers through a website, there are four gaps that prevent e-SQ to meet customers' expectations. These gaps are the design, communication, information and fulfilment gaps.

Based on the criteria, namely efficiency, system availability, fulfilment, privacy, responsiveness, and compensation, as well as contact, Zeithaml et al. furthered their research in 2005. They used an e-SQ scale that they had developed to undertake empirical research on Amazon online bookstores and Wal-Mart shopping websites. Their research achieved tremendous results (Zeithaml et al., 2000). This study was also based on the criteria mentioned above. However, as the pattern of online bookstores and shopping websites is different for house rental websites, it was inappropriate to directly adopt the assessment model mentioned above. Therefore, the assessment criteria of e-SQ ought to be modified with the help of experts. It is hopeful that the suggestions given by experts and scholars can make the assessment criteria more applicable to the research on house rental websites.

The e-SQ of various types of website

The Internet can be divided into four major types in terms of its transaction objectives, namely B2C, B2B, C2C and P2P (Turban and Lang, 2009). (1) B2C (Business to Consumer): this refers to an e-commerce operational model in which firms use the Internet to trade with customers and provide commercial services for them. Laudon and Traver (2004) pointed out that it mainly includes: 1. Portal; 2. e-Tailer; 3. Content Provider; 4. Transaction Broker; 5. Market Creator; 6. Service Provider; and 7. Community Provider. (2) B2B (Business to Business): this refers to an e-commerce operational

model which is used to integrate the information of different firms through the Internet. Laudon and Traver, 2004 suggested that it included: 1. e-Distributor; 2. e-Procurement; 3. Marketplace; 4. Industry Consortia; 5. Private Industrial Network; and 6. Industrial Network. (3) C2C (Consumer to Consumer): this refers to an e-commerce operational model that allows a large number of buyers and sellers to communicate in order to provide information for each other to share. A typical example is eBay. (4) P2P (Peer to Peer): through P2P, users can share with each other the soft and hardware resources, but they may often have concerns that their intellectual property rights will be violated by others.

The above literature shows that e-SQ assessment criteria frequently appear and can enjoy a high level of application to different types of website. Therefore, in this study, they are adopted as the basic criteria for the e-SQ assessment of house rental websites. The assessment criteria of e-SQ should be modified with the help of experts and scholars as well as the Fuzzy Delphi method. It is hopeful that the suggestions given by the experts can make the assessment criteria more applicable to research on house rental websites.

Kano model

The Kano model was proposed by the Japanese quality controller, Kano et al. (1984). They extended the Motivation-Hygiene Theory, proposed by Herzberg (Herzberg, 1959), into the field of quality management, pointing out that the sufficiency of quality factors and customer satisfaction are not traditionally one-dimensionally related, but two-dimensionally related. The attributed differences are attractive quality, one-dimensional quality and must-be quality, as well as indifferent quality, and even reverse quality.

The classification of quality attributes in this study is in accordance with the two-dimensional quality attribute classification version, which was modified by Matzler and Hinterhuber (1998). A is attractive quality; O is one-dimensional quality; M is must-be quality; I is indifferent quality; R is reverse quality. They are classified based on the quality attributes of the largest number of samples. When these samples are non-existent and there is no significant difference between these samples, these quality attributes are regarded as multiple quality attributes (Yang, 2009).

According to Matzler et al. (1996), traditional two-dimensional quality attributes take M>O>A>I as the prior ranking of improvement. However, some peoples pointed out that taking the relational influence between quality attributes into account, it is necessary to make proper modifications based on the two-dimensional graphic so that the research results will be more valuable for decision making. If the reverse quality attribute is added, it is necessary to stop putting more resources so as to avoid wasting resources and decreasing customer satisfaction (Lee, 2008).

Based on the viewpoint mentioned above, this study adopted the Multiple Criteria Decision Making method (MCDM) as the research method to ascertain the real ranking of e-SQ factors of house rental websites. In addition, with the concepts of aspired level and assessment plans as examples, this study has put forward some suggestions for improvements.

METHODOLOGY

Assessment dimensions and criteria

The dimensions and criteria of this study are based on the assessment scale of e-SQ proposed by ZPM (Zeithaml, 2002). In accordance with the differences between website operational models and with reference to research on various websites, this study has made a proper modification to the dimensions and criteria.

Additionally, with the help of experts and scholars (by sending questionnaires to them), the dimensions and criteria were further improved.

With reference to the Fuzzy Delphi proposed by Hsu et al. (2007), this study adopted the 0~10 grading method, meaning that a higher grade represents better applicability. It is assumed that α-cut is 6.0. Then, experts of different expertise give the highest grade (the most appropriate grade: A^i), the minimum grade (the most pessimistic grade:C^i), as well as the maximum grade (the most optimistic grade:O^i). In addition, these experts put down their suggestions and opinions attached to the questionnaires so that their ideas could be fully expressed. The specialist consensus value (G^i) was calculated based on the double-triangle fuzzy number proposed by Cheng (2001), which is more objective than the single-triangle fuzzy number, in order to integrate the experts' perceptions. The convergent gray zone test can then be used to test whether specialist consensus value is convergent or not.

The method of establishing the double-triangle fuzzy number is to take each minimum value (C^i_L, O^i_L), and maximum value (C^i_U, O^i_U), as well as the geometric mean (C^i_M, O^i_M) of C^i and O^i. Furthermore, this study referred to the water-jumping rules of the Fédération Internationale de Natation Amateur (FINA), which is a marking method involving 5 judges and 7 judges, as the way of deleting the extreme values.

According to the loose standard (5:2) and strict standard (7:4), the highest and lowest extreme values are directly deleted and the differences in the results can be observed (Tables 4-7).

The research framework

This study is based on the criteria of the e-SQ assessment scale proposed by Zeithaml et al. (2000), and adopts the Fuzzy Delphi Method (FDM) which requires scholars and professionals to modify the criteria so as to meet the requirements of an e-SQ assessment of house rental websites. In addition, the DEMATEL was used to analyze the relational influences of these criteria and a DEMATEL with ANP was adopted as the weight calculation of these criteria. The performance value was calculated by multiplying the weight with the satisfaction value drawn from the questionnaires.

Finally, the method of VIseKriterijumaka Optimizacija I Kompromisno Resenje (VIKOR) was adopted to arrange the calculation order of the assessment plan and how to achieve the aspired level was considered in order to put forward suggestions for improving the e-SQ of house rental websites.

This study assumes that the criteria of the e-SQ assessment scale, proposed by ZPM (Zeithaml et al., 2005), were inter-

influenced. Additionally, with the aim of exploring the best assessment plan of e-SQ, an e-SQ assessment framework of house rental websites was established (Figure 2).

ANALYSIS METHOD

DEMATEL

A DEMATEL can help to effectively explore the complex causal structure. Through observation of the influence degree of two factors, and by using a matrix and its related mathematic theory, the causal relation and its influence degree of all factors can be figured out. A DEMATEL can be generally divided into the following steps:

(1) Figuring out the average matrix: Suppose there are R experts and factors in this study, and each expert is required to indicate the influence level of *i* on *j*, then a comparative matrix a_{ij} will be formed between each of two factors. In this matrix, the contact is orderly represented by 0, 1, 2, 3, 4, meaning no influence (0), low-level influence (1), middle-level influence (2), high-level influence (3), and extremely high-level influence (4). All these values made by the experts can form a $n \times n$ matrix of non-negative value $X^k = \left[X_{ij}^k \right] \; 1 \le k \le R$, which indicates that $X^1, X^2, ..., X^R$ represents each matrix of non-negative value among the R experts. Each factor x_{ij}^k of X^k is an integer and diagonal factor of each answer matrix $\boldsymbol{X}^k$ and is set at 0. It can then calculate the average matrix $n \times n$ *A* of the R experts. The formula for calculation is as follows:

$$a_{ij} = \frac{1}{R} \sum_{k=1}^{R} x_{ij}^k \tag{3}$$

The average matrix $A=a_{ij}$ can be also called a direct relational matrix. *A* represents the initial relational influence of one factor to the others. In addition, in accordance with the causal relationship of each pair of factors, a direct relationship graphic can be drawn.

(2) The calculation of standardized direct relational matrix: a standardized direct relational matrix *D* is drawn from the average matrix *A*, and the formula is:

$$s = \max\left(\max_{1 \le i \le n} \sum_{j=1}^{n} a_{ij}, \max_{1 \le j \le n} \sum_{i=1}^{n} a_{ij} \right) \tag{4}$$

If

$$\boldsymbol{D} = \frac{\boldsymbol{A}}{s} \tag{5}$$

Then

In matrix *A*, the sum of each line j represents the total direct influence of *i*, $\max_{1 \le j \le n} \sum_{i=1}^{n} a_{ij}$ indicating the greatest direct influence of the influenced factor. *S* represents the upper value, which is the larger one. The matrix *D* is drawn through differentiating each factor in *A* by *s*. The value of each factor d_{ij} in matrix *D* is between 0 and 0.99.

(3)The calculation of total relational matrix: the indirect influence of each question factor keeps decreasing with the increase of power. For example, $\boldsymbol{D^2}, \boldsymbol{D^3}, \ldots, \boldsymbol{D^\infty}$, the convergent answer is confirmed as a reversed matrix, which is similar to a Markov chain matrix, $\lim_{R \to \infty} \boldsymbol{D^R} = [0]_{n \times n}$ and $\lim_{R \to \infty} (\boldsymbol{I} + \boldsymbol{D} + \boldsymbol{D^2} + \boldsymbol{D^3} + \ldots + \boldsymbol{D^R}) = (\boldsymbol{I} - \boldsymbol{D})^{-1}$, in which 0 is $n \times n$ zero matrix, while *I* is $n \times n$ unit matrix, and the total relational matrix *T* is $n \times n$ matrix. The definition is:

$$\boldsymbol{T} = \lim_{R \to \infty} \left(\boldsymbol{D} + \boldsymbol{D^2} + \boldsymbol{D^3} + \cdots + \boldsymbol{D^R} \right) = \boldsymbol{D}(\boldsymbol{I} - \boldsymbol{D})^{-1} \tag{6}$$

(4) Drawing the causal graphic: $T = \left[t_{ij} \right] \; t_{ij} = 1, 2, \ldots, n$ is the factor of the total relational matrix T, the sum of the lines and that of the rows are represented by r_i and c_j. The definition is:

$$r_i = \left(\sum_{j=1}^{n} t_{ij} \right)_{n \times 1} \tag{7}$$

$$c_j = \left(\sum_{i=1}^{n} t_{ij} \right)'_{1 \times n} \tag{8}$$

$\boldsymbol{r}_i$ represents the total direct or indirect influence of i on other factors; $\boldsymbol{c}_j$, as a result of j, represents the sum of influence by other factors. ($\boldsymbol{r}_i + \boldsymbol{c}_j$) is called prominence, representing the total level of influence and being influenced through this factor. It can indicate the prominence of the factors in the questions; ($\boldsymbol{r}_i - \boldsymbol{c}_j$) and is called relation. If the result is a positive value after subtraction, this means the factor is inclined to be cause-oriented; if it is a negative value, the factor is inclined to be influence-oriented. The causal graphic is drawn with ($\boldsymbol{r}_i + \boldsymbol{c}_j$, $\boldsymbol{r}_i - \boldsymbol{c}_j$) as the ordered pair, ($\boldsymbol{r}_i + \boldsymbol{c}_j$) as the X-axis and ($\boldsymbol{r}_i - \boldsymbol{c}_j$) as the Y-axis. Therefore, the causal graphic can simplify complicated causal relationships into a simple structure so as to explore in depth problems and provide solutions. Furthermore, with the help of this graphic, decision makers can make appropriate decisions based on the cause-oriented or influence-oriented factors.

DANP

Yang et al. (2008) pointed out that in the super matrix of ANP, the

method of standardization treatment is to assume that each dimension has the same weight. The method of integrating DEMATEL and ANP was instigated to solve this problem, and the empirical results show that this method is more consistent with real application.

This method is divided into the following steps:

(1) Establishing an unweighted supermatrix: obtaining the influential relation matrix of total significance of criteria from DEMATEL, each influence level of criterion is considered as a standardization, the formula is as follows (Equation 9):

$$T_E = \begin{array}{c} \\ B_1 \\ \\ \\ \\ B_2 \\ \\ \\ \\ B_n \\ \\ \end{array} \begin{array}{c} \begin{array}{cccc} E_{11}\cdots E_{1m_1} & E_{21}\cdots E_{2m_2} & \cdots & E_{n1}\cdots E_{nm_n} \end{array} \\ \begin{bmatrix} T_E^{11} & T_E^{12} & \cdots & T_E^{1n} \\ & & & \\ T_E^{21} & T_E^{22} & \cdots & T_E^{2n} \\ & & & \\ \vdots & \vdots & \ddots & \vdots \\ T_E^{n1} & T_E^{n2} & \cdots & T_E^{nn} \end{bmatrix} \end{array} \quad (9)$$

After the standardization of the influence matrix of total significance of criteria T_E, we can obtain T_E^{α}, and the result is shown in Equations 10.

$$T_E^{\alpha} = \begin{array}{c} \\ B_1 \\ \\ \\ \\ B_2 \\ \\ \\ \\ B_n \\ \\ \end{array} \begin{array}{c} \begin{array}{cccc} E_{11}\cdots E_{1m_1} & E_{21}\cdots E_{2m_2} & \cdots & E_{n1}\cdots E_{nm_n} \end{array} \\ \begin{bmatrix} T_E^{\alpha 11} & T_E^{\alpha 12} & \cdots & T_E^{\alpha 1n} \\ & & & \\ T_E^{\alpha 21} & T_E^{\alpha 22} & \cdots & T_E^{\alpha 2n} \\ & & & \\ \vdots & \vdots & \ddots & \vdots \\ T_E^{\alpha n1} & T_E^{\alpha n2} & \cdots & T_E^{\alpha nn} \end{bmatrix} \end{array} \quad (10)$$

In which, the method of $T_E^{\alpha 11}$ standardization is shown in Equations 9 and 10. The other $T_E^{\alpha nn}$ can be calculated with the method mentioned earlier.

$$d_i^{11} = \sum_{j=1}^{m_1} t_{ij}^{11}, \quad i, j = 1, 2, ..., m_1 \quad (11)$$

$$T_E^{\alpha 11} = \begin{bmatrix} t_{11}^{11}/d_1^{11} & \cdots & t_{1j}^{11}/d_1^{11} & \cdots & t_{1m_1}^{11}/d_1^{11} \\ \vdots & & \vdots & & \vdots \\ t_{i1}^{11}/d_i^{11} & \cdots & t_{ij}^{11}/d_i^{11} & \cdots & t_{im_1}^{11}/d_i^{11} \\ \vdots & & \vdots & & \vdots \\ t_{m_1 1}^{11}/d_{m_1}^{11} & \cdots & t_{m_1 j}^{11}/d_{m_1}^{11} & \cdots & t_{m_1 m_1}^{11}/d_{m_1}^{11} \end{bmatrix} = \begin{bmatrix} t_{11}^{\alpha 11} & \cdots & t_{1j}^{\alpha 11} & \cdots & t_{1m_1}^{\alpha 11} \\ \vdots & & \vdots & & \vdots \\ t_{i1}^{\alpha 11} & \cdots & t_{ij}^{\alpha 11} & \cdots & t_{im_1}^{\alpha 11} \\ \vdots & & \vdots & & \vdots \\ t_{n1}^{\alpha 11} & \cdots & t_{nj}^{\alpha 11} & \cdots & t_{nm_1}^{\alpha 11} \end{bmatrix} \quad (12)$$

According to the interrelationship of groups, the standardization of the influence matrix of total significance of criteria can be filled up and form a supermatrix, as shown in Equation 13:

$$W = \begin{array}{c} \\ B_1 \\ \\ \\ \\ B_2 \\ \\ \\ \\ B_n \\ \\ \end{array} \begin{array}{c} \begin{array}{cccc} E_{11}\cdots E_{1m_1} & E_{21}\cdots E_{2m_2} & \cdots & E_{n1}\cdots E_{nm_n} \end{array} \\ \begin{bmatrix} W^{11} & W^{12} & \cdots & W^{1n} \\ & & & \\ W^{21} & W^{22} & \cdots & W^{2n} \\ & & & \\ \vdots & \vdots & \ddots & \vdots \\ W^{n1} & W^{n2} & \cdots & W^{nn} \end{bmatrix} \end{array} \quad (13)$$

Then, according to $T_E^{\alpha 11}$, W^{11} is transformed, as shown in Equations 14:

$$W^{11} = \left[T_E^{\alpha 11}\right]' = \begin{bmatrix} t_{11}^{\alpha 11} & \cdots & t_{1j}^{\alpha 11} & \cdots & t_{1m_1}^{\alpha 11} \\ \vdots & & \vdots & & \vdots \\ t_{i1}^{\alpha 11} & \cdots & t_{ij}^{\alpha 11} & \cdots & t_{im_1}^{\alpha 11} \\ \vdots & & \vdots & & \vdots \\ t_{n1}^{\alpha 11} & \cdots & t_{nj}^{\alpha 11} & \cdots & t_{nm_1}^{\alpha 11} \end{bmatrix}' \quad (14)$$

(2) Obtaining a weighted supermatrix: the influence matrix of total significance of dimensions is shown in Equation 15, with the influence level of each dimension as a standardization.

$$T_B = \begin{bmatrix} t_B^{11} & \cdots & t_B^{1j} & \cdots & t_B^{1n} \\ \vdots & & \vdots & & \vdots \\ t_B^{i1} & \cdots & t_B^{ij} & \cdots & t_B^{in} \\ \vdots & & \vdots & & \vdots \\ t_B^{n1} & \cdots & t_B^{nj} & \cdots & t_B^{nn} \end{bmatrix} \quad (15)$$

After the standardization of the influence matrix of total significance of dimensions T_B, we can obtain T_B^{α}, and the result is shown as follows:

$$d_i = \sum_{j=1}^{n} t_{ij}, \quad i, j = 1, 2, ..., n \quad (16)$$

$$T_B^{\alpha} = \begin{bmatrix} t_B^{11}/d_1 & \cdots & t_B^{1j}/d_1 & \cdots & t_B^{1n}/d_1 \\ \vdots & & \vdots & & \vdots \\ t_B^{i1}/d_i & \cdots & t_B^{ij}/d_i & \cdots & t_B^{in}/d_i \\ \vdots & & \vdots & & \vdots \\ t_B^{n1}/d_n & \cdots & t_B^{nj}/d_n & \cdots & t_B^{nn}/d_n \end{bmatrix} = \begin{bmatrix} t_B^{\alpha 11} & \cdots & t_B^{\alpha 1j} & \cdots & t_B^{\alpha 1n} \\ \vdots & & \vdots & & \vdots \\ t_B^{\alpha i1} & \cdots & t_B^{\alpha ij} & \cdots & t_B^{\alpha in} \\ \vdots & & \vdots & & \vdots \\ t_B^{\alpha n1} & \cdots & t_B^{\alpha nj} & \cdots & t_B^{\alpha nn} \end{bmatrix} \quad (17)$$

the standardization of influence matrix of total significance of dimensions T_B^{α} into the unweighted matrix were then completed and form a supermatrix, as shown in Equation 18:

$$W^* = \begin{bmatrix} t_B^{\alpha 11} \times W^{11} & t_B^{\alpha 21} \times W^{12} & \cdots & \cdots & t_B^{\alpha n1} \times W^{1n} \\ t_B^{\alpha 12} \times W^{21} & t_B^{\alpha 22} \times W^{22} & \vdots & & \vdots \\ \vdots & \cdots & t_B^{\alpha ji} \times W^{ij} & \cdots & t_B^{\alpha ni} \times W^{ni} \\ \vdots & & \vdots & & \vdots \\ t_B^{\alpha 1n} \times W^{n1} & t_B^{\alpha 2n} \times W^{n2} & \cdots & \cdots & t_B^{\alpha nn} \times W^{nn} \end{bmatrix} \quad (18)$$

In order to obtain the limit supermatrix, the weighted matrix was multiplied many times and the limit super-matrix was obtained. The authors can then calculate the weight of each assessment criterion.

$$\lim_{h\to\infty} = W^h$$

Where W stands for limit supermatrix and h stands for any number.

VIKOR ranking method

Opricovic and Tzeng (2004) suggested that a VIKOR should be used for the order of plans so that different distance conceptions can be considered. As for Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), when several plans drop at the diagonal line, the assessment values are the same, but the actual plans are different from the distance of the ideal solution. So, with some compromise, a TOPSIS can be used to find out the plan which is closest to the ideal solution. The main executive steps are described as follows.

(1) Finding out the ideal solution and non-ideal solution: Confirm the best and worst value of each assessment criterion so as to calculate the difference between the ideal solution and non-ideal solution of each plan. This can be calculated from Equations 16 and 17. f_i^* is the ideal solution of *i,* and f_i^- is the non-ideal solution of *i*. If all the criteria of a plan achieve ideal solutions, this means that all the criteria achieve the best effect, namely the aspired level.

$$f_i^* = \max_j f_{ij} \; ; \; j = 1,2,\cdots,n \quad (19)$$

$$f_i^- = \min_j f_{ij} \; ; \; j = 1,2,\cdots,n \quad (20)$$

(2) The calculation of distance: The authors can adopt Equations 18 and 19 to calculate the distance of each plan and criterion. S_k Means the ratio of distance of plan *K* and the ideal solution. R_k Means the ratio of distance of plan *K* and the non-ideal solution. w_i Is the weight of each criterion based on DEMATEL with ANP. f_{ij} Is the performance of each criterion through the collected questionnaires.

$$S_k = \sum_{i=1}^{n} w_i (f_i^* - f_{ik}) / (f_i^* - f_i^-) \quad (21)$$

$$R_k = \max_i [(f_i^* - f_{ik}) / (f_i^* - f_i^-)] \quad (22)$$

(3) Calculating the comprehensive index: In order to ascertain the plan order, Equation 20 was used to calculate the comprehensive index Q_k . The closer it is to 0, the closer will it be to the ideal solution. This is made as the basis of plan order.

$$S^* = \min_k S_k, \quad S^- = \max_k S_k, \quad R^* = \min_k R_k, \quad R^- = \max_k R_k,$$

the value of $\min_k S_k$ represents the maximum group effect, and the value of $\max_k R_k$ represents the minimum individual regret. v Means strategic weight. If v is larger, more people will prefer the majority's decision. Conversely, they may prefer the minimum objection. Generally, v =0.5, which can be adjusted according to the need.

$$Q_k = v(S_k - S^*)/(S^- - S^*) + (1-v)(R_k - R^*)/(R^- - R^*) \quad (23)$$

EMPIRICAL RESULT ANALYSIS

The empirical analysis of criterion applicability

This study adopted the convergent gray zone test to undertake a questionnaire survey on 10 scholars and 5 senior managers who were from the fields of e-commerce, property management and quality management. Subsequently, the data from the questionnaires were analyzed. Two different methods were used for the analysis process and the results testing, which were not removing extreme value (5:2/7:4). Finally, an observation was made for the differences in the analysis results. Table 1 shows the result of the assessment criteria with the method of not deleting extreme value. It indicates that the testing result of fulfilment, compensation and contact was a negative value, which means that the gray zone was larger than the average geometric range. So even though the cross point of the double-triangle fuzzy number can be calculated, it cannot represent the special consensus value. Table 2 is the result of the assessment criteria with the method of deleting extreme value (5:2). It indicates that the Z^i of all criteria were below 0 or equivalent to 0, meaning that there was no gray zone. Hence, the geometric mean of double-triangle fuzzy number can be used to calculate the arithmetic average as the special consensus value. The result showed that after the deletion of extreme value, the gray zone can be reduced in order to find out the specialists' consensus value. Table 3 is the result of the assessment criteria with the method of deleting extreme value (7:4). It indicates that if the ratio of deleting extreme value is over large, the testing result will tend to be in between, and then the results have little difference from the majority's decision. To sum up, this study adopted the ratio of 5:2. As there were 15 samples, the highest and lowest of the three extreme values were directly deleted. It was assumed

Table 1. The result of assessment criteria with the method of non-deleting extreme value.

Assessment criterion	minC^i		maxO^i		Geometric mean		Gray zone	Range	Testing value	Consensus value
	min	max	min	max	C^i_M	O^i_M	Z^i	M^i	M^i-Z^i	G^i
Efficiency	5	10	8	10	7.189	9.504	2	2.315	0.315	8.697
Systematic availability	5	10	8	10	6.631	9.026	2	2.395	0.395	8.467
Fulfillment	2	10	5	10	6.635	9.211	5	2.576	-2.424	-
Privacy	5	10	8	10	7.603	9.647	2	2.044	0.044	8.815
Responsiveness	1	9	7	10	5.923	8.829	2	2.906	0.906	7.746
Compensation	1	10	5	10	5.907	8.612	5	2.705	-2.295	-
Contact	3	10	7	10	6.328	8.750	3	2.422	-0.578	-
							(α-cut) = 6.0		Number of criteria = 4	

- Represents Z>M, gray zone is over large, no common value.

Table 2. The result of assessment criteria with the method of deleting extreme value (5:2).

Assessment criterion	minC^i		maxO^i		Geometric mean		Gray zone	Range	Testing value	Consensus value
	min	max	min	max	C^i_M	O^i_M	Z^i	M^i	M^i-Z^i	G^i
Efficiency	7	8	9	10	7.211	9.769	-1	2.558	3.558	8.490
Systematic availability	5	8	8	10	6.676	9.081	0	2.405	2.405	7.879
Fulfillment	6	8	9	10	7.302	9.769	-1	2.467	3.467	8.536
Privacy	7	9	9	10	7.753	9.884	0	2.131	2.131	8.819
Responsiveness	6	7	8	9	6.425	8.883	-1	2.458	3.458	7.654
Compensation	6	8	9	10	6.968	9.322	-1	2.354	3.354	8.145
Contact	6	7	8	9	6.536	8.883	-1	2.347	3.347	7.710
							(α-cut) = 6.0		Number of criteria = 7	

Zi≤0 means no gray zone, Gi is the mean of geometric mean.

Table 3. The result of assessment criteria with the method of deleting extreme value (7:4).

Assessment criterion	minC^i		maxO^i		Geometric mean		Gray zone	Range	Testing value	Consensus value
	min	max	min	max	C^i_M	O^i_M	Z^i	M^i	M^i-Z^i	G^i
Efficiency	7	8	9	10	7.135	9.851	-1	2.716	3.716	8.493
Systematic availability	5	8	8	10	6.78	9.12	0	2.340	2.340	7.950
Fulfillment	7	8	9	10	7.412	9.851	-1	2.439	3.439	8.632
Privacy	7	8	10	10	7.701	10	-2	2.299	4.299	8.851
Responsiveness	6	7	9	9	6.41	9	-2	2.590	4.590	7.705
Compensation	6	8	9	10	6.979	9.275	-1	2.296	3.296	8.127
Contact	6	7	9	9	6.552	9	-2	2.448	4.448	7.776
							(α-cut) = 6.0		Number of criteria = 7	

If the ratio of deleting extreme value is over large, the testing results will tend to be in between.

that α-cut is 6.0. As the specialists' consensus value of all criteria was above 7.5, all the criteria were selected.

Based on the analysis of the collected questionnaires given to the experts, it was suggested that the e-SQ assessment criteria have a high-level application to house rental websites. Therefore, they can perfectly be considered as the criteria of an e-SQ assessment of house rental websites (Figure 2).

Using the Fuzzy Delphi method, the specialists' consensus value can be calculated through a double-

Table 4. The influence level of the criteria.

	D_i	R_j	D_i+R_j	D_i-R_j
Efficiency	5.616	5.642	11.258(1)	-0.026(4)
Systematic availability	5.608	5.590	11.198(2)	0.018(3)
Fulfillment	5.603	5.479	11.082(3)	0.124(1)
Privacy	4.856	4.920	9.776(7)	-0.064(7)
Responsiveness	5.253	5.314	10.567(5)	-0.062(6)
Compensation	5.140	5.077	10.217(6)	0.062(2)
Contact	5.413	5.467	10.880(4)	-0.054(5)

Table 5. Limit matrix.

Limited	Efficiency	Systematic availability	Fulfillment	Privacy	Responsiveness	Compensation	Contact
Efficiency	0.132	0.132	0.132	0.132	0.132	0.132	0.132
Systematic availability	0.131	0.131	0.131	0.131	0.131	0.131	0.131
Fulfillment	0.129	0.129	0.129	0.129	0.129	0.129	0.129
Privacy	0.115	0.115	0.115	0.115	0.115	0.115	0.115
Responsiveness	0.165	0.165	0.165	0.165	0.165	0.165	0.165
Compensation	0.158	0.158	0.158	0.158	0.158	0.158	0.158
Contact	0.170	0.170	0.170	0.170	0.170	0.170	0.170

Table 6. Total performance assessment scale.

Dimension/criterion	Original weight	Total weight	www.591.com.tw		www.twhouses.com.tw		www.tmm.org.tw	
			Performance	Difference	Performance	Difference	Performance	Difference
Key dimension	**0.507**		**3.542**	**0.292**	**3.232**	**0.354**	**3.303**	**0.339**
Efficiency	0.261	0.132(4)	3.733	0.253	3.200	0.360	3.267	0.347
Systematic availability	0.259	0.131(5)	3.667	0.267	3.267	0.347	3.333	0.333
Fulfillment	0.253	0.129(6)	3.467	0.307	3.200	0.360	3.400	0.320
Privacy	0.227	0.115(7)	3.267	0.347	3.267	0.347	3.200	0.360
Restored dimension	**0.493**		**3.223**	**0.355**	**3.158**	**0.368**	**3.379**	**0.324**
Responsiveness	0.335	0.165(2)	3.200	0.360	3.133	0.373	3.400	0.320
Compensation	0.320	0.158(3)	3.200	0.360	3.067	0.387	3.333	0.333
Contact	0.344	0.170(1)	3.267	0.347	3.267	0.347	3.400	0.320
Total performance value			**3.385(1)**		**3.196(3)**		**3.340(2)**	
Average difference				**0.323(1)**		**0.361(3)**		**0.332(2)**

Table 7. The order of modification.

	Weight	D_i+R_j	D_i-R_j	Quadrant	Kano	Order of modification
Efficiency	0.132(4)	11.258(1)	-0.026(4)	IV	M	(3)
Systematic availability	0.131(5)	11.198(2)	0.018(3)	I	M	(2)
Fulfillment	0.129(6)	11.082(3)	0.124(1)	I	M	(1)
Privacy	0.115(7)	9.776(7)	-0.064(7)	III	M	(7)
Responsiveness	0.165(2)	10.567(5)	-0.062(6)	III	M	(6)
Compensation	0.158(3)	10.217(6)	0.062(2)	II	O	(5)
Contact	0.170(1)	10.880(4)	-0.054(5)	IV	O	(4)

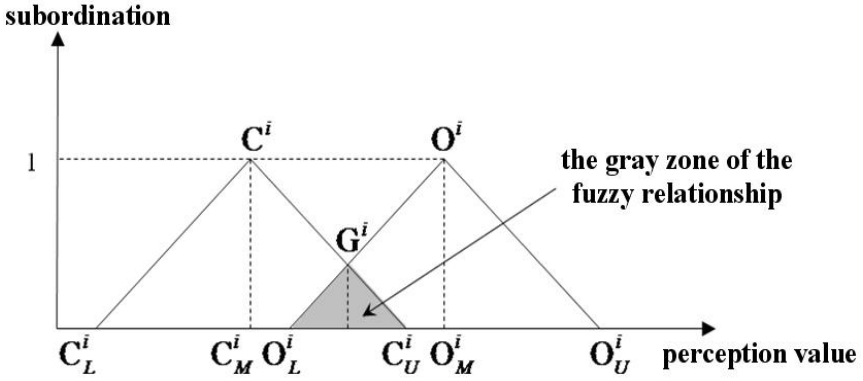

Figure 1. Double-triangle fuzzy number of the most pessimistic perception and the most optimistic perception [Parasuraman et al., 1988].

triangle fuzzy number and it can be tested whether it is convergent or not by the convergent gray zone test. The simple deletion method of this study was proposed with reference to the grading method of Federation Internationale de Natation (FINA) water-jumping rules. In addition, by way of deleting the 7-judge system (7:4), which has an over large ratio of extreme values, the simple deletion method adopted an appropriate 5-judge system (5:2) as the deleting ratio of extreme values, thereby helping to reduce the gray zone and making the specialists' consensus value easier to be convergent (Figure 1).

The empirical research on the order of causal weighting

The questionnaire of this study was conducted during May 2010 with 15 experts as the participants, including 3 scholars of management and 12 senior managers with rich internet marketing experience. Figure 4 indicates that each dimension and criterion of the e-SQ of the house rental websites has, to some extent, a relation with the others and has self-feedback. The criterion with the strongest influence was fulfilment (0.124), then compensation (0.062), and the third was systematic availability (0.0180). The criterion with the highest level of being influenced was privacy (-0.064), then responsiveness (-0.062), and the third one was contact (-0.054). In addition, the influence of key dimension on resorted dimension is 0.004.

After a DEMATAL was used to calculate the relational influence of dimensions and criteria of the e-SQ of house rental websites, using a DEMATEL with an ANP, the former matrix of the originally total relational influence was used to figure out the underlying dynamic relational influence of significance in order to replace the criterion significance degree represented by that of the ANP. This can be regarded as the weight of the e-SQ assessment of house rental websites. The calculated result showed that the criterion significance degree (in order) was contact (0.170), responsiveness (0.165), compensation (0.158), efficiency (0.132), systematic availability (0.131), fulfillment (0.129) and privacy (0.115).

By multiplying the weight (drawn from the DEMATEL with the ANP) with the satisfaction degree of the e-SQ of house rental websites drawn from the collected questionnaires (5-point Likert scale), the performance value of each assessment plan was calculated. A VIKOR was then adopted to calculate the total performance value and the average difference of the comprehensive index. The highest total performance value was 5, a higher value represents a better e-SQ. The lowest average difference was 0, a lower value representing that the e-SQ was closer to the aspired level.

Figure 3 indicated that, for the e-SQ assessment plan of house rental websites, the order of its total performance value was as follows: www.591.com.tw (3.385), www.tmm.org.tw (3.340) and www.twhouses.com.tw (3.196). Meanwhile, the order of average difference was www.591.com.tw (0.323), www.tmm.org.tw (0.332) and www.twhouses.com.tw(0.361). In terms of the different distances of VIKOR, it was indicated that the order of the e-SQ of the house rental websites was in order, www.591.com.tw (1), www.tmm.org.tw (2), and www.twhouses.com.tw (3).

Figure 4 shows that although compensation may have quite a high level of influence on the minority of criteria, it is never the key to the problems. Therefore, it is not necessary to be modified first (ranking No.5). This is totally different from the result of the DEMATEL (without the introduction of the traditional Kano causal graphic) in which the factor (ranking No.2) needs to be modified first. As for the rest of the criteria, after excluding compensation, their order of modification had no change, and neither did the criteria in each quadrant have any difference from M > O > A > I, as proposed by Matzler et al. (1996).

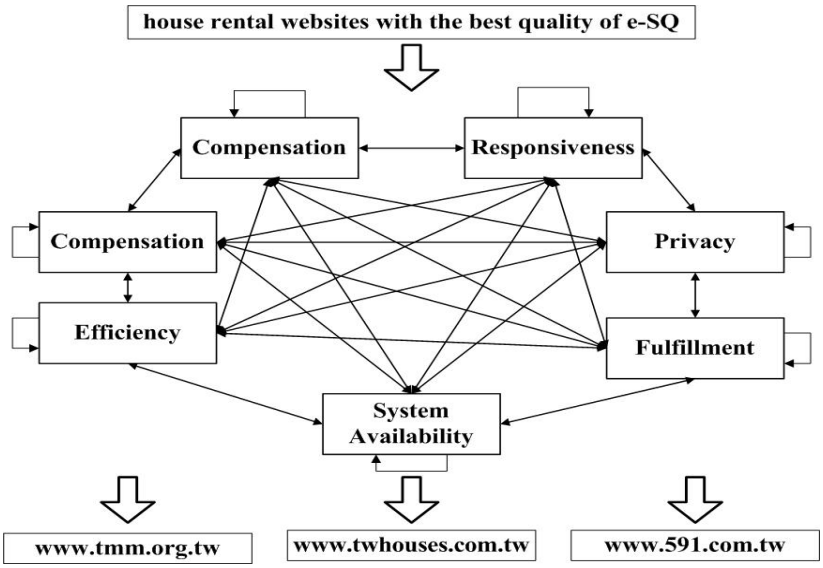

Figure 2. The e-SQ assessment framework of house rental websites.

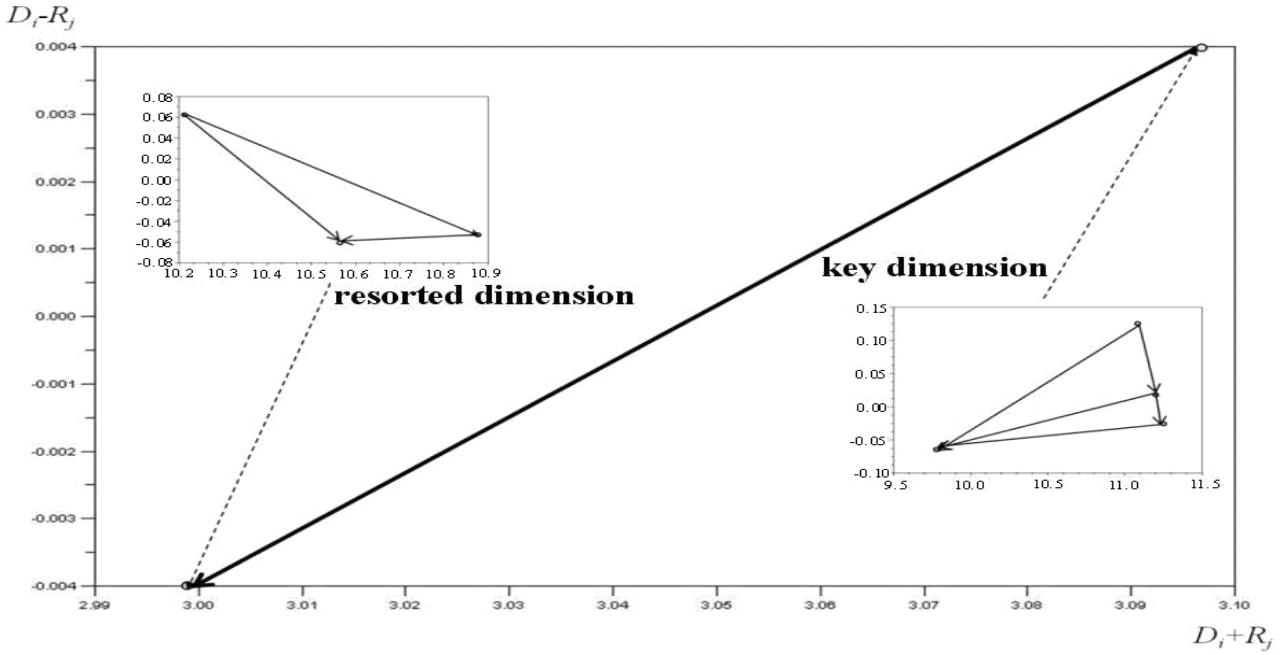

Figure 3. Causal graphic; data is organized from this study.

Conclusions and suggestions

(1) Exploring the criteria of the e-SQ assessment questionnaire of house rental website: According to the organized literature of this study and the confirmation of FDM, the e-SQ scale, as proposed by ZPM [43], had a high level of application to the e-SQ assessment of house rental websites. Therefore, it was regarded as the criteria for the assessment of questionnaire of this study.

(2) Analyzing the relational influence of the e-SQ criteria of house rental websites: In accordance with the DEMATEL, this study suggested that key dimensions have a great influence on resorted dimensions, indicating that when there is something wrong with key dimensions, the restored dimensions will be influenced. Conversely, if key dimensions have nothing wrong, the restored dimensions are useless. For instance, if house rental websites work very well, the tenants naturally have no

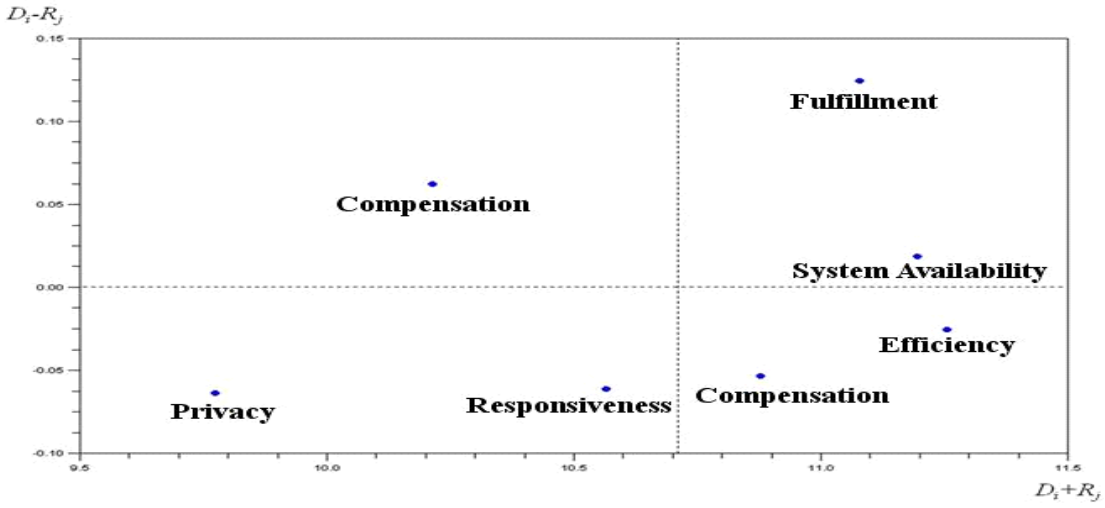

Figure 4. Kano causal graphic.

complaints.

(3) Research on the significance degree of the e-SQ criteria of house rental websites: Based on the calculation of the DEMATEL with the ANP, this study concluded that contact (0.170), responsiveness (0.165) and compensation (0.158) were the most significant criteria. Interestingly, they all belong to restored dimensions. Therefore, it is obvious that when key dimensions have problems, the quality of the restored dimensions would greatly affect whether customers felt good about the e-SQ.

(4) Exploring the performance of the e-SQ assessment plan for house rental websites: This study used www.591.com.tw, www.twhouses.com.tw and www.tmm.org.tw for the e-SQ assessment plan for house rental websites. Through the order of VIKOR, it showed that www.591.com.tw ranked No.1 in terms of the house rental website e-SQ assessment plan. In the second place was www.tmm.org.tw, and in third was www.twhouses.com.tw. This indicated that the success of www.591.com.tw was not only due to the large quantity of advertisements, but also owing to the contribution of the high level of e-SQ.

Furthermore, this study introduced the concept of aspired level so as to improve the assessment quality. The purpose is to avoid the misconception of picking one bad apple from a basket of bad apples. The Kano causal graphic showed that, although compensation may have quite a high level of influence on the minority of criteria, it was never the key to the problems (Figure 3).

Therefore, it is not necessary to be modified first (ranking No.5). This was totally different from the result of the DEMATEL (without the introduction of the traditional Kano causal graphic) where the factor (ranking No.2) needs to be modified first. It implied that when house rental websites have something wrong, high quality compensation can not only maintain consumer confidence, but also achieve a good reputation, showing that the website can deal well with a consumer's problem.

However, compensation, after all, is a kind of remedy. If the resources of firms can be appropriately used for fulfilment with the highest level of modification, which enhances the capabilities of fulfilling customers' needs, or into the systematic availability (ranked NO.2), which can strengthen the system workload and correctly maintain the updating of information, then the e-SQ of house rental websites can be greatly improved.

There will then be fewer mistakes, compensation will be reduced and the resources of firms will be safeguarded.

In conclusion, when compared with the DEMATEL graphic, the Kano graphic can present a more authentic world and provide more precise information concerning decision making, thereby helping decision-makers to make more appropriate decisions. Therefore, it contributes to the research results.

Limitation and suggestions

The participants of the questionnaire were experts and scholars with practical experience in related fields, not the actual ordinary consumers. Therefore, the research results can only be used for reference and cannot be applied to the research on consumer behaviour and satisfaction. Therefore, it is suggested that more questionnaires be distributed to extend this study.

The dimensions and criteria of this study were a simplified version of the e-SQ scale, not the full version. Therefore, the research results can only be used for a rough reference instead of an in-depth reference on decision making. It is suggested that, in a further study, large quantities of questionnaires should be used with an e-SQ scale of the full version or with some modifications.

In addition, researchers should observe whether the criteria in each quadrant have any differences from M > O > A > I, as proposed by Matzler et al. (1996), in order to make advance contributions to this research.

Conflict of interests

The authors have not declared any conflict of interests.

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