Employing MCDM Methodology to Verify Correlationship between Social Media and Service Quality in the Dynamic M-commerce Era

Ming-Yuan Hsieh

Department of International Business, National Taichung University of Education, Taiwan
cpawisely@mail.ntcu.edu.tw

Abstract

This research innovatively employs Quality Function Deployment model of House of Quality method (QFD-HOQ) model to identify the most potential and influenced determinants of Social Media (SM) technology in order to provide the highest service quality in customer's purchasing processes through comprehensively evaluate the SM technologies functions of customer's desired (WHATs) and the SM technological services of company provided (HOWs). Specifically, in terms of the decrement of the linguistic amphiboly of surveyed questionnaires, multiple criteria decision making (MCDM) methodology and fuzzy-set qualitative comparative analysis (fsQCA) approach are hierarchically cross-employed in the compared assessable statistics and measurements of QFD-HOQ model. As a result of a series of evaluated measurements, the most influenced five determinants of corporate SM technological services, including multiple device accessibility service, the content reality service, the individualizational service, the keyword-search engine service and identity feature service that are able academically to re-supply SM research gap related to this research topic as well as to empirically provide practical suggestions in corporate empirical m-commerce strategies.

Keywords: Social media, Service quality, Multiple criteria decision making (MCDM) methodology

1 Introduction

With so many advances in the development of internet technology, many customers have not been satisfied in the traditional one-way Business-to-Business ("B2B") and Business-to-Customer ("B2C") marketing methods. On the contrary, customers generally desire to express their preferences and standpoints in the digital two-way customer-to-business ("C2B") or Customer-to-Customer ("C2C") marketing platforms. This preferential digital marketing platform has resulted in the establishment of the electronic commerce ("e-commerce") age. As a result of the rapid rise in diversified internet technology functions, many social network communication platforms (such as Blog, Facebook, Twitter and etc.) have been established in the digital internet world which have resulted in customers can freely express not only their comment and opinion regarding specific products and services but it has also led to people to be able to individually express their thoughts and experiences regarding the purchasing process [1-3]. In the beginning period of the E-commerce, online technology connectivity hardware become a restricted barrier in the internet technology development because the only means for customers to connect to the internet was through a computer, which meant people could not surf the internet, download data and upload individual information in anytime and anywhere mode. The speedy development of wireless telecommunication technology cleared the hardware restriction of earlier e-commerce and commenced the mobile commerce ("m-commerce") era [4-6]. Peculiarly, Figure 1 synthetically describes the four developed tendency phases of commerce marketing from paper-oriented to digital-oriented marketing.

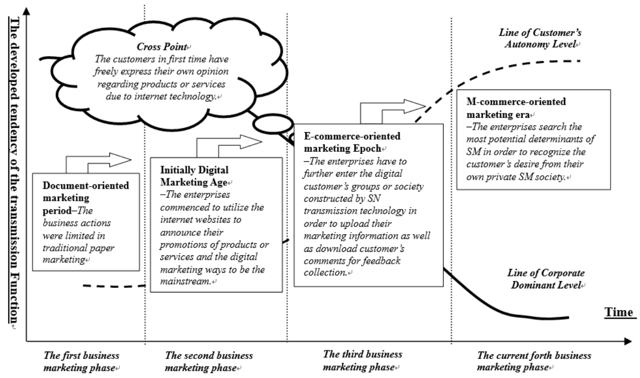


Figure 1. The developed trend and phases of corporate marketing

*Corresponding Author: Ming-Yuan Hsieh; E-mail: cpawisely@mail.ntcu.edu.tw
DOI: 10.3966/160792642018031902022

In the first phase of business marketing (document-oriented marketing period): enterprises easily can sell or promote their products or services through traditional paper-oriented delivery method and customers may not be able to obtain sufficient information regarding products or services before they purchase products or services. The information asymmetry between sellers and buyers exists and corporate dominant is the highest level in this period. In the second phase of business marketing (initially digital-oriented marketing age): with creation of computer devices and internet technology, the enterprises commences to utilize the digital marketing way of their own corporate internet websites to deliver their promotions of products or services and extensive customers can obtain the information of products or services without time limitation though individuals computer devices. Possibly, enterprises are not capable of satisfying customers' desires through a single one-way digital technology (such as picture-sharing, vlogs, wall-postings, email, instant messaging, crowdsourcing and etc.) [7].

Contiguously, in the third business marketing phase (e-commerce-oriented marketing epoch): with the rapid development of individual computer hardware and internet and wireless transmission technologies, a majority customers not only survey and download the relative information of products and services from digital internet websites before they purchase but also share and upload the trade-off information after they purchase into their own private digital group and virtual society (such as Blog, Facebook, Twitter, Youtube, and etc.) through the diversified social media ("SM") channels due to the technological open of internet source code. Specifically, the extensive customers start to have higher and higher predominant power in the purchasing processes and hence, in order to systematically analyze passive and negative opinions and effectively catch customer's preference to achieve the higher customer's satisfaction, the enterprises commence to organize professional e-commerce marketing specialists to further survey the digital customer's groups or society in order to directly acquire customer's dynamic and various feedback comments. In particular, level of customer's autonomy numerously surmounts the level of corporate dominant in this phase [8]. Currently, in the fourth business marketing phase (m-commerce-oriented marketing era): the various electronic hardware (smartphone, GPS products, online video games etc.) are consolidated into the smartphone resulting in each customer can easily surf websites, download website information and upload individual information in their own private groups or society in any time and where mode [9-10], according to the speedy development in the wireless transmission bandwidth of telecommunication industry. With swift development of wireless transmission technology of telecommunication industry, extensive customers, in purchasing process, can easily utilize the technologies functions of diversified SM of instant messaging sharing, photo-sharing, video-sharing, global positioning system ("GPS") and etc., of mobile smartphone device to survey relative information and express their written opinions and video-oriented data of products and services immediately. With reference to this developed tendency of extensive customer's purchasing behavior passing each day, the level of customer's autonomy has been increasing as the level of corporate dominant has been decreasing [11]. Contiguously, without doubt, enterprises realize the influence of SM technology have played a critical role on the customer's purchasing decision in trade-off process [12] and hence, a majority of enterprises have commenced to offer multiple opening interface services of SM technology [13] in order to provide the highest service quality in order to achieve the highest satisfaction in current mobile-commerce-oriented marketing era [12].

However, after reviewing currently relative literatures in SM fields [14-20], there is no any research can identify the most potential and influenced determinants of SM technology from the analytical perspective of service quality and customer's satisfaction trough cross-evaluation the interrelations between SM technology and customer's satisfaction. For this reason, this research firstly employs the quality function deployment of the house of quality ("QFD-HOQ") model [21-25] to re-identify the most influenced determinants of SM technology through the cross-measurements between the SM technologies functions of customer's desired ("WHATs") and the SM technological services of company provided ("HOWs"). Subsequently, in order to avert the linguistic amphiboly of surveyed questionnaires, the grey relation analysis ("GRA") approach, entropy method, fuzzy theory ("FT") and the technique for order preference by similarity to ideal solution ("TOPSIS") method of the multiple criteria decision making ("MCDM") methodology are hierarchically cross-applied in the compared assessable statistics and measurements [26]. Consequently, in terms of the research validity increment, the fuzzy-set qualitative comparative analysis ("fsQCA") [27-28] approaches is employ to verify the measured results of QFD-HOQ model in order to academically re-supply SM research gap related to this research topic as well as to empirically provide practical suggestions in corporate empirical m-commerce strategies.

2 Relative Literature Reviewing

2.1 Literature on Social Media

When including a subsection you must use, for its heading, small letters, 10pt, left justified, bold, Times New Roman as here. With the awakening of consumers' self-consciousness and the rapid development of internet technology, customers have started to express their comments of products or services in SM channels and platforms through double two-way surfing and editing functions of internet technology. SM was formed on the fundamental internet communication channel of SM technology. Further, SM has pervaded in various present-day individual and commerce organizational communicated channels for expanding personal friendships, increasing corporate sales promotions, executing marketing research, managing customer relationship development and etc. [29]. Therefore, SM has recently become one of the developed mainstream online-technology because it is a group of internet-based applications that builds the ideological and technological foundations of Web 3.0, and allows the creation and exchange of user-generated content [30]. In general, SM possesses the five brief characteristics: (1) multiple-users frequency: multiple users can one-way surf and two-way edit with high frequency times through diversified SM technology (2) friendly-operation function: each user operate easily each function of SM (such as surfing, uploading, downloading and etc.) because SM is established on the each user, (3) various content quality: SM substantially and narrowly comprehends various internet documental and video contents, (4) wide-spread device accessibility: each user can upload or download diversified data through each electronic devices (such as personal computer, smart-phone, i-Pad and etc.) with the internet connected function and (5) permanent information record: SM can be altered almost instantaneously by comments or editing in the permanent virtual internet digital world [31]. Specifically, with the swift development of SM technology, there are two more characteristics to be covered in SM technology and these are (6) specific-immediacy: each SM technology channel can be capable of virtually instantaneous responses; (7) immediate-usability: each user of SM technology can immediately browse and record without any specifically professional internet skills in anytime and anywhere. As for the application of SM, the applied features of SM was creatively classifies into four types of categories: (1) space-locators with only location sensitiveness: exchange of messages with relevance for one specific location and it is tagged to a certain place and read later by others (such as Yelp and Qype), (2) quick-timers with only time sensitiveness: transfer of traditional SM applications to mobile devices to increase immediacy (such as posting Twitter messages or Facebook individual status updates), (3) space-timers with both located and time sensitiveness : exchange of messages with relevance for one specific location at one specific real time (such as Facebook Places; Foursquare) and (4) slow-timers without neither located and time sensitiveness: transfer of traditional SM applications to mobile immediate devices (such as watching a YouTube online video or reading a Wikipedia explanatory entry). Extraordinarily, Kietzmann et al. [32] pioneers a contiguity of honeycomb of seven functional building blocks: (1) identity, (2) conversations, (3) sharing, (4) presence, (5) relationships, (6) reputation, and (7) groups, based on the two briefly analytical examined perspectives: (1) a specific facet of SM user experience, and (2) its implications for firms. Subsequently, there are six main current SM sites consisted of (1) collaborative projects (such as Pinterest, Wikipedia and WordPress), (2) blogs (such as Bebo, Blogger, Microblogs, MySpace and Twitter), (3) content communities (such as YouTube), (4) social-networking sites (such as Facebook), (5) virtual game worlds (such as World of Warcraft) and (6) virtual social worlds (such as Second Life) [33]. Consequently, there are a series of interesting issues in SM research field and these are (1) the disparity of information available, (2) the trustworthiness and reliability of information presented, (3) the ownership of media content, (4) transfer right of the information from one to another and etc. [34].

2.2 Literature on Service Quality

On account of comprehensively expounding the definition of service in recent literatures, Jackson and Cooper [35] points out that service is a variety of selling activity for providing corporate benefits or customers' satisfaction and service can not offer or receive from customer's oneself. Then, Heish [36] expounds that service is a kind of activity for identifying and providing the requirements of other people and further, service alternatively relates to the selling activity. Subsequently, Grönroos [37] defines that there are three main key characteristic of service: (1) intangibility, (2) activity and (3) concurrent. Furthermore, Parasuraman et al. [38] induces that service are supposed to be comprise of four crucial characteristics: (1) intangibility, (2) inseparability, (3) heterogeneity and (4) disappearance. Additionally, Cronin and Taylor [39] deems not only the entity of service is intangible but the operation of service is for satisfying other people; especially, the service is not easy to control than the production quality [40]. Consequently, Dabholkar et al. [41] induces that service must comprise of the most essential features: (1) intangibility, (2) inseparability, (3) variability and (4) perishability.

2.3 Literature on Quality Function Deployment of House of Quality Model

Bevilacqua et al. [42] innovatively pioneers QFD-HOQ model to evaluate each influenced element in product design process because QFD-HOQ model not only depends on a systematically effective method to design innovative products under limited resources and time to satisfy the exact needs of customers but it also further, effectively and instantaneously reflected highly changeable customers' desires on the design systematic procedures [43]. After reviewing a great deal of literature regarding the various applications of QFD-HOQ model, this research innovatively integrates the WHATs into the HOWs. Therefore, as for the essential concept of QFD-HOQ model, the interrelationship between the WHATs and HOWs can be systematically discussed as well as hierarchically assayed through the relationship matrix (WHATs vs. HOWs) and technological requirement matrix (HOWs vs. WHATs) in order to distinctly achieve the order of WHATs and HOWs [24, 44]. Consequently, in order to concentrate on the relationship among the WHATs, the HOWs and goal of the WHATs and the HOWs, the two interrelation matrices of functional interactions of WHATs and HOWs are described in Figure 2 [45-46].

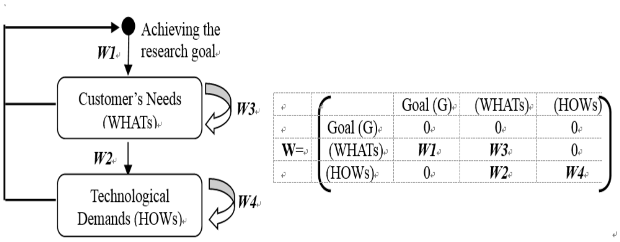


Figure 2. The analytical integrity matrix of QFD-HOQ model

The ***W1*** indicates a vector which expresses the impact of the goal, which achieves the satisfaction of the WHATs. From the customer needs perspective, ***W2*** is the evaluated matrix that expresses the influence of the WHATs on each How. ***W3*** and ***W4*** individually present the assessed matrices of the internal dependence of the WHATs and HOWs [47].

Accordingly, in order to effectively avoid the linguistic amphiboly and vagueness of the questionnaires, this research chooses three more popular assessable approaches comprised of FT [48-49], GRA and TOPSIS of MCDM methodology to deal with the questionnaire results from thirty customers, five scholar and five telecom senior managers. As for the relative literatures of FT, Yoon and Hwang [50] innovatively addresses fuzzy set theory that creates fuzzy set and membership of meaning in order to substitute crisp set of traditional mathematics which can set up the uncertain and fuzzy research problems. Furthermore, fuzzy set covers two characteristics (membership degree and membership function) in order to solve the two-side (correct or incorrect) logical positivism issue of the traditional appraised mathematics [51]. Based on the initial concept of FT, the questionnaires weights are measured by the specific fuzzy set expressing a fuzzy concept "uncertain b" or "approximately b" which presents the Crisp Numbers ("CNs") and Symmetrical Triangular Fuzzy Numbers ("STFNs"), such as for linguistic evaluation to improve questionnaire indefiniteness [52]. Consequently, as to the defuzzified measurements, Tsujimura et al. [53] pioneers the innovative similarity measure by applying extension principle [54] to estimate the fuzzy number of two triangle sharp and the assessed number of similarity measure ("S【A,B】") [55] is expressed as

A= (c_1, a_1, b_1) and B= (c_2, a_2, b_2), and then,

$$S【A,B】= \begin{cases} 1 & \text{, if } A=B \\ \exp.(-(d_{LR}^2[A,B]/\sigma)) & \text{, if } A \neq B \end{cases}$$

$$d_{LR}^2[A,B] = (a_1 - a_2)^2 + [(c_1 + a_1) - (c_2 + a_2)]^2/4$$
$$+[(b_1 + a_1) - (b_2 + a_2)]^2/4; \quad \textbf{(1)}$$
$$\sigma = (D^* + D_*)/2 + (|c_1 - c_2| + |b_1 - b_2|)/8;$$
$$D^* = |(a_1 + b_1) - (a_2 + b_2)|/2;$$
$$D_* = |(a_1 + c_1) - (a_2 + c_2)|/2$$

Further, according to the essential measurements of FT, Chen et al. [56] applies the associated approach, structure measure and model-making method to induce the Grey System Theory ("GST") [57] which is located between block system and white system, in order to integrate the indefinite or missing research data to become useful data in order further to handle the level of relation between each assessable criteria for achieving the research purposes of managerial control, decision-making, and foreseeing under the patterns of uncertain research problems or circumstances [58].

Hence, the most creative idea of GST which is distinct with traditional measure statistics is to utilize the trend-level among uncertain and incomplete information of each assessable criterion to quantify the level of relation in order to assess the dependence or independence relations between each assessable criterion in the equation (2), (3) and (4) [59].

The analytical goal belongs efficient goal and satisfies the maximized analytical goal (the larger the better, LTB):

$$X_i^* = (X_i^{(0)}(k) - Min X_i^{(0)}(k)) / (Max X_i^{(0)}(k) - Min X_i^{(0)}(k)) \quad \textbf{(2)}$$

The analytical goal belongs cost goal and satisfies the minimized analytical goal (Smaller the better, STB):

$$X_i^* = (Min X_i^{(0)}(k) - X_i^{(0)}(k)) / (Max X_i^{(0)}(k) - Min X_i^{(0)}(k)) \quad \textbf{(3)}$$

The analytical goal belongs specific goal (nominal the best):

$$X_i^* = 1 - (|X_i^{(0)}(k) - OB| / Max\{(Max X_i^{(0)}(k) - OB, OB - Min X_i^{(0)}(k))\} \quad \textbf{(4)}$$

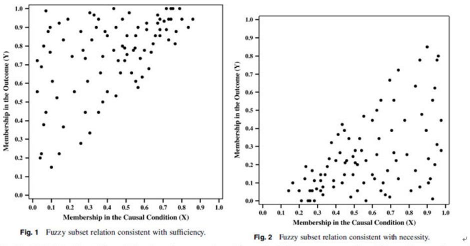
In the equation (2), equation (3) and equation (4), the X_i^* represents comprehensive grey weights after GRA measurements, $\text{Min} X_i^{(0)}(k)$ expresses the minimum of original data and $\mathrm{MaxX}_i^{(0)}(k)$ is the maximum of original data [60]. Recently, in order to increase the science, accuracy, manoeuvrability of MCDM methodology, most social science researchers and scholars have cross-employed TOPSIS in the decisive-selected evaluation such as the evaluation of land usage, manufacture material selection, finance investment assessments, health medicine and hygiene investigation and etc. [61]. The reason is that TOPSIS not only is a synthetically measure but it is also an in-depth discussion of the relative distances and influences among the each evaluated criterion, sub-criterion and solution (alternative scheme or decision).

Hence, the evaluators can employ TOPSIS not only to appraise and decide the best selected solution under complicated environments but to also rank each considered alternative solutions from both positive and negative perspectives through the measured distances of the order preference by similarity from to each considered solution to two extreme-value positive and negative ideal solution. Subsequently, the brief and preliminary concept and assumption in TOPSIS is that the ideal solution is the Positive Ideal Solution ("PIS") and the Negative Ideal Solution ("NIS") [62] and the selected solution is not only the shortest distance from PIS but it is also the longest distance from NIS simultaneously. In viewing TOPSIS mathematics, the research goals and evaluated criteria are supposed to be discussed by the experts and scholars and then, the weights of each selected goal and evaluated criterion are created through the consequences of their comments and questionnaires generated the mathematic goal-decision-weight matrix in order to optimize the evaluation among each selected goal and evaluated criterion. Significantly, Shih [63] first defined not only the distance and vector quantities of the measured distances of the order preference by similarity between 1 (1,1,1) and 0 (0,0,0) in TOPSIS resulted in the vector quantities of PIS is (1,1,1) and of NIS is (0,0,0) but it also the selected alternative are supposed to have the shortest distance from fuzzy positive ideal reference point ("FPIRP", A^+) and also have the longest distance from fuzzy negative ideal reference point ("FNIRP", A^-) for handling a series of relative problems in MCDM fields [64]. Consequently, the distance between each assessable criterion and PIS and NIS can individually denoted as

$$d_i^+ = \sum_{k=1}^{n} d(V_{ij}, V_j^+) = \sqrt{((a_1-1)^2+(b_1-1)^2+(c_1-1)^2)/3} \;,$$
$$i=1,...,m \;;\; i=1,...,n \,,\; \mathrm{V}_j^+=(1,1,1)$$
$$d_i^- = \sum_{k=1}^{n} d(V_{ij}, V_j^-) = \sqrt{((a_1-0)^2+(b_1-0)^2+(c_1-0)^2)/3} \,, \quad \textbf{(5)}$$
$$i=1,...,m \;;\; i=1,...,n \,,\; \mathrm{V}_j^-=(0,0,0)$$
$$\mathrm{CC}_m(V1,V2) = d_j^- / d_j^+$$

where $\mathrm{CC}_m(V1,V2)$ presents the comprehensively evaluated weights of TOPSIS.

Extraordinarily, in order to directly increase the research reliability and validity of measured results, the qualitative analysis of Qualitative Comparative Analysis ("QCA") approach is significantly applied to synthetically assess linear correlationships between entire evaluated criteria (independent variables) and the best solution for research topic (dependent variable), according to set theorem [65] of the essential Boolean Algebra Theory ("BAT") [66]. With reference to measurements of QCA, two conditions ("in" ($\mathrm{X}_1,\mathrm{X}_2,....,\mathrm{X}_n$) variable and "out" ($\mathrm{Y}_1,\mathrm{Y}_2,....,\mathrm{Y}_n$) variable), such as poor is "out" and rich is "in", are covered in a combination set (crisp set, "cs") that resulted in csQCA. As for discussion of interplays between "in" and "out" combination set, there are two situations to appear: (1) "sufficient analysis": any "in" condition can only "possibly" and not "necessarily" result in "out" condition and (2) "necessarity analysis": any "in" condition is necessary to result in "out" condition. Specifically, the interplays and interrelations of "sufficient analysis" are evaluated in the recent relative researches of social science. As for evaluation processes, "consistency" and "coverage" are calculated because "consistency" represents the extent to which a causal combination leads to an outcome and "coverage" represents how many cases with the outcome are represented by a particular causal condition. A simple measure of the "consistency" and "coverage" of sufficient analysis are calculated as consistency $(\mathrm{X}_i \le \mathrm{Y}_i) = \sum(\min(\mathrm{X}_i,\mathrm{Y}_i))/\sum(\mathrm{X}_i)$; coverage $(\mathrm{X}_i \le \mathrm{Y}_i) = \sum(\min(\mathrm{X}_i,\mathrm{Y}_i))/\sum(\mathrm{Y}_i)$ (s.t. ''min'' indicates the selection of the lower of the two values) and there are three situations to exist in the below equations: "(1) the X_i values are all less than or equal to their corresponding Y_i values, the consistency score of sufficient analysis is 1; (2) there are only a few near misses, the consistency score of sufficient analysis is slightly less than 1 and (3) there are many inconsistent scores, with some X_i values greatly exceeding their corresponding Y_i values, the consistency score of sufficient analysis drops below 0.5" [67]. Furthermore, the consistent level of "in" is going to increase during the numbers of "in" conditions are bigger than the numbers of "out" conditions and then, a set of the level of "in" will become "necessity analysis" to a set of "out". The "consistency" and "coverage" of necessity analysis are calculated as consistency $(\mathrm{X}_i \succ \mathrm{Y}_i) = \sum(\min(\mathrm{X}_i,\mathrm{Y}_i))/\sum(\mathrm{X}_i)$; coverage $(\mathrm{X}_i \succ \mathrm{Y}_i) = \sum(\min(\mathrm{X}_i,\mathrm{Y}_i))/\sum(\mathrm{Y}_i)$ and there are two situations to exist in these equations: "(1) all Y_i values are less than or equal to their corresponding X_i values, this equations returns a value of 1 and (2) many Y_i exceed their corresponding X_i values by wide margins, it returns a value less than 0.5)" [67]. Specifically, only a few social science researches have evaluated necessity analysis interrelations between "in" and "out" conditions. Eventually, in order to solve more complicated research issues, the fuzzy concept [68-69] was involved into QCA to form "fuzzy set" [70-71] which distinctively refines all numbers of a set of "in" (consistency) have to be in "0" and "1" [72-73] and Figure 3. expresses sufficiency and necessity analyses of fsQCA.



Source: Ragin CC (2006), Set Relations in Social Research: Evaluating Their Consistency and Coverage, Political Analysis 14:291–310.

Figure 3. Sufficiency and necessity analyses of fsQCA

3 Empirical Measurements of Proposed Model

Besides, fuzzy transitivity, comparing weights principle, evaluating criteria, and estimating positive reciprocal matrix and supermatrix, research data source must collectively and statistically consist of all impacted expert's opinions related to each assessable criterion in the measurements. Based on the initial structure of QFD-HOQ model, the systematically main 6-step empirical measurements is described in Figure 4.

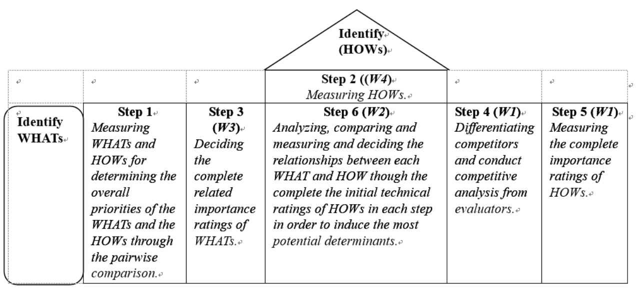


Figure 4. Main 6-step of QFD-HOQ model

For the execution of the research representativeness, this research utilizes the Delphi method to orderly collect the questionnaires from 15 experts in the systematical cross-evaluations of QFD-HOQ model. These 15 experts consisted of five senior managers who have over ten years in the relative electronic marketing industries, five academic scholars with at least 10 years of extensive research in social media and five professionals with over ten-year research experiences in customer's purchasing behaviors.

First Step: Identifying each WHAT in order to determine the overall priorities of WHATs and HOWs through the comparison of pairwise matrices. Concretely, according to a comprehensive series of relevant literatures of service quality characteristics (intangibility, activity, concurrent, inseparability, heterogeneity, disappearance, variability and perishability) as mentioned in session 2, there are sixteen critical determinants to be considered to the accessible criteria of WHATs : (1) multiple-users frequency (W_1), (2) friendly-operation function (W_2), (3) various content quality (W_3), (4) wide-spread device accessibility (W_4), (5) permanent information record (W_5), (6) specific-immediacy (W_6), (7) immediate-usability (W_7), (8) virtual game (W_8), (9) collaborative projects sites (W_9), (10) individual social sites (W_{10}), (11) video communities sites (W_{11}), (12) virtual social community sites (W_{12}), (13) the disparity of information available (W_{13}), (14) the trustworthiness and reliability of information presented (W_{14}), (15) the ownership of media content (W_{15}) and (16) transfer right of the information from one to another (W_{16}) [33].

Subsequently, in order to fully refine the assessable weights of each WHAT, GRA is employed to appraise the questionnaire results from thirty customers who have purchasing experiences of electronic commerce and with reference to the equation (2), equation (3) and equation (4). Consequently, after comparing grey relation coefficients of each WHAT, the surveyed weights of the WHOs are $WHAT_{VIS} = 0.353$, $WHAT_{VCS} = 0.251$, $WHAT_{VDS} = 0.238$ and $WHAT_{VTS} = 0.158$.

Second Step: Identifying each HOWs in order to determine the overall priorities of WHATs and HOWs through the comparison of pairwise matrices. specifically, based on a comprehensive series of relevant literatures as mentioned in the literature reviewing session, there are sixteen critical determinants to be considered to the accessible criteria of the HOWs: (1) content reality (H_1), (2) individualizational service (H_2), (3) keyword-search engine (H_3), (4) multiple device accessibility (H_4), (5) application programming interface (H_5), (6) guide program (H_6), (7) Web 3.0 (H_7), (8) social networking communication channel (H_8), (9) behavior targeting (H_9), (10) identity feature (H_{10}), (11) conversations feature (H_{11}), (12) sharing feature (H_{12}), (13) presence feature (H_{13}), (14) relationships feature (H_{14}), (15) reputation feature (H_{15}) and (16) groups feature (H_{16}). Then, in order to fully refine the assessable weights of each HOW, GRA is also employed to appraise the surveyed questionnaire results of randomly selected thirty customers who have purchasing experiences of electronic commerce and with respect to the equation (2), (3) and (4). Consequently, after comparing the grey relation coefficients of each HOW, the surveyed weights of WHOTs are $HOW_{VIS} = 0.287$, $HOW_{VCS} = 0.216$, $HOW_{VDS} = 0.262$ and $HOW_{VTS} = 0.235$.

Third Step: Deciding the complete related importance ratings of WHATs (*W1 matrix*). in order to fully canvass the extent of users' desires with higher research reliability, this research collected the compare-matrix questionnaire-weights from 5 scholars. Specifically, in order to avoid the questionnaire linguistic vagueness with higher research validity, the conceptual measurements of FT is utilized in the statistic measurements of the 9-point Liker's scale of the complete related importance ratings of WHATs as shown in Table 1.

Table 1. The related importance ratings of WHATs

		Scholar 1		Scholar 2		Scholar 3		Scholar 4		Scholar 5		Related important ratings	
		GN	STEN	GN	STEN	GN	STEN	GN	STEN	GN	STEN	GN	STEN
$WHAT_{VIS}$ (0.353)	W_1	6	【5,7】	8	【7,9】	7	【6,8】	8	【7,9】	7	【6,8】	2.5416	【2.1886,2.8946】
	W_2	8	【7,9】	5	【4,6】	8	【7,9】	7	【6,8】	5	【4,6】	2.3298	【1.9768,2.6828】
	W_3	6	【5,7】	6	【5,8】	8	【7,9】	7	【6,8】	4	【3,5】	2.1886	【1.8356,2.5416】
	W_4	6	【5,7】	5	【4,6】	6	【5,7】	6	【5,7】	6	【5,7】	2.0474	【1.6944,2.4004】
$WHAT_{VCS}$ (0.251)	W_5	5	【4,6】	6	【5,7】	6	【5,7】	5	【4,6】	5	【4,6】	1.3554	【1.1044,1.6064】
	W_6	6	【5,7】	6	【5,7】	7	【6,8】	6	【5,7】	6	【5,7】	1.5562	【1.3052,1.8072】
	W_7	3	【2,4】	5	【4,6】	6	【5,7】	4	【3,5】	5	【4,6】	1.1546	【0.9036,1.4056】
	W_8	3	【2,4】	4	【3,5】	8	【7,9】	5	【4,6】	6	【5,7】	1.3052	【1.0542,1.5562】
$WHAT_{VDS}$ (0.238)	W_9	4	【3,5】	2	【1,3】	6	【5,8】	6	【5,7】	5	【4,6】	1.0948	【0.8568,1.3328】
	W_{10}	5	【4,6】	5	【4,6】	5	【4,6】	7	【6,8】	6	【5,7】	1.3328	【1.0948,1.5708】
	W_{11}	4	【3,4】	6	【5,7】	8	【7,9】	8	【7,9】	4	【3,5】	1.428	【1.19,1.666】
	W_{112}	3	【2,5】	4	【3,5】	7	【6,8】	6	【5,7】	4	【3,5】	1.1424	【0.9044,1.3804】
$WHAT_{VTS}$ (0.158)	W_{13}	5	【4,6】	5	【4,6】	6	【5,7】	5	【4,6】	5	【4,6】	0.8216	【0.6636,0.9796】
	W_{14}	7	【6,8】	5	【4,6】	6	【5,7】	5	【4,6】	4	【3,5】	0.8532	【0.6952,1.10112】
	W_{15}	6	【5,7】	4	【3,5】	5	【4,6】	6	【5,7】	6	【5,7】	0.79	【0.632,0.948】
	W_{16}	7	【6,8】	5	【4,6】	7	【6,8】	5	【4,6】	5	【4,6】	0.9164	【0.7584,1.0744】

Fourth Step: Differentiating competitors and conduct competitive analysis from evaluators (*W1 matrix*). in order to increase the representativeness, the competitive analysis of the HOWs is conducted in this session through four selected appraised enterprises ("C_A", "C_B", "C_C" and "C_D") which have operated E-commerce for an extended period of time. As for the measurement of the "probability distribution", the entropy method is applied for calculating the entropy number ($EM(H_m)$) because in general, the entropy method can deal with the amount of uncertain and various databases by discrete probability distribution ($EM(H_1,H_2,....,H_m)$) as the following equation:

$$EM(H_1,H_2,....,H_m) = -\varnothing_L \sum_{l=1}^{L} \mathrm{P}_l In(p_l) \quad \textbf{(6)}$$

where $\varnothing_L = 1/In(L)$ means a normalization constant to make sure $0 \le E(H_1,H_2,....,H_m) \le 1$.

For the row of *m* of the comparison matrix *X* from scholars corresponding to the HOWs D_m, the total score with reference to $EM(H_1,H_2,....,H_m)$ can computed as $X_m = \sum_{l=1}^{L} X_m$; $X = (X_1, X_2, ...X_m)$. In order to truly discover technological evaluation of each four competitor of HOWs, the entropy method is employed in the assessable measurements of the "probability distribution" of the $EM(H_1,H_2,....,H_m)$ is calculated as

$$EM(H_1,H_2,....,H_m)\text{=}E\text{M(HOW}s_m) = -\varnothing_L \sum_{l=1}^{L} P_{mL} In(p_{mL}) = -\varnothing_L \sum_{l=1}^{L} (X_{mL}/X_m) In(X_{mL}/X_m) \quad \textbf{(7)}$$

Besides, beyond the assumed consideration in competitive analysis, the assessable weights of goals are 8 in each HOW. Subsequently, in order to avoid the questionnaire linguistic vagueness with higher research validity, the conceptual measurements of FT is also applied in the statistic measurements of the 9-point Likert's scale of the improvement ratings for WHATs (IR_x ; $X = (X_1, X_2, ...X_m)$) as calculated as $IR_x = Gaol_{HOWs} / AverageX_{HOWs}$. Therefore, the improvement ratings of H_1 is measured as

$IR_{H_1} = 8/(5+5+7+8+7)/5 = 1.25$ and the others' improvement ratings are presented in Table 3. Consequently, based on the equation (6) and (7), entropy method complete related importance ratings of HOWs of H_1 ($E\text{M}(\text{HOW}s_m)$) is calculated as

$$E\text{M}(\text{H}_1)_{GM} = \sum_{l=1}^{1} P_{H_1} In(p_{H_1}) = -\varnothing_L \sum_{l=1}^{1} (X_1/X_1) In(X_1/X_1)$$

$$= -\begin{bmatrix} ((0.2581*\ln(0.2581)) + ((0.2576*\ln(0.2579)) + \\ ((0.2782*\ln(0.2782)) + ((0.2339*\ln(0.2339)) \end{bmatrix}$$

$$= 0.0635$$

Consequently, the entropy complete related importance ratings of the others' HOWs are as shown in Table 2.

Table 2. Improvements ratings of each HOW under the competitive analysis of entropy method

	C_A	C_B	C_C	C_D	C_A	C_B	C_C	C_D	C_A	C_B	C_C	C_D	C_A	C_B	C_C	C_D	C_A	C_B	C_C	C_D	C_A	C_B	C_C	C_D			
H_1	5	7	7	6	5	7	6	5	7	6	5	5	8	7	5	7	7	7	6	6	6.4	6.8	5.8	5.8	8	1.25	0.0635
H_2	7	4	6	8	8	7	5	6	6	7	3	8	6	8	6	7	7	6	6	4	6.8	6.4	5.2	6.6	8	1.1765	0.0635
H_3	4	6	4	5	7	6	4	5	8	5	3	7	7	8	8	8	8	5	8	5	6.8	6	5.4	6	8	1.1765	0.0635
H_4	2	5	5	5	5	4	5	6	4	7	5	5	6	6	7	5	5	6	7	5	4.4	5.6	5.8	5.2	8	1.8182	0.0622
H_5	5	4	5	4	6	5	4	3	5	5	5	6	4	7	5	5	5	7	8	7	5	5.6	5.4	5	8	1.6	0.0627
H_6	6	5	6	5	7	6	6	5	4	7	5	7	5	8	6	7	7	5	6	6	5.8	6.2	5.8	6	8	1.3793	0.0632
H_7	4	5	5	5	5	5	4	3	5	4	8	3	4	8	7	8	6	7	7	7	4.8	5.8	6.2	5.2	8	1.6667	0.0624
H_8	5	5	6	3	5	4	3	5	5	5	6	5	6	5	8	7	5	4	5	6	5.2	4.6	5.6	5.2	8	1.5385	0.0624
H_9	2	5	8	5	6	4	6	7	8	3	5	4	5	6	6	4	4	3	4	3	5	4.2	5.8	4.6	8	1.6	0.0619
H_{10}	3	2	4	4	5	8	4	3	4	4	4	5	7	6	3	5	5	3	7	4	4.8	4.6	4.4	4.2	8	1.6667	0.0622
H_{11}	4	3	5	3	7	6	7	5	5	5	8	3	8	5	4	3	4	8	4	4	5.6	5.4	5.6	3.6	8	1.4286	0.0622
H_{12}	7	6	5	5	7	8	5	2	7	4	4	2	7	7	3	5	5	7	5	3	6.6	6.4	4.4	3.4	8	1.2121	0.0623
H_{13}	7	8	6	4	8	7	6	4	6	6	7	4	6	6	2	6	6	6	5	5	6.6	6.6	5.2	4.6	8	1.2121	0.0632
H_{14}	6	8	4	3	6	6	5	4	5	7	5	5	7	6	4	2	5	6	6	5	5.8	6.6	4.8	3.8	8	1.3793	0.0626
H_{15}	6	9	5	4	8	55	6	5	7	7	6	3	7	8	2	3	6	5	5	6	6.8	16.8	4.8	4.2	8	1.1765	0.0587
H_{16}	7	9	6	4	8	8	7	6	5	6	5	5	7	6	5	4	7	8	6	7	6.8	7.2	5.8	5.2	8	1.1765	0.0635

Fifth Step: Measuring the complete importance ratings of the HOWs (*W1* matrix). with reference the measured results of the improvements ratings of each HOW under the competitive analysis of entropy method from first step to fourth step, the complete importance ratings of HOWs in CN ($CIM(HOW_s)_{CM}$) are compute as $CIM(HOWs_{VIS,VCS,VDS,VTS})_{GM}$ $= (HOW_{VIS,VCS,VDS,VTS} \times W1 \times W2)$. Specifically, the application of the quantitative entropy methods, similar measure and TOPSIS are utilized in this study to minimize the indistinctness of the linguistic exactitude and to decreasing the subjective concepts of the 5 experienced customers. Hence, the complete importance ratings of HOWs of H_1 ($CIM(H_1)_{CM}$) in CN is calculated as $CIM(HOWs_{VIS,VCS,VDS,VTS})_{CM}$ $= (HOW_{VIS,VCS,VDS,VTS} \times W1 \times W2) = 2.5416*1.25*0.0635$ $= 0.2017$. Accordingly, the total complete importance ratings of HOWs in GN are measured and described as

$$CIM(H_1,....., H_{16})_{CM}$$
$$= 0.2017, 0.1742, 0.1635, 0.2315, 0.1359, 0.1356,$$
$$0.1201, 0.1252, 0.1085, 0.1382, 0.1269, 0.0863,$$
$$0.0629, 0.0737, 0.0546, 0.0684$$

Therefore, the complete importance ratings of HOWs of H_1 ($CIM(H_1)_{GM}$) in STEN is measured as

$$CIM(H_1)_{STEB} = W1_{STEN} \times W2 \times W3$$
$$= \text{【}2.1886,\ 2.8946\text{】}*1.25*0.0635$$
$$= \text{【}0.1737,\ 0.2297\text{】}$$

Consequently, the total complete importance ratings of HOWs in STEN are calculated and presented as

$$CIM(H_1,....., H_{16})_{STEN}$$
$$= \begin{pmatrix} \text{【}0.1737,\ 0.2297\text{】},\text{【}0.1478,\ 0.2006\text{】},\text{【}0.1371, 0.1898\text{】}, \\ \text{【}0.1916, 0.2714\text{】},\text{【}0.1107, 0.1611\text{】},\text{【}0.1138, 0.1575\text{】}, \\ \text{【}0.094, 0.1462\text{】},\text{【}0.1011, 0.1493\text{】},\text{【}0.0849,\ 0.1321\text{】}, \\ \text{【}0.1135, 0.1629\text{】},\text{【}0.1058, 0.1481\text{】},\text{【}0.0683, 0.1043\text{】}, \\ \text{【}0.0508, 0.0751\text{】},\text{【}0.06, 0.0873\text{】},\text{【}0.0437, 0.0655\text{】}, \\ \text{【}0.0566, 0.0802\text{】} \end{pmatrix}$$

Furthermore, in defuzzified consideration with the assumption of $A_1 = (c_1, a_1, b_1) = (1,1,1)$ and $A_2 = (c_2, a_2, b_2)$ $= (0.1737, 0.2017, 0.2297)$, the final related importance ratings of HOWs of H_1 ($Fuzzy(FRIM(H_1)_{GM}) = Fuzzy(H_1(S\text{【}A, B\text{】}))$) following measurements:

$$D^* = |(a_1 + b_1) - (a_2 + b_2)|/2 = 0.8123;$$

$$D_* = |(a_1 + c_1) - (a_2 + c_2)|/2 = 0.7843$$

$$\alpha = (D^* + D_*)/2 + (|c_1 - c_2| + |b_1 - b_2|)/8 = 1.7209;$$

$$d^2(A_1, A_2) = (a_1 - a_2)^2 = \left[((c_1 + a_1) - (c_2 + a_2))^2/4\right]$$

$+\left[((b_1+a_1)-(b_2+a_2))^2/4\right]=1.9121$

$Fuzzy(FRIM(H_1)_{STEN}) = Fuzzy(S【A,B】)$ = exp. ($-(d^2/\alpha)=0.9$), if $V_1 \neq V_2$

Further, the total final related importance ratings of HOWs in STEN is calculated and described as

$$Fuzzy(FRIM(H_1,...,H_{16})_{STEN}) = (0.9,\ 0.8689,\ 0.8576,\ 0.941,\ 0.8294,\ 0.8279,\ 0.8148,\ 0.8188,\ 0.8031,\ 0.8315,\ 0.8193,\ 0.7814,\ 0.7599,\ 0.7693,\ 0.7528,\ 0.7643)$$

Eventually, the rank of the final related importance ratings of HOWs in the below order:

$$FEIM(S[A,B]): H_4 \succ H_1 \succ H_2 \succ H_3 \succ H_{10} \succ H_5 \succ H_6 \succ H_{11} \succ H_8 \succ H_7 \succ H_9 \succ H_{12} \succ H_{14} \succ H_{16} \succ H_{13} \succ H_{15}$$

The multiple device accessibility service (H_4), the content reality service (H_1), the individualizational service (H_2), the keyword-search engine service (H_3) and identity feature service (H_{11}) are the most critical and influenced factors in defuzzified measurements of QFD-HOQ model. Furthermore, as for the enhancement of research reliability and validity, in STEN, based on the equation (1), is measured as the

TOPSIS method is further applied in these assessable measurements as well. Based on the equation (5), the final related importance ratings of HOWs of H_1 ($FEIM(CC_{H_1}(V_1,V_2))$) in TOPSIS is measured as

$$H_1(d_i^+)=\sqrt{\left[(a_1-1)^2+(b_1-1)^2+(c_1-1)^2\right]/3}=0.7986,$$

where $V_1=(0.1737,0.2017,0.2297), V_2=(1,1,1)$

$$H_1(d_1^-)=\sqrt{\left[(a_1-0)^2+(b_1-0)^2+(c_1-0)^2\right]/3}=0.1765,$$

where $V_1=(0.1737,0.2017,0.2297), V_2=(0,0,0)$

$$(CC_{H_1}(V_1,V_2))=H_1(d_i^-)/(H_1(d_i^+)+H_1(d_i^-))=0.181$$

Furthermore, the total final related importance ratings of the HOWs ($FEIM(CC_{H_1,...,H_{16}}(V_1,V_2))$) in STEN is calculated and described as

$$FEIM(CC_{H_1,...,H_{16}}(V_1,V_2)) = (0.181, 0.1566, 0.1474, 0.2112, 0.1234, 0.1219, 0.1104, 0.1139, 0.0996, 0.1251, 0.1142, 0.0788, 0.0569, 0.0665, 0.0495, 0.0613)$$

Ultimately, the rank of the final related importance ratings of HOWs in the below order:

$$FEIM(CC(TOPSIS)): H_4 \succ H_1 \succ H_2 \succ H_3 \succ H_{10} \succ H_5 \succ H_7 \succ H_{11} \succ H_8 \succ H_7 \succ H_9 \succ H_{12} \succ H_{14} \succ H_{16} \succ H_{13} \succ H_{15}$$

In order to increase the research reliability, fsQCA is further applied to refine the weight-measured consequences of QFD-HOQ model. In terms of fsQCA assessed measurements, WHOTs-weights of each expert's questionnaire, IRs of each HOW and weights of each HOW in entropy method are considered a set of "in" and crisp set of the complete importance ratings of

HOWs in CN ($CIM(HOW_s)_{CM}$) is considered a set of "out". Consequently, the measured results of fsQCA are expressed in Figure 5 through the calculations of fsQCA computed software.

	Model: *CIM*(*HOWs*)*CM* = f(WHOTs-weights, IRs of each How*weights of each How in entropy method)			
(f1)		raw coverage	unique coverage	consistency
	WHOTs-weights*IRsof each HOW*weights of each How in entropy method	0.904157	0.904157	0.950243
	solution coverage: 0.904157			
	solution consistency: 0.950243			

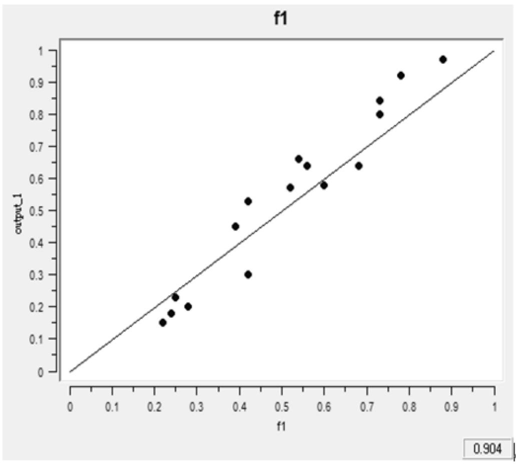


Figure 5. Measured results of fsQCA

In Figure 5, the consistency (0.950243) and raw coverage (0.904157) both are the solution consistency and coverage which means the sample linear interrelations exists between a set of "in" and a set of "out". In order to achieve fit the Boolean logit/probit model of fsQCA, "WHOTs-weights* IRs of each HOW* weights of each HOW in entropy method" ("WHOTs-weights" and "IRs of each HOW" and "weights of each HOW in entropy method") is the preliminary conditions that associated with a set of "out" (outcome or dependent variable). This result very definitely induces that the "HOTs-weights" and "IRs of each HOW" and "weights of each HOW in entropy method" are definitely associated with the rank of the final related importance ratings of HOWs of QFD-HOQ model. Apparently, the highest potential five factors are the multiple device accessibility service (H_4), the content reality service (H_1), the individualizational service (H_2), the keyword-search engine service (H_3) and identity feature service (H_{11}) in under TOPSIS method. Inductively, the ranking of the final related importance ratings of HOWs under FT are similar with the ranking of the final related importance ratings of the HOWs under TOPSIS method.

Sixth Step: Analyzing, comparing and measuring and deciding the relationships between each WHAT and each HOW and complete the initial technical ratings of HOWs (*W2* matrix). As for the increment of research representativeness, the questionnaire data are collected from 5 senior managers as described in Table 3. In addition, with reference to the higher research reliability and validity, the competitive analyses of the relationships between each WHAT and each HOW in the CN through the complete the initial technical ratings of HOWs are conducted in this step. The FT is applied to measure the relationship competitive weights ($In(H_m)$) of the competitive analyses of the relationships between each WHAT and each HOW through the complete the initial technical ratings of HOWs and according to the equation (6) and (7), the competitive weight ($In(H_1)$) in the GN of H_1 is measured as

$$In(H_1)_{CN} = \left[\left(\sum_{1}^{m} (W_m \,\&\, H_1) * CIM(H_m) \right) * HOWs_{VIS} \right] / 16$$

$$= \left[\begin{pmatrix} 0.2017*6+0.1742*7+0.1635*5 \\ +0.2315*6+0.1359*6+0.1356*4 \\ +0.1201*6+0.1252*5+0.1085*4 \\ +0.1382*5+0.1269*4+0.0863*5 \\ +0.0629*6+0.0737*6+0.0546*7 \\ +0.0684*6 \end{pmatrix} *0.2017 \right] /16$$

$$= 0.1976$$

Table 3. The competitive weights between the WHATs and the HOWs in Ns

	HOW_{VIS} = 0.287				HOW_{VCS} = 0.216				HOW_{VDS} = 0.262				HOW_{VTS} = 0.235			
	H_1	H_2	H_3	H_4	H_5	H_6	H_7	H_8	H_9	H_{10}	H_{11}	H_{12}	H_{13}	H_{14}	H_{15}	H_{16}
W_1	6	7	7	8	8	8	5	7	8	7	7	6	5	7	5	7
W_2	7	6	6	6	7	7	7	5	7	8	6	8	4	8	5	5
W_3	8	6	7	8	5	5	8	6	8	6	8	8	5	6	5	4
W_4	6	8	7	8	5	6	5	5	5	5	4	6	5	6	6	6
W_5	6	6	5	8	7	7	8	6	6	5	5	5	5	5	4	6
W_6	8	5	6	6	7	5	6	7	6	8	7	7	4	4	5	7
W_7	6	7	6	6	8	5	7	5	5	6	6	3	5	6	4	5
W_8	5	8	6	8	4	7	5	5	8	7	5	4	7	5	5	6
W_9	8	8	7	8	5	7	7	6	4	8	6	3	6	4	6	7
W_{10}	7	5	7	6	6	6	5	5	5	5	7	5	7	5	7	6
W_{11}	8	5	4	7	5	5	4	6	6	6	6	3	5	6	5	5
W_{12}	8	6	7	8	5	5	4	6	8	5	5	4	6	4	5	5
W_{13}	6	6	7	8	6	6	6	6	5	6	6	7	4	6	6	6
W_{14}	6	8	7	6	7	7	6	7	6	5	7	8	6	5	4	4
W_{15}	8	7	6	8	5	5	7	6	5	8	4	6	6	6	6	4
W_{16}	6	8	7	8	6	5	5	5	6	6	7	8	5	5	5	5
I_N	***0.2436***	***0.2374***	***0.2294***	***0.2627***	***0.2186***	***0.2208***	***0.2136***	***0.208***	***0.2251***	***0.2269***	***0.2165***	***0.2052***	***0.1886***	***0.2043***	***0.1873***	***0.2032***

Accordingly, the total relationship competitive weights ($In(H_1,...,H_{16})$) in the GN are calculated as

$$In(H_1,...,H_{16}) = (0.2436, 0.2374, 0.2294, 0.2627, 0.2186, 0.2208, 0.2136, 0.208, 0.2251, 0.2269, 0.2165, 0.2052, 0.1886, 0.2043, 0.1873, 0.2032)$$

Based on the equation (6) and (7), the competitive weights ($In(H_m)$) of the competitive analyses of the relationships between each WHAT and each HOW in STEN through the complete the initial technical ratings of HOWs is measured as

$$In(H_1)_{STEN} = \left[\left(\sum_{1}^{m} (W_m \,\&\, H_1) * CIM(H_m) \right) * HOWs_{VIS} \right] / 16$$

$$= \left[\begin{pmatrix} 0.2017*【5,7】+0.1742*【6,8】+0.1635*【4,6】 \\ +0.2315*【5,7】+0.1359*【5,7】+0.1356*【3,5】 \\ +0.1201*【5,7】+0.1252*【4,6】+0.1085*【3,5】 \\ +0.1382*【4,6】+0.1269*【3,5】+0.0863*【4,6】 \\ +0.0629*【5,7】+0.0737*【5,7】+0.0546*【6,8】 \\ +0.0684*【5,7】 \end{pmatrix} \right]$$

$$*0.2017/16$$

$$= 【0.2076, 0.2796】$$

Subsequently, the total the competitive weights of the HOWs in the STEN are calculated and presented as

$$In(H_1,.....,H_{16})_{STEN} = \begin{pmatrix} 【0.2076,0.2796】,【0.1478,0.2006】,【0.1371,0.1898】, \\ 【0.1916,0.2714】,【0.1107,0.1611】,【0.1138,0.1575】, \\ 【0.094,0.1462】,【0.1011,0.1493】,【0.0849,\ 0.1321】, \\ 【0.1135,0.1629】,【0.1058,0.1481】,【0.0683,0.1043】, \\ 【0.0508,0.0751】,【0.06,0.0873】,【0.0437,0.0655】, \\ 【0.0566,0.0802】 \end{pmatrix}$$

Furthermore, in defuzzified consideration with the assumption of $A_1=(c_1,a_1,b_1)=(1,1,1)$ and $A_2=(c_2,a_2,b_2)=(0.2076,0.2436,0.2796)$, the relationship competitive weights of H_1 ($Fuzzy(In(H_1,.....,H_{16})_{STEN})$ $= Fuzzy(H_1(In(S【A,B】)))$) in STEN, based on the equation (8), is measured as the following measurements:

$$D^*=|(a_1+b_1)-(a_2+b_2)|/2=0.7744;$$
$$D_*=|(a_1+c_1)-(a_2+c_2)|/2=0.7384$$
$$\alpha=(D^*+D_*)/2+(|c_1-c_2|+|b_1-b_2|)/8=1.6388;$$
$$d^2(A_1,A_2)=(a_1-a_2)^2=\left[((c_1+a_1)-(c_2+a_2))^2/4\right]$$
$$+\left[((b_1+a_1)-(b_2+a_2))^2/4\right]=0.5452$$
$$Fuzzy(lm(H_1)_{STEN})=Fuzzy(S【A,B】)=\exp.$$
$(-(d^2/\alpha)=0.3422)$, if $V_1\neq V_2$

Further, the total final related importance ratings of the HOWs in the STEN is calculated and described as

$$Fuzzy(lm(H_1,...,H_{16})_{STEN})$$
$$=(0.3422,0.3388,0.3342,0.3528,0.3291,0.3303,$$
$$0.3266,0.3239,0.3324,0.3334,0.3281,0.3225,$$
$$0.3146,0.3221,0.314,0.3216)$$

Eventually, the rank of the final related importance ratings of the HOWs in the below order:

$$lm(S[A,B]): H_4\succ H_1\succ H_2\succ H_3\succ H_{10}\succ H_9\succ H_6$$
$$\succ H_5\succ H_{11}\succ H_7\succ H_8\succ H_{12}\succ H_{14}\succ H_{16}\succ H_{13}\succ H_{15}$$

As a series of assessable results of the competitive analyses of the relationships between each WHAT and each HOW in CN through the complete initial technical ratings of HOWs, the multiple device accessibility service (H_4), the content reality service (H_1), the individualizational service (H_2), the keyword-search engine service (H_3) and identity feature service (H_{11}) are also the most potential assessable factors as well.

In particular, in order to distinctly assay the questionnaire results from the five senior managers, TOPSIS method is further employed to intensify the research reliability and validity from the vector statistical perspective. Based on the equation (5), the relationship competitive weights of HOWs of H_1 ($lm(CC_{H_1}(V_1,V_2))$) in TOPSIS is measured as

$$H_1(d_i^+)=\sqrt{\left[(a_1-1)^2+(b_1-1)^2+(c_1-1)^2\right]/3}=0.757,$$

where $V_1=(0.2076,\ 0.2436,\ 0.2796), V_2=(1,1,1)$

$$H_1(d_1^-)=\sqrt{\left[(a_1-0)^2+(b_1-0)^2+(c_1-0)^2\right]/3}=0.2141,$$

where $V_1=(0.2076,\ 0.2436,\ 0.2796), V_2=(0,0,0)$

$$(CC_{H_1}(V_1,V_2))=H_1(d_i^-)/(H_1(d_i^+)+H_1(d_i^-))=0.2205$$

Furthermore, the total relationship competitive weights ($lm(CC_{H_1,...,H_{16}}(V_1,V_2))$) of HOWs in STEN is calculated and described as

$$lm(CC_{H_1,...,H_{16}}(V_1,V_2))$$
$$=(0.2205,0.215,0.2069,0.2374,0.1985,0.2005,$$
$$0.1942,0.1894,0.2042,0.2058,0.1967,0.1869,$$
$$0.1725,0.1862,0.1714,0.1852)$$

Eventually, the total relationship competitive weights of HOWs in the below order:

$$lm(TOPSIS): H_4\succ H_1\succ H_2\succ H_3\succ H_{10}\succ H_9\succ H_6$$
$$\succ H_5\succ H_{11}\succ H_7\succ H_8\succ H_{12}\succ H_{14}\succ H_{16}\succ H_{13}\succ H_{15}$$

Significantly, as a result of a series of TOPSIS method, the multiple device accessibility (H_4), the content reality (H_1) and the individualizational service (H_2), the keyword-search engine (H_3) and identity feature (H_{11}) are also the most potential assessable factors. As for the increment of the research reliability, fsQCA is further adopted to refine the weight-measured consequences of QFD-HOQ model. With respect to the fsQCA assessed measurements, WHOTs-weights of each expert's questionnaire and crisp set of the complete importance ratings of HOWs in CN ($CIM(HOW_s)_{CM}$) are considered a set of "in" and the total relationship competitive weights ($lm(CC_{H_1,...,H_{16}}(V_1,V_2))$) of HOWs in STEN is considered a set of "out". Consequently, the measured results of fsQCA are expressed in Figure 6 through the calculations of fsQCA computed software.

	Model: $lm(C\ CH_1,\ldots,H_{16}\ (V_1,\ V_2))$ = f(WHOTs-weights of each expert's questionnaire and crisp set of the complete immportance ratings of HOWs in $CN\ (HOWs)_{CM}$))			
(f1)		raw coverage	unique coverage	consistency
	WHOTs-weights of each expert's questionnaire* crisp set of the complete importance ratings of HOWs in $CN\ (CIM\ (HOWs)_{CM})$	0.473267	0.180858	1.000000
	solution coverage: 0.473267			
	solution consistency: 1.000000			

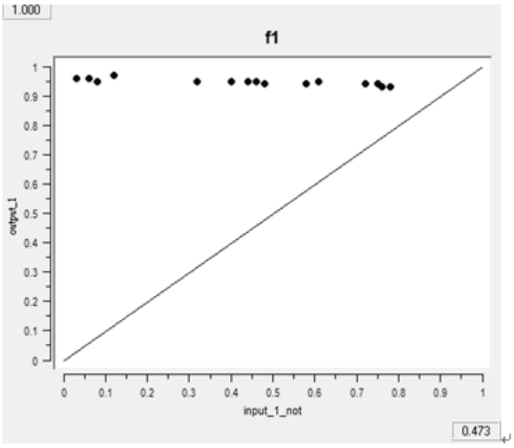


Figure 6. Measured results of fsQCA

In Figure 6, the consistency (0.473267) and raw coverage (0.473267) both are the solution consistency and coverage which means the sample linear interrelations exists between a set of "in" and a set of "out". In order to achieve fit the Boolean logit/probit model of fsQCA, "WHOTs-weights of each expert's questionnaire *crisp set of the complete importance ratings of HOWs in CN ($CIM(HOW_s)_{CM}$)" ("WHOTs-weights of each expert's questionnaire" and "crisp set of the complete importance ratings of HOWs in CN ($CIM(HOW_s)_{CM}$)") is the preliminary conditions that associated with a set of "out" (outcome or dependent variable). This result very definitely induces that the WHOTs-weights of each expert's questionnaire and crisp set of the complete importance ratings of HOWs in CN ($CIM(HOW_s)_{CM}$) are combination set of "in" of "sufficient analysis" for combination set of "out" of the total relationship competitive weights ($lm(CC_{H_1,\ldots,H_{16}}(V_1,V_2))$) of HOWs in STEN.

4 Conclusion

Beyond the potential for significant profits and developing a niche in the current hyper-competitive m-commerce area, a majority of enterprises strive to discover the most potential and influenced indicators of SM in order to satisfy customer needs. As a result of a series of the complicated measurements, there is valuable consequence is to induce the most potential determinants of SM technology: this research innovatively employs QFD-HOQ model to identify the most potential and influenced five determinants of SM technological services of company provided (HOWs), including multiple device accessibility service (H_4), the content reality service (H_1), the individualizational service (H_2), the keyword-search engine service (H_3) and identity feature service (H_{11}) in order to provide the highest service quality in customer's purchasing processes through comprehensively evaluate the sixteen WHATs and the sixteen HOWs. These contributive results are able academically to re-supply SM research gap related to this research topic as well as to empirically provide practical suggestions in corporate empirical m-commerce strategies. Extraordinarily, as for decrement of the linguistic amphiboly of surveyed questionnaires, GRA, FT and TOPSIS methods of MCDM methodology and fsQCA approach are hierarchically cross-employed in the compared assessable statistics and measurements of QFD-HOQ model. Consequently, as for future direction after this research, there are still some effective and efficient methods of MCDM methodology to effectively decrease the measured errors and inaccuracy of surveyed expert's questionnaires and surveyed data is able to expand in the future.

References

[1] P. Beynon-Davies, M. Williams, I. Owens, R. Hill, The Electronic Procurement of Ideas, *International Journal of Electronic Business*, Vol. 2, No. 1, pp. 3-19, May, 2004.

[2] J. Suzuki, T. Suda, A Middleware Platform for A Biologically Inspired Network Architecture Supporting Autonomous and Adaptive Applications, *IEEE Journal on Selected Areas in Communications*, Vol. 23, No. 2, pp. 249-260, February, 2005.

[3] L.-L. Xie, P. R. Kumar, A Network Information Theory for Wireless Communication: Scaling Laws and Optimal Operation, *IEEE Transactions On Information Theory*, Vol. 50, No. 5, pp. 748-767, May, 2004.

[4] P. Beynon-Davies, *E-Business*, Palgrave Macmillan, 2004.

[5] F. Ghys, A. Vaaraniemi, Component-based Charging in A Next-generation Multimedia Network, *IEEE Communications Magazine*, Vol. 41, No. 1, pp. 99-102, January, 2003.

[6] D. Millen, J. Feinberg, *Using Social Tagging to Improve Social Navigation*, https://pdfs.semanticscholar.org/4ef3/e217f029103d9b39d67a2408a1c7893dc794.pdf.

[7] C. Cockburn, T. Wilson, Business Use of the World Wide Web, *International Journal of Information Management*, Vol. 16, No. 2, pp. 83-102, April, 1996.

[8] P. Beynon-Davies, Personal Identity Management as A Socio-technical Network, *Technology Analysis and Strategic Management*, Vol. 22, No. 4, pp. 463-478, April, 2010.

[9] J. Fleck, A Distributed Near Real-time Billing Environment, *Proceedings of 1999 Telecommunications Information Networking Architecture*, Oahu, HI, USA, 1999, pp. 142-148.

[10] S. Glisic, *Advanced Wireless Communications: 4G Technology*, John Wiley & Sons, 2004.

[11] Q. Tang, B. Gu, A. Whinston, Content Contribution for Revenue Sharing and Reputation in Social Media: A Dynamic Structural Model, *Journal of Management Information Systems*, Vol. 29, No. 2, pp. 41-76, Fall, 2012.

[12] P. Beynon-Davies, I. Owens, M. Williams, Information Systems Evaluation and the Information Systems Development Process, *Journal of Enterprise Information Management*, Vol. 17, No. 4, pp. 276-282, December, 2004.

[13] A. Kumar, Y. Liu, J. Sengupta, Divya, Evolution of Mobile Wireless Communication Networks: 1G to 4G, *International Journal of Electronics and Communication Technology*, Vol. 1, No. 1, pp. 68-72, December, 2010.

[14] Y. Chen, S. Fay, Q. Wang, The Role of Marketing in Social Media: How Online Consumer Reviews Evolve, *Journal of Interactive Marketing*, Vol. 25, No. 2, pp. 85-94, May, 2011.

[15] İ. E. Erdoğmuş, M. Çiçek, The Impact of Social Media Marketing on Brand Loyalty, *Social and Behavioral Sciences*, Vol. 58, pp. 1353-1360, October, 2012.

[16] E. Fischer, R. Reuber, Social Interaction via New Social Media: (How) Can Interactions on Twitter Affect Effectual Thinking and Behavior?, *Journal of Business Venturing*, Vol. 26, No. 1, pp. 1-18, January, 2011.

[17] R. Hanna, A. Rohm, V. Crittenden, We're All Connected: The Power of the Social Media Ecosystem, *Business Horizons*, Vol. 54, No. 3, pp. 265-273, May-June, 2011.

[18] M. Y. Hsieh, The Application of the SCT and the ANP Model to Refine the Most Critical ICT Determinants in Minimizing the Digital Divide, *Mathematical Problem in Engineering*, Vol. 2014, pp. 1-9, August, 2014.

[19] M. Y. Hsieh, The Most Potential Principles of Social Media, *Computers & Electrical Engineering*, Vol. 51, pp. 376-388, April, 2016.

[20] N. Michaelidou, N. T. Siamagka, G. Christodoulides, Usage, Barriers and Measurement of Social Media Marketing: An Exploratory Investigation of Small and Medium B2B Brands, *Industrial Marketing Management*, Vol. 40, No. 7, pp. 1153-1159, October, 2011.

[21] Y. Akao, G. Mazur, The Leading Edge in QFD: Past, Present and Future, *International Journal of Quality and Reliability Management*, Vol. 20, No. 1, pp. 20-35, 2003.

[22] L.-K. Chan, M.-L. Wu, Quality Function Deployment: A Literature Review, *European Journal of Operational Research*, Vol. 143, No. 3, pp. 463-497, December, 2002.

[23] M. Gągolewski, P. Grzegorzewski, Possibilistic Analysis of Arity-monotonic Aggregation Operators and Its Relation to Bibliometric Impact Assessment of Individuals, *International Journal of Approximate Reasoning*, Vol. 52, No. 9, pp. 1312-1324, December, 2011.

[24] M. Y. Hsieh, The Innovative Grey-Clustering Macroeconomic Assessment Model To Detect The Fluctuation In The Ten Economies, *Journal of Grey System*, Vol. 24, No. 1, pp. 67-80, April, 2012.

[25] R. Koubek, G. Salvendy, Cognitive Performance of Super-experts on Computer Program Modification Tasks, *Ergonomics*, Vol. 34, No. 8, pp. 1095-1112, May, 2007.

[26] G. Adamopoulos, C. Pappis, A Fuzzy-Linguistic Approach to Multi-criteria Sequencing Problem, *European Journal of Operational Research*, Vol. 92, No. 3, pp. 628-636, August, 1996.

[27] B. Rihoux, C. Ragin, Qualitative Comparative Analysis (QCA), State of the Art and Prospects, *Newsletter of the America Political Science Association Organized Section on Qualitative Methods*, Vol. 2, No. 2, pp. 3-13, September, 2004.

[28] C. Schneider, C. Wagemann, *Set-theoretic Methods for the Social Sciences: A Guide to Qualitative Comparative Analysis (QCA)*, Cambridge University Press, 2012.

[29] M. Y. Hsieh, Y. K. Chan, Is Online Learning Able to Effectively Decrease Tuition and Miscellaneous Fees Debt of Higher Education in Taiwan, *Eurasia Journal of Mathematics, Science & Technology Education*, Vol. 12, No. 5, pp. 1313-1326, May, 2016.

[30] D. M. Boyd, N. Ellison, Social Network Sites: Definition, History, and Scholarship, *Journal of Computer-Mediated Communication*, Vol. 13, No. 1, pp. 210-230, October, 2007.

[31] R. W. Lariscy, E. J. Avery, K. S. Sweetser, P. Howes, An Examination of the Role of Online Social Media in Journalists' Source Mix, *Public Relations Review*, Vol. 35, No. 3, pp. 314-316, September, 2009.

[32] J. Kietzmann, K. Hermkens, I. P. McCarthy, B. Silvestre, Social Media? Get Serious! Understanding the Functional Building Blocks of Social Media, *Business Horizons*, Vol. 54, No. 3, pp. 241-251, May-June, 2011.

[33] A. Kaplan, M. Haenlein, Users of the World, Unite! The Challenges and Opportunities of Social Media, *Business Horizons*, Vol. 53, No. 1, pp. 59-68, January-February, 2010.

[34] J. W. Tipping, E. Zeffren, A. Fusfeld, Assessing the Value of Your Technology, *Research Technology Management*, Vol. 38, No. 5, pp. 22-39, September-October, 1995.

[35] R. W. Jackson, P. D. Cooper, Unique Aspects of Marketing of Industrial Services, *Industrial Marketing Management*, Vol. 17, No. 2, pp. 111-118, May, 1988.

[36] M. Y. Hsieh, Online Learning Era: Exploring the Most Decisive Determinants of MOOCs in Taiwanese Higher Education, *Eurasia Journal of Mathematics, Science & Technology Education*, Vol. 12, No. 5, pp. 1163-1188, May, 2016.

[37] C. Grönroos, An Applied Service Marketing Theory, *European Journal of Marketing*, Vol. 16, No. 7, 1982, pp. 30-41, May, 1982.

[38] A. Parasuraman, V. A. Zeithaml, L. L. Berry, SERVQUAL: A Marketing Review 287 Multiple-item Scale for Measuring Consumer Perceptions of Service Quality, *Journal of Retailing*, Vol. 64, No. 1, pp. 12-40, Spring, 1988.

[39] J. Cronin, S. Taylor, Measuring Service Quality: A Reexamination and Extension, *Journal of Marketing*, Vol. 56, No. 3, pp. 55-68, July, 1992.

[40] A. Parasuraman, V. A. Zeithaml, L. L. Berry, Alternative Scales for Measuring Service Quality: A Comparative Assessment Based on Psychometric and Diagnostic Criteria,

Journal of Retailing, Vol. 70, No. 3, pp. 201-230, 1994.

[41] P. Dabholkar, D. Thorpe, J. Rentz, A Measure of Service Quality for Retail Stores: Scale Development and Validation, *Journal of the Academy of Marketing Science*, Vol. 24, No. 1, pp. 3-16, December, 1996.

[42] M. Bevilacqua, F. E. Ciarapica, G. Giacchetta, A Fuzzy-QFD Approach to Supplier Selection, *Journal of Purchasing and Supply Management*, Vol. 12, No. 1, pp. 14-27, January, 2006.

[43] Y. Akao, QFD: Past, Present, and Future, *Proceedings of the International Symposium on QFD'97*, Linkoping, Sweden, 1997, pp. 1-12.

[44] A. Lockamy, A. Khurana, Quality Function Deployment: Total Quality Management for New Product Design, *International Journal of Quality and Reliability Management*, Vol. 12, No. 6, pp. 73-84, September, 1995.

[45] E. Karsak, S. Sozer, E. Alptekin, Product Planning in Quality Function Deployment Using a Combined Analytic Network Process and Goal Programming Approach, *Computers & Industrial Engineering*, Vol. 44, No. 1, pp. 171-190, January, 2003.

[46] C.-Y. Tsai, C.-C. Lo, A. C. Chang, Using Fuzzy QFD to Enhance Manufacturing Strategic Planning, *Journal of the Chinese Institute of Industrial Engineers*, Vol. 20, No. 1, pp. 33-41, 2003.

[47] J. Hauser, D. Clausing, The House of Quality, *The Harvard Business Review*, Vol. 3, No. 4, pp. 63-73, May, 1988.

[48] T. Saaty, *Theory and Applications of the Analytic Network Process: Decision Making with Benefits, Opportunities, Costs and Risks*, RWS, 2005.

[49] T. Saaty, B. Cillo, *A Dictionary of Complex Decisions Using the Analytic Network Process*, RWS, 2009.

[50] K. Yoon, C.-L. Hwang, Manufacturing Plant Location Analysis by Multiple Attribute Decision Making: Part I-Single-Plant Strategy, *International Journal of Production Research*, Vol. 23, No. 2, pp. 345-359, March, 1985.

[51] L. A. Zadeh, Fuzzy Sets, *Information and Control*, Vol. 8, No. 3, pp. 338-353, June, 1965.

[52] Y. Tsujimura, M. Gen, E. Kubota, Solving Fuzzy Assembly-Line Balancing Problem with Genetic Algorithms, *Computers and Industrial Engineering*, Vol. 29, No. 1-4, pp. 543-547, September, 1995.

[53] Y. Tsujimura, S. H. Park, I. S. Chang, M. Gen, An Effective Method for Solving Flow Shop Scheduling Problems with Fuzzy Processing Times, *Computers and Industrial Engineering*, Vol. 25, No. 1-4, pp. 239-242, September, 1993.

[54] S. Mu, C. Wang, M. Liu, D. Li, M. Zhu, X. Chen, X. Xie, Y. Deng, Evaluating the Potential of Graphics Processors for High Performance Embedded Computing, *Design, Automation & Test in Europe Conference & Exhibition (DATE)*, Grenoble, France, 2011, pp. 1-6.

[55] S. Opricovic, G.-H. Tzeng, Defuzzification within A Multi-criteria Decision Model, *International Journal of Uncertainty Fuzziness and Knowledge-Based Systems*, Vol. 11, No. 5, pp. 635-652, October, 2003.

[56] S. H. Chen, H. T. Lin, H. T. Lee, Enterprise Partner Selection for Vocational Education: Analytical Network Process Approach, *International Journal of Manpower*, Vol. 25, No. 7, pp. 643-655, September, 2004.

[57] J.-L. Deng, Control Problems of Grey Systems, *Systems & Controls Letters*, Vol. 1, No. 5, pp. 288-294, March, 1982.

[58] J.-L. Deng, Introduction to Grey System Theory, *The Journal of Grey System*, Vol. 1, No. 1, pp. 1-24, October, 1989.

[59] J.-L. Deng, *Grey Control System*, HUST Press, 1993.

[60] J.-L. Deng, *The Primary Methods of Grey System Theory*, HUST Press, 2005.

[61] H.-S. Shih, W.-Y. Lin, E. S. Lee, Group Decision Making for TOPSIS, *9th IFSA World Congress and 20th NAFIPS International Conference*, Vancouver, Canada, 2001, pp. 2712-2717.

[62] H.-J. Shyur, H.-S. Shih, A Hybrid MCDM Model for Strategic Vendor Selection, *Mathematical and Computer Modlling*, Vol. 44, No. 7-8, pp. 749-761, October, 2006.

[63] H.-S. Shih, Incremental Analysis for MCDM with An Application to Group TOPSIS, *European Journal of Operational Research*, Vol. 186, No. 2, pp. 720-734, April, 2008.

[64] H.-S. Shih, H.-J. Shyur, E. S. Lee, An Extension of TOPSIS for Group Decision Making, *Mathematical and Computer Modelling*, Vol. 45, No. 7-8, pp. 801-813, April, 2007.

[65] M. Vink, O. V. Vliet, Potentials and Pitfalls of Multi-value QCA: Response to Thiem, *Field Methods*, Vol. 25, No. 2, pp. 208-213, May, 2013.

[66] F. Hohn, *Applied Boolean Algebra: An Elementary Introduction*, Macmillan, 1966.

[67] C. C. Ragin, Set Relations in Social Research: Evaluating Their Consistency and Coverage, *Political Analysis*, Vol. 14, No. 3, pp. 291-310, July, 2006.

[68] M.-S. Yang, W.-L. Hung, S.-J. Chang-Chien, On A Similarity Measure between LR-type Fuzzy Numbers and Its Application to Database Acquisition, *International Journal of Intelligent Systems*, Vol. 20, No. 10, pp. 1001-1016, October, 2005.

[69] L. A. Zadeh, Fuzzy Algorithms, *Information and Control*, Vol. 12, No. 2, pp. 94-102, February, 1968.

[70] J. Verkuilen, Assigning Membership in a Fuzzy Set Analysis, *Sociological Methods & Research*, Vol. 33, No. 4, pp. 462-496, May, 2005.

[71] M. P. Vink, O. V. Vliet, Not Quite Crisp, Not Yet Fuzzy? Assessing the Potentials and Pitfalls of Multi-value QCA, *Field Methods*, Vol. 21, No. 3, pp. 265-289, August, 2009.

[72] L. Griffin, C. C. Ragin, Some Observations on Formal Methods of Qualitative Analysis, *Sociological Methods and Research*, Vol. 23, No. 1, pp. 4-21, August, 1994.

[73] C. C. Ragin, *The Comparative Method: Moving Beyond Qualitative and Quantitative Strategies*, University of California Press, 1987.

Biography

Ming-Yuan Hsieh is an Assistant Professor in the Department of International Business, National Taichung University of Education (Taiwan). His research interests focuses on various technological management specifically in the areas of social media technology, innovation management, electronic commerce, diversified performance evaluation and multiple criteria decision making analysis.