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Using Fuzzy Quality Function Deployment Model to Evaluate Solutions of Customer Value for Global Shipping Carrier-based Logistics Service Providers

Ji-Feng Ding
Department of Aviation and Maritime Transportation Management,
Chang Jung Christian University, Gui-Ren,
Tainan 71101, Taiwan

Abstract: The main purpose of this study was to apply the fuzzy Quality Function Deployment (QFD) model to evaluate the suitable solutions of customer value for three global shipping carrier-based logistics service providers (GSLPs). At first, some concepts of the fuzzy sets theory were introduced. Second, the systematic steps of fuzzy QFD model were proposed. Then, an empirical analysis was studied. Finally, the results show that 'the simplified operational procedure' is the most important technology solution for each GSLP company. It is suggested that the GSLP companies should check their procedures to smooth their operations in the future.

Key words: Customer value, shipping, logistics, fuzzy quality function deployment

INTRODUCTION

Many changes on the integrated business logistics services (Heaver *et al*., 2001) have arisen to be needed to meet the customers' requirements. In the global shipping market, more and more container shipping carriers launch into a new logistics service scope in the recent decade. Besides, these shipping carriers have been playing up their own brand names to strive for an effort to get customer satisfaction and customer value in the shipping market, while the shippers have been considering the brand name as an important criterion to consign for their shipments (Liang *et al*., 2007). As a result, the global shipping carrier-based logistics service providers (GSLPs) are emerged.

However, they are facing a critical issue that they should consider how to create significantly added value for their customers. On the other hand, how to keep competitive advantage of promoting high customer value for GSLPs is an important issue (Ding, 2009c). In this field, Christopher (2005) pointed out that the customer value level within the company can determine the success of failure of any business. Ding (2012) argued some customer value factors influencing three GSLP companies that needed to improve; however, what kind of solutions can be used to improve their customer value were the motives behind this study. Hence, it is important to find out the technology solutions for GSLP companies in order to provide integrated logistics services for their customers.

In short, the customer value factors really influence customers' loyalty in the shipping market (Ding, 2009c, 2010, 2012). When the customer value factors are not provided by the GSLPs, the issue of service solutions is emerged (Christopher, 2005; Gronroos, 2000); hence, the evaluation of solutions of customer value is essential to study. Based on the Ding (2012), there are gaps between importance and perception among the customer value factors for GSLPs. In this study, it is proposed to solve the gaps problem for the customers and GSLPs. In the light of this, a fuzzy Quality Function Deployment (QFD) model is a suitable approach to explain this circumstance in this study. Therefore, this paper is based on the Ding's study to evaluate the solutions of customer value for GSLPs.

In summary, the main purpose of this paper was to apply the fuzzy QFD model to evaluate the suitable solutions of customer value for GSLPs. The main contribution of this paper is in the treatment of vague and complex multi-factors based on the traditional QFD model. Furthermore, it can be applied to develop a practical model for business application. The following parts present the research methods, an empirical study, and the conclusion, respectively.

MATERIALS AND METHODS

Some of the concepts and methods used in this study are briefly introduced.

Triangular fuzzy numbers and the algebraic operations: A fuzzy number A (Dubois and Prade, 1978) in real line $\Re$ is a triangular fuzzy number if its membership function f_A: $\Re \rightarrow [0, 1]$ is:

$$f_A(x)=\begin{cases}(x-c)/(a-c), & c\le x\le a\\(x-b)/(a-b), & a\le x\le b\\0, & \text{otherwise}\end{cases}$$

with $-\infty<c\le a\le b<\infty$. The triangular fuzzy number can be denoted by (c, a, b).

We use the extension principle (Zadeh, 1965) to handle the algebraic operations of fuzzy numbers in this study. Let $A_1 = (c_1, a_1, b_1)$ and $A_2 = (c_2, a_2, b_2)$ be fuzzy numbers, the algebraic operations of any two fuzzy numbers A_1 and A_2 can be expressed as:

- Fuzzy addition : $A_1 \oplus A_2 = (c_1+c_2, a_1+a_2, b_1+b_2)$
- Fuzzy subtraction : $A_1 \ominus A_2 = (c_1-b_2, a_1-a_2, b_1-c_2)$
- Fuzzy multiplication : $k \otimes A = (kc, ka, kb), k\ge 0, k\in R$, $A_1 \otimes A_2 \approx (c_1c_2, a_1a_2, b_1b_2)$, $c_1\ge 0, c_2\ge 0$
- Fuzzy division : $A_1 \oslash A_2 \approx (c_1/b_2, a_1/a_2, b_1/c_2)$, $c_1\ge 0, c_2>0$

Linguistic variables: Linguistic variables (Zadeh, 1975a-c) are represented by triangular fuzzy numbers, which are employed to express the fuzzy relationship strength between the customer requirements and solutions of customer value. According to the practical needs and for matching the fuzzy QFD model developed in this study, the triangular fuzzy numbers are utilized to describe the set of relationship degree as: S = {High, Medium, Low, Non}, where the linguistic values are defined as High is (0.5, 0.7, 1), Medium is (0.3, 0.5, 0.7), Low is (0, 0.3, 0.5), and Non is (0, 0, 0), respectively.

Ranking of fuzzy numbers: To match the fuzzy QFD model developed in this study, and to solve the problem powerfully, the Graded Mean Integration Representation (GMIR) method, proposed by Chen and Hsieh (2000), is employed to rank the final ratings of alternatives. Let $A_i = (c_i, a_i, b_i)$, i = 1, 2,..., n, be n triangular fuzzy numbers. By the GMIR method, the GMIR value $P(A_i)$ of A_i is:

$$P(A_i)=\frac{c_i+4a_i+b_i}{6}$$

Suppose $P(A_i)$ and $P(A_j)$ are the GMIR values of the triangular fuzzy numbers A_i and A_j, respectively. We define:

$$A_i>A_j \Leftrightarrow P(A_i)>P(A_j)$$

$$A_i<A_j \Leftrightarrow P(A_i)<P(A_j)$$

$$A_i = A_j \Leftrightarrow P(A_i) = P(A_j)$$

Basic concept of the QFD model: The QFD model (Cohen, 1995; Crow, 2003; Hauser and Clausing, 1988; Hjort *et al.*, 1992) can be used to translate customer requirements into product specifications. It is a tool to deploy the Voice of Customer (VOC) into searching for best solutions of product development (Ding, 2009a). In this study, we used the concepts of QFD model to develop the procedures and to identify the solutions of customer value for GSLPs. An important part in the QFD model, called the "House of Quality (HOQ)," which is a matrix to show multiple relationships between customer's requirements (i.e., 'what' customer value needed to improved) and technical specifications (i.e., 'how' the solutions of customer value have to be made). In this study, the matrices of HOQ are used for organizing the selected customer value factors and evaluating priorities of solutions of customer value.

The typical chart of the HOQ (the American style) is shown in Fig. 1, which consists of six basic steps. The difference between the American style and the Japanese style of HOQ is that latter one lacks Area CM in Fig. 1. Due to the fact that the Japanese style is easy to use, hence, the Japanese style was applied in this study.

- Area CR represents customer needs and requirements, which is the VOCs to be identified. Those needs and requirements are the selected factors of customer value in the Ding (2012) study
- Area RI represents the relative importance of customer value factors
- Area DR represents design requirements or technical specifications, which means 'how' the solutions of customer value have to be made. In this study, this 'how' question is the main issue, which is identified solutions of customer value
- Area RM represents relationship matrix, which is the core element of the HOQ. In this study, the relationship strength is showed with linguistic variables, e.g., high, medium, low or non
- Area CM represents correlation matrix, which expressed how design requirements affect each

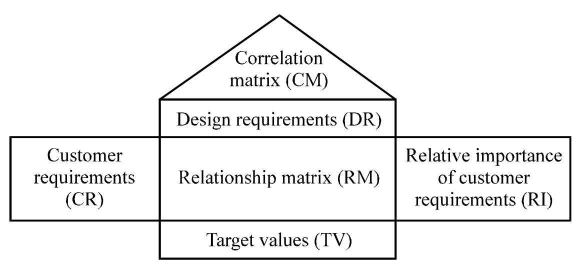

Fig. 1: House of quality (HOQ), Ding (2009a)

other. Correlations are showed with symbols or a rating scheme of 1-3-9 or linguistic variables

- Area TV represents target values of design requirements. In this study, the priority of solutions of customer value can be measured

SYSTEMATIC STEPS OF FUZZY QFD MODEL

The systematic steps of fuzzy QFD model are proposed below:

Step 1: Identify customer requirements: Ding (2012) had referred that the important factors of customer value in the 'competitive vulnerability' zone have high perception importance but low satisfaction; hence, the shippers' satisfaction for the service provided by the GSLP company should be improved. In this study, the customer requirements are those customer value factors needed improvements for three GSLP companies belong to the 'competitive vulnerability' zone. Their codes are shown in parentheses.

- **For GSLP company A:** The customer value factors of 'competitive vulnerability' zone are 'providing diversity of value-added services (C_{a1}),' 'reliability (C_{a2}),' 'providing adequacy of physical facilities and equipment (C_{a3}),' 'increasing marketing channel and network (C_{a4}),' 'safety (C_{a5}),' 'reducing lead time of core logistics services (C_{a6}),' and 'quick responsiveness (C_{a7}),' respectively
- **For GSLP company B:** The customer value factors of 'competitive vulnerability' zone are 'providing diversity of value-added services (C_{b1}),' 'reliability (C_{b2}),' 'providing adequacy of physical facilities and equipment (C_{b3}),' 'increasing marketing channel and network (C_{b4}),' 'safety (C_{b5}),' 'implementing integrated logistics information system (C_{b6}),' and 'quick responsiveness (C_{b7}),' respectively
- **For GSLP company C:** The customer value factors of 'competitive vulnerability' zone are 'providing diversity of value-added services (C_{c1}),' 'reliability (C_{c2}),' 'providing adequacy of physical facilities and equipment (C_{c3}),' 'increasing marketing channel and network (C_{c4}),' 'accuracy and precision of shipments (C_{c5}),' 'implementing integrated logistics information system (C_{c6}),' and 'quick responsiveness (C_{c7}),' respectively

Step 2: Compare the importance and satisfaction levels of customer value factors: The customer value factors can be measured using a Likert's seven-points to evaluate the discrepancies between levels of importance and perception. If the latter are greater than the former, it implies that the customer value of customer requirements is acceptable. On the other hand, if the former are greater than the latter, it implies that some solutions should be identified, and then proceeding with Step 3.

Step 3: Identify technical solutions: The direction of this 'how' issue is considered from the technical specifications involved in identifying solutions of customer value, which are obtained from academic literature (Christopher, 2005; Ding, 2009b, c, 2010, 2011; Gronroos, 2000; Lu and Yang, 2006, 2010; Lovelock and Wirtz, 2011) and experts in GSLPs. The four suitable solutions of customer value for GSLPs are suggested, and their codes are shown in parentheses. These suitable solutions include 'strengthening of service personnel's logistics ability (A_1),' 'a complete information system (A_2),' 'the simplified operational procedure (A_3),' and 'safety management of cargo distribution (A_4)', respectively.

Step 4: Calculate the priorities of customer value factors: As mentioned in the Step 2, the importance and perception degrees for each customer value factor are compared to obtain the arithmetic averages of all importance and perception levels. The priorities of the customer value factors have to calculate to evaluate the perception of the VOCs. This is because that the higher the importance levels and the lower the perception levels, the higher the customer value factors of customer requirements should be improved.

Let $\tilde{I}_t$ and $\tilde{P}_t$, t = 1, 2,..., u be the fuzzy arithmetic averages of importance and perception levels for each customer value factor (C_t, t = 1, 2,..., u). Here, by using the GMIR method to defuzzify the fuzzy importance and perception levels, they can denote as $P(\tilde{I}_t)$ and $P(\tilde{P}_t)$. Since the priority of each customer requirement has a direct relationship with the importance level, whereas the priority has an inverse relationship with the perception level (Liang *et al.*, 2006). Thus, the original priority o_t of C_t can be denoted by $o_t = P(\tilde{I}_t)\times[8 - P(\tilde{P}_t)]$. For being convenient to compare with the priorities, these crisp weights are normalized and denoted by:

$$w_t = o_t \Big/ \sum_{t=1}^{u} o_t$$

Step 5: Construct the fuzzy relationship matrix: The fuzzy relationship matrix can be constructed to link between the customer value factors ((C_t, t = 1, 2,..., u) and technical solutions (A_s, s = 1, 2,..., z) of customer value. Let x_h^{ts}, h = 1, 2,..., E, be the linguistic variable given to tth customer value factor corresponding to sth technical solution by hth expert. The linguistic relationship degree in the position (t, s) of the matrix should be transferred into triangular fuzzy numbers firstly, and then calculate the integrated fuzzy relationship degree R_{ts} by arithmetic mean method. Finally, the integrated fuzzy relationship matrix can be constructed as $[R_{ts}]_{u \times z}$.

Step 6: Calculate the fuzzy relationship strength: Let $R_{ts} = (c_{ts}, a_{ts}, b_{ts})$, t = 1, 2,..., u; s = 1, 2,..., z, be the triangular fuzzy numbers of integrated fuzzy relationship degree in the fuzzy relationship matrix. After integrating the opinions of all E experts, the fuzzy relationship strength corresponding to each technical solution can be denoted by:

$$RS_s = \left(\frac{\sum_{t=1}^{u} c_{ts}}{u}, \frac{\sum_{t=1}^{u} a_{ts}}{u}, \frac{\sum_{t=1}^{u} b_{ts}}{u} \right), \quad s = 1, 2, \ldots, z$$

Step 7: Defuzzify the fuzzy relationship strength to rank the priority: The GMIR method is used to defuzzify the fuzzy relationship strength RS_S. The priorities can be denoted by:

$$P(RS_s) = \frac{\left(\sum_{t=1}^{u} c_{ts} + 4\sum_{t=1}^{u} a_{ts} + \sum_{t=1}^{u} b_{ts} \right)}{6u} \quad s = 1, 2, \ldots, z$$

Then, based on the ranking rules, we can rank the technical solutions of customer value.

RESULTS AND DISCUSSION

Here, an empirical survey of evaluating customer value solutions for three GSLP company is studied. Based on the results of Ding (2012), the author combined the seven customer value factors of three GSLP companies and four suitable solutions to construct a matrix table to evaluate the relationship strength. Due to the fact that the relationship strength is generated by a group of professional experts (Robbins, 1994); hence, the seven experts of GSLP industry, most are working fifteen years, were selected to fill in the QFD questionnaire of this survey.

At first, the author used the systematic steps of the proposed fuzzy QFD model to evaluate the solutions of three GSLP companies in this study. We can obtain some values, e.g., the $P(\tilde{I}_t)$ and $P(\tilde{P}_t)$ represent the defuzziness of fuzzy arithmetic averages of importance and perception for each customer value factor; the o_t show the original priority; and the w_t represents the crisp weight for each customer value factor, respectively. Finally, the final results were obtained, as shown in Table 1-3.

We can summarize the critical customer value factors influencing the improvement for three GSLP companies in Table 1-3. They are 'providing diversity of value-added services,' 'reliability,' 'providing adequacy of physical facilities and equipment,' 'increasing marketing channel and network,' and 'quick responsiveness,' respectively.

Furthermore, according to the Table 1-3, the top key customer value factor and the customer value solution for the GSLP companies A, B, and C can be summarized and shown in Table 4.

For the GSLP company A in the Table 1. The rankings of customer value factors are 'providing adequacy of physical facilities and equipment (0.153),' 'increasing marketing channel and network (0.151),' 'reliability (0.146),' 'providing diversity of value-added services (0.143),' 'safety (0.141),' 'quick responsiveness (0.134)' and 'reducing lead time of core logistics services (0.132)', respectively. The values of weights of these seven factors are fairly close; the difference between the largest and the least is 0.021. This indicated that they are almost equally important in this study. As for the rankings of the technology solution are 'the simplified operational procedure (0.468),' 'strengthening of service personnel's logistics ability (0.464),' 'a complete information system (0.485)' and 'safety management of cargo distribution

Table 1: The final result for GSLP company A

	A_1	A_2	A_3	A_4	$P(\tilde{I}_t)$	$P(\tilde{P}_t)$	o_t	w_t
C_{a1}	(0.129, 0.343, 0.514)	(0.243, 0.471, 0.686)	(0.114, 0.343, 0.529)	(0.271, 0.50, 0.729)	6.048	4.663	20.181	0.143 (4)
C_{a2}	(0.414, 0.614, 0.871)	(0.157, 0.371, 0.557)	(0.186, 0.443, 0.671)	(0.329, 0.557, 0.814)	5.887	4.513	20.525	0.146 (3)
C_{a3}	(0.343, 0.514, 0.729)	(0.357, 0.586, 0.857)	(0.257, 0.50, 0.743)	(0.171, 0.414, 0.614)	6.180	4.525	21.476	0.153 (1)
C_{a4}	(0.343, 0.514, 0.729)	(0.271, 0.457, 0.657)	(0.386, 0.586, 0.829)	(0.20, 0.443, 0.657)	6.238	4.585	21.304	0.151 (2)
C_{a5}	(0.329, 0.514, 0.743)	(0.20, 0.40, 0.586)	(0.257, 0.50, 0.743)	(0.257, 0.50, 0.743)	5.873	4.630	19.793	0.141 (5)
C_{a6}	(0.157, 0.371, 0.557)	(0.157, 0.371, 0.557)	(0.371, 0.586, 0.843)	(0.20, 0.40, 0.586)	5.748	4.773	18.548	0.132 (7)
C_{a7}	(0.214, 0.386, 0.571)	(0.357, 0.586, 0.857)	(0.186, 0.443, 0.671)	(0.086, 0.314, 0.486)	5.957	4.832	18.873	0.134 (6)
RS_s	(0.276, 0.465, 0.673)	(0.249, 0.463, 0.680)	(0.251, 0.486, 0.718)	(0.216, 0.447, 0.661)				
GMIR values	0.468	0.464	0.485	0.444				
Ranking	2	3	1	4				

$P(\tilde{I}_t)$, $P(\tilde{P}_t)$, o_t and w_t: Defuzziness of fuzzy arithmetic averages of importance and perception for each customer value factor (C_{a1}-C_{a7}), the original priority and the crisp weight for each customer value factor, respectively, The value in the parenthesis on the w_t column represents as ranking, RS: Fuzzy relationship strength corresponding to each technical solution (A_1-A_4)

Table 2: The final result for GSLP company B

	A_1	A_2	A_3	A_4	$P(\tilde{I}_t)$	$P(\tilde{P}_t)$	o_t	w_t
C_{b1}	(0.157, 0.329, 0.486)	(0.20, 0.40, 0.586)	(0.40, 0.614, 0.886)	(0.271, 0.50, 0.729)	6.070	4.820	19.303	0.140 (5)
C_{b2}	(0.157, 0.329, 0.486)	(0.40, 0.614, 0.886)	(0.414, 0.614, 0.871)	(0.229, 0.429, 0.629)	5.720	4.863	17.942	0.130 (7)
C_{b3}	(0.143, 0.329, 0.50)	(0.343, 0.557, 0.80)	(0.343, 0.557, 0.80)	(0.229, 0.471, 0.70)	5.892	4.725	19.292	0.140 (6)
C_{b4}	(0.20, 0.40, 0.586)	(0.371, 0.586, 0.843)	(0.343, 0.557, 0.80)	(0.30, 0.529, 0.771)	6.217	4.863	19.50	0.142 (4)
C_{b5}	(0.229, 0.386, 0.557)	(0.229, 0.429, 0.629)	(0.343, 0.514, 0.729)	(0.20, 0.40, 0.586)	5.920	4.330	21.726	0.158 (1)
C_{b6}	(0.257, 0.457, 0.671)	(0.071, 0.271, 0.429)	(0.30, 0.529, 0.771)	(0.286, 0.486, 0.714)	5.945	4.70	19.619	0.143 (3)
C_{b7}	(0.086, 0.271, 0.414)	(0.214, 0.429, 0.643)	(0.20, 0.443, 0.657)	(0.271, 0.457, 0.657)	5.825	4.527	20.232	0.147 (2)
RS_s	(1.229, 2.50, 3.70)	(1.829, 3.286, 4.814)	(2.343, 3.829, 5.514)	(1.786, 3.271, 4.786)				
GMIR values	0.355	0.471	0.552	0.468				
Ranking	4	2	1	3				

$P(\tilde{I}_t)$, $P(\tilde{P}_t)$, 'o_t and w_t: Defuzziness of fuzzy arithmetic averages of importance and perception for each customer value factor (C_{b1}-C_{b7}), the original priority, and the crisp weight for each customer value factor, respectively, The value in the parenthesis on the w_t column represents as ranking, RS_s: Fuzzy relationship strength corresponding to each technical solution (A_1-A_4), column represents as ranking

Table 3: The final result for GSLP company C

	A_1	A_2	A_3	A_4	$P(\tilde{I}_t)$	$P(\tilde{P}_t)$	o_t	w_t
C_{c1}	(0.157, 0.371, 0.557)	(0.243, 0.429, 0.614)	(0.114, 0.386, 0.60)	(0.20, 0.443, 0.657)	5.977	4.893	18.568	0.140 (5)
C_{c2}	(0.443, 0.643, 0.914)	(0.157, 0.329, 0.486)	(0.114, 0.386, 0.60)	(0.286, 0.529, 0.786)	5.960	4.918	18.367	0.138 (6)
C_{c3}	(0.271, 0.414, 0.586)	(0.357, 0.543, 0.786)	(0.186, 0.443, 0.671)	(0.171, 0.414, 0.614)	6.372	4.810	20.326	0.153 (1)
C_{c4}	(0.343, 0.514, 0.729)	(0.271, 0.457, 0.657)	(0.386, 0.586, 0.829)	(0.20, 0.443, 0.657)	6.338	4.918	19.533	0.147 (2)
C_{c5}	(0.329, 0.514, 0.743)	(0.20, 0.40, 0.586)	(0.257, 0.50, 0.743)	(0.257, 0.50, 0.743)	6.002	4.990	18.065	0.136 (7)
C_{c6}	(0.157, 0.371, 0.557)	(0.157, 0.371, 0.57)	(0.371, 0.586, 0.843)	(0.20, 0.40, 0.586)	5.948	4.822	18.906	0.142 (4)
C_{c7}	(0.214, 0.386, 0.571)	(0.357, 0.586, 0.857)	(0.186, 0.443, 0.671)	(0.086, 0.314, 0.486)	6.085	4.863	19.087	0.144 (3)
RS_s	(1.914, 3.214, 4.657)	(1.743, 3.114, 4.543)	(1.614, 3.329, 4.957)	(1.40, 3.043, 4.529)				
GMIR values	0.463	0.446	0.473	0.431				
Ranking	2	3	1	4				

$P(\tilde{I}_t)$, $P(\tilde{P}_t)$, o_t, and w_t: Defuzziness of fuzzy arithmetic averages of importance and perception for each customer value factor (C_{c1}-C_{c7}), the original priority, and the crisp weight for each customer value factor, respectively, The value in the parenthesis on the w_t column represents as ranking, RS_s: Fuzzy relationship strength corresponding to each technical solution (A_1-A_4)

Table 4: The top key customer value factor and solution for the GSLP companies

	Key customer value factor	Key customer value solution
Company A	Increasing marketing channel and network	Simplified operational procedure
Company B	Reliability	Simplified operational procedure
Company C	Increasing marketing channel and network	Simplified operational procedure

(0.444)', respectively. The GMIR values of these four technology solutions are fairly close; the difference between the largest and the least is 0.024. This indicated that these four technology solutions are almost equally important when they are executed in the future. However, 'the simplified operational procedure' is the most important technology solution for the GSLP company A.

For the GSLP company B in the Table 2. The rankings of customer value factors are 'safety (0.158),' 'quick responsiveness (0.147),' 'implementing integrated logistics information system (0.143),' 'increasing marketing channel and network (0.142),' 'providing diversity of value-added services (0.140),' 'providing adequacy of physical facilities and equipment (0.140)' and 'reliability (0.130)', respectively. The values of weights of these seven factors are fairly close, too. The difference between the largest and the least is 0.028. This indicated that they are almost equally important in this study. As for the rankings of the technology solution are 'the simplified operational procedure (0.552),' 'a complete information system (0.471),' 'safety management of cargo distribution (0.468)' and 'strengthening of service personnel's logistics ability (0.355)', respectively. The difference of GMIR value between the largest and the least is too big. Hence, we can see 'the simplified operational procedure' is the most important technology solution for the GSLP company B.

For the GSLP company C in the Table 3. The rankings of customer value factors are 'providing adequacy of physical facilities and equipment (0.153),' 'increasing marketing channel and network (0.147),' 'quick responsiveness (0.144),' 'implementing integrated logistics information system (0.142),' 'providing diversity of value-added services (0.140),' 'reliability (0.138)' and 'accuracy and precision of shipments (0.136)', respectively. The values of weights of these seven factors are fairly close, too. The difference between the largest and the least is 0.017. This indicated that they are almost equally important in this study. As for the rankings of the technology solution are 'the simplified operational procedure (0.473),' 'strengthening of service personnel's logistics ability (0.463),' 'a complete information system (0.446)' and 'safety management of cargo distribution (0.431)', respectively. The GMIR values of these four technology solutions are fairly close; the difference between the largest and the least is 0.042. This indicated that these four technology solutions are almost equally important when they are executed in the future. However, 'the simplified operational procedure' is the most important technology solution for the GSLP company C.

In summary, for the GSLP companies A, the most important customer value factor is 'increasing marketing channel and network;' whereas the most important technology solution is 'the simplified operational procedure.' For the GSLP companies B, the most important customer value factor is 'reliability;' whereas the most important technology solution is 'the simplified operational procedure.' For the GSLP companies C, the most important customer value factor is 'increasing marketing channel and network;' whereas the most important technology solution is 'the simplified operational procedure.'

We can see 'the simplified operational procedure' is the most important technology solution for each GSLP company. That means a simplified operational procedure within a GSLP can accelerate operation process and shorten customers' waiting time. The 'simplified' concept is a composite of values, mindset, and procedures. We can survey each steps in the operational procedures. The critical thinking points in the operational procedure can not only be increased the operational speed and safety but also be reduced the mistakes and manpower needs. The operational procedure can be simplified to create the value-added capability and the marginal effects for the GSLP companies. It is a win-win strategy. In a word, it is convenient for customers and the companies. Finally, it is suggested that the GSLP companies should check their procedures to smooth their operations in the future.

CONCLUSIONS

In the global shipping market, providing the significantly added value to meet the customers' requirements is a critical issue. Some important literature argued that customer value factors influencing GSLP companies should be improved. Hence, it is important to find out the technology solutions for GSLP companies in order to provide integrated logistics services for their customers. In short, a fuzzy QFD model is applied to evaluate the suitable solutions of customer value for GSLPs in this study.

At first, the customer value factors needed improvements for the GSLP companies are conducted by Ding (2012). Secondly, we proposed a systematic procedure with seven steps in the fuzzy QFD model. Then, an empirical analysis for the evaluation of suitable solution of customer value is performed to demonstrate the computational process of the proposed model adopted by this paper. Finally, the empirically results show that: (1) The 'increasing marketing channel and network' is the key customer value factor for the GSLP companies A and C, (2) The 'reliability' is the key customer value factor for the GSLP company B and (3) 'The simplified operational procedure' is the most important solution for each GSLP company. Moreover, it is suggested that the GSLP companies should check their procedures to smooth their operations in the future. Furthermore, the limitations of this study only argued three GSLP companies; the future study can expand the scope of this industry to compare with the customer value. Further study can also apply this fuzzy QFD model to assess the implications and strategies on customer satisfaction, service quality, efficiency, speed, flexibility and reliability, cost, effectiveness, and so on.

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