AN EMPIRICAL APPLICATION OF FUZZY QFD TO IMPROVE THE RELATIONSHIP QUALITY OF THE HOME DELIVERY

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ABSTRACT

This paper presents an extended quality function deployment (QFD) approach that incorporates fuzzy logic to decrease the subjectivity of relationship strength and equip enterprises with better improvement techniques to fulfill customers' needs and enhance their relationship quality. The proposed fuzzy QFD (FQFD) model is simple, flexible, and easy to understand. The empirical case examined in this paper demonstrates the efficiency of the process and indicates five critical techniques for improving quality of relationship with the customer. Overall, the FQFD approach requires only an average amount of data that can be collected quickly. The requisite calculations do not require any sophisticated knowledge or cumbersome statistical procedures. Our results can provide directions for home delivery company improving the relationship quality with customers. Progress can be measured by continuously evaluating performance against a competitor's or the industry leader's performance. We have tested the model empirically in the home delivery industry with one case example, and are interested in extending its application to other industries and operation management issues.

I. INTRODUCTION

In business-to-business (B2B) markets, long-term orientation has become one of the main issues in fostering relationships between customers and suppliers (Crosby et al., 1990). Recent industry evidence has suggested that collaborative relationships with key partners can help achieve favorable outcomes. Wilson and Jantrania (1994) proposed that suc-cessful B2B relationships are characterized by seven attributes: goal compatibility, trust, satisfaction, investments, structural bonds, social bonds, and the relative level of investment in alternative relationships. Buttle (1996) also asserted that, for a relationship to be an effective collaborative effort, there should be a high degree of goal congruence in the major areas between the relevant parties. As a result, home delivery companies and business consignors have formed an inseparable partnership in which better coordination of transportation and marketing strategy is critical to their mutual success in the market. Thus, it is necessary to gain a thorough understanding of the factors underpinning successful long-term relationships with customers as well as to develop techniques for enterprises to maintain and improve the quality of relationships.

Few studies have discussed the enhancement of relationship quality in the fields of relationship marketing and relationship management; most studies have instead focused on the factors impacting relationship quality (Walter et al., 2003; Gounaris, 2005; Chou, 2014) or the importance of maintaining relationship quality (Carter et al., 1998). Our study presents a systematic approach toward developing effective techniques for enhancing relationship quality. First, we conducted a survey, collecting real data both from home delivery companies and their business consignors to understand and present the needs underpinning relationship quality for business consignors. Following this, we adopted the proposed fuzzy quality function deployment (FQFD) model to identify improvement techniques that the home delivery company can utilize to satisfy the consignors' requirements.

Quality Function Deployment (QFD) is usually applied to understand customers' requirements for products and relate them to various business circumstances through a house of quality (HOQ). Based on the concept of Company Wide Quality Control, QFD is a method of continuous product improvement that emphasizes the impact of organizational learning on innovation, and should therefore be a part of any management process (Govers, 1996; Govers, 2001). Generally, the relationship strength between technical requirements and customer needs is assessed by decision makers based on their professional knowledge, experience, and the limited information to which they have access, which often does not translate exactly

to practice. Consequently, the precision-based QFD model may not be able to eliminate the inherent subjectivity; as a result, it can become ineffective. Additionally, relationship strength is often assessed by linguistic values, such as "high" and "low," etc. The fuzzy QFD approach, on the other hand, is extensively used in processing relationships to handle efficiently the subjectivity of human judgment and preference (Liang et al., 2006). The aforementioned linguistic values can be symbolized as triangular fuzzy numbers to represent the fuzzy relationship strengths between enhancement techniques and customer needs. The FQFD approach has been applied in different fields with most studies focused on the production domain and objective selection (Albino et al., 1998; Vanegas and Labib, 2001; Bevilacqua et al., 2006). To the best of our knowledge, few FQFD studies have dealt with relationship quality enhancement. In a previous study, by illustrating the FQFD approach on supply chain management with data obtained from literature rather than data collected empirically, Bottani (2009) pointed out that the FQFD approach can achieve agility. This paper applies the FQFD model to demonstrate empirically that the modeling results can help home delivery companies prioritize enhancement techniques for better relationship quality.

The QFD model incorporating fuzzy logic (FQFD) to solve the subjective problem of relationship strength between technical requirements and consignor needs, and to further equip home delivery companies with better improvement techniques to fulfill enterprise consignors' needs and enhance their relationship quality. The remainder of this paper is organized as follows. We give an overview of relationship quality in section 2. Section 3 presents the research methods and describes the FQFD model. Section 4 discusses the FQFD application to a real case. We then conclude the paper in section 5.

II. RESEARCH BACKGROUND

Relationship marketing is an important strategy for organizations that strive to remain competitive in today's marketplace (Kale, 2004). Establishing and maintaining long-term B2B relationships offer opportunities to firms, create competitive advantages, and help achieve superior results (Ulaga, 2003; Čater and Čater, 2010). This is due to the important influence of customer commitment and customer satisfaction on customer retention (Fornell et al., 1996; Lahiri and Kedia, 2011).

The dimensions of relationship quality have been presented and tested in various studies. Crosby et al. (1990) and Anderson and Gerbing (1988) considered relationship quality as dimensions of trust and satisfaction. Kumar et al. (1995) and Hennig-Thurau et al. (2002) incorporated commitment into their evaluations while Rauyruen and Miller (2007) proposed that relationship quality comprises of four dimensions, namely, perceived service quality, trust, commitment, and satisfaction. Scholars have agreed that relationship quality is a higher order construct consisting of several first-order constructs, among which trust, satisfaction with the salesperson, and commitment to the relationship are used most commonly (Holmlund, 2008;

Athanasopoulou, 2009). Here, relationship quality is accordingly divided into three dimensions: trust, commitment, and satisfaction.

All customers want to be secure when conducting transactions with vendors. Several researchers have regarded trust as a key factor in the maintenance of successful relationships and customer loyalty in B2B markets (Rauyruen and Miller, 2007). Parasuraman et al. (1985) introduced trust as a critical success factor in successful service relationships, and Berry (1995) also suggested that relationship marketing is built on trust. The level of trust between enterprises is deemed fundamental in building a relationship (Wilson and Jantrania, 1994). Trust is defined as the behavioral intention that reflects confidence or reliance on another person or entity, or the state of vulnerability and uncertainty (Moorman et al., 1993). Trust in a relationship between firms is defined as one firm believing that the actions taken by another company would result in positive outcomes, or that the other firm will not take any unexpected action (Anderson and Narus, 1990). In the context of a B2B service, trust is an important element affecting the perceived quality of the service (Turnbull and Moustakatos, 1996). Morgan and Hunt (1994) argued that functional conflict and uncertainty arise from a lack of trust, and conversely, strong cooperation between partners has its roots in relationship commitment and trust.

Satisfaction is the assessment of the experience of interacting with a service provider and can be used to predict customers' future intentions (Crosby et al., 1990; Rauyruen and Miller, 2007). Satisfaction has been defined as a positive state originating from the appreciation of all aspects of the relationship (Anderson and Narus, 1990). It has been discussed extensively as a central element of the marketing concept. In studies of marketing channels, loyalty is the result of economic satisfaction with transactions due to volumes, margins, or discounts (Geyskens and Steenkamp, 1995). Satisfaction with the actors is regarded as an attitude that reflects positive evaluation and perceptions of the quality and performance of the firm (Garbarino and Johnson, 1999; Alison et al., 2015).

Commitment is another important ingredient in forming successful business relationships (Morgan and Hunt, 1994; Hennig-Thurau et al., 2002). Commitment is defined as the desire for continuity that manifests itself through the willingness of two parties to invest resources into a relationship (Gounaris, 2005). It has also been defined as an enduring desire to maintain a valued relationship, and the intent to build and maintain a long-term relationship (Walter et al., 2003). In a business relationship, commitment is a psychological viewpoint through which a continued willingness to work with a business partner is formed (Wetzels et al., 1998). Thus, commitment is another important factor that holds together the harmonious, cooperative, and long-term relationship between suppliers and customers. Based on our literature survey, we found that domestic research on this topic is rare, despite its importance. Hence, we believe that this article will spur domestic research on this subject.

III. RESEARCH METHODS

1. Quality Function Deployment

The purpose of timing synchronization is to allow the locally generated spreading signal to synchronize with the one embedded in the received signal. The timing synchronization is usually achieved in two stages: code acquisition and code Quality Function Deployment (QFD) originated in 1972 in Japan as a methodology to improve product quality in Japanese firms, such as Mitsubishi, Toyota, and their suppliers (Hauser and Clausing, 1988). QFD is not only a technical tool, but also a managerial philosophy that can help enhance organizational and managerial effects. Technically (Lai and Thanh, 2015), QFD belongs to the sphere of quality management methods, offering a linear and structured guideline for converting customer's needs into the specifications and characteristics of new products and services (Bevilacqua et al., 2006).

2. Fuzzy Set Theory

Usually, decision makers encounter questions, problems, and uncertainties while making decisions. To reduce uncertainty and clarify the process of decision making, we can use fuzzy logic (Zadeh, 1965). Generally, people use the outcomes of a bivalent logic gate (yes/no, true/false) as logical tools. However, bivalent logic is limited in its ability to clarify problems in real-life situations and does not illustrate either the human thought process or approaches to problem solving (Tong and Bonissone, 1980).

A fuzzy number (Zadeh, 1965) A in $\Re$ (real line) is a triangular fuzzy number if its membership function f_A: $\Re \rightarrow [0, 1]$ is

$$f_A(x) = \begin{cases} \dfrac{x-c}{a-c}, & c \le x \le a \\[2mm] \dfrac{x-b}{a-b}, & a \le x \le b \\[2mm] 0, & \text{otherwise} \end{cases} \quad (1)$$

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

In this article, triangular fuzzy numbers defined on [0, 1], and/or linguistic values characterized by triangular fuzzy numbers defined on [0, 1] are used to describe the fuzzy relationship strength between each needs attribute and service requirement. By the extension principle (Zadeh, 1965; Zadeh, 1975a; Zadeh, 1975b; Zadeh, 1975c; Liang et al., 2006), the fuzzy addition $\oplus$ and real number multiplication $\otimes$ of any two triangular fuzzy numbers are also triangular fuzzy numbers. That is, if $A_1 = (c_1, a_1, b_1)$ and $A_2 = (c_2, a_2, b_2)$, then

$$A_1 \oplus A_2 = \left(c_1 + c_2, a_1 + a_2, b_1 + b_2\right)$$

$$k \otimes A_1 = (kc_1, ka_1, kb_1), k \ge 0, k \in \Re .$$

3. Ranking of Triangular Fuzzy Numbers

Fuzzy ranking methods play an important role in prioritizing the techniques used to improve relationship quality in the home delivery industry. Many fuzzy ranking methods have been developed. Since the graded mean integration representation not only improves the drawbacks of existing ranking methods, but is also easy to implement and powerful at problem solving, we adopted it in this study to find the ideal and anti-ideal solutions (Chen and Hsieh, 2000).

According to the graded mean integration representation method, we can obtain the presented and ranking values of the triangular fuzzy number $A_i = (c_i, a_i, b_i)$ as

$$R(A_i) = (c_i + 4a_i + b_i)/6 . \quad (2)$$

Using $R(A_i)$, i = 1, 2, … n, we can rank the n triangular fuzzy numbers as $A_1, A_2, ..., A_n$. Let A_i and A_j be two fuzzy numbers and define:

$$A_i > A_j \Leftrightarrow R(A_i) > R(A_j);$$

$$A_i = A_j \Leftrightarrow R(A_i) = R(A_j);$$

$$A_i < A_j \Leftrightarrow R(A_i) < R(A_j) .$$

IV. EMPIRICAL STUDY

An overview of the case study company in Taiwan is presented below. The home delivery company contracted with a Japan transportation corporation in October 1999, and established the case study company in October 2000. The main objectives of this enterprise are "convenience," "fast delivery," and a wide delivery range described as "anywhere reachable". To achieve these objectives, the company established multiple channels of delivery and several locations for collecting goods. In addition to convenience stores, other channel partners can be identified by their trademarks. Moreover, the company has an excellent low-temperature distribution system providing three different temperature distribution services, namely, frozen (-18°C), cold storage (3°C), and room temperature. In order to establish a comprehensive service network to reach customers quickly and deliver the consignments safely, case company A has set up four transit centers in Taiwan at Keelung, Linkou, Taichung, and Kaohsiung to provide professional, convenient, and friendly delivery service.

1. Questionnaire Design

After summarizing the literature review and conducting personal interviews with the experts, senior managers of several consignors, and home delivery companies, 18 relationship quality attributes were selected for the survey. The importance and satisfaction ratings of the consignor needs followed the

Table 1. The priorities of enterprise consignors' requirements for relationship quality.

Requirement Factors	Requirement Attributes	Importance mean (a)	Satisfaction mean (b)	Original weight (a*(5-b))	Standard weight	Priority
Trust	The company provides customers with the correct information	4.164	3.801	4.992636	0.06653	**1**
	The company has a reliable corporate image	4.123	3.979	4.209583	0.05610	7
	The company protects the customer's confidentiality	4.048	3.904	4.436608	0.05912	**3**
	Customer's benefit is the company's prior consideration	3.986	3.966	4.121524	0.05492	10
	The company never conceals necessary information from customers	4.048	3.979	4.133008	0.05508	9
	Their salesmen are trustworthy	4.055	3.938	4.30641	0.05739	**5**
Commitment	I will not purchase other services even if the cost is less	3.932	3.973	4.038164	0.05381	15
	I will continue using the service from the company	3.966	3.932	4.235688	0.05645	6
	I am willing to maintain a long-term cooperative relationship with the company	3.945	3.945	4.161975	0.05546	8
	It is worth keeping a relationship with the company	3.993	3.973	4.100811	0.05465	12
	The company complies with their commitments to customers	4.068	4.075	3.7629	0.05015	16
	The company is very honest and solid	4.068	3.842	4.710744	0.06278	**2**
Satisfaction	The service of the company is unique	4.048	4.171	3.355792	0.04472	18
	The company is the industry benchmark	4.034	4.068	3.759688	0.05010	17
	Our business transactions have social value	4.019	3.897	4.432957	0.059087	**4**
	Transaction experiences with the company are pleasant	4.103	4.007	4.074279	0.05430	14
	It is a correct decision to choose the company	4.041	3.986	4.097574	0.05461	13
	Compared with others, this company is very satisfactory	3.986	3.969	4.109566	0.05477	11

Likert 5-point scale, from 1 (least important/bad) to 5 (most important/good).

2. Survey Design and Reliability Test

Several experts in this field were consulted for their viewpoints on the first draft of the questionnaire. We revised and finalized the questionnaire based on their comments, and sent it by post to 250 business consignors in Taiwan. The survey was carried out from May to June 2010. 195 responses were elicited from the initial and follow-up mailing, which consisted of 32 invalid answers and 163 usable responses, making the overall response rate 65.2%.

Reliability was examined using Cronbach's alpha values, which were statistically determined to provide a summary measure of the inter-correlations among sets of items. The values of three factors were above 0.80, the threshold used for explanatory research. The content of this questionnaire was created through literature reviews and interviews with professional academics and consignors. In addition, we also conducted a pre-test, thus validating the content of the questionnaire.

3. Priority Calculation of Enterprise Consignors' Requirements

Let Xiq and Yiq, $i = 1, 2, \cdots, n$; $q = 1, 2, \cdots, s$ denote the importance and satisfaction levels assigned to consignor needs A_i by consignor D_q, respectively. Since the priority of consignor needs has a direct relationship with the importance level and an inverse relationship with the satisfaction level, the original priority rating w_i of A_i can be obtained as follows:

$$w_i = \overline{X_i}(5 - \overline{Y_i})$$

where $\overline{X_i} = \sum_{q=1}^{s} X_{iq}/s$ and $\overline{Y_i} = \sum_{q=1}^{s} Y_{iq}/s$, and the normalized priority rating v_i is

$$v_i = \frac{w_i}{\sum_{i=1}^{n} w_i} . \quad (3)$$

As shown in Table 1, the priorities of the consignor needs of relationship quality were obtained according to the aforesaid calculation procedure. A comparison between the importance and satisfaction rating levels showed that the mean of total satisfaction or the satisfaction levels of individual attributes were smaller than the mean of importance levels. Thus, the actual experience of important attributes in the consignors' perception was unsatisfactory, suggesting that the home delivery company should pay attention to these gaps. The priority of consignor needs had positive and negative relations with importance and satisfaction, respectively. The top five requirements are highlighted in Table 1.

4. Developing Improvement Techniques for Enhanced Relationship Quality

After examining the consignors' requirements for relationship quality, we consulted eight academic experts and six professional home delivery managers and generated fourteen

Table 2. The corresponding improvement techniques for relationship quality.

Improvement Factors	Improvement Techniques
Customer Recognition	(B$_1$) Understand the interests of the customer
	(B$_2$) Identify customer's values
Professionalism	(B$_3$) Understand the designated task well
	(B$_4$) Answer all questions clearly
	(B$_5$) Provide customers with industry information
Relationship Maintenance	(B$_6$) Contact customers voluntarily
	(B$_7$) Offer accurate information based on customer's demands
	(B$_8$) Introduce new product information voluntarily
	(B$_9$) Keep in touch with customers regularly
	(B$_{10}$) Develop long-term relationships with customers
Customer Concerns	(B$_{11}$) Fulfill customer's requirements correctly
	(B$_{12}$) Possess integrity and moral sense
	(B$_{13}$) Make customers feel secure
Image Building	(B$_{14}$) Establish company's product and service image

corresponding improvement techniques (as shown in Table 2) for further discussion.

5. Construction of the Central Relationship Matrix

In this article, we constructed the central relationship matrix by combining consignors' requirements for relationship quality and improvement techniques to show their linkage. The fuzzy relationship degree set was used to estimate the fuzzy relationship strength between improvement techniques and consignors' requirements.

Managers of the case company assigned the fuzzy strength of each relationship. In this article, we defined the following three levels of correlation strength: low, medium, and high. The membership functions of those linguistic values were high = (0.4, 0.8, 1), medium = (0.3, 0.5, 0.7), and low = (0, 0.2, 0.6). In addition, the managers employed the triangular fuzzy numbers defined as [0, 1] to report their preference for the fuzzy strength of the relation.

6. Prioritizing the Improvement Techniques

After converting the fuzzy strength of relationships into its respective triangular fuzzy number, we used fuzzy addition and real number multiplication to summarize and obtain the average fuzzy relationship rating of the consignor needs attributes. Values were multiplied by the standardizing weight v_i (Eq. (3)) of the consignor needs attributes to sum up the average fuzzy relationship rating. This article ranked the consignors' requirements by applying Eq. (2) to obtain the $R(A_i)$. The results are listed in Table 3.

The top five improvement techniques for relationship quality are (B$_{13}$), (B$_{11}$), (B$_{10}$) (B$_{12}$), and (B$_3$). They are divided into three factors of "Customer Concerns," "Relationship Maintenance," and "Professionalism." This means that the

home delivery enterprise can frame strategies in terms of these three aspects to satisfy consignors' requirements. This study provides the following practical suggestions in light of these factors:

1)Make Customers Feel Secure

- **Information transparency:** by sharing information and making it publicly available, enterprise consignors can understand the market and the home delivery company's supply situation. This also gives enterprise consignors more time for scheduling transportation to fulfill downstream customers' requirements.

- **Establish business image:** by establishing an image of public welfare, the long-term public praise of sincerity, and the transmission of professional salespeople, enterprises can improve enterprise consignors' trust and image perceptions.

- **Obtain international authentication:** if a home delivery company applies for and obtains international authentication, such as ISO or SGS, etc., it can not only improve the efficiency of its internal operations but also gain enterprise consignors' trust in the service that it offers.

2) Fulfill Customer's Requirements Correctly

- **Value identification:** understand customer's demands and psychological experiences to reach a common goal effectively.

- **Adequate communication and confirmation:** fully understand, communicate, and conform to enterprise consignors' demands to increase work efficiency and avoid mistakes.

Table 3. The result of HOQ.

Improvement Factors		Customer Recognition		Professionalism			Relationship Maintenance	
Improvement Techniques / Consignors' Requirements		(B₁)Understand the interests of the customer	(B₂) Identify customer's values	(B₃)Understand the designated task well	(B₄) Answer all questions clearly	(B₅) Provide customers with industry information	(B₆) Contact customers voluntarily	(B₇) Offer accurate information based on customer's demands
Trust	The company provides customers with the correct information	(0.03, 0.10, 0.19)	(0.09, 0.21, 0.34)	(0.43, 0.69, 0.86)	(0.46, 0.76, 0.97)	(0.39, 0.67, 0.90)	(0.10, 0.27, 0.47)	(0.41, 0.71, 0.94)
	The company has a reliable corporate image	(0.03, 0.07, 0.11)	(0.09, 0.24, 0.41)	(0.31, 0.56, 0.76)	(0.39, 0.67, 0.90)	(0.20, 0.43, 0.66)	(0.17, 0.33, 0.47)	(0.19, 0.43, 0.67)
	The company protects the customer's confidentiality	(0.03, 0.07, 0.11)	(0.17, 0.33, 0.47)	(0.13, 0.29, 0.44)	(0.07, 0.20, 0.36)	(0.07, 0.17, 0.29)	(0.21, 0.37, 0.50)	(0.06, 0.20, 0.37)
	Customer's benefit is the company's prior consideration	(0.24, 0.47, 0.69)	(0.30, 0.56, 0.77)	(0.14, 0.31, 0.50)	(0.17, 0.39, 0.61)	(0.27, 0.51, 0.73)	(0.67, 0.52, 0.72)	(0.66, 0.52, 0.73)
	The company never conceals necessary information from customers	(0.09, 0.30, 0.56)	(0.13, 0.34, 0.59)	(0.24, 0.47, 0.69)	(0.46, 0.76, 0.97)	(0.50, 0.80, 1.00)	(0.27, 0.54, 0.80)	(0.13, 0.34, 0.59)
	Their salesmen are trustworthy	(0.16, 0.39, 0.63)	(0.17, 0.36, 0.54)	(0.46, 0.76, 0.97)	(0.33, 0.63, 0.89)	(0.27, 0.51, 0.73)	(0.13, 0.31, 0.51)	(0.03, 0.19, 0.40)
Commitment	I will not purchase other services even if the cost is less	(0.23, 0.50, 0.77)	(0.17, 0.41, 0.69)	(0.20, 0.40, 0.59)	(0.17, 0.39, 0.61)	(0.13, 0.26, 0.37)	(0.31, 0.59, 0.83)	(0.27, 0.51, 0.73)
	I will continue using the service from the company	(0.23, 0.50, 0.77)	(0.23, 0.50, 0.77)	(0.27, 0.51, 0.73)	(0.23, 0.50, 0.77)	(0.20, 0.40, 0.59)	(0.34, 0.63, 0.87)	(0.31, 0.56, 0.76)
	I am willing to maintain a long-term cooperative relationship with the company	(0.19, 0.46, 0.74)	(0.24, 0.50, 0.76)	(0.24, 0.47, 0.69)	(0.27, 0.54, 0.80)	(0.23, 0.44, 0.63)	(0.39, 0.67, 0.90)	(0.34, 0.60, 0.80)
	It is worth keeping a relationship with this company	(0.26, 0.54, 0.81)	(0.26, 0.54, 0.81)	(0.27, 0.51, 0.73)	(0.26, 0.54, 0.81)	(0.30, 0.56, 0.77)	(0.34, 0.63, 0.87)	(0.34, 0.60, 0.80)
	The company complies with their commitments to customers	(0.17, 0.33, 0.47)	(0.24, 0.44, 0.61)	(0.24, 0.50, 0.76)	(0.06, 0.20, 0.37)	(0.23, 0.44, 0.63)	(0.23, 0.44, 0.63)	(0.39, 0.64, 0.83)
	The company is very honest and solid	(0.09, 0.21, 0.34) v	(0.03, 0.13, 0.26)	(0.17, 0.30, 0.40)	(0.23, 0.47, 0.70)	(0.60, 0.38, 0.55)	(0.07, 0.20, 0.36)	(0.39, 0.67, 0.90)
Satisfaction	The service of this company is unique	(0.06, 0.20, 0.37)	(0.17, 0.41, 0.69)	(0.31, 0.59, 0.83)	(0.20, 0.46, 0.73)	(0.24, 0.47, 0.69)	(0.34, 0.47, 0.68)	(0.39, 0.67, 0.90)
	The company is the industry benchmark	(0.00, 0.09, 0.21)	(0.13, 0.31, 0.51)	(0.24, 0.50, 0.76)	(0.13, 0.31, 0.51)	(0.16, 0.33, 0.49)	(0.16, 0.33, 0.49)	(0.24, 0.47, 0.69)
	Our business transactions have social value	(0.13, 0.29, 0.44)	(0.10, 0.27, 0.47)	(0.06, 0.26, 0.51)	(0.10, 0.24, 0.40)	(0.03, 0.19, 0.40)	(0.13, 0.31, 0.51)	(0.10, 0.27, 0.47)
	Transaction experiences with this company are pleasant	(0.16, 0.36, 0.56)	(0.20, 0.40, 0.59)	(0.24, 0.50, 0.76)	(0.20, 0.43, 0.66)	(0.24, 0.47, 0.69)	(0.37, 0.67, 0.91)	(0.07, 0.20, 0.36)
	It is the correct decision to choose this company	(0.13, 0.31, 0.51)	(0.14, 0.29, 0.43)	(0.34, 0.63, 0.87)	(0.26, 0.54, 0.81)	(0.46, 0.76, 0.97)	(0.34, 0.60, 0.80)	(0.26, 0.51, 0.74)
	Compared to others, this company is very satisfactory	(0.16, 0.39, 0.63)	(0.23, 0.47, 0.70)	(0.39, 0.67, 0.90)	(0.23, 0.50, 0.77)	(0.41, 0.71, 0.94)	(0.39, 0.67, 0.90)	(0.23, 0.47, 0.70)
Triangular Fuzzy Numbers		(0.130, 0.307, 0.492)	(0.169, 0.369, 0.572)	(0.260, 0.493, 0.703)	(0.237, 0.478, 0.706)	(0.277, 0.47329, 0.667)	(0.272, 0.471, 0.674)	(0.263, 0.476, 0.687)
Representation Value		0.3083	0.3695	0.4532	0.4758	0.4727	0.4717	0.4757
Rank		13	12	9	5	7	8	6

Table 3. The result of HOQ (Cont.).

Relationship Maintenance			Customer Concerns			Image Building	Weight
(B_8) Introduce new product information voluntarily	(B_9) Keep in touch with customers regularly	(B_{10}) Develop long-term relationships with customers	(B_{11}) Fulfill customer's requirements correctly	(B_{12}) Possess integrity and moral sense	(B_{13}) Make customers feel secure	(B_{14}) Establish company's product and service image	
(0.24, 0.44, 0.61)	(0.27, 0.51, 0.73)	(0.16, 0.36, 0.56)	(0.24, 0.44, 0.61)	(0.24, 0.47, 0.69)	(0.43, 0.71, 0.93)	(0.14, 0.34, 0.57)	0.0665331
(0.53, 0.25, 0.38)	(0.20, 0.40, 0.59)	(0.23, 0.50, 0.77)	(0.39, 0.67, 0.90)	(0.31, 0.56, 0.76)	(0.41, 0.71, 0.94)	(0.24, 0.44, 0.61)	0.0560979
(0.00, 0.03, 0.07)	(0.13, 0.29, 0.44)	(0.20, 0.46, 0.73)	(0.03, 0.16, 0.33)	(0.39, 0.67, 0.90)	(0.39, 0.67, 0.90)	(0.20, 0.37, 0.51)	0.0591233
(0.51, 0.28, 0.48)	(0.53, 0.32, 0.55)	(0.26, 0.51, 0.74)	(0.13, 0.31, 0.51)	(0.09, 0.24, 0.41)	(0.27, 0.54, 0.80)	(0.17, 0.39, 0.61)	0.0447201
(0.13, 0.31, 0.51)	(0.16, 0.33, 0.49)	(0.16, 0.36, 0.56)	(0.19, 0.40, 0.60)	(0.31, 0.53, 0.69)	(0.23, 0.47, 0.70)	(0.17, 0.74, 0.96)	0.0501025
(0.03, 0.13, 0.26)	(0.06, 0.20, 0.37)	(0.10, 0.24, 0.40)	(0.10, 0.24, 0.40)	(0.36, 0.60, 0.79)	(0.17, 0.36, 0.54)	(0.23, 0.47, 0.70)	0.0590747
(0.20, 0.40, 0.59)	(0.19, 0.43, 0.67)	(0.34, 0.63, 0.87)	(0.41, 0.71, 0.94)	(0.23, 0.47, 0.70)	(0.27, 0.54, 0.80)	(0.13, 0.37, 0.66)	0.0542948
(0.10, 0.24, 0.40)	(0.14, 0.41, 0.71)	(0.46, 0.76, 0.97)	(0.34, 0.63, 0.87)	(0.23, 0.47, 0.70)	(0.26, 0.54, 0.81)	(0.09, 0.27, 0.49)	0.0549244
(0.10, 0.27, 0.47)	(0.33, 0.63, 0.89)	(0.50, 0.80, 1.00)	(0.43, 0.71, 0.93)	(0.26, 0.51, 0.74)	(0.46, 0.76, 0.97)	(0.23, 0.50, 0.77)	0.0550775
(0.17, 0.39, 0.61)	(0.24, 0.54, 0.83)	(0.50, 0.80, 1.00)	(0.43, 0.71, 0.93)	(0.23, 0.47, 0.70)	(0.46, 0.76, 0.97)	(0.16, 0.41, 0.70)	0.0573883
(0.10, 0.27, 0.47)	(0.24, 0.54, 0.83)	(0.46, 0.76, 0.97)	(0.43, 0.71, 0.93)	(0.27, 0.51, 0.73)	(0.41, 0.71, 0.94)	(0.19, 0.43, 0.67)	0.0538136
(0.00, 0.11, 0.29)	(0.27, 0.51, 0.73)	(0.34, 0.60, 0.80)	(0.39, 0.64, 0.83)	(0.17, 0.33, 0.47)	(0.39, 0.64, 0.83)	(0.13, 0.29, 0.44)	0.0564458
(0.23, 0.47, 0.70)	(0.26, 0.54, 0.81)	(0.30, 0.56, 0.77)	(0.31, 0.56, 0.76)	(0.31, 0.53, 0.69)	(0.31, 0.56, 0.76)	(0.13, 0.29, 0.44)	0.0554635
(0.09, 0.27, 0.49)	(0.14, 0.39, 0.64)	(0.33, 0.63, 0.89)	(0.39, 0.67, 0.90)	(0.39, 0.67, 0.90)	(0.50, 0.80, 1.00)	(0.20, 0.43, 0.66)	0.0546484
(0.07, 0.20, 0.36)	(0.16, 0.36, 0.56)	(0.31, 0.56, 0.76)	(0.50, 0.80, 1.00)	(0.39, 0.67, 0.90)	(0.39, 0.67, 0.90)	(0.20, 0.37, 0.51)	0.0501453
(0.13, 0.31, 0.51)	(0.13, 0.31, 0.51)	(0.20, 0.40, 0.59)	(0.37, 0.67, 0.91)	(0.46, 0.76, 0.97)	(0.34, 0.63, 0.87)	(0.24, 0.41, 0.54)	0.0627765
(0.13, 0.29, 0.44)	(0.26, 0.54, 0.81)	(0.31, 0.56, 0.76)	(0.50, 0.80, 1.00)	(0.20, 0.43, 0.66)	(0.39, 0.64, 0.83)	(0.23, 0.50, 0.77)	0.0546053
(0.16, 0.36, 0.56)	(0.29, 0.59, 0.86)	(0.31, 0.56, 0.76)	(0.46, 0.76, 0.97)	(0.20, 0.43, 0.66)	(0.34, 0.60, 0.80)	(0.21, 0.50, 0.79)	0.0547651
(0.159, 0.280, 0.456)	(0.218, 0.437, 0.668)	(0.302, 0.554, 0.767)	(0.334, 0.588, 0.794)	(0.282, 0.522, 0.729)	(0.358, 0.631, 0.851)	(0.233, 0.416, 0.632)	
0.2892	0.4390	0.5475	0.5800	0.5165	0.6222	0.4215	
14	10	3	2	4	1	11	

3) Develop Long-Term Relationships with Customers

- **Understand customers' demands:** use all means of communication to interact with enterprise consignors and fully understand enterprise consignors' demands, and allow enterprise consignors to understand the home delivery company's efforts.

- **Show consideration voluntarily:** actively contact and visit enterprise consignors in order to improve customer satisfaction and strengthen loyalty.

4) Possess Integrity and Moral Sense

- **Train before carrying out a duty:** address the importance of possessing personal integrity, and explain the punishments and consequences to which violators are subject.

- **Create an organizational culture with integrity:** this cannot be just a slogan. It is necessary to take action to show employees the kind of culture that truly exists in the organization.

- **Set an example:** enterprises' administrators or department heads should act as role models for employees.

- **Clearly define rewards and punishments:** give appropriate punishments to the staff that violate regulations and appropriate rewards to the staff with stellar records, and further prompt others to be conscientious at the same time.

5) Answer All Questions Clearly

- **Education and training:** on-job training or in-house education should take place regularly. This will keep staff updated with relevant information and skills.

- **Performance evaluation:** set up an evaluation system to encourage or monitor employees' work. This will provide feedback to employees to let them know how well they are doing and in what areas they can improve.

- **Provide job manuals:** establish thorough job manuals that can help staff better understand their work at the beginning. Further, this can help employees follow standard procedures to get things done effectively and efficiently.

Encourage experience sharing among employees: informal discussions or meetings, in which staff can share their working experiences with one another, can be held from time to time.

This can help the organization build a corporate knowledge base and prevent staff from making the same mistakes in the future.

V. CONCLUSIONS

This article presented a FQFD model to equip management with better improvement techniques to fulfill enterprise consignors' needs and improve their relationship quality. In an uncertain and constantly changing environment, this model can efficiently counteract the essential vagueness of human judgment and preferences by applying fuzzy logic to linguistic values. This paper also discussed the characterization of the linguistic values between improvement techniques and enterprise consignors' needs in terms of triangular fuzzy numbers. This can help managers to evaluate possible techniques to enhance relationship quality with customers when faced with limited internal resources. The application and effectiveness of the FQFD model were demonstrated here with an empirical research case.

Overall, we can summarize the results from the empirical case as follows. The top five enterprise consignors' requirements for relationship quality are "the company provides customers with the correct information," "the company is very honest and solid," "the company protects customer's confidentiality," "our business transactions have social value," and "their salesmen are trustworthy." From the results of HOQ, we obtained the top five improvement techniques for enhancing relationship quality with enterprise consignors for the home delivery company. These techniques include "make customers feel secure," "fulfill customers' requirements correctly," "develop long-term relationships with customers," "possess integrity and a moral sense," and "understand the designated task well." Simultaneously, this study provides the home delivery company with 15 practical suggestions to ensure the fulfillment of their commitment to their customers and gain competitive advantages.

Finally, it should be noted that the FQFD model applied in this study is simple, flexible, and easy to understand. It requires a moderate amount of data that can be collected in a short period of time. The requisite calculations do not require any sophisticated knowledge or cumbersome statistical procedures. Moreover, the information provided in the analysis can help determine directions for improvement. Measurements of progress can be made by continuous performance evaluations against a competitor's or the industry leader's performance. In conclusion, even though we limited the empirical testing to the home delivery industry with one example case, it would be interesting to extend the application of our FQFD approach to other industries and management issues.

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