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ASSESSMENT OF SERVICE QUALITY USING SYNERGIES OF FUZZY SERVQUAL, FUZZY KANO'S MODEL, AND FUZZY ANALYTIC NETWORK PROCESS INTO QFD

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A B S T R A C T

The essence of banking service will always be service quality. To gain customer satisfaction, enhance market rivalry, and achieve sustainable performance. The primary goal of this article is to identify the primary factor contributing to high customer dissatisfaction and poor service quality in bank services. This article synergies fuzzy SERVQUAL, fuzzy Kano model, and fuzzy analytic network processing into QFD. Structured survey questions based on SERVQUAL and Kano models were developed and disseminated to collect data. According to the findings, the bank should offer the promised service within the time range, respond to client concerns immediately, and supply appropriate service within the time frame. Furthermore, an employee should give timely care to the client; the employee should never be too busy to respond to customer demands and inform the consumer when service is delivered. In conclusion, focusing on customer requirements can enhance the bank's service level, which increases customer satisfaction.

1. INTRODUCTION

In today's competitive market, businesses lose customers owing to the poor quality of services or products they provide (Tesfaye, 2015). Meanwhile, the primary reason for client loss is that service providers frequently fail to adequately comprehend their customers' expectations, resulting in dissatisfaction with the service they receive. However, to overcome these issues, service providers must focus on customer service (Berushie, 2014). Hence, "the longer a customer stays with a bank, the more utility the customer generates" (Kebede, 2017). According to Basari & Shamsudin (2020); Hamzah & Shamsudin (2020); and Ilias & Shamsudin (2020), customers recreate a significant persona in business performance. In line with this, customer satisfaction increases as the quality of services/products offered by the firm advances (Hasfar et al., 2020).

Johnston & Clark (2001), cited in Goldstein et al., (2002), define and pinpoint the concept of services in the following ways: Services operations: a method of extraditing services; services experiences: the client directly uses the services; services outcomes: the welfare and success of the services; the value of the services: the benefits the client perceived to be inherent

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in the service's consideration of the service's cost. Furthermore, Grönroos (2001) defines the service concept as "an idea of how the quality-generating resource should function and what result they should achieve for the customer." On the other hand, Hernon & Nitecki (2001) define service quality from a different perspective; these include excellence, value, conformance to specification, and meeting or exceeding expectations. Also, Ramya et al., (2019) describe service quality as the capacity of a service provider to satisfy clients in a way that improves its commercial performance. The services sector encompasses a diverse and complex range of businesses and initiatives. Subsequently, Ghobadian et al., (1994) sort the services sector into three categories: national and local government, which includes areas like education, health, social security, police, military, transport, legal, information, and credits; non-profit private services, which includes institutions like charities and churches; mutual societies and art foundations; and for-profit private services, which includes utilities, hotels, airlines, architects, restaurants, solicitors, retailers, entertainment, banks, insurance companies, advertising agencies, consulting firms, market research companies, and communications. In short, several different types of research were done to determine what aspects affect service quality in the banking industry. For example, Gebre (2017) primary causes of poor service quality in the banking services sector are a lack of customer database management and inadequate infrastructure and technology. Furthermore, "employee competence and skills, the reliability of the electronic system, the reliability of the service system, the impeccability of the banking system's integrity, and the accountability instrument were among the other factors that affected the excellence of service quality of the bank services" (Pourmohammad et al., 2016). However, despite extensive research on the many facets of service quality, no study provides solid advice on how customer-oriented service businesses could raise customer satisfaction by combining various quality measurement tools with customer-oriented approaches. Therefore, this article uses an optimal decision framework for bank services based on the synergies of fuzzy SERVQUAL, fuzzy Kano's model, and fuzzy analytic network processing into the QFD model.

2. LITERATURE REVIEW

2.1 Service Quality

Concepts of service quality have been contested for centuries and are still a prominent area of study today. In many academic works of literature, service quality is also primarily defined in terms of the superiority of the service (Gera et al., 2017; Marković et al., 2015). Harvey & Green (1993) summarized quality into two distinct relative concepts: first, quality has multiple meanings for different individuals, and second, quality is related to "process" or "outcomes." As a result, they reflected exceptional quality, fitness for purpose, value for money, and transformative. Considering this, the concept of quality leads to a meeting between what customers expect and perceive (Saghier & Nathan, 2013). Ghobadian et al., (1994) categorized the definition of quality into five broad categories based on how crucial they are to service businesses, including transcendence, product, process or supply, customer, and value approaches. While Mackay & Crompton (1990) defined service quality as "the relationship between what customers desire from a service and what they perceive that they receive." On the other hand, Lenka et al., (2009) specified that service quality is the discrepancy between customer expectations and perceived service. Accordingly, Elmayar (2011) defines the degree of service quality from the customer's perspective, and there is a relationship between anticipated and perceived service quality. Likewise, Sawant (2016) defines service quality as "the overall assessment of service by the customer." Ali (2018) stated that definitions of service quality differ and are subject to various models, customer expectations, and satisfaction. Following that, Gupta et al., (2018) defined service quality as "the consumer's level of satisfaction from the service encounter; the consumer's expectations before taking the service; and how the service is conveyed concurrently." Satisfaction, in particular, is the result of a correlation between consumers' expectations and their views of the service's implementation (Shayestehfar & Yazdani, 2018). Furthermore, meeting or exceeding customers' service requirements will result in higher service quality and customer satisfaction (Uppal, 2019). Given that customer expectations are influenced by their perceptions of a company's image, and corporate image is the outcome of how customers perceive a company, improving the technical and functional quality of service by businesses increases customer satisfaction (Gronroos, 1984). Furthermore, there are two categories of service quality: first, "how" the service is delivered, and second, "what" the final perception of the customer is (Brady & Cronin, 2001; Kang, 2006). Also, Zameer et al., (2015) define a corporate image as "the perception about the organization that the customer holds in their memories." Venetis & Ghauri (2004), currently, operating service businesses consider service quality to be a significant success element; in general, two main mechanisms explain the influence of service quality on profitability: first, service quality is considered a way for service differentiation and competitive advantage to attract new customers and increase market share, and second, service quality is becoming a way for customer retention. Also, Ravichandran et al., (2001) indicated that several techniques were devised to keep customers, but the crux was to improve service quality. Moreover, Sigit Parawansa (2015) stated that customer retention has four main stages, known as "the four-stage model of loyalty power," such as cognitive loyalty, affective loyalty, conative loyalty, and action loyalty. Service

quality is remarkably relevant for the banking industry, as customers typically look for the service they perceive. Successful bank firms prioritize offering higher-quality service than their competitors. Likewise, quality of service is the principal determinant by which banks can invite new customers and helps to retain existing customers (Ahmed, 2017). Service quality has become a critical determinant for every business's survival and competitiveness (Hu et al., 2009). Therefore, service companies should plan, organize, implement, and control the quality system to meet or exceed customer expectations and increase customer satisfaction (Ramdhani et al., 2011). As a further significant causal aspect of company competitiveness, service quality is seen to have a direct bearing on firm costs and profits (Gounaris et al., 2003; Gupta et al., 2018).

2.2 Customer Satisfaction

Customer satisfaction has been a popular subject in marketing and academic research. (Cengiz, 2010; Chiguvi et al., 2017; Kombo, 2015; Murugiah & Akgam, 2015; Narteh & Kuada, 2014; Ozatac et al., 2016); and others are examples. Subsequently, Gunasekare (2016) states that "customer satisfaction is a set of feelings or outcomes attached to a customer's experience with any product or service." But nowadays, consumer happiness is a significant precursor to client retention and returning business (Syed, 2019). Also, Hanif et al., (2010) explained that in the telecommunications service sector, if a company wants to be profitable in the long run, it must satisfy its customers by crediting fair tariffs and high customer service, thereby dominating the market. On the other hand, Vásquez et al., (2017) explained that measuring customer service satisfaction is a method that should be chronic in any company so that they can control the processes and activities executed to enhance their performance. Furthermore, a hospital is a significant healthcare provider and must acknowledge the value of patients' choices; patients call the hospital seeking relevant, high-quality medical care, a safe environment, and moderately sufficient facilities (Singh, 2012). Meanwhile, Manzoor et al., (2019) stated that patient satisfaction is noted as a touchstone to assess the potency of health services given in the hospital. Furthermore, the hotel is a primary hospitality industry and provides customer-confined service. In line with this, the hospitality industry's service sectors must put the customer need first to remain competitive and establish a name for themselves in the market (Pazir & Amin, 2015). Likewise, Luturlean & Anggadwita (2015) highlighted how businesses could use the customer experience management approach to keep customers and increase the intention to revisit. Nevertheless, in the banking service sector, the main component of customer satisfaction is the correlation between the customer, the service provider, and the service they perceive (Saghier & Nathan, 2013). Besides, Bena (2010) discovered two key issues: the criteria for assessing client happiness must be defined first, according to the field of business and the firm's requirements, and second, clients prefer to declare they are pleased or select an indecisive response. Therefore, to compete in the global market, any organization must put customer satisfaction before company profits and other operations. Similarly, customer satisfaction is critical for the continued success of any business (Mekonen et al., 2019). Customer satisfaction is a significant concern for all companies to enhance customer loyalty and design more reliable business performance (Grønholdt et al., 2000). Further, Munusamy et al., (2010) define customer satisfaction as "global issues that affect all organizations, regardless of their size, whether profit or non–profit, local or multinational." As, Lenka et al., (2009) explained, customer satisfaction is a synergy of their cognitive and affective responses to the service encounter.

2.3 Quality Measurement Tools for Customer-Oriented Approaches

Giannikas et al., (2019) assert that "customer orientation concerns the degree to which an organization focuses on the customer, recognizes their desires and places meeting their needs as a foremost priority." According to previous study findings, the impact of customer orientation, including value-based customer orientation, may be described in terms of two factors connected directly to customer satisfaction Wang et al., (2012) and action-based customer orientation (H. He & Li, 2011). Also, value-based concerns meet customer demand by being aware of the customer's expectations for service quality, which can determine customer satisfaction (Blocke et al., 2011). While action-based approaches emphasize utilizing customer feedback and accommodating it when making organizational choices (Y. He et al., 2011). Accordingly, Dragolea & Ungureanu (2008) explain how an organization's success depends on its capacity to control customer expectations while promoting investment and loyalty. Consequently, to keep its current customers, every organization needs to be customer-centric and open to hearing what they have to say.

2.3.1 SERVQUAL Model

Several research publications cover the theoretical and practical use of SERVQUAL in a wide range of industrial, business, and non-profit organizations. For example, in the healthcare sector (Anbari et al., 2014; Umath et al., 2015), higher education (Galeeva, 2016; Ulewicz, 2014), tourism service (Home, 2006), restaurant (Lee & Hing, 1995; Yu-qiang & Jun-jia, 2011), bank (Ilyas et al., 2013; Lau et al., 2013), telecommunication (Alnsour et al., 2014), apparel retail (Bhaskar & Shekha, 2011), public service (Brysland & Curry, 2001), local government (Donnelly et al., 1995), electronic commerce B2C (Alzola &Robaina, 2005), business – to – business service (Mehta & Durvasula, 1998), technical and vocational colleges (Akhlaghi et al., 2012) and more. Further, SERVQUAL has a variety

of potential applications; it can assist service and retail firms in assessing customer expectations and perceptions of service quality, as SERVQUAL has five universal dimensions (Parasuraman et al., 1988).

Table 1. Essential dimensions of service quality

SERVQUAL dimensions	Definitions	Source
Tangible	Physical facilities, equipment, and appearance of personnel.	Parasuraman et al., (1988)
Reliability	Ability to perform the promised service dependably and accurately.	
Responsiveness	Willing to help customers and provide prompt service.	
Assurance	Knowledge and courtesy of employees and their ability to inspire trust and confidence.	
Empathy	Carrying, individualized attention the firm provides its customer.	

SERVQUAL reports respondent responses on their expectations and perceptions of service quality (Prakasha & Mohanty, 2012). Moreover, SERVQUAL contains 22 items (Likert-type) with five dimensions, so each item in the SERVQUAL tool is of two classes: one to measure expectations and, thereby, firms overall within a business, and the second to measure perceptions about the particular company (Mohd. Adil et al., 2013). Accordingly, Robinson (1999) claims that the difference between the two findings provides a gauge for the discrepancy between expectations and perceived service quality, which is performance minus expectations. Following that, for the particular respondent, the service quality for each dimension is determined as follows:

$$SQj = \sum_{j=1}^{nj} \frac{P_{ij} - E_{ij}}{nj} \quad (1)$$

Where

SQ_j = service quality of dimensions

E_{ij} = expectations of the firms for item i in dimension j

P_{ij} = perceived performance of the form on item i in dimension j

n_j = number of items in dimension j.

However, despite its widespread usage and popularity, SERVQUAL has received several philosophical and practical objections. See, for example: (Babakus & Boller, 1992; Bolton & Drew, 1991; Boulding et al., 1993; Cronin & Taylor, 1992; Genestre & Herbig, 1996; Teas, 1993) As a result, Buttle (1996) categorizes the critiques into two parts: one theoretical (paradigmatic objections, gaps model, process orientation, and dimensionality) and one operational (expectations, item composition, a moment of truth (MOT), polarity, scale points, too much administrative work, and variance extracted).

2.3.2 Kano's Model

Doctor Noriaki Kano, a Tokyo professor, created the Kano model in 1984 to define service quality based on customer satisfaction (Seyedi et al., 2012). In the meantime, customer satisfaction is a one-dimensional operation, implying that the higher the perceived service quality, the higher the customer satisfaction (Kazemi et al., 2013). Perhaps, fulfilling the customer's request does not result in a higher degree of satisfaction from the customer (Mostafa et al., 2013). Based on the Kano model, customer needs were categorized into three phases: basic, performance, and excitement needs (Bhattacharyya & Rahman, 2004).

Similarly, Five kinds of customer satisfaction with a quality attribute exist, such as "must be," "one – dimensional," "attractive," "indifferent," and "reverse" Kurt & Atrek (2012); Lin et al., (2017), and the quality attribute is defined as shown in table 2.

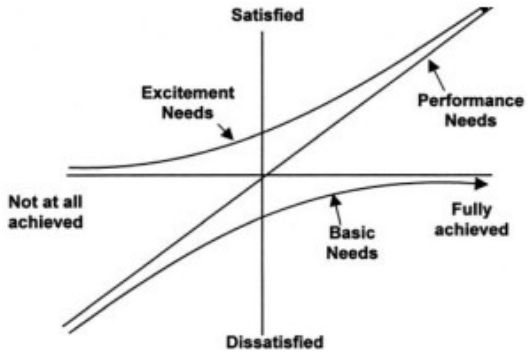

Figure 1. Kano's model.
Source: Bhattacharyya & Rahman (2004)

Table 2. Categories Kano's model of quality attributes

Quality attribute	Definitions	Source
Must – be	"Sufficient quality attributes *do not* lead to customer satisfaction but insufficient quality attributes lead to customer dissatisfaction."	(Kurt & Atrek, 2012; Lin et al., 2017)
One – dimensional	"Sufficient quality attributes lead to customer satisfaction but insufficient quality attributes *do not* lead to customer dissatisfaction."	
Attractive	"Sufficient quality attribute leads to customer satisfaction but insufficient quality attributes *do not* lead to customer dissatisfaction."	

Indifferent	"Sufficient quality attributes *do not* lead to customer satisfaction and insufficient quality attributes *do not* lead to customer dissatisfaction."
Reverse	"Sufficient quality attributes lead to customer dissatisfaction and insufficient quality attributes lead to customer dissatisfaction."

Likewise, to categorize requirements or quality attributes, it is necessary to use Kano's questionnaires, which are sorted into two types, i.e., functional and dysfunctional forms of questions. See, for example, the figure 2 (Madzík et al., pp. 3, 2019).

Numerous research papers consolidate the application of Kano's model in an assortment of industrial, profit, and non-profit firms (table 3).

But, regardless of the numerous benefits of Kano's model, it may have been criticized for a case in which, Gregory & Parsa, pp -40 (2013) include lengthy questionnaires that exclude the quantitive or qualitative performance of the specific attributes.

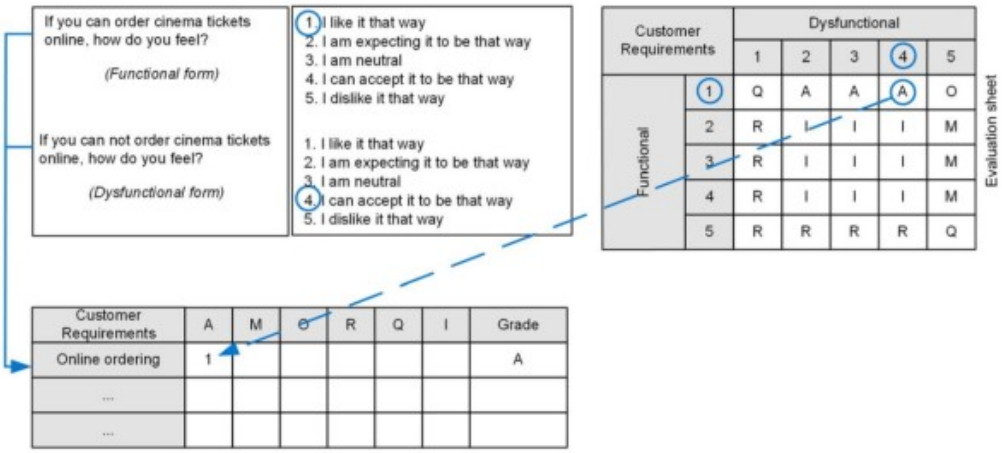

Figure 2. Categorization of a requirement using the Kano approach.
Source: Madzík et al.,pp-3 (2019)

Table 3. Analysis of the application of Kano's model

Author & year	Description	Kano's quality element	Model type
Madzík et al., (2019)	Understanding customer requirements in higher education	Kano method	CR
HSU et al., (2007)	Capturing passenger's voice in the airline industry	Kano method	CS
Chiang et al., (2019)	Classifying technological innovation attributes for hotel service	Use synergies of the Kano method, self-importance questioners, and factor analysis	CS
Gregory & Parsa (2013)	Hospitality and Tourism industry	Kano method	CS
Llinares & Page (2011)	Kansie Engineering to evaluate subjective real estate consumer preference	Use synergies of the Kano method, self-importance questioners, and factor analysis	CR
Ma et al., (2019)	Differentiate between future vehicle–driving services	Use synergies of the Kano method, self-importance questioners, and factor analysis	CS
Rozaq et al., (2019)	Assessing customer satisfaction with hospital service quality	Kano method	CS
Velikova et al., (2016)	Identification of wine festival satisfaction drivers	Penalty – Reward Contrast Analysis (PRCA)	CS

2.3.3 Quality Function Deployment (QFD)

Bouchereau & Rowlands (2000) define QFD as "a visual connective process that helps teams focus on the needs of the customer throughout the total development cycle." Quality function deployment (QFD) is supported by a matrix approach to design and function the essentials (commencing with customer requirement) upon the way of attaining them (Jagdev et al., 1997). As a result, a set of charts originated to show the connection between client expectations for service attributes and service planning. Likewise, "Quality Function Deployment (QFD) is a service planning and development support method, which provides a structured way for service providers to assure quality and customer satisfaction while maintaining a sustainable competitive advantage" (Andronikidis et al.,pp-320, 2009). The indicated usage of the QFD approach in many service areas demonstrates its universal applicability. Such as bank service (Purba et al., 2018), hospitality (hotel service) (Paryani et al., 2010), healthcare service (Dijkstra & Bij, 2002; Gremyr & Raharjo, 2013), utility service (Jahanzaib et al., 2016), design/build project (Pheng & Yeap, 2001),

software product development (Haag et al., 1996; Thackeray & Van Treeck, 1990) and more. In light of this, numerous circumstances or significant aspects described in the illustration below are necessary to put into practice and advance QFD (Kathawala & Motwani, 1994).

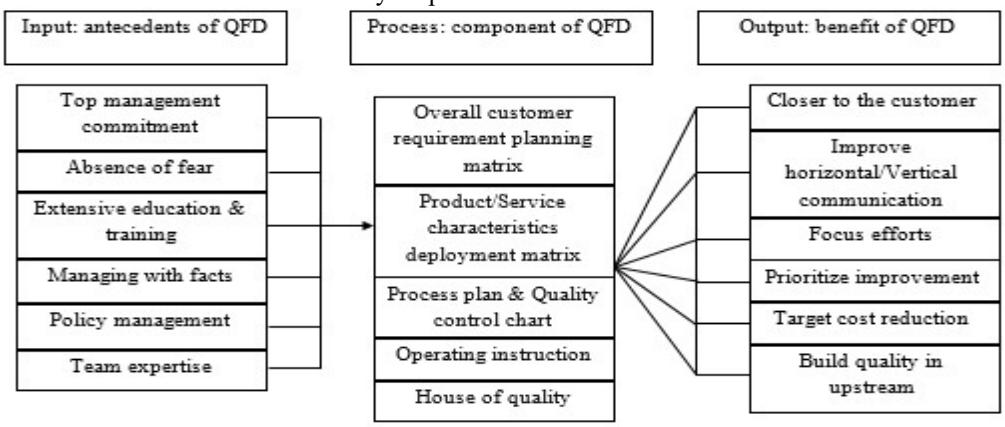

Figure 3. The Three Components of QFD: A System Model. Source: Kathawala & Motwani (1994) Modified

Despite its popularity and widespread acceptance, quality function deployment is subject to numerous criticisms; see, for example, Wolniak, pp-16 (2018) , who argue that it is not flexible, time-consuming, labor-intensive, only allows for qualitative data, and creates difficulties for collaboration within multidisciplinary teams; and Andronikidis et al., pp-321 (2009) , who assume linear association within customer requirements and service attributes, impose a Poel (2007) critiques quality function deployment from a methodological aspect, which includes that "customer demands are product/service dependent, customer demand can not always be represented by a linear additive value function, individual customer preference cannot be translated into a colleactive customer preference ordering without violating a number of very reasonable conditions, the correlation between customer demand and engineering characteristics is not always non-negative and constant, the realtive importance of customer demand can not be uniformly translated into a relative importance of the engineering characteristics, and the meaning of tragedy values is unclear or disputable."

2.4. Multi-Criteria Decision-Making Tools

Multi-criteria decision-making analysis (MCDA) was introduced as a subsection of operations research intended to assist in solving problems (Jato-Espino et al., 2014). Since then, numerous multi-criteria decision-making techniques have been introduced to use them for different service and manufacturing sectors (Kiker et al., 2005; Lahdelma et al., 2000; Løken, 2007; Słowiński, 1986; Tonietto & Carbonneau, 2004).

2.4.1 Analytic Network Process (ANP)

The analytic network process consists of similar attributes to the analytic hierarchy process, which includes simplicity, flexibility, and coincident implementation of qualitative and quantitative measures and can add ebullience to the judicial process. In addition, the analytic network process deals with every event, i.e., a network of criteria, sub-criteria, and alternatives; moreover, in the analytic network process, every component in the network can interplay with each other by any means (Kheybari et al., 2020). Likewise, Kheybari et al., (2020)recapitulate the analytic network process in four main steps, such as:

Step1. Building a model and converting a problem into a topic network structure.

Step2. Formulating a pairwise comparison matrix and determining priority vectors.

Step3. Generating a supermatrix and converting it to a weighted supermatrix.

Step4. Selecting the best option.

Numerous research papers discuss the use of analytic network processing (ANP) in a variety of industrial, profit, and non-profit organizations (table 4).

Table 4. Analysis of the Application area of the Analytic Network Process (ANP)

Author & year	Description	Area
Galankashi et al., (2015)	Prioritizing green supplier selection criteria	Green supply chain
Çelebi et al., (2010)	Logistics management	Small electronic appliance manufacturer
Simwanda et al., (2020)	Modeling the drivers of urban land-use change	Urban development
Abdi (2012)	Product family formation & selection for configurability	Manufacturing system
Gheshlaghi et al., (2019)	GIS-based forest fire risk mapping	Environmental planning
Bayazit (2006)	Vendor selection decisions	Supply chain
Boateng et al., (2015)	Risk prioritization in mega projects	Project management

Author & year	Description	Area
Cheng & Li (2004)	Contractor selection	Project management
Cheng & Li (2005)	Project selection	Construction management
Cooper et al., (2012)	Selection of a third-party logistics provider	Pharmaceutical company
Dabestani et al., (2017)	Evaluation and prioritization of service quality dimension	4 – star hotel
Farman et al., (2017)	Optimum cluster head selection	Wireless sensor network
Genevois et al., (2015)	Automatic teller machine deployment problem	Bank service sector
Godse et al., (2008)	Web service selection	Web service industry
Hasanzadeh et al., (2013)	Coastal oil jetties site selection	Oil production industry
S. H. Chen et al., (2004)	Enterprise partner selection	Vocational education
Jharkharia & Shankar (2007)	Selection of logistics service provider	Logistics
Meade & Presley (2002)	R&D project selection	Research & Development program
Mulebeke & Zheng (2006)	Software selection in product development	Manufacturing industry
Wu et al., (2012)	Porter's Five Force analysis	Strategic management
Zhu et al., (2010)	A portfolio-based analysis for green supplier management	Supply chain management
Zare et al., (2018)	Prioritizing shift work disorder	Hospital service

Despite its reputation and widespread use, ANP has been subjected to several theoretical and practical criticisms. For instance, the method's complexity, the length of the implementation, and the uncertainty in giving judgment, especially at the cluster level (Kadoić et al., 2017).

2.5 Integration of Customer-Oriented Tools for Improving Service Quality

In the current worldwide competitive market, it is not adequate for firms to depend exclusively on continuous improvement to sustain and advance their competitive advantage. The introduction of integrated customer-oriented tools for increasing service quality, similar to the synergy of changed processes, has been widely applied in many service and industrial businesses. See, for example, a fuzzy QFD approach using SERVQUAL and Kano models (in the case of hotel service) (Beheshtinia & Farzaneh Azad, 2017), integration of SERVQUAL and Kano models (in the case of airline service) (Basfirinci & Mitra, 2015), application of integration of Kano model, AHP technique and QFD matrix (case of banking service) (Pakizehkar et al., 2016); integration of Kano model and AHP (case of banking service) (Kazemi et al., 2013), application of integrating SERVQUAL and Kano model into QFD (case of logistics service) (Baki et al., 2009), integrating SERVQUAL and Kano model into QFD (case of simulation – based training on project management) (Rahmana et al., 2014), integrating SERVQUAL and Kano model into QFD (case of hotel industry) (P. Gupta & Srivastava, 2012), a hybrid of Kano model and QFD (case of banking service) (Pourhasomi et al., 2013), integrating fuzzy SERVQUAL into refined Kano model (case of restaurant service) (Hsieh et al., 2015), combination of the Kano model and QFD (designing new product) (Tontini, 2007), integrating SERVQUAL and Kano model and QFD (case of PT POS Indonesia) (Singgih & Ardhiyani, 2010) and more. Accordingly, Tan & Pawitra (2001) mentioned and clarified the fundamentals of the procedure involving the collaboration of SEVQUAL, the Kano model, and QFD to evaluate customer satisfaction to develop service excellence and innovation for business organizations. The key arguments or problems for incorporating SERVQUAL and the Kano model into QFD are then briefly reviewed.

Table 5. The Major Point for Integrating SERVQUAL and Kano's Model into QFD

SERVQUAL	Kano's model	QFD
Assumes a linear relationship between customer satisfaction & service attributes performance.	Helps SERVQUAL to prioritize the improvement of an organization's weakness based on the category of needs that can lead to the highest customer satisfaction.	Generally serves as the planning process for translating customer needs into an appropriate organizational requirement.
As a continuous improvement & innovation tool.	It Helps SERVQUAL to address innovation issues, attractive attributes are a source of customer delight so it is one area where effort for improvement should be targeted.	
Provides important information on the gap between predicate service and perceived service, however, it is not able to address how the gaps can be closed.	Helps SERVQUAL to prioritize which service gap to focus on and to make effort on.	

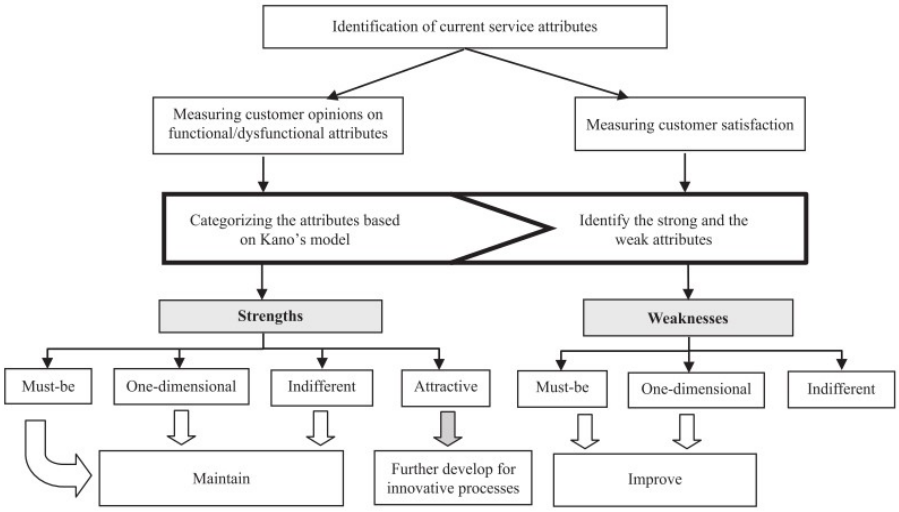

Figure 4. A framework of integrated Kano's model into SERVQUAL.
Source: Tan & Pawitra (2001)

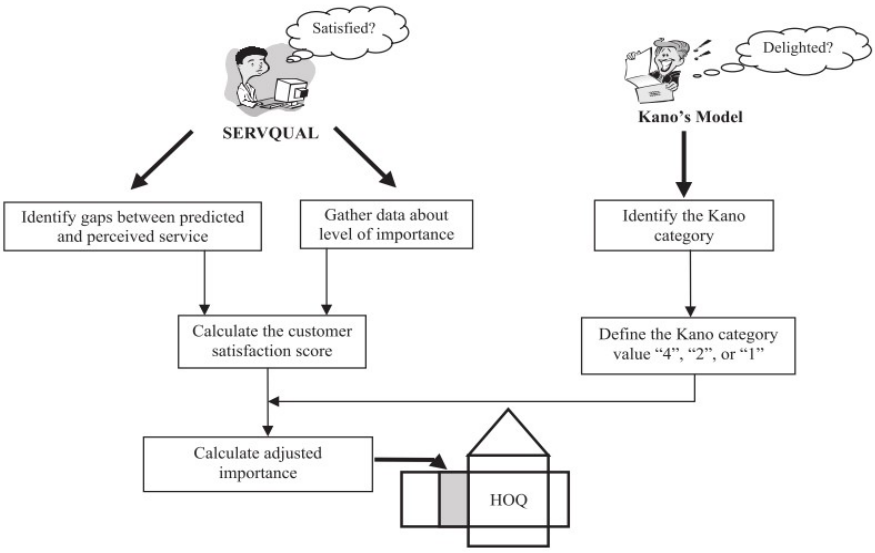

Figure 5.A framework of integrated SERVQUAL and Kano's model into QFD.
Source: Tan & Pawitra (2001)

Andronikidis et al., (2009) assessed and stated that when working with quantitive methods related to QFD, various issues arise at different stages of QFD execution, as follows: "QFD methodology imposes the need to deal with large amounts of data gathered from customers, competitors, and cross-functional, time-consuming, requiring input and analyzing a large amount of subjective data, bias may be easily inserted into any stage of the QFD, etc." The employment of quantitive approaches like the analytic hierarchy process (AHP) is thus necessary to build a new strategy for enhancing QFD's efficacy to resolve those problems. A better service delivery that meets or surpasses client expectations is made possible by the analytic network process (ANP) and Markov chains, increasing sales and customer satisfaction.

3. MATERIAL AND METHODS

3.1 Fuzzy SERVQUAL Model

The main steps incorporated in the appraisal of bank service quality are discussed as follows: the questionaries' design; distributing survey questionaries and gathering survey data; analyzing customer expectations and perceptions of service quality; and finally, the interpretation of fuzzy SERVQUAL analysis.

Step 1. Questionnaire Design
This article adapts questionnaires from previous literature. The SERVQUAL model questionnaires addressing customer perceptions and expectations are weighted using the linguistic variables scale. For instance, the linguistic variables include "strongly

disagree," "disagree," "neutral," "agree," and "strongly agree."

Table 6. A linguistic variable of perceptions & expectations.

Likert scale	Linguistic variables	Fuzzy membership function
1	Strongly disagree	(1, 1, 3)
2	Disagree	(1, 3, 5)
3	Neutral	(3, 5, 7)
4	Agree	(5, 7, 9)
5	Strongly agree	(7, 9, 9)

Step 2. Distribution of Survey Questionnaires and Collection of Survey Data

A simple random sampling technique was used for the SERVQUAL model questionnaire's respondents. In line with this, the basic formula for calculating the sampling error for a sample estimate of a population parameter is as follows (Bozorgi, 2007).

$$\text{Sample error} = \frac{\text{Variability of the measurement (Values among the sampling units)}}{\sqrt{\text{Size of the sample}}} \quad (2)$$

Also, this article describes a pilot test and the standard variation in factors of service quality measurement in the Grönroos model. Likewise, table 7 summarizes the standard deviation of service quality variables (Grönroos, 2000).

Table 7. Mean standard variation of services quality measurement. Source: Grönroos (2000)

Items	Mean standard variation
Tangibles	0.708
Reliability	0.301
Responsiveness	0.521
Assurance	0.263
Empathy	0.755
Technical factor	0.605
Image	0.603

Therefore, for this purpose, this article considers using a 5% sample error to be adequate for academic research. Accordingly, to get an accurate sample size, we should select the maximum value of the mean variation of a factor, so the sample size is calculated as follows:

$$0.05 = \frac{(0.755)}{\sqrt{\text{Size of the sample}}} = \mathbf{240.24 \approx 240}$$

Step 3. Analysis of Customer Expectations and Perceptions

The main mathematical operations on fuzzy number

Previous literature has discussed the mathematical operations of the fuzzy number (Adamo, 1980; Campos & Verdegay, 1989; Dubois & Prade, 1978; Nahmias, 1978).

The primary mathematical operations on fuzzy numbers include the ones listed below: Triangular fuzzy numbers $A_1 = (c_1, a_1, b_1)$ and $A_2 = (c_2, a_2, b_2)$ should be used as examples.

1. The triangular fuzzy number Y = (c, a, b) is a special case of a generalized trapezoidal fuzzy number. The ranked average integration representation of the triangular fuzzy number Y will be.

$$P(Y) = \frac{1}{6}(c + 4a + b) \quad (3)$$

2. Addition operation of A_1 and A_2

$$A_1 + A_2 = (c_1 + c_2,\ a_1 + a_2,\ b_1 + b_2) \quad (4)$$

Where: c_1, c_2, a_1, a_2, b_1, b_2 are real numbers

3. Subtraction operation of A_1 and A_2

$$A_1 - A_2 = (c_1 - b_2,\ a_1 - a_2,\ b_1 - c_2) \quad (5)$$

Where: c_1, c_2, a_1, a_2, b_1, b_2 are real numbers

4. Division operation of Aand any real number r

$$\frac{A}{r} = \left(\frac{c}{r}, \frac{a}{r}, \frac{b}{r}\right) \quad (6)$$

Where: r are real numbers

5. Multiplication operation

$$P\ (Y_1 * Y_2) = \frac{1}{6}(c_1 + 4a_1 + b_1) * \frac{1}{6}(c_2 + 4a_2 + b_2) \quad (7)$$

The analysis steps are discussed as follows:

1. Let fuzzy number A_{ein} be the service quality expectation from the n^{th} customer under service item *i*, let fuzzy number A_{pin} be the service quality perceptions from the n^{th} customer under service item *i*, and let fuzzy number TA_{ei} be the sum of service quality expectation from all customer under service item *i*, let fuzzy service number TA_{pi} be the sum of service quality perception from all customer under service item *i*.

$$TA_{ei} = \sum_{1}^{N} A_{ein} \quad (8)$$

$$TA_{pi} = \sum_{1}^{N} A_{pin} \quad (9)$$

By using equations (4) & (8) we can analyze the sum of service quality expectations from all customers under service item *i*, alike, by using (4) & (9) we can analyze the sum of service quality perception from all customers under service item *i*.

2. Let fuzzy number MA_{ei} be the average service quality expectations from all customers under service item *i*, and let fuzzy number MA_{pi} be the average service quality perceptions from all customers under service item *i*.

$$MA_{ei} = \frac{TA_{ei}}{N} \quad (10)$$

$$MA_{pi} = \frac{TA_{pi}}{N} \quad (11)$$

By using equations (6) & (10) we can analyze the average service quality expectation from all customers under service item *i*, alike, by using equations (6) & (11) we can analyze the average service quality perception from all customers under service item *i*.

3. Let fuzzy number Gap_i be the gap within the perception and expectation of service quality from all customers under service item *i*.

$$Gap_i = MA_{pi} - MA_{ei} \quad (12)$$

By using equations (5) & (12) we can analyze the service quality gap with the expectation and perception from all customers under service item *i*, likewise, by using equation (3) we can analyze the representation of a fuzzy number.

3.2. Fuzzy Kano's Model

Following is a discussion of the primary methods used to assess the functional and dysfunctional requirements for bank service quality: design, dissemination, and data gathering for Kano model questionaries; Kano categorization; customer satisfaction and self-stated importance; and, lastly, customer needs and technical requirements.

Step 1. Kano's Model Questionnaire Design

This article adapts questionnaires from previous literature. Kano models' functional and dysfunctional interpretations were careful. In line with this, customer responses are weighted using linguistic variables. For example, the linguistic variables include "I like it," "I expect it," "I am neutral," "I can tolerate it," and "I dislike it." And the second type of Kano model questionnaire addresses customers' views on how important a given feature is to them, and their responses are weighted using the linguistic variables scale. For example, the linguistic variables include "not important," "somewhat important," "important," "very important," and "extremely important."

Table 8. Linguistic variables of Kano's model.

Self-stated importance scale	Linguistic variable	Fuzzy membership function
1	Not important	(1, 1, 5)
3	Somewhat important	(1, 5, 7)
5	Important	(5, 7, 11)
7	Very important	(7, 11, 13)
9	Extremely important	(11, 13, 13)

Step 2. Distribution of Kano's Model Questionnaires and Collection of Survey Data

The snowball sampling technique was used for Kano's model questionnaire respondents, and the formula for calculating the sample size is as follows:

$$n = \frac{Z^2 * \sigma^2}{e^2} = \frac{Z^2 * P(1-P)}{e^2} \quad (13)$$

$$n = \frac{1.96^2 * 0.3(1-0.3)}{0.05^2} = \mathbf{322.69 \approx 323}$$

Step 3. Determine Kano's Classification, Customer Satisfaction Coefficient, and Self-Stated Importance

The customer satisfaction coefficient indicates whether a service's ability to satisfy criteria may boost customer satisfaction or whether doing so only keeps them from being unsatisfied. As seen below, the two equations were used to calculate how satisfied and unsatisfied people were with their lives.

$$Customer\ satisfaction\ (better) = \frac{A+O}{A+O+M+I} \quad (14)$$

$$Customer\ dissatisfaction\ (worst) = -\frac{O+M}{A+O+M+I} \quad (15)$$

Step 4. Determine Customer Requirements and Technical Requirement

Utilizing the fuzzy SERVQUAL and fuzzy Kano models, customer needs were determined. A similar concentrated group conversation with the branch manager and customer support representative led to the discovery of the technical necessity.

3.3. Fuzzy Analytic Network Process

The major steps undertaken in the fuzzy analytic network process are discussed as follows.

Step 1. Establish Fuzzy Analytic Network Process Pairwise Comparison Matrices

Following the identification of the customer requirement from fuzzy SERVQUAL and fuzzy Kano model analysis, the next step is to construct a fuzzy pairwise comparison of customer requirements to analyze the weight of each customer requirement, respectively. On the other hand, the analytic network process is weighted using the linguistic variables scale; for instance, the linguistic variables include "equally important," "weakly important," "fairly important," "strongly important," and "absolutely important."

Step 2. Analyze The Local Weight of Each Technical Requirement Concerning Customer Requirement

This step entails examining the fuzzy weights associated with each technical requirement and each customer requirement for compliance.

Table 9. Linguistic variables of the Analytic Network Process.

Saaty scale	Linguistic variable	Fuzzy membership function
1	Equally important	(1, 1, 1)
3	Weakly important	(2, 3, 4)
5	Fairly important	(4, 5, 6)
7	Strongly important	(6, 7, 8)
9	Absolutely important	(9, 9, 9)

3.4. Integrated Fuzzy SERVQUAL, Fuzzy Kano's Model, and Fuzzy ANP into QFD

The approach incorporated in the design of an integrated HOQ is discussed as follows: Kano categories were allocated based on their fuzzy Kano model analysis, and the importance of "what" was gathered using fuzzy SERVQUAL analysis. The Kano categories were then multiplied with fuzzy SERVQUAL results to determine the modified importance (importance of "what" value).

Also, the adjusted importance was then multiplied with each technical requirement in the row and summed up the results of the total value to determine the (importance of the "how" value). Briefly, the application of integrated fuzzy SERVQUAL, fuzzy Kano model, and fuzzy ANP into QFD is presented in the figure 7.

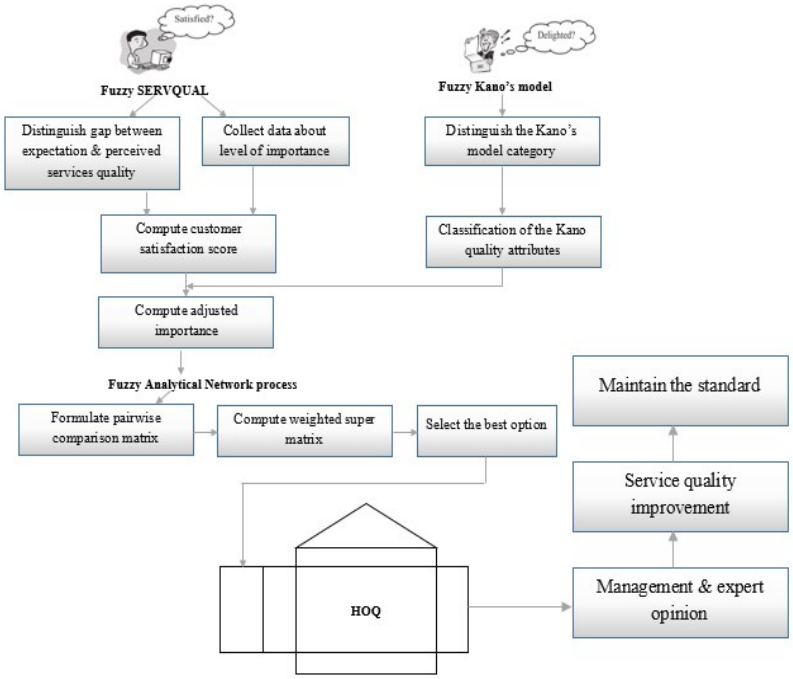

Figure 6. A framework of synergies of fuzzy SERVQUAL, fuzzy Kano's model, and fuzzy analytical network process into QFD.

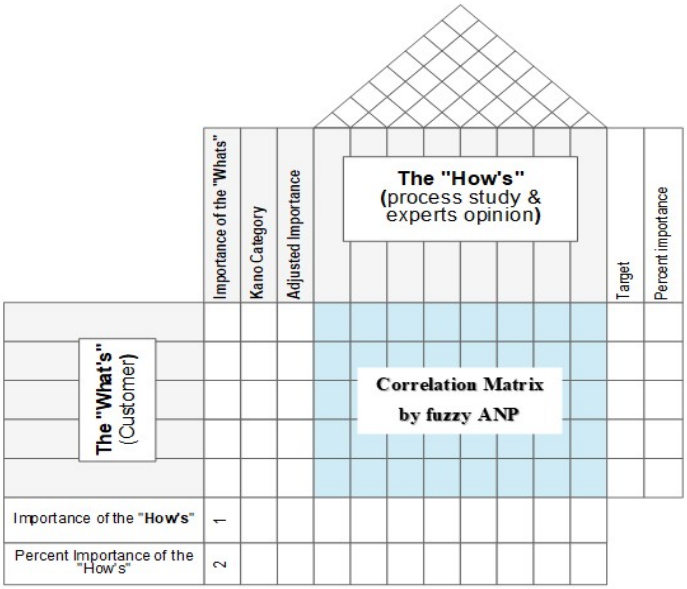

Figure 7. House of Quality (HOQ) for service quality design by using fuzzy ANP for correlation matrix

4. RESULTS AND DISCUSSION

Based on the statistics obtained from the table below, we can interpret the following analysis result as follows: These include the first variable, reliability, which contains: the bank providing the promised service within a given time frame (-4.478); the bank responding to your claim fast and delivering adequate service

within the time frame (-4.324); the bank performing the service right the first time (-3.310); and whenever you face a problem, the bank always shows a sincere interest in solving it (-3.216). understanding your specific needs of you (-3.010).

Table 10. The analysis of expectations and perceptions

Dimension	Expectation	Perception	Gap	Rank
Reliability	**7.726**	**4.089**	**-3.637**	**-3.637[1]**
Item 1	8.154	3.676	-4.478	-4.478[1]
Item 2	7.762	4.546	-3.216	-3.216[8]
Item 3	7.762	4.905	-2.857	-2.857[12]
Item 4	7.065	3.755	-3.310	-3.310[6]
Item 5	7.886	3.562	-4.324	-4.324[2]
Assurance	**7.580**	**5.279**	**-2.301**	**-2.301[4]**
Item 6	7.811	5.918	-1.893	-1.893[17]
Item 7	7.539	4.771	-2.768	-2.768[13]
Item 8	7.686	5.680	-2.006	-2.006[16]
Item 9	7.284	4.748	-2.536	-2.536[15]
Tangible	**7.597**	**6.203**	**-1.394**	**-1.394[5]**
Item 10	7.977	7.118	-0.859	-0.859[22]
Item 11	7.441	5.739	-1.702	-1.702[19]
Item 12	7.536	6.016	-1.520	-1.520[20]
Item 13	7.435	5.938	-1.497	-1.497[21]
Empathy	**7.175**	**4.388**	**-2.787**	**-2.787[3]**
Item 14	7.232	4.013	-3.219	-3.219[7]
Item 15	7.399	5.520	-1.879	-1.879[18]
Item 16	6.814	4.098	-2.716	-2.716[14]
Item 17	7.069	3.957	-3.112	-3.112[9]
Item 18	7.363	4.353	-3.010	-3.010[10]
Responsiveness	**7.885**	**4.485**	**-3.400**	**-3.400[2]**
Item 19	7.814	4.323	-3.491	-3.491[5]
Item 20	8.030	4.425	-3.605	-3.605[3]
Item 21	8.124	5.154	-2.970	-2.970[11]
Item 22	7.572	4.039	-3.533	-3.533[4]

The second variable is responsiveness which contains bank employees delivering prompt service to you (-3.605), bank employees never being too busy to respond to your request (-3.533), and bank employees informing you exactly when service will be performed (-3.491).

Table 11. Kano classification

Customer requirement		A	O	M	I	R	Q	Total	Categories
Item 1	Response	14	**53**	22	10	1	1	101	**O**
	Percentage	13.86%	52.48%	21.78%	9.90%	0.99%	0.99%	100%	
Item 2	Response	8	24	**42**	10	4	13	101	**M**
	Percentage	7.92%	23.76%	41.58%	9.90%	3.96%	12.87%	100%	
Item 3	Response	21	**57**	13	6	2	2	101	**O**
	Percentage	20.79%	56.44%	12.87%	5.94%	1.98%	1.98%	100%	
Item 4	Response	17	28	**37**	14	2	3	101	**M**
	Percentage	16.83%	27.72%	36.63%	13.86%	1.98%	2.97%	100%	
Item 5	Response	27	**38**	13	18	1	4	101	**O**
	Percentage	26.73%	37.62%	12.87%	17.82%	0.99%	3.96%	100%	
Item 6	Response	14	**45**	20	20	0	2	101	**O**
	Percentage	13.86%	44.55%	19.80%	19.80%	0.00%	1.98%	100%	
Item 7	Response	25	**29**	22	20	1	4	101	**O**
	Percentage	24.75%	28.71%	21.78%	19.80%	0.99%	3.96%	100%	
Item 8	Response	16	**30**	23	29	1	2	101	**O**
	Percentage	15.84%	29.70%	22.77%	28.71%	0.99%	1.98%	100%	
Item 9	Response	12	**34**	22	28	3	2	101	**O**
	Percentage	11.88%	33.66%	21.78%	27.72%	2.97%	1.98%	100%	
Item 10	Response	10	33	**45**	9	1	3	101	**M**
	Percentage	9.90%	32.67%	44.55%	8.91%	0.99%	2.97%	100%	
Item 11	Response	22	38	13	22	1	5	101	O
	Percentage	21.78%	37.62%	12.87%	21.78%	0.99%	4.95%	100%	
Item 12	Response	30	**44**	14	7	3	3	101	**O**
	Percentage	29.70%	43.56%	13.86%	6.93%	2.97%	2.97%	100%	
Item 13	Response	8	**42**	30	14	4	3	101	**O**
	Percentage	7.92%	41.58%	29.70%	13.86%	3.96%	2.97%	100%	
Item 14	Response	0	**61**	36	1	3	0	101	**O**
	Percentage	0.00%	60.40%	35.64%	0.99%	2.97%	0.00%	100%	
Item 15	Response	13	**43**	17	10	14	4	101	**O**
	Percentage	12.87%	42.57%	16.83%	9.90%	13.86%	3.96%	100%	

The third variable is empathy which contains the bank giving care and individual attention to you (-3.219), the bank giving you the best interest at heart (-3.112), and bank employees always The majority of client requirements, according to the Kano classification study, are characterized as one-dimensional needs; thus, the bank should take note of aspects in the design of the service system that suggest greater customer satisfaction. Examples of one-dimensional items are item 14 (response of 61 and percentage of 60.40), item 3 (response of 57 and 56.44%), and item 1 (response of 53 and 52.48%). This analysis enables us to determine or identify customer requirements, which also helps the company understand the voice of its customers to improve service quality.

Customer Satisfaction Coefficient and Self-Stated Importance

stated importance

Based on the statistics obtained from the table above, we can interpret the following analysis result as follows: the self-stated importance analysis indicates that having the promised service within a given time frame (10.845), getting a fast claim response and getting adequate service within the time frame (11.082), having the employee inform you exactly when the service will be performed (10.796), and having the employee deliver prompt service (10.944) are all significant. This analysis result is critical to distinguish features from each other and helps to know which are most relevant to the customer; therefore, in the next step, we can determine customer requirements from fuzzy SERVQUAL and fuzzy Kano's model analysis results.

Table 12. Customer satisfaction coefficient and self-

Service requirement	$Better = \frac{A+O}{A+O+M+I}$	$Worst = -\frac{O+M}{A+O+M+I}$	Self-stated importance
Item 1	0.68	-0.76	10.845
Item 2	0.38	-0.79	10.093
Item 3	0.80	-0.72	11.082
Item 4	0.47	-0.68	10.231
Item 5	0.68	-0.53	9.212
Item 6	0.60	-0.66	9.954
Item 7	0.56	-0.53	9.895
Item 8	0.47	-0.54	9.548
Item 9	0.48	-0.58	9.845
Item 10	0.44	-0.80	10.092
Item 11	0.63	-0.54	9.806
Item 12	0.78	-0.61	9.726
Item 13	0.53	-0.77	10.796
Item 14	0.62	-0.99	10.944
Item 15	0.67	-0.72	10.944

Determine Customer Requirements and Technical Requirement

Customer requirements were identified by using fuzzy SERVQUAL and fuzzy Kano's model. One of the main reasons for identifying the main customer requirement is to determine which service attributes have a significant effect on customer service perception.

Table 13. List of customer requirements

No.	Customer requirement
1	The bank should provide the promised service within a given time frame
2	The bank should respond to customer clam fast and deliver adequate service within the time frame
3	An employee should deliver prompt service to the customer
4	The employee should never be too busy to respond to customer request
5	The employee should inform the customer exactly when service will be performed

Table 14 summarize the main technical requirements based on focused group discussions with the branch manager and customer support representative led to the discovery of the technical requirements.

Table 14. List of technical requirements

No.	Technical requirement
1	Collect customer feedback on a continuous basis
2	Identify dissatisfied customers & frequent service failure issues
3	Update service standards & guidelines
4	Conduct adequate training, performance evaluation & rewards
5	Improve internal service quality by concentrating on employee issues and concerns
6	Establish experience-sharing conducts

Analyze the Local Weight of each Technical Requirement Concerning Customer Requirement

Following this, the next step is to determine the fuzzy weight of each customer requirement correspondingly and evaluate each technological requirement's fuzzy weight by considering customer requirements as a factor.

Table 15. Fuzzy weight of customer requirement

	Fuzzy weight				Weight
CR_1	0.329042	0.397976	0.472305	0.399774	0.4788824
CR_2	0.078474	0.085344	0.092577	0.085465	0.10237726
CR_3	0.056147	0.066162	0.078717	0.067009	0.08026851
CR_4	0.166245	0.213171	0.264957	0.214791	0.25729409
CR_5	0.051774	0.066162	0.085367	0.067768	0.08117774
			Total	0.834807	1

Acquire the Weighted Supermatrix

In this section, the main task is to construct the weighted supermatrix; having done that, the next step is to multiply each column of the technical requirement by a fuzzy weight.

Table 16. The weighted supermatrix

	Weight	TR_1	TR_2	TR_3	TR_4	TR_5	TR_6
CR_1	0.479	0.354697	0.068647	0.255945	0.163718	0.125744	0.031248
CR_2	0.102	0.241429	0.075028	0.097211	0.097211	0.244401	0.100502
CR_3	0.080	0.270366	0.046822	0.132208	0.273316	0.054156	0.223131
CR_4	0.257	0.222068	0.050393	0.102766	0.270215	0.114411	0.240147
CR_5	0.081	0.12392	0.18745	0.121312	0.182614	0.117983	0.266722

Analyze the Comprehensive Weight

When the abovementioned stage is complete, we may build the relationship matrix between customer needs and technical requirements, which is needed for HOQ analysis.

Table 17. Relationship matrix between customer requirement and technical requirement

	TR_1	TR_2	TR_3	TR_4	TR_5	TR_6
CR_1	0.169858	0.0328738	0.122568	0.078402	0.060216	0.014964
CR_2	0.024717	0.00768115	0.009952	0.009952	0.025021	0.010289
CR_3	0.021702	0.00375836	0.010612	0.021939	0.004347	0.01791
CR_4	0.057137	0.0129658	0.026441	0.069525	0.029437	0.061788
CR_5	0.01006	0.01521673	0.009848	0.014824	0.009578	0.021652

Integrated Fuzzy SERVQUAL, Fuzzy Kano's Model, and Fuzzy ANP into QFD

From the integrated HOQ analysis, prioritize the technical requirements based on their importance, for example, collecting customer feedback continuously with a value of 29.7%, updating service standards and guidelines (19.88%), conducting adequate training, performance evaluation, and reward (18.8%), improving internal service quality by concentrating on employee issues (13.3%), establishing experience sharing practices (10.97%), and finally identifying dissatisfied customers and frequent service failure issues (7.5%). Accordingly, the study claimed that enhancing each of those technical requirements might enhance the bank's level of customer satisfaction through higher service quality.

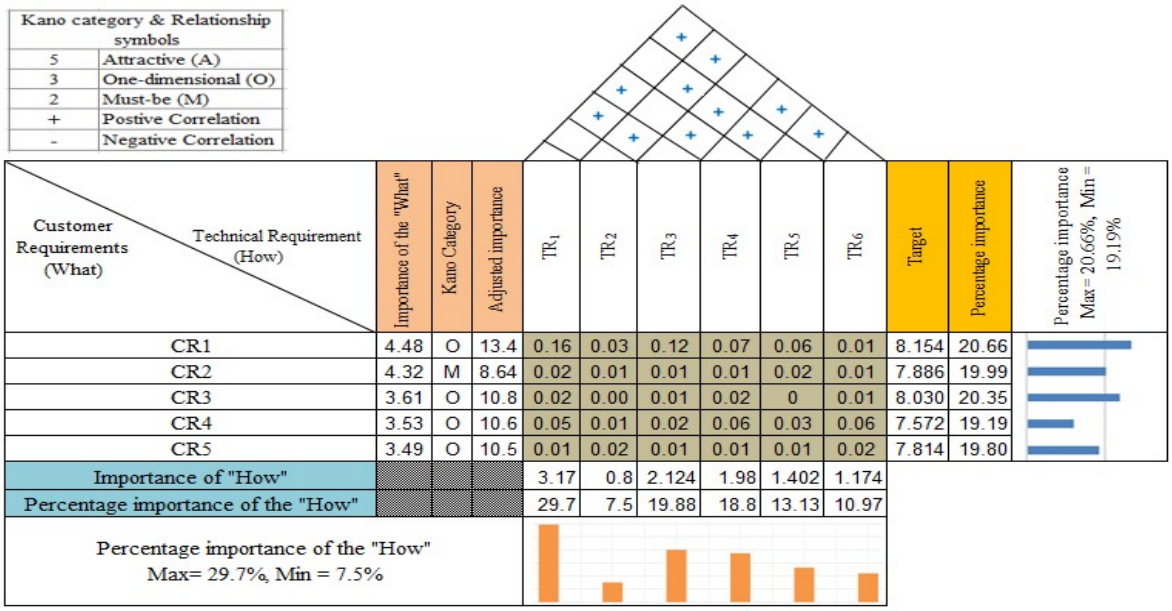

Figure 8. Integrated House of Quality

Besides, the analysis also prioritizes the customer requirements based on their importance. The bank should provide the promised service within a given time frame (20.66%), and an employee should deliver prompt service to the customer (20.35%). The bank should respond to a customer's claim fast and provide adequate service within the time frame (19.99%); the employee should inform the customer exactly when service will be performed (19.80%). And the employee should never be too busy to respond to customer requests (19.19%). Therefore, this article declares that fulfilling those customer requirements can increase customer satisfaction.

5. Conclusion

With the increasing progress in bank service in today's competitive market, people experience fast and prudent service delivery of bank service this phenomenon has enhanced customer expectations about bank service. The finding has a practical implication for service industries to explore their drawbacks related to service quality. Likewise, increase customer satisfaction and increase their competitiveness in the current marketplace. The bank should also constantly collect customer feedback, identify the root causes of service failures that commonly leave customers dissatisfied, update service standards and guidelines, and implement proper training, performance assessments, and incentive schemes. And raise the standards of internal services by emphasizing worker issues and concerns. And finally, establish procedures for exchanging experiences.

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