Total Quality Management
Vol. 23, No. 12, December 2012, 1397–1411

Routledge
Taylor & Francis Group

A quality function deployment application using qualitative and quantitative analysis in after sales services

Fatma Pakdil[a,b]*, Feride Bahar Işın[c] and Hande Genç[d]

[a]*School of Engineering, Department of Industrial Engineering, Başkent University, Baglica Kampusu Eskisehir Yolu, Ankara, Turkey;* [b]*Department of Management and Marketing, Indiana University–Purdue University Fort Wayne, Fort Wayne, IN 46805, USA;* [c]*Faculty of Economics and Administrative Sciences, Başkent University, Baglica Kampusu Eskisehir Yolu, Ankara, Turkey;* [d]*School of Engineering, Department of Industrial Engineering, Başkent University, Ankara, Turkey*

A thorough and accurate understanding of customer demands and expectations is the key to possessing competitive advantage in the market place. Quality function deployment (QFD) is one of the most effective tools to learn, understand, and apply these demands and expectations in production lines. This study consists of a holistic QFD application comprising both qualitative and quantitative analysis techniques in after sales services at a leading construction equipment manufacturer firm. As a qualitative analysis method, content analysis was performed to identify customer dissatisfactions and customer expectations. As a quantitative analysis method, SERVQUAL was used to determine customer expectations for the house of quality (HOQ). Factor analysis was incorporated into SERVQUAL in order to classify customer expectations for the HOQ. As a result, the QFD identified the most important customer expectations as: competency and experience of employees, immediate identification of product defects, and good customer service during the warranty period. This study also exhibited that repair time, the duration of customer interaction, employees' attention, and spare parts availability were the most critical technical requirements in after sales services.

Keywords: quality function deployment; after sales services; content analysis; SERVQUAL; construction manufacturing industry

Introduction

Understanding, building, and maintaining quality are major concerns of business firms today. Creating quality begins at the design stage. Quality function deployment (QFD) has been used, for many decades, as an effective tool to hear the voice of customers and meet their expectations and needs. QFD takes into account both the voice of customer and the organisational capability. However, the quality of QFD outputs depends on how accurately the organisation hears the voice of customer. At this point, organisations need to employ both quantitative and qualitative analysis techniques to perform more effective QFD.

This paper presents a QFD application performed in a leading international construction machinery manufacturing firm's after sales services department. Although the firm's products, such as backhoe loaders and excavators, were highly regarded in the market place, the buyers were dissatisfied with the after sales services. QFD was then implemented in quality improvement activities to decrease customer dissatisfaction. Akao (1990) showed that comments about existing qualities can be sampled in QFD

*Corresponding author. Email: fpakdil@baskent.edu.tr

ISSN 1478-3363 print/ISSN 1478-3371 online

http://dx.doi.org/10.1080/14783363.2012.715797
http://www.tandfonline.com

processes. Furthermore, studying consumer complaints about existing products and services is an analytical approach in which one starts at the downstream point and moves upstream through the production process searching for factors that contribute to the problems (Akao, 1990). As a real life problem-oriented research, this study combines some qualitative and quantitative analysis techniques simultaneously, such as content analysis, factor analysis (FA), and SERVQUAL, into the QFD. This study differs from earlier published QFD research in this way. Although similar techniques had been used previously, there is no particular research utilising these three techniques together in a QFD application. Also, research depicted that there was no similar study previously undertaken in the construction equipment industry. Carnevalli and Miguel (2008) found that there was no published study between 2002 and 2006 containing both qualitative and quantitative techniques in QFD. As a starting point, content analysis was used to learn customer needs and expectations and determine the most frequent dissatisfaction reasons derived from a customer satisfaction survey. These reasons were constructed in a questionnaire designed based on the SERVQUAL structure. Thereafter, customer needs, expectations and their importance levels were ranked by the customers. Additionally, customer needs and expectations were classified on the basis of FA within factor loads.

The paper is laid out as follows. A brief review of QFD is presented in the first part. Next, the quantitative and qualitative tools used in this study and then how they were incorporated into the construction machinery manufacturing firm are introduced. Finally, conclusive results are provided in the last part.

As a scientific tool QFD

How to shorten cycle time, while still improving product quality, is one of the most addressed questions in the highly competitive business world. In this context, QFD has been employed as an interdisciplinary teamwork to shorten cycle time for many decades. QFD developed by Akao was utilised by major automobile companies and their suppliers as well as other global manufacturers. It has been shown to be very useful in helping designers to focus on the most important engineering characteristics of a product and to meet customer requirements simultaneously (Cristiano, Liker, & White, 2001). Bicknell and Bicknell (1995, p. 28) define QFD as 'a systematic approach mapping the customers' needs into definable and measurable product and process parameters, using matrices and other quantitative and qualitative techniques'. With interdisciplinary teamwork, 'QFD refers to the functions responsible for quality in a company's areas of design, manufacturing, service, and so forth' (Akao, 1990, p. xiii).

QFD is constructed within the house of quality (HOQ) through a well-known procedure. The HOQ is a key strategic tool to aid companies in developing products that satisfy customer needs (Karsak, 2004). 'With its design-oriented nature, the HOQ serves both as a valuable resource for designers and a way to summarise and convert feedback from customers into information for engineers' (Karsak, 2004). HOQ basically converts customer expectations into engineering requirements (Gérson, 2007). Within the HOQ, QFD's straightforward procedure is performed within seven sections, namely (1) customer needs and expectations, (2) planning matrix, (3) technical requirements, (4) targets of the technical requirements, (5) relationship matrix, (6) technical correlation matrix, and (7) customer evaluations (Figure 1). These sections are interconnected within the structure of the HOQ. First, the voice of customer is heard and transferred into 'customer needs and expectations' section. Second, the planning matrix includes a step-by-step procedure to delineate the most important customer expectations. Then, the voice of customer is transformed into technical requirements in order to improve product or service quality. Afterwards, design

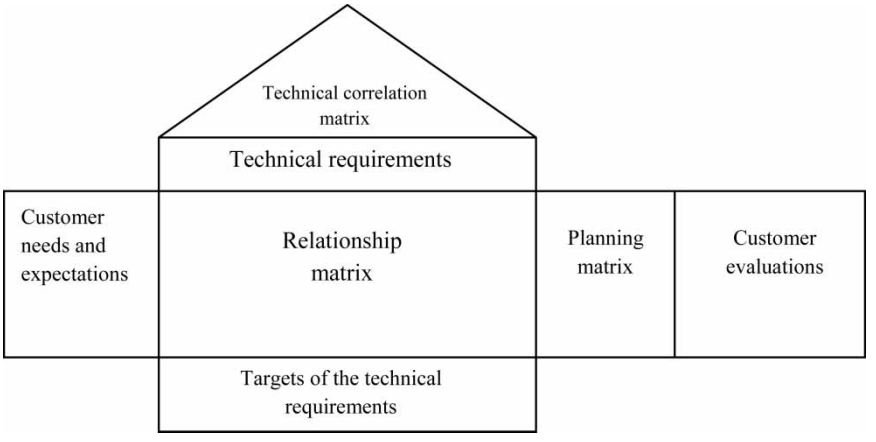


Figure 1. HOQ sections.

teams focus on the target values for each technical requirement. In the fifth step, customer expectations and technical requirements are matched in the relationship matrix. The relationships between customer needs and technical measures then have to be paired by the research team. This step is essential to see how the technical requirements are met to satisfy each customer expectation. In the technical correlation matrix, the associations between technical requirements are determined in the roof of the HOQ. Lastly, in the customer evaluations, the satisfaction level of the customers on each expectation is compared with the competitor's performance.

In the early years of the development of QFD, engineering characteristics were often determined based on engineers' experience. With such inputs, results tended to be rather subjective with diverse opinions. However, in time, customer needs, expectations, and demands become more dominant variables to formalise engineering characteristics. In this sense, QFD was implemented and developed in design and production processes.

Even though QFD was originally developed by manufacturing firms, it has also been shown that QFD can be applied in non-manufacturing firms as well (Ansari & Modarress, 1994). Furthermore, QFD is not only used in the development of new services. It is also used for the improvement of an existing service, which is the main area of application in this paper.

In previous literature, QFD applications have been developed and implemented within well-known straightforward methodologies. Additionally, some researchers have applied various quantitative techniques into QFD (Chen & Huang, 2011; Kahraman, Ertay, & Büyüközkan, 2006; Şen & Baraçlı, 2010). Within a holistic perspective, QFD also requires qualitative analysis to learn in particular, customer expectations and needs. This study aims to apply content analysis as a qualitative analysis technique for hearing the voice of customer in HOQ. The next part of this paper shows how content analysis was implemented into QFD methodology.

Content analysis in QFD

The QFD process starts with the determination of customer needs and expectations. Customer needs and expectations are called the 'voice of customer' since these are expressed in customers' own words (Shillito, 1994). In order to reach exact customer needs and

expectations, marketing science offers various techniques, such as focus group studies, market research and surveys, etc. In addition to these techniques, content analysis is a tool that can be applied to discover customer needs and expectations. Content analysis is a technique that systematically collects and analyses the makeup and exchange of communication through various visual, auditory, and print media (Holdford, 2008). Content analysis has been defined as a systematic, replicable technique for compressing many words of text into fewer content categories based on explicit rules of coding (Berelson, 1952; Krippendorff, 1980; Weber, 1990). The value of content analysis lies in its capacity to explore questions unanswerable by more quantitative methods (Holdford, 2008).

The classic analytical technique of content analysis is frequency analysis. In frequency analysis, the frequency of text units is counted in a written manuscript. Thus, with pure frequency analysis, the value, importance, and intensity of a variable are determined from the start. The variables can be considered equal (Bos & Tarnai, 1999). In this study, content analysis was performed on the basis of frequency analysis by the qualified QFD team. The QFD team consisted of representatives from sales and marketing, after sales services, planning, and quality assurance departments. Prior to this study, the firm previously had conducted a nation-wide customer satisfaction survey on both its construction equipment products and after sales services among the current and potential customers. Current and potential customers' expressions were analysed through open-ended questions in this survey. The QFD team assessed certain words that represent dissatisfaction or satisfaction reasons about either product or services. Their words were classified and the dissatisfactions were ranked in an order on the basis of their frequencies as given in Table 1. According to the results of the frequency analysis, 'service delays' (24.6%) and 'the price of the service' (18.8%) are the main dissatisfaction reasons in the after sales services.

Next, dissatisfaction types were implemented in a SERVQUAL-based questionnaire. To understand the most recent voice of customers, research was conducted through this questionnaire among current customers. This research also revealed customer needs and expectations' rates of importance for the further steps of QFD. The following section gives the details of this application.

SERVQUAL in QFD

The customer is the key to defining quality (Hansen, 1990). Company's definition of quality is meaningless if it fails to reflect customer requirements. Service quality and its

Table 1. Types of dissatisfaction among the current and potential customers.

#	Types of dissatisfaction	Frequency (%)
1	Service delays	24.6
2	The price of service	18.8
3	The quality of service	8.7
4	Procurement of spare parts	8.2
5	Unconcerned service employees	7.3
6	Insufficient technical equipment	6.3
7	Fair paid to reach service area	5.8
8	Inexperienced and unskilled employees	5.3
9	Warranty conditions	4.8
10	Number of employees	4.8
11	Wrong spare parts	1.0
12	Others	4.5

measurement have become an important research area because of its relationship to profitability and return of investment (Koska, 1990), cost (Buzzell & Gale, 1987), customer retention (Reichheld & Sasser, 1990), and customer satisfaction (Bolton & Drew, 1991). The evaluation of quality for services is more complex than for goods because of their nature of heterogeneity, inseparability between process and output, perishability, and intangibility (Zeithaml, Bitner, & Gremler, 2006). Service quality is defined as a function of the magnitude and direction of the gap between expected and perceived service (Parasuraman, Zeithaml, & Berry, 1985). Understanding exactly what customers expect is the most crucial step in defining and delivering high quality service (Zeithaml, Berry, & Parasuraman, 1996). Expectations serve as a major determinant of a consumer's service quality evaluations and satisfaction (O'Connor, Trinh, & Shewchuk, 2000). Therefore, firms should hear the voice of customer before their competitors.

Since its development, service quality research has been dominated by studies conducted in the context of consumer services (Brady & Cronin, 2001). Only a limited number of studies have addressed business-to-business services (Bienstock, Mentzer, & Murphy, 1997). It has been said that in industrial markets, relationships are long-term oriented, enduring, bilateral, and complex (Hutt & Speh, 1992). Business organisations especially, are required to improve their service quality for long-term customer retention (Katarne, Satyendra, & Negi, 2010).

After sales services has been recognised as one of the competitive differentiators. After sales services can be as important as the initial purchase (Accenture, 2008). The quality of after sale services can directly affect the customer repeat purchase (Yan & McLaren, 2010). Therefore, it is vital to measure the quality of after sale services in order to have a better understanding of customers' expectation and perception especially in industrial markets.

Researchers have suggested many ways for measuring service quality. Of these methods, SERVQUAL remains a reference point in service quality studies (Berndt, 2009). The SERVQUAL has been approved as a model that can be applied to a broad sub-service sector spectrum, despite some criticisms of the methodology (Buttle, 1996). Although SERVQUAL has been criticised, it remains the dominant framework for studies of service quality and continues to be widely applied (Trocchia & Janda, 2003). SERVQUAL fit the purpose of this paper, because it is a comprehensive, straightforward, and empirically grounded method providing valuable information (Heung, Wong, & Qu, 2000). Also, in a number of studies focused on after sales services (Cavalieri, Gaiardelli, & Ierace, 2007; Yan & McLaren, 2010), and in the majority of the studies conducted in the business-to-business context (Gounaris, 2005), SERVQUAL has been used by many researchers.

The SERVQUAL is based on the idea that service quality is a subjective customer evaluation (Parasuraman, Zeithaml, & Berry, 1988) rather than evaluating whole engineering and design outcomes. The SERVQUAL includes five main quality dimensions to measure service quality; *tangibles, reliability, responsiveness, assurance,* and *empathy* (Zeithaml, Parasuraman, & Berry, 1990) as given in Table 2. In this study, SERVQUAL was employed to discover customer expectations.

Questionnaire design

The questionnaire was constructed with an acceptance of the general validity of the SERVQUAL (Zeithaml et al., 1990) and a customer satisfaction survey was performed on the basis of SERVQUAL. This survey included a two-fold questionnaire with 16

Table 2. The SERVQUAL dimensions.

Dimension	Description
Tangibles	Physical facilities, equipment, and appearance of the personnel
Reliability	Ability to perform the promised service dependably and accurately
Responsiveness	Willingness to help customers and provide prompt service
Assurance	Knowledge and courtesy of employees and their ability to inspire trust and confidence
Empathy	Caring, individualised attention the firm provides its customers

Source: Parasuraman et al. (1988).

questions. The first part aimed to determine customers' expectations about after sales services, while the second part measured their perceptions in the firm. Customer expectations and perceptions were rated using a five-point Likert scale. Perceptions were rated from 1 = strongly disagree to 5 = strongly agree, and expectations were rated from 1 = unimportant to 5 = very important. Even though SERVQUAL contains general quality dimensions for service industries, it does not include specific dimensions for each service type. Chang and Yeh (2002, p. 167) assert that 'service quality attributes are context-dependent and should be selected to reflect the service environment investigated'. Therefore, a 16-item questionnaire was constructed on the basis of construction equipment users' dissatisfaction reasons as service quality dimensions consistent with the SERVQUAL dimensions.

Sampling and survey procedure

The sample was taken from the current customers of the firm in two different segments. The first segment included the firm's local customers. The local survey was done at after sales service points with a face-to-face method in the first segment. The second segment contained national customers within various district service areas. The sample size was determined as 370 to represent the population (more than 10,000 customers annually), with a 95% confidence level and a 5% error margin (DeVaus, 2000). A total of 500 questionnaires were distributed. After the survey was completed, the actual response rate was 27.4% , and the survey totally comprised 137 construction equipment users.

In terms of reliability analysis, Cronbach's alpha was found to be 0.9217 for expectation-related items and 0.8738 for perception-related items. At that point, the reliability of the questionnaire was deemed adequate.

FA and validity

FA is a statistical technique applied to a single set of variables when the researcher is interested in discovering which variables in the set form coherent subsets that are relatively independent of one another (Tabachnick & Fidell, 2001). One of the goals of FA is to reduce a large number of observed variables to a smaller number of factors. In this study, exploratory FA was performed to sum up SERVQUAL items on the basis of customers' expectation scores with quartimax rotation via principal components analysis. The Kaiser–Meyer–Olkin score was found to be 0.834. As a result, three factors were extracted from the expectation data set, namely 'reliability', 'responsiveness', and 'empathy', for after sales services in the firm. FA endeavoured to classify customer

Table 3. Principal components analysis factor loadings.

Items	Factor 1	Factor 2	Factor 3	Internal consistency
1. Reliability				0.87
Identification of defects in a short time	0.866			
Competency and experience of the employees	0.847			
Paying attention during warranty period	0.844			
The speed of procurement of spare parts	0.806			
Congruity of spare part to equipment	0.683			
Employees' attention to customer expectations	0.659			
Adequacy of the number of the employee	0.624			
Accurate procurement of spare parts	0.605			
Employees' tolerance	0.596			
2. Responsiveness				0.72
Waiting for service		0.764		
Waiting after defect identification		0.707		
Fair paid to reach service area		0.596		
The fee of spare parts		0.538		
Working hours		0.531		
3. Empathy				0.69
Clean and tidy service			0.821	
Accessibility to service in local area			0.775	
Eigenvalues	9.517	2.414	1.743	
% of variance	35.14	16.89	9.98	

expectations on a statistical base rather than a subjective base. Factor loadings and internal consistency values are given in Table 3.

Constructing planning matrix in HOQ

After designating customer needs and expectations, the QFD team progressed to the planning matrix. A construction of the planning matrix contains calculations of various variables for each customer expectation. These variables are *the importance rate, the customer rate, the quality plan score, the rate of level up, the priority factor, absolute weight,* and *relative weight*, respectively.

First, *the importance rates of customer expectations* were calculated. The rates of importance reflect how important each customer expectation is in the eyes of customers (Dikmen, Birgonul, & Kiziltas, 2005). Shillito (1994, p. xxx) stated that 'not only do we need to know what the customer wants, but also how important those needs are'. In use the SERVQUAL-based survey, the level of importance was ranked based on customers' expectations for the QFD planning matrix. For each customer expectation, mean values were calculated on the basis of scores given by 137 respondents. As seen in Table 4, customer expectations in after sales services were divided into three categories and reliability-related items were ranked as more important items in comparison with the other two factors. The most important expectations appeared as 'competency and experience of the employees (4.5)', 'identification of defects in a short time (4.5)', and 'paying attention during warranty period (4.5)'. Similarly, reliability-related expectations were rated as the top priority expectations in the literature. In an example of a particular

Table 4. Customer rates of importance.

Factors	Items	Importance level
Reliability	Identification of defects in a short time	4.5
	Competency and experience of the employees	4.5
	Paying attention during warranty period	4.5
	The speed of procurement of spare parts	4.4
	Congruity of spare parts to equipment	4.3
	Employees' attention to customer expectations	4.3
	Adequacy of the number of the employees	4.3
	Accurate procurement of spare parts	4.4
	Employees' tolerance	4.4
Responsiveness	Waiting for service	4.0
	Waiting after defect identification	3.9
	Fair paid to reach service area	3.5
	The fee of spare parts	3.9
	Working hours	3.8
Empathy	Clean and tidy service	4.3
	Accessibility to service in local area	4.4

service branch, Sultan and Simpson (2000) indicated that reliability is the top priority in the airline services. In general, Zeithaml et al. (1990) stated that the reliability is crucially important factor in the service sector.

Thereafter, the QFD team addressed the *customer rates*. Current customer satisfaction and the competitors' customer satisfaction levels were ascertained within the same sample to determine the customer rates. Respondents also answered the same questions by describing at least one of their experiences with one of the competitor firms. In this step, customer rates were calculated as the gap scores in SERVQUAL. For each customer need, the gap scores were calculated as the mathematical difference between perception and expectation score given by each customer. Then, mean values for each expectation were calculated. Customer rates are given in Table 5.

The quality plan scores were assigned by the QFD team. In this step, the team explored the gap scores emerging from current customers' expectations and perceptions. The team also took into account their views about the quality targets.

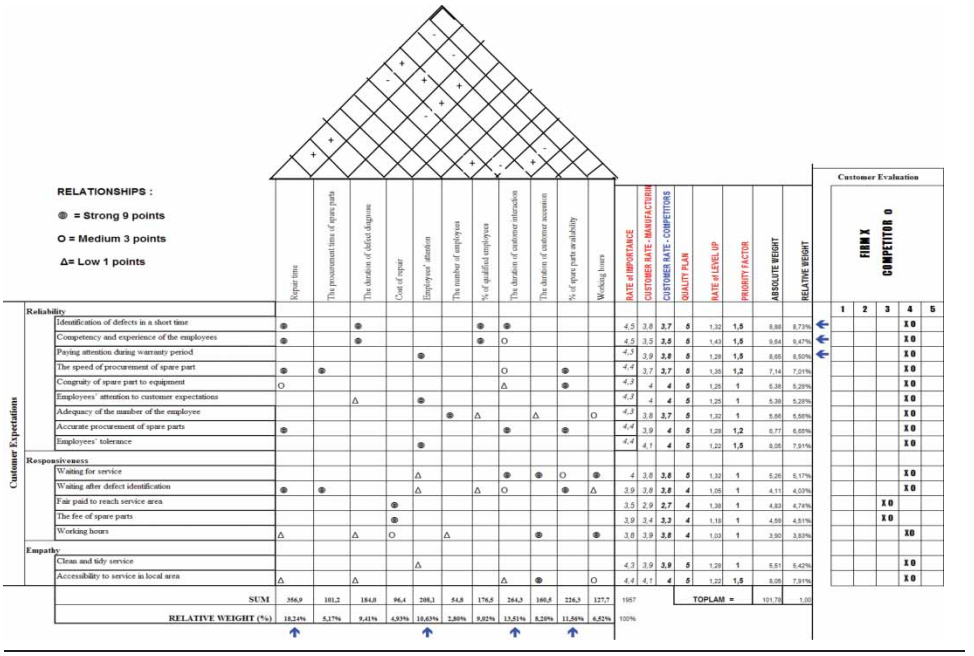
As the next step in the planning matrix, *rate of level up* scores were calculated as given in formula (1).

$$\mathrm{RL}_i = \mathrm{QP}_i \div \mathrm{CCSC}_i, \quad i = 1, 2, \ldots, n, \tag{1}$$

where n is the number of customer expectation, RL_i is the rate of level up, QP_i is the quality plan score, and CCSC_i is the current customer satisfaction score. The purpose of this calculation was to indicate where the firm was relatively unsuccessful in meeting the customer expectations.

Priority factors were assigned to each customer expectation by the QFD team. Priority factors show whether any improvement is expected in the total sales if the firm meets customer expectations in higher levels. The team assigned '1' point if they assumed that there would be no improvement in the sales, while assigning '1.2' points for medium improvement and '1.5' points for strong improvement. Table 5 shows that 'competency and experience of the employees', 'accessibility to service in local area', 'employees' tolerance',

Table 5. House of quality.



'paying attention during warranty period', and 'identification of defects in a short time' were assigned as the items that would have a strong improvement effect on the total sales.

Following these assignments, *absolute weights* and *relative weights* for each customer expectation item were calculated as given in formulae (2) and (3).

$$\mathrm{AW}_i = \mathrm{QP}_i \times \mathrm{RL}_i \times \mathrm{PF}_i, \quad i = 1, 2, \ldots, n, \tag{2}$$

$$\mathrm{RW}_i = \mathrm{AW}_i \div \sum \mathrm{AW}_i, \quad i = 1, 2, \ldots, n, \tag{3}$$

where n is the number of customer expectation, AW_i is the absolute weight, QP_i is the quality plan score, RL_i is the rate of level up, PF_i is the priority factor score, and RW_i is the relative weight.

In the light of relative weights, 'competency and experience of the employees' (9.47%), 'identification of defects in a short time' (8.73%), and 'paying attention during warranty period' (8.50%) were determined to be the most critical customer expectations in after sales services. The firm should place these three expectations in first place during the service design process. If the firm possesses broad flexibility in constraints such as cost, design, and production time, the design team can also take into account the rest of the expectations. In service quality literature, employee-oriented and time-oriented expectations and needs have been shown to be the most important phenomena (Rosander, 1989). In this manner, the findings of this study prove that competency and experience of the employees is considered the top priority expectation in the after sales services. Additionally, waiting time and process time spent in queues are two of the main quality characteristics in the service quality literature (Naumann & Giel, 1995;

Norman, 1991). 'Identification of defects in a short time' rates as the second top priority customer expectation in the study. Since the construction machinery firm has both nationally and internationally comprehensive activities in after sales services, the quality level of these items have a great impact on the total customer satisfaction level.

Technical requirements in HOQ

The technical requirements corresponding to each customer expectation were identified in this step by the QFD team. It is known that higher design quality depends on how accurately the voice of customer is translated into the technical requirements in design processes (Akao, 1990). The technical requirements, *voice of developer* (Özgener, 2003), reflect *how* each customer expectation will be met in the production or service delivery process. Customer expectations identify *what* will be done, while technical requirements indicate *how* these expectations will be met. 'The technical requirements help the different disciplines to understand customer requirements in the same context and to avoid confusion that can arise while interpreting the customer needs' (Dikmen et al., 2005). In order to identify technical requirements, in other words *how*, QFD team conducted brainstorm sessions in the light of their expert knowledge. The technical requirements are listed in Table 6.

Relationship matrix in HOQ

In order to progress further in QFD, it should be identified which customer expectation will be met by which of technical requirements. Correlations between customer expectations and technical requirements were assigned by the QFD team within three scores, by means of numerical grading according to their strength using the traditional system (Akao, 1990); 9 – a strong relationship, 3 – a medium relationship, 1 – a weak relationship, and 0 – no relationship. The professional knowledge and experience of the QFD team members managed this process in brainstorming sessions. The scoring scale and their symbols used in this study are given in Table 7. Table 5 presents the relationships and their magnitudes between each customer expectation and relevant technical requirements.

'Repair time' (18.24%), 'the duration of customer interaction' (13.51%), 'employees' attention' (10.63%), and '% of spare parts availability' (11.56%) appear as the most

Table 6. Technical requirements to meet customer expectations.

No.	Technical requirements
1	Repair time
2	The procurement time of spare parts
3	The duration of defect diagnose
4	Cost of repair
5	Employees' attention
6	The number of employees
7	% of qualified employees
8	The duration of customer interaction
9	The duration of customer accession
10	% of spare parts availability
11	Working hours

Table 7. Scoring scale of the relationships.

Score	Symbol	Score definition
9	◎	Strong relationship
3	⊙	Moderate relationship
1	◯	Weak relationship
0		No relationship

important technical requirements in the after sales services. As stated in the early studies (Bode & Fung, 1998; Karsak, 2004), there are always crucial constraints in the design process, such as cost, production cycle time, resource constraint, and feasibility of the designed product/services. These constraints limit the design processes in the realistic application. In this respect, the firm decided to focus on these four technical requirements initially, rather than focusing on providing all technical requirements in the after sales services.

Technical correlations in HOQ

The interactions between technical requirements were examined and correlations were determined by the QFD team in the roof of the HOQ (Table 5). This step is crucial in identifying the positive or negative associations between technical requirements. There are some technical dimensions that affect each other and also outcomes positively, while the other/s effect in a negative direction or vice versa. In the next stages of the manufacturing process, engineering problems may emerge since the relationships among the technical dimensions were not reviewed. For example, there is a positive association between 'repair time' and 'the procurement time of spare parts' as given in HOQ. The longer the procurement time of a spare part, the longer the repair time. Additionally, a negative association appears between '% of spare parts availability' and 'the duration of customer interaction'. The higher the availability of the spare parts, the shorter the duration of the customer interaction with the firm. The other correlations were used in the design process of the after sales services.

Limitations and further research

This study provided very useful insights regarding the quality of the after sales services in construction machinery industry. As Cialdini (1984, p. 9) said 'no matter how careful and thorough I tried to be, I observed seen only through my eyes and registered through the filter of my expectations and previous experience'; as well as its contributions, this study had some limitations. Therefore, caution should be exercised when interpreting and generalising the findings.

The first limitation is the small sample size. The second limitation is the current customers' opinions about the competiting manufacturer's performance. If we had been able to reach the competitor's actual customers, the customer evaluation results and planning matrix might have resulted in different angles.

Perceptions of quality are industry-specific (Lovelock, 1983). Therefore, future research is required in other sectors. While the reported research investigates a specific service, care should be taken in extending the study beyond this specific research set. Future research is encouraged to apply the method to other types of service across different

countries including a cross-cultural component to enhance the generalisation of the results. There are some studies which have shown that perceived service quality is culture-specific (Cronin & Taylor, 1992). It is also recommended that similar studies are conducted in other countries so that the results can be compared in order to have a better overall understanding of the service quality.

To establish its generalisation, multiple samples in other market contexts are also needed. Also, given both the distinct differences between consumer and business-to-business -services, various alternative measures for assessing the quality of business-to-business services, other than the SERVQUAL instrument, should be used in further research.

The present study involved a cross-sectional survey and is not a longitudinal study. This means that the data were gathered at one point in time. Hereby, the results offer a static view. An interesting area of research could be use of the measure to assess the customer's view of quality over time to investigate how it changes over time. Therefore, the research must be replicated not only in different sectors and cultures, but also over time to increase confidence in the nature and power of the method.

The results have implications regarding how a manager views quality and the methods he/she uses to improve the quality offered to customers. These results should be considered as only one contribution to the ongoing construction of the proposed method.

In this research, qualitative and quantitative methods were used together in harmony. Qualitative methods can add considerable depth to understanding how consumers behave in manners they regard as responsible, and are guided by ideas or perspectives (Creswell, 1994). On the other hand, quantitative methods are based on the premise of empiricism and positivism (Rossi, 1994) and allow researchers to be objective, formal, and systematic, and arrive at a series of numbers to quantify phenomena (Creswell, 1994). Repeated further research could strengthen this harmony.

Conclusion

Facing competitive market conditions, fast and efficient after sales services is highly demanded by the customers. In this manner, this study tangibly enriches the current knowledge on the improvement of the quality of after sales services in construction machinery industry. Babakus and Boiler (1992, p. 266) suggested that 'continued effort is needed to further define and understand the complexity of perceived service quality'. In the manufacturing industry, the importance of after sales services has been ignored. The industry has to satisfy customer demands to retain their loyalty. As a main quality improvement tool, QFD was incorporated into the study. QFD is a structured methodology for specifying the customer's desires and evaluating the ability of alternative products to satisfy those desires. In this paper, we studied a new approach combining qualitative and quantitative methods to learn both customer demands and technical requirements. In this sense, we employed content analysis through frequency analysis and SERVQUAL to learn customers' needs and expectations. We also conducted a nation-wide market research to learn current customers' satisfaction levels. Moreover, customer expectations were classified through FA. The combination of the qualitative and quantitative analysis tools in QFD executed a generic QFD application. According to the case study implementation, it has been indicated that QFD can be utilised to determine the most effective factors in higher customer satisfaction and loyalty within after sales services. Furthermore, this study generated some significant findings for after sales services. For example, the employees' competency and experience in after sales services were concerned as the top priority expectation. Other important expectations were the defect identification

time and paying attention to customer needs during the warranty period of the construction equipment. Simultaneously, repair period, the time of customer interaction, employees' paying attention to customer needs, and spare part availability were the highest technical requirements in effectively meeting customer expectations.

Industrial manufacturing firms try to sell their goods, and keep high customer loyalty and satisfaction. Within this aspect, excellent service brings higher customer retention and satisfaction (Anderson, Fornell, & Lehmann, 1994) and the quality of after sales services has the potential to determine the repurchase decision. After sales services are effective functions in construction equipment manufacturing industry since manufacturers can get detailed information about their product and services through the processes of after sales services. The results of this study suggest that after sales service quality, as viewed by customers, is multidimensional. Adopting the customer's view of quality and linking this view to company resources provide a way for managers to identify and develop opportunities to differentiate their company. When approached multi-dimensionally, customer-perceived quality deficiencies are more specific and consequently more easily addressed.

References

Accenture. (2008). *Service management. Building profits after the sale*. Retrieved April 14, 2008, from http://www.accenture.com/NR/rdonlyres/6BBEC529-3EE0-491F-6BFA19F2750E6EB/0/profit_after_sales.pdf

Akao, Y. (1990). *Quality function deployment, integrating customer requirements into product design*. New York: Productivity Press.

Anderson, E.W., Fornell, C., & Lehmann, D.R. (1994). Customer satisfaction, market share, and profitability: Findings from Sweden. *Journal of Marketing*, *58,* 53–6.

Ansari, A., & Modarress, B. (1994). Quality function deployment: The role of suppliers. *Journal of Supply Chain Management*, *30*(4), 27–35.

Babakus, E., & Boiler, G.W. (1992). An empirical assessment of the SERVQUAL scale. *Journal of Business Research*, *24,* 253–268.

Berelson, B. (1952). *Content analysis in communication research*. Glencoe, IL: Free Press.

Berndt, A. (2009). Investigating service quality dimensions in South African motor vehicle servicing. *African Journal of Marketing Management*, *1*(1), 1–9.

Bicknell, B.A., & Bicknell, K.D. (1995). *The road map to repeatable success using QFD to implement change*. Boca Raton, FL: CRC Press.

Bienstock, C.C., Mentzer, J.T., & Murphy, B.M. (1997). Measuring physical distribution service quality. *Journal of the Academy of Marketing Science*, *25,* 31–44.

Bode, J., & Fung, R.Y.K. (1998). Cost engineering with quality function deployment. *Computers and Industrial Engineering*, *35*(3–4), 587–590.

Bolton, R., & Drew, J. (1991). A multistage model of customers' assessment of service quality and value. *Journal of Consumer Research*, *17,* 375–384.

Bos, W., & Tarnai, C. (1999). Content analysis in empirical social research. *International Journal of Educational Research*, *31*(8), 659–671.

Brady, M.K., & Cronin, J.J. (2001). Some new thoughts on conceptualizing perceived service quality: A hierarchical approach. *Journal of Marketing*, *65,* 34–49.

Buttle, F. (1996). SERVQUAL: Review, critique, research agenda. *European Journal of Marketing*, *30,* 8–32.

Buzzell, R., & Gale, B. (1987). *The PIMS principles*. New York: Free Press.

Carnevalli, J.A., & Miguel, P.C. (2008). Review, analysis and classification of the literature on QFD – types of research, difficulties and benefits. *International Journal of Production Economics*, *114,* 737–754.

Cavalieri, S., Gaiardelli, P., & Ierace, S. (2007). Aligning strategic profiles with operational metrics in after sales service. *International Journal of Productivity and Performance Management*, *56*(5/6), 436–455.

Chang, Y.H., & Yeh, C.H. (2002). A survey analysis of service quality for domestic airlines. *European Journal of Operational Research*, *139,* 166–177.

Chen, C.W., & Huang, S.T. (2011). Implementing KM programmes using fuzzy QFD. *Total Quality Management & Business Excellence*, *22,* 387–406.
Cialdini, R. (1984). Principles of automatic influence. In J. Jacoby & C.S. Craig (Eds.), *Personal selling: Theory, research and practice* (p. 21). Lexington, MA: Lexington Books.
Creswell, J.W. (1994). *Research design: Qualitative and quantitative approaches*. Thousand Oaks, CA: Sage.
Cristiano, J.J., Liker, J.K., & White, C.C. (2001). Key factors in the successful application of quality function deployment (QFD). *IEEE Transactions on Engineering Management*, *48*(1), 81–95.
Cronin, J.J., & Taylor, S.A. (1992). Measuring service quality: A reexamination and extension. *Journal of Marketing*, *56*(3), 55–68.
DeVaus, D.A. (2000). *Surveys in social research*. London: Routledge.
Dikmen, I., Birgonul, M.T., & Kiziltas, S. (2005). Strategic use of quality function deployment (QFD) in the construction industry. *Building and Environment*, *40,* 245–255.
Gérson, T. (2007). Integrating the Kano model and QFD for designing new products. *Total Quality Management & Business Excellence*, *18,* 599–612.
Gounaris, S. (2005). Measuring service quality in b2b services: An evaluation of the SERVQUAL scale vis-a'-vis the INDSERV scale. *Journal of Services Marketing*, *19*(6), 421–435.
Hansen, B.G. (1990). *An analysis of factors influencing quality perceptions and purchase of office furniture* (Ph.D. dissertation). Virginia Polytechnic Institute and State University, Blacksburg, VA.
Heung, V.C.S., Wong, M.Y., & Qu, H. (2000). Airport-restaurant service quality in Hong Kong. *Cornell Hotel & Restaurant Administration Quarterly*, *41*(3), 86–96.
Holdford, D. (2008). Content analysis methods for conducting research in social and administrative pharmacy. *Research in Social and Administrative Pharmacy*, *4*(2), 173–181.
Hutt, M.D., & Speh, T.W. (1992). *Business marketing management: A strategic view of industrial and organizational markets*. Fort Worth, TX: The Dryden Press.
Kahraman, C., Ertay, T., & Büyüközkan, G. (2006). A fuzzy optimization model for QFD planning process using analytic network approach. *European Journal of Operational Research*, *171*(2), 390–411.
Karsak, E.E. (2004). Fuzzy multiple objective programming framework to prioritize design requirements in quality function deployment. *Computers & Industrial Engineering*, *47,* 149–163.
Katarne, R., Satyendra, S., & Negi, J. (2010, January). *Measurement of service quality of an automobile service centre*. Paper presented at the International Conference on Industrial Engineering and Operations Management, Dhaka, Bangladesh.
Koska, M. (1990). High quality care and hospital profits: Is there a link? *Hospital*, *64,* 62–63.
Krippendorff, K. (1980). *Content analysis: An introduction to its methodology*. Newbury Park, CA: Sage.
Lovelock, C. (1983). Classifying services to gain strategic marketing insights. *Journal of Marketing*, *47,* 9–20.
Naumann, E., & Giel, K. (1995). *Customer satisfaction measurement and management*. Boise, ID: Thomson Executive Press.
Norman, R. (1991). *Service management* (2nd ed.). New York: John Wiley & Sons.
O'Connor, S.J., Trinh, H.Q., & Shewchuk, R.M. (2000). Perceptual gaps in understanding patient expectations for health care service quality. *Health Care Management Review*, *25*(2), 7–23.
Özgener, Ş. (2003). Quality function deployment: A teamwork approach. *Total Quality Management & Business Excellence*, *14,* 969–979.
Parasuraman, A., Zeithaml, V.A., & Berry, L.L. (1985). A conceptual model of service quality and its implications for future research. *Journal of Marketing*, *49,* 41–50.
Parasuraman, A., Zeithaml, V.A., & Berry, L.L. (1988). SERVQUAL: A multiple-item scale for measuring customer perceptions of service quality. *Journal of Retailing*, *64*(1), 2–40.
Reichheld, F., & Sasser, W. (1990). Zero defection: Quality comes to service. *Harvard Business Review,* September–October, 105–111.
Rosander, A. (1989). *The quest for quality in services*. Milwaukee, WI: Quality Press.
Rossi, P. (1994). The war between the quals and quants: Is a lasting peace possible? *New Directions for Program Evaluation*, *61,* 23–36.
Şen, C.G., & Baraçlı, H. (2010). Fuzzy quality function deployment based methodology for acquiring enterprise software selection requirements. *Expert Systems with Applications*, *37*(4), 3415–3426.

Shillito, M.L. (1994). *Advanced QFD linking technology to market and company needs*. New York: John Wiley & Sons.

Sultan, F., & Simpson, M.C. (2000). International service variants: Airline passenger expectations and perceptions of service quality. *The Journal of Services Marketing*, *14,* 188–216.

Tabachnick, B.G., & Fidell, L.S. (2001). *Using multivariate statistics*. Boston, MA: Allyn & Bacon.

Trocchia, P.J., & Janda, S. (2003). How do consumers evaluate internet retail service quality? *Journal of Services Marketing*, *17,* 243–54.

Weber, R.P. (1990). *Basic content analysis* (2nd ed.). Newbury Park, CA: Sage.

Yan, B., & McLaren, P.A. (2010, December). *Measuring after-sales service quality in automobile retails: An application of the SERVQUAL instruments*. Paper presented at the 2010 IEEE International Conference on Industrial Engineering and Engineering Management, Macao.

Zeithaml, V.A., Berry, L.L., & Parasuraman, A. (1996). The behavioral consequences of service quality. *Journal of Marketing*, *60,* 31–52.

Zeithaml, V.A., Bitner, M.J., & Gremler, D.D. (2006). *Services marketing: Integrating customer focus across the firm*. New York: McGraw-Hill Irwin.

Zeithaml, V.A., Parasuraman, A., & Berry, L.L. (1990). *Developing quality service: Balancing customer perceptions and expectations*. New York: The Free Press.