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SERVICE QUALITY OF INDIAN BANKS: A FUZZY INFERENCE SYSTEM APPROACH

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ABSTRACT

A major shift has been observed in the banking sector in recent times worldwide. The Indian banking sector has witnessed a massive transformation over the last few years due to the introduction of certain government policies. Banks are now considering the development of new service quality policies and strategies that promote customer satisfaction and loyalty. The present study attempts to evaluate the service quality of Indian banks from the customer's perspective. We propose a fuzzy inference system for predicting various dimensions of service and identifying deficient service dimensions that promote effective strategy design.

Keywords: service quality, fuzzy inference system, customer's perspective, banks, India

INTRODUCTION

The banking sector has undergone major changes over the past few decades as a result of regulatory and technological forces (Angur, Nataraajan, & Jaheera, 1999). Intense competition has forced organizations to pay attention to service quality as a critical measure of success (Lassar, Manolis, & Winsor, 2000; Yavas & Yasin, 2001). Research studies have noted that high service quality levels should result in improved customer satisfaction, retention and superior complaint management (Bitner, 1990; Danaher, 1997; Headley & Miller, 1993; Levesque & McDougall, 1996; Magi & Julander, 1996; Zeithaml, Parasuraman, & Berry, 1996). Banks must manage consumer perceptions of bank quality levels and reputations in their attempt to retain customers (Liu & Wu, 2007). Research findings have extensively indicated a link between customer satisfaction, loyalty (Jung & Yoon, 2013) and retention (Danesh, Nasab, & Kwek, 2012). In competitive environments, banks must focus on customer retention and loyalty to maintain a strategic advantage (Pal, 2011; Cohen, Gan, Au Yong, & Chong, 2007). Consumers generate positive perceptions when their expectations are met

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(Laroche, Kalamas, Cheikhrouhou, & Cézard, 2004; Park, Robertson, & Wu, 2005). However, consumers become unsatisfied with service providers when their expectations are not met (Pham & Simpson, 2006).

Studies of this nature have been conducted to address two issues. Although considerable research has been conducted to explore the relationships between service quality and behavioural outcomes in the USA, England, the United Arab Emirates (Jamal & Nasser, 2002), Greece (Athanassopoulos, Gounaris, & Stathakopoulos, 2001) and Turkey (Yavas, Bilgin, & Shemwell, 1997), there is a dearth of such research focusing on the Indian context. The findings of the current study aimed to provide valuable insight to Indian bankers about consumer quality perception and behavioural outcomes.

Indian Banking: Service Quality Perspective

The India banking industry responded to post-liberalisation reforms with full enthusiasm (Savlani, 2000). Global competition enabled bankers to strike a balance between acquiring and retaining customers. The arrival of private and multinational banks to India made a plethora of benefits and service options available to customers (Panigrahy, 2000). Fourteen major banks were nationalised in 1969, and six major private sector banks came under government control in 1980 (Indiaonline, 2009). According to McKinsey (2009), "the last decade has seen many positive developments in the Indian banking sector". Competition in the banking industry increased after liberalisation, allowing multinational banks to establish in India and offer multitude of services.

Banks were generally ranked by leading Indian business magazines in terms of financial parameters such as profitability and productivity. Unlike in developing economies, service quality issues are considered important in developed economies such as the U.S. and Europe (Kassem, 1989; Firoz & Maghrabi, 1994; Yavas et al., 1997, Angur et al., 1999). As per Moody's Banking Sector Report (2008), Indian consumers prefer multinational banks. This has forced the Indian banking industry to re-think total quality management practices (Faisal, Zillur, Qureshi, & Jamshed, 2011). With increasing demands for convenient services, self-service technologies (Mark & Ki-hyun, 2011) for service delivery (Khare & Handa, 2011) and customer relationship management systems have been on the rise (Chang, 2007). Customer service initiatives result in cost savings and increased market share and profitability levels (Kimiloglu, & Zarali, 2009; Heffernan, O' Neill, Travaglione, & Droulers, 2008; Chattananon, & Trimetsoontorn, 2009). Several innovative services such as automated teller machines (ATMs), electronic fund transfer services and net banking options (Bilgin & Yavas, 1995; Rawani & Gupta, 2000), which are designed to better serve customers, are no longer absent in India. Demanding and competent

customers (Bilgin & Yavas, 1995; Akan, 1995) have forced banks to pay greater attention to service quality levels.

LITERATURE REVIEW

Service quality is an essential prerequisite for developing and sustaining satisfying relationships with customers. European perspectives (Ozden, 2003; Gronroos, 1982; Gronroos, 1984; Lehtinen & Lehtinen, 1982) emphasise technical quality, functional quality and corporate legitimacy as three dimensions of service quality, while American perspectives (Parasuraman, Zeithaml, & Berry, 1985; 1988) emphasise functional quality dimensions such as tangibles, reliability, responsiveness, assurance and empathy (Kang & James, 2004). Practitioners and academics have been keen to identify the antecedents and consequences of service quality levels to help businesses achieve a competitive advantage by building customer loyalty (Lassar et al., 2000). Zeithaml (1987) defines service quality as a "consumer's judgment about an entity's overall excellence or superiority". Lewis and Booms (1983) define service as "a measure of how well service level delivered matches customer expectations". Parasuraman, Zeithaml and Berry (1991) stated that an understanding of customer expectations serves as a starting point to the achievement of customer expectations. Parasuraman, Zeithaml and Berry (1994) described service quality as a "minimum (would expectations) and desired service level (should expectations), and perceived performance". In the financial services sector, consumer decisions are guided by perceived risk and trust (Anita & Nicole, 2010).

In competitive environments, service industry survival is largely dependent on the quality of services provided (Howcroft, 1991; Khan, Mahapatra, & Sreekumar, 2009). The service quality scale (SERVQUAL) developed by Parasuraman et al. (1985, 1988, 1991, 1993) has been used extensively in the service sector to measure perceptions of service quality. Previous studies have identified relationships between service quality and market share, investment returns (Bateson, 1995; Parasuraman et al., 1991; Buzzell & Wiersema, 1981; Reichheld & Sasser, 1990), manufacturing costs and productivity (Garvin, 1983; Kotler & Armstrong, 1999; Leonard, Leonard, & Sasser, 1982). Service-oriented firms exhibiting superior levels of service quality will enjoy an economic advantage (Aaker & Jacobson, 1994). Mavri and Ioannou's (2008) study focused on banking services and customer change behaviours. Sachin, Sudheer, Rakesh and Ranjan (2011) found significantly different service quality perceptions between public and private sector customers. The competitive advantage of the banking industry in terms of service quality has been documented in Roth and van der Velde (1991, 1992).

Though several methodologies have been used to evaluate service quality levels, the fuzzy approach has recently grown more popular. Rastaghi and Jafari (2011) compared fuzzy systems, neural fuzzy systems and statistical regression analyses to measure customer satisfaction with banking services. The authors found fuzzy systems to perform better than statistical methods. Darestani and Jahromi (2009) presented a new method based on a fuzzy inference system called the Fuzzy Customer Satisfaction Measurement Method (FCSMM), which is designed to measure individual customer satisfaction. Aburrous, Hossain and Dahal (2008) presented a Fuzzy Logic based model for assessing and evaluating e-banking security performance and quality. Abdolvand and Taghipouryan (2011) used fuzzy multi-criteria decision making to evaluate service quality levels. Hu, Lee and Yen (2010) employed fuzzy linguistic analyses to evaluate levels of hospital service quality and found that the Fuzzy linguistic scale generates more reliable results than the Likert scale does. Customer expectations and perceptions are measured in linguistic terms as "strongly satisfied", "satisfied", or "dissatisfied", which are highly subjective and indicatives of individual judgments. Fuzzy set theory is thus employed to minimise ambiguities and judgments characteristic of linguistic terms.

This study uses fuzzy sets theory to measure service quality levels. A fuzzy inference system was used to predict levels of service quality provided by Indian banks. The fuzzy inference system used considers human perception factors. Zadeh first presented fuzzy sets in 1965 for the quantitative measurement of human thought processes (Zadeh, 1973). Juang, Lin and Kao (2007) employed a fuzzy inference system for supporting customer needs that involved a machine tool manufacturing unit that processed verbally vague descriptions. Lin (2010) cautioned that assessment results obtained via complex decision-making of varying intensity levels can generate misleading results if the fuzziness of subjective human judgment is not taken into consideration. In the present study, we employed a fuzzy inference system to measure service quality more accurately. Chien and Tsai (2000) used triangular fuzzy numbers to measure perceived service quality, consumer satisfaction and discrepancy levels. Azadeh, Ebrahimipour and Bavar (2010) employed a fuzzy inference system to diagnose pump failures and to improve maintenance processes. Lee and Huang (2009) used fuzzy questionnaires to modify Kano's two-dimensional questionnaire, which was considered subjective.

RESEARCH METHODOLOGY

The present study aims to identify critical factors that affect customer perceptions regarding Indian bank service quality. A factor analysis was employed to identify

dimensions that influence overall service quality levels. We conducted a factor analysis to reduce the number of variables subsequently used as input for the fuzzy inference system. We identify seven inputs and "overall service quality" as perceived by the respondents as output. The experiment was designed to determine various combinations of rules for the study. Three input levels were used for the purpose of rule formulation, i.e., low, medium and high. These were taken over seven identified inputs.

Responses were collected from customers of the following three major Indian banks involved in retail banking: State Bank of India (SBI), the Industrial Credit and Investment Corporation of India (ICICI), and the Housing Development Finance Corporation (HDFC). The study was conducted in a metropolitan city of western India due to its large and diverse population. Questionnaires with 30 statements were distributed to customers who have made banking transactions over the last three years. A total of 450 customers were contacted (150 across all three banks). The sample size was ideal with respect to the number of variables used in this study (30 × 5) = 150 (Veena & Venkatesha, 2008). The participants responded on a five-point Likert scale (strongly agree to strongly disagree). The overall response rate was 88.5%.

FINDINGS

A statistical analysis was carried out using SPSS 16.0. The descriptive statistics shown in Table 1 indicate that the mean values of all of the variables exceed 3.68 on a scale of 1 to 5. Several of the variables exceeded a value of 4, denoting that the Indian banks deliver high-quality services. The restroom variable interestingly generated the highest standard deviation value, which denotes high levels of variation in the respondents' opinions. Variables that may require further attention from Indian bankers include operating hours and convenient parking facilities for customers. The Indian banks appear to be excelling in terms of account maintenance, the maintenance of confidential customer matters, error free transactions and records, and timely service delivery.

A factor analysis was conducted to identify factors that influence the service quality of Indian banks. Bartlett's test of sphericity measures correlations between variables (Hair, Black, Babin, Anderson, & Tatham, 2006). A KMO value of 0.931, as shown in Table 2, denotes that the factor analysis is appropriate (Malhotra, 2003).

Table 1
Descriptive statistics

SI no.	Item	Mean	SD
Variable 1	Modern equipment and furniture	4.01	0.810
Variable 2	Visually appealing physical facilities	4.01	0.808
Variable 3	Convenient and attractive restrooms	3.68	1.044
Variable 4	Physical layout that makes it easy for customers to identify appropriate service counters	4.49	0.741
Variable 5	Layout facility that allows for ease of customer movement	4.37	0.746
Variable 6	Timely service delivery	4.71	0.690
Variable 7	Convenient form and document accessibility	4.56	0.736
Variable 8	Error-free transactions and records	4.71	0.675
Variable 9	Staff are able to answer customer questions	4.62	0.663
Variable 10	Staff behaviours instil confidence in customers	4.40	0.779
Variable 11	Provision of customer satisfaction and customised service as promised	4.45	0.727
Variable 12	Prompt service	4.55	0.723
Variable 13	Customer complaints addressed promptly	4.58	0.689
Variable 14	Highly skilled and competitive staff	4.32	0.700
Variable 15	24-hour operation facility	3.93	1.021
Variable 16	Sufficient and convenient parking for customers	3.87	0.925
Variable 17	Customer queries regarding new transaction are addressed adequately	4.32	0.660
Variable 18	Valuing the customer is considered a corporate motto	4.23	0.800
Variable 19	Courteous and well-dressed staff	4.00	0.830
Variable 20	Customers' unique needs are given utmost priority	4.19	0.795
Variable 21	Regular customers are recognised and given priority	4.05	0.958
Variable 22	Accounts and other customer details are kept confidential	4.74	0.625
Variable 23	Financial reputation of the bank	4.50	0.718
Variable 24	Corporate brand image	4.29	0.794
Variable 25	Product offerings and policies are well communicated	4.18	0.801
Variable 26	Customers are assured of individualised services during emergencies or when experiencing difficulties	4.38	0.750
Variable 27	Service facilities are available online	4.40	0.803
Variable 28	Services are provided within stipulated timeframes	4.46	0.679
Variable 29	Specific customer needs are recognised	4.39	0.678
Variable 30	Secure and safe experiences	4.58	0.690

Table 2
KMO and Bartlett's Test [a]

Bartlett's Test of Sphericity	Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.931
	Approx. Chi-Square	4.658E3
	Df	435
	Sig.	.000

a. Based on correlations

A principal component extraction method with varimax rotation was used in the present study. A total of seven factors were extracted that cumulatively account for 60.29% of the total variance. Individual factor variances are shown in Table 3.

Table 3
Total variance explained

Component	Initial eigenvalues[a]			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	5.449	30.213	30.213	5.449	30.213	30.213	2.943	16.321	16.321
2	1.399	7.758	37.971	1.399	7.758	37.971	2.155	11.948	28.268
3	1.131	6.271	44.242	1.131	6.271	44.242	1.259	6.983	35.251
4	.893	4.952	49.194	.893	4.952	49.194	1.176	6.523	41.774
5	.712	3.950	53.144	.712	3.950	53.144	1.218	6.754	48.529
6	.670	3.715	56.859	.670	3.715	56.859	1.201	6.661	55.190
7	.619	3.432	60.291	.619	3.432	60.291	.920	5.101	60.291
8	.569	3.157	63.447						
9	.518	2.870	66.317						
10	.479	2.656	68.973						
11	.449	2.487	71.460						
12	.437	2.424	73.884						
13	.400	2.219	76.103						
14	.388	2.150	78.253						
15	.368	2.039	80.293						
16	.334	1.853	82.146						
17	.320	1.772	83.918						
18	.309	1.713	85.631						
19	.299	1.658	87.290						

(*continue on next page*)

Table 3 (*continued*)

Component	Initial eigenvalues[a]			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
20	.283	1.567	88.856						
21	.258	1.432	90.289						
22	.253	1.406	91.694						
23	.244	1.354	93.048						
24	.235	1.303	94.351						
25	.213	1.181	95.532						
26	.187	1.038	96.569						
27	.172	.953	97.522						
28	.161	.893	98.414						
29	.157	.870	99.285						
30	.129	.715	100.000						

Extraction Method: Principal Component Analysis.
a. When analysing a covariance matrix, initial eigenvalues remain the same across raw and rescaled solutions.

The factor loadings of each variable across the seven dimensions are shown in Table 4. Variables with eigenvalues greater than one were selected. Variables 11, 14, 17 and 26 were omitted, as these variables generated factor loading values of less than 0.50.

Table 4
Rotated component matrix [a]

	1	2	3	4	5	6	7
Variable 1	.819	.062	.172	.140	.024	.088	–.027
Variable 2	.790	.086	.025	.152	.032	.152	.183
Variable 3	.896	.182	–.017	.253	.042	.132	.050
Variable 4	.560	.182	.167	.099	–.194	.204	.036
Variable 5	.554	.323	.095	.062	–.131	.169	–.044
Variable 6	.770	.129	.116	.066	–.012	.054	–.095
Variable 7	.699	.149	.117	.025	.071	.186	.123
Variable 8	.195	.734	.152	.066	–.030	–.055	.041
Variable 9	.031	.272	.661	.183	.137	–.035	.023
Variable 10	.309	.204	–.026	.147	.582	.053	.016

(continue on next page)

Table 4 (*continued*)

	1	2	3	4	5	6	7
Variable 11	.472	.482	.029	.122	.116	.117	.013
Variable 12	.082	.126	.680	.075	.228	–.011	.169
Variable 13	.083	.119	.633	.042	.174	.062	.116
Variable 14	.335	.245	.183	.245	.317	.106	.150
Variable 15	.071	.273	.055	.012	.052	.891	.024
Variable 16	.635	.066	.094	.085	.325	.472	.067
Variable 17	.246	.494	.311	.051	.037	.005	.061
Variable 18	.210	.035	.072	-.062	.123	.045	.690
Variable 19	.008	.230	.353	.248	.533	.064	.101
Variable 20	.118	–.044	.695	.029	.137	.089	.381
Variable 21	.154	.213	.263	.176	.049	.850	.056
Variable 22	.040	.106	.232	.700	–.069	–.078	–.004
Variable 23	.356	.129	.013	.540	–.088	–.071	.098
Variable 24	.166	.297	.158	.621	.029	–.023	.163
Variable 25	.156	.272	.306	.517	.058	.049	–.199
Variable 26	.434	.407	.321	.092	.079	.071	–.004
Variable 27	.340	–.074	.261	.167	.187	.568	–.195
Variable 28	.406	.544	.117	-.010	–.010	.061	.095
Variable 29	.332	.064	.123	.087	.089	.088	.569
Variable 30	.365	.257	.273	.524	–.020	–.107	–.015

a. Rotation converged in nine iterations

Based on the factor analysis results, the variables were classified into seven dimensions and were named as shown in Table 5.

Table 5
Factors influencing bank service quality levels

SI no.	Dimensions	Items
1	Tangible	Physical layout makes it easy for customers to identify appropriate service counters
		Layout facility that allows for ease of customer movement
		Timely service delivery
		Modern equipment and furniture
		Visually appealing physical facilities
		Sufficient and convenient parking for customers
		Convenient and attractive restrooms
		Convenient forms and document accessibility
2	Reliable	Error free transactions and records
		Services are provided within stipulated timeframes
3	Responsive	Staff are able to answer customer questions
		Prompt service
		Customer complaints are addressed promptly
		Customers' unique needs are given utmost priority
4	Credible	Accounts and other customer details are kept confidential
		Product offerings and policies are well communicated
		Financial reputation of the bank
		Corporate brand image
		Secure and safe experiences
5	Courteous	Staff behaviours instil confidence in customers
		Courteous and well-dressed staff
6	Accessible	24-hour operation facility
		Regular customers are recognised and given priority
		Service facilities are available online
7	Customer oriented	Valuing the customer is considered a corporate motto
		Specific customer needs are recognised

Note: Tangible = physical evidence; Reliable = consistency and dependability; Responsive = employee readiness and willingness to provide services; Credible = believability and honesty; Courteous = politeness and friendliness; Access = approachability and ease of contact; Customer-oriented = understanding of customer needs

The average scores of each dimension presented in Figure 1 show that the most important dimension according to the consumers is reliability (4.58), followed by responsiveness (4.48), credibility (4.45), customer orientation (4.31), courteousness (4.31), accessibility (4.12) and tangibility (3.64). The importance of the tangibility, reliability, responsiveness, credibility, courteousness, accessibility and customer orientation dimensions can be determined based on the variance explained by each dimension.

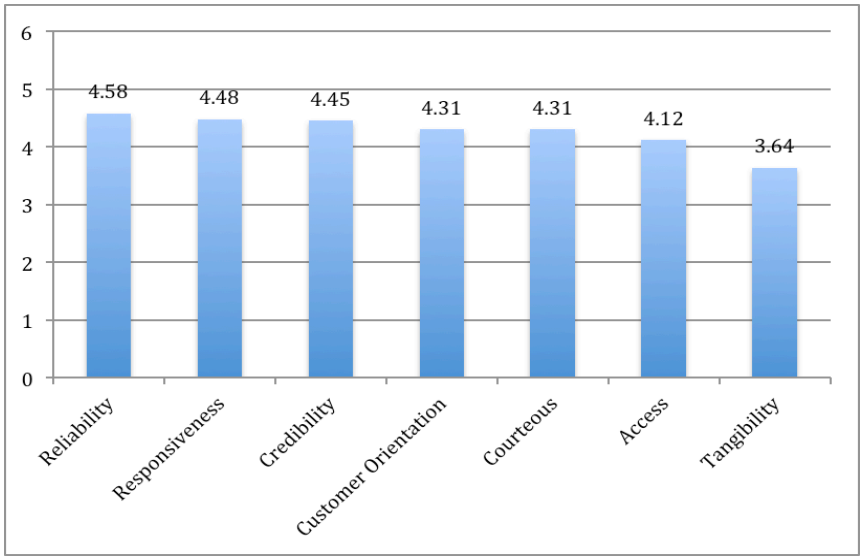

Figure 1. Importance of dimensions

FUZZY MODELLING

Zadeh (1965) introduced fuzzy modelling to address issues of uncertainty in systems modelling. Zadeh defined fuzzy sets as, "sets with boundaries that are not precise. The membership in a fuzzy set is not a matter of affirmation or denial, but rather a matter of degree". Fuzzy set theory challenges Aristotle's conventional two-valued logic or binary logic, which states that every proposition must be either true or false. Fuzzy logic allows for high-level of computation by converting linguistic strategies into control actions (Sivanandam, Sumathi, & Deepa, 2007). Inference systems vary in the way outputs are determined and are referred to as Mamdani or Sugeno methods (Jang & Sun, 1997; Mamdani & Assilian, 1975, Sugeno, 1985). Mamdani's fuzzy inference method involves several steps (Sivanandam et al., 2007). We used Mamdani's method, as it is considered to be most suitable for examining complex systems and decision-making processes (Zadeh, 1973).

To predict the service quality of Indian banks, seven inputs against a single output were used. The seven inputs constituted the average of the seven factors that were obtained from the factor analysis. The single output was directly drawn from the participants' responses on their perceptions of the Indian bank service quality levels. Both input and output responses were recorded on a five-point scale. The model used is shown in Figure 2. Minitab 13.1 was used to design the experiment, and Matlab 7.0 was used to implement the fuzzy inference system.

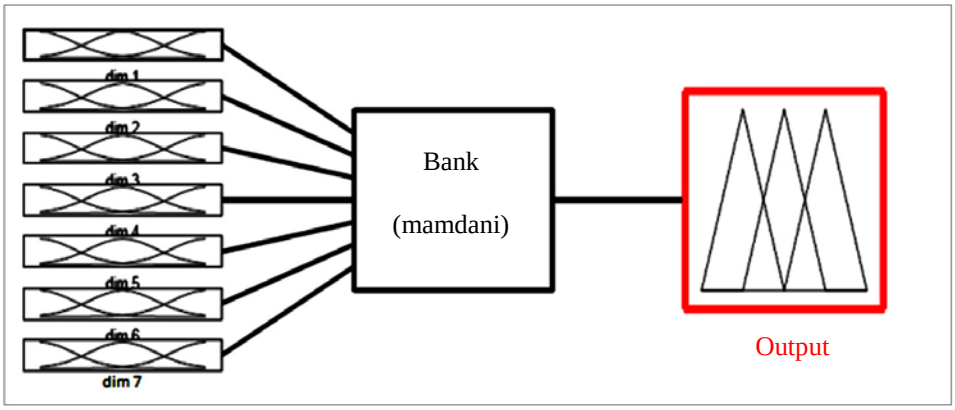

Figure 2. The basic fuzzy model used

For the input function, the triangular fuzzy membership function was used. Three levels were used for input classification, i.e., Low, Medium and High. The input membership function is shown in Figure 3.

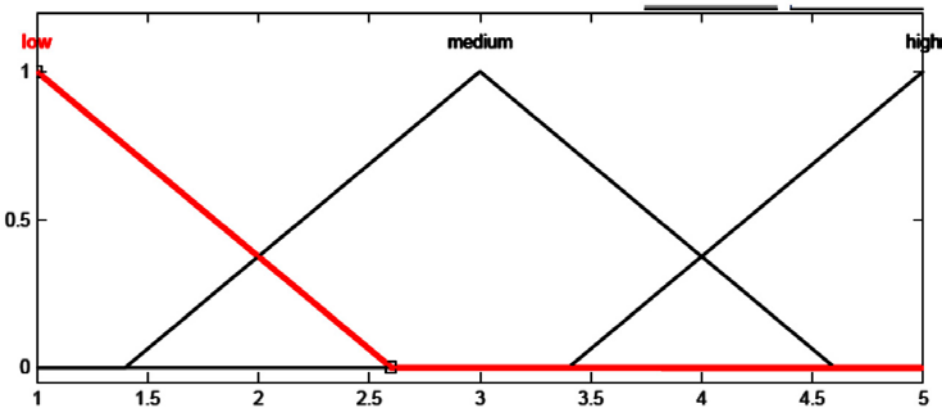

Figure 3. The triangular fuzzy membership function for inputs

The same triangular fuzzy membership function was used for the outputs. Outputs were classified into the following five levels: Very Low, Low, Medium, High and Very High. The output membership function is shown in Figure 4.

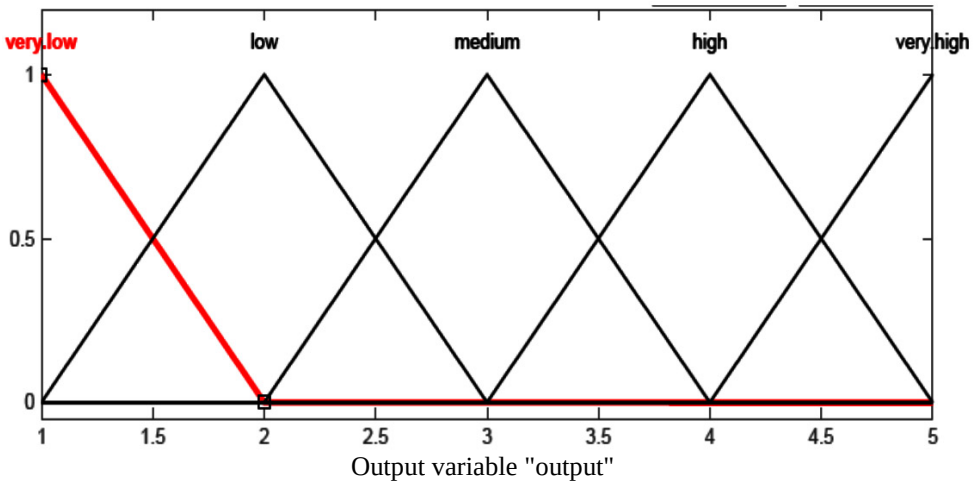

Figure 4. The triangular fuzzy membership function for outputs

Experimental Design and Rule Base Formulation

The experimental design refers to all aspects of information gathering and related variations, whether under the full control of the researcher or not. A Taguchi orthogonal array design was adopted to create various possible levels of inputs for the fuzzy inference system. Each row of the design specified a combination of factor levels to be used for running the experiment. As the number of fuzzy membership functions for each input approached three, a three-level design (low, medium and high) with seven factors (dimensions) was considered. An L_{27} array was generated using MINITAB 13.1. The response of the design referred to the overall level of customer satisfaction expressed in the seven membership functions. The rule base generated is shown in Table 6. Here, "dim" denotes the dimension.

Using the rule in Table 6, the fuzzy inference system was run, and the results for 48 test data were recorded. The results were compared with the actual outputs. The fuzzy predicted output with relative error is shown in Table 7.

Table 6
System rule base

Rule no.	Rule
1	If (dim.1 is high) and (dim.2 is low) and (dim.3 is high) and (dim.4 is high) and (dim.5 is medium) and (dim.6 is high) and (dim.7 is medium) then (output is high)
2	If (dim.1 is high) and (dim.2 is high) and (dim.3 is high) and (dim.4 is high) and (dim.5 is high) and (dim.6 is high) and (dim.7 is high) then (output is very high)
3	If (dim.1 is high) and (dim.2 is high) and (dim.3 is medium) and (dim.4 is high) and (dim.5 is medium) and (dim.6 is medium) and (dim.7 is medium) then (output is medium)
4	If (dim.1 is high) and (dim.2 is high) and (dim.3 is high) and (dim.4 is medium) and (dim.5 is medium) and (dim.6 is medium) and (dim.7 is medium) then (output is medium)
.	……
.	……
26	If (dim.1 is medium) and (dim.2 is high) and (dim.3 is medium) and (dim.4 is high) and (dim.5 is high) and (dim.6 is medium) and (dim.7 is high) then (output is high)
27	If (dim.1 is high) and (dim.2 is high) and (dim.3 is medium) and (dim.4 is low) and (dim.5 is high) and (dim.6 is high) and (dim.7 is medium) then (output is high)

Table 7
The fuzzy predicted output and relative error

SI no.	Dim1	Dim2	Dim3	Dim4	Dim5	Dim6	Dim7	Output	Fuzzy predicted output	Relative error
1	4.50	3.67	4.33	4.50	5.00	5.00	3.00	3.00	3.05	0.02
2	4.40	4.33	3.67	4.00	5.00	3.00	4.00	3.00	3.05	0.02
3	3.20	3.50	3.33	2.50	3.00	3.00	4.00	4.00	4.01	0.00
4	4.60	3.50	4.67	4.00	4.00	3.00	4.00	5.00	4.93	0.01
5	3.80	3.67	4.00	3.50	4.00	3.00	3.00	1.00	1.01	0.01
6	3.70	3.50	3.67	4.00	3.00	3.00	4.00	4.00	4.20	0.05
7	4.00	4.50	4.33	3.50	4.00	3.00	4.00	4.00	3.05	0.24
8	3.60	3.67	3.33	4.00	4.00	4.00	4.00	4.00	4.06	0.02
9	3.30	3.33	3.33	3.50	4.00	3.00	3.00	3.00	3.00	0.00
10	4.60	4.00	3.00	4.00	3.00	5.00	4.00	2.00	2.01	0.01
11	4.60	3.83	4.67	3.50	5.00	4.00	5.00	4.00	4.01	0.00
12	4.90	4.67	5.00	3.00	3.00	4.00	3.00	1.00	1.10	0.10
13	4.60	4.17	3.67	4.50	2.00	3.00	3.00	4.00	3.92	0.02
14	4.70	3.50	5.00	3.00	4.00	5.00	5.00	4.00	4.06	0.01
15	4.90	4.67	4.33	4.50	4.00	2.00	4.00	4.00	3.81	0.05

(*continue on next page*)

Table 7 (*continued*)

SI no.	Dim1	Dim2	Dim3	Dim4	Dim5	Dim6	Dim7	Output	Fuzzy predicted output	Relative error
16	5.00	4.00	3.67	3.50	3.00	4.00	4.00	3.00	3.34	0.11
17	4.50	4.67	4.33	5.00	4.00	4.00	4.00	3.00	3.09	0.03
18	4.70	4.00	5.00	5.00	1.00	5.00	5.00	5.00	4.73	0.05
19	4.20	3.60	4.67	4.00	4.00	4.00	4.00	4.00	3.91	0.02
20	4.50	4.17	4.67	4.00	4.00	4.00	4.00	1.00	1.06	0.06
21	4.90	4.33	4.00	4.50	3.00	5.00	4.00	4.00	3.82	0.05
22	4.50	4.50	4.67	4.50	5.00	4.00	4.00	3.00	3.42	0.14
23	5.00	4.50	4.00	4.50	3.00	2.00	5.00	4.00	3.80	0.05
24	4.70	4.50	4.33	4.00	4.00	4.00	5.00	1.00	1.10	0.10
25	4.60	3.67	3.67	4.00	5.00	2.00	5.00	3.00	3.05	0.02
26	4.90	4.5	4.33	3.50	3.00	3.00	3.00	3.00	3.00	0.00
27	4.60	3.83	3.67	4.00	4.00	4.00	5.00	3.00	3.17	0.06
28	3.90	4.00	4.33	4.00	3.00	3.00	2.00	3.00	3.00	0.00
29	4.70	3.50	3.67	3.50	3.00	4.00	3.00	3.00	3.00	0.00
30	4.70	4.67	4.67	4.50	4.00	4.00	4.00	3.00	3.15	0.05
31	4.90	4.17	4.67	5.00	3.00	3.00	4.00	4.00	4.00	0.00
32	4.20	3.67	4.67	4.50	3.00	5.00	5.00	4.00	4.53	0.13
33	4.60	4.33	4.67	4.00	4.00	4.00	4.00	3.00	3.40	0.13
34	4.30	4.17	3.67	3.50	2.00	3.00	3.00	4.00	3.25	0.19
35	4.20	4.17	4.337	3.50	5.00	4.00	4.00	3.00	3.27	0.09
36	4.10	4.00	4.67	2.50	4.00	2.00	5.00	4.00	4.00	0.00
37	4.50	4.33	5.00	4.00	5.00	5.00	5.00	4.00	4.06	0.01
38	4.70	4.00	4.00	5.00	4.00	3.00	4.00	4.00	3.74	0.06
39	4.70	4.00	4.00	5.00	4.00	3.00	4.00	1.00	2.54	1.54
40	5.00	5.00	5.00	5.00	5.00	5.00	5.00	4.00	4.07	0.02
41	4.60	4.83	4.00	4.00	4.00	5.00	5.00	4.00	4.20	0.05
42	4.60	3.67	3.33	5.00	5.00	3.00	5.00	4.00	3.80	0.05
43	4.50	4.33	4.00	4.50	4.00	3.00	4.00	1.00	1.54	0.54
44	4.90	4.00	4.33	4.50	4.00	4.00	4.00	4.00	3.82	0.05
45	4.50	4.67	4.67	4.50	4.00	5.00	5.00	4.00	4.30	0.07
46	4.11	4.50	5.00	5.00	5.00	5.00	5.00	4.00	4.31	0.08
47	4.70	4.83	4.67	4.50	5.00	5.00	5.00	5.00	4.65	0.07
48	4.50	5.00	4.00	4.00	4.00	5.00	5.00	4.00	4.60	0.15
Average relative error										0.09

The relative error column indicates the accuracy at which the fuzzy inference system developed above can predict the actual output, i.e., overall service quality. Figure 4 shows the plot between the actual and fuzzy predicted service quality levels.

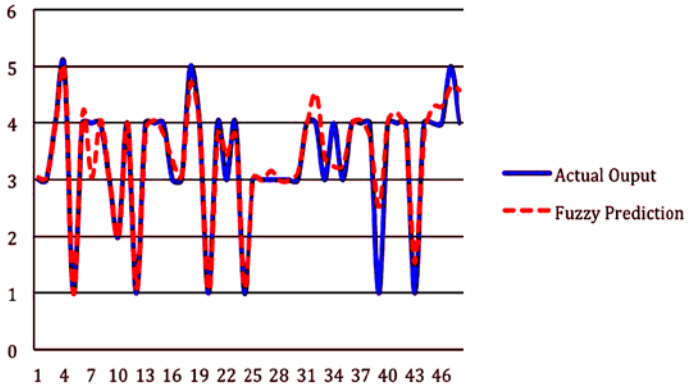

Figure 4. Actual and fuzzy predicted service quality plot

It is evident from the above figure that the fuzzy inference system developed was able to predict service quality levels fairly accurately. As shown in Table 7, of the 48 test data, 7 outputs were predicted with 0% error, 13 outputs were predicted with less than 2% error, and 10 outputs were predicted with error levels between 2% and 5%. The average relative error percentage calculated was 9.44%. Table 7 shows that average dimension values are less than five in several cases, indicating that certain dimensions require urgent attention in order for overall service quality levels to improve. Dimension value deficiencies can be addressed through strategic planning, commitment from upper management teams and staff involvement. However, fuzzy inference systems can generate numerous scenarios for different combinations of dimension values and can predict overall bank service quality levels. Such systems generate scenarios suited to desired levels of service quality by changing the values of dimensions of existing combinations.

DISCUSSION AND MANAGERIAL IMPLICATIONS

The Indian banking sector has undergone major changes throughout India's post-liberalisation period. This had forced Indian banks to shift from a product-oriented approach to a customer-oriented approach through the provision of high-quality customer service. Given this context, a study on Indian bank service quality performance was warranted. Seven dimensions (tangible, reliable, responsive, credible, courteous, accessible and customer orientated) were identified as important service quality parameters according to the customer respondents.

This study is novel in its use of a fuzzy inference system to predict levels of service quality provided by Indian banks on the basis of controllable inputs. Fuzzy inference systems (FIS) apply fuzzy logic and fuzzy sets theory. Broadly speaking, the power of FIS lies in its ability to address linguistic concepts while performing nonlinear mapping between inputs and outputs (Guillaume, 2001).

The overall service quality level, which was taken as the output of the model, was predicted on the basis of seven inputs constituting the average performance of the banks on the seven quality dimensions. The Taguchi orthogonal array design was used to develop various possible input levels for the fuzzy inference system. The developed model was able to predict the overall service quality of the Indian banks with a good degree of accuracy. The overall relative percentage of error was calculated at 9.44%. In today's highly competitive environment, customer satisfaction is continually shaped by customer service experiences over a product's lifetime. Customer satisfaction also constitutes an essential performance metric, as it promotes customer retention, which in turn increases a company's profitability. Marketing executives face the challenge of determining appropriate levels of customer satisfaction that will allow their organisations to remain competitive while keeping costs down enough for reasonable profits to be made. Company executives can determine where and how to focus their improvement efforts, thereby providing companies with economic justifications and a prioritization of management actions. Typically, few companies assess their efforts to improve customer satisfaction levels on a constant and continuous basis. The present study attempts to address this issue by examining how company performance on customer satisfaction can be measured using the proposed approach.

This study addressed questions surrounding ways of measuring and improving service quality perceptions. The study provides insights that may guide gap analyses that can help managers identify organisational weaknesses and thereby devise improvement plans to achieve systematic quality improvements. The study presents insights of great managerial importance because it will help bank managers understand their customers' perceptions of the overall quality of services provided. Hence, inputs that can be controlled by banking organisations can be adjusted accordingly to achieve desired levels of service quality at optimum costs.

Study Limitations and Future Research

The generalisability of study results requires further validation, as convenience sampling was employed. It is necessary to validate the study results for an even broader geographical scope and across various countries. This study could be replicated to confirm the longitudinal validity of the results. As customer

preferences may change over time, the results of this study may not hold longitudinally. Future studies should attempt to validate the proposed method by applying the framework to real-world cases and by considering customer preferences over a period of time and across competitor products or services.

REFERENCES

Aaker, D. A., & Jacobson, R. (1994). The financial content of perceived quality. *Journal of Marketing Research*, *31*, 191–201.

Abdolvand, M. A., & Taghipouryan, M. J. (2011). Evaluation of customs service quality by using fuzzy SERVQUAL and fuzzy MCDM. *American Journal of Scientific Research*, *35*, 89–103.

Aburrous, M. R., Hossain, A. T., & Dahal, K. (2008). *Intelligent quality performance assessment for e-banking security using fuzzy logic.* Proceedings of the Fifth International Conference on Information Technology: New Generations, IEEE Computer Society Washington, DC, 420–425.

Akan, P. (1995). *Dimensions of service quality: Expectations of Turkish consumers from services*. Istanbul: Bogazici University.

Angur, M. G., Nataraajan, R., & Jaheera, J. S. (1999). Service quality in the banking industry: An assessment in a developing economy. *International Journal of Bank Marketing*, *13*(3), 116–123.

Anita, L. Z., & Nicole, K. L. (2010). Adoption of internet banking services in China: Is it all about trust? *International Journal of Bank Marketing*, *28*(1), 7–26.

Athanassopoulos, A., Gounaris, S., & Stathakopoulos, V. (2001). Behavioral responses to customer satisfaction: An empirical study. *European Journal of Marketing*, 5/6, 687–707.

Azadeh, A., Ebrahimipour, V., & Bavar, A. P. (2010). A fuzzy inference system for pump failure diagnosis to improve maintenance process: The case of a petrochemical industry. *Expert Systems with Applications*, *37*(1), 627–639.

Bateson, J. E. G. (1995). Perceived control and service encounter. In J. Bateson (Ed.), *Managing services marketing text and readings* (pp. 42–44) (3rd ed.). Fort Worth, TX: Dryden Press.

Bilgin, Z., & Yavas, U. (1995). Marketing of consumer credit services in a developing country: A status report. *International Journal of Bank Marketing*, *5*, 31–36.

Bitner, M. J. (1990). Evaluating service encounters: The effects of physical surroundings and employee response. *Journal of Marketing*, *2*, 69–82.

Buzzell, R. D., & Wiersema F. D. (1981). Successful share building strategies. *Harvard Business Review*, *59*(1), 135–144.

Chang, H. H. (2007). Critical factors and benefits in the implementation of customer relationship management. *Total Quality Management*, *18*(5), 483–508.

Chattananon, A., & Trimetsoontorn, J. (2009). Relationship marketing: A Thai case. *International Journal of Emerging Markets*, *4*(3), 252–274.

Chien, C. J., & Tsai, H. H. (2000). Using fuzzy numbers to evaluate perceived service quality. *Fuzzy Sets and Systems*, *116*, 289-300.

Cohen, D., Gan, C., Au Yong, H., H., & Chong, E. (2007). Customer retention by banks in New Zealand. *Banks and Bank Systems*, *2*, 40–56.

Danaher, P. J. (1997). Using conjoint analysis to determine the relative importance of service attributes measured in customer satisfaction surveys. *Journal of Retailing*, *2*, 235–260.

Danesh, S. N., Nasab, S. A., & Kwek, C. L. (2012). The study of customer satisfaction, customer trust and switching barriers on customer retention in Malaysia hypermarkets. *International Journal of Business & Management, 7*, 141–150.

Darestani, A.Y., & Jahromi, A. E. (2009). Measuring customer satisfaction using a fuzzy inference system. *Journal of Applied Sciences*, *9*, 469–478.

Faisal, T., Zillur, R., Qureshi, M. N., & Jamshed, S. (2011). Total quality management and service quality: an exploratory study of quality management practices and barriers in service industry. *International Journal of Services and Operations Management*, *10*(1), 94–118.

Firoz, N. M., & Maghrabi, A. S. (1994). The role of service marketing in economic development: An analysis. *International Journal of Management*, *11*, 641–747.

Garvin, D. A. (1983). Quality on the line. *Harvard Business Review*, *61*(5), 65–75.

Gronroos, C. (1982). *Strategic management and marketing in service sector*. Research report, Swedish School of Economics and Business Administration.

Gronroos, C. (1984). A service quality model and its market implication. *European Journal of Marketing*. *18*(4), 36–44.

Guillaume, S. (2001). Designing fuzzy inference systems from data: An interpretability-oriented review. *IEEE Transactions on Fuzzy Systems*, *9*(3), 426–442.

Hair, J. F. Jr., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate data analysis* (6th ed.). New Jersey: Prentice Hall.

Headley, D. E., & Miller, S. J. (1993). Measuring service quality and its relationship to future consumer behavior. *Journal of Health Care Marketing*, *4*, 32–41.

Heffernan, T., O' Neill, G., Travaglione, T., & Droulers, M. (2008). Relationship marketing: The impact of emotional intelligence and trust on bank performance. *International Journal of Bank Marketing*, *26*(3), 183–199.

Howcroft, J. B. (1991). Customer satisfaction in retail banking. *Service Industry Journal*, *1*, 11–17.

Hu, H. Y., Lee, Y. C., & Yen, T. M. (2010). Service quality gaps analysis based on fuzzy linguistic SERVQUAL with a case study in hospital out-patient services. *The TQM Journal*, *22*(5), 499–515.

Indiaonline. (2009). Banking in India: Modern banking. Retrieved 15 November 2009 from, http://indiaonline.in/Utilities/Banks

Jamal, A., & Nasser, K. (2002). Customer satisfaction and retail banking: an assessment of some of the key antecedents of customer satisfaction in retail banking. *International Journal of Bank Marketing*, *4*, 146–60.

Jang, J. S. R., & Sun, C. T. (1997). *Neuro-fuzzy and soft computing: A computational approach to learning and machine intelligence.* Upper Saddle River, NJ: Prentice Hall.

Juang. Y. S., Lin, S. S., & Kao, H. P. (2007). Design and implementation of a fuzzy inference system for supporting customer requirements. *Expert Systems with Applications*, *32*(3), 868–878.

Jung, H. S., & Yoon, H. H. (2013). Do employees' satisfied customers respond with a satisfactory relationship? The effects of employees' satisfaction on customers' satisfaction and loyalty in a family restaurant. *International Journal of Hospitality Management*, *34*, 1–8.

Kang, G. D., & James, J. (2004). Service quality dimensions: An examination of Gronroos's service quality model. *Journal of Managing Service Quality*, *14*(40), 266–277.

Kassem, M. S. (1989). Services marketing: The Arabian Gulf experience. *The Journal of Services Marketing*, *3*(3), 61–71.

Khan, M. S., Mahapatra, S. S., & Sreekumar. (2009). Service quality evaluation in internet banking: An empirical study in India. *International Journal of Indian Culture and Business Management*, *2*(1), 30–46.

Khare, A., & Handa, M. (2011). Customers' quality perceptions towards online railway reservation services in India: An exploratory study. *International Journal of Services and Operations Management*, 9(4), 491–505.

Kimiloglu, H., & Zarali, H. (2009). What signifies success in e-CRM? *Marketing Intelligence & Planning*, *27*(2), 246–267.

Kotler, P., & Armstrong, G. (1999). Principles of marketing (8th ed.). Englewood Cliffs, NJ: Prentice-Hall.

Lai, F., Griffin, M., & Babin, B. J. (2009). How quality, value, image, and satisfaction create loyalty at a Chinese telecom. *Journal of Business Research*, *62*(10), 980–986.

Laroche, M., Kalamas, M., Cheikhrouhou, S., & Cézard, A. (2004). An assessment of the dimensionality of should and will service expectations. *Canadian Journal of Administrative Science*, *21*(4), 361–375.

Lassar, W. M., Manolis, C., & Winsor, R. D. (2000). Service quality perspectives and satisfaction in private banking. *Journal of Services Marketing*, *14*(3), 244–271.

Lee, Y. C., & Huang, S. Y. (2009). A new fuzzy concept approach for Kano's model. *Expert Systems with Applications*, 36(3), 4479–4484.

Lehtinen, U., & Lehtinen, J. R. (1982). *Service quality: A study of quality dimensions*. Helsinki: Service Management Institute.

Leonard, S., Leonard, F., & Sasser, W. E. (1982). The incline of quality. *Harvard Business Review*, September–October, 163–171.

Levesque, T., & McDougall, G. H. G. (1996). Determinants of customer satisfaction in retail banking. *International Journal of Bank Marketing*, *14*(7), 12–20.

Lewis, R. C., & Boom, B. H. (1983). The marketing aspects of quality. In L. Berry, G. Shostack, & G. Upah (Eds.), *Emerging perspectives of services marketing* (pp. 99–107). Chicago, IL: American Marketing Association.

Lin, H. T. (2010). Fuzzy application in service quality analysis: An empirical study. *Expert System Applied*, *37*, 517–526.

Liu, T. C., & Wu, L. W. (2007). Customer retention and cross-buying in the banking industry: An integration of service attributes, satisfaction and trust. *Journal of Financial Services Marketing*, *12*, 132–145.

Magi, A., & Julander, C. R. (1996). Perceived service quality and customer satisfaction in a store performance framework. *Journal of Retailing and Consumer Services*, *1*, 33–41.

Malhotra, K. N. (2003). *Marketing research an applied orientation* (3rd ed.). Sydney, Australia: Pearson Education.

Mamdani, E. H., & Assilian, S. (1975). An experiment in linguistic synthesis with a fuzzy logic controller. *International Journal of Man-Machine Studies*, *7*(1), 1–13.

Mark, Y., & Ki-hyun, P. (2011). Self-service technologies (SSTs): Determinants of adoption and its post-usage outcomes from a focal company perspective. *International Journal of Services and Operations Management*, *8*(3), 305–321.

Mavri, M., & Ioannou, G. (2008). Customer switching behaviour in Greek banking services using survival analysis. *Managerial Finance*, *34*(3), 186–197.

McKinsey Report (2009). India banking 2010: Towards a high-performing sector. Retrieved 30 October 2009 from, http://www.mckinsey.com/~/media/McKinsey/dotcom/Insights%20and%20pubs/MGI/Research/Financial%20Markets/Accelerating%20Indias%20growth%20through%20financial%20system%20reform/Accelerating_India_Growth_through_Financial_System_Reform.ashx

Moody's Banking Sector Reports (2008). Indian banking system challenges remain as asset quality is tested amid loan growth slowdown. Retrieved 30 October 2009 from, http://www.encyclopedia.com/doc/1G1-179966408.html

Ozden, B. (2003). Total quality management (TQM) practices in Turkish manufacturing organization. *The TQM Magazine*, *15*(5), 345–350.

Pal, P. (2011). Customer retention through service recovery. *International Journal of Research in Commerce and Management*, *2*, 131–134.

Panighary, D. (2000). *Relationship marketing an opportunity for bankers in the next millennium.* Proceedings of the International Conference on Delivering Service Quality- Managerial Challenges for the 21st Century, New Delhi. 85–91.

Parasuraman, A., Berry, L. L., & Zeithaml, V. A. (1993). More on improving service quality measurement. *Journal of Retailing*, *69*, 140–147.

Parasuraman, A., Zeithaml, V. A., & Berry L. L. (1991). Refinement and reassessment of SERVQUAL scale. *Journal of Retailing*, Spring, 420–450.

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1985). A conceptual model of service quality and its implication 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), 12–37.

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1994). Reassessment of expectations as a comparison standard in measuring service quality: implications for further research. *Journal of Marketing*, *58*, 111–124.

Park, J., Robertson, R., & Wu, C. (2005). Investigating the effects of airline service quality on airline image and passengers' future behavioral intentions: findings from Australian international air passengers. *The Journal of Tourism Studies*, *16*(1), 2–11.

Pham, K. V., & Simpson, M. (2006). The impact of frequency of use on service quality expectations: an empirical study of trans-Atlantic airline passengers. *The Journal of the American Academy of Business*, *10*(1), 1–6.

Rastaghi, K., & Jafari, S. (2011). Performance assessment and comparison of fuzzy System and ANFIS and statistical methods to measure customer satisfaction of banking services. *International Journal of Science and Advanced Technology*, *1*(2), 49–54.

Rawani, A. M., & Gupta, M. P. (2000). *IT versus service quality in banks – a few learning issues*. Proceedings of the International Conference on Delivering Service Quality: Managerial Challenges for the 21st Century New Delhi, 167–172.

Reichheld, F. F., & Sasser, W. E. (1990). Zero defections: Quality comes to services. *Harvard Business Review*, *68*(5), 105–111.

Roth, A. V., & van der Velde, M. (1991). Customer perceived quality drives retail banking in the 90s. *Bank Management*, *November*, 29–35.

Roth, A. V., & van der Velde, M. (1992). *World class banking: Benchmarking the strategies of retail banking leaders.* Chicago: Bank Administration Institute.

Sachin, S. K., Sudheer, M. D., Rakesh, D. R., & Ranjan, C. (2011). Measurement of service quality in banks: A comparative study between public and private banks in India. *International Journal of Services and Operations Management*, *10*(3), 274–293.

Savlani, H. D. (2000). *Delivering quality services at two commercial cooperative banks in Gujarat*. Proceedings of the International Conference on Delivering Service Quality: Managerial Challenges for the 21st Century, New Delhi, 153–159.

Sivanandam, S. N., Sumathi, S., & Deepa, S. N. (2007). Introduction to fuzzy logic using MATLAB. Berlin: Springer Verlag.

Sugeno, M. (1985). *Industrial applications of fuzzy control*. New York: Elsevier Science Pub. Co.

Veena, A., & Venkatesha, R. H. (2008). Dealers performance and customers preference in passenger car marketing. *Vilakshan*, *5*(2), 59–70.

Yavas, U., Bilgin, Z., & Shemwell, D. J. (1997). Service quality in the banking sector in an emerging economy: A consumer survey. *International Journal of Bank Marketing*, *6*, 217–223.

Yavas, U., & Yasin, M. M. (2001). Enhancing organizational performance in banks: A systematic approach. *Journal of Services Marketing*, *6*, 444–453.

Zadeh, L. A. (1965). Fuzzy sets. *Information and Control*, *19*, 338–353.

Zadeh, L. A. (1973). Outline of a new approach to the analysis of complex systems and decision processes. *IEEE Transactions on Systems, Man, and Cybernetics*, *3*(1), 28–44.

Zeithaml, V. (1987). *Defining and relating price, perceived quality, and perceived value* (Report No. 87–101), Marketing Science Institute, Cambridge, MA.

Zeithaml, V. A., Parasuraman, A., & Berry, L. L. (1996). The behavioral consequences of service quality. *Journal of Marketing*, April, 31–46.