

Prioritizing Service Quality Dimensions: A Neural Network Approach

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Abstract—One of the determinants of a firm's prosperity is the customers' perceived service quality and satisfaction. While service quality is wide in scope, and consists of various dimensions, there may be differences in the relative importance of these dimensions in affecting customers' overall satisfaction of service quality. Identifying the relative rank of different dimensions of service quality is very important in that it can help managers to find out which service dimensions have a greater effect on customers' overall satisfaction. Such an insight will consequently lead to more effective resource allocation which will finally end in higher levels of customer satisfaction. This issue –despite its criticality- has not received enough attention so far. Therefore, using a sample of 240 bank customers in Iran, an artificial neural network is developed to address this gap in the literature. As customers' evaluation of service quality is a subjective process, artificial neural networks –as a brain metaphor- may appear to have a potentiality to model such a complicated process. Proposing a neural network which is able to predict the customers' overall satisfaction of service quality with a promising level of accuracy is the first contribution of this study. In addition, prioritizing the service quality dimensions in affecting customers' overall satisfaction –by using sensitivity analysis of neural network- is the second important finding of this paper.

Keywords—service quality, customer satisfaction, relative importance, artificial neural network.

I. INTRODUCTION

IN recent years, huge technological advancements have changed the face of banking sector in Iran, among which the development of new contact channels such as ATMs and telephone banking have enabled customers to use the banking services more easily and less costly.

Besides technological changes, deregulation coupled with privatization has caused the Competition to intensify. This condition has forced the Iranian banks to use any available instrument to grasp a higher degree of customer satisfaction and loyalty. To achieve this objective, they have to improve the quality of their services, because Service quality is commonly noted as a critical prerequisite for establishing and sustaining satisfying relationships with valued customers [1] and expanding market share [2]. Service quality is considered to be the result of a comparison between customers' perceived service performance and expected service level –i.e. the arithmetic differences between customer expectations and perceptions across the various dimensions of service quality [3]. A number of instruments have been developed based on this definition to measure service quality and evaluate

customers' overall satisfaction of it. The most widely-recognized instrument in this sense is SERVQUAL in which service quality consists of five conceptually distinct dimensions: assurance, empathy, reliability, responsiveness and tangibles [4], [5]. This instrument has been used in different customer satisfaction surveys [6]-[10]. Despite the fact that the principal objective of these surveys is to measure the quality of different dimensions of service, but it is in addition necessary to prioritize the different dimensions of service quality in affecting customers' overall satisfaction. Identifying the relative rank of different dimensions of service quality is very important in that it can help managers to find out which service dimensions have a greater effect on customers' overall satisfaction. Such an insight will consequently lead to more effective resource allocation which will end in higher levels of customer satisfaction. This issue – despite its criticality- has not received enough attention so far.

On the other hand, it is believed that the evaluation of service quality is a subjective process that mainly occurs in the minds of customers [11].

This state of subjectivity necessitates the use of specific techniques in dealing with the issue. Artificial neural networks (ANNs) as a brain metaphor may appear to have a potentiality to model such a complicated process. ANNs are information processors that are inspired from the structure of human brain [12]. So they might be more accurate than traditional statistical methods in analyzing customers' evaluation of service quality and the relative importance they give to different dimensions service quality in their mind. The previous works (for example: [13]) have supported this idea and demonstrated that ANNs' forecasting results are often better than the ones with classical statistical methods.

In this study the application of ANNs in forecasting customers' satisfaction of service quality based on their perceived service quality is examine. Particularly two specific questions are to be answered:

- a) Is it possible to develop a neural network to accurately predict customers' overall satisfaction of service quality?
- b) Is it possible to grade different dimensions of service quality based on their effect on customers' overall satisfaction?

II. SERVICE QUALITY IN SERVICE SECTOR

Service quality, as a concept which has attracted substantial attention in marketing, is a key strategic issue for organizations operating in service sectors [14]. [19] believes that service quality is the outcome of an evaluation process,

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where a consumer compares his expectations with the service he perceives he has received.

One of the most interesting issues in this regard, is the determinants of service quality. [32] claims that, one of the pressing issues before services research is the identification of the determinants of service quality. While the constituents of service quality are not specified, it is not possible to evaluate and improve service quality. In response to this issue, [11] considers "physical quality" and "interactive quality" as the two dimensions of service quality. In addition, [19] believes that "technical dimension", "functional dimension" and "the firm's image" are the constituents of service quality.

After all, the most popular notion was stated by [4, 5]. Their works have ended in five dimensions, as the constituents of service quality, i.e. reliability, Empathy, Responsiveness, Assurance, and finally, tangibles. Additionally, these researchers assert that the customers' perception of service quality depends on the size and direction of the gap between the customers' expected service quality and their perceptions toward that [4].

Another important issue, concerning service quality is the relationship between service quality and customer satisfaction, which has been the major focus of many studies e.g. [15, 16]. It is believed that customers' expectation and perceptions of service quality are the most important determinants of customer satisfaction. This idea is illustrated in the "gap analysis" [17] according to which: if customer's perception of service quality equals their expectations, the customer will be satisfied. If the perception exceeds expectations, then customer will be delighted. And finally if expectations exceed the perception, then customer will be dissatisfied.

Over the recent years, a considerable attention has been paid to service quality and customer satisfaction measurement that has ended in the introduction of various instruments [18], [19].

The SERVQUAL instrument prevails as one of the most widely used approaches in this regard [20], which has also been successfully used in banking.

In this paper, using data from a SERVQUAL survey of 240 bank customers in Iran, a neural network is developed to represent the cause-effect dependencies between customers' perceived service quality and their overall satisfaction.

III. BANKING SECTOR IN IRAN

Banking industry in Iran is a two-level sector. Central bank of Iran forms the first level and several government-driven and private banks shape the second level. The central bank holds regulatory and supervisory authority in all aspects related to banking and its mission is to create and maintain a productive banking system to preserve and facilitate the interests of customers and overall economy of Iran. Till recently, this sector was generally governed by the government-led banks, as a consequence of the "banking system nationalization" policy [21]. Since about one decade ago, this governmental monopoly begun to disappear gradually and a series of changes in Iran's banking sector took place. Private Banks constituted with the permission of Iran central bank and Competition started to intensify. To date, eight private banks which are all Local, have entered Iran's financial market to utilize the good business opportunities available in this

environment, but foreign banks are still prohibited to directly enter the market. Although Iran's financial market is so attractive for private banks, there exist Major hurdles that endanger their survival. Probably the most important difficulty is the fact that however notable changes have taken place and private banks have been allowed to be established, but still government-led banks dominate the market. These governmental banks are powered by the government and they are all long lived (e.g. BANK-E-SEPAH was established in 1938), so they are very experienced and powerful rivals for inexperienced, young private banks that don't rely on the government budget. So private banks have to improve the quality of their services and create more values for customers in such a biased market.

The condition will get worse, if international banks enter this market and impose global competitive pressures on these domestic banks. Iranian banks suffer from several deficiencies compared to big international banks. Perhaps the most important one is their inferior service quality. Iran's traditional financial market used to be a monopoly, and due to the weak competition, delivering excellent services to the customers and concentrating on services quality were not major concern of banks. However after the entrance of private banks and due to the increase of competition, service quality became more important to both governmental and private banks, but the quality of services provided by Iranian banks is still far inferior compared to international counterparts. So the probable entrance of famous foreign banks in the near future may demolish them. This is more critical to private banks, because government-owned banks may be able to survive in such an increasingly innovative and aggressive financial service sector due to the governmental support, but private banks have to rely on their own capabilities to survive. So it is vital for private banks to use any available instrument to attain a sizable market share and preserve it, which is possible by grasping a higher degree of customer satisfaction and loyalty. To do so, they have to concentrate on services quality and customers' expectation, in that Service quality is commonly noted as a critical prerequisite for establishing and sustaining satisfying relationships with valued customers [1]. Iranian banks will have to compete with big experienced international banks which have recognized the importance of banking service quality for a long time. So in order to survive in the increasingly competitive banking sector of Iran, Service quality and customers' evaluations and perceptions toward it appear to be an issue of very high criticality.

IV. METHOD

A. Data gathering and preprocessing

Data were gathered from a face-to-face survey within a three-month period. Although the target population of this study is all bank customers in Iran, due to existing limitations, the survey questionnaire was distributed among 240 bank customers living in Iran's three metropolises, i.e. Tehran, Esfahan and Tabriz.

The questionnaire used in this study is the standard SERVQUAL questionnaire which consists of two sections. A 21-item section measuring the service quality expectation within five aforementioned dimensions and a corresponding

twenty-one item section measuring the perception of service quality of a particular company in that sector [5], [22]. Perceived service quality is indicated by the differences between the expected service quality and the corresponding perceived quality. All the 42 questions are on a seven-point Likert scale. For each pair of corresponding questions the gap is computed as the difference between expectation and perception. Accordingly for each filled out questionnaire twenty one gaps will be calculated that will be used as the independent variables of the neural network. Additionally, one single question concerning the customer's overall satisfaction with service quality will serve as the dependent variable.

B. Neural networks

The most successful artificial neural network model in dealing with prediction and classification problems is known as multilayered perceptrons (MLPs).

An MLP is composed of three kinds of layers, each of which including a number of nodes (neurons). The input layer contains the input (independent) variables in which each variable is represented by one node. The hidden layer takes the responsibility of capturing and processing the non linear relationships among the variables. Finally the output layer corresponds to the dependent variable(s). Each neuron receives a weighted sum from each neuron in the prior layer and provides an input to every neuron of the next layer.

The MLP training process i.e. the calculation of the network weights, is carried out using a set of input values and the corresponding output variable(s) values called the data set. The input values are introduced to the input layers and the network computes the output value(s) using the initial weights and transfer function.

Then the output values are compared to the actual output values and the error is calculated. In order to improve the predictive accuracy of the network, the network weights are updated by propagating the error backward through the network to determine how to best update the interconnection weights between individual neurons. For this reason, the learning algorithm is called back propagation [23].

Artificial neural networks have been applied in many disciplines, including biology, psychology, statistics, mathematics, medical science and computer science. Recently ANN have been applied to a variety of business areas such as accounting and auditing, finance, management and decision making, marketing and production [24].

It is believed that the customers' perception of service quality is a multifaceted and subjective process that mainly occurs in the minds of customers [25], [11], therefore artificial neural networks -as a brain metaphor- may appear to have a potentiality to model such a complicated process.

C. Network configuration and experiments

In order to determine the neural network configuration, the 240 filled out questionnaires were divided into three subsets. This procedure enables us train the network and to evaluate the predictive power of the network. In this procedure the set of all 240 filled out questionnaire (each is called a fact) is subdivided into three parts. 10 percent of the data set will be used to evaluate the power of the network which is called "the secondary test dataset". Another 10 percent of the facts in the

data set are dedicated to determining the best configuration of the neural network and is called "the primary test dataset". The remaining facts will be employed to train the network.

The criterion used to determine the best configuration and to evaluate the power of the network is the RMSE. This criterion is defined as:

$$RMSE = \sqrt{\frac{\sum_{i=1}^n (T_i - O_i)^2}{n}} \quad (1)$$

Where T is the actual output value and O is the predicted output value, and n is the size of "the secondary test dataset".

Following this procedure and employing the sigmoid transfer function and back propagation learning algorithm it was found that the network with 17 hidden nodes performs the best using the primary test dataset and on the criterion of RMSE.

So the best configuration for our neural network is 21-17-1 for input, hidden and output layer respectively. It is mentioned that the software "NeuroSolutions version 5.05" was used in the experiments.

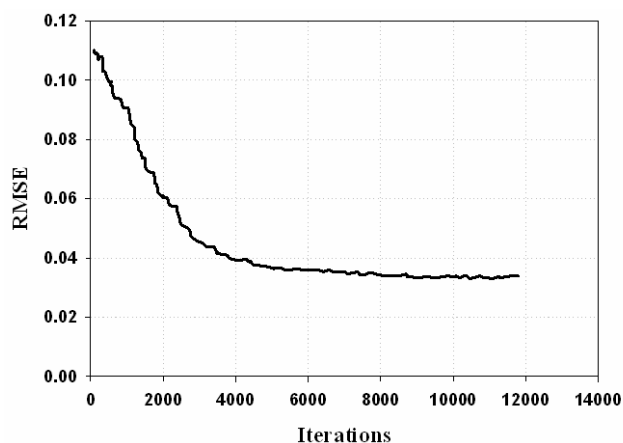


Fig. 1 The rate of classification error for the proposed neural network

The network was then retested using "the secondary test dataset". As indicated in figure 1, proposed neural network shows a satisfactory power in predicting customers' overall satisfaction of banks' services based on their perceived service quality exhibiting only 0.0339 RMSE.

The experiments clearly show the cause-effect dependencies between customers' perceived service quality and their overall satisfaction.

V. PRIORITIZING SERVICE QUALITY DIMENSIONS

The experimental results indicate that the proposed neural network is powerful in modeling banks customers' overall satisfaction of service quality. In this section the proposed neural network is used to address a critical issue in banking industry i.e. prioritizing service quality dimensions in contributing to customers' overall satisfaction.

While service quality and customer satisfaction are wide in scope, and depend on various factors, there may be differences in the relative importance of these dimensions in affecting customers' overall satisfaction of service quality. Identifying the relative ranks of different dimensions of service quality is very important in that it can help managers to find out which service dimensions have a greater effect on customers' overall satisfaction. Such an insight will consequently lead to more effective resource allocation which will finally end in higher levels of customer satisfaction.

Typically, relative importance of predictors – which in our special case are service quality dimensions-, is assessed by simply comparing their standardized regression coefficients [26]. However, when the predictors are correlated, which is generally the case in most of the causal study in primary research, it is recognized that regression coefficients cannot be used to unambiguously explain variance shared by two or more predictors [27], [28]. In this sense, neural networks may appear to be a very good candidate because of their ability to capture nonlinear and complex relationships [29].

In this study, one of the objectives is to rank service quality dimensions using the sensitivity analysis of our proposed neural network.

For this purpose “the secondary test dataset” was used. As mentioned before, our proposed neural network contains 21 input nodes, each representing one “gap” belonging to one specific element in the SERVQUAL questionnaire.

In order to rank these elements based on their effect on customers' overall satisfaction; a specific procedure was employed and repeated 21 times, each time for one specific input. In each iteration one specific element was varied $\pm 15\%$, while keeping all other inputs fixed. Then the quantity of the

change in the output resulted from the change in input was captured. For each specific element this method was iterated 24 times i.e. equal to the existing data in “the secondary test dataset”. This means that the total number of changes –for all inputs and across the secondary test dataset- was 24^{21} . The output changes corresponding to each specific input across “the secondary test dataset” was averaged and scaled. The findings of the sensitivity analysis are illustrated in table 1.

The sensitivity analysis of our proposed neural network revealed precious information regarding the preferences and concerns of banks' customers in Iran. As reported in table 1, it can be inferred that the dimension “reliability” has the greatest effects on customers' overall satisfaction because 4 out of 5 elements of this dimension are the highest ranked elements. This means that the changes in these elements most significantly affect customers' overall satisfaction. This is identical to the results of a number of previous studies e.g. [30], [5] that all found the reliability to be the most important dimension. Another finding of our study is that the dimension “tangibles” is the least important dimension in affecting Iranian customers' overall satisfaction of banks' service quality. This can be easily grasped from table 1 since almost all elements belonging to this dimension are among the lowest ranked elements. This also supports the findings of [26] who reported that this dimension is the least important, in affecting customers' satisfaction. Although no explicit conclusion can be made regarding the rankings of the remaining three dimensions, our findings provide precious information for bank managers in Iran to help them allocate their resources.

TABLE I
 PRIORITIZATION OF SERVICE QUALITY ELEMENTS

Service quality element (input)	Corresponding dimension	Mean scaled effect
Performing the service right the first time	Reliability	-0.0433
Doing the promises on time	Reliability	-0.0431
insisting on error-free records	Reliability	-0.0431
providing the services at the promised time	Reliability	-0.0426
Employees giving prompt service to customers	Responsiveness	-0.0389
having operating hours convenient to all customers	Empathy	-0.0388
Employees having the knowledge to answer customer questions	Assurance	-0.032
employees understanding the specific needs of their customers	Empathy	-0.03
Customers feeling safe in their transactions	Assurance	-0.0295
Showing a sincere interest in solving customers' problems	Reliability	-0.0287
Employees telling customers exactly when service will be performed	Responsiveness	-0.0268
Employees being consistently courteous with customers	Assurance	-0.0266
Employees always being desirous to help customers	Responsiveness	-0.0261
Employees never being too busy to respond to customer requests	Responsiveness	-0.0249
having employees who give customers personal attention	Empathy	-0.0245
modern looking equipment	Tangibles	-0.0222
The behavior of employees instilling confidence in customers	Assurance	-0.0211

giving customers individual attention	Empathy	-0.0184
physical facilities being visually appealing	Tangibles	-0.0169
Employees being neat in appearance	Tangibles	-0.0127
Materials associated with the service being visually appealing	Tangibles	-0.0067

In this sense it can be concluded that banks should allot the biggest portion of their budget improving the dimension "reliability" to make the greatest improvement in their customers' overall satisfaction. About the other dimensions it can be said that "Responsiveness", "Empathy", and "Assurance" need similar amounts of attention and budget allocation in that they all affect customers' overall satisfaction almost the same. Finally although "tangibles" is the least important dimension, it also needs proper amounts of consideration.

VI. CONCLUSION

This study pursued two main objectives. Firstly due to the potential of artificial neural networks in capturing the nonlinear and complex relationships, it was tried to develop a neural network which is able to predict the customers' overall satisfaction of service quality with a promising level of accuracy. In this regard the standard SERVQUAL questionnaire was distributed among 240 Iranian bank customers and used the gathered data in developing our neural network. The results were quite promising in that our proposed neural network was able to predict customers' overall satisfaction with a relatively low amount of error (RMSE= 0.0339). Secondly the proposed neural network was used to address a critical issue in banking industry i.e. prioritizing service quality dimensions in contributing to customers' overall satisfaction. This issue is specifically critical in Iran's banking sector because of the recent intensification of competition in this sector. In this regard our findings support the previous studies reporting that "reliability" is the most important and "tangibles" the least important dimension. Bank managers in Iran can benefit from the results of this study in developing quality improvement plans.

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