A Conceptual Model To Achieve Operational Excellence In A Public Sector Bus Transport Company: A Research Paper

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INTRODUCTION

In several Asian countries, the public sector occupies an important position in the economy. The Bus is a very popular sector of transportation in India because of its low-cost and the Bus as a form of transportation has made a great and significant contribution to the national economy. Decision makers in various sectors, such as the transport sector are frequently confronted with the problem of assessing a wide range of alternatives, and selecting one, based on a set of conflicting criteria. Transit agencies generally give more importance to saving money at the expense of service quality levels; therefore, they essentially focus on cost efficiency and cost effectiveness. An organization uses performance measurement to establish the parameters within which programs, investments, and acquisitions are achieving the intended targets. Often, it requires the use of statistical evidence to determine the progress towards specific and defined organizational objectives. A measure of cost efficiency is typically defined as produced services (e.g. vehicle kilometers), while a measure of service effectiveness is defined as consumed service (e.g. passenger kilometers). Transit agencies, however, have an interest in obtaining a high service quality level, taking into account passengers' priorities and requirements. Hence, the increased necessity of using techniques to identify the importance of service quality attributes at par with global satisfaction levels and assessing service quality. In today's world with thrust towards privatization of government-owned sectors, particularly the Public Sector, bus companies in India face stiff competition from the Private Sector. It, therefore, becomes relevant that they formulate policies and strategies to suit the needs of the situation. The present study becomes relevant in getting to know the customers' or passengers' perspective on the quality of services rendered to them. In India, the State Road Transport Undertaking (SRTUs), with its 58 members, serves in the mobility of both urban and rural population across the country. It operates over 1, 15, 000 buses, serving over 65 million passengers a day, and it provides employment to nearly one million people (ASRTU). Thus, it is vital to improve the efficiency and effective operation of public transport companies. Effectiveness is 'doing the right things', and efficiency is about 'doing things right' (Svikis, 2003). The performance of an organization relies on improving both efficiency and effectiveness.

A government service provider may increase the measured efficiency at the expense of the effectiveness of the service. For instance, a state transport undertaking may reduce the inputs used, like fleet size, cost, bus to carry the same number of passengers. This could increase the apparent efficiency of the transport, but reduce its effectiveness in providing satisfactory service for passengers. Thus, it is important to develop effectiveness indicators (Bhagavath, 2006).

The development of techniques for customer satisfaction analysis is necessary as they allow the critical aspects of the supplied services to be identified and customer satisfaction to be increased. The measure of how products and services supplied by a company meet or surpass the customers' expectations is seen as a vital performance indicator. In a competitive market place, where businesses compete for customers, it is seen as a key indicator that provides an

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indication of how successful the organization is at providing services. The level of expectation can also vary depending on other factors, such as other products against which they can compare the organization's products. The usual measures of getting this may involve a survey with a set of statements or questionnaire using a Likert's scale (1 to 5). The customer may be asked to evaluate each statement or question in their perception and expectation of performance of the service being measured (Wikipedia). For a customer survey to be conducted, a questionnaire has to be developed. The identification of parameters to be considered is to be listed. The various inputs could be obtained for the same through "expert's opinion". Experience and thorough knowledge are vital for evolving an exhaustive and sufficient list of questions or parameters (Chidambaranathan et al., 2009). The experience and expertise of both the experts from the concerned sector or field and / or academicians would form a part such an exercise. The list of questions evolved may initially be administered to a group of customers to ascertain if all the parameters are important or necessary.

OBJECTIVES OF THE STUDY

The main objectives of the paper are to:

1) To identify the customer's characteristics for the public bus transport and validate the factors responsible for service quality in the transport.

2) To feed these factors as the customer's needs or requirements to the House of Quality (HOQ).

3) To identify the technical descriptors for the HOQ.

4) To interrelate the customer's needs and technical descriptors.

5) To prioritize the technical measures to meet the customer requirements through Conjoint Analysis.

6) To use the customer competitive evaluation matrix for planning and improvement to achieve operational excellence.

This paper is organized as follows: The literature review of quality function deployment in the transport sector has been presented in the next section, followed by a case study that discusses the customer characteristics and its validation through PCA, and using Conjoint Analysis to prioritize the technical descriptors. Then, the discussions are presented and finally, the conclusions are drawn.

LITERATURE REVIEW

Performance measurement is a process by which an organization establishes the parameters within which programs, investments, and acquisitions are achieving the intended targets to provide an effective performance measurement methodology for measuring the effectiveness of supplied services in a public transport (Mazzulla and Eboli, 2006). Some authors like Silva (2011) , Choudhary and Sharma (2009) presented studies on improvement in operational efficiency and performance. Quality function deployment is a concept that involves customer-driven planning, continuous improvement and people's participation (Chin et al., 2001 and Liu and Wu, 2008). It has three important decision making stages - the first one is collecting the customer's requirements, the next is to determine the relationship between customer's needs / requirements and the technical descriptors / measures, and lastly, to prioritize the technical measures to meet the customer's needs (Liu and Wu, 2008).

QFD has various stages involved in its development such as:

1) Voice of the customer or the customer requirements (WHATs),

2) Technical measures or descriptors (HOWs),

3) Customer Competitive Evaluation Matrix also called the Planning Matrix,

4) Interrelationship Matrix (relation between WHATs and HOWs),

5) Technical Assessment Matrix.

The review of literature on QFD, which has been carried out in the transport and related sectors over the last few years is presented herewith.

Mazur and Hopwood (2007) reviewed the transportation project development process to yield improved transportation decision making; Daman and Elbuzidi (2004) described the improvement in service quality in Air Transportation Services in Libya; and Hsu et al. (2009) applied QFD to improve the service quality for container terminal operators to improve their service quality in a shipping company.

Chen (2009) presented how the quality improvement framework has been used in the cargo sector in air transport in a Taiwan airport; Tu. C.S. et al. (2010) utilized the requirement-based site selection for an airport cargo logistics center in Taiwan; and Cheng et al. (2004) applied it for cultivation of the aircraft maintenance technicians.

Conjoint Analysis is a means of designing and conducting particular experiments among costumers in order to model their decision-making processes. Here, potential customers make judgments about the attributes that affect their usage decisions conjointly, rather than evaluate each attribute individually. This allows finding out which product or service attributes are the most valued by a customer and how they are likely to react to different products and service configurations. This information invariably leads to the creation of optimal value propositions.

The review of literature on Conjoint Analysis (CA), which has been carried out in the various sectors over the last few years is presented herewith.

Kotri (2006) used CA for analyzing customer value in a packaging company in Estonia; Soutar and Ridley (2002) investigated the importance of a number of attributes considered by students in choosing universities in Australia; and Ong et al. (2010) used Conjoint Analysis to examine how Malaysian consumers make decisions regarding consumer durable products. From the above, it is clear that Conjoint Analysis has not been used in the transport sector, and it has been used in this study to analyze the technical descriptors as a combination of service configurations.

In this study, quality function deployment has been developed for a public sector bus company to translate the customers' needs (analyzed using PCA) into quality characteristics to improve the quality of service provided by prioritizing the technical measures (using CA).

CONCEPTUAL MODEL

The methodology of this conceptual model with different phases is presented in the Figure 1. The model has been developed based on a State Road Transport Undertaking (SRTU) located in South India, operating passenger buses. The following are the highlights of the model:

- ❖ In this model, traditional quality function deployment has been modified.
- ❖ The Principal Component Analysis (PCA) was used to find out the weights for the customer needs.
- ❖ The Conjoint Analysis (CA) was used to aid the prioritization of the technical descriptors.
- ❖ This QFD helps to prioritize the different technical measures, and also provides guidelines to managers to focus and improve services to achieve operational excellence.

The various stages involved in the development of the Quality Function Deployment (QFD) model are presented in a detailed manner as given below.

❖ **The Voice of The Customer :** The data was collected through a survey using a questionnaire developed by a group of managers, transport officials, and academicians through the brainstorming methodology. The questionnaire consisting of a set of questions on the customer characteristics was developed. The questionnaire was used to enumerate the responses through the interview method. The respondents were asked to rate the parameters on a 1-5 Likert's scale (Very Good (5), Good (4), Fair (3), Poor (2), And Very Poor (1)).

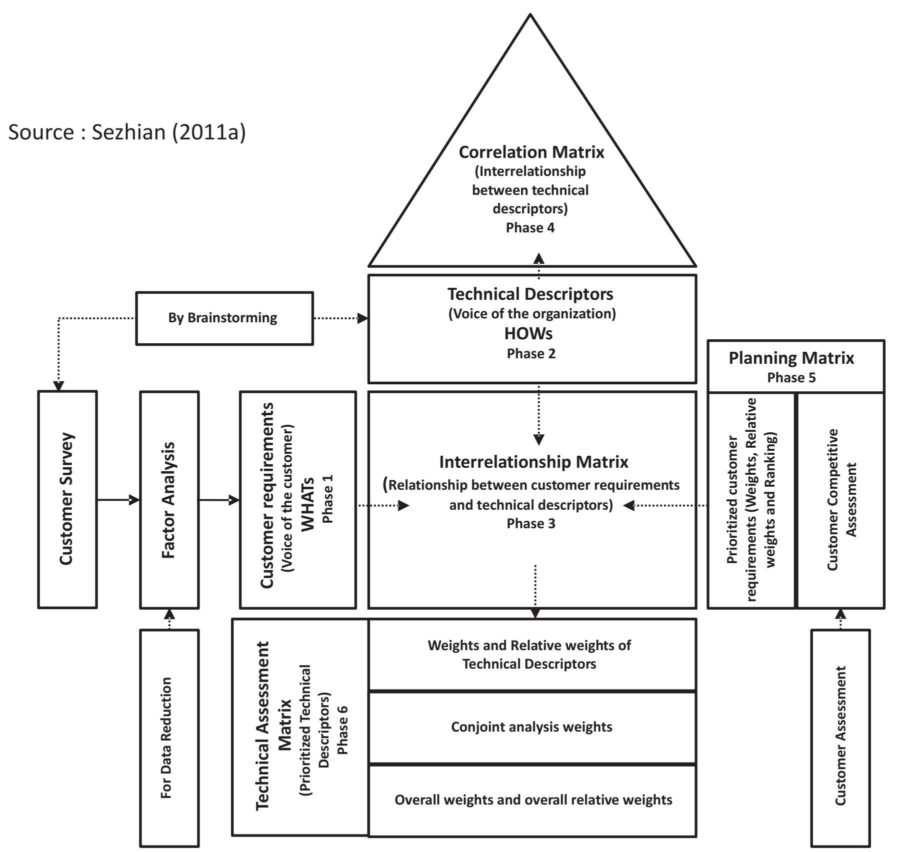
Ahead of assessing the collected data, the reliability analysis was conducted and it returned a Cronbach's α value of 0.94 (min value of α is 0.7, (Hair et al., 2006)). This ascertained the ability of the survey instrument to produce consistent results. Then, the received responses were subjected to Principal Component Analysis (PCA), and it extracted two components with Eigen values > 1 . The two components accounted for a total variance of 58.73%. All the factor loadings were greater than 0.5 and thus, all the eighteen sub-criteria were significant (Kannan and Tan, 2002).

PCA provides a method to reduce a complex data set to a lower dimension to reveal the sometimes hidden, simplified structures that often underlie it (Shlens, 2009). It is one of the most widely used multi-variate techniques and is a popular ranking method, which involves a mathematical procedure that transforms a number of correlated variables into a lesser number of uncorrelated variables called principal components (Petroni and Braggia, 2000). Even though the objective of PCA may be to reduce the number of variables of a dataset, it retains most of the original variability in the data. The first principal component accounts for as much of the data variability as possible and succeeding components account for as much of the remaining variability as possible (Hair et al., 2006).The PCA extracts components with Eigen values > 1. From the analysis, all the factor loadings which are greater than 0.5; i.e., those found significant may be chosen (Kannan and Tan, 2002, Sezhian et al., 2011). They are taken as the customer's needs (WHATs) for the house of quality (HOQ) and are placed on the left hand side, and their corresponding weights are placed on the right hand side of the HOQ (Figure 1).

❖ **Technical Descriptors :** Next, the Technical Descriptors (HOWs), which is the stage where the customer's needs are translated into technical requirements was developed. A group of managers, transport officials and academicians developed the technical descriptors through the brainstorming methodology. They were placed on top of the HOQ as seen in Figure 1.

Conjoint Analysis is considered to be one of the best methods for understanding which aspects of a product and service are most valued by the customers. Conjoint Analysis allows for the overall ranking of individual products and through mathematical analysis, the underlying value system of the individual can be assessed (Dolan, 2007). Conjoint Analysis is used to determine the relative importance customers attach to the various attributes and the utilities for the levels of attributes. The information is obtained from the consumers' evaluation of the profiles composed of these attributes and levels (Malhotra, 2004). The customers or respondents are given a choice of stimuli, which consists of combinations of various attribute levels. In this model, Conjoint Analysis was used to assess the technical descriptors. These technical descriptors were grouped as attributes and these were then divided into two levels each. The level 1 was assigned a value of '1' and the level 2 was assigned a value of '0' (also called dummy variables). If there are 'n' attributes and two levels; there are $(2)^n$ possible combinations (Malhotra, 2004 and Nargundkar, 2008). This along

Figure 1 : Flow Chart For Developing The HOQ For Bus Passenger Transport



with the ranking of the various combinations was the input data for the Conjoint Analysis (CA). The importance values obtained from this were taken to the HOQ in Figure 1 as the Conjoint Analysis weights.

❖ **Planning Matrix :** The Planning Matrix placed on the right-hand side of HOQ in Figure 1 consists of two parts; the first part is the Importance Weights and Ranking, and the second part is the Customer Competitor Assessment Matrix. This gives an idea and direction for the company to know its position, fix target values and plan strategies to improve performance.

❖ **Importance Weights And Ranking :** Placed on the left side of the Planning Matrix in HOQ (Figure 1) is the importance weights obtained by PCA and the relative weights are presented along with the ranking for the customer needs. The relative weights of each customer needs are the ratio of each importance rating with the sum of the importance weights.

Here,

i = number of customer requirements

W_{Wi} = Weights of i^{th} customer requirement (or WHATs)

R_{Wi} = Relative weight of i^{th} customer requirement (or WHATs)

$$R_{Wi} = \frac{\text{Weights of } i^{th} \text{ customer requirement} * 100}{\text{Sum of Weights of customer requirements}}$$

$$R_{Wi} = \frac{Wwi * 100}{\sum Wwi}$$

Apart from the above, eighteen customer characteristics were ranked and placed along with the weights and relative weights as seen in the HOQ.

❖ **Customer Competitor Assessment Matrix :** The Customer Competitor Evaluation Matrix was placed adjacent to the importance weights and ranking was placed on the extreme right side of the HOQ. It gives an idea of the depot's performance and how the competing depots are performing as per the customers' assessment, i.e., mean values of passenger assessment of the depots. The best values of the three depots observed for the customer characteristics were placed as the target values. The target depot for improvement was chosen so that its value is compared to the target value to get the improvement ratio.

Improvement Ratio = (Target Value / Value Of Customer Assessment For The Target Depot)

❖ **Interrelationship Matrix :** The next stage involves the development of central part of the HOQ, i.e., Relationship Matrix. It establishes the relationship or the strength of the relationship between the voice of the customer (WHATs) and technical descriptors (HOWs). To build this, the relationships have to be categorized as strong, medium and weak. A value of 9, 3 and 1 are assigned for strong, medium and weak relationship between WHATs and HOWs (Zaim and Sevkli, 2002). It may also be noted that all combinations of these may not be related; hence, if no entry is made, it means there is no relationship.

❖ **Correlation Matrix :** The roof of the house of quality is called the Correlation Matrix and it correlates the technical descriptors against each other. Here also, the 9, 3 and 1 values were assigned for strong, moderate and weak correlations. The values were added for each row (for the corresponding technical descriptor) and placed in its extreme right of the roof. The correlation weights are calculated as follows:

$$\text{Correlation Weight For A Technical Descriptor, } W_{Cj} = \frac{\text{(Sum Of Correlation Value Of A Row)} * 100}{\text{Total Value Of All The Correlations}}$$

❖ **Technical Assessment Matrix :** At the base of the HOQ in Figure 1 is the Technical Assessment Matrix, where the column weights are placed. The column weight serves the purpose of prioritizing the technical descriptors. This can help an organization to decide which of the technical descriptors are important to improve first, so that its efforts could be concentrated for improvement. This Technical Assessment Matrix includes the following details:

Here j = the number of technical descriptors
W_{Hj} = Weights of j^{th} technical descriptors (or HOWs) = $\sum(R_{Wi} * V_{ij})$
where

V_{ij} = relationship value assigned for i^{th} WHAT and j^{th} HOW

R_{Hj} = Relative weight of j^{th} technical descriptors (or HOWs)

$$R_{Hj} = \frac{\text{Weights of } j^{th} \text{ technical descriptors} * 100}{\text{Sum of Weights of technical descriptors}}$$

$$R_{Hj} = \frac{W_{Hj} * 100}{\sum W_{Hj}}$$

W_{Cj} = Correlated weight of j^{th} technical descriptors (or HOWs)

TW_{Cj} = total correlation weights = $R_{Hj} + W_{Cj}$

TR_{Cj} = Total relative weight of j^{th} technical descriptors (or HOWs)

$$TR_{Cj} = \frac{TW_{Cj} * 100}{\sum TW_{Cj}}$$

AW_{Hk} = Attribute weight of the k^{th} attribute = $\sum TR_{Cj}$ where k = 1 to 'n'
CW_{Hk} = Conjoint weights of the k^{th} attribute
OW_k = Overall weights of k^{th} attribute = $(AW_{Hk} * CW_{Hk})/100$
ROW_k = Overall relative weights of the k^{th} attribute

$$ROW_k = \frac{OW_K}{\sum OW_K}$$

The importance weights, W_{Hj} of the technical descriptors are the sum of value of the relationship multiplied with the relative weight of the customer needs (Chin et al., 2001). The relative weights, R_{Hj} of each technical descriptor are the ratio of each importance rating with the sum of the importance weights. Below this correlation weights, W_{Cj} obtained from the roof of HOQ was placed. Total correlated weights, TW_{Cj} are the sum of the relative weights and the correlation weights. The total relative weights, TR_{Cj} were obtained by the ratio of total correlated weight to the sum of the total correlated weights. For further analysis, the total correlated weights were added up to get the attribute weights, AW_{Hk}.
Then, the weights obtained from the Conjoint Analysis were taken and adopted additionally as CW_{Hk} to the base of the traditional HOQ as an additional input by grouping the technical descriptors into four attributes. This was done in this study to enhance the importance of the technical descriptors. The overall weights, OW_k were obtained by multiplying the attribute weights of the four groupings obtained initially with the conjoint weights. The last row in this matrix is the overall relative weight, ROW_k which was obtained by the ratio of overall weights to the sum of the overall weights.

DISCUSSION

The quality function deployment (QFD) for the passenger bus transport is presented in the Figure 1. The customer characteristics which were obtained through the survey consisting of questions that were found to be valid by the PCA were fed as the customer requirements for the HOQ on the LHS. On the RHS of the HOQ, the Planning Matrix was placed. The left half of this matrix has the weights, relative weights and the ranks of these customer requirements placed in it. The rankings serve the purpose of prioritizing the customer characteristics. The Customer Competitive Assessment Matrix was on the right side of the Planning Matrix. Here, the customer assessment (mean values) of the depots were placed for all the customer requirements. A particular Depot was targeted for improvement and so, target values were fixed from competing depots, and the improvement ratio was also presented for all customer requirements.

The technical descriptors were placed at the top of the HOQ and below the roof. They were subjected to a technical assessment procedure as presented in the Technical Assessment Matrix at the base of the HOQ seen in the Figure 1. The importance weights and the relative weights of each technical descriptor formed the first two rows of the matrix. In the next two rows, correlated weights obtained from the roof or Correlation Matrix and the total relative weights were placed. The total relative weights (fifth row) were added up to get the total weights of the Attributes (sixth row). After this, the Conjoint Analysis for the attributes was performed. The importance values obtained for the attributes from the Conjoint Analysis were taken and added to the base of the traditional HOQ (as the seventh row) as an additional input by grouping the technical descriptors into four attributes. This has been done in this study to enhance the importance of the technical descriptors. The new overall weights were obtained by multiplying the total values of the four groupings obtained initially with the conjoint weights (eighth row). Then, the overall relative weights were determined and added as in the ninth and last row in the Technical Assessment Matrix.

CONCLUSION

This paper has presented the development of Quality Function Deployment (QFD) in the transport sector using the customer characteristics (analyzed using PCA), and using Conjoint Analysis to prioritize the technical descriptors for a public sector bus transport company in South India. The study aimed at helping the company management to formulate their strategies. This QFD would not only help prioritize the different technical descriptors (measures) to meet the customers' requirements; it also provides guidelines to managers to focus on for improvement to achieve operational excellence.

In today's world, there is thrust for privatization of government-owned sectors; particularly, the public sector bus companies in India face stiff competition from the private sector. It, therefore, becomes relevant that they formulate policies and strategies to suit the needs of the situation. Such models give a clear picture to the management so that it comes up with action plans both for short term and for medium / long term for all the depots to meet the expectations of the customers. When the customers' feedback is appropriately acted upon, it in turn may be a customer retention strategy (short-term benefit) and will bring in more customers to patronize the transport in the future, i.e., customer development strategy (long-term benefit).

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