

Assessment of Mass Transit Quality of Service Employing Passenger Satisfaction in Soft Computing Techniques

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Assessment of Mass Transit Quality of Service Employing Passenger Satisfaction Using Soft Computing Techniques

A thesis submitted in partial fulfilment

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in

Civil Engineering

By

Hetsav Dholawala

(Roll No - 215CE3276)

based on research carried out

under the supervision of

Prof. P.K. Bhuyan



May 2017

Department of Civil Engineering

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May 23, 2017

Certificate of Examination

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Declaration

I hereby declare that all the work in this thesis was carried out in accordance with the requirements of the Postgraduate Programme in Transportation Engineering from NIT Rourkela and that it has not been submitted to any other institute for academic award of degree. To my best knowledge the work is original, authentic and belongs to my research work. The work done with assistance and idea of other researcher's work have been mentioned in specific references and acknowledgement in the text.

Hetsav Dholawala

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Abstract

Numerous methods for relating Quality of service with Customer satisfaction have been evolved. In this research, Neuro-Fuzzy approach has been used for assessing the Quality of Service based on the data collected on customer satisfaction from Ahmedabad BRTS (Janmarg) and Surat BRTS (Sitalink) from cities of Ahmedabad and Surat city respectively. Neuro Fuzzy was conceived as a Universal Approximator by Jang (1993) incorporating Fuzzy Inference system in the artificial neural network framework, exploiting the advantages of both the methods. Adaptability and learning of NNs and Inference of Fuzzy reasoning has made it reasonable to use it as a Universal Approximator which is highly accurate as well as it can deal with uncertain and vague character of the Human perception.

CHAPTER 1

INTRODUCTION

1.1 General

With urbanization's lively pace, there come the issues related with that. The primary issues that are confronted by today's urban agglomerations are transportation and water issues. In this exploration the concentrate will be continued the issue identified with Urban Transportation as it were. As the urban populace and the salary levels increment, requests for brilliant fast transportation additionally increment. Among different urban needs, urban transportation is probably the most essential requirement for the general improvement of the nation. Urban transport gives versatility to individuals and merchandise and furthermore an entrance to business, training, shopping, wellbeing, excitement openings. It additionally influences the pay levels of the general population, arrive qualities and condition. More or less, it decides the personal satisfaction in a region.

1.2 Scope & Objectives

The main objectives of this research can be defined as followed:

- i. To identify the most important service attributes that affects the user's perception on public transit,
- ii. To devise a survey procedure for assessing the user's satisfaction levels regarding current operating conditions,
- iii. To develop a suitable methodology to provide a suitable tool for decision-making in public transit.

Chapter 2

Literature Review

2.1 Introduction:

This chapter focuses on the methods utilized by the researchers to evaluate customer satisfaction for various transportation facilities provided.

2.2 User Perception Based LOS:

Eboli and Mazzulla (2006) With the point of deciding the relative weights of the considerable number of properties on worldwide consumer loyalty, a method to figure an Importance Value (IV) of each administration quality property is proposed, agreeing just to open transport clients expressed inclinations on some administration quality traits. A Service Quality Index (SQI) is figured by utilizing assessed coefficients.

Parasuraman et. al (1988) built up a technique for assessing the administration quality with the thought of factors of five classifications to be specific the Tangibles, Service dependability, Responsiveness, Assurance and Empathy. This strategy essentially comprise of poll and talking procedures and the administration quality is figured by totaling the reactions gathered from the clients about the administration quality characteristics.

Eboli and Mazzola (2007) endeavored to clarify the apparent nature of administration in light of the Structural Equation Model. The creators have attempted to mirror the idle factors that influence the apparent quality and build up a comprehension between impression of two sorts. Once when travelers have not thought about any factors and have been requested that specifically give general discernment about the administration and second is the point at which the travelers are considered the administration quality characteristic that influence the fulfillment of client.

Hu and Jen (2006) created and tried scale for open recognition and estimation of the administration quality in the city of Taipei. Blend of Churchill's worldview and center gathering interviews come

about into the multistage scale improvement. Last scale contained 20 dimensioned which were arranged into four measurement viz. collaboration with travelers, unmistakable administrations gear, accommodation of administration and working administration bolster. The generally more regrettable markers were overseeing conclusions and protestations and additionally driver's driving capacity which were incorporating into the most reduced scoring 'cooperation with travelers' measurement. The 'substantial administrations gear' got moderately most noteworthy score supported by agreeable offices and equipment.

Graham Currie (2005) utilized excursion ascribe way to deal with decide relative engaging quality of different open travel modes including BRT, HRT and LRT frameworks. How the outing traits fluctuates for a client crosswise over different modes was analyzed. It was found that the clients see BRT and LRT in a comparative way in respect to the off road transport benefit. The discoveries proposed that the BRT ought to have the capacity to discover support like the LRT as the observation for both is comparative. The investigation recommended that the exchange punishments and mode particular variables are the main that shifts crosswise over different modes. Facilitate, generally low foundation and upkeep cost could even launch the points of interest over light rail in wording viability.

Chapter 3

Methodology

3.1 Introduction

There are two primary hypothetical streams for dissecting Quality of administration offered by any item or any administration. These two streams are: i) Statistical approach ii) Multivariate basic leadership. Quadrant and crevice examination, figure investigation, Pearson connection, bunch investigation, discriminant investigation, Regression models, Logit models, Discrete decision models are sorted in the primary kind of relationship. While in second class, Structural Equation models, ANNs, fuzzy rationale based models, neuro-fuzzy are there.

3.2 Factor Analysis:

Factor analysis is used just as a tool to reduce the number of service attributes to such extent with which modelling can be easily implemented.

3.3 Soft Computing:

Delicate figuring is a rising way to deal with processing which parallels the exceptional capacity of the human personality to reason and learn in a situation of vulnerability and imprecision. At this point, the vital constituents of Soft Computing (SC) are Fuzzy Logic (FL), Neural Computing (NC), Evolutionary Computation (EC) Machine Learning (ML) and Probabilistic Reasoning (PR), with the last subsuming conviction systems, tumult hypothesis and parts of learning hypothesis. What is critical to note is that delicate registering is not a blend. In this point of view, the primary constituent procedures in SC are integral as opposed to focused. Moreover, delicate figuring might be seen as an establishment segment for the developing field of reasonable knowledge.

Methodology	Strengths
Neural Networks	Learning & Adaptation
Fuzzy set theory	Knowledge representation via fuzzy if-then rules
Evolutionary Algorithms	Systematic random search
Artificial Intelligence	Symbolic Manipulation

Table 3.1: Methodologies and their strengths

3.3.1 Fuzzy Inference System:

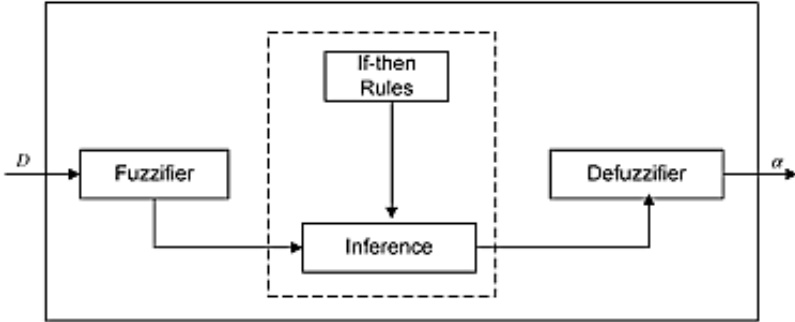


Figure 3.1: Information flow in Fuzzy inference system

3.3.2 NN Architectures:

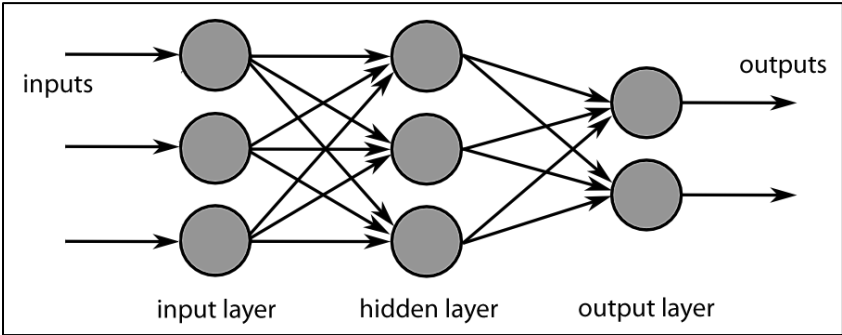


Figure 3.2: Feedforward neural network

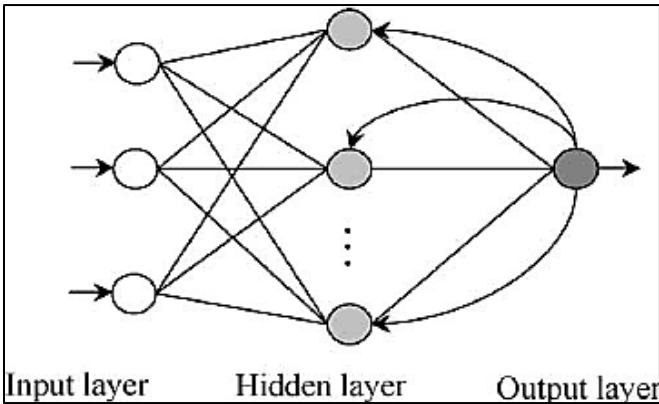


Figure 3.3: Recurrent neural network

3.3.3 Adaptive Neuro Fuzzy Inference System (ANFIS)

The technique was developed in the early 1990s.

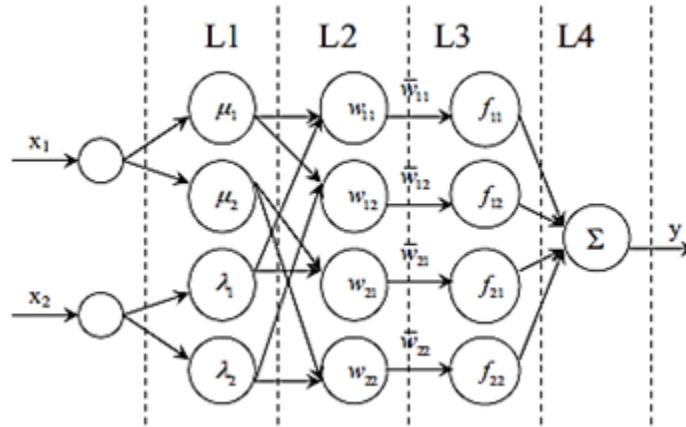


Figure 3.5: An ANFIS model with four layers and two inputs

3.4 Ordered Regression Analysis:

Ordinal analysis is in many ways similar to OLS (Ordinary Least squares) regression method. The difference between OLS and Ordinal regression is the nature of dependent variable. The forms of ordinal regression and OLS regression are given below.

$$y = a + bx \tag{9}$$

$$y = f(a + bx) \tag{10}$$

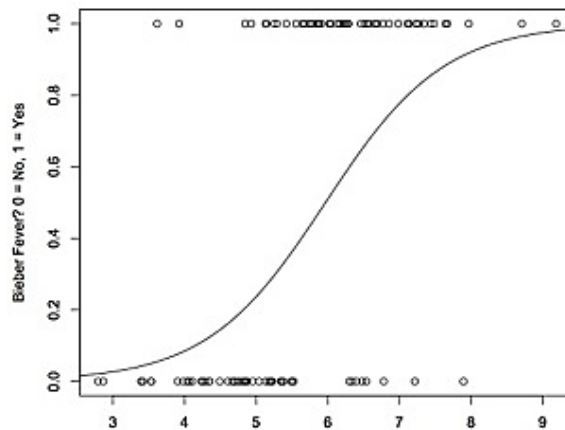


Figure 3.6: Link function

4.1 Study Area

Ahmedabad is divided into eastern and western parts by Sabarmati River. The eastern part of Ahmedabad houses the old city and main regional railway station of Ahmedabad. The eastern part houses the development of British age with narrow streets and old constructions. The western part of Ahmedabad houses relatively urbanized locality and facilities. High employment, education opportunities are destined in this part of the city. Hence one can presume with relative ease that the operations and facilities in only western part of Ahmedabad can be effectively termed as urbanized area. Development of Ahmedabad has been taking place in the radial directions resulting

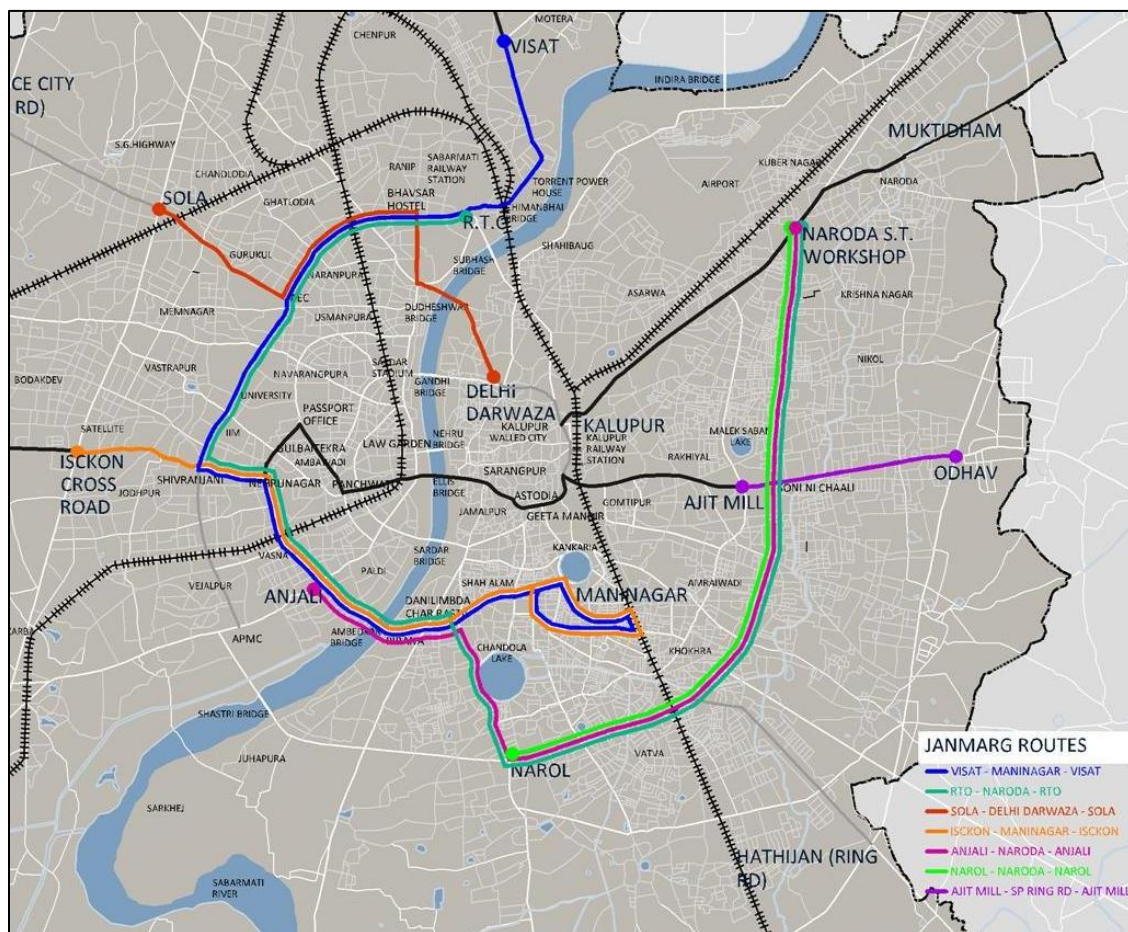


Figure 4.1: Janmarg Ahmedabad BRTS routes

From development of linear nature along the connecting routes between satellite cities and mainland Ahmedabad.

4.1.1 Janmarg-Ahmedabad BRTS:

Public transport of Ahmedabad mainly consist of Bus Rapid Transit Service (Janmarg) and its feeder bus service AMTS (Ahmedabad Municipal Transportation Service). Janmarg, a bus rapid transit system (BRTS) of the city, is operated by Ahmedabad Janmarg Limited, a subsidiary of Ahmedabad Municipal Corporation and others. Janmarg is devised on the basis of moving the people and not the vehicles. Janmarg was conceptualized on the ideology of “Connect busy places and Avoid busy routes.” The network expanded to 89 kilometers (55 mi) by December 2015 with daily ridership of 1, 32,000 passengers. From January 2016, special ladies’ buses are started for convenience of female riders.

4.1.2 Surat City: A Demographical Introduction

Surat is having the Highest population density of 1376 persons per sq. km in Gujarat state. The development of city is highly centralized with high density population. Most of the employments zones are situated on the radials to the cities and therefore, it is comparatively easy to provide service on these radials focused on moving people along these radials and also to adhere to the schedule of BRT.

Owing to heavy traffic congestion on major highways passing through Surat city, the Sitalink BRTS (Bus Rapid Transit System) is provided for public mobility as well as for decongesting roads; constructional aspects of BRT are near completion in Surat. Apart from Sitalink Surat-BRTS, the city has been equipped with Surat City Bus services which are characterized by the typical bus service issues. Overcrowding, irregular service, ill-devised routes and limited accessibility along with slow rate of mobility has rendered it unsuitable to be sustainable. The basic fault is that City Bus services have connected busy places through excessively busy routes in order to increase the access zone. But that resulted in high travel times through those route and longer waiting times for passages at the bus stops. The City bus services have not been able to attract any ridership due to these implications and have triggered a model shift. The customers avoiding the city bus services have been shifting to the shared auto rickshaws since then. Hence, one can presumably imply that the major mode of public transport in Surat is shared autos. Without

any restrictions on the movements of autos on the streets along with high number of 2-wheeler and car traffic, pose a serious threat to the mobility of people and goods.

4.1.3 Sitilink-Surat BRTS:

It has been operational since 26 Jan, 2014. The first operations were carried out on Udhna Darwaja to Sachin GIDC route and as of now it has 4 operational lines with approximately 15,000 passengers per day. The existing network is planned to be expanded to the length of 114 kms and 15 routes.

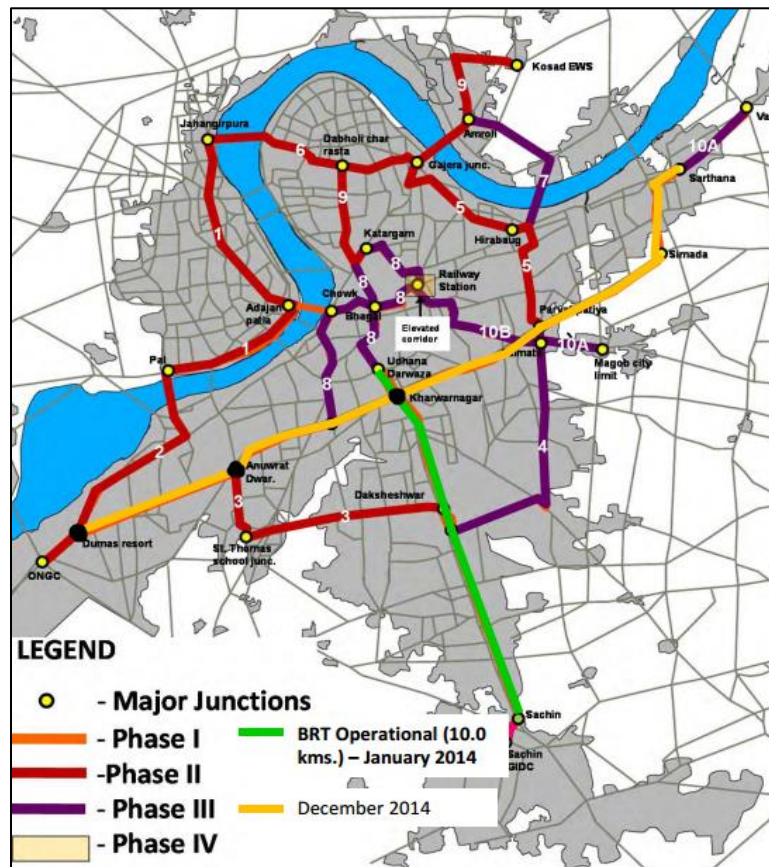


Figure 4.2: Sitilink Surat BRTS network (Routes and Interchanges)

On Sitilink networks, buses are operated on exclusive bus lanes which cordoned by means of steel railings. However, at the intersections, the BRTS merges with the mixed traffic and no priority till date, is given to BRTS operations and hence contributing towards the similar patterns of delay as observed in the conventional bus services.

4.1.4 Selection of the Study Area:

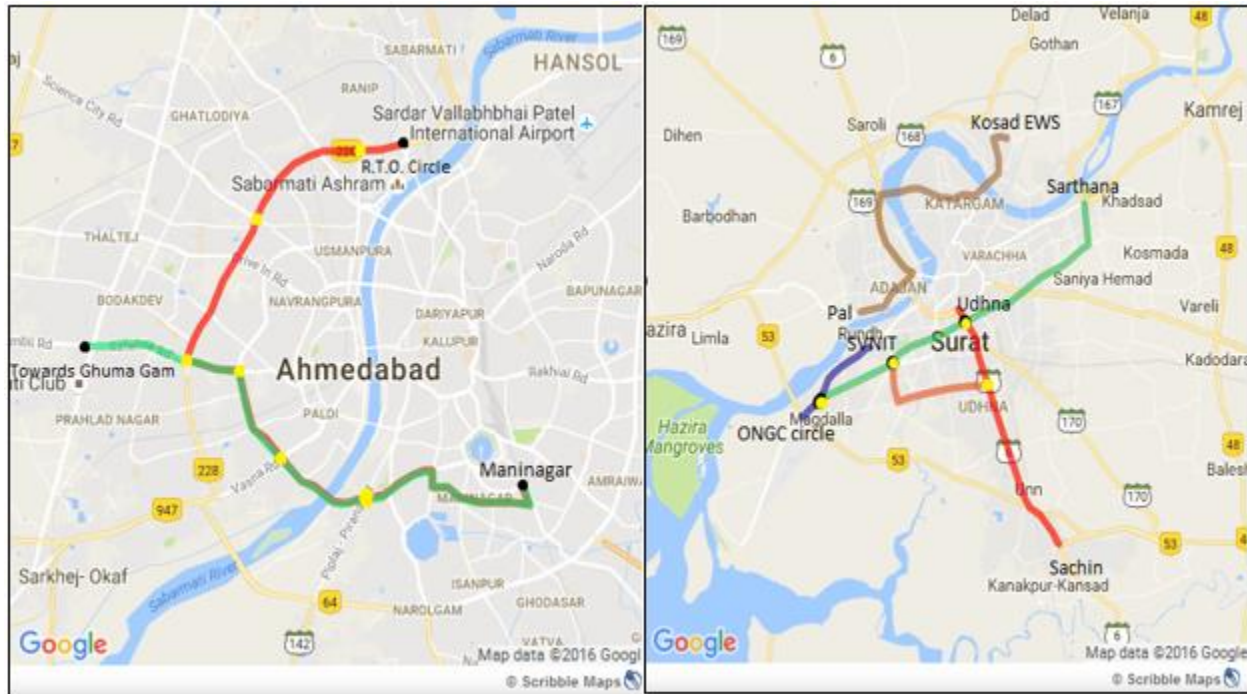


Figure 4.3: Study area in Janmarg BRTS and Sitalink BRTS respectively

4.2 Data Collection:

For travel organizations, increment in the consumer loyalty can make an interpretation of straightforwardly into held clients, expanded use of framework, pulling in new clients and accordingly, more positive open picture. To accomplish these goals, the specialist organization needs effective and solid techniques to gauge consumer loyalty in regards to administration quality. The apparatus to be utilized as a part of the review ought to be characterized and outlined evenhandedly to recreate the consumer loyalty. The device ought to be embraced to such an extent that the discoveries can correspond with office based execution measures. Before, analysts have embraced distinctive apparatuses to guide consumer loyalty in light of various situations considered in their review.

Chapter 5

Analysis & Results

5.1 Factor Analysis:

5.1.1 Communalities:

Communalities indicate the amount of variance in each variable that is accounted for. Initial communalities are estimates of the variance in each variable accounted for by all components or factors. For principal components extraction, this is always equal to 1.0 for correlation analyses. Extraction communalities are estimates of the variance in each variable accounted for by the components. The communalities shown in the Table 5.3 are all relatively high, which indicates that the extracted components represent the variables well. If any communalities are very low in a principal components extraction, you may need to extract another component.

Table 5.1: Communalities

	Initial	Extraction
Gender	1.000	.597
Trip purpose	1.000	.605
Age	1.000	.500
Temporal availability	1.000	.488
Spatial availability	1.000	.595
Ease in access	1.000	.802
Mode of access	1.000	.539
Parking	1.000	.585
Bus stop nearness	1.000	.827
In bus time	1.000	.643
Transfers	1.000	.506
Fare structure	1.000	.543
Fare collection	1.000	.501
Reliability	1.000	.651
Seating/standing	1.000	.485
Boarding/alighting	1.000	.623
Door width	1.000	.502
Cleanliness	1.000	.586
Lighting conditions	1.000	.528
Personnel behavior	1.000	.552
Comfort	1.000	.617
Accidents/breakdowns	1.000	.429
Safety and Security	1.000	.507

5.1.3 Scree Plot:

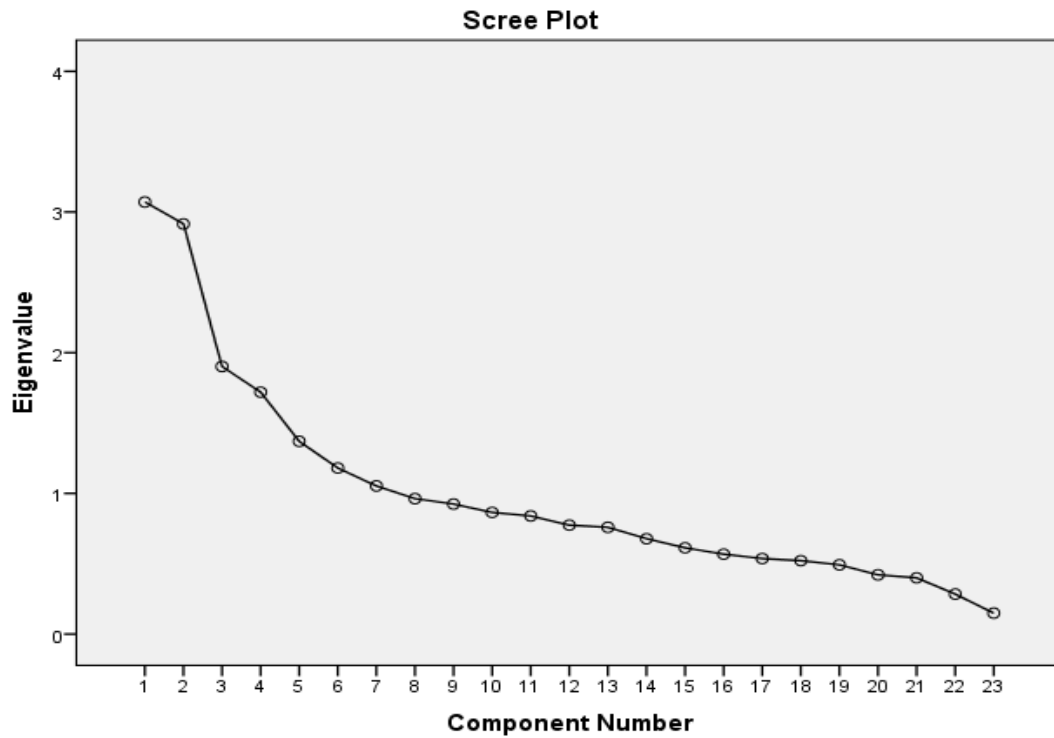


Figure 5.1: Scree Plot

5.2 ANFIS Results using Hybrid Optimization method:

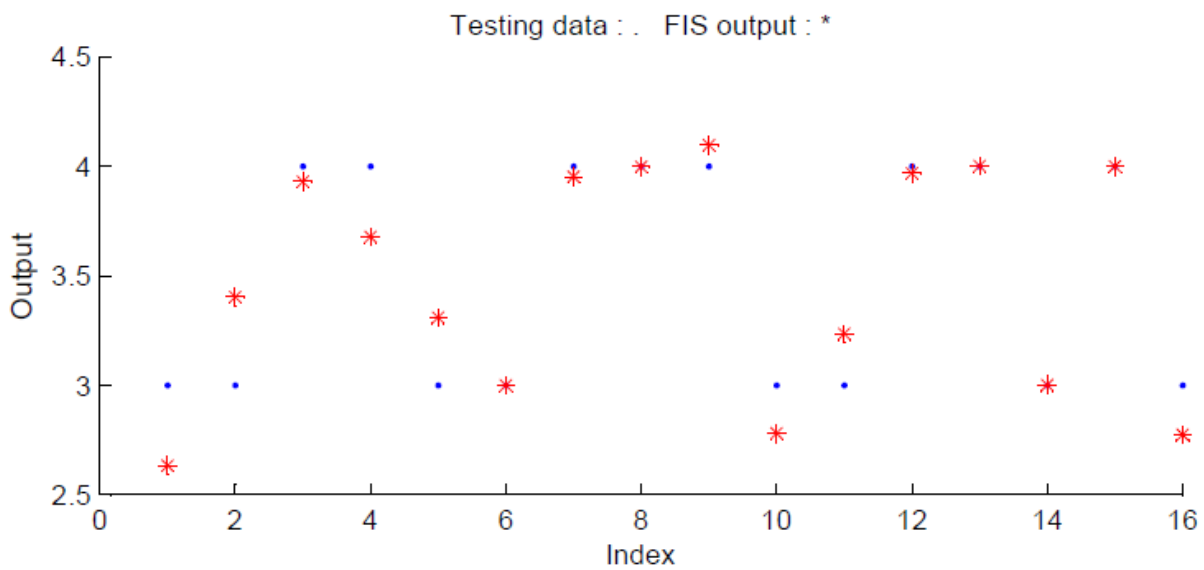


Figure 5.2: Plot between testing data and FIS output (Error 0.1413)

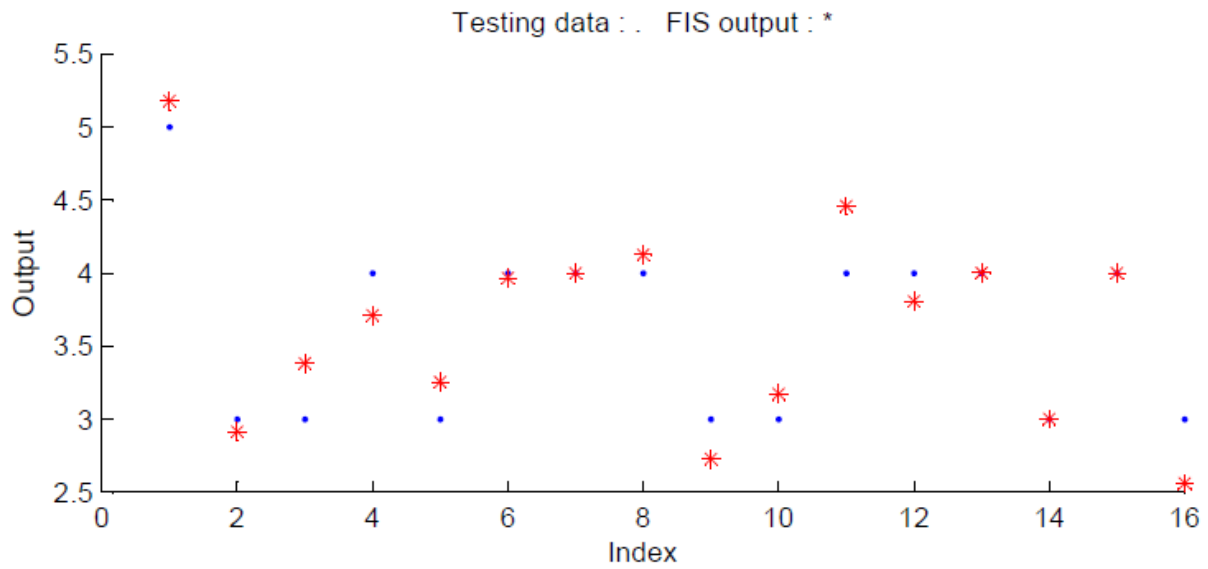


Figure 5.3: Plot between testing data and FIS output (Error 0.2046)

5.3.1 NN Architecture:

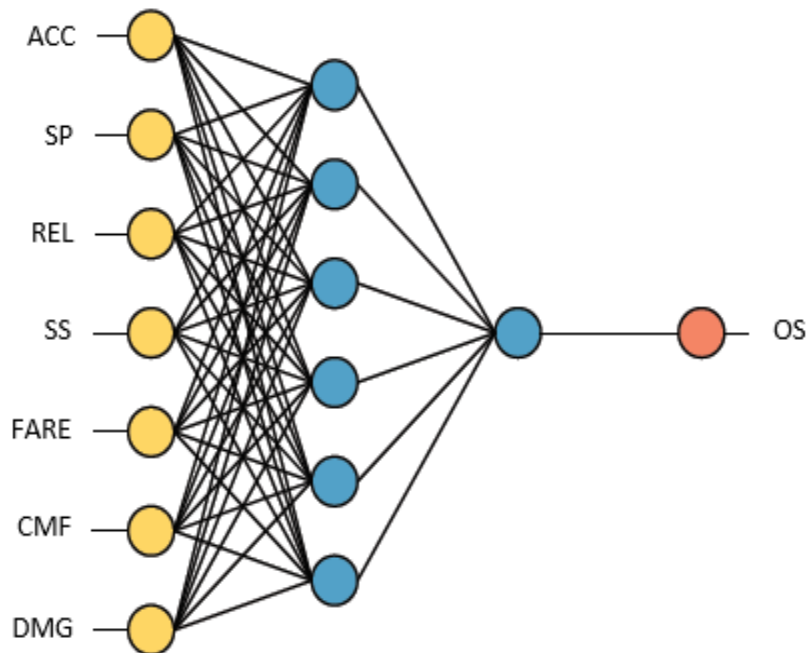


Figure 5.4: Neural Network Architecture

5.3.4 Model performance:

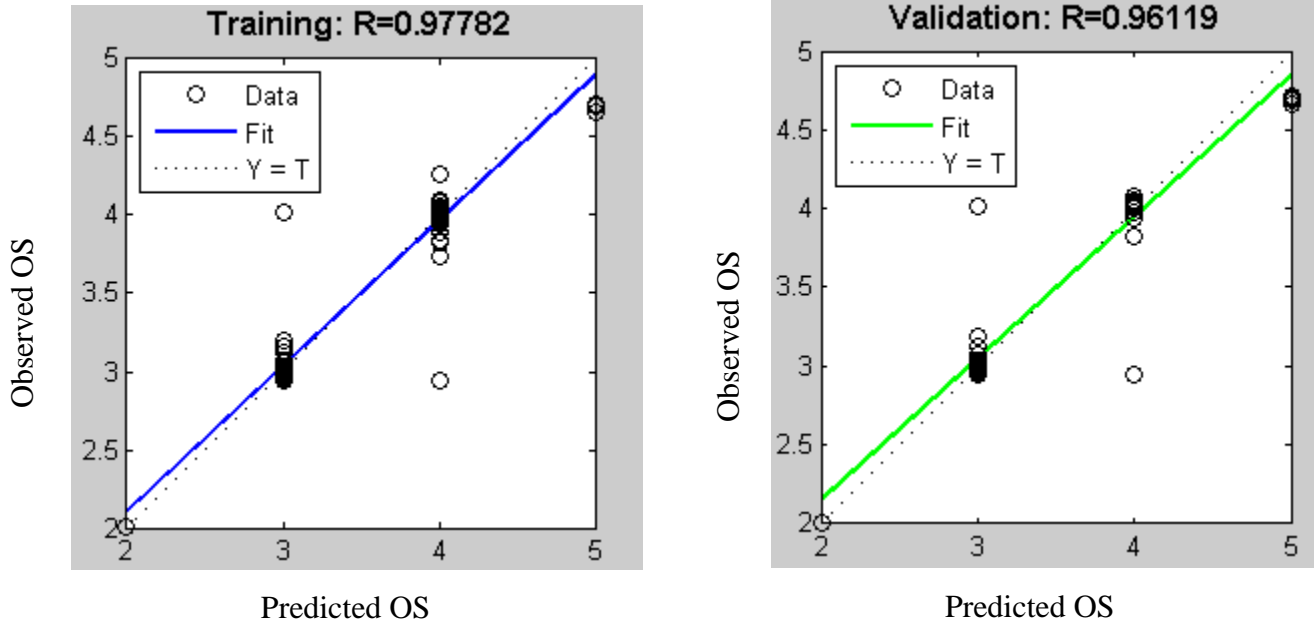


Figure 5.5: NN model training and validation error results

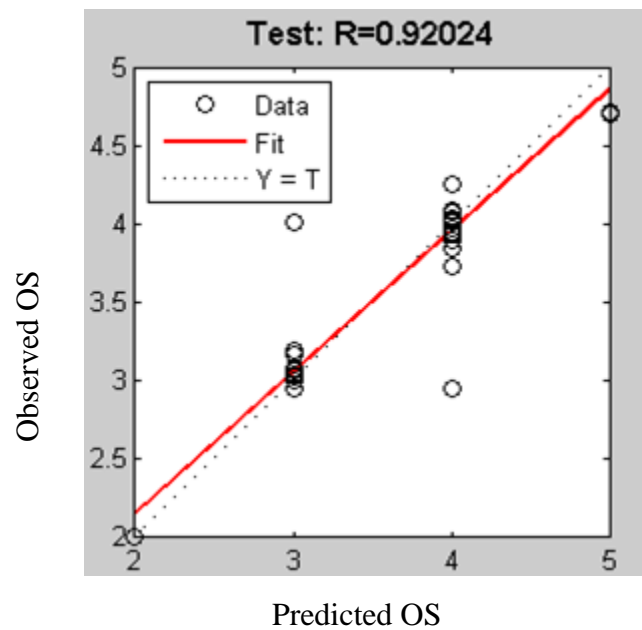


Figure 5.6: NN model testing errors

5.5 Ordered Probit Analysis:

Table 5.2: Case Processing Summary

		N	Marginal Percentage
OS	HDS	2	1.23%
	2	5	3.09%
	3	42	25.93%
	4	30	18.52%
	5	66	40.74%
	HSD	17	10.49%
Valid		162	100.00%
Missing		0	
Total		162	

Model Fitting Information:

Table 5.3: Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	3143.309	432	.000
Deviance	1204.741	432	.000

Link function: Probit.

Table 5.4: Pseudo R-Square

Cox and Snell	0.699
Nagelkerke	0.743
McFadden	0.426

Chapter 6

Conclusions

6.2 Conclusions:

- From the audit of writing concerning estimation of client discernment with respect to open travel benefit, it was reasoned that the poll study in light of ServQual was the best and most oftentimes connected test.
- Literature in regards to the strategies connected to examine consumer loyalty information guided that the figure examination is required request to diminish the various administration properties in couple of collinear traits bringing about idle administration measurements. These administration measurements could be utilized to relate benefit properties with consumer loyalty in a roundabout way.
- Analyzing perceptual information prompted a reasoning that evaluating consumer loyalty exclusively in light of delicate registering won't be sufficiently adequate. Delicate processing strategies created here must be utilized for assessing issues and not for approach suggestions.

Chapter 7

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