A Framework for Quality of Service Assessment for Bus, Auto and E-Rickshaw in Indian Context

Avinash Kumar and Ranja Bandyopadhyaya

***Abstract*—Within-city public transport demand for most old and congested Indian cities is catered by small city ride buses and para transits including autos and e-rickshaws. It is important to assess the quality of service of bus and para transit modes taking into account the comfort, safety and security of service offered by the modes. The present study aims to develop a quality of service assessment tool to assess the quality of service of public transport modes namely bus, auto and e-rickshaws considering user's comfort, safety and security perception for these modes for mid-sized cities of developing countries. For the study 22 attributes related to commuters' comfort, safety and security is considered. The importance survey of the 22 attributes was conducted using 5 point Likert scale in Patna, Bihar, India, and 439 regular public transport users participated in the survey. Exploratory Factor Analysis (EFA) was conducted to find important determinants of quality of service for the three modes.**

***Keywords*— Exploratory Factor Analysis, Quality of Service Assessment Tool; Within-city Public Transport.**

I. INTRODUCTION

Public transport forms the infrastructure backbone of any city. The development of a city is measured by the connectivity it provides to its citizens. Measurement of quality of service offered by public transport has been of great interest to researchers and policy makers. Khurshid, et al. [1] analyzed the relationship between service quality and customer satisfaction across the public transport system of Pakistan and concluded that commuter satisfaction is highly dependent on service quality provided by the public transport mode.The quality of service offered by a mode influences the commuters satisfaction level and in turn influences their mode choice behaviour. Some researches focused on assessing influence of service quality attributes on mode choice behavior of commuters using Stated Preference experiment [2, 3, 4]. Delbosc et al. [5] concluded that personal safety and security offered by a public transport mode is an important attribute for quality of service assessment. Redman et al. [6] tried to understand the contribution of quality of service offered by public transport modes in terms of accessibility, reliability and mobility in mode choice behavior of commuters.

Some researchers tried to identify the determinant factors that decide the quality of service offered by specific public transport modes [7, 8, 9, 10]. Dell 'Olio et al. [8] studied commuters expectations and perceptions from efficient public transport modes considering SWOT (Strength, Weakness, Opportunity, Treats) analysis of the public transit modes. Filipovic et al. [11] summarized the research and trends towards the changes in the expected and perceived quality of service within the mass passenger public transport modes using QUATTRO (Quality Approach) technique. Dragana et al. [12] identified 24 quality of service parameters for assessment of service quality of public transport modes. St-Louis et. al. [7] considered identified personal, social, attitudinal and trip variables for identifying public transport quality assessment parameters. Petnji et al. [13] proposed scales to evaluate customers' perceived service quality of public transport and then identified the demographic characteristics that influenced customer perceived quality. Imre et al. [14] attempted to provide a a framework for measuring perception of comfort which is one of the most important determinants of the public transport convenience.

Some studies focussed on assessment of determinant factors for quality of service assessment for bus or mass transits. Noor, et al. [9] identified 24 determinant factors for comfort, accessibility and safety parameters that influenced the satisfaction of public bus service in Kota Kinabalu, Malaysia. They observed that factors that commuters perceive to be important for quality of service assessment are different for minibus and bus transit. Very few researches focus on assessing quality of service of para-transits. Tangphaisankun et al. [15] studied the potential of low capital-intensive paratransit services and determination of influences of commuter perceptions in metropolitans in developing countries which connected the people to the stations in Bangkok. They recommended various improvements in terms of safety and security, accessibility and comfort to the passengers for the paratransit.

The within-city public transport demand for most old and congested Indian cities is catered by small city ride buses and para transits including autos and e-rickshaws. The quality of service offered by these modes in terms of comfort, safety and security apparently seems inadequate as commuters prefer using privately owned vehicles instead. The level of service assessment of public transport modes is usually based on travel time and waiting time while important aspects like safety, security and comfort offered by the modes are usually ignored. Thus, it is important to assess the quality of service of bus and para transit modes taking into account the comfort, safety and security of service offered by the modes.

The present study aims to develop a quality of service

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assessment tool to assess the quality of service of public transport modes namely bus, auto and e-rickshaws considering user's comfort, safety and security perception for these modes for mid-sized cities of developing countries. For the study 22 attributes related to commuters' comfort, safety and security is considered. The importance survey of the 22 attributes was conducted using 5 point Likert scale in Patna, Bihar, India, and 439 regular public transport users participated in the survey.

The next section details the methodology of the study. Section III describes the data and exploratory factor analysis to identify the service quality determinants for the three modes of public transport. Section IV summarizes the work and provides major conclusions from the work.

II. Methodology

Initially, a questionnaire for measuring service quality was developed consisting of two parts. The first part contained demographic variables like age, gender, education, occupation and family income and also trip characteristics like mode used, trip length, frequency and trip purpose. The second part included 22 service quality parameters, identified from literature, whose importance was to be measured in 5-point Likert Scale separately for three common transit modes namely bus, auto and e-rickshaw. The 22 attributes/ variables identified for this study and their codes are mentioned in Table 1.

Roadside personal interview was conducted of 439 commuters the major stretches of Patna using available public transit and paratransit systems using the questionnaire developed.Submit your manuscript electronically for review.

III. Data And Analysis

Table 2 gives the demographic and trip characteristics of 439 survey respondents.

TABLE II: DEMOGRAPHICS AND TRIP CHARACTERISTICS

Demographic Characteristics	
Gender	67% males; 33% females
Age	<10 years: 2%; 10-25 years: 25%; 25-40 years: 49%; 40-55 years: 17%; >55 years: 7%
Educational Qualification	Matriculation: 12%; intermediate: 16%; graduate: 55%; above graduation: 14%; others: 3%
Family Income	<10,000: 20%; 10,000-20,000: 32%; 20,000-35,000: 23%; 35,000-50,000: 12%; >50,000: 13%
Trip Characteristics	
Frequency of Travel	1 To 2 Days/ Week: 17%; 3 To 4 Days/ Week: 30%; 5 To 6 Days/ Week: 18%; 7 Days/ Week: 35%
Purpose of Travel	Work: 44%; Educational: 19%; Recreational: 10%; Others: 27%
Vehicle Ownership	No: 49%; Two-Wheeler Only: 39%; Four-Wheeler Only: 9%; Both Two- Wheeler & Four-Wheeler: 3%

TABLE I: ATTRIBUTES FOR SERVICE QUALITY

Attributes/ Variables	Code
Access distance of mode from origin/ destination	ADM
Ease of reaching stoppage for this mode from origin/ destination	ESR
Safety in the route to access the public transport mode	IRS
Lighting condition of access road	LCR
Seating and shade facility at stop	SFS
Personal safety at the stop	PSS
Cleanliness of the stop	COS
Safety at the stoppage at night	SST
Availability of mode	AOM
Schedule information of the mode	SIM
Ease of getting on/off the vehicle	EOV
Reliability of service time	RST
Availability of Seats	AOS
Comfort in seating	CIS
Crowding in the vehicle	CIV
Leg space in vehicle	LSV
Smoothness in Ride	SIR
Helpfulness of driver/staff	HOD
Attitude of co-passengers	ACP
Night time safety	NTT
Condition of vehicle	COV
Cleanliness inside vehicle	CLV

Factor analysis was performed on 22 variables using IBM SPSS 22.0 for all the three transit systems. For bus transit, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy value was 0.693 and significance of .000 in Bartlett's Test of Sphericity both suggest that the data is suitable for conducting factor analysis. Factor analysis was performed on 22 variables using IBM SPSS 22.0 and total of five factors were extracted based on Eigen value (greater than 1) and factor loading greater than 0.45. Cronbach's alpha value (0.793) suggests that the samples are internally consistent. Table 3 summarizes the factors identified for the bus transit.

TABLE III: FACTORS FOR BUS TRANSIT

Factors	**Attributes/ Variables**
Factor 1 (Accessibility)	ADM; ERS; IRS and EOV
Factor 2 (Vehicle Condition)	CIS; ACP; COV and CLV
Factor 3 (Availability)	AOS; AOM and CIV
Factor 4 (Travel comfort)	LSV; SIM and HOD
Factor 5 (Safety)	LCR and SST

For auto (three-wheelers) transit, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy value was 0.772 and significance of .000 in Bartlett's Test of Sphericity both suggest that the data is suitable for conducting factor analysis. Factor analysis was performed on 22 variables using IBM SPSS 22.0 and total of five factors were extracted based on Eigen value

(greater than 1) and factor loading greater than 0.45. Cronbach's alpha value of 0.873 suggests that the samples are internally consistent. Table 3 summarizes the factors identified for the auto transit.

TABLE IV: FACTORS FOR AUTO TRANSIT

Factors	Attributes/ Variables
Factor 1 (Travel condition)	EOV; CIV; LSV; ACP; NTT; COV and CLV
Factor 2 (Availability)	AOM and CIV
Factor 3 (Stop Condition)	IRS; LCR; SFS; COS and SST
Factor 4 (Access)	ADM; ERS and SIM
Factor 5 (Reliability)	RST and AOS

For e-rickshaw (electric three-wheelers) transit, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy value was 0.601 and significance of .000 in Bartlett's Test of Sphericity both suggest that the data is suitable for conducting factor analysis. Factor analysis was performed on 22 variables using IBM SPSS 22.0 and total of six factors were extracted based on Eigen value (greater than 1) and factor loading greater than 0.45. Cronbach's alpha value (0.696) suggests that the samples are internally consistent. Table 4 summarizes the factors identified for the e-rickshaw transit.

TABLE V: FACTORS FOR E-RICKSHAW

Factors	Parameters
Factor 1 (Vehicle condition)	ACP; COV and CLV
Factor 2 (Access to mode)	ADM; ERS and IRS
Factor 3 (Reliability)	EOV and RST
Factor 4 (Safety)	LCR and SST
Factor 5 (Travel comfort)	LSV and SIM
Factor 6 (Stop condition)	SFS and PSS

IV. Conclusion

Exploratory Factor Analysis (EFA) was conducted to find the principal components from the 22 attributes for bus, auto and e-rickshaw separately. For bus, the data was found to be reliable with Cronbach's alpha value of 0.793. For bus, 22 attributes were reduced to 16 attributes and were grouped in 5 factors. The factors identified were Accessibility, Vehicle Condition, Availability, Travel Condition and Safety. For Auto, the data was found to be reliable with Cronbach's alpha value of 0.873. For Auto, 22 attributes were reduced to 19 attributes and were grouped in 5 factors. The factors identified were Travel Condition, Availability, Stop Condition, Access Condition and Reliability. For E-Rickshaw, the data was found to be reliable with Cronbach's alpha value of 0.696. For E-Rickshaw, 22 attributes were reduced to 14 attributes and were grouped in 6 factors. The factors identified were Vehicle Condition, Access to mode, Reliability, Safety, Travel Comfort and Stop Condition.

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