

## Determining the service quality of the city bus service based on users' perceptions and expectations

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### ABSTRACT

This study aims to find out the service quality of the city bus service based on users' perceptions and expectations of the service. The results of this study show that both perceptions and expectations of the passengers' are important to estimate the service quality. To collect the passengers' perceptions and expectations data, a questionnaire survey has been conducted and the respondents are asked to rate some qualitative attributes of the city bus service as per their perceptions and their minimum expectations from the service. Data has been analyzed by a combination of statistical tools comprising of factor analysis, linear regression analysis, and structural equation modeling to find out the latent factors which affect users' perception and expectation. From these analysis four latent factors namely safety, comfort, accessibility, and timely performance have been extracted along with their perceived and expected values. Using the percentage differences of the perceived and expected values, a level of service (LOS) scale has been established to find out the service level of the city bus service. The range of this LOS scale varies from LOS 1 to LOS 5 depicting best to worst service quality. It is found that, safety, comfort, and timely performance fall under LOS 3 group while accessibility falls under LOS 2 group. Based on the results of the study, some recommendations have been made to improve the service quality of the bus service.

### 1. Introduction

In India, around 32% population is residing in urban areas and this is likely to increase to 40% by 2030 (NIPFP, 2007). This rapid growth in population in the cities has resulted in an increased demand for the transportation infrastructure which has caused to an increased use of the vehicles across the city resulting in congestion. In India, the number of motor vehicles is doubling every four years for the last three decades (MORTH, 2004) to meet the increasing demand for transportation. The vital problem is not the increasing number of the vehicles in the country but the maximum concentrations of the motor vehicles in the cities (Singh, 2005). Around 32% of the total registered vehicles in India are operating in the cities alone (Singh, 2005). This increasing numbers of the motor vehicles in the cities also caused some detrimental effect on the environment. Transport sectors in India emit nearly 261 Tg of CO<sub>2</sub>, of which 94.5% was emitted by the road transport (Sharma et al., 2011). Among the different vehicle classes, the number of two wheelers is highest among the other vehicle classes with a proportion of more than 73% in total vehicle population followed by three wheelers with a proportion of 15% and passenger vehicles with a proportion of 10% (Sharma et al., 2011). The proportion of commercial vehicle is very

low, near about 5% (Sharma et al., 2011). These huge numbers of two wheelers and three wheelers are mostly responsible for the over-saturation of the traffic flow on the city roads resulted in congested city traffic (Sharma et al., 2011). With an increased income and better need for mobility, the number of private vehicles is increasing rapidly in the country. According to recent data, the sales of private vehicles have increased by 9.23% where the sales of commercial vehicles have increased only 4.16% in April-March 2017 over the same period last year (SIAM, 2017). As per the MoUD (2008), the mode share of the public transport will decrease from 5% in 2007 to 2% in 2031. They also predicted that the mode share of the non-motorized vehicles will go down from 38% in 2007 to 26% in 2031. Smaller and medium sized Indian cities are rapidly growing, and mode share of the private transport are also predicted to be increased from 57% in 2007 to 72% in 2031 (MoUD, 2008). From these data, it can be said that, though the non-motorized transport occupies a significant mode share in present situation but it tends to decrease in near future and maximum of the current users of the non-motorized transport will shift to private vehicles for their commuting needs. This will increase the number of private vehicles in the cities and will eventually deteriorate the already prevailing traffic congestion. This increasing growth of the private

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vehicles has also accelerated by the poor service quality of the public transport available in the cities (Badami and Haider, 2007). Therefore, it is very much important to improve the service quality of the public transport system. Public transport have the potential to reduce the number of private vehicles in the cities and it is able to extend the transport service to the proportion of people who do not have any private vehicles and who cannot afford the frequently changing paratransit or taxi fares (Nwachukwu, 2014). Therefore, an improvement of the public transport is necessary to reduce the dependency on the private cars and other modes of transport and helps to reduce the problems like traffic congestion, air and noise pollution, parking problems and energy consumptions (Nocera, 2011).

The major mode of public transport in most of the Indian cities is buses. The number of private vehicles and paratransit modes is increasing day by day in the cities because of the poor service quality of the city buses. Therefore, it is very much important to improve the service quality of city buses to minimize the use of private vehicles. To improve the service quality, Ministry of Urban Development (MoUD, 2009), GOI has taken some initiatives to measure the service quality of the city buses. The performance measurement of the service quality is based on the benchmarking technique which measures the level of service (LOS) of different performance indicators representing the city bus service. MoUD (2009) prescribed six performance indicators and they are presence of organized public transport, availability of public transport, service coverage, average waiting time, load factor, and percentage fleet. In this report, the service quality of these performance indicators is measured through an LOS scale, ranging from LOS value 1 to 4 representing the best to worst service quality. All these six performance indicators are quantitative in nature and expressed as numerical values which are compared with some standard values to represent their service levels. These standard values are developed on the basis of some expert judgments without considering the users' perception from the service. Therefore, they are the service quality from the operators' perspective (Joewono et al., 2016) and are very much inadequate in representing the passengers' perceptions of the service.

The overall method for developing the service quality of the service depends on the priorities of the passengers (Hensher et al., 2003; Joewono et al., 2016). The perception based measure of the service quality is a vital tool for assessing transit service quality (TRB, 2003). The perceptions of the users of the transit facilities can be evaluated by using importance and satisfaction measures of the transit system (Diana, 2012; Iseki and Smart, 2012; de Oña and de Oña, 2014). The performance measurement of the transit service based on the perceptions and satisfaction data are qualitative in nature and they truly depict the users view on the available transit system. Researchers have used different multivariate data analysis techniques to analyze the satisfaction data to understand the key identifying factors which affect the users' perceptions of the transit service. Among the different statistical techniques, exploratory factor analysis (Hu et al., 2015; Jomnonkwo and Ratanavaraha, 2016; Nwachukwu, 2014; Popuri et al., 2011; Tyrinopoulos and Antoniou, 2008), confirmatory factor analysis (Hu et al., 2015; Jomnonkwo and Ratanavaraha, 2016; Ratanavaraha et al., 2016; Wen et al., 2005), structural equation modeling (de Oña et al., 2013; Eboli and Mazzulla, 2007; Eboli and Mazzulla, 2012; Jen and Hu, 2003; Lai and Chen, 2011; Machado-León et al., 2016) are widely used by different researchers to identify the major factors which affects the different attributes of the transit service. Comfort (dell'Olio et al., 2011; Eboli and Mazzulla, 2011; Filipović et al., 2009; Popuri et al., 2011), driver behavior (Cafiso et al., 2013; Chang and Yeh, 2005; Jomnonkwo and Ratanavaraha, 2016; Ratanavaraha et al., 2016; Sezhian et al., 2014), fare (Joewono et al., 2016; Popuri et al., 2011), safety (Joewono et al., 2016; Popuri et al., 2011), information about the service (de Oña et al., 2013; Eboli and Mazzulla, 2007; Filipović et al., 2009; Hu et al., 2015), customer service (Eboli and Mazzulla, 2011; Lai and Chen, 2011; Machado-León et al., 2016), frequency (de Oña et al., 2013; Tyrinopoulos and Antoniou,

2008), waiting time (Bordagaray et al., 2014; Tyrinopoulos and Antoniou, 2008), reliability (Bordagaray et al., 2014; Eboli and Mazzulla, 2007; Tyrinopoulos and Antoniou, 2008), cleanliness (de Oña et al., 2013; Popuri et al., 2011), accessibility (de Oña et al., 2013; Filipović et al., 2009; Tyrinopoulos and Antoniou, 2008), punctuality (de Oña et al., 2013; Sezhian et al., 2014), availability (Hu et al., 2015; Tyrinopoulos and Antoniou, 2008), service quality (Jen and Hu, 2003; Kaplan et al., 2014; Popuri et al., 2011), on-board amenity (Sezhian et al., 2014; Wen et al., 2005) etc. are some of the performance indicators which are reported by various researchers. Besides identifying the latent factors researchers also evaluated the relative weight of all the factors by using multinomial logit model (dell'Olio et al., 2011; Eboli and Mazzulla, 2008), ordered probit model (Bordagaray et al., 2014; Rojo et al., 2013), ordered logit model (Rojo et al., 2013) and regression analysis (Chang and Yeh, 2005; Nwachukwu, 2014).

All the previous studies identify users' perceptions as an important tool to measure the service quality. They also provide an insight about the unobservable or observable factors which effect users' perceptions. Most of the previous studies provide a good measure of the existing service quality but very few studies (Verma et al., 2014; Sam et al., 2017) provided a measure of the expected or desired service quality. The quality requirement of service varies with the expectation of the users. Therefore, it is very much important to know the passengers' expectations from the service in addition to their perceptions about the service. Moreover, most of the previous research works failed to acknowledge the procedure for finding the service level of all the factors which affect the overall service quality of the transit service. Therefore, the aims of this study are: (1) to identify the important factors which affect users' perception and expectation of the city bus service, (2) to estimate the service levels of all the factors based on users' perception and expectation of the service, (3) to find out the importance of users' expectation in determining the overall satisfaction of the service.

## 2. Study area and selected transit system

The city bus service of the Agartala city has been considered for the quality assessment in this study. Agartala is small sized Indian city and the capital of the Indian state Tripura. The population of the city is 400,004 as per the 2011 census data. As per the ministry of road transport and highways, during the years 2005–2015 the average annual growth rate of the registered vehicles of Tripura is 14.5% which is highest among the different states of India (MORTH, 2004). Agartala is the capital of Tripura and it is quite natural that the growth rate of the vehicles in Agartala is more than the state average. In Agartala, among the total registered vehicles, the number of two wheelers is found to be highest with 69%, followed by light motor vehicles (jeep/taxi/van/car) with 16.1%, three wheelers with 8.8% and buses with only 0.98% (Transport Department, 2017). In terms of mode share, 37.2% trips generated in the city are non-motorized (Sarkar and Mallikarjuna, 2017). The remaining trips (62.8%) are either made by city buses, auto-rickshaw or private vehicles. But most of the trips among the motorized trips are made by either auto-rickshaws or two wheelers (Sarkar and Mallikarjuna, 2017) which made the city traffic congested during peak hours. Nevertheless, in India, the mode share of the non-motorized modes and public transportation is decreasing rapidly for cities like Agartala with population less than five hundred thousand (MoUD, 2008). These decreasing trends in the non-motorized modes and public transportation will lead to increase the number of private vehicles and auto-rickshaws in the city. Paratransit modes are considered important for such type of small Indian cities to meet with the travel demand. But these types of vehicles are operated by the private operators and they cause serious emission and safety violations (Poiani and Stead, 2015). Small sized Indian cities are growing rapidly which causes to an enormous increase of the travel demand in such type of cities (MoUD, 2008). To meet with this demand, maximum of the funds are allocated to widen the road which primarily benefit the private vehicle users

(Pojani and Stead, 2015). A focus on smaller Indian cities is necessary because nearly half of the urban dwellers reside in such types of small cities (Cohen, 2006). Emerging mega cities have become the center of attention for all the policy makers, while the small sized cities are underserved and lack the basic services. The small sized cities have the potential for more sustainable alteration than the mega cities (Cohen, 2006). Moreover, the small and medium sized cities have very little resource to implement on the transport sector which made them more exposed to fluctuations to world economy and climate (Pojani and Stead, 2015). The small sized cities have less efficient public transport which led to an increase of paratransit and private vehicle and therefore, per capita energy consumption in transport sector is more than the mega cities (Newman and Kenworthy, 1999). In this study, it has been tried to improve the existing city bus service to attract the trip maker and to minimize the extensive use of paratransit and private vehicles. As a consequence the congestion and the pollution caused by the paratransit and private vehicles are likely to reduce.

City bus is the only transit in Agartala. But because of the poor service quality of the city buses, the maximum portion of the population is dependent on private vehicles or paratransit for their daily commuting. Therefore, it is very important to improve the service quality of city buses to minimize the extensive use of other modes. The entire study is based on users' perception and expectations, which will be useful in determining the key factors needed to improve the service quality of the buses. Moreover, very limited studies have been conducted on such type of cities. The study will be helpful in improving the city bus service in Agartala.

### 3. Methodology

#### 3.1. Data collection and questionnaire design

To fulfill the objectives of the study, data were collected through questionnaire survey to know the users' perceptions and expectations of the city bus service. For this questionnaire survey the minimum sample size is determined on the basis of following equation (Johnson and Wichern, 2002):

$$n \geq N \left[ 1 + \frac{N-1}{P(1-P)} \left( \frac{d}{z_{\alpha/2}} \right)^2 \right]^{-1} \tag{1}$$

where,

- n is the minimum sample size to be considered
- N is the population of the city
- P is the quality characteristics which are to be measured. As per Johnson and Wichern (2002), for neutral cases or where no previous experience exists then the value of P is taken as 0.5
- d is the margin of error which is taken as 5%
- $z_{\alpha/2} = 1.96$  for 95% confidence interval

The questionnaire consists of three parts. The first part of the questionnaire consists of questions related to passengers' socio-economic characteristics like age, sex, vehicle ownership, income etc. In the second part, respondents are asked to rate twenty three city bus service related qualitative attributes according to their perceptions on a scale of 1–9, where 1 means they are absolutely satisfied with the attribute and 9 means they are utterly dissatisfied with the attribute. In a separate column, respondents were also asked to rate the attributes according to their expectations from the service. In the third part, passengers were asked to rate the overall performance of the current city bus service on a similar scale.

#### 3.2. Tools and techniques used

After data collection, preliminary statistical tests have been

**Table 1**  
Sample characteristics.

Socioeconomic characteristics of the respondents		Percentage of the total surveyed data (%)
Gender	Male	47.8
	Female	52.2
Monthly income in Rupees	Less than 5000	37.2
	5000–10,000	34.2
	10,000–15,000	12.8
	15,000–20,000	6.1
Vehicle ownership	More than 20,000	9.4
	Two wheelers (bike, scooters)	12.8
	Private car	2.8
	None	84.4
Choice of mode	Auto rickshaw	41.1
	Two wheelers	12.8
	Private car	2.8
	City bus	43.3
Employment status	Unemployed	34.4
	Employed	65.6
Age (years)	15–20	20.6
	20–30	55.5
	30–50	22.2
	Over 50	1.7

conducted to know the different properties like mean, inter-correlations among the variables etc. Data are analyzed with exploratory factor analysis, confirmatory factor analysis, regression analysis and structural equation modeling to know the different factors affecting the users' perceptions and expectations. The detailed discussion of these statistical analyses is described in section 4.

### 4. Results and discussions

#### 4.1. Descriptive statistics of the data

As per the 2011 census data, the population of Agartala is 400,004. Minimum sample size is determined on the basis of Eq. (1) and found to be 384. Considering the minimum sample size, a total number of 400 data were collected through questionnaire survey which includes 191 (47.8%) male respondents and 209 (52.2%) female respondents. The descriptive statistics of the questionnaire based on the socioeconomic characteristics are shown in Table 1. Among the 400 respondents, it has been observed that 173 (43.3%) respondents are city bus dependent. The remaining 227 (56.7%) respondents prefer other available modes. Though they have experience in travelling by the bus, they prefer other modes over the bus service due to the inadequacy of the service. The survey also reveals that the respondents mostly prefer auto rickshaws (41.1%) for their daily commuting among the other modes.

Along with the socioeconomic characteristics of the respondents, the questionnaire also contains twenty three city bus service related qualitative attributes and a separate question related to overall satisfaction of the service. The respondents need to provide ratings on this qualitative attributes as per their level of perception and expectations on a scale of 1–9, where 1 means they are absolutely satisfied with the attribute and 9 means they are utterly dissatisfied with the attribute. The qualitative attributes of the city bus service along with their average ratings on the basis of perceptions and expectations of the respondents are reported in Table 2.

In Table 2, column 3 represents the average value of the qualitative attributes as per their perceptions about the service. It has been observed that the minimum mean value is found for the q10 which represents the availability of the seats in the city buses. Besides q23, all the remaining attributes are rated with an average value less than 5 which means that the service provided by the city bus in Agartala is

**Table 2**  
Service quality attributes.

Qualitative attributes	Code assigned for analyzing the perception data set	Code assigned for analyzing the expectation data set	Mean Values as per the perceptions	Mean Values as per the expectations
Boarding and alighting time	q1	q1i	4.44	6.79
On board safety against crime	q2	q2i	3.55	7.29
Safety in terms of accidents	q3	q3i	3.55	7.37
Safety in the bus stops	q4	q4i	3.77	7.32
Condition of the vehicle	q5	q5i	3.98	6.97
Cleanliness of the vehicle	q6	q6i	3.78	6.86
Cleanliness of the seats	q7	q7i	3.83	6.98
Condition of the doors and windows	q8	q8i	4.17	7.01
Comfortability of the seats	q9	q9i	3.75	7.19
Availability of the seats	q10	q10i	2.57	6.89
Overcrowding nature	q11	q11i	2.77	6.84
Behavior of staffs	q12	q12i	3.60	7.24
Overall journey experience	q13	q13i	4.38	6.98
Facilities provided for the disabled	q14	q14i	2.93	7.37
Frequency of the breakdowns	q15	q15i	3.56	7.09
Availability of the service	q16	q16i	4.67	6.89
Prior information about the bus fare	q17	q17i	4.83	7.41
Travel cost	q18	q18i	4.59	7.33
Travel speed	q19	q19i	4.54	7.29
Arrival and departure time	q20	q20i	3.58	7.02
Prior information about the journey time	q21	q21i	3.61	7.06
Prior information about the waiting time	q22	q22i	4.35	7.28
Regularity of the service	q23	q23i	5.63	7.34
Overall satisfaction of the bus service	Satisfaction		4.92	

very poor as per the respondents' perceptions. Column 4 represents the average values of the attributes as per the minimum expectations of the respondents.

The data were collected through a questionnaire survey; therefore, it is necessary to check the reliability of the data. The reliability of the data set is checked by Cronbach's alpha value (Hair et al., 2010). The alpha values for the perception and expectation data set are found to be 0.941 and 0.929 respectively. It indicates the data set is highly reliable (Hair et al., 2010).

After the reliability check, the inter-correlation between different variables of the data set needs to be checked to decide the appropriate statistical measures for further analysis. The correlations between the variables are checked by Variance Inflation Factor (VIF). VIF represents the amount of variance of a regressor explained by the remaining regressors present in the regression model due to correlation among them (Crane and Surles, 2002). Different cut-off values for the VIF has been suggested by different researcher depending on the nature of the study. In this context, the cut-off value of the VIF is considered as 2 (Banerjee et al., 2016) i.e. the variable with a VIF value greater than 2 is highly correlated with the remaining variables. It has been found that the VIF values for all the variables are more than 2. It indicates that the all the variables are highly correlated and unsuitable for regression analysis. Factor analysis has been conducted to analyze these highly correlated variables. Factor analysis is a multivariate data analysis technique to determine the underlying factors affecting a set of correlated observed variables (Hair et al., 2010). The factor analysis techniques can be broadly classified into two groups: Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA).

#### 4.2. Identifying the latent factors affecting the qualitative attributes by EFA

EFA is used when the researcher does not have any clear idea about the number of unobservable summary variables or factors which are needed to explain the correlations between variables (Jomnonkwo and Ratanavaraha, 2016). The goal of the EFA is to reduce the number of

variables (data reduction) and to identify the relationship between observed variables and the latent factors. Both the perception and expectation data were separately analyzed by EFA. For both the data set, four latent factors with eigenvalues greater than one (Hu et al., 2015) were extracted from the twenty three correlated attributes. Based on the results of EFA, CFA model has been conducted.

#### 4.3. Establishing the structural relationship between latent factors and observed variables by CFA

CFA is used to verify and confirm the structural relationship between the latent variables and the observed variables (Hu et al., 2015; Jomnonkwo and Ratanavaraha, 2016). The researcher must have specific knowledge of the total number of factors and the relationship between observed variables and the latent factor prior to the CFA model (Hu et al., 2015; Jomnonkwo and Ratanavaraha, 2016). Therefore, EFA is to be conducted before CFA.

The latent structure of the CFA model for both the perception and expectation data set is specified based on the results obtained from the EFA. The goodness of fit of the CFA model is determined based on the five fit statistics measures, namely the chi-square to degrees of freedom ratio ( $\chi^2/d.f.$ ), comparative fit index (CFI), root mean squared error of approximation (RMSEA), standardized root mean squared residual (SRMR), and coefficient of determination (CD). Chi-square to degrees of freedom ratio of less than 5 (Lai and Chen 2011), CFI value greater than 0.9 (Hu et al., 2015; Lai and Chen, 2011), RMSEA value of less than 0.08 (Hu et al., 2015; Lai and Chen, 2011), SRMR value less than 0.08 (Schreiber et al., 2006) and CD value close to 1 (Stata Corp, 2013) indicate a good fit. Based on this fit statistics some modifications have been done to the model structures and the best fit models for both the data set with the standardized coefficients are presented in Figs. 1 and 2.

Fig. 1 represents the CFA model for the perception data. The  $\chi^2/d.f.$ , CFI, RMSEA, SRMR, and CD values for the model are found to be 2.33, 0.901, 0.078, 0.079, and 0.999 respectively which are within their

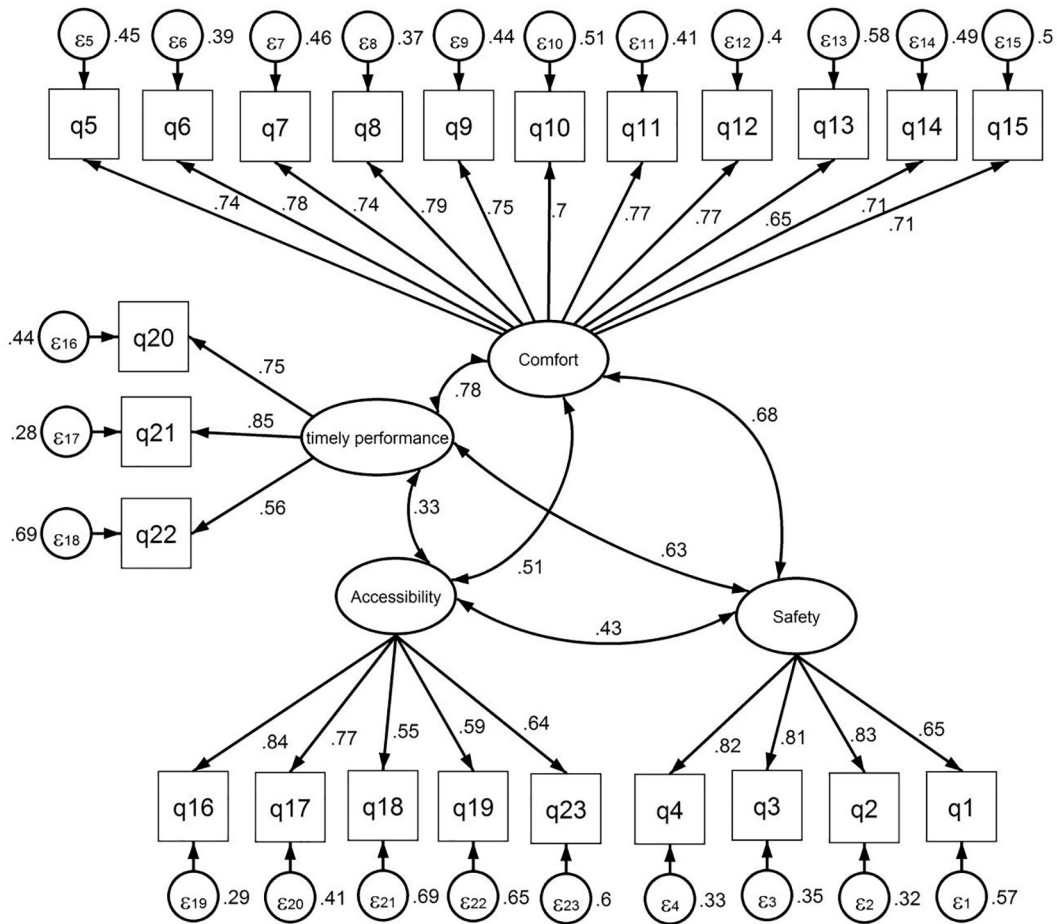


Fig. 1. CFA model for perception data.

acceptable limits. Therefore, the model fits the data very well. The extracted latent factors for this model are comfort, timely performance, accessibility, and safety. It is worth noting that, travel speed (q19) is grouped under the perception factor accessibility. This is because the respondents perceive travel speed as a measure of the accessibility of the service. The travel speed is included in the factor accessibility on the basis of the statistical analysis of the data. The respondents might think that, if the travel speed is adequate than the city bus may reach to its destination in time and users of the service may avail the bus without considering the other services like auto-rickshaws. Therefore, a good travel speed is necessary to make the service more accessible to all the users. The users of the service relate the travel speed as index of accessibility more than the index of timely performance.

Fig. 2 represents the CFA model for the expected data. The  $\chi^2/d.f.$ , CFI, RMSEA, SRMR, and CD values for the model are found to be 1.67, 0.913, 0.074, 0.068, and 0.977 respectively which are within their acceptable limits. Therefore, the model fits the data very well. The extracted latent factors for this model are expected comfort, expected timely performance, expected accessibility, and expected safety.

In Figs. 1 and 2 the oval boxes represent the latent factors. The numerical values written over the single arrowed lines are the standard factor loadings. The squares of these standardized factor loadings represent the portion of the variance of the observed variables which can be explained by the latent factors. The values written beside the small round shapes are the standardized error variances which represent the portion of the variance that is not explained by the latent factors. For example, the standardized factor loading of safety on q2 is 0.83. It means that the portion of the variance explained by this factor is 0.68 ( $0.83^2$ ) or 68% and the unexplained portion of the variance is 0.32 or

32% which is represented by the variance of the error  $\epsilon_2$ . The values written over the double arrowed curves represent the correlation coefficients. It can be observed from the correlation coefficient values that all the latent variables are correlated with each other, as they together depict the overall service quality of the bus service. It can be noted that, the factor loadings for all the variables are found to be statistically significant with 95% confidence interval. The CFA analysis enables the policy makers to discover how different attributes of the bus service are perceived by the users. It will be useful for the policy makers to find out which attributes are needed to improve the particular perception factor.

After the CFA analysis, it is important to check the convergent validity of all the factors. For CFA, convergent validity represents the internal consistency of all the variables within a factor (Campbell and Fiske, 1959). The convergent validity of the factors can be assessed through standardized factor loadings of the observed variables, composite reliability (CR) values of the factors and Average Variance Extracted (AVE) by the factors (Hair et al., 2010). For a reasonable convergent validity, the standardized factor loadings should be more than 0.5, the CR values should be more than 0.7 and AVE should be more than 0.5 (Hair et al., 2010). From Figs. 1 and 2 it can be observed that all the factor loadings are more than 0.5. The values of the AVE and CR are indicated in Table 3. All the CR and AVE values represented in Table 3 are within the acceptable limits. Therefore, it can be said that the convergent validity of the model is acceptable. From the CFA analysis the factor scores for all the latent variables have been stored for further analysis.

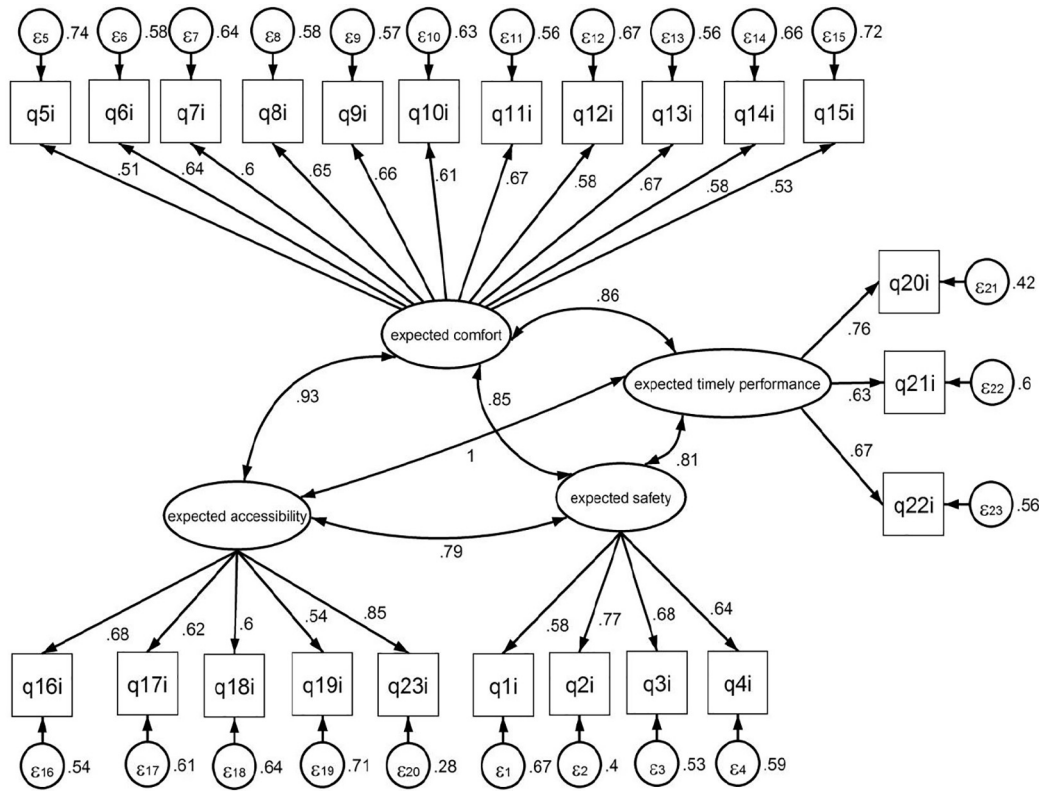


Fig. 2. CFA model for expectation data.

Table 3  
Values of the CR and AVE of the latent factors.

CFA model for perception data set			CFA model for expectation data set		
Latent factors	CR	AVE	Latent factors	CR	AVE
Safety	0.86	0.60	Expected safety	0.83	0.55
Comfort	0.92	0.54	Expected comfort	0.92	0.53
Accessibility	0.81	0.52	Expected accessibility	0.84	0.52
Timely performance	0.77	0.53	Expected timely performance	0.78	0.54

4.4. Converting the factor scores in the same unit as of the observed variables by regression analysis

Factor scores are the linear functions of the observed variables which represent the factors (Stata Corp, 2013; Hair et al., 2010). These factor score values can be used as observed variables for other analysis like regression (Nwachukwu, 2014). But these factor score values are reported in standardized forms which are not directly comparable with the observed variables (Stata Corp, 2013; Hair et al., 2010). To represent the factor scores on the same scale as of the observed variables, regression analysis has been conducted by using standardized factor scores as a dependent variable and the observed variables under the same factor as independent variables. From the regression coefficients, the relative weights of all the variables for a particular factor are found out and reported in Table 4. Using these relative weights, the factor score values for all the latent factors have been estimated in the same unit as of the observed variables. The average values for these estimated factor scores are presented in Table 4. By observing the mean values of the latent factors for both the perception and expectation data set, it can be said that all the perception factors are performing poorly in comparison with their minimum expected values. The worst performing perception factor is comfort followed by timely performance, safety, and accessibility (Table 4). Therefore, the regression analysis is useful

to understand the service level of the attributes which will be helpful in determining which particular attribute is needed to be improved.

4.5. Effect of perception and expectation on overall satisfaction

Structural equation modeling (SEM) has been used to know the effect of perception and expectation on overall satisfaction. The SEM model structure is indicated in Fig. 3. The model structure is found to be acceptable with  $\chi^2/d.f.$  value of 2.82, CFI value of 0.928, RMSEA 0.079, SRMR value of 0.073, and CD value of 0.991. The CR values for the latent factors perception and expectation are found to be 0.70 and 0.80 respectively. The AVE values for the latent factors perception and expectation are found to be 0.80 and 0.88 respectively. It is observed from Fig. 3 that all the factor loadings values are more than 0.5. All the factor loadings are found to be significant with 95% confidence interval. Looking into factor loadings, CR and AVE values it can be said that the model has reasonable convergent validity. From Fig. 3, it also can be seen that the overall satisfaction of the passengers not only depends on their perceptions of the service but also depends on their expectation of the service.

4.6. Determination of service levels of all the latent factors

To determine the service level of the city bus service, the percentage deviations of all the latent perception factor from the respective latent expectation factors are found out by the following formula:

$$\text{Percentage deviation value} = \frac{\text{expected } x_i - \text{perceived } x_i}{\text{expected } x_i} \times 100 \tag{2}$$

where  $x_i$  are the latent factors. The values of the expected  $x_i$  and perceived  $x_i$  are taken from Table 4.

For example, the percentage deviation of the latent factor safety from expected value of the safety can be determined by

**Table 4**  
Relative weights of the observed variables.

Attributes	Latent factors from the Perception data set			Latent factors from the Expectation data set						
	Dependent variables	Observed variables	Relative weight	R <sup>2</sup>	Mean	Dependent variables	Observed variables	Relative weight	R <sup>2</sup>	Mean
Boarding and alighting time	Safety	q1	0.135	0.98	3.73	Expected safety	q1i	0.213	0.92	7.20
On board safety against crime		q2	0.270				q2i	0.344		
Safety in terms of accidents		q3	0.288				q3i	0.246		
Safety in the bus stops		q4	0.306				q4i	0.197		
Condition of the vehicle	Comfort	q5	0.064	0.99	3.19	Expected comfort	q5i	0.056	0.95	7.03
Cleanliness of the vehicle		q6	0.069				q6i	0.106		
Cleanliness of the seats		q7	0.054				q7i	0.056		
Condition of the doors and windows		q8	0.074				q8i	0.113		
Comfortability of the seats		q9	0.044				q9i	0.106		
Availability of the seats		q10	0.441				q10i	0.049		
Overcrowding nature		q11	0.059				q11i	0.134		
Behavior of staffs		q12	0.059				q12i	0.063		
Overall journey experience		q13	0.039				q13i	0.127		
Facilities provided for the disabled		q14	0.044				q14i	0.113		
Frequency of the breakdowns		q15	0.054				q15i	0.077		
Availability of the service	Accessibility	q16	0.371	0.99	4.81	Expected accessibility	q16i	0.212	0.90	7.24
Prior information about the bus fare		q17	0.242				q17i	0.110		
Travel cost		q18	0.105				q18i	0.127		
Travel speed		q19	0.145				q19i	0.110		
Regularity of the service		q23	0.137				q23i	0.441		
Arrival and departure time	Timely performance	q20	0.321	0.95	3.71	Expected timely performance	q20i	0.168	0.89	7.15
Prior information about the journey time		q21	0.518				q21i	0.374		
Prior information about the waiting time		q22	0.161				q22i	0.458		

$$\begin{aligned}
 \text{percentage deviation of safety value} &= \frac{\text{expected safety} - \text{perceived safety}}{\text{expected safety}} \\
 \times 100 &= \frac{7.20 - 3.73}{7.20} \times 100 = 48.19\% \quad (3)
 \end{aligned}$$

Similarly, the percentage deviations of all the latent factors are calculated. The percentage deviations values range from 0% to 100%. A higher percentage deviation means a lower level of service (LOS) of the performance indicators. The entire range of the percentage deviation is divided into five equal parts and their service levels according to these divisions are reported in Table 5. The five service levels are LOS 1, LOS 2, LOS 3, LOS 4, and LOS 5.

In MoUD (2009) guidelines, they have mentioned four LOS scale ranges which are LOS 1, LOS 2, LOS 3 and LOS 4. These four LOS scale ranges represent best to worst service level. There is no mention of the median range. Median ranges are necessary to represent a neutral point on the scale. Therefore, in this study the entire range of the percentage deviation is divided into five equal parts as LOS 1, LOS 2, LOS 3, LOS 4 and LOS 5 where, LOS 3 represents a median range. Moreover, using higher order of scale ranges will provide a higher number of LOS categories, which warrants a higher precision in measuring of the service quality (Das and Pandit, 2015). Das and Pandit (2015) used five LOS scale ranges to evaluate the service quality of city bus service and in

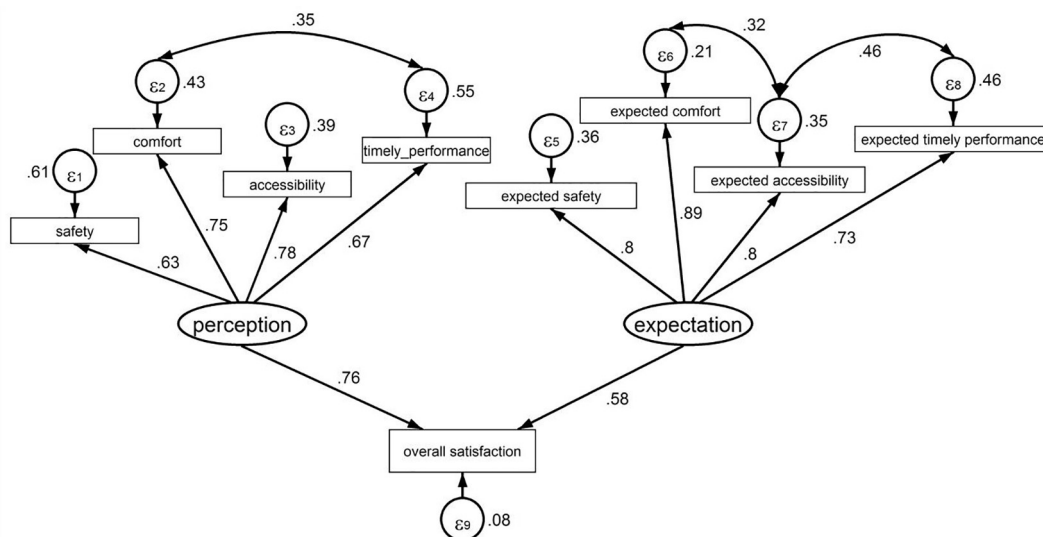


Fig. 3. Effect of perception and expectation on overall satisfaction.

**Table 5**  
LOS ranges with brief descriptions.

Range of the percentage deviation values	Assigned linguistic service levels	Descriptions
0%–20%	LOS 1	<ul style="list-style-type: none"> <li>● Best service level.</li> <li>● All the respondents are happy with all the performance indicators of the service.</li> <li>● City bus service is very much efficient in the city</li> </ul>
20%–40%	LOS 2	<ul style="list-style-type: none"> <li>● All the respondents are happy with maximum of the service indicators</li> <li>● City bus service good in the city</li> </ul>
40%–60%	LOS 3	<ul style="list-style-type: none"> <li>● All the respondents are somewhat happy with the performance of the city bus service.</li> <li>● Some of the service indicators are not performing as per the respondents' expectations</li> </ul>
60%–80%	LOS 4	<ul style="list-style-type: none"> <li>● A major portion of the respondents is not happy with the performance of the service.</li> <li>● Though the bus service is available in the city, it performing poorly compared to other modes of transport</li> <li>● A poor quality of the service of the bus service will force the maximum passengers to avoid the bus service</li> </ul>
80%–100%	LOS 5	<ul style="list-style-type: none"> <li>● This the worst service level.</li> <li>● City bus service is almost negligible in the city</li> </ul>

TCQSM report (Kittelson, 2013), performance of some of the indicators (accessibility and on time performance) are described with some value ranges which are divided in five parts. Therefore, in this study a five point LOS scale is used.

Based on the service level values provided in Table 5, the percentage deviation values for all the performance factors are converted into above mentioned five LOS scales which is presented in Table 6.

It can be understood from Table 6 that except accessibility all the perception factors performs poorly according to the expectations of the respondents. Therefore, these performance indicators need to be improved. To improve a performance indicator it is suggested to improve the qualitative attributes of the city bus service representing the performance indicators. For example, the safety of the city bus service can be improved by improving the security measures at the bus stops and within the bus. The drivers of the city buses should be instructed to avoid rash driving to avoid any types of accidents. All the performance indicators can be improved in a similar way.

**5. Conclusion**

The objective of the study is to determine the importance of passengers' expectations on the overall performance of the city bus service and to estimate the service levels of all the performance indicators representing the service quality of the city bus service on the basis of passengers' perceptions and expectations. To achieve these objectives, data were collected through questionnaire survey and analysis of the data is conducted through suitable statistical measures.

It is found through the questionnaire survey that the passengers are very much unhappy with the service quality of the bus service. They also stated that if the service quality of the city bus service is improved up to their expectation then they will avail bus service instead of private vehicles and other paratransit modes. Therefore, their minimum expectation from city bus service is also collected through questionnaire survey. It is found that the collected questionnaire data is highly correlated. To analyze the questionnaire data and to understand their correlations, factor analysis has been conducted for both the perception and expectation data. Factor analysis determines that the correlated

**Table 6**  
Performance factors with their LOS values.

Performance factors	Percentage deviation values (%)	LOS
Safety	48.19	LOS 3
Comfort	54.62	LOS 3
Accessibility	33.56	LOS 2
Timely performance	48.11	LOS 3

perception data are highly affected by the four latent factors namely safety, comfort, accessibility and timely performance. Factor analysis also determines the key identifying factors for the expectation data and they are expected safety, expected comfort, expected accessibility and expected timely performance. These perception and expectation factors are the latent factors and the factor scores from the respective analysis are the indicators of these variable. But these factor score values are reported in different units and hence they are not comparable with the observed variables and they are also not easily understandable. Therefore, these factor score values need to be converted into the same unit as of the observed variable so that they can be made easily comparable with each other and the observed variables. In this context, the difference between the perception factors and expectation factors indicate dissatisfaction of the passengers from the city bus service.

After estimating all the factor scores in the same unit as of the observed variables, now it is important to know whether these performance factors (perception factors and expectation factors) affect the overall satisfaction of the respondents. The effect of these perception and expectation factors on the overall satisfaction of the respondents is found out by analyzing the data with SEM. It is found that both the perception factors and expectation factors reasonably affect the overall satisfaction of the respondents. In most of the earlier studies, researchers only discussed the importance of passengers' perception on the overall satisfaction of the service. But through this study, it is established that both the perceptions and expectations of the respondents play an important role in determining the service quality of the service. Therefore in this study, the service quality of the city bus service is determined on the basis of both perception and expectation data.

The service quality of the city bus service is assessed by estimating the service levels of all the performance factors. To estimate the service levels of these performance factors, the percentage difference of the perception factors from the expectation factors is calculated. These percentage values represent the passengers' percentage dissatisfaction from the service. These percentage dissatisfaction values vary from 0% for an ideal system to 100% for the worst service quality. Therefore, lower percentage dissatisfaction indicates a higher service quality and higher percentage dissatisfaction indicates a lower service quality. This range of the percentage dissatisfaction values is further subdivided into five equal parts namely LOS 1 to LOS 5 depicting best to worst service quality. By determining the service quality in this easily understandable measures, make all the stakeholders relate to the original situation of the city bus service in an easily understandable way.

From the analysis of the data, it is found that safety, comfort and timely performance of the city bus service are poor with a service quality of LOS 3. But the accessibility of the city bus service is found to be better with a service quality value of LOS 2. Because of the poor



service quality of the service, passengers' tend to move to other vehicle modes for their daily commuting needs. Therefore, the service quality of the bus service needs to be improved in terms of safety, comfort and timely performance. By looking into the results of the CFA analysis, the policy makers can determine which attribute of the bus service is needed to be improved in order to improve a particular perception factor. In this study, a total of twenty three attributes are used to reflect the service condition of the bus service. But it is not possible to improve all the service attributes simultaneously. By looking into the analysis of the results, the policy makers can prioritize the attributes based on their relative weightage and eventually can improve the attributes as per their priorities. It is found that the accessibility of the bus service is relatively better than the other factors. Therefore, the attributes related to the accessibility of the bus service may not be improved now rather effort should be made to improve the attributes related to other perception factors. To improve these performance indicators it is suggested to improve the service quality attributes associated with the particular performance indicators. For example, to improve the perception factor safety, it is suggested to improve safety measures at the bus stops and in the vehicles. The driver of the bus service should be instructed to drive carefully to avoid any kind of accidents. To improve the timely performance of the bus service, it is suggested to instruct the bus operators to follow a strict arrival and departure time and avoid any unnecessary delay during the journey. The operators of the bus service are also suggested to publish the journey time for different routes and acknowledge the passengers about the same. In a similar way, all the performance factors can be improved. An improved service quality of the bus service will make the service more appealing for the passengers and it will reduce the excessive use of private vehicles and paratransit mode. Therefore, this study is very much important in assessing the passengers' viewpoint about the service and makes the service more appealing as per their expectations from the service. This study provides an insight of the current bus service of the city and it will help the operators of the bus service in determining the areas need to be improved.

## 6. Future scope

This study is based on users' perception data. User perception of the service is not same for all the users. It differs between individuals and different market segments based on socioeconomic variables (Bhat et al. 2005; dell'Olio et al., 2011). Therefore, it is advantageous to study the effect of demographic and socioeconomic characteristics of the passengers on their perception of the service to make the service more appealing across different groups. Moreover, the results of this study can be compared with the conventional methods of determining the service quality of the bus service described in MoUD (2009) and TRB (2003) handbooks.

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