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Service quality estimation and improvement plan of bus Service: A perception and expectation based analysis

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ABSTRACT

City buses are one of the primary modes of public transport in most of the Indian cities. But because of the dissatisfaction regarding the bus service, the number of passengers in the buses are reducing. Therefore, quality of the city bus service is estimated based on users' perception of present service quality and perception of expected service quality. A questionnaire survey was carried out to collect the users' perception data. Data was analysed using factor analysis, path analysis and regression analysis to estimate the factor effecting users' perception. It is found that a gap in users' perception of present and expected service quality leads to dissatisfaction. Six performance indicators namely safety, vehicle condition & hygiene, comfort, reliability & convenience, information availability and reasonable travel expenses are found to effect user's perception of service quality. It is found that the users are having high dissatisfaction levels in terms of safety, comfort, vehicle condition & hygiene and reliability & convenience and information availability of the bus service. The categorical analysis of the data show that with increasing income and age, the users are more concerned with the safety, comfort and vehicle condition & hygiene than the travel expense. Female users are found to be more concerned with the safety and vehicle condition & hygiene of the service than the male users. Very few studies emphasised on perception of expected service quality along with the perception of present service quality. But in this study both the expectation and perception of the users are considered. Moreover, the categorical analysis of the data will be helpful in understanding priorities of different factors so that improvement can be done based on the priorities of the users.

1. Introduction

Travel demand in urban areas is increasing in emerging countries such as India as a result of rapid urbanization. For the last few decades, the number of motorized vehicles in India has been steadily growing (MORTH, New Delhi, India, 2004) and cities alone have the highest density of motorized vehicles (Singh, 2005; Sharma et al., 2011). In Indian cities, it is found that, the proportion of two wheelers, mostly motorized, are maximum with 73 % of the total vehicular population. Three wheelers and passenger cars with proportions of 15 % and 10 % respectively are also effecting the city traffic considerably (Sharma et al., 2011). The commercial vehicle market share is estimated to be less than 5 % (Sharma et al., 2011). The number of passenger cars and two wheelers in the country is quickly growing as the country's affluence rises and its desire for mobility grows (Deb and Ali Ahmed, 2018). This has caused a reduced use of the public transport services within the cities. It is predicted that the mode share of the public transport will be further reduced in near future (MoUD, , 2008). For small and medium sized Indian cities, non-motorized modes of transport play a significant role. But the mode share of the non-motorized mode is predicted to be decreased from 38 % in 2007 to 25 % in 2031 (MoUD, , 2008). And in turn, mode share of private vehicles is predicted to be increased manyfold in near future (MoUD, , 2008). These increasing numbers private vehicles will add up to the already prevailing congestion and pollution in the city environment (Deb and Ahmed, 2019). Low standard of public transport services have further boosted the amount of para-transit and private vehicles in the cities (Deb and Ali Ahmed, 2018). In most of the Indian cities, overcrowding and punctuality are found to be major concerns for the users of the public transport (Suman et al., 2018). In general, public transport, mainly city buses are perceived as

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inconsistent, moderate and cram-full mode of transport (Suman et al., 2018). The efficiency of bus transit facilities must therefore be increased, in order to minimize reliance on private vehicles and other forms of transport, which would help to mitigate such issues as road congestion, noise pollution, air pollution, challenges in parking and energy usage (Nocera, 2011). In this regard, bus transit, like all public services, should meet its consumers' requirements and expectations. Service quality estimation of the bus transit enable the policy makers to understand various significant factors affecting users' satisfaction and ultimately it will be helpful in policy determination to upgrade the service quality. The quality of bus transit could be enhanced by increasing the various features of the service as perceived by passengers. The service quality measures based on users' perception are qualitative in nature and are evaluated from the questionnaire survey (Deb and Ahmed, 2019; de Oña and de Oña, 2014; Iseki and Smart, 2012).

Service quality estimation using users' perception is an essential technique for analysing the quality of transport services (Trb, 2003). The transit service's performance measurement focused on perception and satisfaction information are of a qualitative nature and fairly reflect the user's view of the present transit system. In order to analyse perception data, researchers have employed various multivariate data analysis approaches to discover the defining elements affecting users' perceptions among which cluster analysis (de Oña et al., 2016), factor analysis (Verma et al., 2017; Hu et al., 2015; Jomnonkwao and Ratanavaraha, 2015; Nwachukwu, 2014; Popuri et al., 2011; Lai and Chen, 2011), structural equation modelling (de Oña and de Oña, 2014; Lai and Chen, 2011; de Oña et al., 2013; Machado-León et al., 2016) are the most prominent methods. Employing these numerical techniques different factors affecting transit service quality have been identified among which comfort (Deb and Ahmed, 2019; dell'Olio et al., 2011; Eboli and Mazzulla, 2011), safety (Verma et al., 2017; Popuri et al., 2011; Sharma et al., 2020; Joewono and Kubota, ; Deb and Ahmed, 2018), driver behaviour (Jomnonkwao and Ratanavaraha, 2015; Chang and Yeh, 2005), service information (de Oña et al., 2016; Hu et al., 2015), service frequency (de Oña et al., 2013; Tyrinopoulos and Antoniou, 2008), reliability (Deb and Ahmed, 2019; Bordagaray et al., 2014), cleanliness (Popuri et al., 2011), accessibility and punctuality (Sezhian et al., 2014), amenity (Lai and Chen, 2011; Sezhian et al., 2014), service quality (Popuri et al., 2011; Kaplan et al., 2014), waiting time (Bordagaray et al., 2014) etc. are the most prominent. Several researchers also used regression analysis (Deb and Ali Ahmed, 2018; Nwachukwu, 2014), logit and probit model (Verma et al., 2017; Bordagaray et al., 2014; Rojo et al., 2013), etc. to assess the significance and relative weight of the different factors on global satisfaction level. All these previous studies described about the different factors influencing users' perception, their level of importance and how these factors influence the users' perception. But there are very limited studies which tried to discuss any methodologies to estimate the service levels of these factors.

The previous literatures on perception-based service quality measures highlighted the importance of users' perception on the present condition of the bus service, but very few literatures (Verma et al., 2017; Sam et al., 2017) emphasized the importance of perception of the expected service quality or users' expectations from the service. Users' expectations are important to improve service delivery. Perception of the present service quality reflects users' day to day encounters with the public transport whereas perception of the expected service quality reflects users' preferences in different aspect of the public transport. Therefore, there are some differences in perception of present and expected service quality. Users' satisfaction is function of perception of present as well as expected service quality. Satisfaction occurs when perception of expected service quality matched with perception of present service quality (Parasuraman et al., 1988). In order to make the service more desirable, transport planners often try to make perceived and expected quality as close as possible. However, only a few researchers (Sam et al., 2017) have investigated parallelly the perception of present service quality and perception of expected service quality on overall satisfaction. Sam et al. (Sam et al., 2017) estimated users' satisfaction level using both the perception and expectation of the users. The study was conducted by using some questionnaire data formed based on SERVQUAL (Parasuraman et al., 1988) dimensions. A significant difference between perception of present and expected service quality was found for the study area which leads to users' dissatisfaction. Reliability and responsiveness were found significant parameters which affect users' dissatisfaction. Therefore, subjective service quality estimation should be based on both perception and expectation of users.

The customer experience across the individual users may not be the same. Based on socioeconomic characteristics of the users, it differs from individual to individual (Das and Pandit, 2013; Dantas et al., 2001). Customers' satisfaction levels are shaped by their perception of present and expected levels of quality (Zeithaml et al., 1993). For the same type of service category, service performance may not be always same, it may differ. The differences in the users' perception affected by demographic and socioeconomic characteristics (Cirillo et al., 2011), openness to the service (Cirillo et al., 2011), trip habits (Dantas et al., 2001). The acceptance of variability in service performance depends on users' levels of tolerance (Lin et al., 2008). Again the level of tolerance depend on the socioeconomic and demographic characteristics of the users along with their levels of expectations from the service (Lin et al., 2008). As a result, it is necessary to investigate the impact of socioeconomic features on users' overall satisfaction level with the service when going for the subjective analysis in effort to make the service more acceptable to various user groups.

In view of the above discussion the objectives of this study are set as below:

- Identifying important factors affecting users' perception of present and expected service quality
- Developing a methodology to estimate the service levels of different factors
- Estimating effect of socioeconomic and demographic characteristics on users' perception

2. Study area

The study was conducted in Guwahati which is the largest city and the gate-way of Northeast India. It is also the largest industrial, commercial and educational hub of Northeast India. The population of Guwahati is 957,352 as per 2011 Census. Average annual population growth rate of the city is 1.63 % (Survey, 2016). Additionally; a large number of workers and students from the rest of the state and other parts of the Northeast region migrate to Guwahati on a regular basis. Due to this increasing growth of the population and limited infrastructure and road development, traffic congestion has become a daily routine for the city. The number of vehicles in Guwahati has increased rapidly during the past few years with an average annual growth rate of 10.50 %. The traffic volume in the city is large enough to make the roads congested during busy hours. The percentage share of different types of motor vehicles registered as on 31st March 2019 in Guwahati is shown in Fig. 1.

Numbers of motorized two wheelers (MTW) are observed as the largest with a proportion of 52.5 % followed by car with a proportion of 27.8 %. The proportion of the buses is found to be lowest with a percentage share of 2.7 %. Moreover, the average annual growth rate of car and MTW are 12.06 % and 11.19 % while the growth rate of buses is only 2.03 %. This massive quantity of MTW and cars are one of the reasons for the oversaturation of traffic in the city. A photograph of conventional traffic jam in Guwahati is shown in Fig. 2. It is observed that the huge numbers of private vehicles and paratransit modes make the city traffic congested.

The percentage share of different motorized modes in terms of total passengers carried is shown in Fig. 3 (based on the survey carried out on August 2019). Among the motorized modes, 22 % of the passengers use

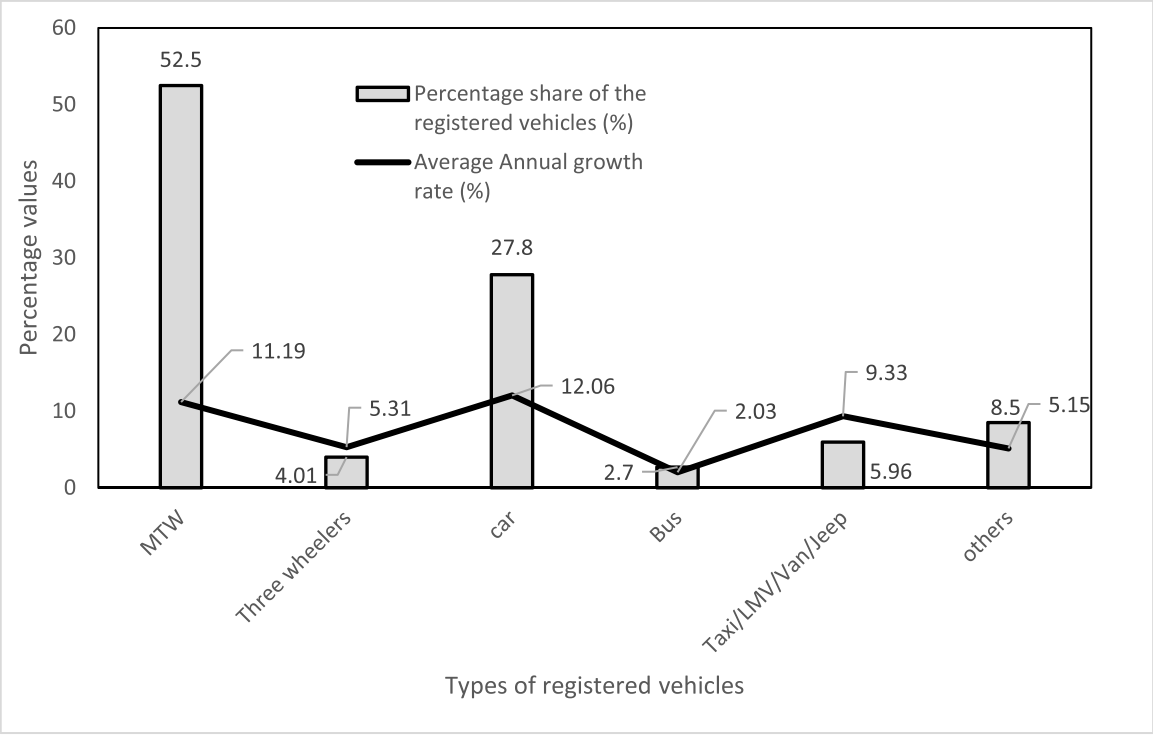

Fig. 1. Percentage share of registered vehicles in Guwahati and their growth rate as on 31st March 2019.

Fig. 2. A photograph of traffic jams in Guwahati.

city buses, 29 % use MTW, 31 % use car and 17 % use IPT (Intermediate Public Transport or paratransit) services. Among the IPT and city buses, 43.5 % of the users use city bus service while 56.5 % uses IPT service. The mode share of city bus and IPT service were 57 % and 43 % in 2001 among the same category (Ahmed and Datta, 2006). The mode share of city bus services is found to reduce from 57 % in 2001 to 43.5 % in 2019. Because of the decline in public transit, it is expected that the numbers of private vehicles and other modes of transport will grow manifold in the city.

Guwahati could be considered as medium sized Indian city. Travel demand in such types of cities is increasing rapidly due to the higher growth rate (MoUD, , 2008). To fulfil travel demand, the majority of funds are dedicated to widening the road, which largely benefits private car users (Pojani and Stead, 2015). Metropolis have captured the attention of all policymakers, while smaller and medium cities are neglected and lack essential services. Small and medium sized cities have the capability for even more continuous improvement than metropolis (Cohen, 2006). Smaller and medium cities have poorly organized public transportation, which has resulted in an increase in

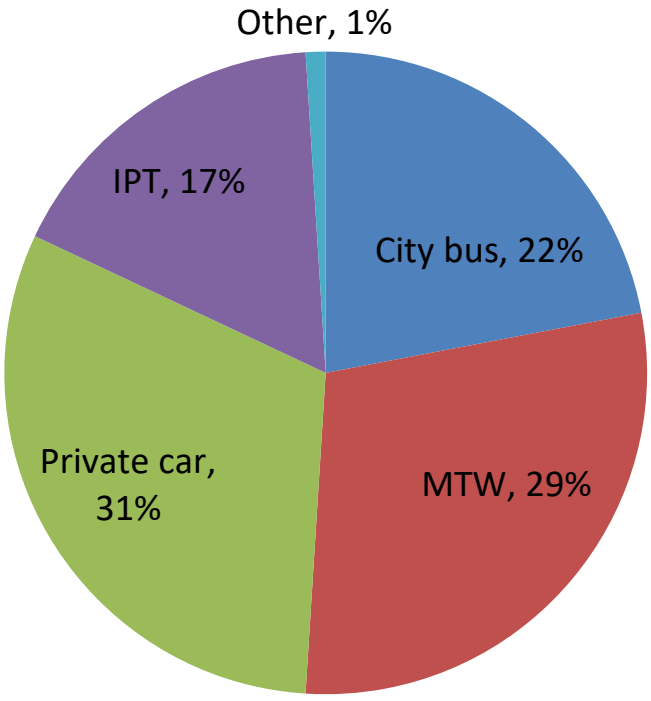

Fig. 3. Percentage share of different motorized modes in terms of total passengers carried in Guwahati.

paratransit and private vehicles, and as a result, per capita emissions in the transportation sector is higher than in metropolis (Newman and Kenworthy, 1999). In order for city busses to draw passengers, it is therefore necessary to enhance the service quality. For this reason, Guwahati has been selected as a study area.

3. Methodology

3.1. Data collection methodology

Data is collected through a questionnaire survey. The questionnaire should cover all the important and relevant qualitative characteristics of the city bus service and be easily understood by the respondents. Therefore, a preliminary survey was conducted before designing the questionnaire for identifying various relevant attributes associated with qualitative characteristics of the bus service.

The preliminary survey could be considered as a normal conversation between the two passengers rather than a traditional survey. The preliminary survey was conducted on board. Therefore, the survey respondents were the city bus users. A total number of 102 respondents were interviewed for the survey. Among the 70 respondents, 35 respondents were found to be school/college going students (less than 25 years of age), 54 respondents were the normal working-class people and 11 respondents were found to belong in a higher age group (may be more than or near about 60). Out of 102 respondents, a total number of 40 respondents were female passengers. Among these 40 female users, 15 were completing the trip for their school or universities, 25 respondents were the normal office goers. Each respondent was requested in the preliminary survey to state the attributes effecting their level of satisfaction. Safety, cleanliness of the vehicle and seats, behaviour of the staff, over-crowding during the office hours, non-adherence of specific schedule, clear idea about the waiting time, slow speed of the vehicle in some of routes etc. are found to be some of issues which troubled the users. Some of the respondents also complained about the bus fare but for maximum of the users, bus fare was justifiable. But one particular problem related to bus fare was faced by every respondent i.e., sudden changes of the fares. Upon enquiring about the fixing of city bus fares for different routes, it was found that, the bus fare is regulated by the city governing bodies. If it is required to changes fare structure, it is communicated through the newspapers and the change in the fare system, is highlighted by the change in fare per Km of bus ride. But, on board no information regarding the fare system is communicated by means of any poster or fare chart. Moreover, changing of the fare structure per Km basis is also creating a lot of confusion among the users. So whenever, the ticket collector tries to collect the fare as per new fare rules, but due to the communication gap, the users perceive this as a deception which sometime led to chaotic situation in the buses. In accordance with respondents' answers and certain previous literatures (MORTH, New Delhi, India, 2004; Sharma et al., 2011; de Oña et al., 2016; Deb and Ali Ahmed, 2018; MoUD, , 2008; Deb and Ahmed, 2019; Suman et al., 2018; Nocera, 2011; de Oña and de Oña, 2014; Iseki and Smart, 2012; Trb, 2003), the final qualitative aspects of the bus service were defined in a range of attributes. The questionnaire also includes numerous questions concerning the socio-economic characteristics of the respondents. Gender, age and monthly income of the users are considered as socioeconomic variables in this study. Respondents were requested to fill-up the questionnaire by grading the attributes in a scale of 1 to 9 as per their perception and expectation (the description of the psychometric scale is given in Fig. 4). The questionnaire also contains a question related to the overall satisfaction of the bus service.

In this study, instead of a traditional Likert scale of 5 points, a 9-point scale is used. The scales with less response levels (3 or 5) were considered to be less accurate and the most accurate values are obtained from the scales of response category 7, 8 or 9 (Preston and Colman, 2000). The internal consistency for scales of response category 7, 8 or 9 is also found to be higher. Longer range scales, though may increase the variance than shorter range scale, but can reliably capture the attitude of the respondents (Preston and Colman, 2000; Matell and Jacoby, 1971; Hancock and Klockars, 1991). In comparison, because of the intrinsic directness of these scales, the shorter scales are less flexible, which often limits their utility for many realistic psychometric uses (Preston and Colman, 2000).

The questionnaire survey was conducted using a face-to-face interview method. Initially the respondents were asked if they are city bus users. Only the existing or previous city bus users were considered as respondents for this survey. The questionnaire sheet was handed over to the selected respondents. They were requested to respond all the questions as per their perception and expectation about the bus service. The survey questions were designed in local language to make it better understandable. This approach also helps to minimize the surveyor biases. It took nearly-two months to complete the questionnaire survey. 850 samples were collected through the questionnaire survey. After screening, 600 responses (70.5 %) were found to be valid and considered for further analysis. The sample characteristic (descriptive statistics) of the collected data is shown in Table 1. Table 2 lists the different attributes for the city bus service included in the survey along with their average ratings based on respondents' perceptions and expectations. From Table 2 it could be said that except the travel expenses, all the attributes are rated below neutral rating which indicates the dissatisfaction of the users. Moreover, low rating of the overall satisfaction

Table 1
Sample characteristics.

Socio-economic characteristics		Proportion of observed data (%)
Gender	Male	54
	Female	46
Monthly income in Rupees	Less than 10,000 (Income group 1)	36.2
	10,000 – 15,000 (Income group 2)	31.3
	15,000 – 20,000 (Income group 3)	16.6
	20,000 – 25,000 (Income group 4)	9.4
	More than 25,000 (Income group 5)	6.5
Age (years)	Less than 25 (age group 1)	21
	25 – 45 (age group 2)	54
	45 – 60 (age group 3)	23
	Over 60 (age group 4)	2

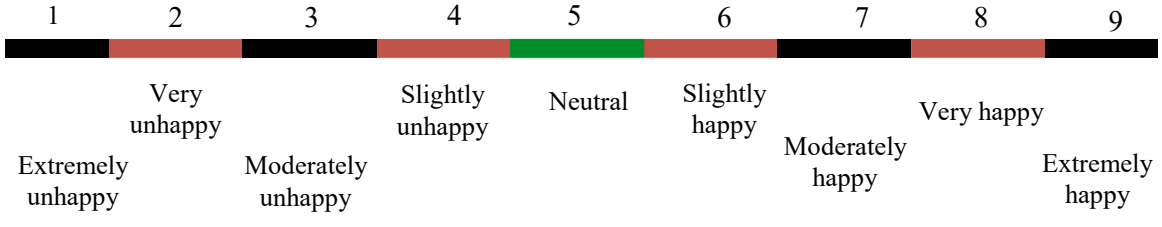

Fig. 4. Descriptions psychometric scale.

Table 2
Service quality attributes.

Qualitative attributes	Assigned code to represent data set about the perception of present service quality	Assigned code to represent data set about the perception of expected service quality	Basic statistics values of users' perception of present service quality		Basic statistics values of user perception of expected service quality		Explanation of the attributes (question asked)
			Mean	SD[a]	Mean	SD[a]	
Vehicle condition in terms of noise/ vibrations	a1	ea1	4.7	1.71	8.2	0.52	Riding comfort of the buses in terms of noise/ vibrations
Cleanliness of the seats	a2	ea2	4.2	1.82	8.1	1.01	Cleanliness of the seats
Sitting comfort	a3	ea3	4.5	1.70	8.1	0.77	Sitting posture, sufficient leg room between the adjacent seats, and seat cushioning
Status of windows and doors	a4	ea4	4.8	1.72	7.8	0.79	Whether the doors and windows are in a proper working condition or not
Hygiene condition of the vehicle and seats	a5	ea5	4.4	1.90	8.1	0.81	Whether the vehicles are clean and odour free
comfortable standing while seats are not available	a6	ea6	3.5	1.42	8.2	0.73	When seats are not available, is it possible to stand comfortably maintaining some distance from the fellow standee passengers
Availability of the seats	a7	ea7	3.3	1.34	8.3	0.62	How often the seats are available
Staff attitudes towards passengers	a8	ea8	4.5	1.64	7.8	0.86	Whether the behavior of the staffs are good or not
Extra facilities offered to elderly people	a9	ea9	3.7	1.12	8.5	0.53	Whether any extra facilities provided for the elderly people in terms of reserved seat, concession in ticket pricing, helping in boarding and alighting etc.
Frequency of breakdowns encountered	a10	ea10	3.5	1.02	8.2	0.76	How often the vehicle got malfunctioned
Adequate travel speed	a11	ea11	3.9	1.64	8.3	0.62	Whether the vehicles are running too slow between some stations which make you bored
Punctuality	a12	ea12	3.2	1.06	8.4	0.73	Whether the vehicle reach the destination in time
Fixed/predefined journey time	a13	ea13	4.0	1.53	8.2	0.78	Passengers know how much time it will take to reach their destinations
Fixed waiting time	a14	ea14	4.1	1.65	8.4	0.56	passengers know how long they have to wait for the next vehicle for the same route
Consistency of the service	a15	ea15	3.8	1.37	8.2	0.60	Bus service is always available irrespective of the weather conditions, unauthorized strikes, holidays etc
Reasonable travel expenses	a16	ea16	6.0	1.62	8.3	0.73	Bus fares are justifiable
Fixed/predefined bus fare	a17	ea17	4.2	1.09	8.0	0.62	Bus fares are already known by the passengers
Accessibility of the service	a18	ea18	3.2	1.03	8.0	0.87	Bus routes are very much accessible from your home
Perception of on-board security	a19	ea19	3.9	1.30	8.2	0.69	You feel safe in the bus in terms of pick pocketing or other mishaps
Perception of safety in the context of accidents	a20	ea20	4.0	1.64	8.5	0.57	Buses operates safely following all the traffic rules
Safety in the bus stops	a21	ea21	4.1	1.52	8.2	0.63	Bus stops are relatively safe
Careful driving during the boarding and alighting	a22	ea22	4.7	1.56	8.3	0.57	Driver starts moving the vehicle after the passengers are completely boarded/alighted to avoid any mishaps/injuries.
Overall satisfaction	OS		4.5	1.47			

[a] Standard Deviation.

value is also indicating the same. In the city, apart from the city buses, maxi cab services are also there as a mean of paratransit service. The maxi cabs are much more accessible than the city buses but have a relatively higher cost than the city buses. The maximum users of the city buses are captive riders. Apart from the city buses, the maximum they can afford is the maxi cab service. Therefore, while perceiving the travel expenses of the city bus service, they naturally compare it with the maxi cab service and find the travel expenses of city bus service more justifiable than the maxi cab service.

Table 3 indicates Socio-economic character wise distribution of the users' ratings on overall satisfaction. The primary screening of the data indicates that 34.8 % of male respondents and 58.4 % of the female respondents have provided a rating of 4 or below on overall satisfaction. 41.7 % male respondents and 27.7 % female respondents were found to provide a neutral rating. 23.5 % of the male respondents and 13.8 % of female respondents were found to be satisfied with the bus service (provided a rating of 6 or more). Percentage of female respondents were found to be more before the neutral ratings while the percentage of male respondents were more after the neutral rating. This indicates that the female respondents are less satisfied with respect to the male respondents.

Age wise distribution of the users' ratings on overall satisfaction of

Table 3
Socio-economic character wise distribution of the users' ratings on overall satisfaction.

Socio-economic Characteristics	Sex	Distribution of users' ratings on the overall satisfaction of the bus service (%)		
		Rating values 4 or below	Neutral rating	Rating values 6 or more
Gender	Male	34.8	41.7	23.5
	Female	58.4	27.7	13.8
Age group	1	39	31.7	29.3
	2	39.4	24.7	35.9
	3	57.1	7.1	35.8
	4	69.6	21.7	8.7
Income Group	1	43.3	28.3	28.4
	2	20.9	24.2	54.9
	3	47.8	34.8	17.4
	4	45.5	45.4	9.1
	5	82.3	11.8	5.9

the bus service indicates that, 39 % respondents of the age group 1 provided a rating of 4 or below, 31.7 % of respondents provided a neutral rating while 29.3 % of the respondents provided a rating of 6 or more. 39.4 % of the respondents provided a rating of 4 or below, 24.7 % provided a neutral rating and 35.9 % of the respondents provided a rating of 6 or more among the users belonging to age group 2. For the respondents belonging to age group 3, these percentage values were found to be 57.1 %, 7.1 % and 35.8 %. For the respondents belonging to age group 4 these percentage values were found to be 69.6 %, 21.7 % and 8.7 %. Therefore, it can be said that with increasing age the dissatisfaction of the users increases.

Income wise distribution of the users' ratings on overall satisfaction of the bus service indicates that the percentage of respondents provided ratings of 4 or less are 43.3 %, 20.9 %, 47.8 %, 45.5 % and 82.3 % respectively for income group 1, 2, 3, 4 and 5. The percentage of respondents provided a rating of 6 or more are 28.4 %, 54.9 %, 17.4 %, 9.1 % and 5.9 % respectively for income group 1, 2, 3, 4 and 5. It indicates that with increasing income, the dissatisfaction of the users' increases.

3.2. Data analysis

The analysis is conducted using different statistical tools like factor analysis, regression analysis, and path analysis. Factor analysis is a multivariate method of data analysis used to evaluate the basic factors that influence a set of associated variables (Hair et al., 2010). The techniques of factor analysis may be divided into two different groups: exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The EFA aims at reducing (data reduction) the number of variables and defining the relations between observed and latent factors. EFA is conducted using IBM SPSS 20 software. In SPSS, different extraction methods for the EFA analysis are there- principal components, principal axis factoring, unweighted least squares, maximum likelihood etc. Principal components is the default extraction method in SPSS and it extracts uncorrelated linear combinations of the variables. As the data set was highly correlated, therefore principal components was used as extraction method for the EFA to extract uncorrelated factor. After extracting the factors, factor rotation is necessary to better fit the data. The most commonly used method is varimax. Varimax is an orthogonal rotation method that tends to produce factor loading that are either very high or very low, making it easier to match each item with a single factor. For this reason, varimax rotation technique was used.

It is necessary to conduct CFA in order to check the factor structure after the EFA has been performed. The CFA uses the different goodness of the fit statistics to check and validate the structural relationship between the latent variables and the observed variables (Verma et al., 2017; Nwachukwu, 2014). The CFA analysis estimates two forms of output: factor loading and factor scores. In this study, factor analysis is used to find out the unobservable variables which affect users' perception and expectations.

Regression analysis is used to estimate the average values of these sets of factors (perception factors and expectation factors) in the same unit as of the observable variables. The dissatisfaction indexes for users are estimated from the differences of the average values of the perception and expectation factors. The service level is estimated using dissatisfaction index values. Regression analysis is used to determine the relationship between dissatisfaction indexes and overall satisfaction of the service.

Path analysis is used to draw the relationship between dissatisfaction indexes and users' socio-economic characteristics. Path analysis can be regarded as a more sophisticated form of the linear regression. The estimate is based on a default model in regression analysis, but in path analysis, the researchers can define their model according to their hypothesis. Multiple related equations can be resolved in the path analysis which cannot be achieved in the regression analysis (Singh, 2005; dell'Olio et al., 2011). Path analysis is more flexible than regression analysis (dell'Olio et al., 2011; Eboli and Mazzulla, 2011). Therefore, path analysis is used in this case. All the statistical analyses used in this study have been conducted using STATA 14 software.

4. Results and discussions

4.1. Preliminary data analysis

Some preliminary analysis has been conducted to explore different basic properties of the data (Deb and Ali Ahmed, 2018). The preliminary analysis consists of reliability check and exploring the inter correlations among the variables. Cronbach's alpha value is used to reliability check of the data set. For fair data set reliability, Cronbach's alpha value greater than 0.7 is considered sufficient (Hair et al., 2010). The alpha values are respectively 0.95 and 0.94 for the perception and expectation data set. This reveals that the data set is robust.

Using the Variance Inflation Factor (VIF), the correlations between variables are examined. The VIF cut-off value is considered as 2 (Banerjee et al., 2016). All variables other than travel expenses (a16) have the VIF values more than 2. Before conducting EFA, sample adequacy has been checked by Kaiser-Meyer-Olkin (KMO) tests. The KMO estimates the ratio of the squared correlation between variables to the squared partial correlation between variables (MoUD, , 2008). When the KMO is near 0, it is difficult to extract a factor and when the KMO is near 1, a factor or factors can probably be extracted. For an acceptable sample adequacy, the KMO value should be more than 0.5 (MORTH, New Delhi, India, 2004). In this case, the tests statistic value was found to be 0.87 indicating a good sample adequacy. Bartlett's Test of Sphericity test is also conducted to check the suitability of the data set. The significance value for this statistic is found to be 0.0 indicating the data set to be highly suitable for factor analysis. After performing the factor analysis, travel expenses (a16) is found to have cross loading values across different variables. Therefore, this variable is dropped and again factor analysis is conducted for all the remaining variables except travel expenses.

4.2. Identifying the subjective indicators affecting Users' perception and expectation

Indicators affecting users' perception of present and expected service quality are identified using exploratory and confirmatory factor analysis. Exploratory factor analysis (EFA) is conducted to identify the latent construct of the variables representing users' perception. Five numbers of underlying factors with eigenvalues greater than 1 were extracted from the bus service related qualitative attributes explaining 75 % of the total variance. Scree plot showing the eigenvalues respective to the components extracted by the factor analysis is shown in Fig. 5. The EFA is extracted using principal components with varimax rotation as described in *Sec*. 3.2. The factor loadings values for EFA are shown in

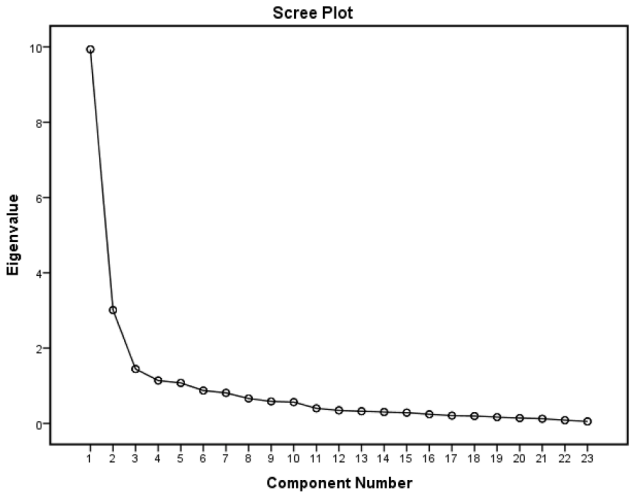

Fig. 5. Scree plot showing the eigenvalues respective to the components extracted by the factor analysis.

Table 4
Component matrix for the data representing perception of present service quality*.

variables	Component Matrix for perception data				
	1	2	3	4	5
a1	0.816				
a2	0.903				
a3					0.859
a4	0.818				
a5	0.913				
a6					0.716
a7					0.703
a8					0.716
a9					0.711
a10			0.757		
a11			0.768		
a12			0.851		
a13				0.743	
a14				0.739	
a15			0.813		
a17				0.763	
a18			0.754		–
a19		0.873			
a20		0.792			
a21		0.865			
a22		0.719			

* The factor loadings value less than 0.3 have been ignored and dropped.

Table 4. The factor loadings value less than 0.3 (Costello and Osborne, 2005) have been ignored and dropped from Table 4.

Confirmatory factor analysis (CFA) is conducted to confirm the factor structure. After establishing the factor structure of the data set representing perception of present service quality, the latent structure of the data set representing the perception of expected service quality is established keeping it similar as of the latent structure of the former. Then, the goodness of fit of the model is checked by different fit statistics values to check whether the model structure is acceptable or not. The aim of the collection of the data representing perception of expected service quality is to compare them with the perception of present service quality of the users. For this reason, the latent structures of both the models are kept similar. Five latent factors have been identified in due process for perception of present service quality as well as perception of expected service quality. Fig. 6 and Fig. 7 indicate the factor structure for the data representing perception of present service quality and perception of expected service quality respectively.

Oval boxes in Figs. 6 and 7 represent the latent variables or factors. Standard factor loadings are written next to single arrowed lines. Factor loadings when squared, reflect the component of the explained variance by latent factors. Standardized error variances are written next to the small circular shapes. They represent unexplained portion of the variance. The values displayed above the double arrow arcs show the coefficients of correlation. Statistically significant factor loadings are found with a confidence interval of 95 percent. The CFA analysis allows regulators to assess how the passengers view the various features of the bus service. Four observed variables namely on board security (a19), perception of safety in the context of accident (a20), perception of safety in bus stop (a21) and careful driving during the boarding and alighting (a22) are categorized under safety factor. a22 is categorized under safety factor because users associated this factor with their personal injuries. Buses operated in the Guwahati city have two doors one for check in (boarding) and another for check out (alighting). Only one helper or ticket collector is assigned in each bus. Therefore, in some cases, if the buses are crowdy, the users while check in or check out do not follow the assigned door for the same. And one helper assigned to the bus is also unable to manage the crowd. In such cases, the driver may not get information whether a particular user completely boarded or alighted. The driver starts the vehicle when the users are about to board or alight. In such cases some injuries may happen to the users. Therefore, they perceive this variable under safety factor.

Vehicle condition in terms of noise/vibrations (a1), cleanliness of the seats (a2), status of windows and doors (a4), hygiene condition of the vehicle and seats (a5) fall under vehicle condition and hygiene factor. a1 and a4 are associated with condition of the vehicle while a1 and a5 represent hygiene condition of the bus.

Sitting comfort (a3), comfortable standing while seats are not available (a6), availability of the seats (a7), staff attitudes towards passengers (a8), extra facilities offered to elderly people (a9) categorized under factor comfort. Here, a7 variable is perceived as a variable related to comfort because user feel more comfortable in sitting than standing. a9 incorporate reserved seat provided in the buses, general perception about the elderly people etc.

Frequency of breakdowns encountered (a10), adequate travel speed (a11), punctuality (a12), consistency of the service (a15), accessibility of the service (a18) categorized under reliability & convenience. If any breakdown of the vehicles happens in between the journey period than the journey become unreliable. Adequate travel speed is required so that the vehicle can reach the destination within stipulated time period. Similarly, punctuality is also an important variable to make the service more reliable. Punctuality is defined as a quality of being on time. Here the variable is used to visualize the fact that whether buses reach in each and every bus stop at stipulated time. In Guwahati, each and every bus are associated with a fixed total journey time to reach the final destination. Some officials are allotted to monitor their total journey time. But no fixed time is associated with whether the buses reach intermediate bus stops within a stipulated time frame. Therefore, this variable is very important aspect of reliability and convenience. Consistency of the service indicates whether the service is available throughout the year. This variable mostly effects the captive bus riders who do not have any other option than the bus service. a18 indicates whether all the important locations of the city are covered by the bus service.

Fixed/predefined journey time (a13), fixed waiting time (a14), fixed/predefined bus fare (a17) fall under factor information availability. These variables indicate whether the service is predictable or not. A predictable service increased the information availability of the travel. The goodness of fit statistics for CFA models are shown in Table 5.

Reliability of the data within the factors were checked using 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). The standardized factor loadings and AVE should be more than 0.5 and the CR values should be more than 0.7 for a reasonable reliability of the model (Hair et al., 2010). The loading values of the factor are more than 0.5 which can be noted from both figures.

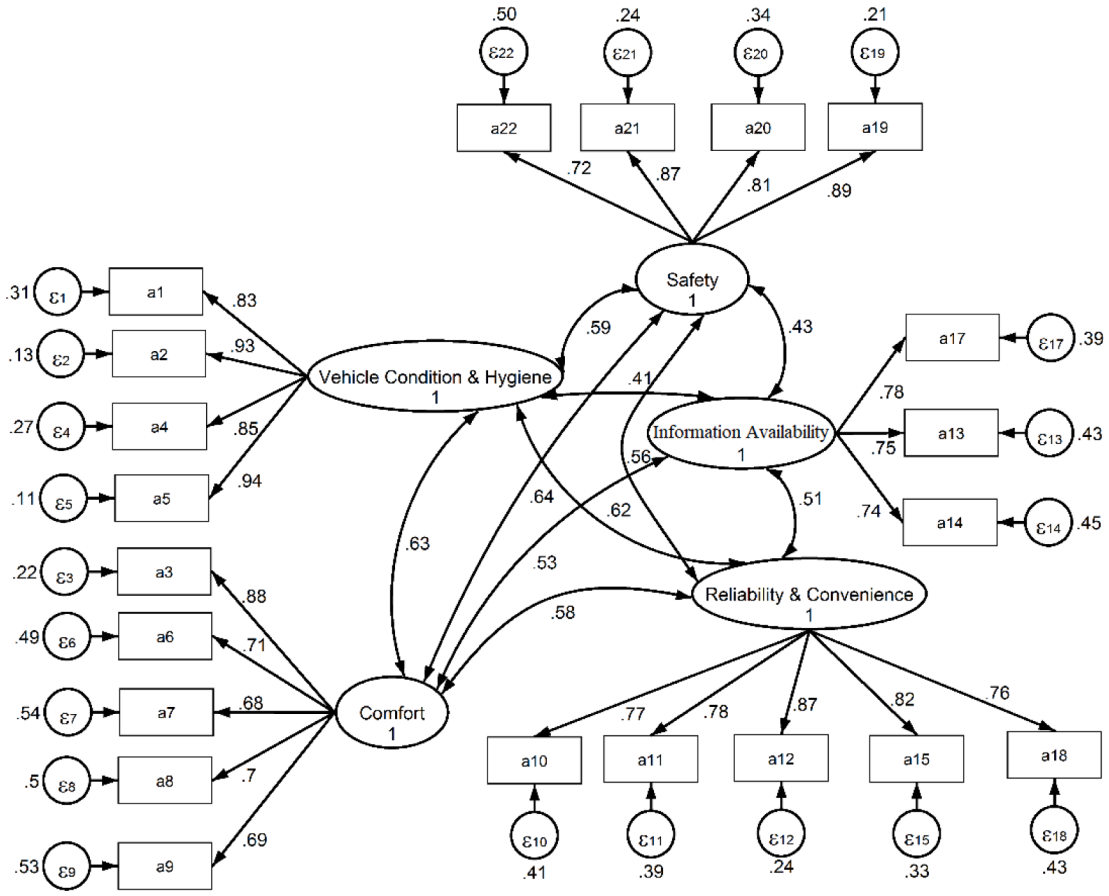

Fig. 6. Factor structure for the data representing perception of present service quality.

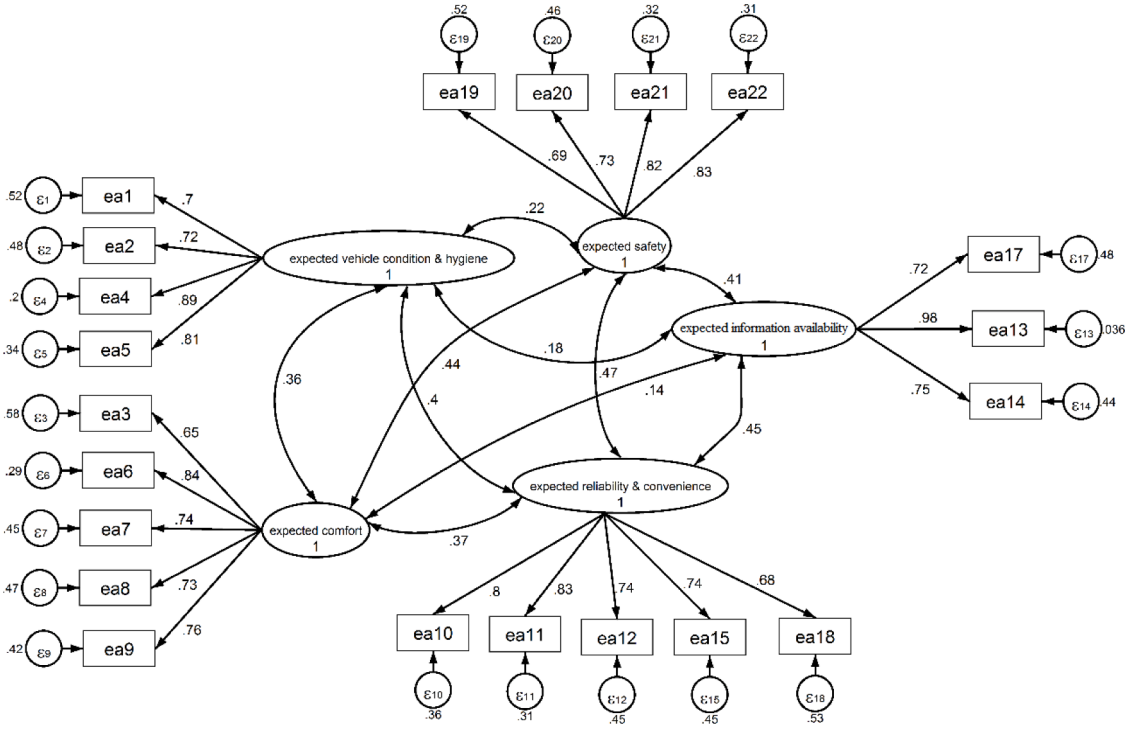

Fig. 7. Factor structure for the data representing perception of expected service quality.

Table 5
Goodness of Fit Statistics.

Parameters	Perception model	Expectation model	Limiting Value
Chi-square to degrees of freedom ratio (χ^2/d.f.)	2.6	2.87	Smaller than 5 (Lai and Chen, 2011)
Comparative fit index (CFI)	0.92	0.91	Greater than 0.9 (Deb and Ali Ahmed, 2018; Suman et al., 2018)
Root mean squared error of approximation (RMSEA)	0.06	0.07	Less than 0.08 (Lai and Chen, 2011)
Coefficient of Determination (CD)	0.99	0.96	Close to 1 (StataCorp, , 2013)
standardized root mean squared residual (SRMR)	0.05	0.07	Less than 0.08 (Schreiber et al., 2006)

Table 6
Values of the CR and AVE of the latent factors.

CFA model for perception data set Latent perception factors	CR	AVE	CFA model for expectation data set Latent expectation factors	CR	AVE
Vehicle Condition and Hygiene	0.94	0.79	Expected Vehicle Condition and Hygiene	0.86	0.61
Comfort	0.85	0.54	Expected Comfort	0.86	0.55
Reliability & Convenience	0.90	0.64	Expected Reliability & Convenience	0.87	0.57
Information availability	0.80	0.57	Expected Information availability	0.86	0.68
Safety	0.89	0.68	Expected Safety	0.85	0.59

Moreover, CR and AVE were also found to be within their acceptable limit (shown in Table 6). Therefore, it can be said that the reliability of the models is acceptable. For further analysis, the factor scores were stored for all the latent variables.

Factor scores may be regarded for further study as an observable variable. Factor scores are the linear functions of the observed variables which represent the factors (Trb, 2003; MORTH, New Delhi, India, 2004). But as they are reported in different unit than the observable variable, therefore it is very difficult to interpret the factor scores in the current form. It is necessary to convert the factor score values in the same unit of the observable variables and it has been done using regression analysis. In this way the average values of all the factors are estimated which are shown in Table 7.

4.3. Estimating the dissatisfaction of users

The difference between the expectation factor and perception factor represents users'.

dissatisfaction. The level of users' dissatisfaction cannot be clearly understood from the dissatisfaction values of the factors. Therefore, the dissatisfaction of the users is expressed in terms of dissatisfaction index which is defined in Eq. (1):

$$Dissastisfactionindexofanyfactor f_i = \frac{Averageexpectedvalueofthefactor f_i - Averageperceivedvalueofthefactor f_i}{Averageexpectedvalueofthefactor f_i} \quad (1)$$

The average values of the expected and perceived factors are taken from Table 8. The dissatisfaction index values range from 0 to 1 where a value close to 0 indicates a low level of dissatisfaction and a value close to 1 indicates a high level of dissatisfaction. The dissatisfaction indexes

Table 7
Relative weights of the observed variables, Guwahati.

For perception data					For expectation data				
Dependent variable	observed variable	Relative weight	R^2	Mean	Dependent variable	Observed variables	Relative weight	R^2	Mean
Safety	a19	0.440			Expected Safety	ea19	0.085		
	a20	0.250	0.97	4.37		ea20	0.041	0.94	8.33
	a21	0.290				ea21	0.660		
	a22	0.101				ea22	0.230		
Vehicle condition and	a1	0.031			Expected Maintenance	ea1	0.160		
hygiene	a2	0.480				ea2	0.097		
	a4	0.161	0.99	4.50		ea4	0.580	0.91	7.93
	a5	0.360				ea5	0.161		
Comfort	a3	0.600			Expected Comfort	ea3	0.146		
	a6	0.081	0.95	4.46		ea6	0.045	0.93	8.32
	a7	0.140				ea7	0.318		
	a8	0.210				ea8	0.134		
	a9	0.025				ea9	0.359		
Reliability & Convenience	a10	0.330			Expected Reliability	ea10	0.310		
	a11	0.140	0.94	4.49		ea11	0.168	0.96	8.19
	a12	0.370				ea12	0.297		
	a15	0.181				ea15	0.048		
	a18	0.291				ea18	0.171		
	a13	0.241			Expected Information	ea13	0.955		
Information availability	a14	0.080	0.92	4.47	availability	ea14	0.051	0.94	8.60
	a17	0.770				ea17	0.004		

Table 8
Performance of the factor.

Factors	Dissatisfaction Index
Safety	0.47
Vehicle condition & hygiene	0.43
Comfort	0.46
Reliability & Convenience	0.45
Information availability	0.48
Reasonable travel expenses	0.27

for all the latent factors are calculated and presented in Table 8. It has to be noted that, in Table 8 the dissatisfaction index of the variable 'reasonable travel expenses' is also added as it was initially dropped from the factor analysis. The dissatisfaction index of 'reasonable travel expenses' is calculated based on the average ratings provided by the users. In section 4.1 travel expense was dropped as the VIF value was found to be higher than 2 in comparison with the other observed variables. In that case, VIF was estimated based on all the observed variables. But here travel expense is added as it is an important variable for the users. And here regression analysis is used only for the factor extracted from the factor analysis. Therefore, VIF in this case would not be same as of the previous case. From Table 8 it could be said that users are highly dissatisfied about the city bus service in Guwahati as indicated by the dissatisfaction index values. Therefore, it is important to improve the service. But the service requirement is not same for all the users. It depends on their socio-economic characteristics. Therefore, further analysis is required to understand the requirements of different group of users.

4.4. Effect of Users' dissatisfaction on overall satisfaction of bus service

Regression analysis is used to know the effect of dissatisfaction on the overall satisfaction of the bus service. Overall satisfaction of the bus service is used as the dependent variable and dissatisfaction index values of all the factors as independent variables in the regression analysis. The coefficient values and standardized coefficient values for the regression analysis are shown in Table 9. All the coefficient values are found to be negative. The standardized coefficients indicate the relative weights of all the variables. It indicates that if the dissatisfaction indexes are decreased than overall satisfaction of the bus service will be increased. The relation between the dissatisfaction indexes of all the factors and overall satisfaction can be assessed through the equation given below:

$$Overall\ satisfaction = 8.34 - 2.03s_d - 2.09m_d - 0.85c_d - 1.68r_d - 0.44f_d - 0.819te_d \quad (2)$$

Where,

s_d is the dissatisfaction index for safety.
m_d is the dissatisfaction index for vehicle condition & hygiene.
c_d is the dissatisfaction index for comfort.
r_d is the dissatisfaction index for reliability & convenience.
f_d is the dissatisfaction index for information availability.
te_d is the dissatisfaction index for reasonable travel expenses.

From Eq. (2) it can be said that the most sensitive factor is vehicle condition and hygiene followed by safety, reliability & convenience, comfort, travel expenses and information availability. It indicates that if the vehicle condition and hygiene of the bus service is enhanced, the overall satisfaction will have maximum impact.

4.5. Effect of socioeconomic characteristics on dissatisfaction indexes

Path analysis is used to estimate the priorities of different groups of respondents on the dissatisfaction indexes of different factors based on their age, income and gender. Path analysis is used to find out the priorities of different group of users. It will help to identify different schemes to attract different group of users. In path analysis, for a particular group of users, a relationship is drawn between the overall satisfaction of that user's group and dissatisfaction indexes of estimated factors for that group. In this way, the path analysis is conducted for each and every group of users.

The outcome of the analysis for income, gender and age are indicated in Table 10, Table 11 and Table 12. The respective path diagrams are shown in Figs. 8, 9, and 10. The negative value of the coefficient indicated that if the dissatisfaction of the factors increases then the overall satisfaction of the users' decreases.

Table 10 indicates the segmentation analysis of different groups based on their income for Guwahati. The path diagram for the analysis is shown in Fig. 8. Reliability & Convenience is found to be most important factor for the people under group 1 followed by reasonable travel expenses. Users falling under this group are dependent on the city bus as it provides a cost-effective service. This group of people mainly consists of student classes. The reliability & convenience of the service is also found to be important for them due to their busy school/ college/ tuition schedule.

The most important factor for the users categorized under group 2 is found to be travel expenses. Comfort of the service are found to be insignificant for them. Vehicle condition & hygiene and safety are found to be most important factors for the users categorized under income group 3, 4 and 5. It is worth noting that with increasing income users tend to have more sensitive towards safety and vehicle condition & hygiene of the service. Therefore, it can be said that travel expenses are not an important factor for the higher income group as long as the service is good. Moreover, travel expanse is found to be positive and insignificant for the users categorized under income group 4 and 5. It indicates that they are less sensitive to cost and they are ready to pay more for better service.

Table 11 shows the priorities of different users' groups based on their gender. The path diagram for the respective analysis is shown in Fig. 9. It is found that female users are more sensitive towards safety and vehicle condition & hygiene of the service. Travel expenses is found to be insignificant and positive for the female users. It indicates that female users are ready to pay more if the vehicle condition & hygiene and safety of the service are good.

Table 12 represents the priorities of different users based on their age. The respective path diagram is shown in Fig. 10. Reliability & convenience and travel expenses are found to be most important factor for group 1 and group 2. A significant portion of age group 1 and 2 consists of students. The users of these groups tend to minimize travel expenses as they have other priorities to satisfy. Reliability & convenience of the service is also found to be important for them due to their

Table 9
Coefficient values for the dissatisfaction indexes for different perception factors.

Independent variables	Coefficients	Significance	Standardized Coefficients	R^2
Intercept	8.34	0.00	–	0.82
Dissatisfaction index for safety	−2.03	0.00	−0.25	
Dissatisfaction index for vehicle condition & hygiene	−2.09	0.00	−0.26	
Dissatisfaction index for comfort	−0.85	0.02	−0.11	
Dissatisfaction index for reliability & convenience	−1.68	0.01	−0.21	
Dissatisfaction index for information availability	−0.443	0.04	−0.06	
Dissatisfaction index for reasonable travel expenses	−0.819	0.03	−0.10	

Table 10
Effect of income on overall satisfaction of the bus service, Guwahati.

Dependent variable	Independent variable	Standard coefficients	P value
Overall satisfaction	Less than 10,000 (Income Group 1)		
	Safety	−0.12	0.04
	Vehicle condition & hygiene	−0.14	0.03
	Comfort	−0.13	0.14
	Reliability & convenience	−0.31	0.03
	Information availability	−0.07	0.04
	Reasonable travel Expenses	−0.28	0.00
	10,000 – 15,000 (Income Group 2)		
	Safety	−0.12	0.03
	Vehicle condition & hygiene	−0.15	0.01
	Comfort	−0.05	0.12
	Reliability & convenience	−0.29	0.03
	Information availability	−0.12	0.00
	Reasonable travel Expenses	−0.33	0.01
	15,000 – 20,000 (Income Group 3)		
	Safety	−0.22	0.04
	Vehicle condition & hygiene	−0.28	0.00
	Comfort	−0.09	0.02
	Reliability & convenience	−0.18	0.03
	Information availability	−0.11	0.03
	Reasonable travel Expenses	−0.19	0.00
	20,000 – 25,000 (Income Group 4)		
	Safety	−0.30	0.00
	Vehicle condition & hygiene	−0.44	0.03
	Comfort	−0.16	0.04
	Reliability & convenience	−0.13	0.04
	Information availability	−0.03	0.00
	Reasonable travel Expenses	0.05	0.07
	More than 25,000 (Income Group 5)		
	Safety	−0.32	0.00
	Vehicle condition & hygiene	−0.46	0.01
	Comfort	−0.17	0.03
	Reliability & convenience	−0.12	0.00
	Information availability	−0.02	0.04
	Reasonable travel Expenses	0.12	0.09

busy school/ college/ tuition schedule. Safety and vehicle condition & hygiene are found to be important for the users of age group 3. Safety, vehicle condition & hygiene and comfort are found to be important for the users of group 4. It can be noted that the importance of safety, vehicle condition & hygiene and comfort increases with increase in age of the users.

Table 11
Effect of gender on overall satisfaction of the bus service, Guwahati.

Dependent variable	Independent variable	Standard coefficients	P value
Overall satisfaction	Male		
	Safety	−0.21	0.04
	Vehicle condition & hygiene	−0.18	0.03
	Comfort	−0.12	0.04
	Reliability & convenience	−0.27	0.03
	Information availability	−0.06	0.20
	Reasonable travel Expenses	−0.19	0.00
	Female		
	Safety	−0.36	0.00
	Vehicle condition & hygiene	−0.32	0.00
	Comfort	−0.08	0.02
	Reliability & convenience	−0.17	0.03
	Information availability	−0.08	0.00
	Reasonable travel Expenses	0.06	0.11

Table 12
Effect of age on overall satisfaction of the bus service, Guwahati.

Dependent variable	Independent variable	Standard coefficients	P value
Overall satisfaction	Less than 25 years (Age Group 1)		
	Safety	−0.11	0.02
	Vehicle condition & hygiene	−0.13	0.00
	Comfort	−0.13	0.04
	Reliability & convenience	−0.32	0.03
	Information availability	−0.08	0.00
	Reasonable travel Expenses	−0.28	0.00
	25 – 45 years (Age Group 2)		
	Safety	−0.13	0.00
	Vehicle condition & hygiene	−0.13	0.03
	Comfort	−0.12	0.13
	Reliability & convenience	−0.29	0.03
	Information availability	−0.07	0.03
	Reasonable travel Expenses	−0.27	0.01
	45 – 60 years (Age Group 3)		
	Safety	−0.29	0.04
	Vehicle condition & hygiene	−0.21	0.00
	Comfort	−0.13	0.02
	Reliability & convenience	−0.16	0.03
	Information availability	−0.07	0.03
	Reasonable travel Expenses	−0.17	0.00
	Over 60 years (Age Group 4)		
	Safety	−0.43	0.00
	Vehicle condition & hygiene	−0.32	0.03
	Comfort	−0.22	0.04
	Reliability & convenience	−0.13	0.04
	Information availability	−0.04	0.00
	Reasonable travel Expenses	−0.08	0.04

4.6. Discussions

To encourage commuters to use public transportation, it must be made appealing by frequent review and modification (Sam et al., 2017). Evaluation of users' perception of present service quality and perception of expected service quality are thus valuable to gauge the performance levels for core users. The performance of the public transport should meet with users' expectation levels to make the users satisfied with the service. A higher user satisfaction is necessary to retain the existing user base as well as to attract new users (Esmailpour et al., 2020). In developed countries, public transport service quality evaluation has become a major research topic in the public transportation research but in case of developing countries estimation of service quality using users' perception is relatively a new concept.

Previous studies on service quality estimation of public transport can be grouped under two categories, "subjective service quality dimension" and "objective service quality dimension" (Deb and Ahmed, 2019). The subjective dimensions include all the parameters which are estimated based on users perceptions (Deb and Ahmed, 2019; Eboli and Mazzulla, 2011). For instance, Deb and Ahmed (Deb and Ahmed, 2019) argued that the subjective dimension consist of passengers' perception of security, comfort, reliability etc. While service frequency, travel time, waiting time etc. are fall under objective service quality dimension as they could be estimated directly. The objective dimensions after comparing with standardized values are characterised by base-lines, trend analyses of the indicators, self-identified values, and typical industry standards. Estimation of ratios by dividing individual measure by another is another format for representation of the performance levels. It is a useful tool for a comparison between the routes, agencies and areas. Finally, index measures are adopted when service quality aspects involve a number of different factors; these indexes combine results from several other performance measures in an equation to produce a single output measure. The service levels of objective indicators are decided on the basis of past performance or some expert opinions without considering customer perception and expectations (Eboli and Mazzulla, 2011;

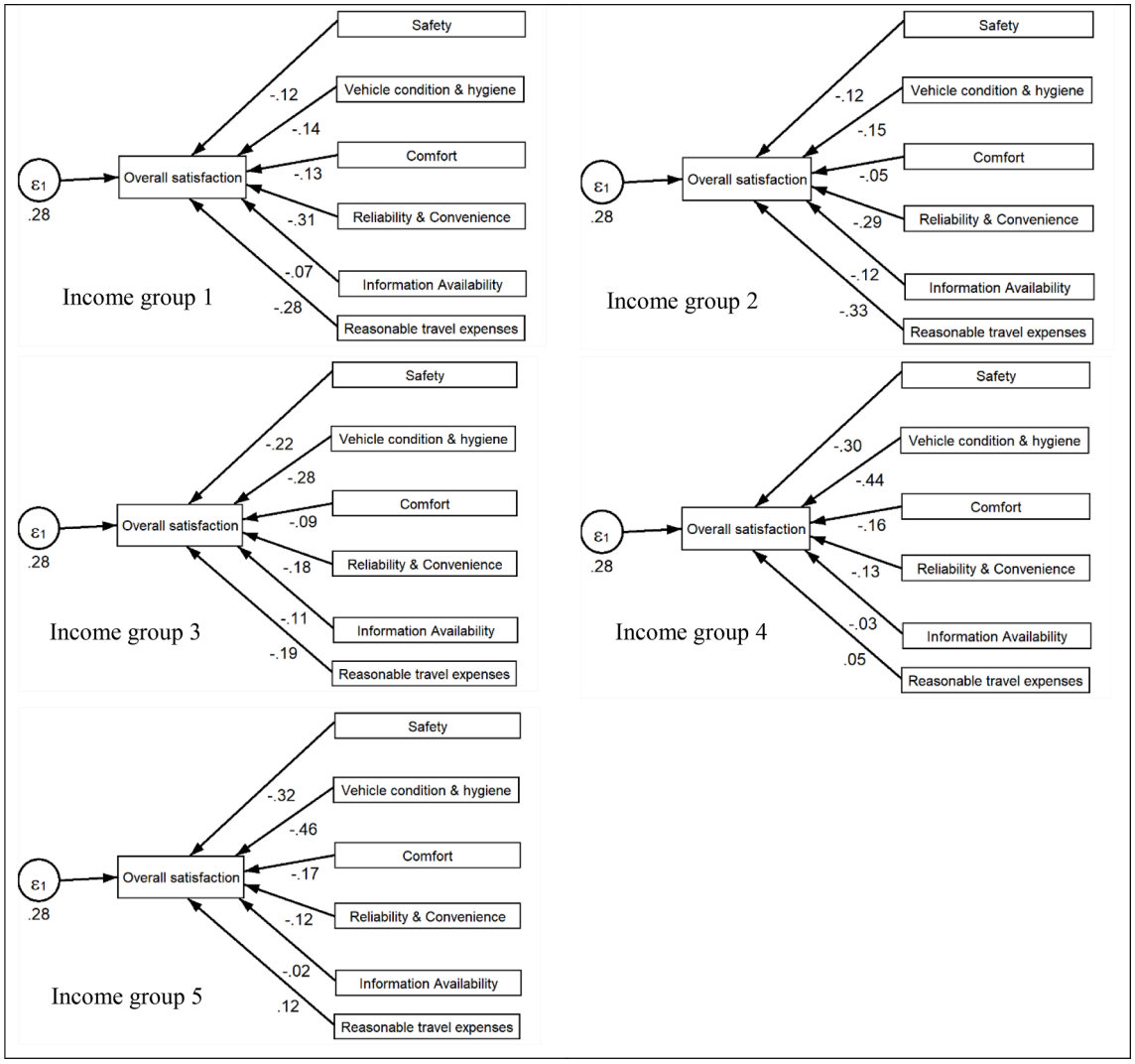

Fig. 8. Path diagrams showing effect of income on overall satisfaction of the bus service.

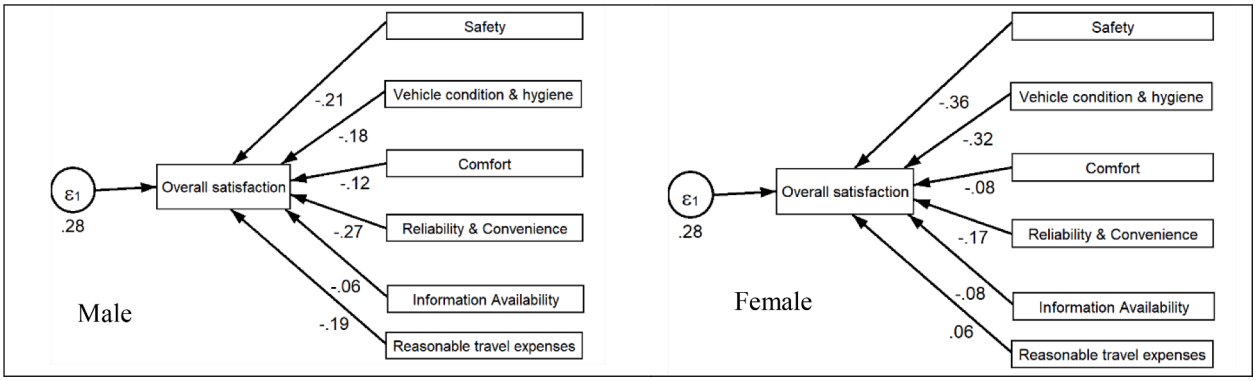

Fig. 9. Path diagrams showing effect of gender on overall satisfaction of the bus service.

Eboli et al., 2012). For instance, in India, Ministry of Urban Development (MoUD) published performance measurement technique (MoUD, Service Level, 2009) based on objective dimensions to estimate the performance of public transport in different cities of India. MoUD (MoUD, Service Level, 2009) indicated six performance indicators namely presence of organized public transport, availability of public transport, service coverage, average waiting time, level of comfort and percentage fleet. The limiting values of these performance indicators were based on some expert opinion without considering the customer priorities. Although, quantitative measurement technique or objective dimensions of service quality could be easily adopted by the transport operators but they are inadequate in estimating the performance measurement of the public transport. Many researchers (Jomnonkwao and Ratanavaraha, 2015; Lai and Chen, 2011; de Oña et al., 2013; dell'Olio

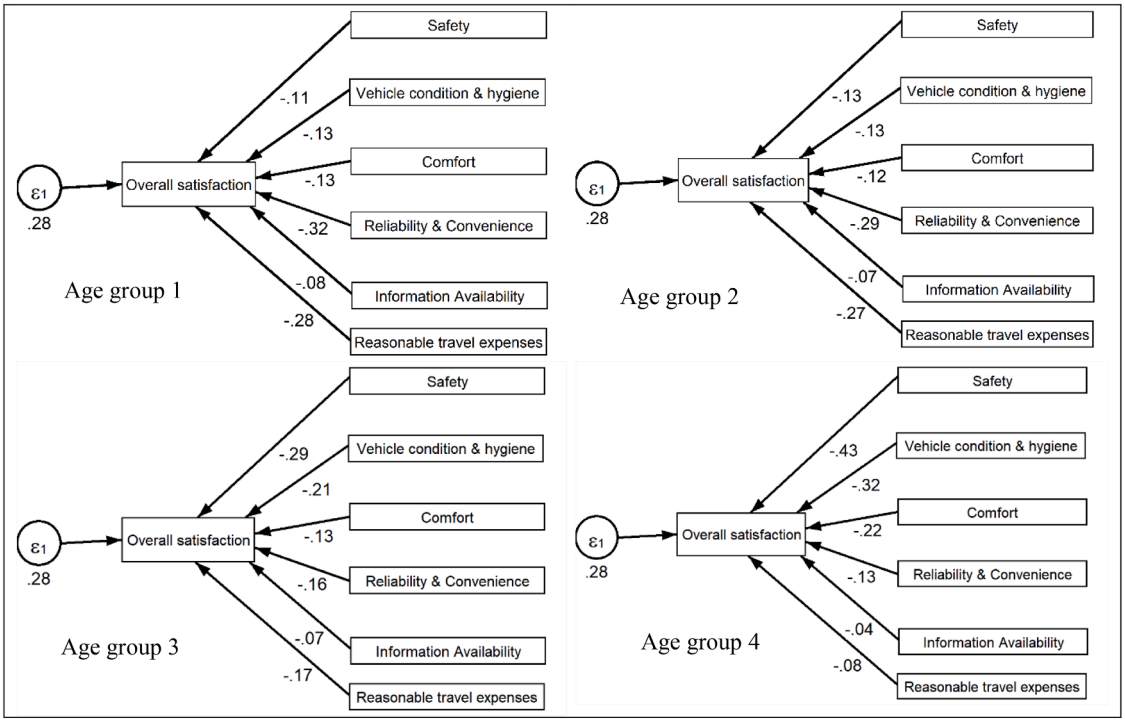

Fig. 10. Path diagrams showing effect of age on overall satisfaction of the bus service.

et al., 2011; Bordagaray et al., 2014) argued that passengers perception are the most important while estimating the transit service quality. For instance Deb and Ahmed (Deb and Ahmed, 2019) found that reliability, safety, on time performance are some of the important parameters which are not included in the MoUD technique. Similarly, Esmailpour et al. (Esmailpour et al., 2020) indicate that for a developing country, comfort, cleanliness of the vehicles, providing facilities for the elderly/ disabled are some of the important factor for the passengers. For this reason, in this study the service quality of city bus service estimated based on subjective service quality dimensions. Moreover, Das and Pandit (Das and Pandit, 2015) found that there are differences in users' perception and expert opinion and the service quality estimation should be based on users' perception. An efficient and reliable public transport system is the desire of commuters, both current and potential. Therefore, It is required to administer users' perception survey in every-six months to maintain and to improve the service quality (Jomnonkwao and Ratanavaraha, 2015; Lai and Chen, 2011; de Oña et al., 2013; dell'Olio et al., 2011; Bordagaray et al., 2014). In estimation of subjective service quality dimensions SERVQUAL methods (Parasuraman et al., 1988) is one of the popular methods. Many researchers (Sam et al., 2017; Jen and Hu, 2003; Park et al., 2006; Wang and Shieh, 2006) used SERVQUAL methods (Parasuraman et al., 1988) in estimating the factor affecting users' perception. But in this study, SERVQUAL methods (Parasuraman et al., 1988) are not used, instead factor analysis is used to estimate the factors affecting users' perceptions and expectations. SERVQUAL analysis is based on predefined factors. But in the present study factors affecting users' perception and expectations are estimated using factor analysis. The attributes of the bus service were decided based on their importance to the users and factors are extracted based on the correlation among the attributes. Therefore, under a particular factor only the similar types of attributes are grouped. The correlation among the variables depends on the perception and expectation of the users and the pattern of ratings of different attributes by the users. However, the priorities of different service quality attributes vary with different user categories based on trip purpose (Phanikumar and Maitra, 2006; Ahmad and Vaidya, 2004), age (Ahmad and Vaidya, 2004), income (Deb and Ahmed, 2018; Das and Pandit, 2015) etc. For example, Verma et al. (Verma et al., 2017) found that safety at bus stops, lack of safety while boarding and alighting the bus, feeling unsafe among the passengers, safety at bus stops etc. are some of the important factors related to safety of the female passengers. The present study also indicates that the priorities of the users vary considerably depending on their socioeconomic characteristics. Therefore, the present study is bound to add some new dimension in estimating and improving the quality of the city bus service which will enhance the bus ridership.

5. Conclusion

In this study, overall service quality of the city bus service is estimated using users' perception of the present service quality and perception of the expected service quality which can also be termed as subjective measure of the service quality. The conclusions for the current study can be summarized as below:

- Subjective analysis has been estimated based on the performance of six factors - safety, vehicle condition and hygiene, comfort, reliability & convenience, information availability and travel expenses. The dissatisfaction index values are found to be 0.47, 0.43, 0.46, 0.45, 0.48 and 0.27 respectively. The dissatisfaction index for travel expenses was found to be lower than the other factors. It indicates that users are less dissatisfied with travel expenses than the other factors.
- The most sensitive factor was found to be vehicle condition & hygiene followed by safety, reliability & convenience, comfort, travel expenses and information availability. It indicates that the improvement of the vehicle condition and hygiene will greatly affect the overall satisfaction of the users.
- With increasing income and age, it is found that users are more concerned with the safety, vehicle condition & hygiene and comfort than the travel expenses of the service.
- It is found that 58.4 % female users provided a rating 4 or below. It indicates that female users are mostly dissatisfied with the service. Female users are found to be more concerned with the safety and

Table 13
Recommendations for improvement of the city bus service.

Indicators	Recommendations
Vehicle condition & hygiene	The city buses should be maintained properly to make it clean and visually attractive for the passengers. This can be achieved by regularly inspecting the buses. Cleaning should be carried out after each trip.
Comfort	Number of buses should be increased to prevent the overcrowding during busy hours. This can be achieved by introducing additional buses during peak hours. The staffs may be provided adequate training in respect of their behavioral aspact towards passengers. Seating arrangements may be redesigned to make it more comfortable.
Reliability & Convenience	The bus service needs to be punctual and consistent. This can be achieved by minimizing the unnecessary delays between the bus stops. The servicing of the buses should be done within the stipulated time to avoid any unnecessary breakdowns during the journey.
Information availability	Buses should follow a predefined journey time, the waiting time should also be known to passengers for each bus stops and there should not be any sudden changes to bus fare. Users should be acknowledged prior to any changes in the journey time, waiting time and bus fare.
Safety	Safety measures need to be increased in the bus stops, and within the buses. The drivers of the city buses should be instructed to avoid rash driving. The drivers need to be more careful while boarding and alighting of the users to avoid any mishap.
Travel Expenses	Travel cost should be affordable for the captive bus riders. Govt. may think of providing subsidy to attract more users. However, care should be taken to make the service self-sustain.

vehicle condition & hygiene of the service than the male users. Poor perception and a higher expectation of these two factors may lead to higher dissatisfaction among the female users. As safety and vehicle condition and hygiene are two of the most sensitive factors, therefore, the improvement of these two factors will lead to higher satisfaction among the female users.

- It was found that the percentage share of users belonging to higher income group and higher age were relatively very less. City bus service can be make attracted to these users' groups by improving the vehicle condition & hygiene, comfort and safety of the service. Similarly, the bus service can be improved for other groups also.

But improving these parameters may lead to increase in travel expenses which may upset some of the user's groups. So, in such situation it is recommended to incorporate some new buses with some additional features. The operators may look for some alternate options of funding like advertisements to enable the financial sustainability of the buses. Based on the performance of these indicators some recommendations have been provide in Table 13 to improve the city bus service. Recommendations are based on the attributes associated with the particular indicator. City bus service can be improved by improving the underperforming indicators.

6. Study limitations and future scope

The estimation of the subjective service quality dimensions depends on the users' perceptions. The users' perceptions data is affected by the socioeconomic and demographic characteristics of the users. Therefore, the subjective service quality dimension discussed in this study is limited for this type of cities only. The condition of the city buses will not be same throughout an entire day. For example, in peak hours the buses may be very crowdy but during the odd hours the buses may remain mostly empty. This type of condition will lead to temporal variation in users' satisfaction as indicated by Echaniz et al. (Echaniz et al., 2022). This temporal variation in the users' satisfaction is also not included in this article. Moreover, Collection and analysis of users' perception data is little bit complicated and time consuming than the traditional data collection for objective dimension. While conducting this study, it is felt that certain aspects of the city bus service deserve further studies. Some of them are mentioned below:

- The effect of climatic changes on users' perception may be studied to estimate the variation of service quality.
- The study can be performed using data from metro cities in India to generalize the model so that a uniform subjective measure could be followed throughout the entire country.
- The methodology used in this study can be used to estimate the service quality of other public transit services like metro service, light rail transit (local train), bus rapid transit etc.
- This temporal variability in the user's satisfaction can be studied in future to make the transit service more effective.

CRediT authorship contribution statement

Saikat Deb: Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Formal analysis, Validation. **Mokaddes Ali Ahmed:** Supervision, Project administration, Resources. **Debasish Das:** Data curation, Visualization, Investigation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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