



ASSESSMENT OF PASSENGER SATISFACTION WITH PUBLIC BUS TRANSPORT SERVICES: A CASE STUDY OF LUCKNOW CITY (INDIA)

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Abstract:

The main aim of this study is threefold. First, it tries to assess the passenger satisfaction with public bus transport services in the city of Lucknow in India. Second, it tries to examine the service quality attributes that influence the passenger satisfaction. Third, it tries to evaluate the relative importance of service quality attributes to find out the priority for service quality improvements to enhance passenger satisfaction. The study is based on a survey of objective as well as subjective questions conducted between May and July 2014. Five major bus stops of Lucknow were selected for the survey. Total 148 respondents were randomly selected to elicit their overall satisfaction and factors that influence their satisfaction in the use of public bus transport services in Lucknow using a self-rated questionnaire. The collected sample of responses is subjected to principal component analysis, a statistical technique for dimensionality reduction of the dataset, and descriptive analysis. The result of these analyses shows that passengers are mostly dissatisfied with public bus transport services in Lucknow. Using principal component analysis, five underlying factors were extracted that influenced passenger satisfaction with public bus transport services in the city. Out of these five factors, comfort and safety has the greatest impact on overall satisfaction, followed by the adequacy of capacity of public bus transport services, orderly and clean environment inside buses, elegant design of buses and bus stops, and accessibility to public bus transport services in the city. The study thus provides a direction for public bus transport administration in the city to understand the gaps that exist and try to fill them to improve its services so that passenger satisfaction can be enhanced and consequently more people can be attracted towards public bus transport.

Key words: Public Transport, Passenger Satisfaction, Principal Component Analysis, Descriptive Analysis, Lucknow

1. Introduction

Lucknow is the capital city of Uttar Pradesh, the most populous state of India. It is experiencing rapid growth in its population; its population increased from 2.25 million in 2001 to 2.81 million in 2011 (Singh, 2015a). Despite being 11th most populous city of

India and among the fastest growing ones, availability and adequacy of public transport services in Lucknow has not been up to the mark. Lucknow does not have any rail based public transport service, though Lucknow metro is under construction and its first phase is likely to be completed by the end of 2016. Bus transport is the main mode of public transport in Lucknow.

As is the case in most of the Indian cities, transport demand in Lucknow has increased substantially over the years due to increase in its population as a result of both natural increase and migration from rural areas and smaller towns. Availability of motorized transport, increase in household income, and increase in commercial and industrial activities has further added to it. Unfortunately, public transport systems have not been able to keep pace with the rapid and substantial increase in travel demand. Qualitatively, the available public transport services are overcrowded particularly during peak hours and involve long waiting periods. As a result, there is a massive shift towards personalized transport, specially cars and two-wheelers, and also proliferation of various types of intermediate public transport modes, such as auto-rickshaws and taxis (Singh, 2012). Presently, two-wheelers and cars together constitute 93% of the total vehicles in Lucknow whereas buses constitute only 0.3%.

Although higher level of motorization brings higher level of mobility particularly to the middle- and high-income segments of urban population, but its adverse impact in the form of congestion, air pollution, and traffic accidents is also substantial (Singh, 2015b). Growing traffic and limited road space have reduced peak-hour vehicle speed close to 10 Km/h in the central areas of Lucknow. The ambient air pollution in terms of suspended particulate matters in Lucknow exceeds the limit set by world health organization. City also faces relatively high burden of road traffic accidents in comparison to its counterparts (Singh, 2009). Road traffic fatality risk, number of fatalities per 100,000 people, in Lucknow (17.7) was 50% higher than that in the whole country (11.2) in 2013, latest year for which data is available.

It is amply clear that Lucknow cannot afford to cater only to the private vehicles and there has to be a general recognition that policy should be designed in such a way that reduces the need to travel by personalized modes and boosts public bus transport. Although rising income of the people is one of the most important reasons for greater dependency on personalized modes, the more important reasons are to be found in the public bus transport system itself. Speed, service quality, convenience, flexibility and availability favor adoption of private mode as the main mode of transport. Given the opportunity, people reveal widely divergent transport preferences, but operator favors a basic standard of services. It is often thought to be inegalitarian to provide special services such as premium or guaranteed seats in return for higher fares. As a consequence, those who can afford private vehicle are successively leaving public bus transport (Padam and Singh, 2004). Until recently the main function of public bus transport was to satisfy the individual needs of the less affluent members of society, but now it has to contribute for congestion relief, road safety, and environmental preservation. This requires a fundamental change of emphasis to fulfill its new role of attracting enough people away from the cars, two-wheelers, auto-rickshaws, and taxis

(Singh, 2012). Previous studies on public bus transport services at national and local levels focused on productivity, efficiency, demand, pricing, financial viability, restructuring, impact on congestion, air pollution, carbon dioxide emissions, etc. (see, e.g., Badami and Haider, 2007; Deb and Sundar, 2002; Pucher *et al.*, 2007; Pucher *et al.*, 2005; Pucher *et al.*, 2004; Schipper *et al.*, 2009; Singh, 2014; Singh, 2012; Singh, 2005; Singh, 2002; and Tiwari, 2002), but there is scant literature on passenger satisfaction with public bus transport services in Indian cities and none, to the best of my knowledge, for Lucknow. To retain existing passengers and attract people away from private and para-transit modes, public bus transport operator should try to understand the problems faced by commuters with the existing services and incorporate the changes to improve their satisfaction. Therefore, this study not only tries to assess the passenger satisfaction but also investigate the service quality attributes that influence passenger satisfaction with the public bus transport services in Lucknow. The study also tries to evaluate the relative importance of service quality attributes to find out the priority for service quality improvements to enhance passenger satisfaction.

Public bus transport services in Lucknow is provided by the Lucknow Mahanagar Parivahan Sewa (Lucknow Metropolitan Transport Service) which is under the control of publicly owned Uttar Pradesh State Road Transport Corporation (UPSRTC). Lucknow Mahanagar Parivahan Sewa started its service in 2005 with a fleet strength of 100 buses, thanks to Jawaharlal Nehru National Urban Renewal Mission (JNNURM) project of the Central Government of India. Presently, it has a fleet strength of 300 buses which operate on around 35 routes. All the buses operate with CNG; out of these 300 buses, 20 are AC low-floor, 90 are non-AC low-floor, 60 are semi low-floor, and 120 are mini-buses.

2. Study Area and the Data

Lucknow, the most populous city of Uttar Pradesh, is situated on the banks of Gomti river. Geographically, Lucknow's location is between 26.50 degree North and 80.50 degree east. It is located at the height of 123 meters above sea level and covers an area of approximately 3000 square kilometers (for the map of Lucknow city, see, Figure 1). Lucknow is surrounded by its rural towns and villages like Kakori, Mohanlal Ganj, Malihabad, Gosainganj, Itaunja and Chinhat. Lucknow is in the heart of the great Gangetic plain, with Barabanki district on its eastern side, Unnao district on the west, Raebareli district on the south and Sitapur and Hardoi districts on its northern side (see, Figure 2). Public bus transport services in Lucknow is provided by the Lucknow Mahanagar Parivahan Sewa (Lucknow Metropolitan Transport Service) which operates with 300 CNG-run buses. There are 35 routes in the city and the major terminals include Alambagh, Engineering College, Babu Banarasi Das University, Kaiserbagh, Charbagh, and Budheshwar Chauraha. The bus depots for city buses are Gomti Nagar, Charbagh, Amausi, and Dubagga.

The study is based on primary data collected from 148 respondents of Lucknow city during the period May to July, 2014. The questionnaire was made after going through related studies, consultation with passengers and brainstorming with stakeholders. The passengers of bus transport services in Lucknow, both transit dependent and choice transit riders, were the target group as they are alike in their use of bus transport services but different in their other characteristics such as income, age, gender, profession, etc. The passengers are able to provide first-hand information about the existing level of public bus transport services and the level of satisfaction with the same. Five major bus stops, Alambagh, Charbagh, Polytechnic Chauraha, Engineering College, and Kaiserbagh, were selected for the survey (for bus transport network in Lucknow, see, Figure 3). At each bus stop area, households were chosen randomly on either side of the bus stop; respondents from chosen households were selected on the basis of their age and use of public bus transport. All respondents were between ages of 15 and 70 years. This age group was chosen for the survey mainly because people in this age group is likely to have a routine commuting travel behavior.

A self-rated questionnaire was used for the study; respondents were asked to rate their overall satisfaction with the bus transport services and the factors affecting the same. A seven point Likert type scale where 'delighted' equals 7, 'pleased' equals 6, 'mostly satisfied' equals 5, 'neither satisfied nor dissatisfied (neutral)' equals 4, 'mostly dissatisfied' equals 3, 'unhappy' equals 2, and 'terrible' equals 1 was used for the rating. Apart from this, respondents were also asked about their age, gender, and employment status. Total 148 respondents were systematically sampled and administered the questionnaire across the five spatially-segregated and randomly selected major bus stops (for number of respondents across bus stops, see, Table 1). Out of 148 respondents, 84 were transit-dependent riders, representing 57% of the bus transport passengers interviewed; remaining 64 passengers, 43% of the total, were choice-transit riders. The sample constitutes 59.5% male and 40.5% female. Age of the respondents varies from 15 to 70 years, with average age of 37 years. However, 90% of respondents are younger than 55 years (see, Table 2). The sample has respondents with varied employment status; 30% of them are employed either in government or public sector, 12% in the private sector (9% in the organized private sector and the remaining in the unorganized private sector), and 12% are self-employed. Besides employed people, sample also constitutes people who are not in the work force (44% including 26% students and 5% pensioners) (see, Table 3).

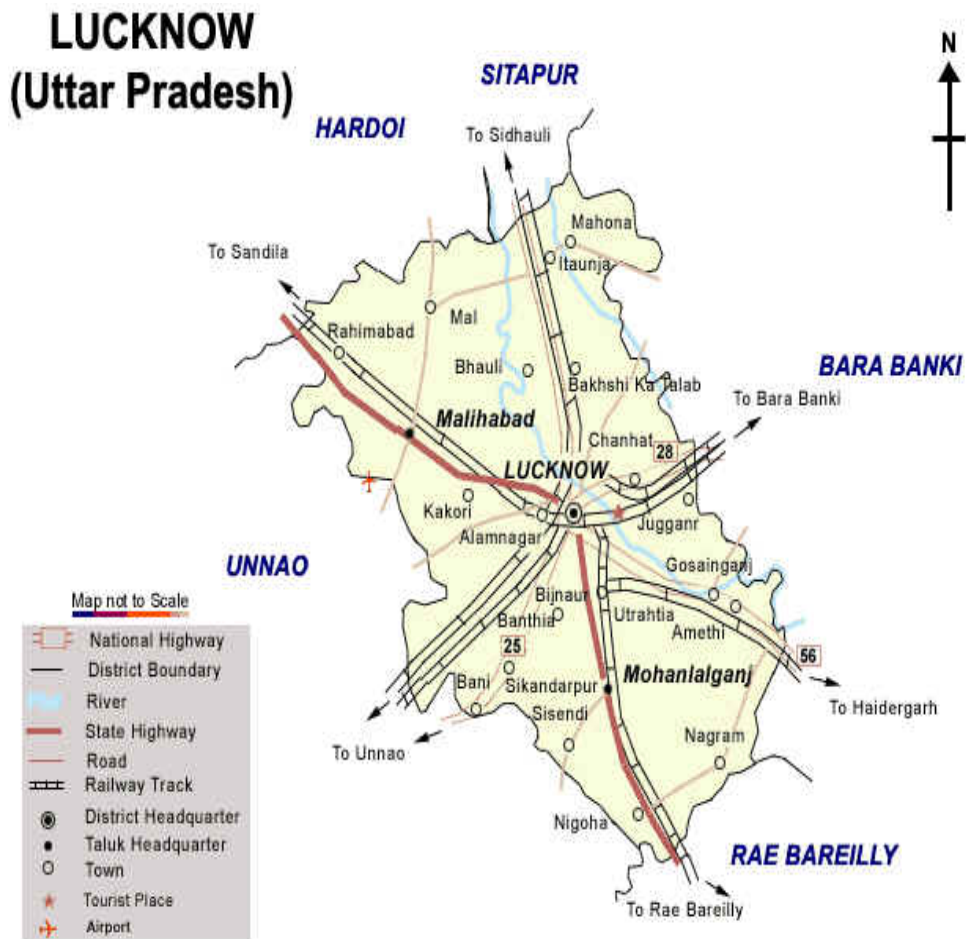
Table 4 presents the factors included in the questionnaire; these factors are assumed to affect the overall satisfaction with public bus transport services. Analysis of overall satisfaction with public bus transport services and factors affecting the same is based on the frequency values obtained from the self-rated questionnaire. A mean value of 4 shows that the respondents are neither satisfied nor dissatisfied (i.e., neutral) whereas mean value above 4 indicates their satisfaction and below 4 indicates their dissatisfaction.

Figure 1: Map of Lucknow city



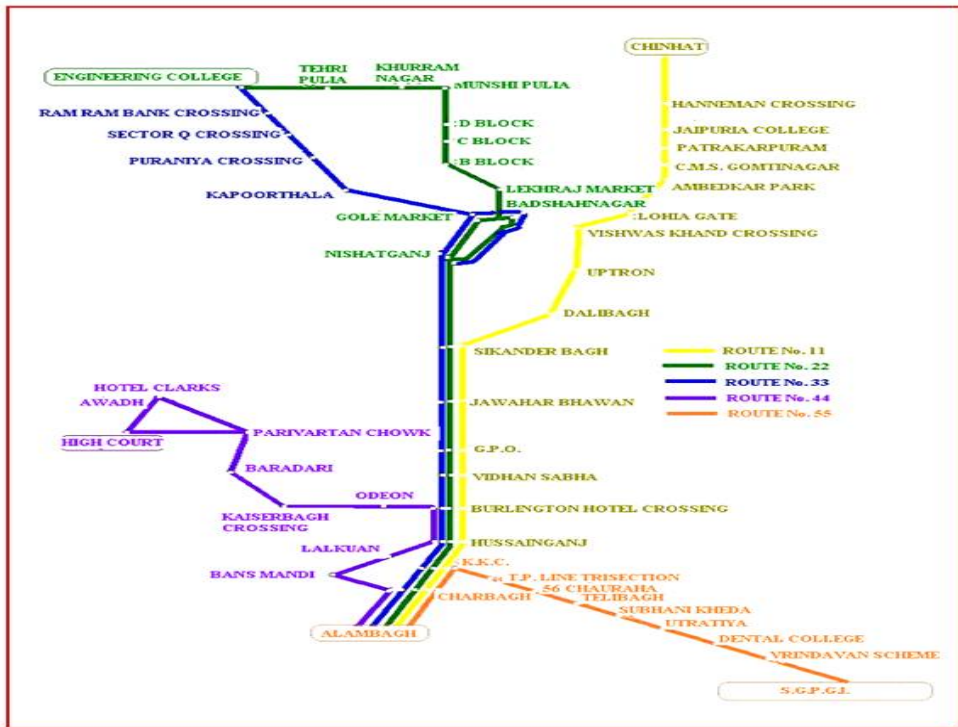
Source: City Map of Lucknow (retrieved on March 4, 2016 from <http://www.mapsofindia.com/maps/uttarpradesh/lucknow-city-map.htm>)

Figure 2: Lucknow and its adjacent districts



Source: Official Website of Lucknow (<http://lucknow.nic.in/>; retrieved on April 4, 2016 from <http://lucknow.nic.in/lucknow-map/Distri1.jpg>)

Figure 3: Bus transport network in Lucknow



Source: Lucknow Mahanagar Parivahan Sewa, Lucknow.

Table 1: Number of respondents across five major bus stops

| Sr. No. | Bus stop | Transit-dependent rider | Choice-dependent rider | Total number of respondents |
|---------|----------------------|-------------------------|------------------------|-----------------------------|
| 1 | Alambagh | 23 | 17 | 40 (27%) |
| 2 | Charbagh | 27 | 13 | 40 (27%) |
| 3 | Polytechnic Chauraha | 12 | 11 | 23 (16%) |
| 4 | Engineering College | 20 | 20 | 40 (27%) |
| 5 | Kaiserbagh | 2 | 3 | 5 (3%) |

Table 2: Age profile of the respondents

| Age group (in year) | Number of respondents | Percentage of respondents |
|---------------------|-----------------------|---------------------------|
| 15-25 | 40 | 27 |
| 25-35 | 30 | 20 |
| 35-45 | 33 | 22 |
| 45-55 | 31 | 21 |
| 55-70 | 14 | 10 |

Table 3: Employment status of the respondents

| Employment status | Number of respondents | Percentage of respondents |
|--------------------------|------------------------------|----------------------------------|
| Government sector | 31 | 21 |
| Public sector | 14 | 9 |
| Private organized | 14 | 9 |
| Private unorganized | 5 | 3 |
| Self-employed | 18 | 12 |
| Unemployed | 2 | 1 |
| Pensioner | 8 | 5 |
| Student | 38 | 26 |
| Housewife | 18 | 12 |

Table 4: Factors affecting the overall satisfaction with public bus transport services

| Factor code | Factor description |
|--------------------|---|
| X ₁ | Availability of seats in buses |
| X ₂ | Enough leg-space in buses |
| X ₃ | Frequency of bus service |
| X ₄ | Short waiting time at bus stop |
| X ₅ | Facilities inside buses are in good condition |
| X ₆ | Bus stops have enough shelters |
| X ₇ | Ceiling heights of buses are comfortable |
| X ₈ | Buses are well maintained |
| X ₉ | Short passenger walking distance to bus stops |
| X ₁₀ | Sufficient benches available at bus stops |
| X ₁₁ | Sufficient number of buses in city |
| X ₁₂ | Affordable fare |
| X ₁₃ | Safety of passengers on board |
| X ₁₄ | Not afraid of being pick-pocketed on bus |
| X ₁₅ | Buses provide short travel time |
| X ₁₆ | Drivers and conductor behave well |
| X ₁₇ | Buses are clean inside |
| X ₁₈ | Sense of personal safety (vis-à-vis IPTs such as auto-rickshaws, e-rickshaws, Vikrams, and taxis) |
| Y | Overall satisfaction with public bus transport services |

3. Method

To determine the key factors affecting the satisfaction with public bus transport services, this study uses principal component analysis (PCA). Principal component analysis is simply a variable reduction procedure that typically results in a relatively small number of components that account for most of the variance in a set of observed variables. It replaces the original variables by a smaller number of principal components, which are linear combinations of the original variables. Often, it is possible to retain most of the variability in the original variables with smaller number of

principal components (Jolliffe, 2005). PCA minimizes the sum of the squared perpendicular distances to the axis of the principal component. By reducing a data set from a group of related variables into a smaller set of components, the PCA achieves parsimony by explaining the maximum amount of common variance using the smallest number of explanatory concepts (for detail on this, see, Field, 2005). In general, PCA is undertaken in cases where there is sufficient correlation among the original variables to warrant the factor/component representation. Also, PCA requires sample size to be greater than 100 or at least 5 times the number of variables.

In PCA, most commonly used criterion to retain number of components/factors is the eigenvalue-one criterion, also known as Kaiser criterion (Kaiser, 1960). The eigenvalues are representations of the variance variables share. With eigenvalue-one criterion, components with eigenvalues greater than 1 are retained. However, there is a considerable chance that too many components are retained (Costello and Osborne, 2005 and Zwick and Velicer, 1986). So, it is important to consider other criteria as well for component retention before drawing any conclusion. With the scree test (Cattell, 1966), the eigenvalues associated with each component is plotted. A 'break' between the components with relatively large eigenvalues and those with small eigenvalues is found. Factor loadings above 0.40 are relevant and can be included in the result (Hair *et al.*, 1998). Moreover, a minimum of at least three significant loadings are required for factor identification (Zwick and Velice, 1986). The retained components/factors can be interpreted on the basis of the variables that they load upon significantly and may be named accordingly. The retained factors/components are rotated orthogonally to make it easier to interpret the retained components. The first component extracted in a principal component analysis accounts for a maximal amount of total variance in the observed variables. Each succeeding component will account for progressively smaller amount of variance in the dataset and are uncorrelated to all previous components.

This study uses rotated PCA method to reduce the 18 selected factors into few principal components. The rotated PCA method rotates the PCA eigenvectors, so they point closer to the local clusters of data points. There are several analytical choices of rotation that were proposed in the past. One of them is the varimax method of orthogonal rotation. The varimax rotation criterion maximizes the sum of the variances of the squared coefficients within each eigenvector, and the rotated axes remain orthogonal (Lin and Altman, 2004). Also, varimax rotation ensures that the resulting components are uncorrelated to each other. This study uses varimax method of orthogonal rotation for rotated principal component analysis. Statistical Analysis Software (SAS) is used to evaluate the survey data by PCA.

Besides principal component analysis, this study also uses descriptive analysis to analyze the satisfaction with public bus transport services in Lucknow and factors affecting the same. In descriptive analysis, passenger satisfaction is analyzed according to various socio-economic and demographic indicators. The study also examines the linkages between passenger satisfaction and various factors affecting the same.

4. Results and discussion

Descriptive analysis

Table 5 presents descriptive statistics of overall satisfaction with public bus transport services in Lucknow and various factors affecting the same on a scale of 1 to 7. It is found that the people of Lucknow is mostly dissatisfied with existing public bus transport services, with a mean score of 2.9. Only 11 percent respondents felt satisfaction with the existing services, though only 1 percent are 'pleased' and none of the respondents felt 'delighted'. Majority of the respondents are found to be dissatisfied; 14 percent of them felt 'terrible', 26 percent are 'unhappy' and 33 percent are 'mostly dissatisfied'. Therefore, out of 148 respondents, 73 percent are dissatisfied with the existing public transport services in Lucknow (Figure 4).

The statistical frequency distribution of respondents' perception of the overall satisfaction and specific service quality attributes that affect their satisfaction with the existing public bus transport services in the city of Lucknow is presented in Table 6. This table reveals that the specific service quality attributes of public bus transport services that affect passenger satisfaction are also poorly perceived. For instance, variable X_{17} (buses are clean inside), with a mean score of 2.3 (<4.0) and coefficient of variation of 0.60, recorded 37.2 percent under 'terrible', 23.6 percent under 'unhappy', and 24.3 percent under 'mostly dissatisfied', i.e., more than 85 percent people are dissatisfied with the cleanliness inside buses. Similarly, 85 percent respondents perceive that buses are ill-maintained, more than 76 percent are afraid of being pick-pocketed during their journey, and close to 74 percent feel that the facilities inside buses are not in good condition. Therefore, four variables, X_{17} (buses are clean inside), X_8 (buses are well maintained), X_{14} (not afraid of being pick-pocketed on bus), and X_5 (facilities inside buses are in good condition), have mean score of 2.3, 2.3, 2.6, and 2.6, respectively. Only two variables somewhat met the expectation of passengers in the city of Lucknow. The first variable is X_{12} (affordable fare), with a mean score of 4.0 and coefficient of variation of 0.40 whereas the second variable is X_7 (ceiling height of buses are comfortable), with a mean score of 3.9 and coefficient of variation of 0.34. However, none of the variables could exceed the mean score of 4. In other words, out of 18 variables analyzed, 16 service quality attributes of public bus transport service in the city of Lucknow were unsatisfactorily perceived by passengers. Only two variables (X_{12} and X_7) somewhat met the expectation of passengers; in fact, passengers were undecided on these two variables, X_{12} and X_7 . This shows that the passengers of public bus transport are not satisfied with the services provided in the city of Lucknow.

However, the level of satisfaction or dissatisfaction defers according to socio-economic and demographic profiles of the respondents. If we compare the overall satisfaction with public bus transport services of males with females, we found that females experienced marginally higher level of satisfaction. Three out of every four male respondents were dissatisfied whereas corresponding figure for female respondents is seven out of ten. It is observed that the satisfaction with public bus transport services varies across age group, though none of the age group is satisfied

with the existing services (Figure 5). People from age group 15-25 years and 41-60 years are mostly dissatisfied with mean score of 3.0. People who are more than 60 years old have slightly better perception about the existing services with mean score of 3.6. Moreover, the most economically active people who belong to the age group of 26-40 years have worst perception about public bus transport services in Lucknow with mean score of 2.5. Almost half of the people of this group were either 'unhappy' or felt 'terrible' with existing bus transport services; only 6 percent of them were satisfied.

Respondents' overall satisfaction with public bus transport services in Lucknow also varies according to their employment status (Figure 6). For instance, people working in private unorganized sector have better perception about the service (with mean score of 3.4) than the people working in private organized sector (with mean score of 2.4). Figure 6 shows that most of the people who are either self-employed or employed in government/public/private organized sector are either 'unhappy' or 'mostly dissatisfied' with existing services. Pensioners, housewives, students, and unemployed people are mostly dissatisfied. It is interesting to note that the unemployed people have relatively lower level of satisfaction than unorganized sector employees. This may be because most of the unemployed people are unemployed because they are unable to find suitable job and they usually belong to relatively well-off families than the people working in unorganized sector. In general, relatively economically well-off people rated public bus transport service quality lower than the worse off ones. This may be because expectation about the service and degree of satisfaction or dissatisfaction depends on people's economic wellbeing and consequently on their employment status. In general, *ceteris paribus*, as income increases, overall satisfaction with public bus transport services decreases. It is because middle and high income people can afford to have private vehicle which is likely to be faster, comfortable and convenient vis-à-vis public bus transport. That's why, choice dependent riders have lower perception (with mean score of 2.7) about existing services than the transit dependent riders (with mean score of 3.0). Similarly, people who travelled daily in public bus transport buses have higher perception about the prevailing services than those who travelled three to six days per week or one to two days per week. In fact, as number of days travelled per week in public bus transport buses increases, dissatisfaction with prevailing services decreases (Figure 7).

Commuters' overall satisfaction with public bus transport services in Lucknow seems to vary across bus stops as well. Satisfaction score is the lowest for Kaiserbagh and Engineering College bus stops (with mean score of 2.6) whereas Alambagh bus stop is rated as the best one (with mean score of 3.1). Commuters' rating for Charbagh and Polytechnic Chauraha bus stops is 2.9 out of 7 (Figure 8). This shows that commuters are not satisfied with overall services at any bus stop. However, Alambagh, being the main bus stop of Lucknow, has relatively better facilities for the commuters.

Public transport in cities not only enables people to access jobs and services, employers to access labor markets, and businesses to reach the customers for their services but also affect the quality of life of people. Good public transport can reduce air pollution and traffic accidents and is fundamental in the drive to create a more

inclusive society. Public transport, therefore, affects the quality of life we enjoy today in all of our cities and towns. In this study, we also asked commuters of Lucknow whether their quality of life is affected by the existing public bus transport services. Nearly 70% of the respondents told that their quality of life is indeed affected by the public bus transport services. This clearly shows that public transport not only creates economic and environmental benefits but also social benefits. Therefore, improving the public transport systems is the only way in which the future challenges of urban growth and mobility and sustainable development can be successfully tackled.

Table 5: Level of people's satisfaction with public bus transport services and factors affecting the same

| Factors | Mean | Coefficient of variation |
|--|-------------|---------------------------------|
| Overall satisfaction with public bus transport services (Y) | 2.9 | 0.43 |
| Availability of seats in buses (X ₁) | 3.0 | 0.46 |
| Enough leg-space in buses (X ₂) | 3.2 | 0.44 |
| Frequency of bus service (X ₃) | 3.6 | 0.41 |
| Short waiting time at bus stop (X ₄) | 3.4 | 0.44 |
| Facilities inside buses are in good condition (X ₅) | 2.6 | 0.55 |
| Bus stops have enough shelters (X ₆) | 3.0 | 0.44 |
| Ceiling heights of buses are comfortable (X ₇) | 3.9 | 0.34 |
| Buses are well maintained (X ₈) | 2.3 | 0.49 |
| Short passenger walking distance to bus stops (X ₉) | 3.3 | 0.42 |
| Sufficient benches available at bus stops (X ₁₀) | 3.1 | 0.45 |
| Sufficient number of buses in city (X ₁₁) | 3.6 | 0.43 |
| Affordable fare (X ₁₂) | 4.0 | 0.40 |
| Safety of passengers on board (X ₁₃) | 3.0 | 0.47 |
| Not afraid of being pick-pocketed on bus (X ₁₄) | 2.6 | 0.47 |
| Buses provide short travel time (X ₁₅) | 3.4 | 0.42 |
| Drivers and conductor behave well (X ₁₆) | 3.3 | 0.50 |
| Buses are clean inside (X ₁₇) | 2.3 | 0.60 |
| Sense of personal safety (vis-à-vis IPTs such as auto-rickshaws, e-rickshaws, Vikrams, and taxis) (X ₁₈) | 3.3 | 0.45 |

Table 6: Absolute and relative frequency distribution of satisfaction with public bus transport services and factors affecting the same (N=148)

| Variable Code | Terrible (N, %) | Unhappy (N, %) | Mostly dissatisfied (N, %) | Neutral (N, %) | Mostly satisfied (N, %) | Pleased (N, %) | Delighted (N, %) | Mean |
|-----------------|-----------------|----------------|----------------------------|----------------|-------------------------|----------------|------------------|------|
| Y | 21, 14.2 | 38, 25.7 | 49, 33.1 | 24, 16.2 | 14, 9.5 | 2, 1.4 | 0, 0.0 | 2.9 |
| X ₁ | 26, 17.6 | 32, 21.6 | 36, 24.3 | 26, 17.6 | 26, 17.6 | 2, 1.4 | 0, 0.0 | 3.0 |
| X ₂ | 22, 14.9 | 21, 14.2 | 47, 31.8 | 23, 15.5 | 30, 20.3 | 4, 2.7 | 1, 0.7 | 3.2 |
| X ₃ | 17, 11.5 | 22, 14.9 | 21, 14.2 | 43, 29.1 | 35, 23.6 | 10, 6.8 | 0, 0.0 | 3.6 |
| X ₄ | 19, 12.8 | 25, 16.9 | 34, 23.0 | 31, 20.9 | 28, 18.9 | 10, 6.8 | 1, 0.7 | 3.4 |
| X ₅ | 40, 27.0 | 38, 25.7 | 31, 20.9 | 20, 13.5 | 14, 9.5 | 4, 2.7 | 1, 0.7 | 2.6 |
| X ₆ | 22, 14.9 | 32, 21.6 | 40, 27.0 | 34, 23.0 | 16, 10.8 | 4, 2.7 | 0, 0.0 | 3.0 |
| X ₇ | 10, 6.8 | 15, 10.1 | 24, 16.2 | 45, 30.4 | 46, 31.1 | 8, 5.4 | 0, 0.0 | 3.9 |
| X ₈ | 40, 27.0 | 46, 31.1 | 40, 27.0 | 18, 12.2 | 2, 1.4 | 1, 0.7 | 1, 0.7 | 2.3 |
| X ₉ | 25, 16.9 | 11, 7.4 | 38, 25.7 | 48, 32.4 | 19, 12.8 | 7, 4.7 | 0, 0.0 | 3.3 |
| X ₁₀ | 24, 16.2 | 23, 15.5 | 44, 29.7 | 29, 19.6 | 22, 14.9 | 6, 4.1 | 0, 0.0 | 3.1 |
| X ₁₁ | 18, 12.2 | 27, 18.2 | 16, 10.8 | 28, 18.9 | 47, 31.8 | 12, 8.1 | 0, 0.0 | 3.6 |
| X ₁₂ | 10, 6.8 | 16, 10.8 | 35, 23.6 | 23, 15.5 | 36, 24.3 | 20, 13.5 | 8, 5.4 | 4.0 |
| X ₁₃ | 23, 15.5 | 37, 25.0 | 28, 18.9 | 39, 26.4 | 14, 9.5 | 5, 3.4 | 2, 1.4 | 3.0 |
| X ₁₄ | 33, 22.3 | 34, 23.0 | 46, 31.1 | 25, 16.9 | 8, 5.4 | 2, 1.4 | 0, 0.0 | 2.6 |
| X ₁₅ | 19, 12.8 | 23, 15.5 | 27, 18.2 | 46, 31.1 | 23, 15.5 | 9, 6.1 | 1, 0.7 | 3.4 |
| X ₁₆ | 32, 21.6 | 16, 10.8 | 27, 18.2 | 35, 23.6 | 20, 13.5 | 18, 12.2 | 0, 0.0 | 3.3 |
| X ₁₇ | 55, 37.2 | 35, 23.6 | 36, 24.3 | 10, 6.8 | 4, 2.7 | 8, 5.4 | 0, 0.0 | 2.3 |
| X ₁₈ | 25, 16.9 | 19, 12.8 | 34, 23.0 | 35, 23.6 | 25, 16.9 | 10, 6.8 | 0, 0.0 | 3.3 |

Figure 4: People's satisfaction with public bus transport services in Lucknow

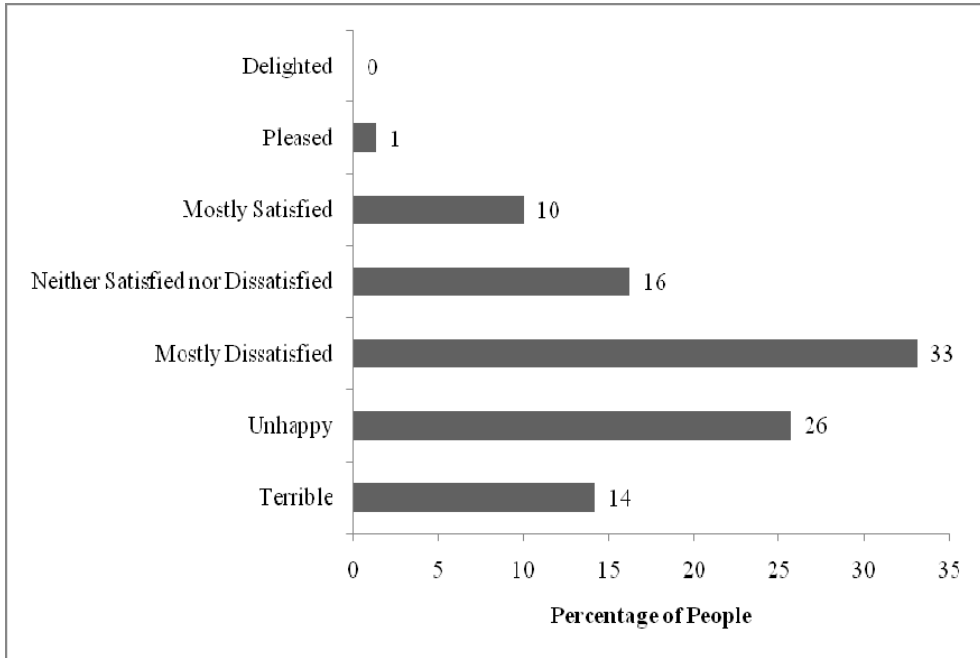


Figure 5: Satisfaction with public bus transport services according to age group

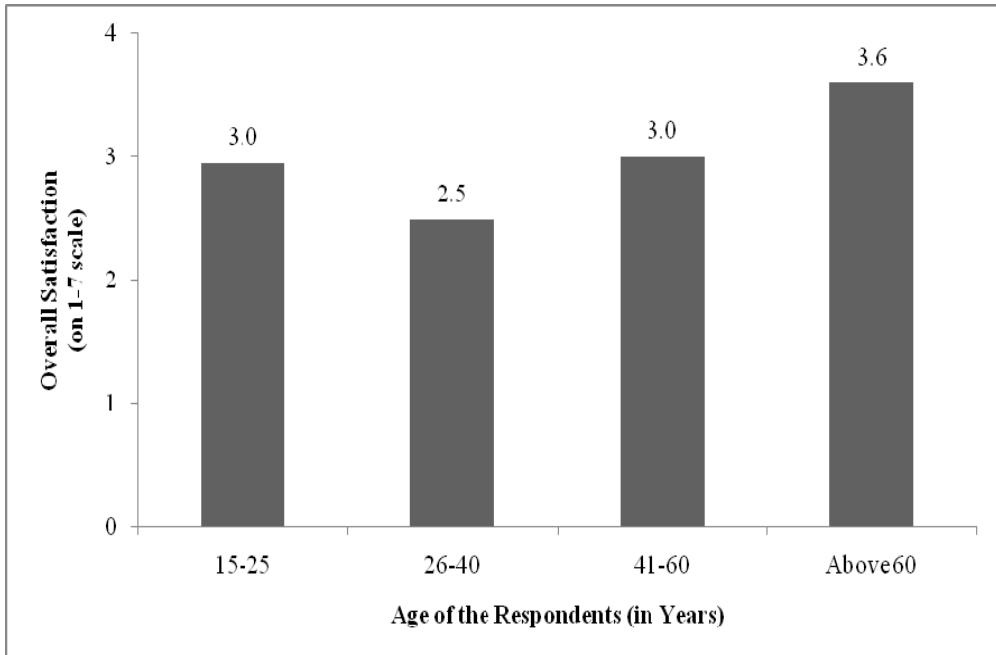


Figure 6: Satisfaction with public bus transport services according to employment status

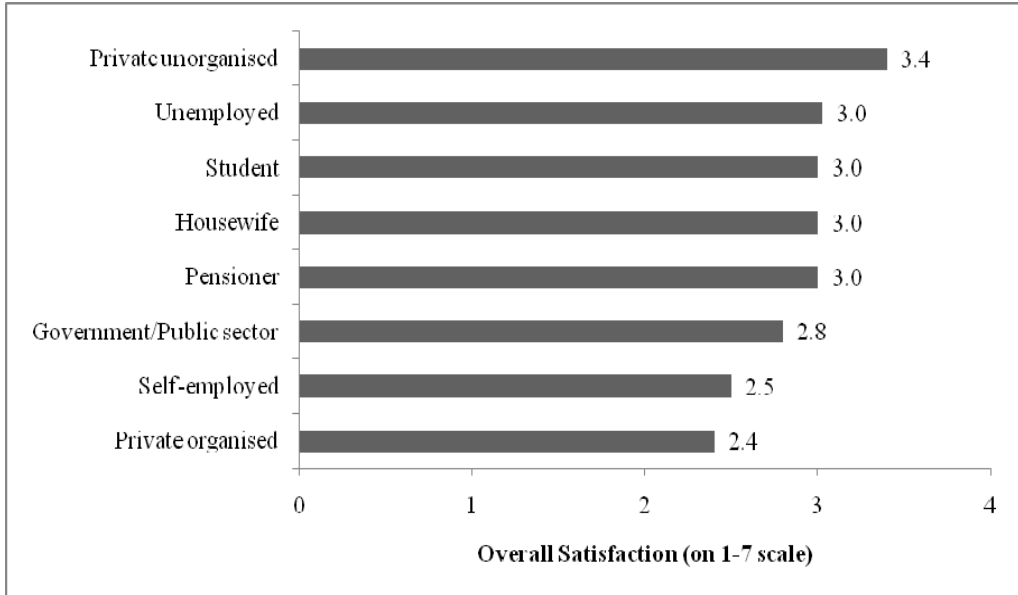


Figure 7: Satisfaction with public bus transport services according to number of days travelled per week

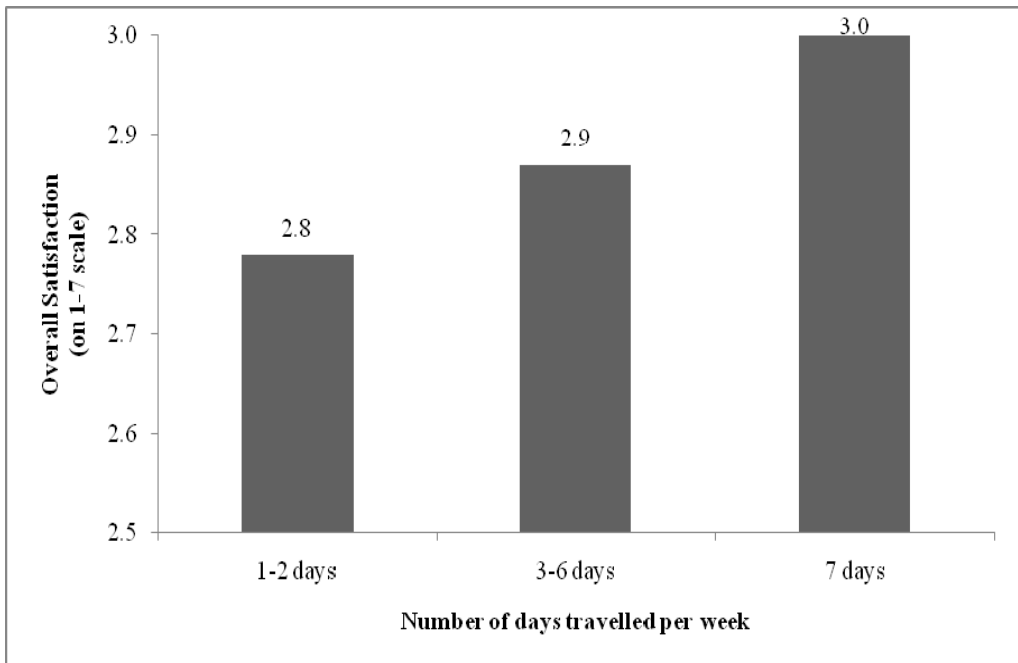
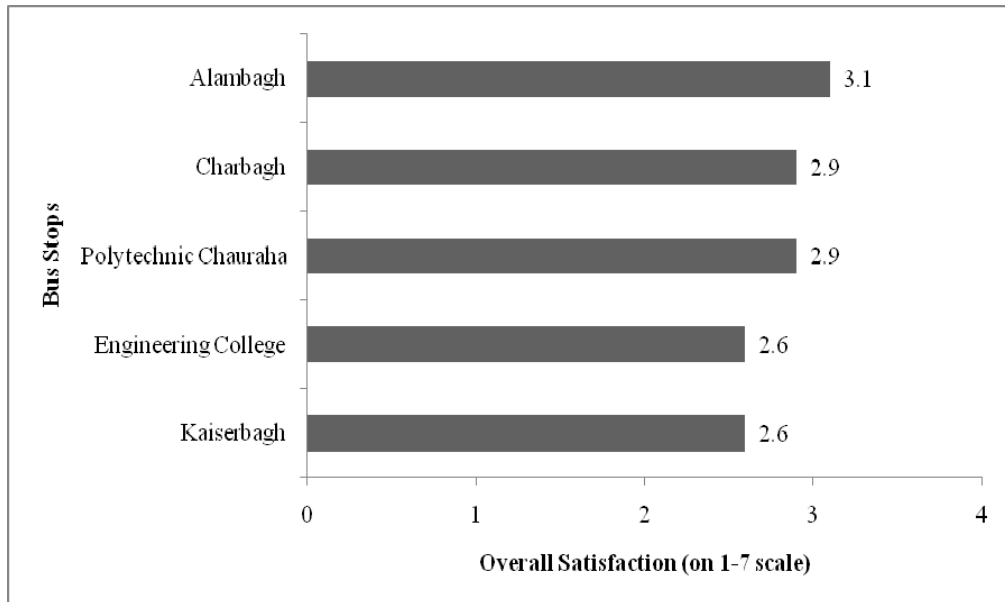


Figure 8: Satisfaction with public bus transport services at different bus stops in Lucknow



Principal component analysis

The 18 bus transport service quality attributes were transformed into a matrix of inter-correlation between the variables to know the strength of their correlations. We found that there are strong inter-correlation between the variables, which accounted for the existence of many redundancies among some variables. To remove the effect of these strong inter-correlations, as well as include the contributions of the apparently redundant variables, PCA is employed to collapse the 18 specific service quality attributes into a few orthogonal factors that could define broader areas for planning and action by the UPSRTC in the provision of public bus transport services in the city of Lucknow.

In other words, PCA is used to identify the most important factors/components that influence the passenger satisfaction with the public bus transport services in Lucknow. With eigenvalue-one criterion, components with eigenvalues greater than 1 are retained. With this criterion, six components are retained. However, there is a chance that too many components are retained (Costello and Osborne, 2005). When we use the interpretability criteria along with eigenvalue-one criterion, a total of five factors are retained. The retained factors/components are rotated orthogonally to make it easier to interpret the retained components. The results of the analysis of the varimax rotated components are presented in Table 7, which succeeded in reducing the 18 variables to 5 components. The 5 components together explained approximately 55 per cent of the total variance. All the five components have positive loadings on their respective significant variables (see, Table 8).

Component 1 has an eigenvalue of 2.435 and accounts for 13.5 percent of the total variance. This component has high positive loadings on availability of seats in buses (X_1), enough leg-space in buses (X_2), safety of passengers on board (X_{13}), and not afraid of being pick-pocketed on bus (X_{14}). Component 1 points to the fact that comfort and safety during travel have significant influence on passengers' satisfaction. Thus, this component can be called as "comfort and safety in buses".

First principal component shows that security on board and comfort level provided by Lucknow city buses is a major concern; in general, passenger discomfort worsens during peak hours when many passengers have to travel standing all the way in crowded condition. Chances of being pick-pocketed gets increased with discomfort level when many passengers travel in standing. Comfort is an important consideration for passengers of public bus transport; therefore, basic level of comfort must be established and monitored to ensure that the Lucknow Mahanagar Parivahan Sewa adhere to them. If comfort level is increased, passenger satisfaction may lead to increased patronage in the use of public bus transport services in the city of Lucknow. This finding is in line with the findings of Nwachukwu (2014), Straddling *et al.* (2007) and Andaleeb *et al.* (2007) that comfort has the greatest impact on passenger satisfaction. Since feeling unsafe could affect the people's willingness to travel by public bus transport, increasing supervision in the bus by adding security personal on board or installing the monitoring device on the public bus transport could increase the feeling of safety and influence overall satisfaction with public bus transport.

Component 2 has an eigenvalue of 2.111 and it explains 11.7 percent of the total variance. This component has high positive loadings on short passenger walking distance to bus stops (X_9), sufficient benches available at bus stops (X_{10}), and sufficient number of buses in city (X_{11}). These variables are mainly related to adequate availability of public bus transport services across the city. Thus, component 2 can be called as "adequacy of the capacity of public bus transport services". Second principal component reveals that passengers' satisfaction gets reduced if they perceive inadequacy of the capacity of public bus transport services to serve their needs. There is indeed a problem of capacity in public bus transport services in the city of Lucknow; presently, Lucknow Mahanagar Parivahan Sewa operates with only 300 buses. In general, 600 to 700 buses per million population are required for adequate supply of bus transport services in cities; therefore, Lucknow with a population of more than 2.8 million needs around 1700 buses for adequate supply of bus transport services in the city. Unavailability of sufficient number of buses in the city of Lucknow is reflected in the long waiting lines and times, the frantic struggle to board the bus upon its arrival at bus stops, and the unavailability of seats in buses particularly during peak hours. If sufficient number of buses are provided for Lucknow commuters, enabling them to reach their destinations comfortably and on time, it will interest more people to use public transport buses for their daily travel needs.

Component 3 extracted from the analysis includes buses are well maintained (X_8) and buses are clean inside (X_{17}). This component has eigenvalue of 1.920 and accounts for 10.7 percent of the total variance. It mainly describes the orderly and

clean environment inside buses. Thus, component 3 can be called as "orderly and clean environment inside buses". This component shows that passengers' satisfaction gets influenced by whether buses are neat and clean or not. In general, Lucknow Mahanagar Parivahan Sewa lacks in cleanliness of both interior as well exterior of its buses. Buses are rarely clean; buses don't have trash cans on them, and passengers regularly toss food wrappers, cold drink cans, and water bottles on the floor. Sometime, movement of cockroaches, wet seats, and bad smell are noticed. Findings of passenger survey reveals that cleanliness of the bus should be considered very important, more important than cost of the trip, frequency of service, and facilities at bus stops for many riders. Therefore, Lucknow Mahanagar Parivahan Sewa should pay serious attention to orderly and clean environment inside its buses.

Component 4 accounts for 10.2 percent of the total variance with eigenvalue of 1.826. This component has positive loadings on X_6 (bus stops have enough shelters) and X_7 (ceiling heights of buses are comfortable). These variables are related to facilities at bus stops and design and dimension of buses. Thus, this component can be called as "elegant design of buses and bus stops". In general, bus stop facilities in Lucknow are inadequate. Inadequate facilities at bus stops and low ceiling height of buses are identified as another source of dissatisfaction among Lucknow commuters. Very few bus stops in Lucknow offer appropriate physical structures and facilities for riders; many bus stops do not even have shelters to protect passengers from sun, rain, dust, and air pollution. There are very few bus stops with appropriate number of benches; many passengers have no place to sit for a long wait at bus stops, so there is no alternative but to remain standing. It's amply clear that unless bus stop facilities are improved adequately, there is no way private vehicle users particularly car owners can be attracted towards public bus transport services. Therefore, Lucknow Mahanagar Parivahan Sewa should start improving its bus stops and go for elegant design of buses and bus stops to attract passengers from all sections of society.

Component 5 has an eigenvalue of 1.583 and accounts for 8.8 percent of the total variance. The component has high positive loadings on frequency of bus service (X_3), short waiting time at bus stop (X_4), and facilities inside buses are in good condition (X_5). These variables are mainly related to accessibility to public bus transport services and thus, component 5 can be called as "accessibility to public bus transport services". Poor accessibility to public bus transport services in Lucknow is identified as another factor leading to passenger dissatisfaction. Passengers perceive that bus routes are not well spread in the city, which in turn reduces the accessibility by bus to many areas of the city. Many passengers require to walk long distances before getting to the nearest bus stop to catch a bus. Furthermore, many passengers face long waiting time at bus stops due to low frequency of bus services. In general, bus riders do not wish to walk very far to their bus stops, and having arrived at the bus stop, they do not wish to wait for very long (Faulks, 1990). Therefore, there is an urgent need to increase the frequency of bus transport services in the city of Lucknow. The current situation of accessibility will not encourage people particularly private vehicle users to use public bus transport for their daily travels.

The internal consistency for each of the factors along with the measures of satisfaction are examined using Cronbach's alpha (α). Cronbach's alpha is found to be 0.70 which is same as the minimum value recommended by Nunnally (1978). Table 9 presents the correlation among underlying factors identified. This table clearly shows that there is a low correlation between different underlying factors, the highest being 0.242 between 'comfort and safety in buses' and 'accessibility to public bus transport services'. This reveals that all the five underlying factors are independent, which indicates that they are measuring unrelated dimensions. The result shows that the key determinants of passengers' satisfaction in the city of Lucknow are comfort and safety in buses, adequacy of the capacity of public bus transport services, orderly and clean environment inside buses, elegant design of buses and bus stops, and accessibility to public bus transport services.

Table 7: Total variance explained by different components

| Principal Component | Initial Eigenvalues | | | Rotation Sums of Squared Loadings | | |
|---------------------|---------------------|---------------|--------------|-----------------------------------|---------------|--------------|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 3.293 | 18.3 | 18.3 | 2.435 | 13.5 | 13.5 |
| 2 | 2.018 | 11.2 | 29.5 | 2.111 | 11.7 | 25.2 |
| 3 | 1.825 | 10.1 | 39.6 | 1.920 | 10.7 | 35.9 |
| 4 | 1.543 | 8.6 | 48.2 | 1.826 | 10.2 | 46.1 |
| 5 | 1.196 | 6.7 | 54.9 | 1.583 | 8.8 | 54.9 |

Table 8: Factor loadings of the retained components on the original variables after orthogonal (varimax) rotation

| Variable Code | Principal Component | | | | |
|-----------------|------------------------------------|--|---|--|---|
| | 1 (comfort and safety in buses) | 2 (adequacy of the capacity of public bus transport services) | 3 (orderly and clean environment inside buses) | 4 (elegant design of buses and bus stops) | 5 (accessibility to public bus transport services) |
| X ₁ | 56* | 27 | -1 | 29 | 1 |
| X ₂ | 72* | 13 | 19 | 14 | 23 |
| X ₃ | 38 | 29 | -27 | 35 | 52* |
| X ₄ | 6 | 15 | -3 | -3 | 86* |
| X ₅ | -4 | -22 | 47 | 8 | 54* |
| X ₆ | 2 | -26 | 31 | 69* | 11 |
| X ₇ | 23 | -3 | -13 | 74* | -4 |
| X ₈ | 5 | 25 | 66* | 2 | -12 |
| X ₉ | 7 | 76* | 14 | -4 | 5 |
| X ₁₀ | -1 | 78* | 6 | -6 | 0 |
| X ₁₁ | 15 | 54* | -26 | 37 | 20 |
| X ₁₂ | -14 | 9 | -48 | 27 | 23 |
| X ₁₃ | 68* | -16 | 0 | 0 | 15 |
| X ₁₄ | 79* | -9 | 0 | -15 | -13 |
| X ₁₅ | 6 | 26 | -21 | 41 | 2 |

| | | | | | |
|-----------------------|-----|----|-----|----|----|
| X₁₆ | -10 | 37 | 40 | 38 | 8 |
| X₁₇ | 13 | -1 | 71* | -3 | 23 |
| X₁₈ | 48 | 14 | 10 | 15 | -4 |

Note: The original values are multiplied by 100 and rounded off to the nearest integer. Original values greater than 0.5 are flagged by an '*'.

Table 9: Factor correlation matrix

| Factor | Comfort and safety in buses | Adequacy of the capacity of public bus transport services | Orderly and clean environment inside buses | Elegant design of buses and bus stops | Accessibility to public bus transport services |
|---|-----------------------------|---|--|---------------------------------------|--|
| Comfort and safety in buses | 1.000 | 0.137 | 0.163 | 0.217 | 0.242 |
| Adequacy of the capacity of public bus transport services | 0.137 | 1.000 | 0.079 | 0.007 | 0.202 |
| Orderly and clean environment inside buses | 0.163 | 0.079 | 1.000 | 0.070 | 0.149 |
| Elegant design of buses and bus stops | 0.217 | 0.007 | 0.070 | 1.000 | 0.199 |
| Accessibility to public bus transport services | 0.242 | 0.202 | 0.149 | 0.199 | 1.000 |

5. Conclusions and recommendations

The study has shown that commuters of Lucknow are mostly dissatisfied with the bus transport services provided by publicly owned operator, Lucknow Mahanagar Parivahan Sewa. PCA result reveals that the factors that influence passenger satisfaction are comfort and safety in buses, adequacy of the capacity of public bus transport services, orderly and clean environment inside buses, elegant design of buses and bus stops, and accessibility to public bus transport services. The study thus provides a direction for Lucknow Mahanagar Parivahan Sewa administration to identify the areas for improvement so that passenger satisfaction with public bus transport services in Lucknow can be enhanced.

Based on the findings of this study, the following recommendations are made to Lucknow Mahanagar Parivahan Sewa administration to improve the public bus transport services in Lucknow. Comfort and security on board is a major concern of Lucknow commuters; thus, basic level of comfort and check on pick-pocketing and on

board theft must be established and monitored by the UPSRTC and the State Government to ensure that the Lucknow Mahanagar Parivahan Sewa abide by them. To control pick-pocketing and on board theft, operator should launch an initiative that aims to disrupt and deter thieves who target unsuspecting commuters and tourists, while also educating members of the public about how they can best look after their property on buses and at bus stations. Thus, there is a need to install CCTV in buses as well as at bus stations besides putting larceny posters to sensitise commuters to take appropriate care. State Government of Uttar Pradesh should collaborate and cooperate with UPSRTC to increase the frequency of bus transport services in the city to reduce the passenger waiting time at bus stops and walking distance to bus stops. Bus stops should be developed on the lines of green infrastructure with elegant design and sufficient benches and shelters should be provided at bus stops to ensure a comfortable resting place for commuters. Lucknow Mahanagar Parivahan Sewa buses lacks in cleanliness; findings of this study reveal that exterior as well as interior cleanliness of buses is of great value for many commuters. Therefore, operator should pay serious attention to cleanliness of its buses and do the needful to improve the same. To begin with, Lucknow Mahanagar Parivahan Sewa should put a trash can in all its buses and ensure that the trash cans are cleaned regularly. Like Ahmedabad in the state of Gujarat in India, Lucknow should also try to develop bus-based mass transit system, BRT (bus rapid transit), through the provision of dedicated lanes. The introduction of dedicated bus lanes will reduce bus travel time and increase service frequency which will encourage more people including private vehicle users to use public bus transport. The existing roads should be repaired and maintained properly and the delayed road projects should be completed on time to have an efficient road network in the city. This will not only reduce the bus travel time but also increase the accessibility to encourage the operator to provide bus transport services to more areas in the city.

Acknowledgement

This study is part of a seed money project sponsored by the Indian Institute of Management, Lucknow, India. I am thankful to the Director and Dean of the institute for providing me with an initiation grant for the study.

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