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Assessment of Service Quality of Public Bus based on Comfort Features

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Abstract
Since the major portion of public transportation in the Kathmandu is covered by the bus services, it has become increasingly important to conduct regular assessment of user satisfaction with these services. Although many researchers have attempted to assess the service quality of public transportation, few have attempted to benchmark service quality of qualitative features such as comforts in public buses, which are often difficult to describe quantitatively. The main propose of this this paper is to determine the benchmark level of service quality of public buses based on user's perception. The technical terms used in study was "bus comfort features" based on various bus design sub-components and features that reflect various aspect of bus users comfort. For this, an average weighted scoring technique was combined with the method of successive interval scaling to create a five graded LOS scale that can benchmarks service quality of public bus based on user's satisfaction for the qualitative features. The majors finding of this study was a LOS scale from LOS A to LOS E that represent users perception from very good to very poor service quality of public buses that are currently operating in Kathmandu valley. For this study different five bus types i.e. Old City bus, Sajha yatayat bus, Digo yatayat bus, Deluxe bus and Electric bus were selected from different routes of Kathmandu valley. Thus using above method it was observed that LOS of Electric bus and Sajha yatayat bus based on users perception was LOS B (Good) with the average total weighted score of 6.00 and 5.14 respectively. Similarly Digo yatayat bus and Deluxe bus was perceived as LOSC (Average) with score 4.95 and 3.85 respectively whereas City yatayat bus was perceived as LOS D (Poor) with average total weighted score of 3.64 respectively. Similarly, the degree of criticality of different features was determined based on user perception, which identified the key features for improvement and was also found to differ for different bus types.

Keywords
LOS scale, Bus comforts features, Qualitative service quality assessment, Law of Successive Interval Scaling

1. Introduction

Out of the total passenger vehicle register in the country, 96 % are the private vehicle while remaining 4% are public vehicle [1]. The share of public transport vehicles in the overall vehicle fleet of the country decreased from 11% in 1990 to 5% in 2018, indicating a shift towards private vehicles [2]. According to survey conducted by Clean Air Network Nepal [3] in Kathmandu valley current public transport service 57.7% of passengers were not happy with the travel time in public transport), 30.5% of people said that they have to wait for more than 10 minutes during morning peak hour [4]. This types of data clearly indicate that the quality of service of public transport seems unsatisfactory.

Unlike the quantitative attributes like travel time, waiting time, running speed, frequency of services of public bus, very little or no research has made to measure the user's perception on service quality of public buses for subjective indicators which cannot be describe by quantitative service level. Different researcher has define the level of service (LOS) for highway, intersection and transit system but limited attempt has been made to measure the user's perception of service quality in terms of LOS scale for transport facility which cannot be describe by quantitative service level.

Since the major portion of public transportation in the Kathmandu is covered by the bus services, it has become increasingly important to conduct regular assessment of user satisfaction with these services.

Although various researchers have tried to assess the service quality of public transportation very few or no research has attempted to benchmark service quality of qualitative features like comforts features in public buses which are often difficult to describe in quantitative terms. The main objective of this study is to develop the method to set the level of service (LOS) scale of public transport facility based on user's perception, by taking the attributes of comfort features of public buses that are currently operating in the Kathmandu Valley and to determine the degree of criticality and to determine where service improvement are necessary by the service provider as per the degree of criticality. As there is no such method which can benchmark the service quality aspect of qualitative features of public buses, the transport authority and public transport providers can adopt this method to assess user satisfaction with existing or new buses introduced in Kathmandu. Beside this the method proposed in this research can be used to assess the performance any public facility like terminal facility (Airport, Bus Park), pedestrian facility, and transit service accessibility so on.

2. Literature Review

Different service quality aspect of public transport used for analysis of public transportation service quality are reliability, Extent of Service, Comfort, Safety and Affordability [5]. Reliability of public transport is used to measure of certainty that travelers have regarding the level of service they will experience while using public transport. Travel time, waiting time are some of the important reliability attributes in public transport. Extent of service consider the range over which service extent as well as geographical and time coverage of services. Comfort features of public buses refers to the attributes that reflect the comfort in the public buses. Safety and security are measures that protect passengers from incidents or becoming victims of crime. Affordability refers to the financial burden that users endure in paying for transports services.

Service quality is an antecedent of passengers' satisfaction which is represented by users' perception. So priority should be given to customer satisfaction and perception while determining the service quality because the customers have to face the consequences of poor services [6]. The performance measures based on users' perceptions are qualitative in nature and can be called as subjective service quality dimensions

2.1 Review of Existing Method that Measures User's Perception of Service Quality

With reference to various literature review, it can be summarized that major three approach has been adopted by researchers to measures users' perception. First one is level of service (LOS) approach which has been widely used approach to set level of service scale of public facility. For example, In India Ministry of Urban Development (MOUD) has develop LOS scale benchmark for urban public transportation across four level from LOS 1 and LOS 4 [7]. However these bench-marking have been developed based on expert opinion not from users perception [8]. The SERVQUAL approach is a second way to assess the gap between customers' perceived level and intended service levels. This method was first used by manager of banking industry to demonstrate that their services are customer-focused and that continuous performance improvement is being delivered [9]. Later this method was used to measure the service quality of public transportation[5]. The weighted perception approach is a third technique that determines the relative significance of several service quality indicators for transit users[10]. Since the second and third methods both measure service quality performance according to customer expectations against various indicators, they do not provide any benchmarking of service quality.

2.2 Law of Successive Interval Scaling

The law of successive interval scaling was developed by Bock and Jones [11] is based on a continuum and is divided into various categories. This technique essentially conducts a conversion from an ordinal scale to an interval scale. The arrangement of LOS order ranges from +∞ to -∞ . A value of -∞ means a bad/unacceptable LOS, while a value of +∞ means excellence. The assumption during analysis using this method is that samples need to be homogeneous and distributed normally [12]. The steps of Law of successive interval scaling is explained in methodology section 3.4.2.

2.3 Characteristics of Bus Types Selected in the Study

The different five types of public buses operating in different routes of Kathmandu valley were selected to exemplify as the public transport services. This include Old City buses, Digo Yatayat Bus, Sajha

Yatayat bus, Old Deluxe bus and Electric bus.

1. City Bus: The City buses are the old model buses operated by different yatayat samiti in different routes of Kathmandu valley. White and blue color city buses have single door and have high door steps. The available leg space is low and sitting arrangement is compacted. This types of buses have setting capacity of 26 to 35.

2. Digo Yatayat Bus: This types of bus are operated by Digo yatayat samiti in the fixed route in core city of Kathmandu provided by DoTM. Digo Yatayat was formed by merging 25 different tempo samiti and 26 different micro samiti in a company model. Altogether there are 17 buses operated as Digo yatatat samiti. This types of buses have 25 seats capacity with overall passenger capacity of around 50 peoples as there is comfortable standing space layout in this bus. There is special provision which suit for standing passengers with provision of 4 seats separated for women.

3. Sajha Yatayat Bus: Sajha Yatayat is a cooperative public transportation organization which was established in 1961/1962 to provide efficient and affordable public transportation. There are altogether 71 diesel buses that are being operating in six different routes joining Kathmandu and Lalitpur. These are the long body buses mainly of two types i.e one of seating capacity of 55 passengers with 13.5 meter body length and seating capacity of 40 seats with 12m body length. Recently Sajha has procure 3 electric buses with seating capacity of 25 passengers. There is provision of separate women seat along with priority seat for elderly and disable peoples and have two separate doors one in the front and one in the back.

4. Old Deluxe Bus: This types of bus are being operated in different route around the Kathmandu valley. In this types of public buses there is low available leg space and sitting arrangement is compacted. This types of buses have setting capacity of 26 to 35.

5. Electric Bus: In the Kathmandu valley, the first electric bus was operated by Sunder Yatayat as EKA electric bus. Although Yatayat has 4 electric buses out of which two electric buses are operated in ring road of Kathmandu and other two are being operated in Butwal – Bhairahawa route. Later Sajha Yatayat has recently operating 3 electric buses. Almost the physical bus structure of both Samiti buses are same with availability of CCTV surveillance, wheel chair entry, provision of low floor level for boarding and alighting, provision of cycle rack in the back of bus. The seating capacity of electric bus is 25 passengers with comfortable standing space in the middle of bus. There is appropriate design of handrails and hand-holds with provision of curtain in appropriately design window.

3. Methodology

3.1 Study Area

Site selection for this study refers to the selection of suitable public buses operating inside the Kathmandu valley. The public buses that are currently operating in the different routes with seat capacity more than 30 seats (which is considered as V3 vehicle class by DoTM,) were only selected for main users survey. The sample size are calculated by using standard calculation formula (Conchran's formula) given by equation 1 with Confidence Level of 95% and margin of error of 5% [3].

$$n = \frac{z^2 pq}{e^2} \tag{1}$$

Where p is the (estimated) proportion of the population, Z is statistical parameter corresponding to confidence level of 95% (1.96 as per the table area under normal curve), e is desired margin of error (adopted as 5%) and q= 1-p. Based on the equation 1 minimum sample size required was 384 however the total sample size collected from main users survey was 400.

3.2 Bus Comfort Features: Subjective Indicators

The qualitative attributes based on various bus design sub components and features that reflect user comfort were described in this study through three-stage process that included a literature review, an expert opinion survey and a pilot bus survey. Through various literature reviews, an initial list of study variables was identified. Bus Body Building standard

2018 published by Department of Transport Management (DoTM) used mainly refers to identified the initial list of features that represent bus design sub components and features which reflect the users comforts in city buses. The technical term used to describe this attributes has been defined as "Bus Comforts Features". The initial list of bus comfort features identified from existing literature was validated further by an expert opinion survey conducted among academicians and transport professionals. The total nine responses were obtained from transport professional from Departments of Road and Department of Transport Managements who mainly suggested to refer to Bus Building Standard 2018 published by DOTM. Additional sub component that were identified by experts include the "Anti-skids surface in door steps and bus floors". Similarly initial list was further validated by conducting pilot bus user's survey in which total 41 responses were obtained. Additional features were identified from the pilot bus survey like "provision of digital payment system" and "Availability of proper dust bin". Thus, based on the findings of the literature review, expert opinion, and pilot bus survey, the following 18 study variables were identified that reflect the user comfort features in Kathmandu valley public buses. The features of public transportation that indicate reliability, affordability, behavioral, and regulatory aspects were not considered as research variables. Table 1 summarizes the list of study variables.

3.3 Data Collection and Final Users Survey

A questionnaire survey was used to collect data. Questionnaire was formed considering the bus comfort features.In the final user survey, respondents were asked to rate their level of satisfaction against each bus comfort features (Table 1) and importance level of each features in each particular five bus types that are currently operating in Kathmandu. In addition, their overall level of satisfaction with each of the five bus types was gathered. The survey was done on all working and non-working days of weeks covering peak and non- peak hours. In order to avoid the biases in sampling the population, random sampling was done using stratifies and clustered technique of random sampling [13].

3.4 Analysis Techniques

Following a review of the literature, the analysis techniques primarily consist of two parts. In first part the average total weighted score was obtain by multiplying importance level assigned to each attributes with their level of satisfaction against each service attributes i.e. Average total weighted score= Mean value of sum of product (importance level assigned to attributes "comfort features" by satisfaction level against each service attributes). And second part is to apply Law of Successive Interval Scaling to average total weighted score to develop five graded LOS scale.

3.4.1 First Part: Calculation of Average Total Weighted score

For the first part of this method, which required user importance for various features, a final users questionnaire survey was conducted, in which they were asked to select from a given list (Table 1) of bus comfort features as "absolutely essential" and "desirable" elements that should be included in the typical city bus service. For the ease of calculation the design attributes that was considered as 'absolutely essential" elements was given a value "2" while the elements that was be considered as 'desired" was given value "1".

For this study purpose five different bus types operated by different bus operator in the selected route was considered. Users perceive these five bus types differently as each have a different overall LOS in terms of bus comfort. Along with the importance, respondents were asked to state their level of satisfaction against the given list of features for each of the five types of buses currently operating in Kathmandu. The level of satisfaction of respondents was measured on a five-point ordered categorical scale ranging from 1 (very poor) to 5 (very good), with 2, 3, and 4 representing "poor," "average," and "good" respectively. Then the importance (assigned either as "1" or "2") thus obtain for each of comfort features for each five bus types was multiplied with the respondent level of satisfaction (assigned as "1", "2", "3", "4", "5") to calculate weighted score for each comfort features for each of the five bus types as describe in Equation 2

$$W_{kji} = I_{kji} x S_{kji} \tag{2}$$

Where, W_{kji} is the weighted score of each bus design attributes(k) of each bus types(j) by each respondent(i).

Following the calculation of the weighted score provided by each respondent toward each comfort features for each bus type, the average weighted score

Table 1: Bus Comfort Features

S. No	Bus Comfort Features	Identification Stage
1	Comfortable seat design and space	Bus Building standard
2	Appropriate seating arrangement and leg-space	Bus Building standard
3	Low-floor height of bus for convenience of boarding and alighting	Bus Building standard
4	Seat segregation for men and women	Literature review
5	Comfortable standing-space layout	Bus Building standard
6	Appropriate design of handrails/hand-holds	Bus Building standard
7	Appropriate size and design of windows	Bus Building standard
8	Availability of sunscreen/curtain for windows	Literature review
9	Overall ventilation mechanism inside bus	Literature review
10	Separate entry and exit doors	Literature review
11	Bus stop arrival announcement facility	Literature review
12	Availability of wheelchair entry	Literature review
13	Availability of CCTV surveillance	Literature review
14	Availability of priority seats for elders/disabled	Literature review
15	Use of appropriate technology to reduce jerks	Literature review
16	Provision of Digital Payment System	Pilot Bus Survey
17	Availability of proper Dust Bin	Pilot Bus Survey
18	Anti-skid surface in steps and floor	Expert opinion

for each of the (k) bus comfort features for each bus type was given in Equation 3.

$$W_{kj} = \frac{1}{n}\sum_{i=1}^{n} I_{kji} x S_{kji} \tag{3}$$

Where n is total number of respondent in each bus types. Then, average total weighted score for over all bus design attributes for bus types (j) will be calculated as in Equation 4.

$$W_{kj} = \frac{1}{k}\sum_{k=1}^{n} w_{kji} \tag{4}$$

Where Bus design attributes K = 1, 2, 3... 18.

3.4.2 Second Part: Law of Successive Interval Scaling

Following the steps outlined below, the law of successive interval scaling was used to determine the level of service scale based on bus comfort features for the selected bus types operating in Kathmandu across five levels/grades ranging from LOS A to LOS E. The following are the steps in the analysis:

1. First, five different types of buses that are currently operating on different routes within the Kathmandu were grouped as five perceived service levels i.e. Separating the various bus types into groups (j) where j =1,2,3,4,5.

2. Second, the number of response against each bus groups and against each ranking category (k) was determine, where k = 1, 2, 3, 4, 5 indicating the level of satisfaction as very poor (1) to very good (5). Then the number of response were converted into cumulative proportion P_{jk} of response at or below (k) category. Since the sample collected is assume as homogeneous and normally distributed, the cumulative proportion of response represent the area under the normal distribution curve

3. Third, normal deviate Y_{jk} against the cumulative proportion of response P_{jk} were obtained from z-score table. Then average normal deviate μ_{av} for each rating (k) was estimated. This represent the interval scale converted from categorical scale. After that, linear regression was established between average normal deviates and normal deviates obtained for particular bus types (service group j) at or below each rating category (k) to obtain the average scale value μ_k^{LOS} for each bus types.

4. Fourth regression was carried out between average scale value μ_k^{LOS} and average perceived service level to determine the scale interval

boundaries for a five-point LOS scale. Linear regression model was established in the form of equation 5.

$$y = ax + b \tag{5}$$

Where y is the average total weighted score and x is average normal deviate.

The model's performance was evaluated by performing the Chi-square test on the differences between the observed proportions of response in each bus type and the response derived from the model.

5. Finally, the service level corresponding to the upper boundaries of each k_{th} category was calculated using the equation developed in step 4. The obtained value was then rounded to the nearest decimal point, and a five-point LOS scale for "bus comfort features" for Kathmandu city buses was established.

3.5 Degree of Criticality

The Degree of Criticality determines the urgency with which the specific bus design sub-components and features must be improved. Since it was vital to understand what are the key features that should be given due importance to improve bus design sub-components which can increase overall perception of users satisfaction. This can be achieved by analyzing the level of importance user's associate for each of the sub-components and their level of satisfaction with each components. For "Desired" features the value of average weighted score will range from "1" to "5" whereas for "Absolutely Essential" sub components the value of value of average weighted score will range from "2" to "10". Any absolutely essential sub components and features with score values less than "6" is considered as critical and need to be improved urgently and score above "6" are the non-critical. In order to improve the overall perception of bus design amongst the users, service provider primarily need to improve the service quality of critical comfort features.

4. Result analysis and Interpretation

4.1 Demographic Characteristic of Respondents

A complete 400 responses were obtained from the final user's survey. Among 400 respondents 197 (49.25%) were female and 203 (50.75%) were male. 26.5% (106) of respondent lies in age below 20 years and 24.5% (98) in age group 20-35 years, 35-50 years and more than 50 years each. 26.75%(107) of respondent were engaged in service, 27.50% (110) of respondent were self-employed, 23%(92) of respondent were unemployed and 22.75%(91) of respondent were student. Among respondent 33.75%(135) use public bus daily in a week , 32.25%(129) use public bus 3 to 4 days and 34% (136) use public bus 1 to 2 days in a week. Similarly 42%(168) of respondent has their own private vehicle whereas 58%(232) does not own their private vehicle.

4.2 Calculation of Average Total Weighted Score

As per the methodology state in chapter 3, the average weighted score for each of 18 bus comfort features for five types of buses were calculated using Equation 2 and Equation 3. Then average total weighted score for each of five bus types were calculated using the Equation 4. The result were summarized in table 2 in which the average total weighted score for Electric buses was 6.00. Similarly total weighted score based on users perception for Sajha bus, Digo bus, Deluxe bus and City bus was 5.14, 4.59, 3.85 and 3.64 respectively.

4.3 Calculation of Five Graded LOS Scale

Using the analysis techniques first the five different types of buses presently operating in Kathmandu were grouped as five perceived service levels. Then from the main users survey total number of response against each rating category for each service group (bus types j) was calculated in Table 3. The number of response against each bus groups and against each ranking category (k) was determine was calculated in Table 4. The number of responses was then converted into a cumulative proportion P_{jk} at or below (k) as shown in table 5. Normal deviate y_{jk} against the cumulative proportion of response P_{jk} were obtained from z-score as shown in table 6. Then average normal deviate μ_{av}^{k} for each rating (k) was estimated.

After that linear regression was established between average normal deviates and normal deviates obtained for particular bus types (service group j) at or below each rating category (k) to obtain the average scale value μ_{j}^{LOS} for each bus types.Figure 1 shows the intercept value of -0.6451 as the mean of the LOS

Table 2: Average total weighted score for five different bus types in Kathmandu.

S.no	Comfort Features	Bus Types				
		City	Sajha	Digo	Deluxe	Electric
1	Comfortable Seat Design and Space	4.28	6.84	5.45	4.98	7.53
2	Appropriate Seating Arrangement and Leg space	3.81	6.15	5.1	3.75	6.33
3	Low- Floor height of bus for a convenience of boarding and alighting	3.99	5.71	4.55	4.16	6.24
4	Seat Segregation for men and women	3.44	6.10	4.7	4.08	5.49
5	Comfortable Standing Space layout	3.31	6.24	5.25	4.00	7.11
6	Appropriate design of handrails/ Handholds	3.44	6.31	5	3.11	6.88
7	Appropriate size and design of windows	3.60	5.01	4.8	3.85	6.09
8	Availability of sunscreen/curtain for windows	3.21	3.24	3.95	3.64	6.46
9	Overall ventilation mechanism inside bus	3.55	4.26	4.25	3.66	6.03
10	Separate entry and exit doors	2.90	6.20	3	3.64	3.85
11	Bus stop arrival announcement facility	4.76	5.63	5.55	4.31	6.46
12	Availability of wheelchair entry	2.79	3.94	5.25	3.78	6.25
13	Availability of CCTV surveillance	2.90	3.30	3.75	3.61	5.74
14	Availability of priority seats for elders/disabled	4.95	6.44	4.55	4.43	6.49
15	Use of appropriate technology to reduce jerks	4.35	4.65	4.9	3.75	6.20
16	Provision of Digital Payment system	2.69	3.65	3.55	3.45	4.24
17	Availability of proper Dust bin	3.25	3.83	5.2	3.43	4.21
18	Anti-skid surface in steps and floor	4.34	4.96	3.75	3.71	6.45
	Average Total Weighted Score	**3.64**	**5.14**	**4.59**	**3.85**	**6.00**

rating for electric bus. Summary table for average scale value μ_j^{LOS} for each perceived service group j is shown in table 7.

Regression was carried out between average scale value and average total weighted score to determine the boundaries of the scale interval for five point LOS scale as shown in figure 2. Curve Estimation using SPSS is shown in table 8. The relationship between mean LOS rating and average total weighted score was established using linear regression because it was more predictive and has a high R^2 value and significance below 5%. Equation 6 represents the established relationship between mean LOS rating and average total weighted score.

$$\mathbf{y = -2.026x+4.757} \quad (6)$$

The performance of this model was tested by conducting Chi- square test of independence i.e. by conducting chi-square for the discrepancies between the observed proportions of response in each category with response derived from model. To determine the degree of freedom, formula used was df = (j-1)x(k-3), where j is the number of service group (bus types) and k is number of category (Bock and Jones, 1968). The calculated value of χ^2 was 2.057 whereas the the tabulated value was 15.51 with degree of freedom 8 and level of significance 5%. Hence χ^2 (calculated) was less than χ^2 (tabulated) then it was not significant and Ho was accepted. Thus we can conclude that there is no discrepancy between the observed proportions of response with response derived from model.So, we can used above model to determine LOS scale.

Finally, the service level corresponding to the upper boundaries of each k_{th} category was calculated using Equation 6, as shown in Table 9. The final output of analysis was five grade LOS scale based on users' perception as shown in Table 10. According to Table 10, bus users in Kathmandu perceived the service quality of public buses as LOS A if the average total weighted score for the given bus is greater than 6.6. Service quality as LOS B if average total weighted score for the given bus is between 5.1 to 6.5. Service quality is said to be LOS C if average total weighted score for the given bus is between 3.8 to 5.0. Service quality is said to be LOS D if average total weighted score is between 1.4 to 3.7 and last, the service quality is said to be LOS E if average total weighted score is

Table 3: Number of responses against each rating category for each service group (bus types)

S.No.	Bus Types	Weighted score	Level of Satisfaction (k)					Total Response
			Very Good (5)	Good (4)	Average (3)	Poor (2)	Very poor(1)	
1	Electric Bus	6.00	29	28	16	7	0	80
2	Sajha Bus	5.14	19	27	14	14	6	80
3	Digo Bus	4.59	18	13	14	21	14	80
4	Deluxe Bus	3.85	7	19	22	19	13	80
5	City Bus	3.64	7	10	20	31	12	80
							Total	400

less than 1.4.

Table 4: Proportion of Response

S.No.	Bus Types	Weighted score	Level of Satisfaction (k)				
			Very Good (5)	Good (4)	Average (3)	Poor (2)	Very poor(1)
1	Electric Bus	6.00	0.363	0.350	0.200	0.088	0.000
2	Sajha Bus	5.14	0.238	0.338	0.175	0.175	0.075
3	Digo Bus	4.59	0.225	0.163	0.175	0.263	0.175
4	Deluxe Bus	3.85	0.088	0.238	0.275	0.238	0.163
5	City Bus	3.64	0.088	0.125	0.250	0.388	0.150

Table 5: Cumulative Proportion of Response at or below satisfaction category (k) for each bus types (j)

S.No.	Bus Types	Weighted score	Level of Satisfaction (k)				
			Very Good (5)	Good (4)	Average (3)	Poor (2)	Very poor(1)
1	Electric Bus	6.00	0.363	0.713	0.913	1.000	1.000
2	Sajha Bus	5.14	0.238	0.575	0.750	0.925	1.000
3	Digo Bus	4.59	0.225	0.388	0.563	0.825	1.000
4	Deluxe Bus	3.85	0.088	0.325	0.600	0.838	1.000
5	City Bus	3.64	0.088	0.213	0.463	0.850	1.000

Table 6: Normal Deviates Y_{jk} against the cumulative proportion of response P_{jk} that was obtain from Z-score table

S.No.	Bus Types	Weighted score	Level of Satisfaction (k)				
			Very Good (5)	Good (4)	Average (3)	Poor (2)	Very poor(1)
1	Electric Bus	6.00	0.363	0.713	0.913	1.000	1.000
2	Sajha Bus	5.14	0.238	0.575	0.750	0.925	1.000
3	Digo Bus	4.59	0.225	0.388	0.563	0.825	1.000
4	Deluxe Bus	3.85	0.088	0.325	0.600	0.838	1.000
5	City Bus	3.64	0.088	0.213	0.463	0.850	1.000
		$\sum Y_{jk}$	-4.51	-0.83	2.34	8.4	19.95
		μ_{av}^{k}	-0.902	-0.166	0.468	1.68	3.99

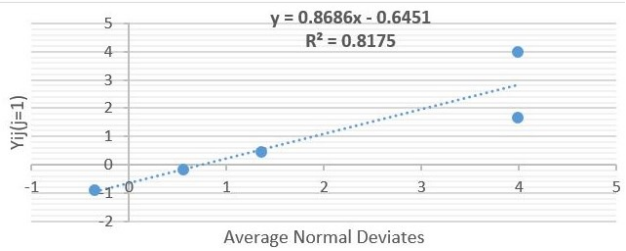

Figure 1: Linear relation between average normal deviates and normal deviates obtained for bus types (Electric Buses) at or below each rating category (k)

Table 7: Summary table for average scale value μ_j^{LOS} for each perceived service group j

S. No.	Bus Types	Average total weighted score	Average scale value
1	Electric Bus	6.00	-0.6451
2	Sajha Bus	5.14	-0.1762
3	Digo Bus	4.59	0.2068
4	Deluxe Bus	3.85	0.3742
5	City Bus	3.64	0.5197

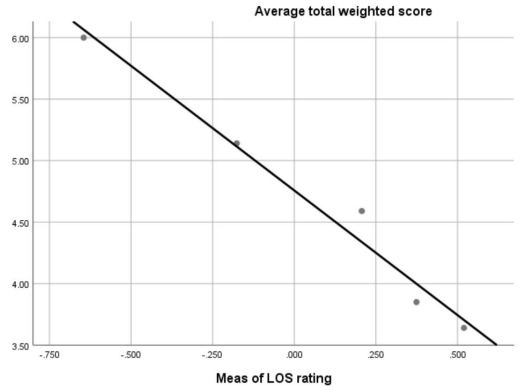

Figure 2: Regression analysis between μ_j^{LOS} and average total weighted score value.

Table 8: Curve estimation between mean LOS rating μ_j^{LOS} and average total weighted score.

Model Summary and Parameter Estimates					
Dependent Variable: Average total weighted score					
Equation	Model Summary			Parameter Estimates	
	R Square	F	Sig.	Constant	b1
Linear	.975	115.250	.002	4.757	-2.026
Independent Variable: Mean LOS rating					

Table 9: Upper boundary values for each category.

Category (k)	μ_k^{av}	Corresponding average total weighted score based on average LOS sale
1	-0.902	6.6
2	-0.166	5.1
3	0.468	3.8
4	1.68	1.4

Table 10: LOS scale based on users perception.

LOS Category	LOS scale value
LOS A "Very Good"	>6.6
LOS B "Good"	5.1-6.5
LOS C "Average"	3.8-5.0
LOS D "Poor"	1.4-3.7
LOS E "Very Poor"	<1.4

5. Conclusion

Based on user's perception LOS scale was developed for public buses operating in different routes of Kathmandu. The technical term used to describe the study variables was "bus comfort features". In this study the list of variables was determined through three stage process including literature review, pilot bus survey and expert opinion survey. The end output of this study was a LOS scale from LOS A to LOS E that represent users perception from very good to very poor. Thus bus users in Kathmandu consider service quality based on bus comforts features to be LOS A when the average total weighted score was more than 6.6, LOS B when average weighted score was between 5.1 to 6.5, LOS C when average total weighted score was in between 3.8 to 5.0, LOS D when average total weighted score was in between 1.4 to 3.7 and LOS E when average total weighted score was less than 1.4. Thus this study provides the basis for transport authorities to enforce the minimum service scale value that particular bus should perceived based on users perception. Bus services with LOS C (Average) or lower should increase the service level by improving the critical comfort features in public buses. Degree of criticality of different comfort features based on users perception was determined which identified the key features for improvements and was also found to vary for different bus types. For example, comfort features of city buses such as comfortable seat design and space, appropriate seating arrangement and leg space etc. were perceived as "absolutely essential" with average weighted score values less than average weighted score value as shown in table 2, and were considered critical features. As City bus was perceived as LOS D (Poor) with an average total weighted score of 3.64, City bus service providers should focus on these critical features for immediate improvement in order to increase the overall perception of user comforts.

References

[1] Department of Transport Management. Details of registered vehicles till end of falgun of fiscal year 2075-76. *Report*, 2019.

[2] Ravi Raj Shrestha, Binay Paudyal, Prasant Basnet, Dayasagar Niraula, Bijen Mali, and Hitendra Dev Shakya. Impact assessment of electric vehicle integration: A case study of kathmandu valley. In *2022 IEEE Kansas Power and Energy Conference (KPEC)*, pages 1–6. IEEE, 2022.

[3] Alim Kumar Shakya. *Economic Importance of Public Transit Investment in Kathmandu Valley*. PhD thesis, 2017.

[4] Bibek Karki and Padma Bahadur Shahi. Assessing the Service Quality of Public Transport Service: A Case of S-5 route in Kathmandu Valley. In *Proceedings of IOE Graduate Conference, 2019-Summer*, volume 6, pages 739 – 744. Institute of Engineering, Tribhuvan University, Nepal, May 2019.

[5] Samiksha Sharma and Rojee Pradhananga. Passengers' Perception towards Quality of Public Transportation Services in Kathmandu Valley . In *Proceedings of 10th IOE Graduate Conference*, volume 10, pages 596 – 603. Institute of Engineering, Tribhuvan University, Nepal, October 2021.

[6] Saikat Deb and Mokaddes Ali Ahmed. Quality assessment of city bus service based on subjective and objective service quality dimensions: Case study in guwahati, india. *Benchmarking: An International Journal*, 2019.

[7] Pradeep Chaitanya Jasti and V Vinayaka Ram. Integrated performance assessment and service level benchmarking of urban bus system using fuzzy logic. *Eur. Transp.-Trasp. Eur*, (69):1–14, 2018.

[8] Shreya Das and Debapratim Pandit. Importance of user perception in evaluating level of service for bus transit for a developing country like india: a review. *Transport Reviews*, 33(4):402–420, 2013.

[9] https://ukdiss.com/examples. Theories and concepts of the servqual model. *origins-of-servqual-model*, page 21, 2021.

[10] Sumana Gupta. *A methodology for assessing service quality of infrastructure at Indian railway stations*. PhD thesis, IIT Kharagpur, 2012.

[11] Ashari Abdullah, Ananto Yudono, Sakti Adji Adisasmita, and Arifuddin Akil. Determination of transit service accessibility standard for intercity bus passengers. *International Review for Spatial Planning and Sustainable Development*, 7(2):92–105, 2019.

[12] Shreya Das and Debapratim Pandit. Qualitative assessment of public facilities: the "public bus". *The TQM Journal*, 28(2):275–294, 2016.

[13] Ranjit Kumar. *Research methodology: A step-by-step guide for beginners*. Sage, 2018.