Scientific Journal of Impact Factor (SJIF) : 3.134

ISSN (Print) : 2348-6406
ISSN (Online): 2348-4470

International Journal of Advance Engineering and Research Development

A Rational Approach for Evaluation of Quality of Service of Public Transport Routes: Case Study of Bhopal

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Abstract *- In most of the Indian cities there is a dawdle between increasing public transport service demand and supply, results in an increase of travel cost, waiting time at bus stop, traffic congestion and pollution, thereby creating economic loss and environmental degradation. Thus, it is necessary to develop a methodology to evaluate the quality of service of public transport routes and services in a city to know how well it is providing transport service to public in the area and provides worthful information based on which important decisions can be taken for implementing new public transport service. This study presents a rational approach for evaluating the quality of service of public transport routes in a city. This study describes a hierarchical structure for identification of performance indicators, relative weight of identified performance indicators for which the passenger survey was conducted at different bus station in Bhopal city. It is expected that this study will be useful to evaluate the quality of public transport routes in Indian cities.*

Keywords- *Public Transport Routes, Performance Indicators, Hierarchical Structure, Rational approach, Quality of Service, Bus Services.*

I. INTRODUCTION

India has the largest public transport services in the world. The public transport services are the primary mode of transportation which improves the quality of life by providing safe, efficient, and economic transportation to people. Nowadays, public transport services in most of the Indian cities are rapidly deteriorating because of the increasing travel demand and inadequate quality of transport routes and system which results in increase of travel cost, traffic congestion, and unreliable services, thereby creating economic loss and environmental degradation. Thus there is an urgent need to ensure that the public transport services are safe, efficient, affordable and effective. Therefore, many researchers focused on improving public transport services in Indian cities. However, improvement of performance of public transport services is a difficult task which is affected by various factors such as social, economical and environmental. Thus it is necessary to evaluate the quality of existing public transport services in a city to know how well it is providing transport service to the public in the area served and provides worthful information based on which important decisions can be taken for implementing new public transport service in a city. Therefore there is an urgent need to develop a rational methodology for evaluating the quality of public transport routes in a city. Therefore, the main objective of this study is to develop a rational methodology for evaluating the quality of public transport routes in a city. This paper contains five sections among which this is the first one. This section presents problem statement, objective of the study and paper organization. The second section briefly explains the literature review and research need. Third section presents a framework of proposed methodology, a hierarchical structure for identification of performance indicators, their relative weight, and evaluation methodology. Fourth section presents analysis and results using proposed methodology. The last section discusses important conclusions drawn from this study.

II. LITERATURE REVIEW

Literature review is carried out on various aspects of evaluating the quality of public transport routes in a city. Baskaran R. et al., (2011) discusses the development of a comprehensive bus route evaluation system using various performance indicators according to rules and regulation of metropolitan transport corporation of Chennai. Analytic Hierarchy Process (AHP) model is built, which integrates quantitative and qualitative attributes of the routes such as comfort and safety level, socio economic level, competence level. To demonstrate the real world application of this developed system seven bus routes from Chennai city have been taken for study [1]. Bus evaluation report of Tumkur city (2013) classifies the performance indicators under separate categories from user's, operators and city perspective. The user perspective includes two indicators which are level of comfort in public transport and average waiting time for public transport users [2] these indicators are comprehensive but this report not suggested any methodology to evaluate explicitly the quality of public transport service in a city. Das S. and Pandit D. (2013) said that most of the research on performance evaluation of public transport system has been conducted in the context of developed country and many performance indicators which might be irrelevant in the developed countries might actually be significant in the Indian context [3]. Kanuganti et al., (2013) "Assess the quality of transport routes. Passenger opinion survey has been conducted, a group of passengers, who

are regular users of the low-floor Jaipur city buses were requested to give the importance of all the nineteen attributes in terms of five descriptors: (i) Extremely important as (A), (ii) very important as (B), (iii) important as (C), (iv) important to some extent as (D), and not at all important as (E). Then other passengers were requested to rate the existing service qualities in regard to all the nineteen attributes in another questionnaire based on their individual level-of-satisfaction. The rating was done in terms of the five descriptors as very good, good, fair, satisfactory and poor. The relative weight of the identified parameters is determined by using the rating given by passengers [6]. Mahmoud et al (2011) said that there is a wide range of performance indicators available in literature so the selection of appropriate indicators is a complicated task [7]. Shaymaa I. Al-Jumailey et al., (2011) in this study FROBSS (Fixed ROute Bus Simulation System) simulation model is used to evaluate the performance of the routes. Five routes have been selected from the network of the General Company for Passenger Transport (GCPT) in Baghdad city. Field data regarding these routes have been collected through field survey during March, April, and May of 2001, by using special field data sheets. These field data include: number of buses working on each route, average running time between nodes, total journey time, headway, frequency and stopping times at each bus stop. Information about the route has been also gathered such as: route length, area type, number of bus stops, and distance between nodes [9].

A critical literature review indicated that the selection of most appropriate set of performance indicator is a challengeable task due to large number of indicators present in literature and various definitions associated with different indicator sets. Further there is no rational methodology available which can evaluate the quality of public transport routes and transport system of a city.

III. METHODOLOGY

The main objective of this study is to develop a rational methodology for evaluating the quality of public transport routes in city. The Framework for proposed methodology is presented in the Figure 1. The framework comprises mainly four stages which are development of a hierarchical structure, identification of performance indicators, determination of relative weight of identified performance indicators, and methodology for evaluation of public transport routes.

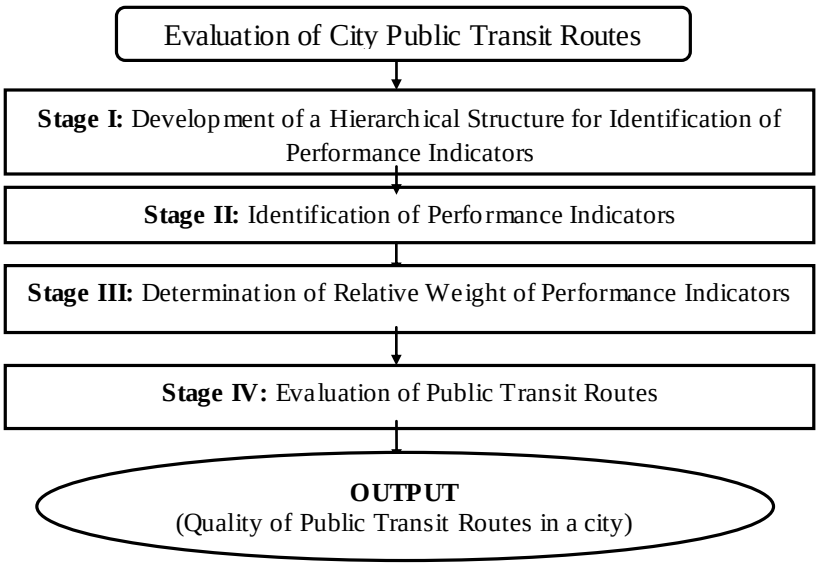

Figure 1: The Framework for Proposed Methodology

3.1. Development of A Hierarchical Structure

The main purpose of this stage is to identify the most appropriate performance indicators for evaluating the quality of public transport services on a city. Therefore, develop a hierarchical structure to identify the appropriate performance indicators and presented in Figure 2. The hierarchical structure consists of four main criteria and eighteen sub-criteria.

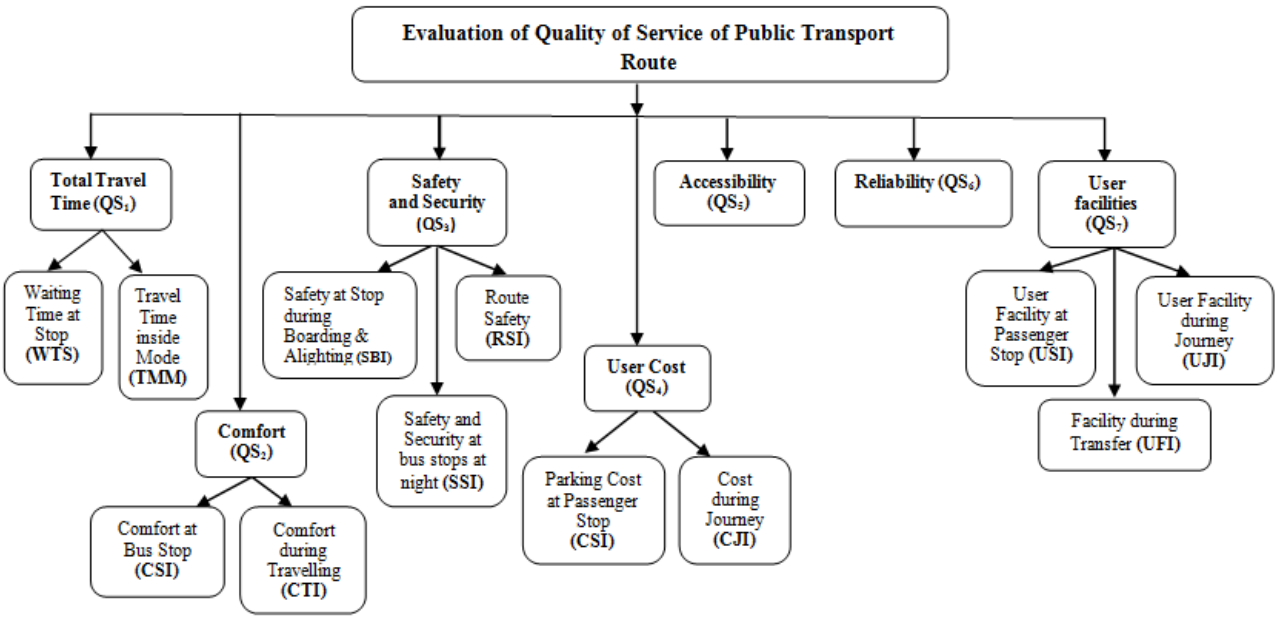

Figure 2: A Hierarchical Structure of Identification of Performance Indicator

3.2. Determination of Relative Weight of Identified Performance Indicators.

The performance indicators may not equally affect the quality. Therefore a system of weights needs to be introduced to reflect the contribution to evaluating the quality of public transport routes in a city. The relative weights of the performance indicators are determined from transport expert and passenger's opinion survey and the rating given by them. Therefore the objective of this stage is to determination of relative importance of identified performance indicators. Table 1 presents the relative weight of identified performance indicators.

Table1 1: Details of Relative Weight of Performance Indicators

S. No.	Performance Indicators	Relative Weight
1	**Total Travel Time**	**0.14**
2	**Comfort**	**0.13**
	Comfort at Bus Stop	0.46
	Comfort during journey	0.54
3	**Safety and Security**	**0.17**
	Safety at Stop	0.33
	Route Safety	0.34
	Safety at night	0.33
4	**Accessibility**	**0.14**
5	**Reliability**	**0.13**
6	**User Cost**	0.15
7	**User Facility**	**0.14**
	Facility at Stop	0.31
	Facilities during journey	0.35
	Facility at transfer	0.34

3.3. Evaluation of Public Transport Routes

The purpose of this stage is to develop a rational methodology of performance indices for each of the identified parameter for evaluation of public transport routes. Table 2 presents a methodology of formulation index for evaluating the quality of service of public transport routes.

Table 2: Methodology for Evaluating the Quality of Service of Public Transport Routes

Sr. No.	Notation	Performance Indicators	Methodology for Evaluating Quality of Service of Public Transport Routes
1	QS_1	**Total Travel Time Index (TTI)**	**TTI= TTC/ TTB** TTC= Travel Time of Car = WTS + TTM TTB= Travel Time of Bus = WTS + TTM WTS= Waiting Time at Stop WTM= Travel Time inside Mode
		Waiting Time at Stop (WTS)	**WTS = 60 / TNB** TNB=Total No. of Transport
		Travel Time inside Mode (TTM)	**TTM= TRL/ASP** TRL = Total Route Length ASP = Average Speed of Transport
2	QS_2	**Comfort Index**	**CFI = W_{21} * CSI + W_{22} * CTI** **W_{21} =** Relative weight of Comfort at Stop **W_{22} =** Relative weight of Comfort during journey **CSI =** Comfort at Passenger Stop index **CTI =** Comfort during Journey index
	QS_{21}	Comfort at Passenger Stop **(CSI)**	**CSI =** $\frac{5*N1+4*N2+3*N3+2*N4+1*N5}{(N1+N2+N3+N4+N5)*5}$ N_1= No of Passenger rated Extremely Important(5) N_2= No. of Passenger rated Very Important (4) N_3= No. of Passenger rated Important(3) N_4 = No. of Passenger rated Important to some Extent (2) N_5 = No. of Passenger rated Not at all Important (1)
	QS_{22}	Comfort during Journey **(CJI)**	**CJI =** $\frac{(5*N1+4*N2+3*N3+4*N2+1*N5)}{(N1+N2+N3+N4+N5)*5}$ N_1= No of Passenger rated Extremely Important(5) N_2= No. of Passenger rated Very Important (4) N_3= No. of Passenger rated Important(3) N_4 = No. of Passenger rated Important to some Extent (2) N_5 = No. of Passenger rated Not at all Important (1)
3	QS_3	**Safety and Security**	**SSI = W_{31} * SBI + W_{32} * RSI + W_{33} * SNI** W_{31} = Relative weight of Safety at Stop W_{32} = Relative weight of Route Safety W_{33} = Relative weight of Route Safety SBI = Safety index at bus stop during boarding & alighting RSI = Route Safety Index SNI = Safety and Security index at bus stop at night
	QS_{31}	Safety at bus stop during boarding & alighting **(SBI)**	**SBI=** $\frac{(5*N1+4*N2+3*N3+4*N2+1*N5)}{(N1+N2+N3+N4+N5)*5}$ N_1= No of Passenger rated Extremely Important(5) N_2= No. of Passenger rated Very Important (4) N_3= No. of Passenger rated Important(3) N_4 = No. of Passenger rated Important to some Extent (2) N_5 = No. of Passenger rated Not at all Important (1)
	QS_{32}	Route Safety (**RSI**)	**RSI = TNA/CP** TNA = Total Number of Accidents CP = City population in Lakhs
	QS_{33}	Safety and Security at bus stops at night **(SNI)**	**SNI =** $\frac{(5*N1+4*N2+3*N3+4*N2+1*N5)}{(N1+N2+N3+N4+N5)*5}$ N_1 = No of Passenger rated Extremely Important(5) N_2 = No. of Passenger rated Very Important (4) N_3 = No. of Passenger rated Important(3) N_4 = No. of Passenger rated Important to some Extent (2) N_5 = No. of Passenger rated Not at all Important (1)
4	QS_4	**Accessibility index**	**ASI = 1/ ADP** ADP = Avg. distance to the Nearest Passenger Stop

5	**QS5**	**Reliability Index**	**RBI = NTT/ TNT** NTT = Numbers of trips on time TNT = Total numbers of trips
6	**QS_6**	**User Cost Index**	**UCI = 1- (UCB/ UCC)** UCB = user cost of bus/ km = CS + CJ UCC = User cost of Car/ km = CC + CJ
	QS_{61}	Cost at stop **(CS)**	**CS = PC/ TRL** PC = Parking cost TRL = Total Route Length
	QS_{62}	Cost during journey **(CJ)**	**CJ = TC/ TRL** TC = Travel cost TRL = Total Route length
7	**QS_7**	**User Facilities index**	**UFI = W_{71} * USI + W_{72} * UJI + W_{73} * UTI** W_{71} = Relative weight of user facility at Stop W_{72} = Relative weight of user facility during journey W_{73} = Relative weight of user facility during transfer USI = User facility index at bus stop UJI = User facility Index during journey UTI = User facility index during transfer
	QS_{71}	User facilities at stop index **(USI)**	**USI** = $\frac{(5*N1+4*N2+3*N3+4*N2+1*N5)}{(N1+N2+N3+N4+N5)*5}$ N_1= No of Passenger rated Extremely Important(5) N_2= No. of Passenger rated Very Important (4) N_3= No. of Passenger rated Important (3) N_4 = No. of Passenger rated Important to some Extent (2) N_5 = No. of Passenger rated Not at all Important (1)
	QS_{72}	User facilities during journey index **(UJI)**	**UJI** = $\frac{(5*N1+4*N2+3*N3+4*N2+1*N5)}{(N1+N2+N3+N4+N5)*5}$ N_1= No of Passenger rated Extremely Important(5) N_2= No. of Passenger rated Very Important (4) N_3= No. of Passenger rated Important(3) N_4 = No. of Passenger rated Important to some Extent (2) N_5 = No. of Passenger rated Not at all Important (1)
	QS_{73}	User facilities during at transfer index **(UTI)**	**UTI** = $\frac{(5*N1+4*N2+3*N3+4*N2+1*N5)}{(N1+N2+N3+N4+N5)*5}$ N_1= No of Passenger rated Extremely Important(5) N_2= No. of Passenger rated Very Important (4) N_3= No. of Passenger rated Important(3) N_4 = No. of Passenger rated Important to some Extent (2) N_5 = No. of Passenger rated Not at all Important (1)

Further an overall quality of service index is also developed for evaluating the overall performance of public transport routes. Equation 1 presents the overall quality of service index for evaluating the overall performance of public transport routes.

$OQSI = W_1 * TTI + W_2 * CFI + W_3 * SSI + W_4 * ASI + W_5 * RBI + W_6 * UCI + W_7 * UFI$ ……. eq^n (1)

Where;

W_1 = Relative weight of Total Travel Time, TTI = Total Travel Time Index, W_2 = Relative weight of Comfort, CFI = Comfort Index, W_3 = Relative weight of Safety and Security, SSI = Safety and Security Index, W_4 = Relative weight of Accessibility, ASI = Accessibility Index, W_5 = Relative weight of Reliability, RBI = Reliability Index, W_6 = Relative weight of User cost, UCI = User cost Index, W_7 = Relative weight of User facilities, UFI = User facilities Index.

IV. DATA COLLECTION

As discussed earlier that the main objective of this study is to develop a rational methodology for evaluating the quality of service of public transport routes in a city. The data is collected for all four routes selected for analysis. The city has main service under public transport system of Bhopal that is City Link limited (BCLL). Four routes have been selected for service connecting different important areas of city (i.e. SR 2, SR 4, SR 6 and SR 8). The data has been collected by survey conducted during peak hours. A team of four members is required to collect data first member note down the

waiting time, boarding and alighting time, the second members note down the number of passengers boarding and alighting at each bus stop. The third and fourth members were engaged in collecting data from passengers about safety level, comfort level. The information about number of trips per day, travel cost is collected by conductors.

V. ANALYSIS AND RESULTS

The main objective of this study is to develop rational methodology for evaluation of quality of service of public transport routes in city. To illustrate the methodology and to illustrate how methodology works, the results are carried out. This chapter presents analysis and results are carried out using proposed methodology.

5.1. Evaluation of Quality of Service of BCLL Route, SR 2

The quality of service of BCLL route SR 2 is evaluated on the basis of travel time, user cost, comfort, safety and security, reliability, user facility and accessibility. These indicator indicates performance of route in terms of travel time index, user cost index, comfort index, safety and security index, reliability index, user facility index and accessibility index respectively. Table - 3 represents the evaluation of quality of service of SR 2route of BCLL.

Table 3: Evaluation of Quality of Service of BCLL Route, SR 2

Sr. No.	Performance Index	Performance Index Value
1.	Travel Time Index(TTI), TTI=TTC/ TTB	0.52
2.	Comfort Index(CFI), CFI= W_{21} * CSI + W_{22} * CTI	0.75
3.	Safety and Security Index(SSI) SSI= W_{31} * SBI + W_{32} * RSI + W_{33} * SSN	0.48
4.	Accessibility Index (ASI) ASI=1/ ADP	0.57
5.	Reliability Index (RBI) RBI=NTT/ TNT	0.76
6.	User Cost Index (UCI) UCI =1- (UCB/UCC)	0.72
7.	User Facility Index (UFI) = W_{71} *UFS + W_{72}*UFJ+W_{73}*UFT	0.69
	Overall Quality of Service Index (OQSI) = W_1* TTI + W_2 * CFI + W_3*SSI + W_4* ASI + W_5*RBI +W_6*UCI + W_7*UFI	0.57

Figure 3 shows the performance index value of the respected performance indicators of public transport routes which clearly indicates quality of service of BCLL route SR 2 in Bhopal city.

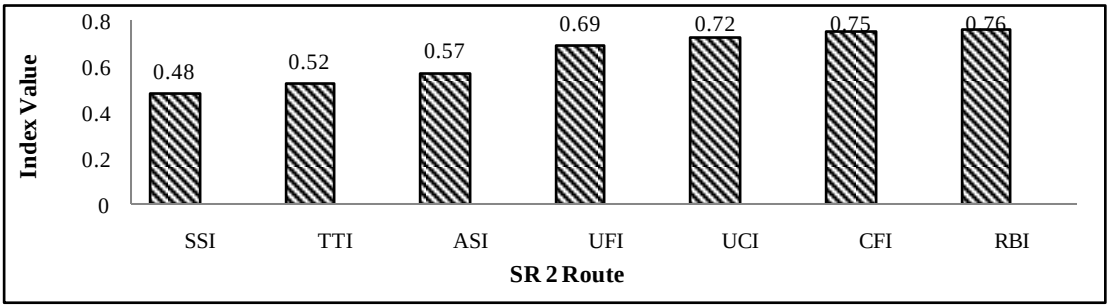

Figure 3: Results of Evaluation of BCLL Route, SR 2

5.2. Evaluation of Quality of Service of BCLL Route, SR 4

The quality of service of BCLL route SR 4 is evaluated in terms of travel time, user cost, comfort, safety and security, reliability, user facility and accessibility. Table - 4 represents the respected value of the performance index of the quality of service for BCLL route SR 4 in city.

Table 4: Evaluation of Quality of Service of BCLL Route, SR 4

Sr. No.	Performance Index	Performance Index Value
1.	Travel Time Index(TTI) TTI=TTC/ TTB	0.53
2.	Comfort Index (CFI) CFI= W_{21} * CSI + W_{22} * CTI	0.77
3.	Safety and Security Index (SSI) SSI= W_{31} * SBI + W_{32} * RSI + W_{33} * SSN	0.48
4.	Accessibility Index (ASI) ASI=1/ ADP	0.89
5.	Reliability Index (RBI) RBI=NTT/ TNT	0.84
6.	User Cost Index (UCI) UCI =1- (UCB/UCC)	0.76
7.	User Facility Index (UFI) = W_{71} *UFS + W_{72}*UFJ+ W_{73}*UFT	0.68
	Overall Quality of Service Index (OQSI) = W_1* TTI + W_2 * CFI + W_3*SSI + W_4* ASI + W_5*RBI +W_6*UCI + W_7*UFI	0.56

Figure 4 shows the performance index value of the respected performance indicators of public transport system which clearly indicates quality of service of BCLL route SR 4 in Bhopal city.

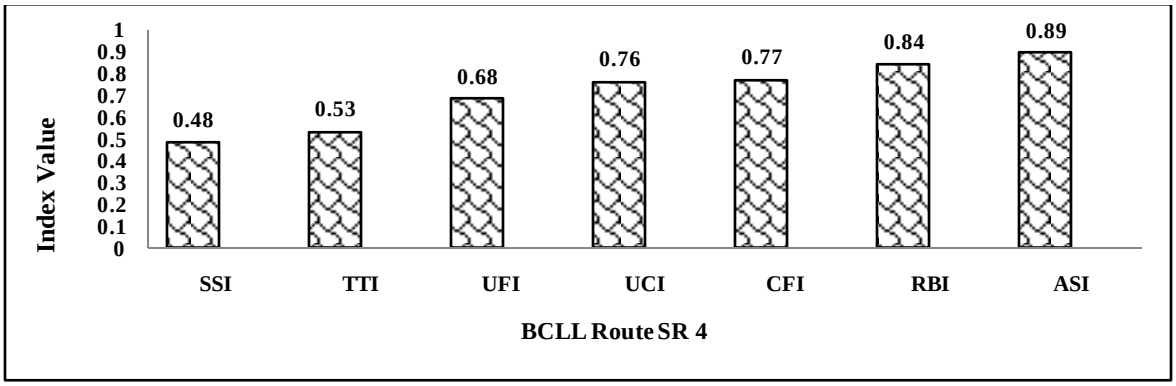

Figure 4: Results of Evaluation of BCLL Route, SR 4

5.3. Evaluation of Quality of Service of BCLL Routes, SR 6

The quality of service of BCLL route SR 6 is evaluated on the basis of travel time, user cost, comfort, safety and security, reliability, user facility and accessibility. These indicator indicates performance of route in terms of travel time index, user cost index, comfort index, safety and security index, reliability index, user facility index and accessibility index respectively.

Table - 5 represents the respected value of the performance index of the quality of service for BCLL route SR 6.

Table 5: Evaluation of Quality of Service of BCLL Route, SR 6

Sr. No.	Performance Index	Performance Index Value
1.	Travel Time Index(TTI) TTI=TTC/ TTB	0.69
2.	Comfort Index (CFI) CFI= W_{21} * CSI + W_{22} * CTI	0.72

3.	Safety and Security Index (SSI) SSI= W_{31} * SBI + W_{32} * RSI + W_{33} * SSN	0.44
4.	Accessibility Index (ASI) ASI=1/ ADP	0.70
5.	Reliability Index (RBI) RBI=NTT/ TNT	0.85
6.	User Cost Index (UCI) UCI =1-(UCB/UCC)	0.77
7.	User Facility Index (UFI) = W_{71} *UFS + W_{72}*UFJ+ W_{73}*UFT	0.69
	Overall Quality of Service Index (OQSI) = W_1* TTI + W_2 * CFI + W_3*SSI + W_4* ASI + W_5*RBI +W_6*UCI + W_7*UFI	0.62

Figure 5 shows the performance index value of the respected performance indicators of public transport system which clearly indicates quality of service of BCLL route SR 6 in Bhopal city.

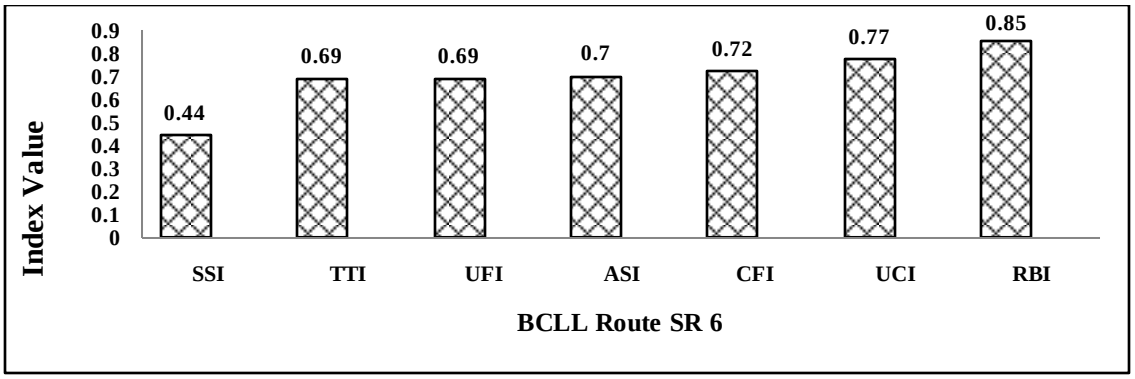

Figure 5: Results of Evaluation of BCLL Route, SR 6

5.4. Evaluation of Quality of Service of BCLL Routes, SR 8

The quality of service of BCLL route SR 8 is evaluated on the basis of travel time, user cost, comfort, safety and security, reliability, user facility and accessibility. These indicator indicates performance of route in terms of travel time index, user cost index, comfort index, safety and security index, reliability index, user facility index and accessibility index respectively. Table 6 represents the respected value of the performance index of the quality of service for BCLL route SR 8 in city.

Table 6: Analysis and Results of Quality of Service of BCLL Route, SR 8

Sr. No.	Performance Index	Performance Index Value
1.	Travel Time Index(TTI) TTI=TTC/ TTB	0.63
2.	Comfort Index (CFI) CFI= W_{21} * CSI + W_{22} * CTI	0.72
3.	Safety and Security Index (SSI) SSI= W_{31} * SBI + W_{32} * RSI + W_{33} * SSN	0.49
4.	Accessibility Index (ASI) ASI=1/ ADP	0.57
5.	Reliability Index (RBI) RBI=NTT/ TNT	0.83
6.	User Cost Index (UCI) UCI =1- (UCB/UCC)	0.78

7.	User Facility Index (UFI) = W_{71} *UFS + W_{72}*UFJ+ W_{73}*UFT	0.65
	Overall Quality of Service Index (OQSI) = W_1* TTI + W_2 * CFI + W_3*SSI + W_4* ASI + W_5*RBI +W_6*UCI + W_7*UFI	0.61

Figure 6 shows the performance index value of the respected performance indicators of public transport system which clearly indicates quality of service of BCLL route SR 8 in Bhopal city.

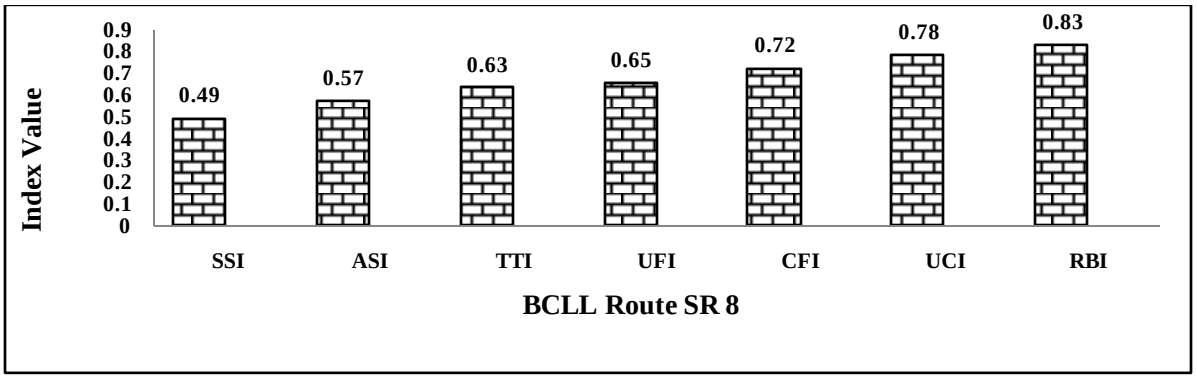

Figure 6: Results of Evaluation of BCLL Route, SR 8

5.5. Comparative Evaluation of Overall Performance of Public Transport Routes

The analysis of all identified routes has been carried out and the performance of routes is varying with each performance indicator. In evaluation of routes it has been found that the user cost index of most of the routes is representing low quality of service on that particular route therefore there is need to pay attention and take some preventive measures to improve the quality of service. Table 7 shows the overall performance of identified routes of BCLL.

Table 7: Overall Performance of Identified Public Transport Routes.

Sr. No.	BCLL Routes	Overall Performance Value
1	SR 2	0.56
2	SR 4	0.62
3	SR 6	0.64
4	SR 8	0.59

Figure 7 represents the overall performance of identified public transport routes.

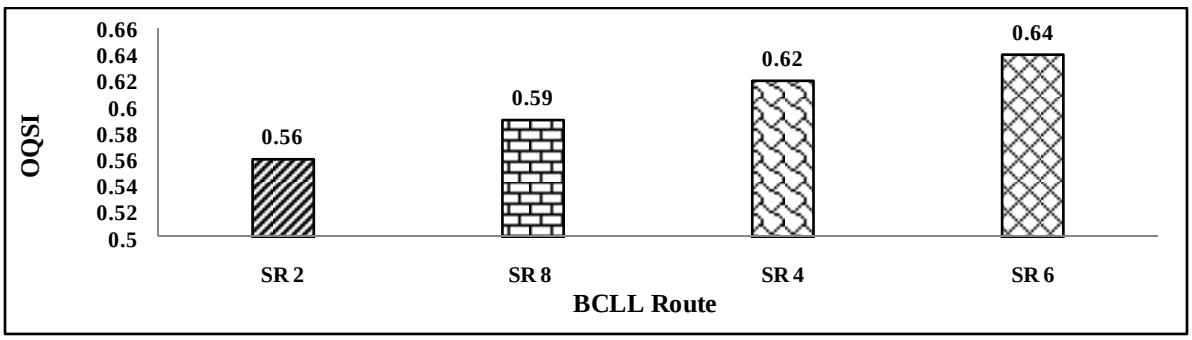

Figure 7: Results of Overall of Quality of Service of BCLL Routes

VI. CONCLUSIONS

The main objective of this study is to develop a rational methodology for evaluating the quality of service of public transport routes on a city. The Important conclusions drawn from this study are summarized as follows.

- It is necessary to evaluate the quality of service of public transport routes in a city to how well it is providing transport service to the public in the area served and provides valuable information based on which important operating decisions can be taken for implementing the new public transport service in a city.
- A critical literature review indicated that there is no rational methodology available which can evaluate the quality of service of public transport routes.
  - This study presents a rational methodology for evaluating the quality of service of public transport routes in a city. The proposed methodology comprises major four stages i.e. development of a hierarchical structure, identification of performance indicators, determination of relative weight of identified performance indicators and evaluation of public transport routes.
  - This study presents a hierarchical structure for identification of performance indicators for evaluating the quality of service of public transport routes in a city.
  - The quality of service of public transport routes in a city is evaluated in terms of Travel time, Comfort, Safety and Security, Accessibility, Reliability, User cost and User facility indicators.
- In this study the analysis was made to quantify the quality of service of public transport routes of BCLL service in Bhopal city. The following results observed from this analysis.
  - Travel time index values for respective routes are as SR 2, SR 4, SR6, SR8 are 0.52, 0.53, 0.63, and 0.69 respectively.
  - Comfort index values for respective routes are as SR 2, SR 4, SR6, SR8 are 0.72, 0.72, 0.75, and 0.77 respectively.
  - Safety and security index values for respective routes are as SR 2, SR 4, SR6, SR8 are 0.44, 0.48, 0.67 and 0.49.
  - Accessibility index values for respective routes are as SR 2, SR 4, SR6, SR8 are 0.57, 0.89, 0.70 and 0.57.
  - Reliability index values for respective routes are as SR 2, SR 4, SR6, SR8 are 0.76, 0.84, 0.85 and 0.83.
  - User cost index values for respective routes are as SR 2, SR 4, SR6, SR8 are 0.72, 0.76, 0.77 and 0.78.
  - User facility index values for respective routes are as SR 2, SR 4, SR6, SR8 are 0.68, 0.67, 0.69 and 0.66.
  - The overall quality of service of identified BCLL route are as SR 2 – 0.56, SR 4 – 0.59, SR 6 – 0.62, SR 8 – 0.64

It is expected that this study will be useful to evaluate the quality of service of public transport routes in Indian cities.

REFERENCES

[1] Baskaran R., Krishnaiah K., "Performance Evaluation of Bus Routes using AHP" European Journal of Scientific Research, ISSN 1450-216X, Vol.66 No.4, pp. 631-642.© EuroJournals Publishing, Inc. 2011.

[2] Castillo, H., and Pitfield, D.,"A Methodological Framework for Identifying and Selecting Sustainable Transport Indicators", Transportation Research Part D, Vol. (15), 179 – 188, 2010.

[3] Das S. and Pandit Debapratim (2013) "Importance of User Perception in Evaluating Level of Service For Bus Transit For A Developing Country Like India: A Review" Transport Reviews: A Transnational Tran disciplinary Journal, Vol. 33, No. 4, 402–420, April 2013.

[4] Dell'olio L., Ibeas A, Cecin P., "The quality of service desired by public transport users", Journal of transport policy, Vol. 18, 217-227, 2011.

[5] Eboli, L., & Mazzulla, G., "A Methodology For Evaluating Transit Service Quality Based on Subjective and Objective Measures from The Passenger's Point of View" Journal of Transport Policy, Vol 18, 172–181, 2011.

[6] Kanuganti S. et al (2013) "Quantification of Level-of-Service Index for Bus Routes in Developing Countries: A Case Study in India" Proceedings of the Eastern Asia Society for Transportation Studies, Vol.9, 2013.

[7] Mahmoud et al, "Bus Transit Service Quality Monitoring in UK: A Methodological Framework" Proceedings of the ITRN2011.

[8] Ministry of Urban Development; "Service Level Benchmarks for Urban Transport", Ministry of Urban Development (MOUD) New Delhi, Government of India, 2009.

[9] Shaymaa I. Al-Jumailey et al, "Planning of operation policies for Fixed Bus Routes in Baghdad City" 978-1-4244-9171-1/11/$26.00 ©2011 IEEE.

[10] Yaakub N., Napiah M., (2011) "Public Transport: Punctuality Index for Bus Operation" World Academy of Science, Engineering and Technology Vol: 60, 12-23, 2011.

