Evaluation of Bicyclist's Level of Service at a Selected Route of Rajkot City

Mr. Shivkumar Dave[1] Prof. Rahul Kasundra[2]
[1]PG Scholar [2]Assistant Professor
[1,2]Department of Civil Engineering
[1,2]Atmiya Institute of Technology & Science, Rajkot, India

Abstract— India is a developing country with many new developed roads and segments in the Urban context, moreover the traffic especially in urban streets is very much heterogeneous consisting various kinds of vehicles having different operational characteristics. Moreover the problems occurring due to the motorized traffic on the road is increasing day-by-day like increasing rate of accidents, pollution in the environment, physical and health problems of the travellers due lack of exercise as a result of which diseases like obesity, heart disease, cancer, mental illness, diabetes and arthritis. So as a solution we can say that promotion of Non-motorized transportation is necessary in which cycling also plays a very important role for which its promotion is necessary in order to increase its usage, for that evaluation of the current level of service of it is necessary which can be termed as Bicycle level of service (BLOS). It is a concept that identifies the quality of service for bicyclists that currently exists within the roadway environment. It deals with real-time human perceptions taking into account the satisfaction level of the bicyclists while riding along the road in terms of their perceived level of safety, comfort and convenience. Hence this evaluation can be determined with the help of factors affecting the bicyclists on road such as about the existing facilities like geometrics of the road segments and intersections, pavement conditions, traffic volumes, speed limits and other variables moreover it would also include the ratings of perceptions or feelings of the bicyclists for the existing facilities. Thus, in this way with the help of this current evaluation we can also help the bicyclists in different ways and suggest for various measures in the increment of this current level of service offered to them.

Key words: Non-Motorized Transportation, Bicyclists, Safety, Comfort, Convenience

I. INTRODUCTION

With the going on increase in vehicle population day by day the problems related to the environment by the motorized-traffic, traffic jams, traffic delays, and increasing accident rate are also increasing. Something needs to be done in this respect to reduce the usage of motorized transportation at least as much as possible in order to reduce the problems related to it. For which we need to increase and promote the usage of non-motorized transportation in which cycling plays an important role.

In order to increase this we need to evaluate the current road scenario with respect to the perceptions of the bicyclists for the existing facilities.

To develop roadways for shared use by the two modes of transportation i.e. bicycle and motor vehicles, we must begin by evaluating existing roadways and determine what can be considered user-friendly from the perspective of a bicyclist. Determination of how existing traffic operations and geometric conditions affect a bicyclist's comfort level needs to be determined.

For this evaluation we need to consider the various factors affecting it which would include,

- Development of models based on the geometrics of intersections and roadway segments
- Pavement conditions
- Traffic volumes
- Speed limits
- Review in the form of ratings of the bicyclists
- Other variables

II. OBJECTIVE

1) To evaluate the current Bicyclists level of Service for the selected study area by a mathematical model.
2) To suggest measures for increasing the current level of service evaluated for the particular study area.

III. SCOPE

To achieve the objective of the thesis, scope of the study is presented as follows:

1) Maps can be produced for the public to guide them to proper selection of the bicycle route Collection of traffic noise and atmospheric data.
2) Identification of the appropriate routes for inclusion in the community bicycle network can be done.
3) Possible weak links in the network can be determined, and improvements needed overthere can be carried out.
4) Other alternatives and treatments for improving bike-friendliness of a roadway can be evaluated.

IV. METHODOLOGY

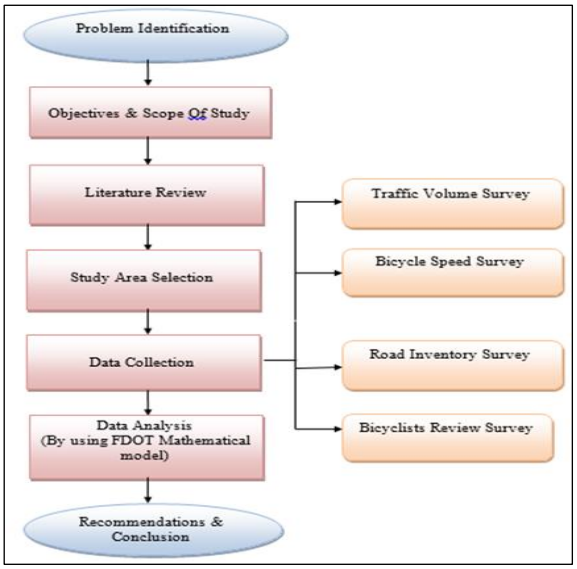

Fig. 1: Methodology Chart

V. STUDY AREA

Rajkot is an important urban centre, centrally located in Saurashtra region, in the State of Gujarat. Located at latitude 200 43' North and Longitude 700 51' East the city is the centre for social, cultural,

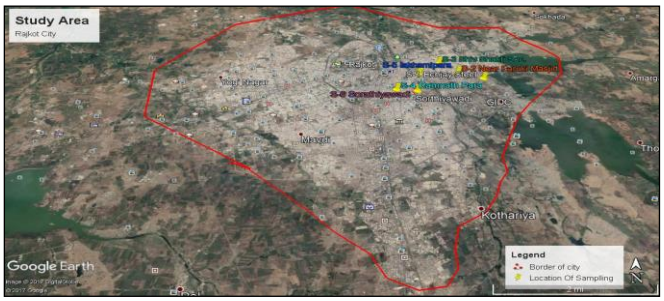

Fig. 2: Rajkot City

In Rajkot city particularly we can say that the 150 ft. ring road is the road containing of the special facility for the bicyclists out of which the segment of Raiya chowk to Mavdi Chowk is taken as our study area.

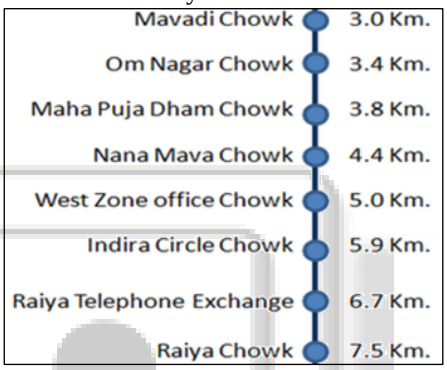

Fig. 3: Segments of Study Area

Some of the pictures of the study area bicycle lane are shown below:-

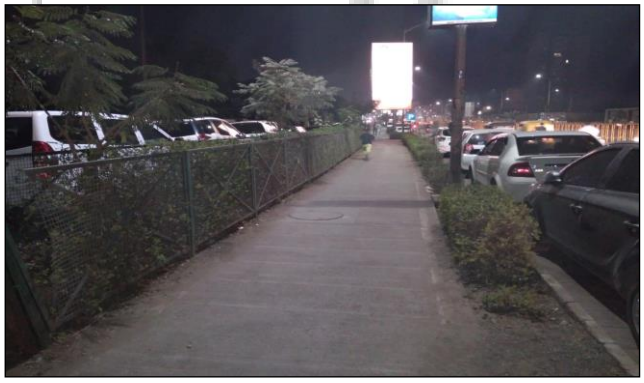

Fig. 4: Study Area Bicycle Lane – 1

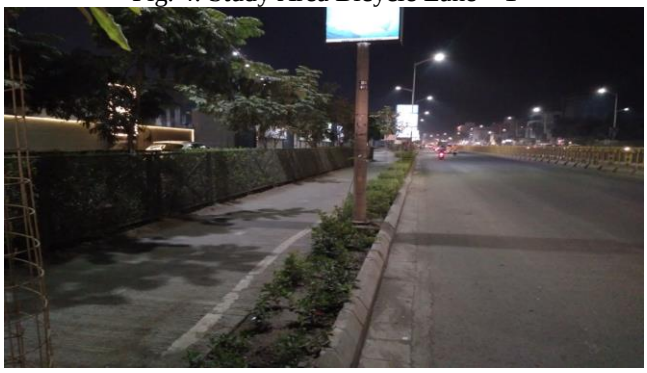

Fig. 5: Study Area Bicycle Lane -2

VI. SURVEYS & DATA COLLECTION

Here first of all for the Evaluation of the bicycle level of service (BLOS) with the help of model developed by us based on the Florida Department of Transportation (FDOT) for our study area we need to carry out some surveys regarding road inventory, traffic volumes and pavement ratings.

Thus, the various details of the road and traffic can be gathered with its help which will be used for the interpretation Bicycle Level of Service (BLOS) model developed by the FDOT.

While our survey locations will mainly include the following 9 intersections and 16 segments.

Here the different survey locations of our study area which will the intersections are as follows:-

1) Raiya Chowk.
2) Raiya Telephone Exchange.
3) Indira Circle.
4) KKV Hall Intersection.
5) West Zone Office Chowk.
6) Nana Mava Chwok.
7) Maha Puja Dham Chowk.
8) Om Nagar Chowk.
9) Mavadi Chowk.

Whereas, the segments between the different intersections which will be considered for data collection includes:-

1) Raiya Chowk to Raiya Tele. Exchange intersection.
2) Raiya Tele. Exchange to Indira Circle.
3) Indira Circle to KKV Hall intersection.
4) KKV Hall intersection to West Zone Office intersection.
5) West Zone Office intersection to Nana Muva circle.
6) Nana Muva circle to Mahapuja Dham intersection.
7) Mahapuja Dham intersection to Omnagar intersection.
8) Omnagar intersection to Mavdi Chowk.
9) Mavdi Chowk to Omnagar intersection.
10) Omnagar intersection to Mahapuja Dham intersection.
11) Mahapuja Dham intersection to Nana Muva circle.
12) Nana Muva circle to West Zone Office intersection.
13) West Zone Office intersection to KKV Hall intersection.
14) KKV Hall intersection to Indira Circle.
15) Indira Circle to Raiya Tele. Exchange intersection.
16) Raiya Tele. Exchange intersection to Raiya Chowk.

The different types of surveys to be carried out are as follows:-

1) CVC (Classified Traffic Volume Count) Survey.
2) Pavement Condition Rating Survey.
3) Speed Calculation survey.
4) Measurement of bicycle pavement width.

The detail data collection and their analysis are shown as below:-

A. CVC (Classified Traffic Volume Count) Survey

Classified Volume Count (CVC) Survey which is the prerequisite of our evaluation of Bicycle Level of Service (BLOS). First of all we have carried out this survey at each intersection coming into our study area. Which will include every intersection Starting from Raiya Chowk till Mavdi Chowk.

B. Pavement Condition Rating Survey

Here by asking for rating the pavement to number of pedestrians we can see that an average rating of four has been observed throughout all the segments from the beginning till the end through which we will be further able to evaluate the BLOS for every segment of our study area.

C. Speed Calculation survey

The second prerequisite of our work is average speed calculation of different vehicles travelling on the different segments of our study area. Here starting from the very first segment between the Raiya to Raiya tele E/x, to the last segment for that directional stretch of Omnagar to Mavdi chowk.

And back from the segment of Mavdi Chowk to Omnagar, till the segment of Raiya Tele E/x to Raiya chowk,

D. Measurement of Bicycle Pavement Width

As per another prerequisite for finding out Bicycle Level Of Service Score is the measurement of width of the Bicycle Pavement to be used by the Bicyclists (Wv) and the width between the Bicycle pavement and the motorised traffic pavement (Wl) is also to be measured over here for the determination of average effective width of outside thru lane which incorporates the existence of a paved shoulder or bicycle lane if present (We). Thus, we is measured for every segment of our study area.

Segment No.	Vol15	ln(Vol15)	L	SPt	HV	PR5	We
1	322.01	5.77	1	3.48	0.515	4	-67.45
2	424.16	6.05	1	3.39	0.434	4	-55.5
3	217.72	5.38	1	2.96	0.258	4	-44.54
4	215.57	5.37	1	3.68	0.26	4	-43.71
5	301.03	5.7	1	3.34	0.408	4	-32.65
6	310.62	5.74	1	3.69	0.499	4	-66.73
7	338.78	5.82	1	3.42	0.498	4	-66.73
8	327.21	5.79	1	2.47	0.505	4	-66.73
9	420.25	6.04	1	2.42	0.498	4	-50.95
10	349.59	5.85	1	3.36	0.498	4	-55.25
11	334.24	5.81	1	3.66	0.508	4	-55.25
12	421.68	6.04	1	3.38	0.571	4	-55.25
13	302.79	5.71	1	2.67	0.412	4	-53.05
14	277.47	5.62	1	3.09	0.27	4	-53.05
15	319.84	5.77	1	3.37	0.385	4	-55.24
16	410.7	6.02	1	2.79	0.52	4	-54.73

Table-1 (all the collected data from different surveys)

VII. DATA ANALYSIS

Here we can say that based on the all of the above data the analysis of the Bicycle Level of Service (BLOS) for our selected study area. We can analyse it with the help of BLOS formulae suggested by the Florida Department of Transportation (FDOT).

This formula is given as below:-

$$BLOS = 0.507\ln(Vol15/L) + 0.199SPt(1+10.38HV)^2 + 7.066(1/PR5)^2 - 0.005(We)^2 + 0.760$$

BLOS = Bicycle level of service score

ln = Natural log

Vol15= Volume of directional motorized vehicles in the peak 15 minute time period

L= Total number of directional thru lanes

SPt= Effective speed factor = 1.1199 ln(SPp - 20) + 0.8103

SPp=average running speed of vehicles

HV= percentage of heavy vehicles

PR5= pavement surface condition rating out of 5

We= Average effective width of outside thru lane

Now putting the average data collected for all the surveys for different study area sections we can get the different BLOS Scores for different segments of our study area as shown in the table below:-diaphragm, i.e. the sound pressure deviation, is converted into an electrical signal.

Bicycle and Pedestrian LOS Categories

LOS	Score
A	≤ 1.5
B	> 1.5 and ≤ 2.5
C	> 2.5 and ≤ 3.5
D	> 3.5 and ≤ 4.5
E	> 4.5 and ≤ 5.5
F	> 5.5

Fig. 6: Classes of BLOS

Evaluating the above scores according to the above given table we can see the different classes of the different segments of our study area as follows:-

Segment No.	BLOS	CLASS
1	8.851563	F
2	14.44517	F
3	-0.73758	A
4	6.265928	F
5	16.21013	F
6	9.668781	F
7	9.575361	F
8	-0.77814	A
9	8.491491	F
10	13.44239	F
11	14.98125	F

12	17.57155	F
13	4.716451	E
14	2.165891	B
15	10.48829	F
16	12.84398	F

Table 2: BLOS Scores According to FDOT.

VIII. MODEL DEVELOPMENT ACCORDING TO LOCAL CONDITIONS

Now, here we can say that the above formula is according to the Florida Department of Transportation (FDOT). All the factors included in the formula are not according to the local traffic conditions.

So, we need to develop our own model with the help of removal of some factors and addition of other factors.

Whereas, based on these corelations results and the addition of new factor according to the local observations the new formula for our local conditions is as follows,

$$BLOS = a1 \ln(Vol15) + a2 \ln(SPt(1+HV)) - a3 (We)^2 + a4 \ln(Comm15*UMA15) + C$$

Where,

Vol15 = Volume of directional motorized vehicles in the peak 15 minute time period

SPt = Effective speed factor = 1.1199 In(SPp - 20) + 0.8103

HV = percentage of heavy vehicles

We = Average effective width of outside thru lane

COM15 = trip generation intensity of the land use adjoining the road segment

UMA = No. of uncontrolled vehicular access on bicycle lane in 15 minutes

While, the data collection for this new term for our study area can be concluded as follows:-

Segment No.	ln(COM15*NCA)
1	3.346
2	1.79
3	0.48
4	2.05
5	5.34
6	2.76
7	4.11
8	2.15
9	3.2
10	3.7
11	2.81
12	3.01
13	4.63
14	1.02
15	3.98
16	5.65

Table 3: Data of New Term

While based on linear regression analysis the constants can be found out and the new formula concluded can be as follows,

$$BLOS = 15.434 \ln(Vol15) + 27.098 \ln(SPt(1+HV)) - 0.003(We^2) - 113.618$$

While, based on this new formula the new evaluation of BLOS for our study area can be concluded as follows,

Segment No.	BLOS	CLASS
1	8.851563	F
2	14.44517	F
3	-0.73758	A
4	6.265928	F
5	16.21013	F
6	9.668781	F
7	9.575361	F
8	-0.77814	A
9	8.491491	F
10	13.44239	F
11	14.98125	F
12	17.57155	F
13	4.716451	E
14	2.165891	B
15	10.48829	F
16	12.84398	F

Table 4: BLOS Scores According To New Formula

IX. COMPARISON OF MODELS AND RESULTS

While, on comparing the old and new model the comparisons of its coeffecients and t-test results can be shown as below:-

FACTOR NAME	Co-effecients	
	MODEL A	MODEL B
ln(Vol15)	1.795	15.434
SPt	6.786	nil
HV	64.659	nil
ln(S(1+HV))	nil	27.098
We	0.496	-0.003
ln(COM15*NCA)	nil	0.622

Table 5: Co-Effecients for Different Models

Comparison of the overall model correlation (R^2) and Adjusted R^2 of both the models can be shown as follows which are both important factors for the standardization of any model.

Factor Name	Model A	Model B
Overall Model Correlation(R^2)	0.966	0.997
Adjusted R^2	0.954	0.995

Table 6: Model Correlations

X. CONCLUSIONS

Thus, here from the above work and comparisons we can say that the model corelations and Adjusted R^2 of the Model B is more which shows that it is more compatible than the old Model A, due to which the results of BLOS Scores and its classes can be considered as more accurate then the Model A according to our local traffic conditions.

REFERENCES

Papers

[1] Petritsch T., "Bicycle Level of Service for Arterials", (2007), Transportation Research Record: Journal of the Transportation Research Board, No. 2031, pp. 34-42.

[2] Bai L., et. al's, "Estimating level of service of mid-block bicycle lanes considering mixed traffic flow", (2017), elseiver Transportation Research Part A 101, pp. 203-217

[3] Jensen S., "Pedestrian and Bicycle Level of Service on Roadway Segments", Transportation Research Record: Journal of the Transportation Research Board, No. 2031
[4] Pikora T., et. al's, Developing a framework for assessment of the environmental determinantsof walking and cycling, (2003), Social Science & Medicine 56, PP. 1693-1703.
[5] Harkey D., "Evaluation Of Shared-Use Facilities For Bicycles And Motor Vehicles", Transportation Research Record 1578, pp. 111-118.
[6] Dixon L., Bicycle and Pedestrian Level-of-Service Performance Measures and Standards for Congestion Management Systems, Transportation Research Record 1538, pp. 1-9.
[7] Phillips R., A Review of Approaches for Assessing Multimodal Quality of Service, (2003), Journal of Public Transportation, Vol. 6, pp. 69-87.
[8] Landis B., et. al's, Real-Time Human Perceptions Toward a Bicycle Level of Service, TRANSPORTATION RESEARCH RECORD 1578, pp.119-126.
[9] Krizek K., What is at the end of the road? Understanding discontinuities of on-street bicycle lanes in urban settings, (2005), elseiver Transportation Research Part D 10, pp. 55–68.
[10] Toole J., et. al's, Bicycle and Pedestrian Facilities, transportation planning handbook, pp. 599-641.

Reports & Manuals

[1] FDOT Quality/Level of service Handbook (2009), Florida Department of Transportation, U.S.A.
[2] Highway Capacity Manual (2010), Transportation Research Board publications Washington D.C., U.S.A.
[3] Multimodal Level of Service Analysis for Urban Streets, NCHRP Report 616, Transportation Research Board Washington, D.C. (2008).

