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Development of a Model for Pedestrians Level of Service

Akash Panchal[1], Prof. Shashikant Dhobale[2]
[1]*M.E. Student,* [2]*Asst. Professor, Department of Civil Engineering, JIT Borawan khargone, (M.P.), India*

Abstract: ***As a cleanest city of india, Indore also exerts a significant impact upon there cleanliness, modern development, medical hubs, media, advance technology, smart education, and entertainment and has been described as the commercial capital of the Madhya Pradesh. Indore is the big city in the state of Madhya Pradesh, and as also cleanest city of india in the year of 2017,2018 and 2019, The objective of the present study is to improve the pedestrian level of service at the major market of indore city (rajwada circle) . improving the road conditions and designing roads in the future Also as pre C.E.S. Delhi report in sep. 2001 rajwad area has 3369 pedestrian. This is also mention in master plan 2021 (table no 4.11) of indore city. Providing proper safety for pedestrians. pedestrian level of service (PLOS) of that market area is used as a parameter to find safety of pedestrian . The PLOS model was developed using multiple linear regression analysis. In order to determine PLOS, a set of data were collected using a self-data collection survey and road side interview. In this study, it is found that, pedestrian flow, pedestrian speed, pedestrian holding area, pedestrian crossing time, vehicular traffic and road side parking are significant factor in the development of the PLOS model, and therefore influence the movement of pedestrians at market area.***

Keywords: Pedestrian level of service (PLOS), Vehicular traffic, Vehicle pedestrian interaction, Volume/Capacity Ratio of Pedestrian, Volume/Capacity Ratio of Vehicle

I. INTRODUCTION

In the most recent year indore city has seen highly development rate and highly increasing in pedestrian and vehicle. In the market are all vehicle share same space without any segregation with pedestrian and due to this number of conflict point of pedestrian and vehicle is high. This analysis was done based on Highway Capacity Manual (HCM2010).To reduce this conflict point it is necessary to segregation between pedestrian and vehicle. The various pedestrian facilities provide segregation of the pedestrian from the vehicular flow, thereby increasing the safety of pedestrian.

A. Necessity Of Study

In the major market like rajwada in indore is very difficult location for pedestrians just because of vehicle move in all the direction and they want to occupy same space at similar time, Vehicle also occupy the space in parking. Due to this the number of conflict point between pedestrian to vehicle, pedestrian to pedestrian or may be vehicle to vehicle is high. The estimation of pedestrian level of service (PLOS) is the most important approach to assess quality of operations of pedestrian facilities. Development of pedestrian LOS measure is intended to indicate the level of difficulty in walking, road crossing. In the simple words by increasing pedestrian LOS we can reduce this conflict point, and this will increases safety of pedestrians.

Also as pre C.E.S. Delhi report in sep. 2001 rajwad area has 3369 pedestrian. This is also mention in master plan 2021 (table no 4.11) of indore city.

B. Objective

Based on the above problem statement, the objectives of this study are:

1) To suggest minimize the conflict point from pedestrian to vehicle.
2) To create the condition for safely walk to pedestrian.
3) To identify factors which influence PLOS for road crossing.
4) To create a regression model to find the pedestrian level of service at market area.
5) To take public opinion for increasing pedestrian level of service.
6) Find to need to footpath and its width.
7) To minimize the pedestrian difficulty.
8) To increasing the safety of pedestrian.\

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II. LITERATURE REVIEW

Takeo Adachi (2005) was studied that the factors affecting pedestrian level-of-service (LOS) at intersections and propose a method for the estimation of pedestrian LOS at intersections. In order to fulfil this objective, a stepwise multi-variable regression analysis was performed using the observed data of various types of intersections in the city of Japan. A significant number of pedestrians were requested to give ratings for each intersection based on their experiences at the actual sites. The scores given by the pedestrians were considered as the dependent variables for the analysis.

A field survey was conducted to collect geometric, operational and traffic characteristics of crosswalks. A number of primary independent variables influencing pedestrian LOS was identified and tested in the stepwise regression analysis. The factors such as space at corner, crossing facilities, turning vehicles,

delay at signals, and pedestrian-bicycle interaction were identified as the primary factors affecting pedestrian LOS at intersections. Each of the factors is weighted by coefficients derived by stepwise regression modelling importance. A statistically reliable t-statistics were obtained for each factor. The pedestrian LOS model was developed as a function of identified.

HCM (2010) pedestrian level of service in facilities where pedestrian flow is not interrupted (sidewalk exclusively used by pedestrians, pedestrian waiting time, paths where share use by pedestrians and bicyclists is allowed) is estimated. Basic criterion for the estimation of pedestrian level of service of sidewalk and pedestrians waiting areas is the average available area per pedestrian. For paths that serve pedestrian movements, bicycle movements, skates etc. the presence of bicycle has a negative result on pedestrian level of service.

As a result, pedestrian level of service is based on the number of incidents. Thus the total number of incident corresponds to the pedestrian level of service (A-F) in relation to a given table.

Singh K. et al. (2011) observed that the pedestrians' movements are not restricted to lanes or specific routes however, they were restricted by the physical boundaries around them such as the presence of walkways or pedestrian ways. Therefore, the needs of the pedestrians should be consider in the design of transportation facilities. Pedestrian facilities include sidewalks, paths, crosswalks, stairways, curb cuts and ramps, and transit stops. In some areas, particularly in suburban and rural communities, pedestrians may be sharing the roadway itself or its shoulders.

These facilities should be pedestrian friendly to promote walking and safety of the pedestrians. The focus of this study was to review current methods of assessing pedestrian level of service (PLOS) and discussing some new concepts, which had proposed by the researchers to evaluate pedestrian environment in a better way.

Khalidur Rahman et al. (2012) study on pedestrian movements on sidewalks in the capital city of Dhaka, Bangladesh has been done to determine the free flow walking speed and to identify the effect of contributing factors. Basic data on walking speeds and the chosen factors were collected from 1,440 pedestrians by a photographic procedure of video recording. A factorial design with mixed levels was used. Results show that the free flow walking speed is greatly affected by the pedestrian age, gender and the 'walkability' of the facility. In addition, male speed is less hampered by the carrying of baggage than female speed. The results of this analysis can be used as a guideline for developing design codes for local pedestrian facilities.

Anand Kumar Raghuwanshi et al.(2016)[5] was studied that the to carry out the pedestrian level of service on the mixed lane urban road sections and to develop condition prediction model for mixed lane for the purpose of improving the serviceability of mixed lane and identifying factors which affect pedestrian LOS at mixed lane. The factors fall into three main categories, pedestrian factors, crosswalk factors and roadway factors.

This analysis was done based on Highway Capacity Manual (HCM) 2010. The PLOS model was developed using multiple linear regression analysis. In order to determine PLOS, a set of data were collected using a video graphic survey. From this study, it is found that, pedestrian flow, pedestrian speed, pedestrian holding area, pedestrian crossing time, vehicular traffic and road side parking are significant factor in the development of the PLOS model, and therefore influence the movement of pedestrians at mixed lane. and they conclude A regression line is developed between average pedestrian space and vol. /cap. ratio of pedestrian, vol. /cap. ratio of vehicle, pedestrian crossing time (sec), and parking factor.

The equation has been tested for statistical parameters. From correlation matrix it is found that pedestrian traffic and vehicular traffic are the most prominent factors.

The observation indicates that at an average pedestrian space greater than 1.5 m2/ped, the average speed of pedestrian is approx. constant. Development of a quantitative level of service model

provides a wider domain for the planning and design of sidewalks in urban areas.

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III. METHODOLOGY

The LOS for each category are different, but all are based on the concept of space per pedestrian, which is a measure of pedestrian comfort and safety. Basically HCM (2010) methodology used for develops a model for Pedestrians LOS. Following are the steps given below followed to determine the LOS of pedestrian in market area.

1) *Step 1:* Select the area for study.
2) *Step 2:* collect data from road side interview and field Observation
3) *Step 3:* Analyzed the data like no. of vehicle, no. of Pedestrian, pedestrian LOS,
4) *Step 4:* Determine the effective walkway width.
5) *Step 5:* Calculate the pedestrian flow rate
6) *Step 6:* Determine pedestrian LOS.
7) *Step 7:* Determine all independent variables.

IV. DATA COLLECTION

The variables in the determination of PLOS are as follows:

1) Average Pedestrian Space (Y).
2) Volume/capacity ratio of Pedestrian (X1).
3) Volume/capacity ratio of Vehicles (X2).
4) Pedestrian Crossing Time (X3).
5) Parking Factor (X4)

Table: 1. Pedestrian Traffic Survey Data at Section 1

Observation Sites : Section 1															Date : 18/07/2019				
Available Roadway Width(m) = 12.2															Day : Thursday				
Effective Walk Width (m) = 2															Capacity : 2-lane (one-way) collector urban road = 1400PCU				
Length of Carriageway (m) = 7.5															Direction of Pedstrians : Both side (capacity=1600)				
S. NO.	Time	Pedestrian vol./15min	PFR (Ped/m/sec)	Avg. Travel Time	Speed m/s	Aps (m2/ped) Speed/PFR	V/C ratio of ped	Vehicle vol./15min						Total PCU	V/C ratio of veh	PCT (sec)	Width occupied by vehicle	PF	
								Pedal Cycle (0.5)	Two wheeler (0.5)	auto Ricksaw (1.0)	Car (1.0)	Buses (3.0)	Electric ricksaw (0.7)						
1	6:00 to 6:15pm	319	0.177	10.52	0.95	5.36													
2	6:15 to 6:30pm	321	0.178			5.33													
3	6:30 to 6:45pm	324	0.180			5.28													
4	6:45 to 7:00pm	285	0.158			6.00													
5	7:00 to 7:15pm	325	0.181			5.26		65	250	35	42	16	24	299					
6	7:15 to 7:30pm	327	0.182	8.33	1.20	6.61	**0.82**	54	298	38	48	18	25	334	**0.90**	**8.70**	7.3	**0.60**	
7	7:30 to 7:45pm	329	0.183			6.57		32	288	42	52	12	18	303					
8	7:45 to 8:00pm	330	0.183	11.11	0.9	**4.91**		68	278	32	64	14	21	326					
9	8:00 to 8:15pm	302	0.168			5.36													
10	8:15 to 8:30pm	289	0.161			5.61													
11	8:30 to 8:45pm	235	0.131			6.89													
				Avg. speed	1.02														

For development of model of multiple linear regressions Analysis is done and data collected at 9 sections of study area. In which average pedestrian space as dependent variable and volume/capacity ratio of pedestrian, volume/capacity ratio of vehicles, crossing time (sec), parking factor (road side parking) as independent variables. The data for all the 9 sections are given in Table number 2.

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Table: 2. Data for Regression Analysis at all 9 sections

S. NO.	Avg. Ped space m2/p take min. value	X1 (V/C of Pedestrian)	X2 (V/C of vehicle)	X3 (Crossing time)	X4 (Parking Factor)
1	4.91	0.82	0.90	8.70	0.60
2	4.86	0.92	0.95	10.10	0.70
3	4.50	0.92	0.91	11.50	0.68
4	4.59	1.94	0.88	8.60	0.66
5	4.41	1.82	0.85	8.90	0.66
6	4.52	0.99	0.90	10.50	0.61
7	3.61	1.33	0.90	10.40	0.60
8	2.89	1.26	1.14	10.80	0.59
9	3.95	0.81	1.00	8.6	0.56

V. RESULT AND CONCLUSION

Table: 3. Regression statistics

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.9610
R Square	0.9234
Adjusted R Square	0.8469
Standard Error	0.2563
Observations	9

Table: 4. Statistical Parameters of Regression Equation

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	6.4190	2.0723	3.0975	0.0363	0.6654	12.1726
X1 (V/C of Pedestrian)	-0.8652	0.2395	-3.6128	0.0225	-1.5300	-0.2003
X2 (V/C of vehicle)	-3.8233	1.2806	-2.9855	0.0405	-7.3789	-0.2677
X3 (Crossing time)	-0.2781	0.0989	-2.8108	0.0483	-0.5528	-0.0034
X4 (Parking Factor)	8.2249	2.4154	3.4052	0.0271	1.5187	14.9311

Table: 4. Correlation factor

Correlation	*Avg. Ped space m2/p*	*X1 (V/C of Pedestrian)*	*X2 (V/C of vehicle)*	*X3 (Crossing time)*	*X4 (Parking Factor)*
Avg. Ped space m2/p	1.000	-0.110	-0.738	-0.323	0.563
X1 (V/C of Pedestrian)	-0.110	1.000	-0.294	-0.301	0.272
X2 (V/C of vehicle)	-0.738	-0.294	1.000	0.292	-0.434
X3 (Crossing time)	-0.323	-0.301	0.292	1.000	0.211
X4 (Parking Factor)	0.563	0.272	-0.434	0.211	1.000

From the analysis quantitative level of service model has been developed to determine the P-LOS is shown below.

$$Y = 6.419 - 0.865X_1 - 3.823X_2 - 0.278X_3 + 8.224X_4$$

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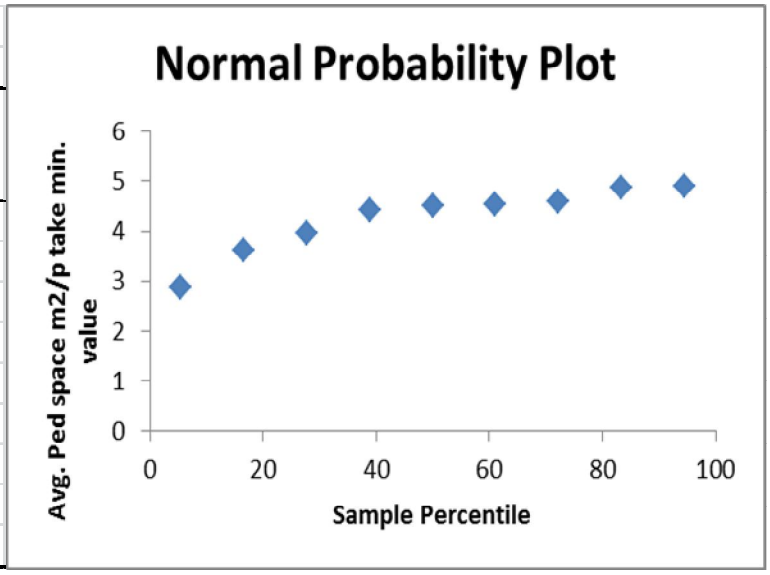
Table: 4. For normal probability curve

PROBABILITY OUTPUT	
Percentile	*Avg. Ped space m2/p take min.*
5.555555556	2.89
16.66666667	3.61
27.77777778	3.95
38.88888889	4.41
50	4.5
61.11111111	4.52
72.22222222	4.59
83.33333333	4.86
94.44444444	4.91



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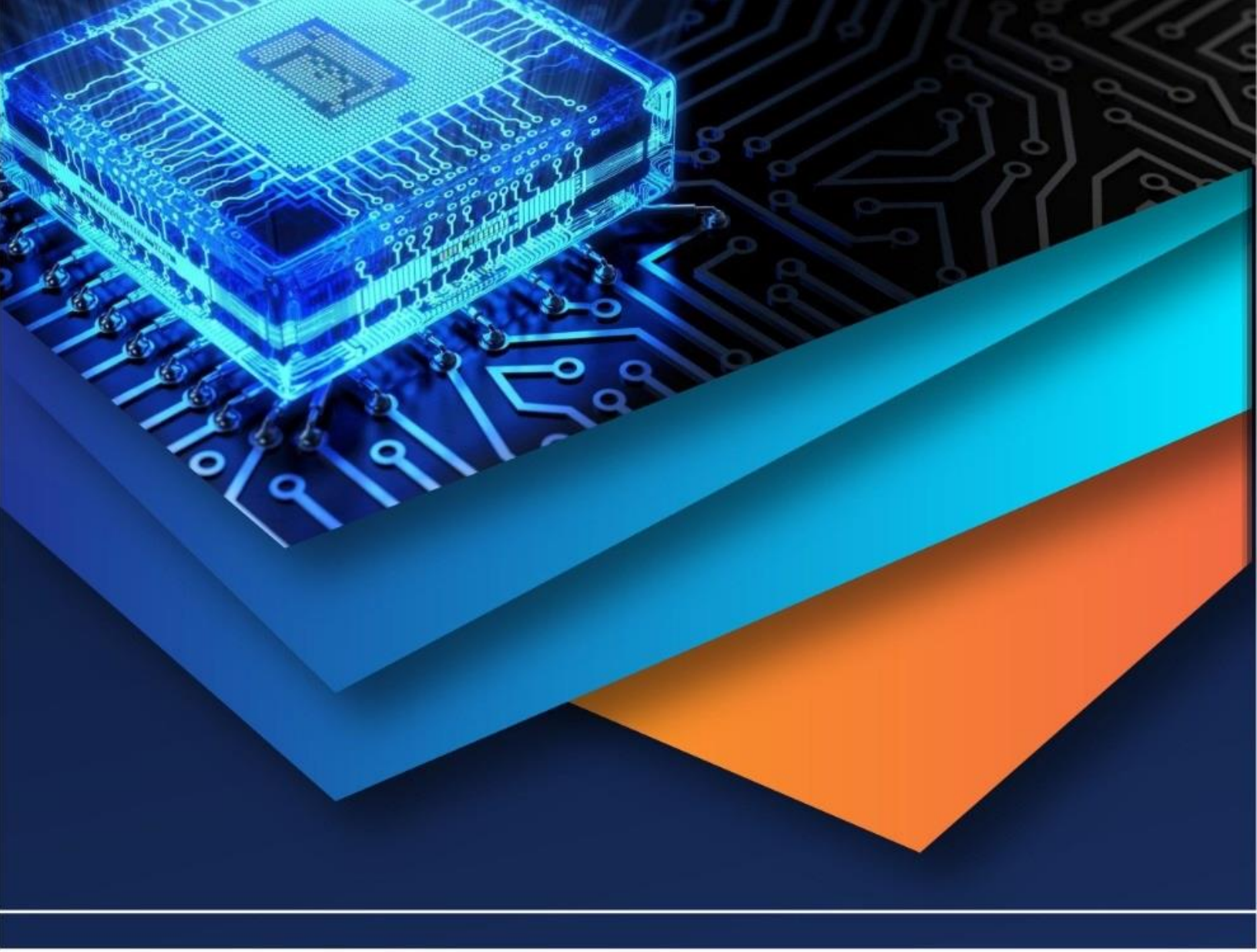

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