

Pedestrian Level of Service at Intersections in Bhopal City

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Abstract - This study aims to find out the factors influencing pedestrian level of service (PLOS) signalized intersections in Bhopal city based on pedestrian perception on safety and comfort. A stepwise multi-variable regression analysis was performed using the observed data of various types of intersection in the Bhopal city. Pedestrian questionnaire survey was conducted to collect pedestrian overall satisfaction level in terms of safety, comfort and convenience for each crossing at signalized intersection based on pedestrian's experiences at the actual sites. Also video graphic method was used for Field survey of each crosswalk at selected five signalized intersection. A significant number of ratings were given by pedestrian for each intersection. The score given by the pedestrian were considered as the independent variables for the analysis. Pearson correlation analysis was done to identify the various significant factors influencing pedestrian level of service. The factors such as Left turning traffic, Right turning traffic, number of pedestrians, number of lanes and pedestrian delay. Pedestrian delay was one of the key performance indicators for pedestrian level of service. Pedestrian overall satisfaction level model were developed by a stepwise multivariable regression analysis using Microsoft excels.

Index Terms - PLOS, Crosswalk, Signalized intersection, mixed traffic, Microsoft Excels.

I. INTRODUCTION

Most of the Indian cities have high pedestrian deaths in road accidents. In Bhopal cities, poorly maintained and unplanned pedestrian infrastructure has become a major road safety issue and as per latest statistics which records as 23 of 75 people who die on Bhopal roads are pedestrian. Pedestrian are facing problem during crossing at signalized intersection crosswalk under mixed traffic condition. Of all the problems faced by pedestrian in signalized intersection crosswalk, pedestrian delay is the most important parameter and also difficult to estimate. In recent times research works on pedestrian delay due to vehicle pedestrian interaction crosswalk have been very less. Generally used pedestrian delay estimation methods and models are mostly derived from HCM and that model is based on cycle length and red phase duration, also with little assumption such as uniform pedestrian arrival rate, noncompliance pedestrian flow, and fixed cycle length of pedestrian following the base rules without violating. These assumptions are not suitable for Indian mixed traffic condition.

II. OBJECTIVE AND SCOPE OF THE STUDY

- Selection of study area and the road intersection at which PLOS is to be identified.
- Selection and study of the intersection pedestrian delay affect the pedestrian LOS.
- Data collection using video camera kept on road intersection.
- Analysis of data and evaluation of relation between various factor and pedestrian LOS by correlation.
- Summary, conclusion and utilization of data in the future.

III. STATEMENT OF THE PROBLEM

The purpose of this study on pedestrian need is to provide better facilities to pedestrian in India. Pedestrian level of service is one of the indicative which represents quality of given intersection in terms of perceived safety, convenience and comfort in terms of pedestrian perspective. In India the number of person prone to accidents and deaths are mainly pedestrian. Pedestrian are one of the major commuters on Indian urban streets. In India mostly pedestrian are neglected in transportation planning and management. So as the pedestrian increasing day by day so better facilities need to be provided.

IV. SIGNALIZED INTERSECTION

In their most common form, signalized intersection have indication for users on each intersection approach show a basic signalized intersection with four vehicle approaches and two pedestrian approaches. It may be necessary to consider the uses of pedestrian signal at location along a corridor with a high correlation of pedestrian. This type of traffic control can be used at signalized interaction with the addition of pedestrian push – bottom and signal heads. Or non-signalized location that has high volume of pedestrian crossing. There of chance of accidents and conflict more as vehicle and pedestrian using the same space at the same time. Till now in India correlation of design of roadway elements mostly on vehicle only as they are the main users of road. Urban area at intersection considered amount of pedestrian using road.

When crossing intersection you must obey all traffic laws this means-

- Only begin crossing intersection when the pedestrian signals show a **walk** display or the white walking man symbol. If there is no pedestrian signal you may cross when the traffic signal is green for the parallel roadway traffic.
- If the pedestrian signal starts flashing **don't walk** or starts flash thing a red hand at you and you already started to cross the street, go ahead any finish. You should still have plenty of time to complete your crossing.
- Do not begin crossing on the flashing **don't walk** phase or the side **don't walk** phase.



Fig.1 -Sign Provided On the Back Each Intersection

Perceived Conflicts

Pedestrian would perceive conflicts to include not just those vehicles that cross the pedestrian path (crosswalk), but also those passing so close to the pedestrian as to make them uncomfortable, the through volume in the lane adjacent to the crosswalk was considered. Thus conflict factor were through to include the following-

- Right turning motorists the street parallel to the crosswalk
- Right turn on red motorists from side streets
- Through motorists on the parallel to the crosswalk
- Left turning motorists approaching from the street parallel to the crosswalk

Perceived Exposure

As stated above, the exposure perceived by the pedestrian was believed to be influenced by more than simply the time the pedestrian is within the roadway. Traffic control devices may also influence a pedestrian perception of exposure and therefore correlation there with should be explored. Thus some of the factors influencing pedestrian perceived level of exposure were through to including the following –

- Crossing distance (cross – street width plus a portion of the intersection)
- Presence of crosswalk – possibly modified by type of markings
- Traffic control devices – No right turn on red sign, yield to pedestrian signs, etc.
- Presence of sidewalk at waiting / landing areas
- Presence of Median type raised.

Pedestrian Delay

Signalized intersections it was hypothesized that a pedestrian's perception of the intersection is a function of the delay experience: waiting for the green light (or walk phase) to cross the street. The HCM describes methods for calculating pedestrian LOS at intersections based on this approach. Since pedestrians crossing at signalized intersections are required to obey the traffic control signals, crossing delay at a signalized intersection is a function of cycle length and the length of the walk phase for crossings with a pedestrian signal. For crossings without a pedestrian signal, it is a function of the facility's cycle length and g/C.

Many pedestrians – particularly in Bhopal city – do not wait for the appropriate signal phase to cross, it important that the LOS evaluations model only legal movements. An equation for calculating the delay to pedestrians at a signalized intersection is provided in the HCM. The impact of this delay upon the pedestrian's perception of level of service was expected to be included within our developed model. The main problem that are facing by pedestrian while crossing the road.

Pedestrian level of service

Level of service is most important criteria express the performance of a road and travels point of view. Design of various road elements transportation planner we have to take care of pedestrian. Resent accidental studies pedestrian are more accidents than any other road users. The design better transportation facility pedestrian level of service has to be taken into consideration. The HCM uses pedestrian space as primary measure of effectiveness with mean speed and flow rate as secondary measures. Provisions of adequate space both moving and queuing pedestrian flow is necessary to ensure a good LOS. Alternatively LOS considered as pedestrian comfort, convenience, perception of safety and comfort. The HCM has characterized six levels A-F for level of service taking into account best of most noticeably awful. The definition that is being taken after is one given in the HCM (2010).

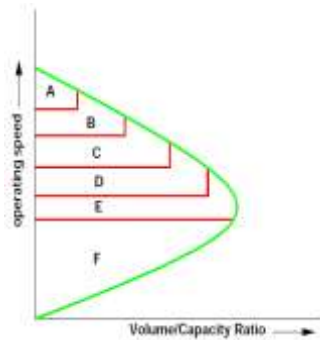


FIG.2. - LEVEL OF SERVICE A TO F

Factor affecting the perceived pedestrian level of service –

- Speed or delay and travel time
- Traffic interruptions restriction
- Operating cost
- Freedom to travel with desired speed
- Driver comfort and convenience
- Information availability
- Number of stop incurred

V. BHOPAL CITY MODEL

This modal is developed mainly considering pedestrian safety and comfort. This modal is developed based on the actual perception of pedestrian on intersection crosswalk. Questionnaire survey is conducted to estimate the LOS of given intersection. Field survey is conducted to identify the various factors influencing factor by doing multiple linear regression analysis. The model is to be developed determine pedestrian delay and pedestrian level of service mixed traffic condition of the urban area in India.

Methodology for Development of PLOS Model

The PLOS model is development of the involved-

- The collection of data by visual surveys and field surveys.
- A statistical analysis of the collected data using multiple linear correlation regression.
- For statistical analysis software Microsoft Excel is used. “Microsoft Excel is spreadsheet program included in the Microsoft office suite of application. Spreadsheet present tables of value arranged in row and columns that can be manipulated mathematically using both basic and complex arithmetic operation and function”. This can perform highly complex data manipulation and analysis with simple instruction.

Data for the Dependent and Independent Variables

They are following two types of variable dependent and independent variable the PLOS model is to be dependent variable and six types of independent variables. The dependent variable was the PLOS score obtained through interviews and questionnaires. Pedestrian were asked to rate the crosswalk in terms of safety and comfort. The average rating of the pedestrian for each crosswalk is considered to be show in table (Table no.2 & 3). The independent variables were the factors as identified consider shown in table (Table no.1). Pedestrian flow (pad/h), pedestrian crossing time (sec), pedestrian delay (sec), (4.5to 5.5-poor, 2.5to 4.5-moderate, 1.5 to 2.5-good), and roadway width (m) were measured at the study location.

Methodology for determination of LOS

- Steps 1** – Estimating LOS of the given intersection by the actual perception of pedestrian this is survey question.
- Steps 2** – video graphic survey to measure the various field conditions that affect the pedestrian LOS.
- Steps 3** – Identification the relation between various factor and pedestrian LOS by Pearson correlation.
- Steps 4** – Result developing a modal to determine pedestrian delay.

VI. STUDY AREA AND DATA COLLECTION

The study area for this research work is taken as Bhopal city of Madhya Pradesh India. The required data of the study area are obtained using video camera. Then the intersection of the road was chosen. A video camera fixed at this intersection during peak hours in the morning from 9A.M.-10A.M. collection the data recorded crosswalks at various locations Signalized intersection namely Jyoti talkies square, Board office square, Vyapam square, Karond bypass square, Bhopal talkies square. A total of five crosswalk data has been collected.

Jyoti talkies square



Fig. 6.1 Jyoti talkies square Map or satellite location and pedestrian crossing the road

Board office square



Fig. 6.2 Board office square Map or satellite location and pedestrian crossing the road

Vyapam square



Fig. 6.3 Vyapam square Map or Satellite location and pedestrian crossing the road

Karond bypass square



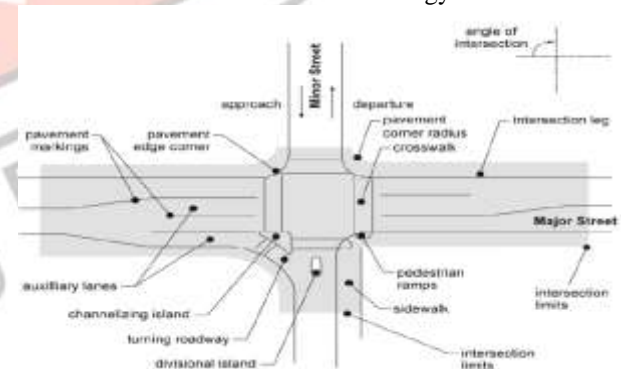
Fig. 6.4 Karond bypass square Map or satellite location and pedestrian crossing the road

Bhopal talkies square



Fig. 6.5 Bhopal talkies square Map or satellite location and pedestrian crossing the road

Intersection terminology



Data Collection Field and Questionnaires

Site Parameter	Left turning traffic	Right turning traffic	Through traffic	Left turn on red	Permitted right turn	Number of pedestrian	Average delay
Jyoti talkies square	89	102	182	168	112	122	4.91
Board office square	102	172	242	133	26	182	8.79
Vyapam square	43	94	174	44.5	19.5	89	11.5
Karond square	74	114	162	92	72	143	4.5
Bhopal talkies square	48	92	148	28	48	169	3.9

Table no.1 Crosswalk intersection traffic and pedestrian flow pcu/h

P-LOS And Participant Score

P-LOS USERS SCORE		
LOCATION	CROSSWALK	NUMBER OF PARTICIPANT
BHOPAL CITY	1	10
	2	10
	3	10
	4	10
	5	10

Table no. 2 Number of participant at crosswalk

Significance of PLOS Score

Many of the literature show that a higher value of PLOS score indicated a low level of service.

PLOS	VALUE
LOS A	$Y \leq 1.5$
LOS B	$1.5 < Y \leq 2.5$
LOS C	$2.5 < Y \leq 3.5$
LOS D	$3.5 < Y \leq 4.5$
LOS E	$4.5 < Y \leq 5.5$
LOS F	$Y > 5.5$

Table no. 3 Significance of PLOS Score indicated a low level of service

P-LOS Users Score

P-LOS USERS SCORE							
LOCATION	CROSSWALK	LOS USERS					NUMBER OF PARTICIPANT
		Delay	No. of pedestrian	No. of lanes	Left turn traffic	Right turn traffic	
BHOPAL CITY	Jyoti talkies square	2.97	2.33	3.12	3.25	2.94	10
	Board office square	1.74	1.89	1.70	1.80	1.87	10
	Vyapam square	1.32	1.87	1.69	1.93	1.68	10
	Karond bypass square	4.25	4.04	4.25	3.89	3.86	10
	Bhopal talkies square	3.08	3.63	4.22	3.02	3.71	10

Table no.4 P-LOS and Participant Users Score

VII. RESULTS AND ANALYSIS

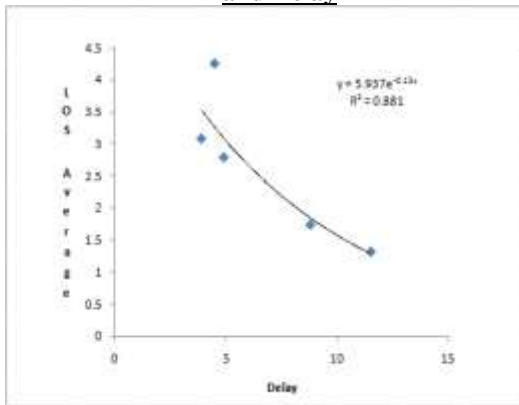
Correlation between PLOS and various factors – Correlation is done to identify the relation between various factor influencing factor and POLS. They are following below relation between independent and dependent variable it is linear or exponential or logarithmic.

S. No.	Site	Delay	Avg. LOS	No. of Pedestrian	Avg. LOS	No. of Lanes	Avg. LOS	Left turn Traffic	Avg. LOS	Right turn Traffic	Avg. LOS
1	Jyoti talkies square	4.91	2.97	122	2.33	4	3.12	89	3.25	102	2.94
2	Board office square	8.79	1.74	182	1.89	4	1.70	102	1.8	172	1.87
3	Vyapam square	11.5	1.32	89	1.87	4	1.69	43	1.93	94	1.68
4	Karod bypass square	4.5	4.25	143	4.04	4	4.25	74	3.89	114	3.86
5	Bhopal talkies square	3.9	3.08	169	3.63	4	4.22	48	3.02	92	3.71

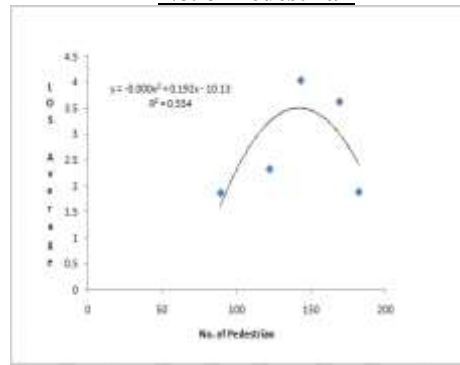
Table no.5 Correlation between PLOS and various factors

Correlation between PLOS and various factors

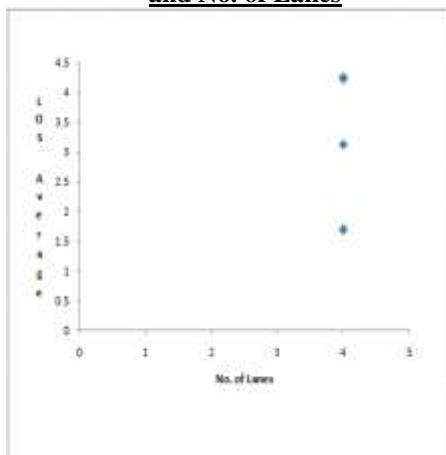
1. Graph of Correlation between Average LOS and Delay



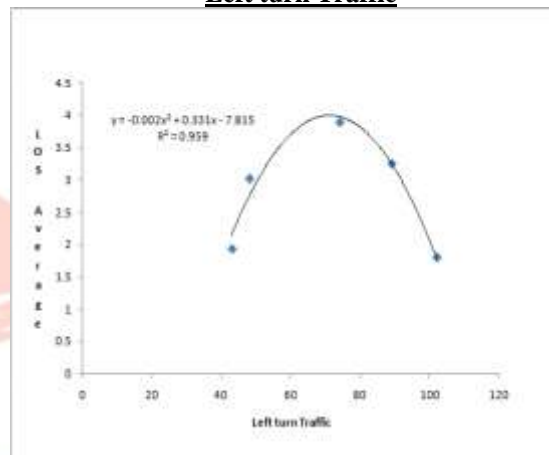
2. Graph of Correlation between Average LOS and No. of Pedestrian



3. Graph of Correlation between Average LOS and No. of Lanes



4. Graph of Correlation between Average LOS and Left turn Traffic



5. Graph of Correlation between Average LOS and Right turn Traffic

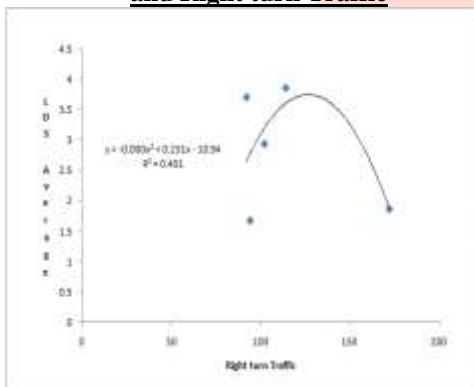


Table no.5 Correlation among various factors and LOS

S. No	Factors	Correlation with LOS	Best fitted trend of Correlation
1	Delay	0.881	Exponential
2	No. of Pedestrian	0.554	Polynomial 2nd degree
3	No. of Lanes	0	0
4	Left turning Traffic	0.959	Polynomial 2nd degree
5	Right turning Traffic	0.401	Polynomial 2nd degree

Correlation among factors affecting Los and average Los has been determined and presented in above table. It has been observed that number of pedestrian, number of lanes and right turning traffic are having very less correlation with LOS, and this indicates that left turning traffic and delay are more significant for LOS values.

In the above graphs two different relations were obtained to determine the value of LOS by using values of delay and left turning traffic. As most influencing parameter is left turning traffic, so, first model is developed to determine LOS value based on values of Delay.

$$y = 6.118e^{-0.13x} \quad \text{eqn. (1)}$$

Where y = LOS and x = Delay values

Second model is developed to determine LOS value based on values of left turning traffic

$$y = -0.002x^2 + 0.331x - 7.815 \quad \text{eqn. (2)}$$

Where y = LOS and x = Left turning traffic

VIII. CONCLUSIONS

Following are the findings from the research estimation of pedestrian level of service at signalized intersection in urban Indian condition-

- Developed a method to define the level of service (LOS) of pedestrian at signalized intersection under mixed traffic condition, in India mostly mixed traffic condition will present due to the presence of different classes of vehicles.
- In the study mainly it has been observed that number of pedestrian, number of lanes and right turning traffic are having very less correlation with LOS, and this indicates that left turning traffic and delay are more significant for LOS values.
- Level-of-service modal was validated with field data of the given Bhopal city and studied the various factors affecting such as number of pedestrian, through traffic, number of lanes, and delay on level of service.
- Roadway designers can use the pedestrian LOS model to test alternative intersection designs by iteratively changing the independent variables to find the best contribution of factor to achieve the desired LOS. The method proposed in this study provides not only the pedestrian LOS at intersection but also the factors contributing to less correlation and more significance LOS values.

IX. REFERENCE

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