International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 9 Issue 6 ǁ 2021 ǁ PP. 44-50

Pedestrian Flow Analysis at Uncontrolled intersection - A Case Study

Nitin Nathani[1], Dr. Pinakin N. Patel[2], Dr. L. B. Zala[3], Amit A. Amin[4]

[1] *P.G. Student, Birla Vishvakarma Mahavidhyalaya, Anand, India*
[2]*AssistantProfessor, Department of Civil Engineering, Birla Vishvakarma Vidhyalaya,*
[3]*Professor and Head, Department of Civil Engineering, Birla Vishvakarma Vidhyalaya,*
[4]*AssistantProfessor, Department of Civil Engineering, Birla Vishvakarma Vidhyalaya.*

Abstract
One of the most common approaches used to assess transportation facilities is the concept of LOS. The objective of this study is to identify the factors affecting pedestrian level-of-service (LOS) at intersection. A significant number of pedestrians were requested to give ratings for each intersection based on their experiences at the actual sites. Pedestrian spaces should be designed in considerations of human convenience and have to be qualitatively suitable top the needs of human beings. Pedestrian level of service indicates the environmental qualities of a pedestrian space and serves as a guide for development of strangers for pedestrian facilities. Additional environmental factors that contribute to the walking experience and therefore to the perceived level of service. Such as comfort, convenient, safety, security and attractiveness, should also be considered. In current study area 'Modasa Char Rasta' (5-legged intersection) with severe pedestrian movement which is popularly called 'Modasa bazaar area' is selected. Pedestrian LOS for pedestrian movement on sidewalks of all roads meeting at the intersection and those crossing the roads is estimated & found to be B & C. Hence it is suggested to make provisions for signals with green phase for pedestrians & vacate the walking area occupied by street hawkers & dwellers as much as possible& also, to check the feasibility of providing foot over bridge with an aim to reduce conflicting movements between pedestrian & vehicular traffic flowing across the intersection.

Keywords: *Pedestrian Level of Service (PLOS), Quality of Service (QOS), Pedestrian Flow Rate, Speed, Density, Space.*

Date of Submission: 10-06-2021 Date of acceptance: 24-06-2021

I. INTRODUCTION

People's needs/wants to move, as well as their desire to satisfy their commodities, drive transportation demand. People's choices in terms of time, money, comfort, and convenience reveal the means of transportation they prefer, providing such a mode is available. In order to plan for a more walkable environment, methods that allow planners and decision-makers to effectively uncover and analyze the aspects of the built environment that support or obstruct walking are required.

Growing motorization and vehicle ownership has resulted in a significant increase in the number of pedestrian and accident casualties, as well as the number of individuals injured. The few civil society and nongovernmental organizations working in this area can play critical roles in encouraging changes in walkability and pedestrian facilities in their city land-use.

There are no proper/less popular methodology is available to compute Pedestrian Level of Service (PLOS) provided by urban streets in India. It is important to build up suitable methodologies for level of service analysis of selected urban streets.

This highlights the need of using practical methodologies while defining pedestrian level of service requirements for urban streets in Indian cities. Due to the lack of well-defined pedestrian level of service criteria for extremely heterogeneous/volatile traffic flow conditions on urban corridors in India, an attempt was made in this study to define pedestrian level of service criteria.

1.1 Study Objective

The objective of study are,

- To achieve an overall view regarding the LOS.
- To Provide the basis for the improvement in Transportation condition especially at peak hours at the study location.
- To analyse the pedestrian's Space, Speed, Flow and Volume/Capacity Ratio (v/c) during Peak hours.

II. LITERATURE REVIEW

Level of service is a quality pointer that describes operational conditions within a traffic stream, typically in terms of speed and travel time, maneuverability, traffic disruptions, and comfort and convenience. Level of service rating given from A to F. LOS A means minor pedestrian flow and LOS F means crowding. **Thambiah(1)** evaluate a pedestrian level of service along sidewalks and at an intersection portion using conjoint analysis. **Kadali(2)** collected a pedestrian data to evaluate a pedestrian crosswalk level of service and find a quality of service of crossing facilities. **Lazou(3)** examine the perceived LOS of two connected pedestrian streets. **Brahmbhatt(4)** studied on pedestrian flow at peak hour in Dakor city and result was compared with the international standards. **Landis(5)** study on pedestrian safety and comfort in the road side environment and give design for effectiveness improvement. **Singh(6)** carried present existing pedestrian level of service methods and to compare their theoretical underpinnings and performance. PLOS methods have been developed in a variety of ways however the analysis of the methods discussed suggests the need for substantial improvements in analysis procedures. **Sahani(7)** selected two important cities Bhubaneswar and Rourkela of Odisha state in India. Different LOS values based on pedestrian space, flow rate, speed of pedestrian and volume to capacity (v/c) ratio are defined from clustering analysis method which gives numeric ranges for LOS categories. By using AP cluster analysis, ranges of parameters for six pedestrian levels of service categories i.e. A, B, C, D, E and F are defined for off-street walking facilities in Indian context. Also qualitative study can be done for defining PLOS categories and relationship between qualitative and quantitative study need to be establish.

IRC-103:2012 specifies the provision of pedestrian crosswalks at all important intersections and at locations where substantial conflict exist between vehicular and pedestrian movements. It describes that wherever possible; crosswalks should be at right angles to the carriageway and properly marked so that pedestrians are subjected to minimum inconvenience. Also, crosswalks should not increase walk distance of pedestrians.

III. RESEARCH METHODOLOGY

The methodology for this implementation based on literature review contains, (1) Selection of a suitable location for the field survey, (2) Collecting the existing geometric data and corresponding traffic data of intersection by field surveys and videography method. (3) Proceeding further with the video data being collected and extracted for various traffic characteristics. (4) Measurement of the operating conditions of facitilities in a quantitative manner via PLOS.

3.1 Study Location

Modasa Char-Rasta (5-legged Intersection) of Arvalli district of Gujarat state is opt for study area. A five-legged intersection of Modasa city is considered as a study area location. Four roads are four lane roads and other one is two lane road. Which all connects the major part of the city.

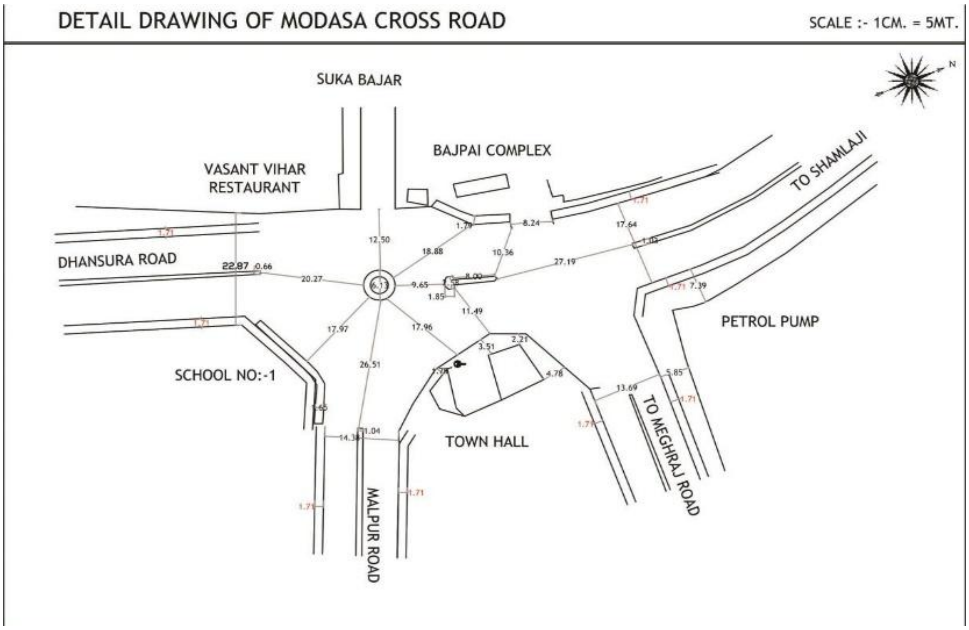

Figure 1 Diagram of Modasa intersection cross road

3.2 Data Collection and Extraction

On each leg, data was collected during peak morning and evening hours. A survey was conducted and data was collected for one hour during each daytime. Side walks, right angle crossings, and diagonal crossings were all recorded. Male, female, and child pedestrians were split into different categories. Existing inventory data, such as type of road, number of lanes, road width, width of footpaths/sidewalks, and so on, were also measured and used as a basis for the study.

Figure 2 Intersection during Peak hours

Categorized Data was extracted manually from recorded video file for both the slots. Intersection boundaries were noted during the intersection inventory survey to simplify the conflict area. The speed of each pedestrian was extracted and Microsoft Excel were used for further analysis.

IV. DATA ANALYSIS

The analysis gives information that can be used to make decisions. The goal of this study is to identify problems and determine countermeasures. When performance indicators for a network or a service on a facility – or a piece of it – do not meet defined criteria, problems are frequently detected. Because pedestrian traffic congestion is so intense at some times, the traditional approach of marking a specific length of road stretch with white bands to monitor density, speed, space, and flow has shown to be atypical. In that case, an arbitrary grid is formed by dividing the already given length and width into an equal number of divisions, of the length of the road stretch, on a transparent sheet depicting the intended road stretch, with each box of the grid giving a 1m × 1m area on the road. To calculate the above flow parameters, the following methodology is used.

- Density: - The total number of heads within the grid area is to be counted up first. The area of the road stretch is known already. So, the total number of heads is divided with the area of stretch to have the density in terms of Pedestrians per Meter Square.
- Space: - The total area of the selected stretch divided by the number of heads within the boundary of the grid gives the space in terms of Meter Square per Pedestrian.
- Speed: - At a particular given moment in time, five numbers of pedestrians are observed for a stretch of 10mt length and the time required moving that 10mt is noted down. This data gives the speed of individual pedestrian when 10 meter is divided by the time in seconds to cover that much length as per speed formula. Then, the average of those five speeds accounts the average speed of pedestrian at that moment of time.

The data thus evaluated is then compared with (i) the H C M 2017 PLOS criteria for walkway and (ii) PLOS criteria as per Rima Sahani and P.K.Bhuyan (Indian Highways, April 2015) for Urban Off-Street facility.

Data collected for the study is analyzed for all the 5 movements at intersection. And it is also analyzed for different type of movement like, sidewalks, cross walks and diagonal cross walks.

Table 1 Composition and Movement of Pedestrian (morning time)

Sr. No.	Name of Road	Type of Movement	Male	FEMALE	Children	Total
			(%)	(%)	(%)	(%)
			Morning			
1	Himmatnagar shamlaji Road to Modasa Intersection	Side Walk(one side)	45.02	39.55	17.19	100
		Side Walk(other side)	40.92	38.72	17.61	100
		Right angle crossing	43.35	35.52	21.13	100
		Diagonalcrossing (shamlajito Malpur)	35.32	36.2	28.28	100
2	Malpur Road to Modasa Intersection Dhansura Road to Modasa Intersection	Side Walk(one side)	41.85	40.04	18.15	100
		Side Walk(other side)	43.99	42.84	14	100
		Right angle crossing	43.79	35.52	19.54	100
3	Meghraj Road to Modasa Intersection	Side Walk(one side)	41.9	42.55	16.04	100
		Side Walk(other side)	43.99	42.24	13.07	100
		Right angle crossing	40.67	39.79		
4	Dhansura road to Modasa Intersection	Side Walk(one side)	50.55	34.66	14.79	100
		Side Walk(other side)	42.64	40.13	17.23	100
		Right angle crossing	39.69	39.21	21.1	100
		Diagonal crossing(Dhansura to Meghraj)	35.81	36.24	27.95	100
5	Bazar Road to	Side Walk(one side)	45.27	40.73	14	100

	Modasa Intersection	Side Walk(other side)	40.85	39.84	19.31	100
		Right angle crossing	37.52	41.07	21.41	100

Table 2: PLOS Criteria for Urban Off-Street Pedestrian Facilities at Modasa Intersection

LOS	Space(m/p)	FlowRate (p/min/m)	Speed(m/s)	v/cRatio
A	>5.6	≤16	>1.30	≤0.21
B	>3.7 – 5.6	≤ 16-23	>1.27– 1.30	>0.21 – 0.31
C	>2.2 – 3.7	≤ 23-33	>1.22– 1.27	>0.31 – 0.44
D	>1.4 – 2.2	≤ 33-49	>1.14– 1.22	>0.44 – 0.65
E	>0.75 – 1.4	≤ 49-75	>0.75– 1.14	>0.65 – 1.0
F	≤0.75	Variable	≤0.75	Variable

4.1 Analysis of Level of Service

Table 3 PLOS Criteria for Footpaths (Indo HCM 2017)

(in ped/min/m)

LOS	Commercial	Institutional	Terminal	Recreational	Residential
A	≤ 13	≤ 13	≤ 15	≤ 12	≤ 16
B	> 13-19	> 13 - 19	> 15 - 26	> 12 - 20	> 16 - 23
C	> 19-30	> 19 - 27	> 26 - 32	> 20 - 32	> 23 - 34
D	> 30-47	> 27 - 36	> 32 - 68	> 32 - 54	> 34 - 47
E	> 41-69	> 36 - 42	> 68 - 78	> 54 - 91	> 47 - 59
F	Variable	Variable	Variable	Variable	Variable

Table 4: Pedestrian Level of Service at Corner as per V/C ratio

Sr.No	Name	Level OfService for corner pedestrians
1	Corner between Meghrajroad to Himmatnagar shamlajiroad	LOSB
2	Corner between Himmatnagar shamlaji road to BazarRoad	LOS C
3	Corner betweenBazar Road to DhansuraRoad	LOS C
4	Corner between DhansuraRoad to Malpur Road	LOS C
5	Corner between MalpurRoad to Meghraj road	LOS C

PLOSvariesbetween‘A’to‘F’when consideredwith respect to Speed,with ‘C’ for most of the times, then ‘B’.

4.2 As per Rima Sahani and P.K. Bhuyan." PedestrianLOS Criteria for Urban Off-Street Facilities of Mid-SizeCities using SOM and ANN

Table 5 Frequency distribution wrt PLOS criteria for Space and Speed at study location

PLOS	Space	Speed	Frequency Distribution	
(Rima Sahani et.al.)	(m2/p)	(m/sec)	Space	Speed
A	> 15.67	> 1.22	0	77
B	> 11.94 - 15.67	> 1.11 - 1.22	0	21
C	> 9.07 - 11.94	> 0.95 - 1.11	0	47
D	> 6.49 - 9.07	> 0.78 -0.95	2	64
E	> 4.48 - 6.49	> 0.62 - 0.78	18	20
F	≤ 4.48	≤ 0.62	227	18

ThePLOScomesout tobe'F'wrtspacein Indiancontext.And itis fluctuatingbetween'A'to'F'when consideredwrt Speed,with 'A' for maximum of times, then 'D' andthen 'C'

V. CONCLUSIONS

The flow parameters at an intersection and all five legs to intersections vary between 40 and 120 persons per meters per minute (ped/m/min), indicating that the levels of service as defined by the HCM 2017 flow parameters criteria are A and B.

According to HCM:2017, pedestrian speed in normal conditions is 1.2 m/s, however the measured average speed of pedestrians is 0.82 m/s on sidewalks, 0.79 m/s on diagonal crossings, and 0.80 m/s on right angle crossings.

This reveals a 25 % to 37 % in pedestrian movement speed. Furthermore, according to the report, there are no solutions such as zebra crossings per pedestrian green phase accessible to aid pedestrian passage across the intersection due to heavy pedestrian flow.

Moreover,thevolumeof no. of pedestrianwalkingonthesidewalksandapproaching thecornerofintersectionisveryhighandthusthelevelofserviceatcorner false down to B &C.

As a result, it is recommended that merchants, hawkers, and slum residents leave the area of sidewalks, crosswalks, and other public spaces for general public use, and that signalized intersections with green phases for pedestrian crossing be provided if the city planning economy allows. Furthermore, because the flow of vehicular traffic across the crossroads is consistently large, local bodies and authorities should consider if building a foot over bridge is viable.

REFERENCES

[1] Thambiah Muraleetharan, Takeo ADACHI, Toru HAGIWARA, Seiichi KAGAYA. Method to determine pedestrian Level-of-Service for crosswalks at Urban Intersections. *Journal of the Eastern Asia Society for Transportation Studies, Vol.6, pp. 127-136, 2005*

[2] B Raghuram Kadali, P Vedagiri. Modelling pedestrian road crossing behaviour under mixed traffic condition. *European Transport/Transporti Europei (2013) Issue 55, Paper no.3, ISSN 1825-3997*

[3] O. Lazou, A Sakellariou, S. BasbasE. Paschalidis, I. Politis. Assessment of LOS at pedestrian streets and qualitative factors. A pedestrian's perception approach. *Th International Coness on Transportation Research (2015).*

[4] IRC :103-2012, Guidelines for Pedestrian Facilities

[5] Indian Highway Capacity Manal - 2017

[6] Chhaya Brahmbhatt, Dr. L.B. Zala, Dr. Mukti Advani, Measurement of Pedestrian Flow Parameters – Case study of Dakor, Gujarat. *International Research Journal of Engineering and Technology (IRJET), Volume 02 Issue 02, May-2015*

[7] Bruce W Landis, P.E, AICP Venkat R. Vattikutti, M.S Russell, M. Ottenberg, Douglas S. McLeodModelling the roadside walking environment a pedestrian level of service, January-2001-Transportation Research Record Journal of the Transportation Research Board *1773(1)*

[8] Singh K. , Jain P>K>. Methods of Assessing Pedestrian Level of Service. *Journal of Engineering Research and Studies E-ISSN0976-7916*.

[9] Rima Sahani, Prasanta Kumar Bhuyan. Pedestrian level of service criteria for urban off-street facilities in mid-sized cities. *Transport (Taylor-francis online) Volume 32,2017-issue 2*

[10] Avinash Chaudhari, Ninad Gora, S.M.ASCE, Shriniwas Aratkar; Gaurang Joshi, Srinivas Pulugurtha, M.ASCE. Pedestriann Crossing Warrants for Urban Midblock Crossings under Mixed-Traffic Environment. *ASCE/DOI:10.1061/JTEPBS.0000338*