IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

PEDESTRIAN LEVEL OF SERVICE AND JUNCTION IMPROVEMENT

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Abstract: The unsafe pedestrian crossing at uncontrolled midblock sections is very common phenomena. At such locations, vehicles do not always yield to pedestrians, and pedestrian are unable to judge suitable gaps between two vehicles, thereby, expose themselves towards crash risk. This paper aims to identify the factors affecting Pedestrian Level of Service (PLOS) for unsignalised intersection. Firstly, the potential primary factors influencing pedestrian LOS at crosswalk were summarized from three respects: traffic conflicts, crossing facilities and delay. Secondly, data for the model were collected, including 92 participants real-time sense of comfort and safety when they crossing the selected intersection crosswalks and the design and operational characteristics of the selected intersection. The study area for research work is taken at Ernakulam district of Kerala, India which includes a two three legged intersection. In order to fulfill this objective, a stepwise multi-variable regression analysis was performed using the observed data. A significant number of pedestrians were requested to give ratings for each intersections based on their experience at the actual sites. The scores given by the pedestrians were considered as the dependent variables for the analysis. A video graphic survey was conducted to collect the primary independent variables influencing LOS was identified and tested in the stepwise regression analysis and were carried out to develop PLOS model for overall unsignalised midblock crossings of roads. This pedestrian LOS model was developed by the identified variables.

Index Terms – Pedestrian LOS, Intersection, Variables

I .INTRODUCTION

Walking is one of the most important travel modes in Indian urban and sub- urban areas. Pedestrian is defined as a person whose mode of travelling is walking. So pedestrian plays an inevitable role in Indian traffic but they are the most vulnerable road user and are always neglected in transportation planning, construction and management. But it is a fact that at some point or the other every person is a pedestrian. Potential for conflict between different types of road users is very high at intersections it is because different traffic moving in different directions occupies the same area to cross. The nature of traffic in India is very heterogeneous so it is very hard for pedestrians to cope up with Indian traffic situation. So more care should be given to improve pedestrian facilities, sidewalk, foot over-bridge, walkway etc. can be provided to increase the safety of pedestrian. Level of service (LOS) is defined as a qualitative measure which describes the operational conditions within traffic stream and their observation by motorists or travelers. The term LOS introduced by the highway capacity manual(HCM) represent the level of facilities a user can derive from road under various operating characteristics and traffic volume. HCM defines six LOS based on operational condition that is from LOS A to LOS F representing the best to worst level of services. Pedestrian level of service (P-LOS) expresses the degrees that the road facilities satisfy the pedestrian's demands of safety, comfort, continuum and celerity. Road facilities include sidewalks, crosswalks, walkways, Refugee Island etc. Our study mainly focuses on effectiveness of crosswalks at the selected unsignalised intersections. The reason behind selecting unsignalised intersection was that compared to signalized intersections unsignalised intersections offer less safety to the pedestrians. An unsignalised intersection functions quite differently from a signalized intersection. In the signalized intersection the common intersecting space is "time shared", at the unsignalised intersections the sharing is a lot more complex.

1.2 Objectives.

The purpose of the study is,

- To identify the significant factors affecting the Pedestrian Level of Service (PLOS) at the selected unsignalized intersections.
- To collect the data by field survey and video graphic survey.
- To develop a regression model to determine the level of service of pedestrians (PLOS) at selected unsignalised intersections and to analyze identified factors of PLOS by undergoing various tests using statistical software.

- To validate the obtained PLOS & model with an evaluation matrix.
- To identify the different type of junction improvement methods can be adopted based on the result of selected intersection.

1.3 Scope of the study.

- Study can be extended and can reach to a common equation that suits present Indian conditions.
- From the model we can understand that pedestrian delay has a great influence on the level of service of pedestrians. By studying the delay factors and the main reasons for the delay we can improve the pedestrian level of service.

II. METHODS OF DATA COLLECTION

The datas are collected from two unsignalised three legged intersection. The areas are Angamaly LF junction & Mattoor junction are shown in fig 2.1 & 2.2 respectively. Three legged of little flower junction road leads to Angamaly, kalady & Angamaly. Pedestrian flow is more because of the presence of hospital and college near the intersection. Mattoor junction leads to Angamaly, kalady & college road. Most of the college students use this particular stretch for accessing public transportation system and thereby increases the traffic flow in the selected stretch.

Fig 2.1: Angamaly LF junction

Fig 2.2 : Mattoor junction

2.1 Data collection.

The data collection is mainly done by conducting questionnaire survey and video graphic survey. The values of dependent and independent variables are determined separately from questionnaire survey and video graphic survey accordingly. Questions based on safety and comfort and are asked to the pedestrians and ratings are given to the answers. The average P-LOS score is taken as the dependent variable to develop the model. The main questionnaire consist of seven multiple choice question. The survey was conducted among pedestrians and people near the bus stop. Video graphic survey is mainly done to find the independent variables. Video cameras had been set up at selected crosswalks of each intersection and video graphic surveys were conducted at each site during morning and evening. Pedestrian volume, pedestrian delay, pedestrian crossing time, through vehicle volume, through left turn vehicle volume, through right turn vehicle volume, side road left turn vehicle volume, side road right turn vehicle volume, vehicle speed are the main factors that identified by conducting interviews and proper literature studies. The video graphic survey will give the values for the software.

The values of all these factors are obtained from video graphic survey selected unsignalised intersections. All the values except speed can be directly obtained by analyzing the video. The speed information for the vehicles are extracted from the video camera as follows:

- The extremities of the stretches are marked as A and B respectively.
- The length of the each stretch being marked as “L”.
- Now we noted down the time lapse taken by the typical vehicle to cover the typical stretch as “t”.
- Then the speed of the vehicle was calculated by making use of the basic distance- speed relation.
- Then the average speed of the vehicles were calculated for the analysis purpose
- Then the other factors are found out through this video graphic survey.

III. DATA ANALYSIS

3.1 Response from pedestrian.

Responses from pedestrians are evaluated by giving scores to the answers which are divided into six levels based on the performance of the intersections. A scale of 1 to 6 is sufficient to accurately cover the range of conformance. These scores were assigned entirely on the basis of literature studies. The scores can subsequently be aggregated and averaged to obtain an overall LOS. The pedestrian response at

Angamaly LF junction and Mattoor junction is shown below in a Table 3.1. The following shows pedestrian LOS classifications, where X is the model's numerical result.
LOS A: $X \leq 1.5$,
LOS B: $1.5 < X \leq 2.5$,
LOS C: $2.5 < X \leq 3.5$,
LOS D: $3.5 < X \leq 4.5$,
LOS E: $4.5 < X \leq 5.5$, &
LOS F: $X > 5.5$.

Table 3.1: Response from pedestrians

ANGAMALY	MATTOOR
5.760	4.917
3.618	4.29
4.427	4.998
5.2372	4.961
4.7138	4.138
5.6186	4.369
4.983	4.318
4.262	4.813
4.123	4.298
4.839	4.562

3.2 Data from video graphic survey.
The values of traffic and pedestrian characteristics at Angamaly LF junction & Mattoor junction are extracted from video graphic survey. The dependent variables are collected from questionnaire survey and independent variable are collected from video graphic survey. The data were collected separately for each 5 minute interval. The dependent and independent variables of Mattoor junction & Angamaly LF junction is shown in Table 3.1 & 3.2 accordingly. Comparison of traffic flow & pedestrian flow are done. Also comparison pedestrian delay & crossing time are done in each intersection.

Table 3.2: Dependent & independent variables of Mattoor junction

Pedestrian score	Pedestrian volume	Crossing time of pedestrian	Pedestrian delay time	Through	Through left	Through right	side left	Side right	Speed
4.917	68	12	21.61	274	127	147	43	30	9.40
4.29	56	14.03	22.66	301	146	155	51	43	7.69
4.998	112	11	20	272	137	135	49	35	8.89
4.961	64	11.29	12	332	197	135	28	32	6.58

4.1384	95	13.73	29.47	302	142	160	39	31	4.13
4.3694	174	8.19	40.22	277	140	137	20	36	4.79
4.318	151	11.69	18.198	292	129	142	20	48	2.08
4.813	152	14.77	13.79	212	124	120	24	23	4.37
4.298	117	11.74	21.38	293	114	179	26	45	2.32
4.562	108	13.54	25.93	219	107	112	28	34	0.70

Table 3.3: Dependent & Independent variables from Angamaly LF junction

Pedestrian score	**Pedestrian volume**	**Pedestrian delay**	**Crossing time of pedestrian**	**Through**	**Through right**	**Through left**	**Side left**	**Side right**	**Speed**
5.76	71	19.81	14.45	209	69	140	79	53	5.82
3.618	55	20.58	14.24	218	75	160	67	49	6.16
4.427	52	21.8	12.45	219	78	141	83	45	4.83
5.237	89	17.22	10.78	208	74	134	62	45	5.73
4.713	77	19.89	11.88	217	78	139	67	54	6.99
5.618	69	21.84	15.17	252	95	157	65	46	8.18
4.983	83	35.95	12.05	261	112	149	73	49	9.27
4.262	92	17.39	11.95	245	101	150	63	47	4.42
4.123	73	18.24	9.83	247	118	146	85	52	4.35
4.839	67	25.46	15.57	266	121	148	87	55	7.69

IV. MULTIPLE REGRESSION MODEL.

Regression analysis refers to a group of technique for studying the relationships among two or more variables based on a sample .NCSS make it easy to run either a simple linear regression analysis or a complex multiple regression analysis, and for variety of response type. NCSS has modern graphical and numerical tools for studying residual, multi co linearity, goodness-of–fit, model estimation, regression diagnostics, subset selection, analysis of variance and many other aspects that are specific to type of regression being performed.

V. TESTS AND RESULTS.

5.1 R-Square Test

R^2 value indicates the quality of the model. If the value is close to one then the model fit the data well while a value closer to zero indicates poor fit. R^2 value always increases with the increase in number of variance. It is a statistic used in the context of statistical models whose main purpose is either the prediction of future outcomes on the basis of other related information. It provides a measure of how well observed outcomes are replicated by the model.

5.2 Normality Test

If the Shapiro Wilk null hypothesis of normality is rejected then the results of the developed model may be questionable. In statistics normality test are used to determine if a data set is well-modeled by a normal distribution and to compute how likely it is for a random variable underlying the data set to be normally distributed.

5.3 T-Test

Regression coefficient t-test record the probability value or p-value for each variable these probability levels test the significance of each variable with all of the other variables included in the model in particular. Very small p-values indicating that they are likely significant predictors, omit those variables with a high probability level on eat a time starting with the variable with highest p-value and rerunning the multiple regression procedure again and again until we arrive at a model where at a model where all of the variables are significant.

5.4 Evaluation matrix

The evaluation matrix is an essential tool for planning and organizing an evaluation. It is simply a table with one row for each evaluation question and columns that address evaluation design issues such as data collection methods, data sources, analysis methods, criteria for comparisons, etc. The design matrix links each evaluation question to the means for answering that question.

5.4.1 Evaluation matrix based on qualitative basis

The initial stage of this method involved the identification of parameters for reflecting the important aspects of level of service experienced by pedestrians. Based on research review six parameters were identified to be included in the evaluation matrix. Six parameters selected based on qualitative analysis are safety, comfort, roadway surface, obstructions, crosswalk visibility and provision of median**.** The evaluation matrices explained below, was filled out through site investigation**.** A scale of 1 to 6 is sufficient to accurately cover the range of conformance. These scores were assigned entirely on the basis of site inspection. Table 5.1 shows the evaluation matrix based on qualitative basis. The scores can subsequently be aggregated and averaged to obtain an overall LOS, with the following ranges and general characteristics. Table 5.2 shows the results obtained from the evaluation matrix.

Table 5.1: Evaluation matrix based on qualitative basis

Evaluation matrix rating scale ↓→	1	2	3	4	5	6
Safety	Very safe	Safe during day only	Safe during night only	Moderately safe	Less safe	Not safe
Comfort	Very comfort	Very comfortable during day time	Very comfortable during night time	Moderately comfortable	Comfortable	Uncomfortable
Roadway surface	very smooth with refugee island	Smooth surface, well maintained, no refugee island	Reasonable quality, walking comfortable	Moderate condition	Bad condition	Very bad condition
Obstruction	No obstruction	Very Few obstruction	Few obstruction	Many obstruction	Too many obstruction	Cannot walk
Crosswalk visibility	Highly visible and illuminating at night	Highly visible	Visible	Moderately visible	Less visible	Not visible
Provision of median	Well spaced and maintained, visible	Well spaced and maintained, less visible	Well spaced but not visible	Not well spaced	Median line is provided	No median

Table 5.2: Evaluation matrix results

Evaluation measures sites ↓ →	Angamaly	Mattoor
Safety	3	4
Comfort	5	5
Footpath surface	5	6
Obstructions	4	4
Crosswalk visibility	5	4
Provision of median	5	6
Average score	4.5	4.8
Overall LOS	**E**	**E**

VI. JUNCTION IMPROVEMENT.

A junction is the general area where two or more roads join or cross. The importance of design of junction stems from the fact that efficiency of operation, safety, speed cost of operation and capacity are directly governed by the design. Since a junction involves conflict between traffic moving in different directions, its scientific design can control accidents and can lead to orderly movement of traffic reducing delays. Junction is a major bottleneck and the planned improvements will reduce traffic congestion considerably. The scheme is the result of a number of years of planning and design to find the best possible solution to reducing congestion and improving safety. The improvements will mean that car drivers, public transport users, cyclists and pedestrians will all find their journeys quicker, easier and safer. There are several methods for the improvement of junction, like providing roundabout, interchange, priority, visibility, road signs & markings, channelization, traffic signal, zebra crossing, speed hump or speed cushion etc. Suitable junction improvement methods are adopted for the both junctions according to the survey results.

VII. CONCLUSION

The study analyses the factors affecting the PLOS of selected unsignalised area & analyses the data using a software (NCSS software) which includes the evaluation and tests required. Also this helps to find out the LOS of the selected location. 7.1 & 7.2 shows the final data results of the software analyses showing in which level of los the selected unsignalised intersection falls. According to the survey done, some of the suitable junction improvement methods are adopted on the both unsignalised intersection. They are Channelization, Traffic Signals, Zebra Crossings, Speed Hump/ Speed Cushion.

7.1 Mattoor junction

- The average PLOS score from the questionnaire survey is 4.566 and it represents PLOS E
- R square obtained is 0.956 that represents that the developed model fit the data well so our model is best fit.
- T test p-values of all the factors are nearer to zero indicates that all the predictors are significant.
- No value output for the Shapiro wilk represents that the model is valid.
- Results from evaluation matrix also validates that the Mattoor junction falls in PLOS E category.

7.2 Angamaly LF junction

- The average PLOS score from the questionnaire survey is 4.758 and it represents PLOS E
- R square obtained is 0.867 that represents that the developed model fit the data well so our model is best fit.
- T test p-values of all the factors are nearer to zero indicates that all the predictors are significant.
- No value output for the Shapiro wilk represents that the model is valid.
- Results from evaluation matrix also validates that the Angamaly LF junction falls in PLOS E category

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