Effect of Pedestrian Movement on Traffic Los

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Abstract

Pedestrian is one of the most important components in transportation system which behaves vulnerable at un-protected mid-block locations under mixed traffic conditions. At mid-block crossing some vehicles yield to pedestrian who are already at crosswalk but some pedestrian use forced gap to cross the road. This action of pedestrian affects the vehicular flow characteristics. As compared to crossing road and sidewalk, sidewalk do not show direct effect on vehicular flow characteristics. The present study discuss about effect of pedestrian walking at mid-block un-signalized road section on traffic LOS (Level of Service). This paper studies the effect of pedestrian movement on traffic LOS. The study result indicated that observed LOS for traffic was ‘D’ with average vehicle speed as 22.268 kmph. Gap acceptance was determined by use of Multi linear regression model. Regression was done using Microsoft excel.

Keywords: Pedestrian flow, Traffic LOS, Gap Acceptance, Pedestrian Behavior, Crossing Time, Waiting Time, Vehicle Speed

I. Introduction

Human being always tries to reduce physical work and get upgraded to higher level. There are various ways of transport used for convenience of Human to reduce the efforts and save time and money. Modes of transportation can be classified on the basis of media used. Road transport is unique mode which gives origin to destination service with maximum flexibility. A person using his foot as a mean of transport is called as pedestrian. Pedestrian safety becomes major problem due to increase in traffic, which has given rise to accidents involving pedestrian and vehicle. For safety of vehicle and pedestrian, behaviour of pedestrian trying to cross road and vehicle flow characteristics should be studied. There are several causes affecting pedestrian movement on road such as gender, age, waiting time, crossing speed, etc.

Due to crossing of pedestrian at un-signalized mid section of road vehicle characteristics such as travel time and vehicle speed gets affected. At signalized mid-block section of road crossing or intersection there is controlled movement of pedestrian as well as vehicle which has less impact on both pedestrian and vehicle characteristics. The person on foot jaywalking condition prompts to the higher clashes at mid-square areas and it additionally prompts to serious mishaps to the people on foot. A number of studies have been conducted to demonstrate the effect of pedestrian movements on signalized intersections. On the other hand, limited research had addressed the issue of random mid-block crossing from pedestrian safety point of view.

A. Objective

- Observe peak hour
- Analyze space, speed, flow and density for pedestrian and vehicles.
- Determine pedestrian LOS and vehicle LOS.

II. Literature review

A number of studies have attempted nationally and internationally to understand the pedestrian behaviour, which are influenced by different factors such as pedestrian perception, roadway and environmental characteristics etc.

M. McDonald et al. (2010) studied pedestrian vehicle interaction behaviour outside crossing facility. Use of binary logit technique. Focused on effect on gap acceptance;

1) Due to traffic gap time - jaywalking pedestrian do not pays attention to far-side incoming vehicle.
2) Due to pedestrian age - older pedestrian waits longer for near-side gap.
3) Due to group size - as time increases pedestrian become more aggressive and accept smaller gap.

P. Vedagiri et al. (2013) observed crossing behaviour under mixed traffic condition. Use of multi linear regression technique and binary logit model. It was observed that pedestrian accept vehicular gap with respect to vehicle speed. As waiting time increases frequency to attempt crossing of available gap increases also jaywalking behaviour is higher.

R. B. Kadali et al. (2015) studied effect of crossing on vehicle speed. Conducted hypothesis test for vehicular flow characteristics with and without pedestrian crossing. It was observed that there is reduction in speed of vehicle at pedestrian crossing location. Average vehicle speed is dropped with increase in density and reduced vehicle speed with pedestrian crossing. Also there was no significant effect of pedestrian crossing on two wheeler as compared to other vehicle.

M. S. Ghanim et al. (2013) studied impact of mid-block crossing using multimodal microscopic simulation. From result it was observed that pedestrian movement has negatively affected the operations of urban arterials. Use of PTV VISSIM software for simulation. From simulation results traffic delay and stop delay was increased while average speed was reduced on congestion level.

Y. S. Kang et al. (2007) studied characteristics of pedestrian vehicle collisions. Used binary logistic regression and PNN. It was observed that performance of binary logistic regression is better than PNN. Pedestrian age, vehicle type and collision speed were independent variables while analysis.

M. McDonald et al. (2012) studied pedestrian vehicle behaviour at unsignalized midblock location using micro-simulation model. Binary logit model was used for pedestrian gap acceptance.

### III. METHODOLOGY

For data collection a video-graphic technique was adopted. Data collection was done using camera which was fitted on second floor adjacent to selected street. Recording was done for both morning and evening peak hours. Morning peak hour was from 8:00 AM to 10:00 AM and 5:30 PM to 7:30 PM for evening peak hour. Pedestrian and vehicle data was extracted after recording the video by using computer.

![Methodology Flow Chart](image)

Fig. 1: Methodology Flow Chart

For selection of site criteria was fixed which include;
- Mixed traffic condition.
- Mid-block section of a road.
- Intersection minimum 300m away from selected site.
- Amount of pedestrian flow should be relevant to vehicle flow.
- No any crossing facility should be available.

Based on above criteria site selected was West Highcourt Road Gokulpeth between Law College Square and Shankar Nagar Square.

For chose site a video recording was accomplished for gathering vehicle stream and walker stream. Recording was accomplished for pinnacle hours amid morning and night of two hours each. Video recorded was used to extract vehicle travel length and time required to travel. By using this two data vehicle speed is computed. For pedestrian flow crossing time, waiting time, crossing pattern and crossing length is extracted and observed.

#### A. Multi Linear Regression Model

The Multi Linear Regression (MLR) model is helpful for discovering the acknowledged crevice estimate for walkers. The base person on foot hole acknowledgment esteem is spoken to by a relapse display. The gathered vehicular whole information is with a precision of 0.001 second. To promote the base crevice acknowledged holes which took after ordinary conveyance. The acknowledged crevice size is best fitted by an ordinary dissemination by considering logarithm of the holes. The general model system of MLR is given underneath
Log-Gap = \beta_0 + \beta_1 X_1 + \beta_2 x_2 + \ldots + \beta_n x_n \quad (1)

Log Gap = logarithm of accepted gap;
X_{i,n} = explanatory variable;
\beta_{1,n} = are estimated parameters from the model.

B. Data Collection

Whenever helpful and sensible intersection focuses are not recognized, most people on foot cross indiscriminately, flighty area. In making random crossing, they create confusion add risk to themselves and drivers.

Various elements effects pedestrian behavior while walking, some elements are environment, number of pedestrian crossing at a time i.e., individual or group etc. For pedestrian behavior study pedestrian speed and crossing pattern, vehicle speed is studied. At mid-block location un-signalized street pedestrian needs to evaluate gap. Pedestrian data extracted from the video graphic survey.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Gender</th>
<th>Pedestrian crossing time In sec.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Straight</td>
</tr>
<tr>
<td>Child</td>
<td>male</td>
<td>4.533</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>4.575</td>
</tr>
<tr>
<td>Adult</td>
<td>male</td>
<td>3.759</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>4.251</td>
</tr>
<tr>
<td>Elderly</td>
<td>male</td>
<td>5.578</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>6.693</td>
</tr>
</tbody>
</table>

Table – 1

Pedestrian Waiting and Crossing Time

Video Recording extraction was completed after collecting pedestrian crossing time and length for respective crossing time speed for respective was calculated by using speed distance and time relation. From the video it was observed that more crossing time was required by elderly females while walking straight as well as jaywalking when compared to Adult males. Respective are the maximum and minimum crossing time required by pedestrians. Maximum crossing time required by elderly females as 10.895 sec and minimum crossing time required by adult males is 3.759 sec.

<table>
<thead>
<tr>
<th>Speed (m/s)</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child</td>
<td>0.834</td>
<td>0.146</td>
</tr>
<tr>
<td>Adult</td>
<td>1.282</td>
<td>0.915</td>
</tr>
<tr>
<td>Elderly</td>
<td>0.718</td>
<td>0.246</td>
</tr>
<tr>
<td>Male</td>
<td>0.991</td>
<td>0.578</td>
</tr>
<tr>
<td>Female</td>
<td>0.729</td>
<td>0.294</td>
</tr>
</tbody>
</table>

Table – 2

Pedestrian Crossing Speed

Crossing pattern for pedestrian depends upon various characters such as amount of pedestrian crossing in group, near-side and far-side of vehicle, vehicle speed assumed by pedestrian before crossing. Generally there were three types of crossing patterns observed likely straight, diagonal and jaywalk. For straight crossing pattern pedestrian observes gap and crosses the road straight as minimum distance is required to cover the crossing width of road. In diagonal crossing pattern pedestrian crosses road in diagonal way with respect to gap accepted. In jaywalking pattern pedestrian do not follow any pattern to cross the road.

Fig. 1: Pedestrian and Vehicle flow Comparison
Through data collected, distance travelled by vehicle in required time is observed and by using speed, distance and time relation speed for respective vehicle was calculated. Below table represents maximum and minimum speeds for different types of vehicle types.

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Speed (km/h)</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bicycle</td>
<td></td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>Two Wheeler</td>
<td></td>
<td>63</td>
<td>15.75</td>
</tr>
<tr>
<td>Three Wheeler</td>
<td></td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>Car</td>
<td>Small</td>
<td>7</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Long</td>
<td>5</td>
<td>55</td>
</tr>
<tr>
<td>Commercial Vehicle</td>
<td>Light</td>
<td>7</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Heavy</td>
<td>4</td>
<td>28</td>
</tr>
</tbody>
</table>

Level of Service depends upon various facilities provided such as road condition, density of vehicles on road, speed of vehicle, comfort of driver maneuvering etc. Accordingly HCM 2000, LOS is divided in six classes namely from A to F.

### IV. DATA ANALYSIS

Data extracted from video-graphic survey was processed under various using Microsoft excel. Data required calculating LOS is vehicle per kilometer per lane and the vehicle speed which is further compared with Highway Capacity Manual 2000. Extracted data from video is analyzed and processed under various equations and processes to evaluate traffic LOS and gap acceptance. From the data extracted speed of vehicle and HCM 2000 was used to determine traffic LOS.

<table>
<thead>
<tr>
<th>LOS</th>
<th>K (veh/km/lane)</th>
<th>FFS (km/h)</th>
<th>v/c</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0-7</td>
<td>120</td>
<td>0.35</td>
</tr>
<tr>
<td>B</td>
<td>7-11</td>
<td>120</td>
<td>0.55</td>
</tr>
<tr>
<td>C</td>
<td>11-16</td>
<td>114</td>
<td>0.77</td>
</tr>
<tr>
<td>D</td>
<td>16-22</td>
<td>99</td>
<td>0.92</td>
</tr>
<tr>
<td>E</td>
<td>22-28</td>
<td>85</td>
<td>1.0</td>
</tr>
<tr>
<td>F</td>
<td>&gt;28</td>
<td>&lt;85</td>
<td>&gt;1.0</td>
</tr>
</tbody>
</table>

(Source: - HCM 2000)

Referring above table traffic LOS observed for selected site at mid-block location when pedestrian crosses the road was ‘D the average vehicle speed observed was 22.268 kmph.

Gap acceptance depends upon dependent and independent variables of pedestrian as well as vehicle characteristics. To analyze gap accepted by pedestrian while crossing the road MLR model was used.

Regression statics are shown as below with ANOVA table respectively. From ANOVA table it was observed that F value is 4.2419.

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>6.3166</td>
<td>2.5851</td>
<td>2.4434</td>
<td>0.1345</td>
</tr>
<tr>
<td>Vehicle speed</td>
<td>-0.0217</td>
<td>0.0233</td>
<td>-0.9284</td>
<td>0.4511</td>
</tr>
<tr>
<td>Pedestrian crossing time</td>
<td>-0.3869</td>
<td>0.6419</td>
<td>-0.6027</td>
<td>0.6079</td>
</tr>
<tr>
<td>Pedestrian waiting time</td>
<td>0.4172</td>
<td>0.2624</td>
<td>1.5897</td>
<td>0.2528</td>
</tr>
</tbody>
</table>

(Note: - p-value and t-value are represented at 95% confidence interval)

\[
\text{Gap Accepted} = 6.3166 - 0.0217 \times \text{AVS} - 0.3869 \times \text{APCT} + 0.4172 \times \text{PWT}
\]

Regression model was generated using Microsoft Excel 2007 software to find out minimum gap accepted by pedestrian while crossing road. From the regression model R square value obtained was 0.8642.

### V. DISCUSSION

Pedestrian road crossing behavior affects traffic flow in various manners. There are various reasons to cross a road. It was observed that when the height of median is low which is sufficient to cross and no crossing facility is provided then pedestrian
crosses the road at his own risk and risking traffic flow too. From literature it was observed that pedestrian age, crossing pattern, crossing facility, amount of pedestrian crossing, etc. are responsible for interaction between pedestrian and vehicle. For research study data collected was by video recording at mid-block location with mixed traffic conditions. Data collection was done for peak hours in morning and evening for weekdays and holidays. Observation for speed, flow, density and time was adopted for vehicle, pedestrian and both vehicle and pedestrian. Data extracted from video recorded was waiting time, crossing time of pedestrian, distance covered while crossing road, crossing pattern adopted were observed for pedestrian same observations were carried for vehicle. Study parameters used were pedestrian gap acceptance and pedestrian road crossing behaviour as well as Traffic LOS. Gap acceptance was determined by multi-linear regression model. LOS was derived by speed, flow and density which further compared with international standards. Vehicular gap acceptance for pedestrian crossing road was derived by using Multi Linear Regression model.

VI. CONCLUSION

Form the above discussion it was concluded that there is need to evaluate the pedestrian road crossing behaviour with individual specific speed as well as path change condition. To achieve the goal objectives set were to study the crossing behaviour of pedestrian. To study effect of factors related to pedestrian characteristics and their movements, to study vehicle and pedestrian interaction w.r.t. Gap Acceptance, to derive change in traffic LOS. An equation was generated for vehicular gap acceptance for pedestrian. The coefficients of dependent variables were obtained from MLR model. The observed LOS for traffic when pedestrian is interaction was ‘D’ which has decreased from designed LOS for the selected site designed LOS was ‘D’. There is minimum effect on vehicle speed for motorcycle as compared to car and commercial vehicle.

REFERENCES