

A Review on Pedestrian Walking Behavioural Analysis in Traffic Space Sharing Scenario

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Abstract - Traffic accidents involving pedestrians have become a major safety problem all over the world, particularly in developing countries, due to high population density, rapid urbanization, and lack of adherence to traffic regulations by both drivers and pedestrians. Transportation researcher has used many different approaches to study and improve safety. Out of all approaches, an attempt to study pedestrian behavior is the most complicated one. The behaviour of walking individuals and especially the influence factors determining behaviour of pedestrians has aroused scientific interest from various perspectives. The aim of this paper is to provide a literature review and discuss about the researchers view who investigated about the pedestrian behavior in space sharing traffic. Various methods and analysis have been adopted by all the researchers to study and analyze the pedestrian behaviour. Simulation software and various other modelling techniques such as Binary Logit model, multiple regression techniques etc. are also used to study behavior of pedestrians.

Keywords - Pedestrian walking behaviour; Age; Gender; Signal condition; Crossing Pattern; Gap acceptance

I. INTRODUCTION

Asian cities traditionally rely on walking, cycling, and public transport for daily travel. Population in the India is increasing tremendously and this is leading to traffic problem as, all the people nowadays have started purchasing their own vehicles. This has led the city to be congested on roads and on intersections. Ahmedabad city is one of the traffic congested cities in the India which is having transit systems like AMTS (Ahmedabad Municipal Transport Services) and BRTS (Bus Rapid Transit System), these two are the basic public transport systems and the third is auto-rickshaws as para transport system. The other modes of transportation in the city are two wheelers and cars as personal transport systems. However, pedestrians are present on all roads regardless of the hierarchy and designated functions. It is well known that Ahmedabad is an environment with a high rate of pedestrian accidents hence pedestrian safety is an important policy issue for such cities. The existing roads design does not provide adequate facilities for pedestrians, bicycles, or any other slow moving traffic. Service roads if present are not maintained well, Footpaths are either not present or poorly maintained, Approaches to bus stops, bus priority lanes, continuous pedestrian paths, lane for slow vehicles like bicycles and rickshaws etc. have not been included in the road network designs. Consequently all road users have to share the carriageway. This often leads to unsafe conditions for pedestrian and slow moving vehicles and congested conditions for motorized vehicles. These all issues are pointing toward the research work required for sustainable planning of the cities considering the pedestrians behavior.

Thus, Pedestrians are an inseparable part of transport system. However, analyzing and simulating pedestrians' behaviour is a complex phenomenon compared to vehicular movement. Looking at the importance of most sustainable mode of travel i.e. walking; this study focuses on understanding the pedestrians' behaviour on different locations of Ahmedabad City. The scope of the review is to get an overview of various factors which affects pedestrian's behaviour while crossing the intersection which further affects the pedestrian's level of service. Considering this into account, the earlier works carried out in India and abroad related to this study is discussed.

II. LITERATURE REVIEW

Gianluca Antonin (2006) has addresses the problem of pedestrian walking behavior modeling, interpreting the walking process as a sequence of choices over time. People were assumed to be rational decision makers. They were involved in the process of choosing their next position in the surrounding space, as a function of their kinematic characteristics and reacting to the presence of other individuals. A mathematical framework based on discrete choice analysis was used, which provides a set of well-founded econometric tools to model disaggregate phenomena. The pedestrian model was applied in a computer vision application, namely detection and tracking of pedestrians in video sequences. A methodology to integrate behavioral and image-based information was proposed. The result of this approach is a dynamic detection of the individuals in the video sequence.[1]

Hubbard et al., (2009) have presented a statistical analysis using a binary logit model that provides new insight into the factors that affect the likelihood that a pedestrian is compromised (delayed, altered their travel path, or altered their travel speed) in response to traffic turning right (on green) during concurrent vehicle/pedestrian direction of travel, right- turn traffic volume, number of pedestrian crossing, whether the pedestrian arrived late and began crossing after the end of the walk interval, and the crosswalk characteristics including location (downtown versus suburban) and one way - / two - way street. Pedestrian crossing

were observed at 13 crosswalks at 10 intersections in four metropolitan areas. The data set included 849 pedestrian crossings at seven crosswalks in CBD and 455 pedestrian crossing at six suburban crosswalks. 76 hours of video were recorded to provide basis for determining compromised crossing. Characteristics about pedestrians included the direction of pedestrian travel, pedestrian compliance and the number of pedestrians crossing in platoon, the number of pedestrians crossing in both directions and whether pedestrian's crossing was determined to be compromised due to right turning traffic. Result of binary logit model concluded that the probability of a pedestrian compromised increases with increasing right turn vehicle flow rate. Probability of a pedestrian compromise is higher for crosswalk outside CBD compared to crosswalks in the CBD for the same right turn flow rate. Result also show that crossing from far side decreases the likelihood of compromise at low right turning vehicle volumes, additional pedestrian crossing during the cycle decreases the likelihood of compromise. Late pedestrian arrivals result in curb departures after the end of walk interval increases likelihood of compromise and crossing at a one Way Street increases the likelihood of compromise.

The findings underscore importance of quantifying conflicting vehicle volumes during pedestrian interval and considering this information when evaluating alternative signal timing strategies at signalized intersection. The finding of this research regarding pedestrian direction of travel may also be relevant when considering the potential benefits of a leading pedestrian interval to improve pedestrian service at signalized intersection.[2]

Athanasios Galani et al., (2010) have presented the findings from the examination of the pedestrian crossing behaviour in signalized crosswalks. The study took place in the city of Volos, Greece, in peak traffic hours, during the summer of the year 2010. The main objective of the study was to count the pedestrian crossing time and velocity for each crosswalk. Moreover they also focuses to identify the illegal pedestrian crossing with red traffic light, criticize their behaviour and propose remedial actions. More than 1300 pedestrians were recorded using a video camera in twelve signalized crossings. The pedestrians were categorized according to their sex in men and women and their age in three age groups: 0-20, 20-50 and over 50 years old. The analysis of the pedestrian video data was achieved with the use of a state of the art tool, the Captiv L2100 (TEA) software. The first step of the analysis was the creation of the project in the site: C:\Program Files\Captiv L2100\Project. The second step was the formation of the "Description Protocol", which is the most important step of the analysis because the researcher forms the coding. The researcher entered the video data in avi format and created the project, the description protocol and the video configuration. The researcher tested each video, marking each pedestrian crossing in the video sequence window, with great accuracy in a short period of time. After the data analysis and the creation of the post coding file, the results were exported in excel format.[3]

Conclusion derived from their work is as follow:

- 17% of pedestrians crossed the streets with red traffic light.
- The velocity of younger pedestrian was 1.32 m/sec & of older ones was 1.19 m/sec.
- Men walked faster (1.32 m/sec) than women (1.25 m/sec).
- Pedestrians walked faster while crossing streets with red traffic (1.34 m/sec) than with the green traffic (1.28 m/sec).
- Most illegal crossing behaviour was noticed in women and pedestrians 20-50 years old.

The study can help engineers and local authorities to understand better pedestrian crossing behaviour and promote remedial actions in urban road network.

Raghuram et al., (2013) investigate the pedestrian road crossing behaviour at the uncontrolled midblock location in India under mixed traffic condition. Pedestrian crossing behavior has been modeled by size of vehicular gaps accepted by pedestrian using Multiple Linear Regression techniques. Also choice model has been developed to ascertain decision making process of pedestrians. Suitable study stretch, which consist of a four lane divided urban arterial in Hyderabad, India, was selected for data collection. The collected data consists of 4198 gap data points which include both accepted and rejected vehicular gaps. Pedestrians' road crossing behaviour has been explained in terms of minimum gap acceptance value by using a rolling gap (pedestrian roll over the small vehicular gaps). It has also been explained by the binary logit model with the help of vehicular gap size, frequency of attempt and rolling gap. The study concludes that the pedestrian behavioral characteristics like the rolling gap, driver yielding behaviour and frequency of attempt plays an important role in pedestrian uncontrolled road crossing. These inferences are helpful for pedestrian facility design and controlling pedestrian safety issues at uncontrolled crossings.[4]

Satish Chandra et al; (2013) Pedestrian crossing behavior has been analyzed in the present study by taking data on 17 locations in five cities of India under varied geometric and spatial conditions. The pedestrian flow analysis and pedestrian - vehicle interaction analyses were conducted on different road systems to understand their variations. The study locations within a city are chosen based on width of the road (number of lanes), provision of medians and type of land use on adjacent land. The selected study locations are categorized as having two lanes or three lanes. In case of 4-lane divided carriageway, the observations are taken for one side of the median only and such location is classified as two-lane one- way road. The methods used to record the pedestrian crossing behavior include photographic and video recording techniques and direct observational methods. The analysis was carried out to find the type of crossing pattern, the crossing speed and the gap accepted during crossing.

The analyses of pedestrian speeds revealed that pedestrians walk differently under different conditions. The average speed on a two-lane one-way system (1.34 m/s) is higher. High average speeds of 1.73 and 1.91 m/s are observed in the present study at locations where heavy bi-directional traffic move with improper lane discipline. Use of average 15th percentile speed (1.00 m/s) is suggested for pedestrian facilities like pedestrian signals so that all pedestrians can cross the road safely. The female pedestrians' crossing speed is found lesser than male pedestrians' crossing speed in all study locations. The average crossing speed of male and female (1.40 and 1.32 m/s respectively) is found to be higher than past studies.

Pedestrian flow characteristics are evaluated for different types of facilities. The study shows that speed- density and flow-density forms exponential relations whereas flow-speed relation is logarithmic. The average value of accepted gap for the data combined from all study locations in the present study is 9.63 s. Based on the gender, the male pedestrians were found to accept shorter gaps than female pedestrians. Old pedestrians accepted a larger gap compared to others at more than half of the locations. The increase in the average accepted gap by old pedestrians as compared to middle aged pedestrians is much higher than that observed between middle aged and young pedestrians on a two way road system as compared to one way road system.[5]

Akash Jain et al., (2014) worked on pedestrian behaviour at intersection. It presents the analysis of pedestrian crossing behavior from a study conducted at Roorkee city (Uttarakhand, India). The effect of pedestrian characteristics like age, gender and that of carrying baggage and luggage as well as their crossing patterns were examined on pedestrian flow characteristics like crossing speed and waiting time. Pedestrian safety was also analyzed with respect to safety margins and gaps accepted by pedestrian in traffic stream. Crossing patterns were observed for different age group and gender. Video graphic method was used in the study. The camera was fixed in an elevated position so as to obtain an overall view of the selected test locations. Recording was done for about 60 minutes at a time, during morning (10.00 am to 12.00 noon) and evening peak periods (4.00 pm to 6.00 pm) on a normal working day. The width of the road sections (i.e. perpendicular and oblique) are measured using an instrument called measuring wheel. Recorded video was used to extract data. The values of pedestrian waiting time and crossing time were observed from the videos and recorded in MS-Excel work sheets for further processing of the data. Based on the above recorded information and using the value of road width sections, pedestrian speeds were estimated. Behavioral aspects like gap acceptance, safety margins etc. are also calculated and examined using the data.[6]

The outcome of this research was as follows

- Among the crossing patterns more pedestrians crosses the roads in perpendicular direction and very few of them crosses the roads in two stages.
- The average crossing speeds at different study locations are varied with respect to various pedestrians' characteristics like gender, age category, Baggage handling condition, volume and composition of traffic moving on road.
- Males and children have the higher crossing speeds.
- The majority of pedestrian are not inclined to take risks since the safety margins and time gaps were not very high but some pedestrians are there who take very high risks while crossing the roads.

The pedestrian crossing behavior analysis is the important factor for deciding the assurance of pedestrian safety on roads and the pedestrians waiting time can be used to decide the need of pedestrian facility in the area.

III. CONCLUSION

Based on the studied literature, it can be concluded that many researchers have conducted various studies on pedestrian's behaviour at different parts of the world. Indian traffic is a mixed traffic including heavy vehicles, four wheelers, Motorised & Non-Motorised two wheelers. Researchers have studied many criteria such as gap acceptance by pedestrian, their crossing patterns, age, gender, crossing time, handling baggage and crossing speed etc., Interaction of pedestrians with this mixed traffic and their behaviour will have to be studied in detailed manner. In order to study the pedestrians comfort under Indian situation we must study their walking behaviour and crossing behavior.

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