Pedestrian Crossing Behaviour at Suchitra Junction on NH-44 using Discrete & Continuous Model

Venkatesh
M. Tech. Student
Malla Reddy Engineering College, (Autonomous) Kompally

A. Nagasaibaba
Assistant Professor
Malla Reddy Engineering College, (Autonomous) Kompally

Dr. M. Kameswara Rao
Professor
Malla Reddy Engineering College, (Autonomous) Kompally

Abstract

In this paper, a brief practical review is presented on the statistical evidence showing the Pedestrian road safety is a key point of the transport road safety policy in urban areas. Pedestrians are vulnerable road users and despite their limited representation in traffic events, pedestrian involved injuries and fatalities are overrepresented in traffic collisions. This paper presents the findings from the examination of the pedestrian crossing behaviour in signalized crosswalks. The study took place in peak traffic hours, during the summer. The target of the study was to count the pedestrian crossing time and velocity for each crosswalk. Furthermore, the target was to identify the illegal pedestrian crossing with red traffic light, criticize their behaviour and propose remedial actions. The traffic planners mostly give stress on motorized mode of movement .All kinds of steps are taken for development of roads in terms of safety, speed or time interval at intersections in case of motorized vehicle. But in present traffic condition, the non-motorized mode of traffic is also increasing. The pedestrians and bicyclists are occupying the track of motorized vehicle as no separate grades are provided for them. It leads to traffic congestion as well as the safety factor of pedestrian is at stake. According to HCM 2010, for this heterogeneous traffic, we can't just increase the level of service by developing the quality of roads for vehicles Steps have been taken to reclaim pavement for pedestrians by removing the encroachment on footpath. A study was carried out on Suchitra Junction where about footpath surrounding it and separated from road by divider along road side. The users were asked to answer the questions the quality of service provided by the system in terms of questionnaire formed .The format of questionnaire was based on the factors that user perceive. From the ratings, an analysis was carried out to find the level of service and waiting time of the interviewers .The analysis consisted of five factors as safety, Comfort level vendors encroachment ,accessibility and side walk performance, climate condition. The analysis was done on discrete continuous model and the area was categorized to a specific level of service out of 6 degrees of level of service (LOS).It is difficult to have LOS value for an area based on perception as it varies from person to person. So the trail is made to its best possible value of LOS depending on majority of the majority of user's perception.

Keywords: LOS, Pedestrain, Comfort, Pedestrain Safety Urban Roads, Suchitra Junction

I. INTRODUCTION

Pedestrian road safety is a key point of the transport road safety policy in urban areas. Pedestrians are vulnerable road users and despite their limited representation in traffic events, pedestrian involved injuries and fatalities are overrepresented in traffic collisions. Crosswalks are sites where pedestrians face lower levels of road safety, because they have to cross the street and must be aware of the incoming traffic. Intersections with high vehicle flows should be signalized in order to prevent accidents and raise the level of road safety for both pedestrians and vehicle drivers. The pedestrian illegal crossing behaviour is a major fact in the road safety issue. The main concerns are the following: Pedestrians cross the streets without noticing the incoming traffic, usually because their attention is distracted.

- Pedestrians usually miscalculate the traffic gaps.
- Pedestrians walk across the street, usually due to lack of space on sidewalks.
- Pedestrians cross the streets in midblock location or out of designated crosswalks.
- Pedestrians do not follow the indications of the traffic lights.

Due to rapid urbanization in India, the traffic volume is increasing on the roads. The motor vehicle industry is demanding with an annual production rate of 5 million vehicles. This leads to clumsiness on roads giving an unsuitable condition for movement. For some time, transportation engineers and planners have focused on the development vehicular transportation system. Even today, the motorized transportation system receives an overwhelming priority over systems that serve the needs of non-motorized users such as pedestrians and bicyclists. However, in recent years, emphasis has been shifted towards multimodal

approaches for improvement in pedestrian facilities and operations in order to counteract the challenges of congestion, air quality, improving safety and quality of life. The researchers are promoted to step forward in improvements of traffic behavior in all aspects. There has been progress in measuring quality-of-life of pedestrian facilities and in walkability. For example Saelens et al.(2003) mentioned this from the way of users' walking decision and neighboring environmental conditions such as population density, connectivity to different transitions ,land use pattern are also the factor of influence.

II. NEED FOR PRESENT STUDY

Road Safety is a multi-sectoral and multi-dimensional issue. It incorporates the development and management of road infrastructure, provision of safer vehicles, legislation and law enforcement, mobility planning, provision of health and hospital Services, child safety, urban land use planning etc. In other words, its ambit spans engineering aspects of both roads and vehicles on one hand and the provision of health and hospital services for trauma cases (in post-crash scenario) on the other. Road safety is a shared, multi-sectoral, responsibility of the government and a range of civil society stakeholders. The success of road safety strategies in all countries depends upon a broad base of support and common action from all stakeholders.

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A. Objective and Scope of the Study

The objective of this study is to develop an instrument for determining factors affecting sidewalk performance based on pedestrian perception. A questionnaire with different items is developed to measure pedestrian perception in five different areas: (a) safety, (b) comfort/convenience, (c) vendors presence, (d) movement easiness and accessibility, (e) environmental condition. It is believed that each item could potentially impact on sidewalk performance. The main objectives are: To provide higher safety to pedestrians without obstructing/hampering the inflow and outflow of traffic.

- How much is the pedestrian crossing time.
- How much is the pedestrian crossing speed.
- Do pedestrians cross the street with red or green traffic light?
- To devise a yardstick for calming the traffic and to design the streets in such a way that it improves the pedestrian walking environment.
- Very little study has been carried out to perk up the pedestrian walking environment and the factors which define it.

III. LITERATURE REVIEW

Earlier studies provide significant facts about pedestrian demographic characteristics (such as age, gender) and how these characteristics influence road crossing behavior. Such studies have focused on detailed experiments to find out the effect of age on road crossing decisions with effect of vehicle distance or speed of vehicle (Oxley et al., 1997; Lobjois and Cavallo, 2007). Most of these studies have been carried out in a virtual environment. Road crossing behavior with respect to gender and baggage held has also been observed in various studies. Males have a tendency to show more hazardous road crossing behavior than females due to less waiting time (Khan et al., 1999; Tiwari et al., 2007).

Few studies have also explored the importance of the pedestrian speed at different locations (Knoblauch et al., 1996; Rastogi et al., 2011), such as the zebra crossing location (Varhelyi, 1998) and signalized intersections (Tarawneh, 2001). Outline of these studies suggest that males walk significantly faster than females while crossing the roads. A recent study was focused on legal versus illegal pedestrian road crossing behavior at mid-block location in China (Cherry et al., 2012). Few studies have identified pedestrian behavior in mixed traffic streets and developed a micro-simulation model in order to find out the fundamental characteristics as well as the conflicts of the pedestrian movement (Shahin, 2006).

A study in Beijing, investigated pedestrian behavior and traffic characteristics at un-signalized midblock crosswalk. Authors have explained the pedestrian speed change condition with pedestrian behavior (Shi et al., 2007). Some studies have also addressed pedestrian road crossing behavior by considering the effectiveness of educational training programs (Dommes et al., 2012). Studies had identified the importance of the environmental characteristics, such as type of crossing facility, traffic volume and roadway geometry on road crossing behavior (Kadali and Vedagiri, 2013). Some studies have also explored the pedestrian road crossing behavior before and after re-construction of traffic facility (Gupta et al., 2010).

Pedestrian crossing behavior is usually get influenced by various factors related to pedestrian characteristics, pedestrian movements, traffic conditions, road conditions and environmental surroundings. Rosenbloom et al. (2008) observed unsafe crossing behavior of children, like not stopping at the curb, not looking before crossing, attempting to cross when a vehicle is nearing and running across the road. Female pedestrians are observed accepting more gaps and less risk compared to male pedestrians. Oxley et al. (2005) have done experimental studies on the effect of age of a pedestrian in gap selection. They reported that, for all age groups, gap selection is primarily based on vehicle distance and speed.

IV. METHODOLOGY

There have been several studies carried out to investigate the pedestrian behavior which is influenced by different factors such as pedestrian perception, roadway, environmental characteristics, etc. Pedestrian crossing behavior is mainly governed by the gap acceptance theory. Each pedestrian has a critical gap to cross the street. Many things correlate the minimum gap from the vehicle that is accepted by pedestrians who intend to cross streets at mid-block. This parameter may be associated with traffic conditions and with vehicle and pedestrian characteristics.

In this study, gap-acceptance theory is used to model pedestrian crossing behavior. An "inconsistent behavior" model is assumed wherein the pedestrian may reject a longer gap before accepting a short one. The critical gap is treated as a random variable at the individual and at the population level. Each gap has a probability of acceptance given by the gap-acceptance function. The gap-acceptance function is assumed to have a multivariate normal distribution, and the parameters are estimated using the maximum-likelihood method.

The major steps involved in this study are: (1) selection of suitable site for field survey (2) field data collection and extraction (3) analysis of pedestrian demographic characteristics and pedestrian behavioural aspects (4) model development for pedestrian road crossing behavior

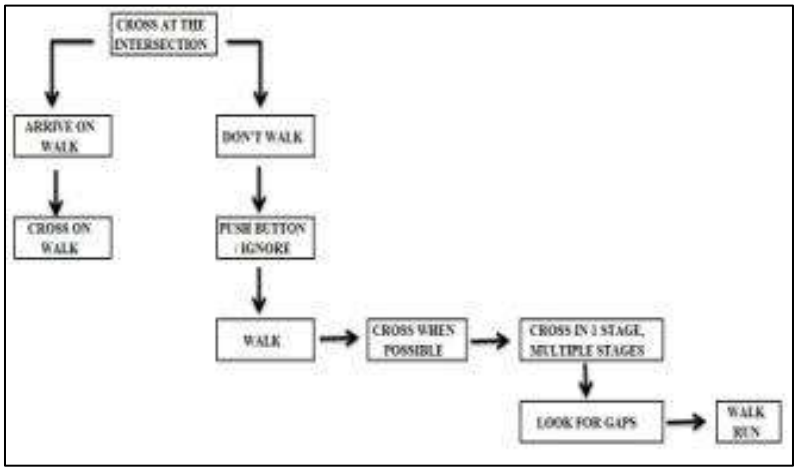

Fig. 1: Methodology

The key step by step procedures for applying methodology for determining performance measures and level of service

B. Questionnaire Formation

A questionnaire with a total of 21 variables is developed to measure pedestrian perception in five different areas: (a) safety, (b) comfort (c) vendors obstruction (d) movement easiness and accessibility (e) environmental condition. It is believed that each variable could potentially impact on sidewalk performance. However, it is unsure which items would contribute the greatest impact and to what degree. In the present study all items are scored on a five-point Likert-type scale with "one" representing strongly disagree, and "five" representing strongly agree. To collect the data, onsite interviews were conducted in the study location. Some interviewers stopped the pedestrians and asked them for possibility to interview. The yes/no type questions were answered as 1(yes)/0(no).

1) Questionnaire Format

- Name
- Age
- Sex

2) Discrete & Continuous Model

As was the case with continuous-continuous data, it is possible to have interrelated variables that are discrete-continuous. An example would be drivers' choice of ITS technology (e.g., visual dashboard display or audio system) and the extent to which it is used (e.g., in minutes per week). To see why this must be considered as part of an interrelated equation system, consider an ITS technology usage equation,

$$U_{kn} = B_k X_{kn} + V_{kn}$$

Where U_{kn} is the minutes of use of technology k by driver n over some time period; X_{kn}. is a vector of driver and technology characteristics; B_k is a vector of estimable parameters; and V_{kn} is an error term. In estimating this equation, information on technology use is only available from those people actually observed using the technology. No information is available for drivers that have not yet purchased the technology or have purchased another competing technology. Because the people observed using a particular technology are not likely to be a random sample of the population, a self-selected bias will result

V. ANALYSIS AND RESULTS

A. Introduction

After analyzing by using inverse variance method the results were obtained. From the data the PLOS of the road was determined by suitably determining the range of each LOS. The result obtained can be utilized by a traffic engineer to improve upon the present roads and a better walkable environment can be provided to the pedestrians in future by adopting suitable design methods for the road.

B. Demography and Pedestrian Behavioural Characteristics

The majority of the subjects were male (58%). Respondents grouped in age in under 25 years (31%), from 25 to 30 years (52%), and 31 to 56 years (6%). Walking behavior included 2 persons (46%), walking alone (30%), walking in group with 3 persons (11%), and walking in group with more than 3 persons (18%). About 67 % of respondents stated that walking was their main mode during the survey. Most of the users were using carriage way (40%) rather than footpath due to the preoccupation by vendors.

Fig. 2: Pedestrian rolling gap movement.

Pedestrians' and drivers' behavioural data were extracted from the video. In this study, the pedestrian rolling gap is the one of the important parameter influencing pedestrian behaviour. Pedestrians are rolling over the small vehicular gap which is characterised as rolling gap as depicted as path A-A in Figure 5.1.

C. Pedestrians Count

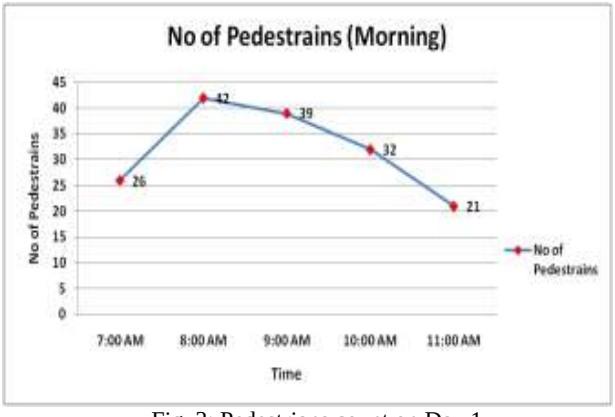

Fig. 3: Pedestrians count on Day 1

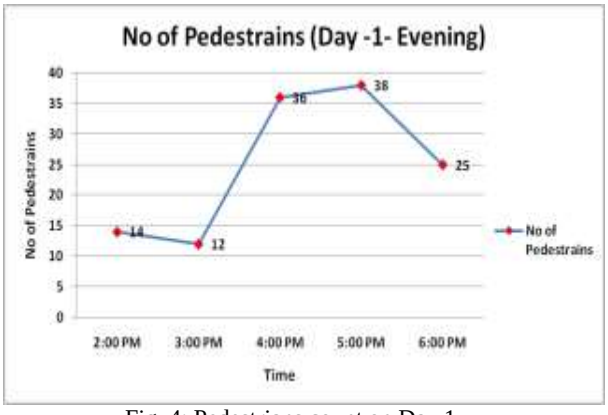

Fig. 4: Pedestrians count on Day 1

D. Factor Determination

Principal component factor analysis with a varimax rotation was conducted on the 21 items. The result for all of the 15 variables was shown in Table.

Intersection		
LOS	*Average Pedestrian delay (Sec)*	*Description*
A	*<10*	*very small delay, nobody crossing irregularly*
B	*10-20*	*small delay, almost no one crossing irregularly*
C	*20-30*	*small delay, very few pedestrian crossing irregularly*
D	*30-40*	*big delay, someone start crossing irregularly*
E	*40-50*	*very big delay, many pedestrians crossing irregularly*
F	*>50*	*very big delay, almost every waiting pedestrian crossing irregularly*

VI. INTRODUCTION

This study was carried out the find the LOS qualitatively. The qualitative method is a better method to determine LOS as it inputs the real time response of people thus providing an option of achieving a better and more accurate result. the data was analyzed by using inverse variance method and the LOS score table was obtained by determining the ranges for each level of service which helped in the estimation of the PLOS of the study area.

VII. CONCLUSIONS

This study focused on pedestrian crossing behaviour to examine the pedestrian compliance with signals under different crossing scenarios. The key findings can be summarised as follows:

- The estimated probabilities show a comparatively higher propensity to start crossing during the "blackout/flashing green" phase than during "red".
- The provision of a "refuge island" gives a perception of safety but at the same time increases the tendency to take a risk by crossing on red.
- There is a higher propensity to cross on red in the following conditions:
  - At non-designated areas
  - In the age group under 30 years old
  - If there are two or more adults in the group
  - When without luggage/children
- Pedestrian compliance is slightly lower at puffin crossing facilities than at any of the other situations considered. This may be due the fact that puffin crossing a relatively recent development compared with existing farside pedestrian facilities, suggesting the need for publicity to raise awareness.

After analyzing the data we arrive at following conclusions:

The LOS score obtained by inverse variance analysis was found out to be 3.62 which was within the range of LOS D i.e. in between 3.435-4.123.This signified that PLOS of the road segments in the study area are providing not good quality of service to the pedestrians in the prevailing geometry and surrounding environmental characteristics.

VIII. SCOPE FOR FURTHER STUDY

Our work leads to a number of recommendations for further study.

First of all, the analyses resulting from this work can feed into the development of a traffic signal control mechanism which takes into account pedestrian crossing behaviour when determining optimum settings.

Some further suggested areas for future work include:

- Further detailed analysis of the video (CCTV) RP data and correlating SP responses to RP data.
- Investigation of the extent to which pedestrians understand the operation/ sequence of different traffic signal types.
- Advice on an education programme on safer crossing and the use of roadside traffic signal infrastructure.
- An awareness programme in schools educating children on puffin crossings.
- Exploration of incentives for compliance.

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