

Study on pedestrian crossing behavior at signalized intersections

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Abstract: A clear understanding of pedestrian crossing behavior under mixed traffic conditions is needed for providing necessary infrastructure and also for enhancing pedestrian safety at signalized intersections. This paper attempts to analyze the crossing behavior of pedestrians like crossing speed, compliance with signal, and pedestrian-vehicular interaction under mixed traffic conditions and to identify the influencing factors based on statistical tests. 775 pedestrian samples were observed from three signalized intersections in Mumbai, India for analyzing crossing behaviors and the significant factors affecting traffic signal compliance by pedestrians were identified by conducting Pearson's correlation coefficient test, ANOVA test, and Student *t* test. Factors influencing pedestrian crossing speed had been studied and a design crossing speed had been determined for old and adult pedestrians at 0.95 m/s and 1.12 m/s respectively. Logistic regression models had been developed in which the odds of pedestrian violation and interactions were modeled and verified. This study can help researchers and practitioners to understand pedestrian crossing behavior at signalized intersections and develop pedestrian delay models under mixed traffic conditions.

Key words: pedestrian; signalized intersection; behavior; interaction; noncompliance

1 Introduction

Traffic research on roadways has always been on vehicles. Concerns for the safety, comfort, and convenience of pedestrian have often come secondly while designing roadways. One of the major reasons is the complexity involved in modeling pedestrian behavior. Complexity arises from multiple parameters which affect the pedestrian crossing behavior and are very difficult to identify. At signalized intersections, pedestri-

an travel is very high in highly populous cities with least amount of safety measures provided to them. Signal phases have been provided to control the interaction between pedestrians and vehicles at signalized intersections crosswalk where they share the same road space. Still pedestrian-vehicular interactions occur due to pedestrian noncompliance behavior with traffic signals. Major reasons for pedestrian noncompliance with traffic signals are low quality traffic management, traffic volume and longer cycle time. Apart

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from these, there are many other factors that affect the pedestrian non compliance behavior with signals and interactions but have not been taken into account in existing studies.

Pedestrian crossing speed is one of the significant design parameters while designing signalized intersection infrastructures in traffic engineering. Pedestrian crossing speed has been found varying largely from the existing manual Indian Road Congress (IRC) estimated walking speed at crosswalks of 1.2 m/s (Indian Road Congress 1985). This constant value is not applicable for dynamic traffic conditions prevailing at signalized intersections. Pedestrian crossing speed varies with regard to the pedestrian characteristics and behavior. To improve pedestrian safety, transportation planners and engineers are predominantly concerned with understanding and modeling pedestrian crossing behavior so as to increase the walkability and also to reduce the interaction between pedestrians and vehicles at signalized intersections under mixed traffic conditions.

2 Literature review

Pedestrian behavior analyses have great implications for transportation and urban planning policies and design practices (Laxman et al. 2010). Many of the existing studies have examined only the pedestrian characteristics and pedestrian flow characteristics in sidewalks and walkways (Laxman et al. 2010; Yordphol et al. 1986). Very few studies have analyzed pedestrian flow characteristics at signalized intersections for the development of pedestrian models for evaluating walking facilities (Lam et al. 2002; Lipovac et al. 2013). Few researches studied pedestrian noncompliance behavior at signalized intersections for the purpose of pedestrian speed flow relationship development (Zhou et al. 2011) and delay model development (Li et al. 2005; Marisamynathan and Vedagiri 2013). Pedestrian crossing behaviors were examined and factors affecting pedestrian crossing behaviors were identified for the improvement of pedestrian safety at signalized intersections (Lee and Lam 2008; Ren et al. 2011).

From the above mentioned existing studies, majority of the factors that have been neglected about pedestrian crossing behavior have been identified. Further-

more, there has not been a study that has examined pedestrian crossing speed variation and pedestrian-vehicular interaction in crosswalks of signalized intersections with affective factors such as pedestrian characteristics, behavior, and traffic characteristics. This paper examines all possible parameters that influence pedestrian crossing behaviors.

3 Research objectives

The objectives of this study are as follows; (a) examine the effects of pedestrian and traffic characteristics on pedestrian crossing behavior; (b) identify the factors that dominantly affect pedestrian crossing speed in the crosswalks at signalized intersections; (c) determine the most significant factors affecting pedestrian compliance rate and identifying of reasons for pedestrian noncompliance; and (d) obtain the factors influencing pedestrian-vehicular interaction in the crosswalks of signalized intersections under mixed traffic conditions.

4 Data collection

Data were collected at 3 signalized intersections in highly populous city Mumbai, India. Signalized intersection sites chosen were of a typical four arm type with fixed traffic signal cycle lengths. Two video cameras had been set up at selected crosswalks of each intersection and one hour videography surveys were conducted at each site during morning and evening peak hours. A detailed description about the study sites and samples collected are shown in Tab. 1. The value of CSDF is calculated by Eq. (1). Pedestrian crossing behaviors were examined from the field video data by direct observation. The video recording offered information about pedestrian crossing volumes, crossing time, pedestrian appearance (like gender and age group), crossing behavior (such as walking or running, alone or in groups and crossing speed variations), crossing locations (whether using the crosswalk or not), pedestrian crossing phase time (whether pedestrians cross during green phase or non-green phase) and pedestrian-vehicle interaction in crosswalks. The various variables used in this study are shown in Tab. 2 along with their respective definitions and parameters.

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