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Original Research Paper

Pedestrian risk analysis at uncontrolled midblock and unsignalised intersections

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HIGHLIGHTS

- Male pedestrians take more risks than female pedestrians in crossing.
- Pedestrians tend to cross more in random location than in a zebra crossing.
- Rolling gap behavior is observed in heavy traffic condition, rather than waiting at the sidewalk for the vehicle to give way for the pedestrians.
- Mean crossing speed for elder pedestrians varies from 0.82 m/s to 1.37 m/s where as the youth pedestrians and middle aged are observed to have crossing speed ranging from 1.24 m/s to 2.04 m/s and 1.37 m/s to 2.11 m/s, respectively.

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ABSTRACT

Transportation is defined as port to port transfer of person or goods by a medium which can be a vehicle or a person. Pedestrians being the most neglected mode of transportation in terms of safety and facility, face difficult situations while crossing near intersections and midblock crossings. It becomes more of a risk when the place of crossing is uncontrolled. But if behaviour of pedestrians while crossing is analysed in such conditions, it might be possible to create suitable solution to lessen the risk and ensure safety. In most of the cities, accepting suitable gaps between vehicles in uncontrolled midblock and intersection crossings pose threat to pedestrians' safety. The present study examines the safety of pedestrian crossing behaviour at midblock and unsignalised intersection crossings. Crossing time, speed, stages of crossing, number of interruptions while crossing, and the type of vehicles for which pedestrians accept the gap were extracted from the video. The tendency to show rolling gap behavior was observed and examined for different age and gender groups to analyse the risk involved in such type of crossings. The risks analysed from the study in correlation with the pedestrian demand in such uncontrolled crossings will help in design of safer pedestrian facilities. It was observed that the size of the vehicle has a significant influence on gap acceptance and crossing behaviour of pedestrians. Male pedestrians take more risks than female pedestrians in crossing unsignalized intersections. Middle aged pedestrian category poses 60.1% more chances of interrupted crossing than the other elder and young age categories of pedestrians. Male pedestrian

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category and the middle aged pedestrian category are more tended to accept the smallest gap between the vehicles showing a risky nature of crossing.

1. Introduction

In the recent past, pedestrian requirements have received considerable attention compared to motorised vehicles. Although the external costs imposed by pedestrians on the system are minimal, no clear credit is given to them in the context of how they are treated in the mode hierarchy, particularly in urban areas. Understanding pedestrians' road-crossing decisions is an important traffic safety issue, especially for those countries, where populations are rapidly aging (Liu and Tung, 2014). Safety of pedestrians becomes more questionable in uncontrolled intersections and midblock sections. The risk to pedestrians becomes high because of the least priority given by the vehicle drivers to yield for the pedestrians. As per the data of Ministry of Road Transport and Highways in India, there were pedestrians killed in 8.7% of total traffic accidents,. Globally, pedestrians constitute 22% of all road deaths, and in some countries this proportion could be as high as two thirds (WHO, 2013). Past studies analysed pedestrian movements in walkways, sidewalks, movements under unidirectional or bidirectional pedestrian flows or under mixed traffic conditions (Chu et al., 2004; Laxman et al., 2010; Kadali and Vedagiri, 2013; Rastogi et al., 2011a). In India, little attention has been devoted to study pedestrian behaviour and the risks involved, or model them for their use in integrated design of urban areas with consideration to walking as a mode of movement (Laxman et al., 2010). In research studies on pedestrian safety, pedestrian behaviour is very often considered in terms of the degree to which pedestrians obey rules, that is, whether the pedestrian cross the road in accordance with road safety regulations or not (Lavalette et al., 2009).

2. Background

Most of the studies observed that male pedestrians move faster than female pedestrians. Pedestrians in the age group of 10–15 years had the highest speed, 82 m/min (Laxman et al., 2010). It was observed that crossing speed increases with road width, traffic volume, and size of the urban area (Rastogi et al., 2011b). The average crossing speeds are lower near educational and bus terminus areas and greater at tourist and shopping locations (Rastogi et al., 2011a). Design manuals, such as Traffic Engineering Handbook, suggest a speed of 0.91–0.98 m/s as an appropriate speed for the design of pedestrian facilities (Dewar, 1992). While some studies focussed on flow performance, some others focussed on behavioural approach. Most of the research studies are aimed at pedestrian safety based on the decision-making process related to the behavioural characteristics. Researchers have also studied how this decision-making is organized, and the variables which lead to the decision (Lavalette et al., 2009).

Survey based methodology have been followed in many studies to rate the performance of facilities with varying pedestrian flow conditions (Thambiah et al., 2004). Studies on how the pedestrian demographic characteristics influence road crossing behaviour 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 (Lobjois and Cavallo, 2006). The pedestrian behavioural characteristics like the rolling gap, driver yielding behaviour and frequency of attempt plays an important role in pedestrian uncontrolled road crossing (Kadali and Vedagiri, 2013).

Instead of crossing the streets when all lanes were completely clear, pedestrians tend to cross the street as they anticipated that the lanes would clear as they crossed and used a "rolling gap" to cross the street. This kind of behavior is called rolling gap behaviour (Brewer et al., 2006; Kadali et al., 2014). Various parameters have been studied to obtain the significant influence on risk taking behaviour of pedestrians while crossing. Accordingly, the Highway Capacity Manual predicts an increasing likelihood of noncompliance as pedestrian delay increases (TRB, 2010). Subsequent studies found that pedestrians tend to display risk-taking behaviour when they have waited 30 s or more at a crossing (Dunn and Petty, 1984). In addition, a great number of pedestrian accidents reported in road statistics may be the result of negligence or unwillingness to make way for pedestrians by another road user, the driver (Varhelyi, 1998). The impact of the street environment, including traffic conditions, roadway characteristics, and signal control characteristics, on crossing behaviours have been discussed previously (Chu et al., 2004). It leads to the research for understanding drivers' driving behaviours and to design appropriate in-vehicle pedestrian detection system. Cui and Namdisan (2003) concluded that pedestrian who is crossing at an intersection has a lower conflict potential than a pedestrian randomly crossing at midblock, with a statistical significance of 95.6% (Cui and Namdisan, 2003). As a part of a case study in Beijing, Shi et al. (2007) investigated the pedestrian movement and traffic characteristics at an unsignalized midblock crosswalk, where the random crossing behaviors of pedestrians were involved.

Against this background, the present study is intended to identify and quantify the attributes of people that influence the vulnerable user preferences while crossing intersection and midblock. To analyze the behavior of pedestrians

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