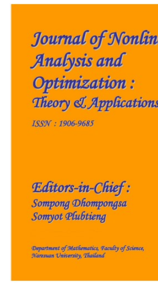
Journal of **N**onlinear **A**nalysis and **O**ptimization
Vol. 15, Issue. 1, No.10 : 2024
ISSN :**1906-9685**



ANALYSIS OF PEDESTRIAN ROAD CROSSING BEHAVIOUR

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ABSTRACT
Pedestrians play a vital role in crossing the roads. Pedestrian safety at crossingroads is a critical concern in Indian transportation. The study aims tocollect and extract the midblock field data andanalyze the speeds of pedestrians and vehicles whichare used to design traffic signals and ensure pedestrian safety atgajuwaka midblock, Visakhapatnam. Mostly pedestrian Accidents happen due the pedestrian speed, vehicle speed, and miscommunication between the drivers and Pedestrians. To fulfill this aim, the data related to the crossing of 870 pedestrians were collected from the gajuwaka midblock usinga videography survey method. These pedestrian crossing data were collected during peak hours which is four hours of data (morning and evening).MPC-HC media player and data from sky software are used to extract the visually observed data and speed (pedestrians and vehicles) respectively. PET (post-encroachment time) and severity code were also derived from the collected data which is useful for further defining threshold values. Through the statistical analysis, we concluded that the crossing speed of male pedestrians is high when compared to that of females. According to age middle-aged pedestrians are crossing at high speed thanyoung, old, and children. The young pedestrians are diverted by using mobile while crossing the road these were observed while collecting field data. According to the type of vehicle, the speed of the 2Wishigher than the remaining vehicles.
The results of this study will be useful in the creation of an efficient midblock control system, which will help to mitigate issues with traffic safety. And also the extracted data was useful for further defining threshold limits at midblock.

Keywords–*Crossing speed, pedestrian safety, PET, severity code,pedestrian, vehicles, Visakhapatnam,midblock, speed analysis*

1. INTRODUCTION

As per the World Health Organization's (WHO, 2023) [1] Road Traffic Deaths Report, the annual number of deaths due to road accidents is around 1.19 million. This relates to a rate of 15 road activity deaths for each one million people. Pedestrians, motorcyclists, and cyclists account for more than half of these fatalities. As of right now, road accidents are the 12th most common cause of fatalities overall and the leading cause of death.

Road accidents have a major effect on GDP in any nation. In India, the socio-economic spending of crashes on the roads accounts for around 3.14% of GDP [2], according to a report published by DIMTS-TRAPP-IIT Delhi titled "Socio-Economic Cost of Road Accidents in India."

According to Naved Alam Siddiqui's (2006) [3] study crossing at midblock sections is more dangerous than crossing at intersections. This conclusion is drawn from an analysis of studies on pedestrian crossing at mid-blocks and intersections. This is because it was shown that a higher impact speed increased the likelihood of a serious injury (Sam D. Doecke et al., 2020) [4]. Road accident figures for 2022 indicate that pedestrian deaths on national highways were roughly 13.5% in 2021 and 2022, according to MoRTH (Ministry of Road Transport and Highways) [5].

It is possible to lower accident rates and raise pedestrian safety by making improvements to pedestrian facilities and attending to safety issues.[6] Having an in-depth understanding of how pedestrians cross highways and interact with moving automobiles is crucial for achieving this.

The introduction of traffic regulations, infrastructural improvements, public awareness events, and advances in technology all contribute to increased pedestrian safety. [7]Creating secure and easily accessible urban areas requires improving pedestrian safety. This entails an integrated approach that includes public education campaigns, enforcement of traffic regulations, infrastructure upgrades, technological advancements, community involvement, and accessibility concerns.[8] Ensuring pedestrian safety is greatly dependent on infrastructure improvements including clean sidewalks, clearly designated crosswalks, and traffic-calming strategies.[9] To increase pedestrian and driver awareness of safe practices and traffic laws, public education campaigns are important. Enforcing traffic laws, such as those about speeding and ceding to pedestrians, is necessary in order to discourage hazardous driving practices. [10]Additional technological advancements that improve safety include sensor-equipped smart crosswalks and automobiles with pedestrian detection systems. Identifying local safety risks and creating specific remedies require community cooperation.

1.1 POST ENCROACHMENT TIME (PET)

The rate and severity of accidents are directly connected to road safety. On the other hand, accidents are rare events, and sometimes minimal accident data is available. When accident data is not available, surrogate safety measures (SSMs) are used to estimate and evaluate the probability and severity of future collisions using videography data. Hyden (1987) [11] asserts that SSMs are more accurate, timely, proactive, and instructive. One of the surrogate safety measures (SSM) is PET, which is used to analyze pedestrian-vehicle (P-V) interactions. According to Allen and Shin (1978) [12], it is the duration of time between the first road user leaving the conflict area and the second road userentering it.

Assume that the first road is used to leave the conflict region at time t1, and that the second road user arrives at the conflict area at time t2.

$$PET = t_2 - t_1$$

2. BACKGROUND

A virtual environment has been used for the majority of this research. Numerous studies have also noted the gender- and baggage-related differences in road crossing behavior.Because they have to wait less time than females, men tend to cross the road more dangerously (Khan et al., 1999) [13]. Studies have identified the importance of environmental characteristics, such as type of crossing facility, traffic volume, and roadway geometry on road crossing behavior (Kadali and Vedagiri, 2013)

[14]. Researchers have also studied the factors that influence the decision and the structure of this decision-making process (Lavalette et al., 2009) [15]. Younger people walk faster than middle-aged people and older people walk slower.When walking, people with luggage move more slowly than those without. Significant differences in speed exist with respect to attributes of age, luggage, gender, and direction (Patra et al., 2016) [16]. Focused on the movement characteristics in staircases of typical student crowds and the quantitative relations of flow rate-speed-density in different dimensions of staircases and different circumstances were obtained (Yulianto, B and Putri, SN. 2021) [17]. Older pedestrians not only move more slowly but also take longer to determine whether or not to cross the road (Lobjois et al., 2013) [18].According to this study, pedestrians' decisions on whether or not to cross the road safely depend on how far away the approaching car is from them; andtherefore, the risk increases with the speed of the vehicle approach. Compared to older walkers, younger pedestrians showed a higher safe road-crossing ratio (Yung, 2021) [19]. It can be deduced that the participants did not function in a constant-time-gap mode because the mean tolerated time gap was less for high speeds. This type of behavior has already been observed in child pedestrians and in elderly drivers turning left at an intersection (Alexander et al., 2002) [20]. These methods are described by their characteristics and properties. For comparison purposes, a set of quality criteria has been formulated by which the usefulness of the different methods can be assessed (Brilon et al., 1999) [21].

3. DATA COLLECTION AND EXTRACTION

The study has focused on a city in Visakhapatnam, India, where there has been an apparent increase in both population and traffic in recent years.[22]The study area includes a midblock at Gajuwaka on a city road. The number of vehicles and pedestrians in mixed traffic situations was the main factor in choosing this location.

The videography method was used to gather the required vehicle and pedestrian data from the field. [23]Video data worked better for the study of P-V interactions. A single camera was used to collect the movement of pedestrians and vehicles with a tripod from the nearest top of the building, providing a clear view of every vehicle and pedestrian crossing the intersection. Using the videography approach, [24]four hours of traffic data during peak hourswere collected from the selected area.

The main aims of the video capture were vehicle movement and pedestrian crossing behavior. Fig.1 below displays the selected location.[25]The geometric properties of the research sites were measured straight out of the field using tape and visual observations. The gajuwaka midblock features a 4-lane divided road that is 8 meters wide on the left and 8 meters wide on the right.[26] The pedestrian crossing divider is 1.3 meters wide.

The MPC: HC media player and DataFromSky (DFS) software were used in the current study to extract the required pedestrian and vehicle parameters from the recorded video at the midblock location. Pedestrian crossing and vehicle approaching speeds were extracted using DFS software. A clear view of the software is displayed in Fig. 2.

The videos were initially loaded into the MPC: HC 1.7 media player, from which the required parameters were taken out by watching the videos again. The pedestrian gender was divided into male and female. [27]The pedestrian's age is classified during the data extraction process based on visual observation. [28]Young pedestrians (16–30 years old), middle-aged pedestrians (31–60 years old), senior pedestrians (>60 years old), and child pedestrians (<=15 years old) are the four age groups for pedestrians, according to Patra et al. (2017).

The degree of P-V interaction severity was retrieved from the video based on visual observations and classified into [29] two categories on a scale of 0 and 1 based on the speed variations of both vehicles and pedestrians where 0 refers to no interactions and 1 refers to severe interactions.

No interactions (NO): Both road users maintain their current speed to prevent collision.

Severe interactions (SI): To prevent a collision, both drivers must stop and move forward.

After the extraction of 1117 P-V interactions from the video, the compositions of vehicles, pedestrian gender, pedestrians' ages, and severity code are shown in Fig. 3 below. [30]As can be shown in Fig. 3(a), at the gajuwaka mid-block, the extracted percentage of P-V interactions was found to be somewhat higher for male pedestrians (55%) than for female pedestrians (45%).[31] Among the various vehicle classifications, two-wheelers had the highest percentage (46%) of interaction data. [32]The remaining vehicles are 3W (22%), Car (20%), and LCV (12%), as shown in Fig. 3(b).
As shown in Fig. 3(c), in the gajuwaka mid-block, the proportion of young, middle-aged, old-aged, and child pedestrians was roughly 27%, 47%, 24%, and 2%, respectively. [33]Middle-aged pedestrians were shown to have a higher percentage of interactions at this midblock compared to other age groups because of a high count of crossing. [34]According to Fig. 3(b), At this mid-block, about 62% were linked to no interactions and 38% were severe interactions. By this, the pedestrians can cross the road with no interactions at a high rate due to accepting the smaller size vehicles which are in high amount as shown in Fig.3 (b).

Fig. 1. Midblock location at Gajuwaka

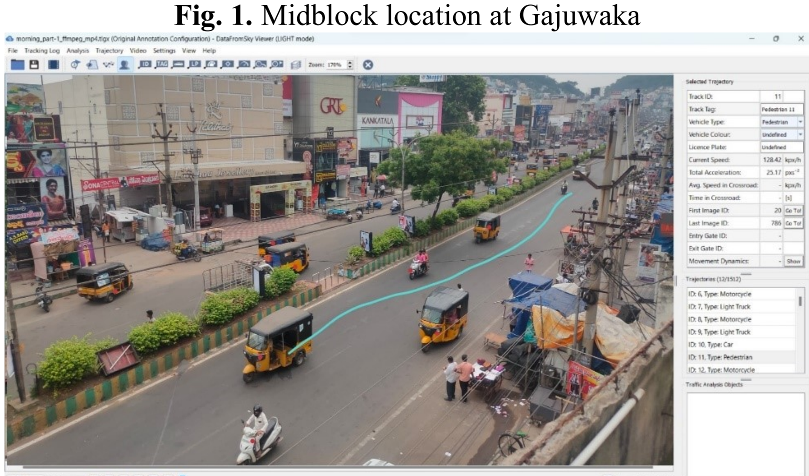
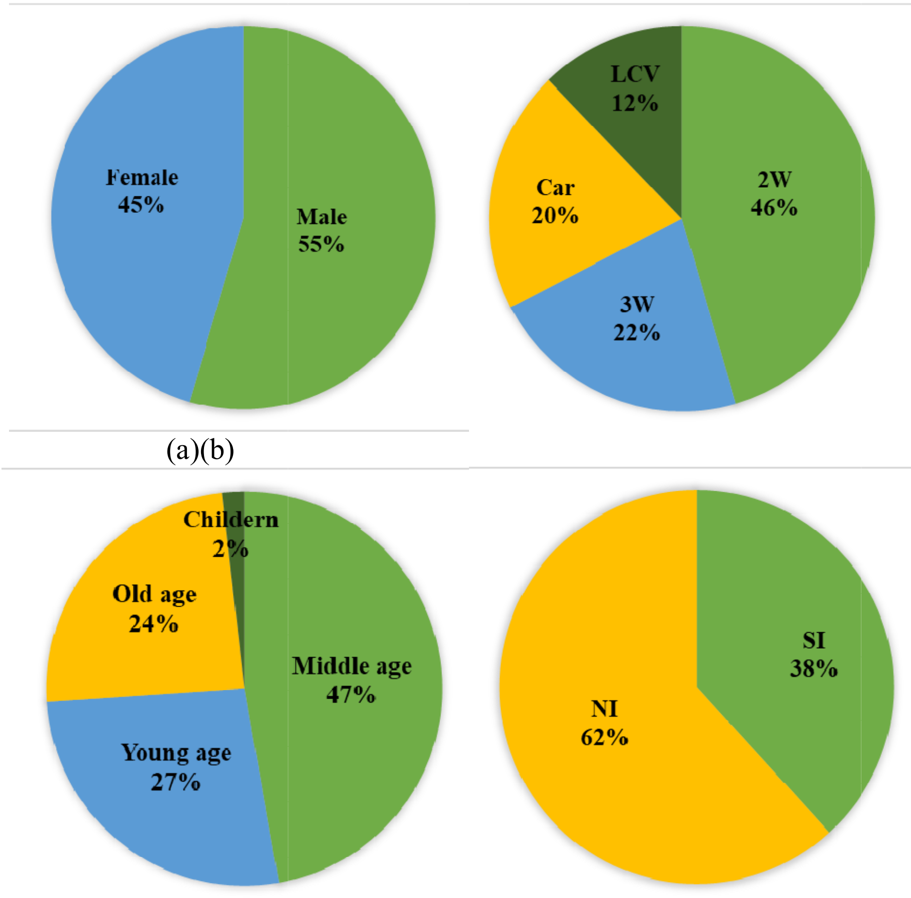


Fig.2. Pedestrian and vehicle path tracking in DataFromSky viewer software



(c) (d)

Fig. 3. Percentage of samples based on (a) Pedestrian gender (b) Vehicle type (c) Pedestrian age (d) Severity levels at Gajuwaka midblock

4. STATISTICAL ANALYSIS

Statistical analysis is used to organize the collected data in a clear chart format and present it with a clear understanding.[35] So the data on crossing speeds of pedestrians and vehicles are extracted using DataFromSky (DFS) software. Fig. 4 and 5show the box plots that show the variance in pedestrian crossing speed according to gender and age respectivelyat the gajuwaka midblock.

After generating the chart the observations made were that a greater crossing speed was observed in male pedestrians and a lower crossing speed was observed in female pedestrians as displayed in Fig. 4.

While comparing the ages in Fig. 5 the middle-aged pedestrians cross the road at a faster rate while comparing the children, young-aged and old-aged pedestrians.[36] Next, there comes young-aged who are slightly low as compared to middle-aged pedestrians, [37]then children come after young pedestrians here the percentage count of children is low so that there is no sufficient data to analyze the exact speed of children and lastly, old-aged pedestrians who have low crossing speeds as compared to all four age groups.

By using DataFromSky (DFS) software,[38] For every P-V interaction sample, the approaching vehicle speeds were also determined, and the variation in speeds based on the type of vehicle was studied. [39,40]Using statistical analysis of the extracted vehicular speeds at Gajuwaka Midblock, the observations were made was the approaching speed of LCV was lower and the approaching speed of 2W was high followed by 3Ws, Cars, and LCVs respectively were shown in Fig. 6.

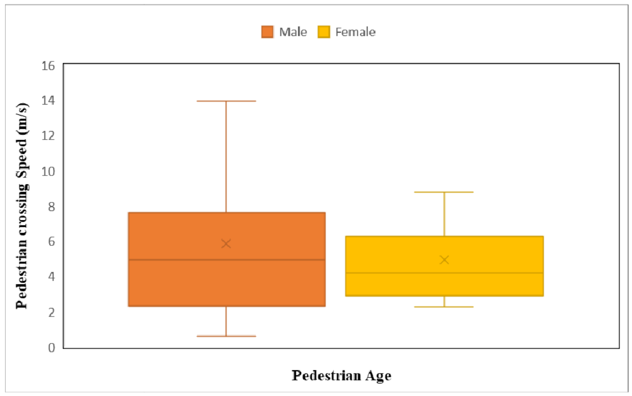


Fig.4. Variation of pedestrian crossing with respect to gender at midblock

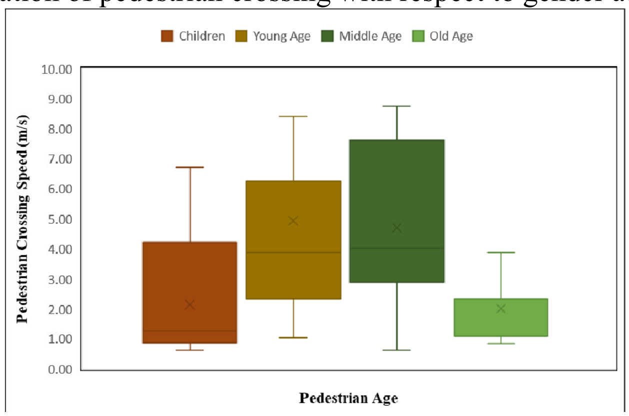


Fig.5. Variation of pedestrian crossing with respect to age at midblock

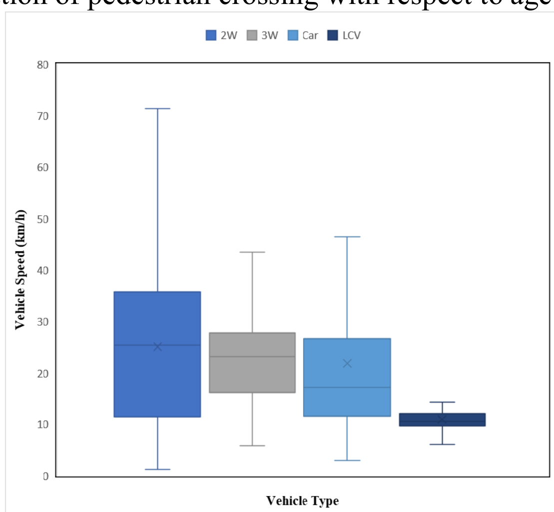


Fig.6. Variation of vehicular approaching speeds with respect to the type of vehicle at midblock

5. CONCLUSIONS

In the present study, thepedestrian (gender, age, crossing type, mobile use, luggage carrying, platoon size, gap-accept/reject) characteristics, vehicle (type, line distribution,platoon size) characteristics, and the severity level of P-V interactions, these are all categorized based on visual observation from the collected video using MPC: HC media player. The gajuwaka midblock was selected to record the video for this study to analyze the crossing speeds of the pedestrians (gender, age) and vehicles (type of vehicle). The software thatwas used to extract the crossing speeds of pedestrians and approaching speeds of vehicles was DataFromSky (DFS).After generating charts and observing the speeds of pedestriansand vehicles, we finally concluded that the crossing speeds were high for male pedestrians, especially for middle-aged pedestrians because middle-aged pedestrians are more focused on crossing than young pedestrians. The young pedestrians are diverted by using mobile while crossing the road these were observed while collecting field data.The approaching speeds of the vehicles were high for 2W due to theirflexibility to pass in narrow-spacedareas because of their smaller size compared with other types of vehicles at the gajuwaka midblock.The unsignalized midblock is also a reason for the high vehicular speed, whereas the high pedestrian crossing speed is a result of pedestrian's ability to adjust their speed in response to vehicle speed.

There is a chance to carry out this study in intersections and other areas, but this study is restricted to midblock locations only. There is a future scope to determine the threshold limits by this extracted data ofthe present study after that there is a scope to model the P-V interactions by the threshold limits.

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