ANALYSING THE INTERACTION BETWEEN DRIVER AND PEDESTRIAN AT UNSIGNALIZED CROSSWALKS

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ABSTRACT - This study aims to improve pedestrian safety at unsignalized crosswalks by analyzing driver-yielding behaviour. Data from two-lane, two-way divided roads was used to capture vehicle trajectories and pedestrian characteristics. Driver-yielding patterns were determined using TRACKER Software and the factors that influence drivers' yielding willingness were determined using logistic regression models. The study found that yielding likelihood is influenced by factors such as female pedestrians, median pedestrians, injured pedestrians, and vehicle position. Further revealed that most vehicle types yield similarly, with a decreasing average rate, and no significant difference was observed among the six vehicle types considered. This research provides insights into key factors affecting pedestrian safety at unsignalized crosswalks, guiding targeted interventions and traffic management strategies.

Keywords: Unsignalized crosswalk; Pedestrian; Vehicle speed

1. INTRODUCTION

The research explores pedestrian safety at unsignalized crosswalks in urban areas, focusing on two-lane two-way divided roads. It aims to understand driver behavior and factors influencing yielding behavior based on pedestrian attributes. The study contributes to understanding complex driver-pedestrian dynamics, offering insights for traffic management strategies and velocity control measures.

2. METHOD

2.1. Data Collection

The study utilized drone technology and video camera camcorders to collect data on road infrastructure and traffic dynamics, providing detailed aerial views for in-depth analysis and insights into driver behavior, traffic management improvements, and pedestrian movements.

2.2. Data Extraction

The study uses video surveys to capture vehicle velocity patterns, especially those yielding to pedestrians. Measurements are taken at multiple gaps and 80 meters upstream from the crossing point. The data is analyzed using TRACKER 5.0, providing insights into deceleration patterns during yielding maneuvers. This understanding can enhance pedestrian safety and inform traffic management strategies. The study analyzed pedestrian characteristics influencing driver-yielding behavior using video footage of crossings. Factors included number of pedestrians, location, gender distribution, disturbances, vehicle type, and lane. Vehicles were categorized into six types: Van, Bus, Lorry, Car, Motorbike, and Three-Wheeler. The dependent variable was whether the vehicle yielded to crossing pedestrians. Yielded events involved a significant drop in velocity, while non-yielded events did not.

2.3. Data Analysis

The study used Python to analyze vehicle velocity values, creating envelope graphs, to represent a range of possible outcomes or variations in data, and average deceleration curves for each vehicle category.

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This information helps develop strategies for pedestrian safety and traffic flow optimization in critical areas. The study analyzed factors influencing drivers' yielding willingness, considering variables such as vehicle type, pedestrian count, and number of pedestrians. The dependent variable was whether the vehicle yielded or not. The logistic regression analysis, a statistical method used for binary classification problems, where the outcome variable can take on only two possible outcomes, typically coded as 0 and 1, was used to determine the probability of yielding. The model's intricate links were assessed using the logistic regression equation shown below. The results, obtained from the analysis of a dataset comprising 916 samples using R Studio software, provide valuable insights into the factors influencing driver-yielding willingness at a crosswalk, with the sample size carefully balanced through class balancing procedures.

$$P(Z) = \frac{1}{1+e^{-z}}$$

Z= a_0 + a_1 * Number of pedestrians at the median + a_2 * Number of pedestrians at the curb + a_3 * Vehicle Type + a_4 * Vehicle Position + a_5 * Number of Male + a_6 * Number of Female + a_7 * Number of Injured + a_8 * Number of Children (a_i= regression coefficients)

3. RESULTS AND DISCUSSION

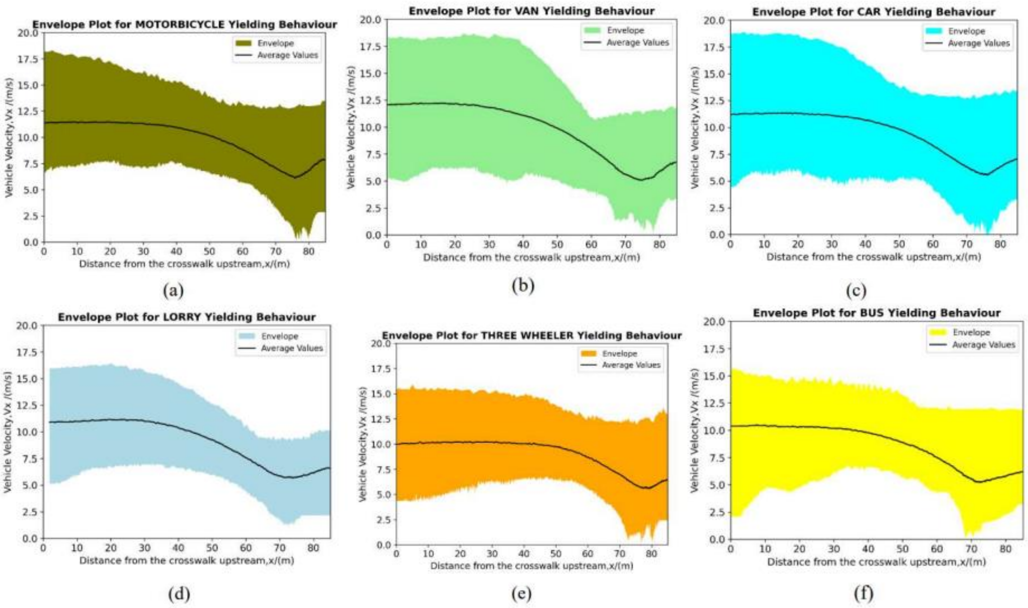

Figure 1. Average Velocity vs Distance graphs and Envelope
(a) For Motor bicycles (b) For Vans (c) For Cars (d) For Lorries (e) For Three Wheelers (f) For Buses

This study examines deceleration patterns of six vehicle classes at unsignalized crosswalks to improve pedestrian safety and traffic control. The data is presented in graphs illustrated in Figure 1 allowing for detailed analysis of speed variations and variability in deceleration patterns. The hatched areas indicate deceleration variability, while the thick line represents the average deceleration curve from the entire data sample within each vehicle category. The dataset includes 40 motorcycles, 40 three-wheelers, 30 vans, 60 cars, 20 lorries, and 30 buses, representing various transportation modes. The study incorporates various vehicle types to analyze deceleration patterns, enhancing our comprehension of their behaviour during pedestrian crossing interactions. The study found that, as illustrated in Figure 2, most vehicle types yield similarly, with a similar decreasing average rate, and no significant difference was observed among the six types. To identify the factors that influence drivers' yielding willingness according to the pedestrian characteristics the outcomes of the stepwise logistic regression analysis are presented in Table 1. As it is assigned 1 to yielded events and 0 to non-yielded events, opting for binary logistic regression analysis was a natural choice.

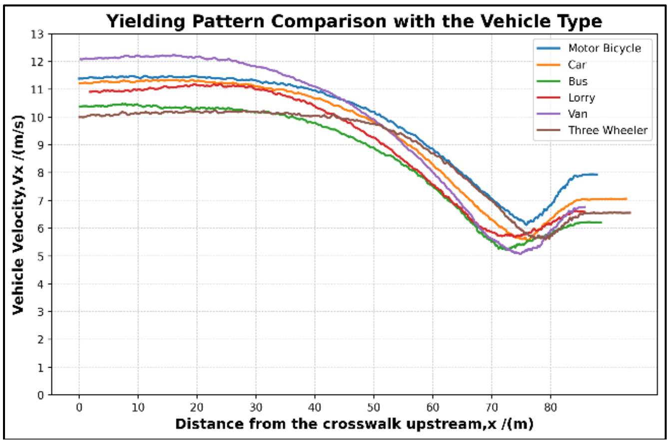

Figure 2: Average deceleration curves

Table 1: Results of the logistic regression analysis (after doing stepwise analysis)

	Estimate	t value	Pr(>|t|)
Intercept	0.685064	37.465	<2e-16 ***
Pedestrian count at median	0.016426	2.173	0.03 *
Female pedestrian count	0.335825	12.872	<2e-16 ***
Injured pedestrian count	-0.701490	-16.108	<2e-16 ***
Vehicle position (Near Lane)	0.218798	9.432	<2e-16 ***
Residual standard error: 0.2687 on 911 degrees of freedom Multiple R-squared: 0.4288 Adjusted R-squared: 0.4263 F-statistic:171 on 4 and 911 DF p-value: < 2.2e-16			

Based on the obtained results, Equation 2 can be refined as follows:
Z= 0.685064 + 0.016426 * Number of pedestrians at the median + 0.218798 * Vehicle Position + 0.335825 * Number of Female - 0.701490 * Number of Injured

This study has limitations, including its focus on four-lane divided roads, its assumption of uniform pedestrian behavior, inability to account for weather conditions, limited geographic scope, and sample size. These factors may affect the generalizability of the findings and the design of future research studies.

Based on the findings derived from the regression analysis, adjustments to the logistic function can be made as above. In this equation, if the vehicle is approaching the pedestrian from the near lane, 1 is substituted; otherwise, 0 and for other variables, the pedestrian count is substituted directly. The model produces values ranging between 1 and 0. Ultimately, the logistic regression function, derived from the analysis, the function can be derived by substituting the z function from Equation 3 into Equation 1, which provides the probability of vehicle yielding by substituting the obtained values. To determine whether a driver yields or not, a 50% threshold is employed.

4. CONCLUSION

The study identified yielding patterns in collaboration with vehicle velocity, considering six distinct vehicle types and highlighting their similarities in the deceleration pattern. The identified factors that significantly influence drivers' yielding willingness among the eight independent variables considered include the number of female pedestrians, the number of pedestrians in the median, the number of injured pedestrians, and the vehicle position/vehicle approaching lane.

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