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Analysis of Pedestrian Risk Exposure in Thrissur City

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Abstract - *Pedestrian Exposure is defined as the exposure risk of pedestrians with collision with motor vehicles. It is one of important factors influencing pedestrian crashes. Because pedestrian exposure or pedestrian volume counts are not readily available, population density is usually used as a substitute in pedestrian crash prediction models. Unfortunately, population density is not a good replacement for pedestrian exposure because it does not account for the amount of walking people do. This study investigates the relationship between the pedestrian exposure and different traffic parameters in few junctions of Thrissur city. Thrissur is one of the few cities of India with connections to other parts by all major modes of transport like road, rail, air and water. When large amount of people use roads, the environment and operating vehicle needs to be safe and pedestrians are not injured or killed. For making roads of Thrissur city safer, it is also required that, certain relations are derived, which connects the pedestrian accidents to different traffic and geometric factors such as lane width, median width and shoulder width. Linear regression modeling is used to find out the significance of these factors in pedestrian crashes. Based on the identification of these factors, the necessary remedial measures to reduce the pedestrian crashes, typical for the Thrissur city can be formulated. This study also suggests extra improvement in pedestrian facilities for the areas of high pedestrian exposure*

Key Words: Pedestrian exposure, Accident prediction, SPSS, Linear regression, Pedestrian crash

1.INTRODUCTION

Pedestrians, one of the vulnerable road user, have become more susceptible to traffic crashes with the rapid growth of motor vehicles in India Walking has always been the primary means of human locomotion. The pedestrian crossing facility at suitable location at favourable environmental conditions in the transportation system is a challenging problem. So the pedestrian crossings with different vehicular movements result in a wide set of conflict points. In this context, the objective of this study was formulated pedestrian accident models and remedial measure suggestions. The pedestrian road crash is influenced by several human and environmental factors, demography, roadway characteristics and vehicular characteristics. This study is made possible through specified data collection effort including detailed review of police reports and collection of roadway conditions.

This report discusses the problem of pedestrian crashes in Thrissur city to support the development and assessment of effective pedestrian crash avoidance systems. Town planners may argue that pedestrians must be the central focus while designing a city transportation network and the people on foot need the right to walk freely on footpaths.

To protect the pedestrian from crashes with motor vehicles and reduce their risk on roadways is one of the main goals of transportation safety. Learning about and studying pedestrian crashes, especially those related to the deaths of pedestrians, is a part of the effort to reach that goal. This report describes pedestrian crash fatalities and injuries in Thrissur city by providing statistics and crash characteristics. Procedures used to discover the findings are explained with results of data analysis are reported. The goals, methods, findings and limitations of this report are introduced in the following sections.

1.1 Need for Study

Based on the analysis done during the preliminary phases of the project, it is found that the pedestrian accident rates of Thrissur city has been on a linear rise for the past few years. The study aims at identifying the possible features and factors, which contribute to this scenario.

For making the roads of Thrissur city safer, it is also required that, certain relations are derived, which connects the pedestrian accidents to these factors. Based on the identification of these factors, the necessary remedial measures, typical for Thrissur city can also be formulated.

1.2 Objectives

- To analyze the pedestrian risk exposure in Thrissur city
- To determine the factors influencing pedestrian risk exposure
- Development of correlation between pedestrian accidents and geometric design parameters of roads

along with traffic operating characteristics for pedestrian accident
- Development of crash prediction model and checking its feasibility for using on wide basis
- Evolving engineering remedial measures for improving safety on roads.

2. LITERATURE REVIEW

"Pedestrian exposure" is defined as the exposure risk of pedestrians to collisions with motor vehicles. It is one of the important factors influencing pedestrian crashes. Everyday thousands of people are killed and injured on our roads, leaving behind shattered families and communities. Consequently, identifying the appropriate measure of exposure for a particular risk event is extremely important for analyzing the likelihood of its occurrence.

The factors affecting pedestrian crash injury severity at signalized and non-signalized intersections include geometric predictors, traffic predictors, road user variables, and environmental predictors [1]. The binary logistic regression models can be used to identify pedestrian fatality risk factors along Bangladesh's roadways using crash data. A higher risk of fatality was observed for pedestrians who crossed the road compared to those who walked along the road [2]. Male and older pedestrians were more prone to severe injuries compared to other groups. Rural and high-speed urban roadways were found to be more dangerous for pedestrians, especially for pedestrians crossing the roadways [3].

Pedestrians could experience reduced awareness of surroundings, distraction, and engage in unsafe behavior while talking or texting on their mobile phones. Mobile phone-related injuries among pedestrians increased relative to total pedestrian injuries. Moreover, pedestrian injuries related to mobile phone use were higher for males and for people under 31 years of age [4]. Pedestrian safety is greatly influenced by number of access points per unit length of the road. Each additional access point per kilometer of road length may increase accident rate by more than 100% [5].

The above discussed review suggests that there is a relatively large amount of pedestrian risk literature. However, there is not so much study that emphasizes many of the contributing factors included in this study that affect pedestrian crash injury severity at intersections such as the geometric features of road. One reason may be because these data are not typically available in the crash and roadway databases. This study was made possible through a data collection effort including detailed review of police reports and collection of roadway conditions.

3. METHOD OF DATA COLLECTION

Data collected by police officers from accident spots were obtained from office of District Police chief. Accident data were collected for past five years. Seven accident prone junctions in Thrissur town were identified from the obtained data. Peak hours of accident occurrence were also recognized.

Knowing the flow characteristics one can easily determine whether a particular section of road is handling traffic much above or below its capacity. If the traffic is heavy the road users suffers from congestion with consequent increase in pedestrian accident rate.

Traffic volume is used as a quantity measure of flow; the commonly used units are vehicles per day and vehicles per hour. Traffic and pedestrian volume during each 15 minutes from 8 am to 1 pm and 5 pm to 9 pm were determined for two working days in each selected locations. Numbers of different vehicles entering the selected intersection were counted separately and converted them into PCU (Passenger car unit) to get traffic volume. And also number of pedestrians crossing the roads was noted as pedestrian volume. PCU values for different vehicles obtained from IRC SP 41 are given in Table 1.

Road geometric data were collected from the respective locations selected for study. The selected intersections are non-signalized and accident prone areas under the past few years analysis. Road width, shoulder width and median width were collected from the corresponding spots.

Table -1: PCU values from IRC SP 41

Sl. No:	Types of vehicles	PCU value
1	Passenger car, Tempos, Auto rickshaw, pick up vans	1.00
2	Motor cycle, Scooters	0.50
3	Light commercial vehicle	1.50
4	Truck, Buses	3.00
5	Cycle, Cycle rickshaw	1.50
6	Cycle	0.50
7	Tractor Trailer, Truck Trailer unit	4.50

4. MODELING

Mathematical modeling was used for deriving relations between pedestrian accidents and other road and traffic characteristics. Regression analysis is a statistical technique for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables. Regression analysis is used for prediction and forecasting, pedestrian accidents. Multiple regression models is also applied to understand which among the independent variables are related to the dependent variable, and to explore the forms of these relationships.

Statistical Package for the Social Sciences (SPSS) software was used for modeling. The dependent variable is number of pedestrian accidents occurred during past five years. The

independent variables selected are: traffic volume in PCU, pedestrian volume, road width in meters, shoulder width in meters and median width in meters.

Correlation refers to any of road class of statistical relationships involving dependence, though in common usage it most often refers to the extent to which two variables have a linear relationship with each other. Table 2 shows how the accident rate varies with traffic volume, pedestrian volume, road width, shoulder width and median width.

Table - 2: Correlations

		TRAFFIC VOLUME	PEDESTRIAN VOLUME	ROAD WIDTH	SHOULDER WIDTH	MEDIAN WIDTH	NO OF ACCIDENTS
TRAFFIC VOLUME	Pearson Correlation	1	.342	.472	.388	.448	.047
	Sig. (2-tailed)		.000	.000	.000	.000	.531
	N	180	180	180	180	180	180
PEDESTRIAN VOLUME	Pearson Correlation	.342	1	.346	.381	.246	.058
	Sig. (2-tailed)	.000		.000	.000	.001	.437
	N	180	180	180	180	180	180
ROAD WIDTH	Pearson Correlation	.472	.346	1	.544	.823	-.495
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	180	180	180	180	180	180
SHOULDER WIDTH	Pearson Correlation	.388	.381	.544	1	.218	-.351
	Sig. (2-tailed)	.000	.000	.000		.003	.000
	N	180	180	180	180	180	180
MEDIAN WIDTH	Pearson Correlation	.448	.246	.823	.218	1	-.384
	Sig. (2-tailed)	.000	.001	.000	.003		.000
	N	180	180	180	180	180	180
NO OF ACCIDENTS	Pearson Correlation	.047	.058	-.495	-.351	-.384	1
	Sig. (2-tailed)	.531	.437	.000	.000	.000	
	N	180	180	180	180	180	180

Table – 3: coefficients[a]

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. error	Beta		
(constant)	1.323	.149		8.903	.000
Traffic volume	.001	.000	.372	5.391	.000
Pedestrian volume	.001	.000	.246	3.844	.000
Road width	-.066	.021	-.428	-3.188	.002
Shoulder width	-.351	.092	-.315	-3.820	.000
Median width	-.323	.202	-.190	-1.603	.111

a. Dependent variable: No. of accidents

The Coefficients table provides us with the necessary information to predict dependent variable from independent, as well as determine whether independent contributes statistically significantly to the model (by looking at the "Sig." column). Furthermore, we can use the values in the "B" column under the "Unstandardized Coefficients". Traffic volume, pedestrian volume, road width and shoulder width are statically significant in the prediction model.

The validation or checking for correctness of the obtained equation was done by inputting the values for independent variables in the equation. Linear regression model obtained for pedestrian accident for five years at a junction shown as:

Number of Accidents = 1.323 + (0.00061* Traffic Volume) + 0.00111*Pedestrian Volume) – (0.06625*Road width) – (0.35002*Shoulder width) – (0.32339*Median width)

5. CONCLUSIONS

The study reveals that the accident rate increased due to reduction in road width, median width and shoulder width. Number of accidents will directly vary with traffic and pedestrian volume. The results from this study could help to recommend appropriate countermeasures for reducing the severity of pedestrian crashes. These countermeasures should be organized through the coordination of law enforcement officers, safety engineers, and the public to integrate the components of the four E's: engineering, education, enforcement, and emergency response.
The suggestible remedial measures are as follows:

- Sufficient Road width, shoulder width and median width along the highway should be provided.
- Elevated footway and subways for crossing of roads in all possible places should be provided.
- Separation of pedestrian movement from heavy moving traffic in all possible places by providing sidewalks.

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