

PEDESTRIAN RISK ANALYSIS AT UNCONTROLLED MIDBLOCK

Prof: Bybin Paul¹, Mohamed Fayiz², Naseef Ahamed V³, Sudharsana A⁴, Archana C⁵

¹Assistant Professor, Dept. of Civil Engineering, Mar Athanasius College of Engineering, Kerala, India

^{2,3,4,5}Student, Dept. of Civil Engineering, Mar Athanasius College of Engineering, Kerala, India

Abstract - Traffic controls and space allocations are generally biased towards vehicular traffic and pedestrians requirements are not given due consideration. One of the most hazardous locations for a person to cross is at uncontrolled midblock. In such locations, pedestrians need to search for adequate vehicular gaps to cross safely. Pedestrian adopts a different behaviour pattern than expected in this situation causing confusion to fatal accidents during the endeavour. Objective of this study is to find out whichever behavioural and demographic factors influence the risk and adopt the safest behaviours while crossing at midblock.

Key Words: Pedestrian risk analysis, Road crossing, waiting time, Risk analysis, Interruption, Rolling gap.

1. INTRODUCTION

Transportation is defined as the transfer of person or goods from one point to another by a medium which can be a vehicle or a person. One of the most accessible modes of transportation is road transportation. Once constructed for the safe transport of pedestrians, it is currently fully overtaken by vehicles. Consequently, this puts pedestrians in a dangerous position of having given the least amount of consideration during the design of roads.

Pedestrians either move along the road or across the road, casually known as a road crossing, to get from A to B. The latter movement is the problematic one, because of its interference with ongoing traffic. It is also influenced by several factors and conditions, accordingly, making it a behavior having a high potential for accidents, as much as driving.

One of the most hazardous locations for a person to cross is at uncontrolled midblocks. Uncontrolled mid-block pedestrian crossings are marked crosswalks placed between intersections which are not controlled by any traffic police personnel. The second Global Report on Road safety shared that, globally, pedestrians constitute 22% of all road deaths and in some countries; this proportion is as high as two thirds. Moreover, millions of people are injured in traffic-related crashes while walking, some of whom become permanently disabled.

The data show that on an average day 1324 accidents occur on Indian roads leading to the death of 349 people. This means 55 accidents and 15 lives lost per hour. In other words, a life lost every four minutes.

In Kerala; it was found that there is a 20% increase in road accidents and injuries compared to the year 2015. Although rash and drunk driving are the leading cause of these fatalities and non-fatal injuries, lack of pedestrian infrastructures and poor urban planning also puts pedestrians at risk.

1.1 Need for Study

With a population of 601,574 as of 2011, the city of Ernakulam has Kerala's second highest population density parameter with 6340 people per km. As the population increases, their need to commute to different locations have increased many times. The accident rate in the city is reportedly on the rise. Out of 2451 accident cases registered in 2018 in the city, 140 cases were fatal and around 2451 had non-fatality injuries. The study aims to identify different factors which may influence the behaviour of pedestrians and their risk and relations. By identifying these factors and relations, safest behaviour traits that can be adopted during crossing can be adopted.

1.2 Objectives

- To qualitatively and quantitatively assess the road crossing conditions.
- To find the effect of gender, age, companions, vehicles and other external factors on the road crossing behavior.
- To give pointers to pedestrians and drivers on the safest behaviors that could be adopted during the midblock crossing.

2. LITERATURE REVIEW

Public transportation influences pedestrian safety. Crossings located close to bus stops, or bus way systems, experience higher pedestrian crash rates[1]. The speed of the pedestrian was found to be influenced by the age and gender. Male pedestrians move faster than female pedestrians. Pedestrians in the age group of 10–15 years had the highest speed, 82 m/min. The speed was reduced by about 85% when pedestrians move with their baggage as friction increases with weight[2].

Pedestrians preferred safe to short paths and they crossed second half of the road with significantly higher speed. In terms of safety, pedestrians who were middle aged; involved in bigger groups, looked at vehicles more often before crossing or interacted with buses rather than cars were safer

while those running were more dangerous [3]. 10.6% of middle aged pedestrians are more likely to have irregular crossing than youth and older pedestrians. It was also found out that male pedestrians are 38.6% more likely to show rolling gap behavior and 75.2% more likely to observe running behavior. Analysis of behavior based on the size of vehicles shows that pedestrians accepting gaps of buses are likely to run in crossing at mid blocks

3. METHODOLOGY

Data for the study were collected in Ernakulam city during the months of February and March of 2019. The videography survey was done at morning and evening peak hours from an elevated position at 22 selected locations. The recorded video was extracted using VLC Player with frame by frame playback. In every 30 milliseconds, behaviors of the pedestrian were analyzed manually.

The data includes different details about a pedestrian and the crossing behavior, including the age, gender, way of crossing, vehicle gap acceptance, group effect etc.

Pedestrians were divided into four age groups based on their visual appearance.

1. Child/Teen
2. Youth
3. Middle-aged
4. Elder

Other data extracted includes

1. Whether or not the pedestrian show running behavior
2. Whether the pedestrian was in a group
3. The pattern of movement
4. Type of vehicles for which the pedestrians cross
5. Crossing time
6. Waiting time
7. Whether or not the pedestrians fully crossed through the marked crosswalks.

The crossing speeds of the pedestrians were found out from the road width and the crossing time from the timeline of the media player. Collected data is shown in Table-1.

OBSERVED DATA	NUMBER OF PEDESTRIANS OBSERVED	PERCENTAGE (%)
GENDER		
1.Male	1037	55.52
2.Female	831	44.48
AGE GROUP		
1.Child	303	15.4
2.Youth	859	43.6
3.Middle aged	616	31.4
4.Elder	191	9.7
BEHAVIOUR		
1.Walk	1553	83.1
2.Run	315	16.9
GROUP OR NOT		
1.Alone	773	41.4
2.Group	315	58.6
PATTERN OF MOVEMENT		
1.Straight	1424	76.2
2.Rolling	444	23.8
INTERRUPTIONS IN CROSSING		
1.Interrupted	426	22.8
2.Uninterrupted	1442	77.2
TYPE OF VEHICLE FOR WHICH PEDESTRIANS CROSS		
1. Car	575	30.8
2. Two Wheeler	583	31.2
3. Three Wheeler	230	12.3
4. Heavy Vehicles/ Bus	478	25.7
CROSSING IN ZEBRA		
1.Yes	1185	63.4
2.No	683	36.6

4. STATISTICAL ANALYSIS

To determine whether the pedestrian demographic factors like age and gender, behavioral factors and vehicle factors have any effect on the risk potential while crossing the road, suitable statistical analysis tools are carried out.

The collected data contains categorical data as well as numerical data. It is essential to select suitable methods for the analysis of each type of data. One-way ANOVA is used to compare between a categorical variable and a numerical variable. Comparison between two categorical variables is done by carrying out Chi-squared test. If any statistical significance is established after carrying out the tests between two variables, odd ratio is calculated to quantify the relation. The odds ratio (OR) is the ratio of the odds of A in the presence of B and the odds of A without the presence of B. For example, if the possibilities those pedestrians in Group A and Group B would run during crossing are 'a' and 'b' respectively, then the OR is given by,

$$OR = \frac{b(1-a)}{a(1-b)}$$

If the OR is greater than 1, then pedestrians in Group A are more likely to run during crossing. If OR is equal to unity, there are no difference between the two groups in terms of the likelihood of showing running behavior while crossing. The results after analysis are shown in Table 2.

5. FACTORS AFFECTING CROSSING BEHAVIOUR

5.1 Gender

Statistical significance test show that males are 34% more likely to run during crossing than female ($p=.009$). This might be because of the risk taking behavior of the gender in the prevailing culture. It was also found that males walk slightly faster than their female counterparts during crossing ($p=.003$). The mean crossing speed of males (ranging from .42m/s to 3.67m/s) is 5% more than females (ranging from .11m/s to 3.5m/s). The risk taking behavior of male pedestrians is still more significant by the fact that they are 34% more likely to disregard the marked crosswalks. Males are also less likely to cross as a group as opposed to female pedestrians whose likelihood of crossing as groups is 1.77 times that of males.

5.2 Age difference

It was found that there exists no significant difference in crossing speed between age groups as per the data from ANOVA test ($p=.191$). However, middle aged pedestrians are

35% more likely to show rolling behavior than the youth and 45% more than other age groups ($p=0.001$). It was also found out that youth are 50% more likely to get interrupted while crossing than children or teens and 37% more likely than other age groups ($p=.032$). Interestingly, Children/teen were found to be 100% more likely cross in groups than any other groups and 70% more likely than youth ($p=.000$). No significant differences were found in running behavior and preference to cross through marked crosswalks between age groups.

5.3 PLATOON SIZE

Crossing as a group is an evolved behavior to maximize safety and attention from the motorists. This behavior lessens the need for an individual to take more risks. This would explain why those who cross alone are 130% more likely to run across the road while crossing compared to those cross as group. Those who cross alone are 71% more likely to cross away from marked crosswalks too. There are no significant difference in pattern of movement and interruption during crossing and platoon size.

5.4 Vehicle Factor

The type of vehicle for which pedestrians tend to cross has significant effect on interrupted crossing ($p=.000$). Pedestrians are 20% more likely to get interrupted if they choose to cross a bus or heavy vehicle than a three wheeler and 74% more likely than any other vehicles. Pedestrians are also 20% more likely to show rolling behavior when crossing for a bus ($p=.013$).

5.5 Other Factors

Though not a factor directly influencing the pedestrian behaviour during the crossing, the time spent waiting for a suitable gap between the ongoing traffic might have an influence on the crossing behavior which follows the waiting time period. It has been quantitatively measured. The mean waiting time of a pedestrian in Ernakulam city is 21.5 seconds which is more than the time taken for the actual crossing. Another surprising relation found out using the statistical analysis is that those who cross through the marked crosswalks are 50% more likely to get interrupted by the vehicles than those who are not. This can be discarded as an anomaly observation. But, if we observe the behaviour of motorists in a multiple lane straight highway, many are unwilling to slow down for a pedestrian whether they are on zebra line or not. This is evident from TABLE 1 that 36.6% of the pedestrians chose not to cross through zebra lines.

Criterion	Behaviour	Gender		Age				Group effect		Type of vehicle for which pedestrian tend to cross(near)			
		Male	Female	Child	Youth	Middle	Old	Group	Alone	Car	2W	3W	HV
Pattern of movement	Rolling			46	185	169	44			133	141	38	132
	Straight			236	624	423	141			442	444	192	346
	OR			0.66	1.0	1.35	1.05			0.95	1.0	0.62	1.2
Interruptions in crossing	Uninterrupted crossing			229	599	470	144			467	474	169	332
	Interrupted crossing			53	210	122	41			108	111	61	146
	OR			1.0	1.5	1.12	1.2			0.64	0.65	1.0	1.21
Type of crossing	Running	196	119					131	184				
	Walking	841	712					964	589				
	OR	1.34	1.0					1.0	2.3				
Crossing in zebra	No	410	273					344	339				
	Yes	627	558					751	434				
	OR	1.34	1.0					1.0	1.71				

6. CONCLUSIONS AND FUTURE SCOPE

One of the objectives of the study was to carryout qualitative and quantitative assessment of road crossing conditions for pedestrians in Ernakulam city. Videography survey was done at 22 locations on weekdays and demographic factors (age, gender etc.) along with behavioural data were collected from the recorded videos. Data of 1868 pedestrians were observed from all the 22 locations.

The collected data were tested for statistical relationship between themselves using significance tests in SPSS software. If any significance difference exists between groups, the strength of the relationship is quantified using Odd Ratio.

Statistical analysis points out to the observation that males are more prone to risk taking. They have a higher crossing speed than females and 34% more likely to run during the crossing. This behaviour, though born out of impatience to wait till a more lasting gap between traffic is opened, does raise the likelihood of endangering themselves and others around them.

When the age difference was considered, middle aged pedestrians were found 45% more likely to show rolling gap behaviour than other groups. Youth were found 50% more likely to get interrupted while crossing than children. This can be accounted to the risk taking behaviour by youth compared to the more cautious approach by children.

Trying to cross over a bus is 74% more likely to get a pedestrian interrupted and they are 20% more likely to show rolling gap behaviour.

Children and females show a significant tendency to cross in a group than their counterparts, which might discourage risk taking and increase driver's attention and response. Crossing in a group has an overall effect on the type of crossing the members choose. Those who cross alone are more likely to run and cross away from the marked crosswalks than those who are in group.

Though not statistically linked with crossing behavior, pedestrians shared their frustrations over the time they have to wait before getting a suitable gap in the traffic. Most of the motorists were unwilling to slow down for the pedestrians waiting one the starting point of zebra lines.

6.1 Pointers on safe crossing

- Crossing in a group is always safer than crossing alone.
- Crossing with raised hands is an effective way to avoid interruptions even on a zebra line.
- Not accepting gaps from heavy vehicles like buses for crossing might reduce the interruptions and possible accidents.
- In divided highways, placing crosswalks in a disconnected way on both the sections to reduce carelessness, might be counterproductive when pedestrians cross the other half of the road away from the zebra line, choosing ease over safety.
- Most of the medians don't have comfortable space to walk along the road from the endpoint of one zebra line to starting point of the other, when zebra lines are disconnected. Providing crosswalks at a short distance from each other and suitable platform to walk on the median will encourage pedestrians to use zebra lines more often.
- Designing crosswalks at the u-turn makes it difficult for both the motorists and the pedestrians to move safely to the other side due to close interactions.

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