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# Study on Pedestrian Crossing Behaviour and various Factors Influencing their Perceptions at Intersections-A Review

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**Abstract:** *The paper reports research on pedestrian crossing behavior at signalized and non-signalized intersections and to analyze the various types of facilities that need to be implemented at desired locations to improve the safety of pedestrians while crossing the road. In this paper various pedestrian characteristics like age, gender, motif of the trip, baggage and luggage being carried by pedestrian and their effect on different pedestrian flow characteristics like speed of crossing and time of waiting are analyzed. Findings from this paper could help researchers and practitioners understand the behavior of pedestrians and help them to come up with better ideas to create ideal street crossing environment.*

**Keywords:** *Pedestrian crossing behaviour, Intersection, Critical gap, jay walking*

## I. INTRODUCTION

United Nations envisions that to meet sustainable development goals by 2030. The very first severe problem that life on planet facing is global warming which is mainly due to continually increasing greenhouse gases. Motorized vehicles are major contributors to these aforementioned greenhouse gases. So the members of United Nations started to take measures and to put curb on these greenhouse gas emissions. Encouraging pedestrians & cyclists and providing facilities like cycling tracks and walking tracks for their safer trip is major responsibility for governments. But until recent times, pedestrians have been given least importance in mode hierarchy mainly in comparison with motorized vehicles as they contribute little or no revenue to the transportation system. This has been the reason for pedestrians happened to be major victims in road accidents. But change in authorities' approach towards pedestrian safety is a welcome note.

When it comes to pedestrians, lack of compliance with traffic rules and regulations on the side of both drivers and pedestrians creating confusion in which pedestrians become the victims of incident where in many cases it may lead to fatality. In a recent study on accidents in India, statistics showed that 65% of fatal victims are pedestrians and out of these 65%, 35% are children. So study of pedestrian behavior during crossing roads is the need of the hour to ensure pedestrian safety.

In India, out of all accidental deaths that happened on road in year 2006, 8.4% of fatal victims are pedestrians which summed up to 8906 human lives. Out of all road related deaths in 2003, 72% fatal deaths occurred in urban areas. <sup>(1)</sup>

Pedestrians are usually exposed to more danger while crossing roads. Why because they have to be more conscious of traffic flow on the road to reach the other end. Intersections with high traffic volume flow should be signalized to offer high safety to the pedestrians and road users and to prevent accidents.

While coming to road safety, pedestrian illegal crossing behavior is the major issue. We should mainly consider these below factors.

- 1) Due to their distraction in attention, pedestrians usually don't notice the incoming traffic flow while crossing a road.
- 2) Not following the traffic signals properly.
- 3) In some cases, lack of sidewalks force the pedestrians to walk across the street.
- 4) Miscalculation of traffic gaps while crossing the roads.
- 5) Walkers cross the roads in midblock area or out of assigned crosswalks.

## II. LITERATURE REVIEW

Akashjain, Ankita Gupta et. al (2014) <sup>(2)</sup> have conducted an observational study by collecting video graphic data at three intersections in Roorkee city. They found that the time of crossing for most of the pedestrians varied between 4 seconds to 10 seconds of oblique or two step crossing. The time of waiting is high for adult people and women. The waiting time that had been taken by children is very less. As compared to 1.98 m/s speed of oblique movement, the speed of perpendicular movement was calculated as 1.36 m/s for an average pedestrian. Authors calculated speed of crossing of male pedestrians as 1.85 m/s and that for

female pedestrians as 1.67 m/s. They observed children are used to cross roads with dangerous speeds at higher risks as compared to other age groups. Baggage had not shown much difference on speed of crossings of pedestrians.

Udit Gupta, NiladriChararjeet et. al (2009) <sup>(3)</sup> have studied two grade separated intersections in Delhi before and after reconstruction of existing intersection. They observed that 22% of pedestrians had not used recently constructed underpass and choose to cross the intersection dangerously through carriage way as the then recently constructed underpass is 41 meters away from the bus stop at one side of the road. They stated risk as a time of exposure at which the pedestrians exhibits a potential conflict with the oncoming vehicle on the carriage way and said that when the accepted gap increases, risk decreases. I.e. both risk and gap acceptances are inversely proportional to each other. Risk = f (1/gap acceptance). If gap accepted is zero then chance of risk is one. Authors observed that speeds of higher percentage of vehicles had increased after reconstruction of site or grade separation, which in turn increased the risk of conflict of pedestrians who used to cross the road on grade, when compared to the risk that had existed before grade separation. Speeds of heavy vehicles, cars, three wheelers and two wheelers have increased by 21.6%, 22.6%, 15% & 31.6% respectively, which in turn increased the chances of pedestrian fatality by 67%, 100%, 100% & 200% accordingly.

Satish Chandra, RajatRastogi et. al (2014) <sup>(4)</sup> had carried out an observational study at 17 locations in 5 cities in India. They noted various types of road crossings; those were single stage crossing, two stage crossing and rolling crossing. It had been observed that pedestrians choose to adopt rolling crossing when compared to single stage and two stage crossing. The average accepted gap was high for old aged people when compared to younger people as they have accepted lesser gaps. Authors observed that the deviation of gaps accepted from critical gap was more for older people when compared to other age groups. The critical gap varies inversely with width of the road and its value range between 5.9 seconds to 7.6 seconds at four cities. It had also showed that pedestrian's crossing speed also had increased with road width.

Gowri Asiathambi, Manu O. Kuthan et. al (2016) <sup>(5)</sup> had conducted an observational study at an uncontrolled intersection in Mangalore city, India. They observed the improved pedestrian behavior after installation of traffic signal when compared to condition before signal installation. They have observed increased pedestrian waiting times by 52% after signal installation, why because pedestrians have to wait for vehicles to get dissipated from signal crossing during green phase. They also observed that the average crossing speed of pedestrians was also reduced by 23% after signal installation as pedestrians mostly choose single stage crossing after the signal installation. Authors observed that 15<sup>th</sup> percentile crossing speed of pedestrians was reduced after signal installation as pedestrians were tend to cross the road calmly without any hurry burry. It was also observed that the accepted gaps taken by male and female pedestrians were appeared to take lower risks after signal installation as compared to before signal installation. The critical gaps taken by pedestrians after signal installation were reduced as decrease in crossing speeds of pedestrians has observed. A model was developed by authors using multiple linear regression technique (MLR) by considering pedestrian gap size as the dependent variables and pedestrian and traffic characteristics as the independent variables. 468 and 333 pedestrian accepted gaps were used for MLR modeling for before and after signal installation respectively. By using this MLR model, authors found that the rolling crossing behavior (or) jaywalking behavior of pedestrians had reduced after signal installation. Authors found that the accepted gap sizes were depend on various factors like age, gender, speed of incoming vehicle, type of vehicle, volume of traffic and pedestrian crossing pattern.

Priyanka Gupta, Yueli et. al (2008) <sup>(6)</sup> had conducted an observational study in Toronto city of Canada. They observed that temperature and time of day had shown significant effects on speeds of pedestrian walking. The walking speeds of pedestrians in colder weathers were as follows. Walking speeds were 1.43m/s at -15degrees Celsius and 1.44m/s at -5 degrees Celsius and these speeds were observed to be decreased with rise in temperature as 1.25m/s at 15degrees Celsius and 1.28m/s at 25degrees Celsius. Authors had also observed the change in walking speeds of pedestrians as the time of day varying. The speeds of pedestrians between 1PM-2PM were different from pedestrian speed at 6PM-7PM.

Syedatabish, Er. Munish Kumar (2017) <sup>(7)</sup> had conducted a questionnaire survey at two study locations. Those were Ambala Cantt railway station and Chandigarh bus stand. When authors enquired pedestrians, whether they prefer under bridge or over bridge facility of grade separation, they found that pedestrians near railway station preferred under bridge as only 33% of people opted for over bridge. Whereas pedestrians near Chandigarh bus stand preferred over bridge as around 65% of pedestrians choose foot over bridge. Authors questioned about lighting at night. More or less same results occurred at both study locations as pedestrians said "YES" to choice of lighting facility.

Marie-AxelleGranie, Thierry Brenac , et al(2014)<sup>(8)</sup> had conducted an experimental study to find out the differentiation made by pedestrians in their crossing decision of how to cross carriage way in various urban environments namely city center, inner suburbs, public households in city outskirts, commercial zones in outskirts, and country side. Authors have carried out this experiment on 77 pedestrians by showing them sets of photographs representing above five environments to know pedestrians perceptions of

pleasantness and how safe they feel in these environments. When it comes to pleasantness and safety, authors observed that participants felt city center environment was more pleasant and safe and commercial zone environment was more dangerous and unpleasant with 95% confidence interval and it is medium for inner suburbs and country side environments. When authors enquired participants about their perceptions to cross the road in above mentioned environments, they felt city center environment is very safe to cross the road with 95% confidence interval and it is moderate for public housing environments and low for city outskirts and commercial zone environments.

### III. DISCUSSIONS

While crossing a road or an intersection, pedestrian have to tradeoff between time saving and avoiding risk of conflict with the vehicles. Crossing at locations where there is no zebra crossing or if pedestrians cross against the red light leads to higher chances of road accident injuries.

The major outline of all papers that we came across suggests that male pedestrians walk significantly faster than female pedestrians while crossing intersection and roads.

As the speed of vehicles increases the likelihood involvement of pedestrians in a crash is always on cards at grade separated intersections. Why because, due to grade separation drivers don't expect pedestrians on the carriage way. So they drive at relatively high speeds.

Male pedestrians are willing to take more risks than female pedestrians while crossing an intersection. Children and young pedestrians are taking less gaps while crossing roads and their waiting times are also less. The crossing speeds of female and old aged pedestrians are high as compared to male pedestrians and children. The critical gap that needed to cross the road varies inversely with the width of the road. With increase in width of the road, pedestrian crossing speed also increases. Installation of a new traffic signal at an intersection increases waiting times and decreases the crossing speeds of pedestrians. Installation of a traffic signal reduces the jaywalking behavior of pedestrian. Installation of lighting facility improves the pedestrian crossing behavior at an intersection during night time. Pedestrian feels safe and pleasant in city center environment due to less traffic and feels unsafe to cross the road in commercial zones and city outskirts due to presence of high traffic flows.

### IV. CONCLUSIONS

- A. A pedestrian crossing time at an intersection, when oblique crossing is adopted varies between 4 seconds to 10 seconds.
- B. Crossing speeds of male pedestrians varies as 1.85 m/s and for female pedestrians varies as 1.67 m/s.
- C. On an average 22% of pedestrians are reluctant to use recently constructed facility for road crossing.
- D. Risk is a function of gap acceptance and it is represented as  $Risk = f(1/gap\ acceptance)$ .
- E. Critical gap available for pedestrians to cross an intersection varies between 5.9 seconds and 7.62 seconds.
- F. Pedestrian waiting times are increased by 52% when a traffic signal is newly installed at a non signalized intersection and crossing speeds are reduced by 23%.

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