

## Study of Pedestrian Flow/ Behavior on Indian Roads

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**ABSTRACT:** Pedestrians are one of the most vulnerable entities of the transportation system. Most of the developments that have taken place are directed towards the improvement of the vehicular network and facilities, but little has been done for the pedestrians. With an increase in the motor vehicular traffic and the corresponding increase in the congestion and increase in the road accidents, the importance for improvement of the pedestrian facilities has assumed great significance. The facilities for such movement can be ramp, stairs or escalators. Pedestrian characteristics need to be studied on these facilities under usually congested flow condition as prevailing in India or other developing countries. This will provide input for the improvement in design of these facilities so that pedestrian movement can be faster, efficient and convenient.

The study/ paper is an effort to gather information about the way the people think for the pedestrian's facilities they are using day to day. It will provide an insight into the people's mind what they think about the facilities and what are the mind blocks for them to discard those facilities leading to accidents.

**Keywords:** Pedestrian safety, behaviour, Transportation.

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### I. INTRODUCTION

Pedestrians include any person walking, running, standing or sitting on a road or persons in a toy vehicle, a pram or in a mobility device not capable of exceeding 10 Km/h. (MUTCD Par 10). It also includes dismounted cyclists. Walking is recommended for a healthy lifestyle. It is also considered to be clear example of sustainable mode of transport especially suitable for urban use and/or relatively shorter distances. Walking is one of the most important travel modes in every country but pedestrians are always neglected in transportation planning and management. Nowadays, with the development of environment friendly and resource saving society, pedestrians are getting more and more attention. Pedestrian spaces are becoming increasingly rare nowadays. The explosive increase in vehicular traffic has relegated the pedestrian to subways and over bridges. A pedestrian is not taken into account in the planning and design of traffic and transportation systems with the importance imparted to vehicular modes of travel. The demand for pedestrian facilities is influenced by a number of factors like the nature of the local community. Walking is more likely to occur in a community that has a high proportion of young people. Car ownership; the availability of the private car reduces the amount of walking, even for short journey. Local land use activities for walking primarily used for short distance trips. Consequently the distance between local origins and destinations (e.g. homes and school, homes and shops) is an important factor influencing the level of demand, particularly for the young and elderly. Quality of provision; if good quality pedestrian facilities are provided, then demand will tend to increase. Safety and security; It is important that pedestrians perceive the facilities to be safe and secure. For pedestrians this means freedom from conflict with motor vehicle, as well as a minimal threat from personal attack and the risk of tripping on uneven surfaces.

#### 1.1 Pedestrian Problems

Pedestrian accidents occur in a variety of ways, the most common type involves pedestrian crossing or entering the street at or between intersections. Some of the other factors are like Darting which is used to indicate the sudden appearance of a pedestrian from behind a vehicle or other sight obstruction. Second in the list is dashing which is referred to the running pedestrians. Next is Age i.e. children under 15 years of age from the largest group of pedestrian victims and have the highest injury rate per population in their age group, the elderly have the highest fatality rate because of the lower probability of their recovery from injuries. Intoxication and Drug effects because of alcohol and drugs impair the behaviour of pedestrians to the extent that they may be a primary cause of accident. Dusk and Darkness, Special pedestrian safety problems arise during the hours of dusk and darkness, when it is most difficult for motorists to see pedestrians.

## **II. REVIEW OF LITERATURE**

Pedestrians are observed to be a major component of the urban traffic accidents. In a very well developed country like the United State of America and Germany and developing country like India, pedestrian deaths and injuries are the major issues. Some of the noteworthy points are:-

- In 1998 total 5220 pedestrians died from traffic related injuries and another 69,000 pedestrians sustained non-fatal injuries in the USA.
- On an average one pedestrian is killed in a traffic crash every 101 minutes.

In India, pedestrian related fatalities accounted for about 8.4% of all motor vehicle related deaths in the year 2006 and around 8906 pedestrians died in accidents. 72% of all pedestrian fatalities in 2003 occurred in urban areas (National Highway Traffic Safety Administration, 2004). In New Delhi, there were 2088 deaths due to road accidents in 2008 and the number of pedestrians among them was 1075 which is 51.48% of the total fatalities.

Pedestrians, bicyclists, and MTW (Motorized Two Wheeler) riders constitute a large proportion of road victims in India compared to those in USA and Japan. Pedestrians, bicyclists and MTW riders, who constitute the vulnerable road users, constitute 60-80% of all traffic fatalities in India (Mohan, 2004). The data show that pedestrians are major victims in road accidents. They constitute about 32% of the total road accidents.

Lee et al (2005) studied walking and travel choice behaviour of pedestrians concerning stairways and escalators in the intercity train station of Den Haag Holland Spoor. With regard to walking behaviour of pedestrians, they focused on deriving traffic characteristics such as free speeds and fundamental diagrams of pedestrian flows. In regard to travel choice behaviour of pedestrians, two types of choice behaviour are discussed the first one considers the selection between available stairways and escalators to facilitate level changes; the second one concerns the choice between walking and standing on the escalators.

Olander and Eves (2011) investigated the impact of elevator availability, pedestrian traffic (number using the elevator and stairs per minute) building occupancy (total individuals in the building) and time of day on stair ascent and descent in a workplace. Stair and elevator choices were monitored by automatic counters every weekday during two phases. In a natural experiment days with four available elevators were compared with days when three elevators were available. The results of the study verified that stair use increased for three elevators compared to four. Increasing building occupancy was associated with increased stair use, whilst increasing pedestrian traffic and time of day was associated with reduced stair use. A follow-up study revealed complimentary effects of building occupancy and time of day on elevator waiting times, indicating that increased stair use by contextual factors reflects increased elevator waiting times. In contrast shorter waiting times are likely when momentary pedestrian traffic is high and later in the day. Crucially, the magnitude of the effects of these contextual factors was ten times larger than previously reported effects of stair climbing interventions. Holland and Hill (2010) collected adult pedestrian accident data which demonstrated that the risk of being killed or seriously injured varies with age and gender. A range of factors affecting road crossing choices of 218 adults aged 17–90+ were examined in a simulation study using filmed real traffic. With increasing age, women were shown to make more unsafe crossing decisions, to leave small safety margins and to become poorer at estimating their walking speed. However, the age effects on all of these were ameliorated by driving experience. Men differed from women in that age was not a major factor in predicting unsafe crossing decisions.

Zhuang and Wu (2011) studied that pedestrian's crossing out of crosswalks (unmarked roadway) contributed to many traffic accidents, but existing pedestrian studies mainly focus on crosswalk crossing in developed countries specifically. Field observation of 254 pedestrians at unmarked roadway in China showed that 65.7% of them did not look for vehicles after arriving at the curb. Those who did look and pay attention to the traffic did so for duration of time that followed an exponential distribution. Pedestrians preferred crossing actively in tentative ways rather than waiting passively. The waiting time at the curb, at the median, and at the roadway all followed exponential distributions. During crossing, all pedestrians looked at the oncoming vehicles. When interacting with these vehicles, 31.9% of them ran and 11.4% stepped backwards. Running pedestrians usually began running at the borderline rather than within the lanes. Pedestrians preferred safe to short paths and they crossed second half of the road with significantly higher speed.

Khatoun, Tiwari and Chatterjee (2013) observed that pedestrians on Delhi roads are often exposed to high risks. This is because the basic needs of pedestrians are not recognized as a part of the urban transport infrastructure improvement projects in Delhi. Rather, an ever increasing number of cars and motorized two-wheelers encourage the construction of large numbers of flyovers/grade separators to facilitate signal free movement for motorized vehicles, exposing pedestrians to greater risk. This paper describes the statistical

analysis of pedestrian risk taking behaviour while crossing the road, before and after the construction of a grade separator at an intersection of Delhi. A significant number of pedestrians are willing to take risks in both before and after situations. The results indicate that absence of signals make pedestrians behave independently, leading to increased variability in their risk taking behaviour. Variability in the speeds of all categories of vehicles has increased after the construction of grade separators. After the construction of the grade separator, the waiting time of pedestrians at the starting point of crossing has increased and the correlation between waiting times and gaps accepted by pedestrians show that after certain time of waiting, pedestrians become impatient and accept smaller gap size to cross the road. A Logistic regression model is fitted by assuming that the probability of road crossing by pedestrians depends on the gap size (s) between pedestrian and conflicting vehicles, sex, age, type of pedestrians (single or in a group) and type of conflicting vehicles. The results of Logistic regression explained that before the construction of the grade separator the probability of road crossing by the pedestrian depends on only the gap size parameter; however after the construction of the grade separator, other parameters become significant in determining pedestrian risk taking behaviour.

### **III. METHODOLOGY AND DATA COLLECTION**

This section of the proposal describes the research design for the study i.e. the various sources of data, sample size, methodology as well as research software. The purpose is to have a clear idea about the research process.

#### **3.1 Source of Data**

Three different data collection techniques were applied during this project. A questionnaire survey was conducted to explore pedestrian satisfaction and safety preferences. An observational survey to obtain supplementary data to quantify pedestrian behaviour was also collected. People from all sections of the society and from all age groups will be selected for the questioning.

Secondly, physical dimensions of various raised pedestrian crosswalk will be checked in Kurukshetra, Ambala and Chandigarh. Physical dimensions, surface texture, incoming slope, outgoing slope, total length etc were noted down. They affect a lot in deciding the pedestrian view towards a pedestrian facility.

Thirdly, a speed study will be done in order to find out the average speed of vehicles in the vicinity of a traffic calming measure. It will be compared with the normal speed of the vehicles.

#### **3.2 Target Sample and Sampling Technique**

The sample size of the study would be 300 from the area of Kurukshetra, Ambala and Chandigarh city. As of now only qualitative aspect of the research is presented but latter it would be extended to quantitative aspect. Factor analysis will be used to find out the important factors leading to pedestrian accidents. Factor analysis would help to study the various significant factors like over speeding, drunken driver, improper sight distance, inadequate lighting etc. Obtaining a factor solution through factor analysis (principal components analysis) is an iterative process that usually requires repeating the SPSS/ E- Views factor analysis procedure a number of times to reach a satisfactory solution. The end result of the factor analysis will tell us which variables can be represented by which components, and which variables should be retained as individual variables because the factor solution does not adequately represent their information. The factor model will be as follows:

$$Y = b_0 + \sum b_i x_i \quad (i=1 \sim n) \quad \dots (A)$$

Where;  $x_1 \sim x_n$  = Factors influencing, given in the questionnaire.

### **IV. RESULTS AND CONCLUSION**

Walking is a significant mode of transport and all human beings are pedestrians for varying time periods on roads, even though motorization is increasing at a rapid pace. Right from the early days - till the person is unable to move, walking remains an important mode of travel. Even people who use cars and motorcycles, depending on their need, walk for shorter or longer distances.

Walking is indeed found to be healthy as it helps in prevention and control of some non-communicable diseases like diabetes, obesity, hypertension, cardiac problems and others. In a country with large population, it is common to see more people walking on roads in both cities and rural areas.

Large number of people including children, elderly, disabled, pregnant mothers and others use roads regularly. When large numbers of such people use roads, the environment and operating vehicles need to be safe, so that pedestrians are not injured and killed. In recent years, pedestrian safety has assumed greater importance as reports indicate that pedestrians are the single largest category of those injured and killed in road crashes in India

In Delhi, the government has made significant investments for the construction of flyovers, i.e., grade-separated intersections, to increase speeds of motorized vehicles, to reduce vehicular delays, and to make signal-free, arterial roads. With the construction of flyovers, pedestrian-crossing problems arise. To solve these problems, the construction of many pedestrian subways, i.e., underpasses and foot over-bridges, i.e., overpasses has occurred. However, the usage and effectiveness of pedestrian subways and foot over-bridges is poor. Understanding the problems that pedestrian's face and why pedestrians are reluctant to use subways and foot over-bridges would ultimately improve the usage and effectiveness of these pedestrian facilities.

The whole study was an effort to gather information about the way the people think for the pedestrian's facilities they are using day to day. It will provide an insight into the people's mind what they think about the facilities and what are the mind blocks for them to discard those facilities leading to accidents.

#### **4.1 Results for Foot Over Bridge in Ambala and Kurukshetra**

Total 91 pedestrians filled the questionnaires in foot over bridge in Ambala Kurukshetra, 63 were male and 28 female. Out of 91, 10 persons are disabled. Around 63% pedestrians voted for foot over bridge. Most of them commented yes for providing lightening at night. Fear of dark is one of the factors causing women not using stairs. Females feel more secure in light. It was observed by some people that old age people will get help by lightening as they have less visibility. Almost 50% voted for ramp and rest staircase. If a close look at the performance is taken, it is observed that the persons in the age group less than 50 recommended for staircase being physically fit. Around 78% of persons used the facility 1-2 times in a day.

Lift facility is convenient to every person of all ages. Even handicapped person also will be benefitted. Most of the people said that if the lift facility is provided, then it should be limited to physically handicapped persons or diseased persons only 69% voted for providing this facility. 14 out of 91 represented unsatisfactory behaviour. When asked why, they were mainly concerned with the lift facility and cleanliness. 52 persons gave satisfactory answer and 25 were fully satisfied. 54 out of 91 commented for the increase in width of stairs. They said that with the increase in the width, there will be less chances of collision of passengers. 58 out of 91 voted for providing sitting arrangement. 73 persons out of 91 commented that cover facility should be provided for rain and sunlight. From this study, it is observed that the lightening facility should be provided in the Kurukshetra railway station. In addition, width of stairs must be increased at both the stations. One ramp at the ascent and descent also needs to be provided. Lift facility, if provided will enhance the chances of use of foot over bridge multifold.

#### **4.2 Results of underbridge in Chandigarh**

Total of 51 pedestrians filled the questionnaire, 44 were male and 7 female. From 51 respondents, 2 people were disabled. 29 out of 51 voted for underbridge. Around 43% voted for foot overbridge. All the females observed that lightening will lead to more women using the subway in night rather than crossing the road.

People in the age group of more than 50 voted for ramp as their health does not allow them to frequently use stairs and they get exhausted. They said that being provided with lift or escalator, almost none will cross the road and all will use subway. It is convenient to every person of all ages. Even handicapped person also will be benefitted. Only 2 out of 51 represented unsatisfactory behaviour. When asked why, they were mainly concerned with the lift facility and cleanliness. 35 persons gave satisfactory answer and 14 were fully satisfied.

35 out of 51 commented for the increase in width of stairs. 39 out of 51 said for providing sitting arrangement. As in Chandigarh, a dome is provided in between to create as much natural condition as possible. From this study, it was observed that sufficient lightening will aggravate the use of under bridge. Major emphasis is to be given on cleanliness and providing lift/escalator facility. Another major emphasis needs to be given on providing sitting arrangement. Majority of them felt the need for this. It is observed that pedestrian spaces need to be architecturally designed and properly fitted out. People want to be able to avail themselves of all kinds of amenities in pedestrian spaces. The aim of introducing amenities is to create external spaces in which a pedestrian can feel at ease. Simple sitting area with chairs, benches or steps where one can have a break is an important element of pedestrian spaces.

Lighting apart from being a source of illumination is an important design element. The shape of fixtures, type of light (direct, diffused or dimmed), the quantum and colour of lighting characterizes the visual quality of a pedestrian space.

## V. RECOMMENDATIONS FOR FUTURE STUDY

A qualitative assessment needs to be conducted which could highlight factors, such as Safety, Security, Comfort, Convenience, and Attractiveness etc. These environmental factors can greatly influence the pedestrians' perceptions of the overall quality of facility. These factors can be analysed in finer detail and an evaluation and grading method can be devised to assess the street. Indian cities were built for walking and cycling. However, rapid motorization combined with limited attention to pedestrian facilities has inadvertently resulted in a decrease in the overall mode share for non-motorized transport. Strategies must be incorporated in order for people to reclaim the urban environment overrun by motor vehicles. Policies and investments provide an impetus to transform Indian cities, encourage pedestrianization and allow people to enjoy better mobility and quality of life.

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