Research paper on Pedestrian Crossing Behaviour between Normal Traffic Conditions

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Abstract: Chandigarh is one of the most densely populated cities of the India. Here huge pedestrian gather in roads, junctions and intersections. At presents pedestrian crossing is one of the greatest challenges for the traffic and safety engineering. Present study deals with pedestrian crossing behavior in at intersections and normal traffic roads in Chandigarh city. To carry out the analysis at first number of crossings were collected from CTU and then survey were conducted to find out the existing pedestrian crossing facilities at near about 46 signalized intersections in Chandigarh city. The study reveals that in Chandigarh city area the generalized situation of pedestrian facilities are very poor. It signifies that about 60% intersections have no visible cross marking and about 57% intersections have no foot over bridges and underpasses.

Six important intersections will be selected to count the amount of pedestrian crossing at peak period namely, Tribune chowk, old Airport Chowk, hello majra chowk,32 medical chowk, gurudwara chowk, kisan bhawan chowk, and doordarshan chowk etc. In this survey, direction wise amount of pedestrian crossing, number of pedestrian crossing with foot and number of legal and illegal crossing were collected. In some crossings at grade crossing becomes very risky because of its high traffic volume and high vehicle speed. But pedestrians always prefer at grade crossing for this reason at grade pedestrian crossing facilities should be improved by different type of latest technologies.

Keywords: Vehicles, Pedestrian, Crossing, Safety and Intersection

Introduction

Pedestrian movement as well as pedestrian crossing at intersection is very important thing for the pedestrian safety and intersection capacity analysis. At busy intersections motorists, cyclists, and pedestrians often have to deal with complex situations and be aware of the position, movement and intent of other users. Mixed traffic of motor vehicles and pedestrians are common in urban intersections. Efficiency of intersections greatly affects the entire network performance.

A pedestrian crossing or crosswalk is a designated point on a road at which some means are employed to assist pedestrians wishing to cross. Some times for improving pedestrian safety and intersection capacity, pedestrians are segregated from the way of motor vehicles by overpasses and underpasses. But Pedestrian chooses the shortest route for crossing the roadway and they want to minimize travel time. Pedestrian also have a basic resistance to change grades when crossing the roadways. They do not voluntarily make use of special pedestrian facilities such as overpasses and underpasses because they need easy way. In Chandigarh city most of the pedestrian may take risk in crossing the road and they often cross at mid-block instead of using crosswalk.

In this circumstance, such a study regarding Pedestrian Road Crossing Behaviour at Signalized Intersections and normal traffic roads in Chandigarh City will reveal analysis on pedestrian road crossing behavior which will be helpful for future policy formulation regarding efficiency and safety improvement of the crossings.

1.1 Objectives of the Study and possible Outcome

This study will be aimed for achieving the following objectives:

- To study the pedestrian crossing facilities at crossings in Chandigarh City.
- To study pedestrian movement pattern at some selected crossings in Chandigarh City
- To identify the problems associated with pedestrian crossing at intersection
- To evaluate the necessity of exclusive pedestrian phase at signalized intersection.

This study will reveal problems and prospects of pedestrian movement pattern at intersections and foot over bridge of Chandigarh City. It will make a clear clarification how to incorporate pedestrian issues in traffic engineering and transport management. In the long run this study will formulate policy guidelines how to incorporate pedestrian issues in future transportation planning and decision making.

Methodology and Study Data

3.1.1 Primary Data Collection

Manual and video recording methods of data collection have been applied in this study. Information has been collected about the basic parameters considered by the study. There are more than 60 signalized intersections in Chandigarh city but my research is for 7 intersections. Many intersections were surveyed for lack of timing to identify the existing pedestrian crossing facilities. Some important un-signalized intersections were surveyed for the same cause which is controlled by traffic police. Pedestrian facilities in 60 intersections have been manually surveyed to know the generalized situation of the intersections of Chandigarh city.

The names of more than 60 intersections were collected from Chandigarh City Corporation. As the population of Chandigarh city is very high huge pedestrian gather in most of the intersections of Chandigarh city. For the lack of timing it could not possible to count pedestrian crossing behavior at every signalized intersections of Chandigarh city.

Six important intersections were selected to count the amount of crossing at peak hours (8:00 a.m to 10:00 a.m and 5:00 p.m to 6:00 p.m) namely Tribune chowk, old Airport Chowk, Hello majra chowk, 32 medical chowk, Gurudwara chowk, and kisan bhawan chowk etc. Although they are signalized intersections but most of them are not operated by traffic signal timing at peak period, they are only operated by traffic signal timing by off peak period and in peak period they are operated by one or more traffic police. In these survey direction wise amount of pedestrian crossing, number of pedestrian crossing with foot and number of legal and illegal crossing were surveyed. Here legal crossing means crossing with signal and grade separated crossing and illegal crossing means crossing without signal and risky crossing. Pedestrian crossing behavior were also observed at 6 selected intersections namely Tribune chowk, old Airport Chowk, Hello majra chowk, 32 medical chowk, Gurudwara chowk, and kisan bhawan chowk etc. which consist of pedestrian for educational institutions and important public buildings.

Peak hour Traffic Volume Survey were conducted by manually in 6 selected intersections at morning peak period from 8:00 a.m. to 10:00 p.m and evening peak period from 5:00 p.m to 6:00 p.m for the necessity of achieving the objective of considering exclusive pedestrian phasing.

Pedestrian Crossing Behavior 4.1 Introduction

Pedestrian may be defined as those human traffic who are supposed to walk as a part of his movement and to use the facilities such as foot over bridge, zebra crossing, underpass, footpath etc at any stage of their travel in order to accomplish their activities. All road users are pedestrians at some stage of each journey and some are pedestrians the whole time (**Waresh**, **2001**).

4.2 Pedestrian as one of the dominant Mode of Transport

There is a wide variety of transport modes available in Chandigarh city. Walking is a commonly used mode of transport in Chandigarh. The proportion of trips made by walking is substantial and for some people, walking is a matter of choice and convenience. However, the reality is that for many people, walking is a matter of economic necessity (STP, 2005). Beside the pedestrians, other means of travel are four wheel, three wheel, two wheels and others etc. Fig: 4.1 shows about 53% mode of transport is walking.

Percentage of different Modal Vehicles of Chandigarh City



Fig: 4.1 Percentage of different Modal Vehicles of Chandigarh City.

Although walking mode is high, most of cases pedestrian do not get proper facilities to cross the road .The Fig: 4.1 show the pedestrian crossing is difficult in a mixed mode zone.

Despite a high preponderance of walking, suitable pedestrian facilities have been neglected and have, in most cases, only been added as an afterthought to road improvements. It has been estimated that there are only about 620 kilometers of footpath within the Chandigarh area. Where footpaths have been built, there are frequent obstructions that block or otherwise reduce their overall usefulness. Such obstructions include: -

- > Temporary vender stations and hawkers who occupy portions of the footpaths.
- Parked cars.
- Solid Waste skips.

> Building materials and debris that are stored or abandoned on the footpath; and Holes, surface irregularities and water accumulation.

4.3 Category of Intersections in Chandigarh City

In order to identify junctions where priority should be shifted to pedestrians it is necessary to understand the crossing behavior of pedestrians and their perceptions of different crossing types (Hao, Xu et all 2005). Manual methods of data collection have been applied in this study. Information has been collected about the basic parameters considered by the study. Pedestrian facilities in 6 intersections have been manually surveyed to know the generalized situation of the intersections of Chandigarh city.

In the field of road transport, an intersection is a road junction where two or more roads either meet or cross at grade (they are at the same level). Such a road junction may also be called a crossroads. Some may classify intersections as 3-way, 4-way etc. depending on the number of road segments (arms) that come together at the intersection. A junction between three road segments (arms) is a circular junction (two arms form one road) or a cross-junction. 4-way intersections are the most common. In Chandigarh city area the study reveals that about a half of the intersections nearly 26% are junction type and followed by 76% as 4-way.

4.4 Presence of Cross Marking

A pedestrian crossing or crosswalk is a designated point on a road at which some means are employed to assist pedestrians wishing to cross. They are designed to keep pedestrians together where they can be seen by motorists, and where they can cross most safely across the flow of vehicular traffic. Pedestrian crossings are found at intersections, and also be at other points on busy roads .They are generally also installed common where large numbers of pedestrians are attempting to cross (such as in shopping areas) or where vulnerable road users (such as school children) regularly cross etc. In Chandigarh city area the study reveals that about 32% intersections have no cross marking and cross marking are present about 50% intersections.

4.5 Pedestrian crossing behavior

Urban traffic movement pattern has a relationship with the existing urban land use pattern. Existing theories relating patterns of pedestrian and vehicular movement to urban form characterize the problem in terms of flows to and from 'attractor' land uses (UCL, 1999). Land use is a critical component affecting pedestrian behavior; creating an environment where pedestrians are comfortable will maintain a higher pedestrian mode share (**Mehndiratta, S. et all 2010**). So surrounding land use of the selected intersections has been analyzed. Pedestrian crossing behavior in 6 intersections namely Tribune chowk, old Airport Chowk, Hello majra chowk, 32 medical chowk, Gurudwara chowk, and kisan bhawan chowk were surveyed which consist of pedestrian traffic volume and direction wise pedestrian crossing. It is suggested that the configuration of the urban grid itself is the main generator of patterns of movement. In the study it has been found that intensity and movement pattern of traffic especially pedestrian flows varies due to category of surrounding land uses of the selected intersections described below:

4.5.1 Crossing Behavior at Tribune chowk:

Crossing behavior of the pedestrians depend on psychological characteristics as age, gender, awareness level of the pedestrians as well as modal characteristics, vehicular speed, presence foot over bridge and overall traffic management pattern prevailing in respective intersection. In Tribune chowk, it is mostly found that the pedestrians are intended to form a group to cross the road where vehicle speed is comparatively higher. Such types of crossing behavior were identified in tribune intersection which is much popularized intersections. Table 4.1 shows the form of single crossing and double (two person together) crossing were 29.49% and 10.76% respectively. The reason of higher rate of cordon is considered as high vehicular speed.

Type of Crossing	No. of Pedestrian	Persentage (%)
Single	2150	29.49
Double	785	10.76
Group	4355	59.73
Total	7290	100

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4.5.3 Crossing Behavior at Hello majra chowk:

This type of crossing behavior is classified in three categories for analysis. Some pedestrians run quickly in mid block section. A group of them are noticed to cross diagonally which type of crossing poses higher probability of fatal accidents at any time. In Hello majra intersection it was found to use crossing by 85% of them where they were noticed to use midblock by 6.67% of them. About 8.33% of them are noticed to follow very risky diagonal crossing which is shown in the following.

4.5.4 Crossing Behaviour at 32 medical chowk:

This Intersection is one of the important nodes in transportation network of Chandigarh metropolitan area. Huge no. of pedestrian traffic is generated in and around it. As it is located at the important location connected hospital areas, there is found huge illegally crossing pedestrian traffic in this intersection. This study reveals that a total number of 4235 pedestrian traffic generated in and around this intersection. The survey was conducted at peak period of 9:00 am to 10:00 am and 5.00 to 6.00 pm along all the direction of this Intersection. The four corners of the intersection are shown 1,2,3,4 for directional flow analysis of the pedestrians. Pedestrian traffic volume per hour of eight direction of this intersection is presented in the following Fig: 4.3. The figure is drawn considering the intensity of traffic volume. The traffic volume showing in the figure include both legal and illegal pedestrian crossing.

4.5.5 **Gurudwara Intersection**

It is another important intersection under the urban arterial system. A lot of pedestrian traffic generated in and around Gurudwara chowk. As it is located at the important location surrounding Chandigarh University, Eden college, Azimpur, Lalbag residential area, Govt staff quarters, Bangladesh University of Engineering and Technology (BUET) and so on. Huge pedestrian traffic is generated and destinated this area. But unfortunately pedestrian traffic route network has not been well developed. Pedestrian traffic volume per hour of eight direction of this intersection is presented in the following Fig 4.18. The figure is drawn considering the intensity of traffic volume

4.5.2 Crossing Behavior at old Airport Chowk:

The pedestrians are noticed to walk normally represented by 86.90% where they are noticed to run quickly by 13.10% which is shown in the following Table 4.2. Such type of crossing by running is highly risky and any fatal injuries or deceased may be happened any time.

Type of Crossing	No. Of Pedestrain	Percentage (%)
Single	1463	44.03
Double	736	22.15
Group	1123	33.8
Total	3322	100

Table 4.2: Percentage of Crossin	ng by Single, double and grou	ups at old Airport Chowk Inte	ersection per Hour.
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Evaluation of Exclusive Pedestrian Phase

5.1 Introduction

An Exclusive Pedestrian Phase which is known as a pedestrian scramble is a pedestrian crossing system that stops all vehicular traffic and allows pedestrians to cross an intersection in every direction, including diagonally, at the same time. It is also known as a 'X' Crossing in Chandigarh.

5.2 **Global Perspectives**

Pedestrian scramble phasing is also commonly referred to as "exclusive pedestrian phase", "pedestrian cross-cross", "scramble lights", "scatter lights", "scramble corners" and "Barnes Dance". The last mentioned terminology is named after Henry Barnes, the prominent traffic engineer, who is credited to be the first to use the system in Kansas City (Kansas) and Vancouver (Washington) and then later in Denver (Colorado), Baltimore (Maryland) and New York City (New York). The terminology came from an article written by a reporter who stated "Barnes had made the people so happy they're dancing in the streets" (Bissessar, R. et all, 2010). It was first used in Canada and the United States in the late 1940's and has since then been adopted in many other cities and countries. Though it fell out of favour with traffic engineers in some countries for a while as it prioritizes pedestrians higher (and thus more than cars, in some situations), the understanding of the benefits in terms of pedestrian amenity and safety have led to new examples being installed in many countries in recent years. The most famous implementation of this kind of intersection is present in Shibuya, Tokyo.

In a typical situation, signal design requirements include development of a phase plan & sequence, determination of cycle length, allocation of effective green time or green split, establishment of yellow and all red for each phase, checking pedestrian crossing requirements (Mannering, Fred L. et all 2007). Here phase can be defined as part of cycle allocated to any combination of traffic movements receiving the right of way simultaneously during one or more interval. Cycle length is the total time for signal to complete one cycle.

An exclusive 'scramble crossing' or 'barnes dance' phase can allow pedestrians to cross safely on the diagonal, minimizing their overall travel distance while eliminating vehicle conflicts, but at the expense of extra pedestrian and vehicle delay. The safety benefits will diminish to the extent that extra delays result in non-compliance. The pedestrian phase can be advanced to give pedestrians an early start (and hence position them where drivers are more likely to notice and give way). The turning needs of large vehicles can be catered for in a pedestrian friendly way by providing appropriate slip lanes.

5.5.2 Performance measures: Performance measures are parameters used to evaluate the effectiveness of the design. There are many parameters involved to evaluate the effectiveness of the design and most common of these include delay, queuing, and stops. Delay is a measure that most directly relates the driver's experience. It describes the amount of time that is consumed while traversing the intersection. The Figure 5.5 shows a plot of distance versus time for the progress of one vehicle.



Fig: 5.1 Illustration of delay measures

The desired path of the vehicle as well as the actual progress of the vehicle is shown. There are three types of delay as shown in the figure. They are stopped delay, approach delay and control delay. Stopped time delay includes only the time at which the vehicle is actually stopped waiting at the red signal. It starts when the vehicle reaches a full stop, and ends when the vehicle begins to accelerate. Approach delay includes the stopped time as well as the time lost due to acceleration and deceleration. It is measured as the time differential between the actual path of the vehicle, and path had there been green signal. Control delay is measured as the difference between the time taken for crossing the intersection and time taken to traverse the same section, had been no intersection. For a signalized intersection, it is measured at the stop-line as the vehicle enters the intersection. Among various types of delays, stopped delay is easy to derive and often used as a performance indicator and will be discussed.

Exclusive pedestrian phase (also "pedestrian scramble" or "Barnes' Dance") as shown in the above Figures an exclusive pedestrian phase dedicates an additional phase for the exclusive use of all pedestrians. This additional phase is configured such that no vehicular movements are served concurrently with pedestrian traffic. During this phase, pedestrians can cross any of the intersection legs and may even be allowed to cross the intersection in a diagonal path. This type of phasing has an advantage of reducing conflicts between right-turning vehicles and pedestrians, but it comes at a penalty of reduced vehicular capacity and longer cycle lengths (which increases delay to all users).

Conclusion and Recommendations

6.1 Conclusion

Generalized situations of pedestrian facilities are very poor in Chandigarh city. The study reveals that there is absence of visible cross marking in 60%, foot over bridge in 65%, Refuge Island in 75%. The situation may be overcome by providing more pedestrian facilities in the intersections of Chandigarh city.

After studied some generalized intersections illegal and unsafe crossing is found in most of the intersections which is induced to face any fatal accident any time. Illegal crossings are found by the pedestrian of 16% at Gurudwara chowk, 23% at Tribune chowk, 28% at old Airport Chowk, 12% at Hello majra chowk,19% at 32 medical chowk, and 21% at kisan bhawan chowk. This situation symbolized very chaotic situation. The situation must be over come by introducing strong imposition to use foot over bridge and cross marking. Awareness generation is needed among pedestrian vehicle users citizens and all the concerned stake holders about safe road crossing and pedestrian safety. Scramble pedestrian phase is a tool of safe pedestrian crossing which is successfully being used in different cities of the world. In Chandigarh city it can be introduced in pilot basis in some selective intersections where pedestrian traffic volume is high. This Study proposed exclusive pedestrian phase at some intersections in Chandigarh city and signal designed has been hypothetically modeled incorporating EPP in two intersections of Chandigarh city.

Pedestrian crossing behavior depends on the destination, age, education, physical condition and overall awareness of the pedestrian. The issues associated with pedestrian crossing activities generally create considerable emotional concern within the community, especially when the community is reacting to an incident involving pedestrian injury. Pedestrian crossing safety relies on the judgment exercised by pedestrians and drivers. To interact safely requires an exchange of information between the pedestrian and the motorist. Although traffic control devices can help to promote an exchange of information, educating pedestrians and drivers is paramount to providing for a safe operation. Provision of visible cross marking must be installed in all the intersections. Considering the high density of pedestrian traffic all over the city, it should be provided to ensure safe pedestrian crossing. Median island with median barrier must be provided in all the intersections to ensure safe pedestrian crossing. Street lighting around the crossing should be adequate so that cross marks are easily captured by the vehicle drivers to have stopping sight distance to avoid collision. Management of existing physical infrastructure must be enhanced to enable more effective use of crosswalks. It is provided with better road markings, signs, traffic signals, canalization at intersections, turn restrictions and separation barriers, space for bus stops, and parking or waiting areas for public transport vehicles (buses, rickshaws, auto-rickshaws, taxis, etc.). Pedestrian crossing should be considered carefully in traffic engineering and planning of the intersections and mid blocks.

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