

A study on conduct of pedestrians along walkways

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Abstract: The name 'pedestrian' in layman language or commonly used is a name given to a person who walks rather than travelling in a vehicle. In other words, we can say that a person who is travelling on foot, no matter whether running or walking or jogging may be termed as a pedestrian. The word has been derived from a Latin word 'pedester' which means going on foot. Most urban roads possess notable pedestrian crossings. Some bridges are constructed solely for pedestrian movement; those bridges are known as footbridges. Due to increase and expansion in population, because of more developments in health and allied sectors, pedestrian movement has increased fore-fold in the subsequent years. According to researchers conducted across Asia and Africa, African people have more walking trips as compared to their Asian counterparts.

1.1 History

Human stirring and action has been greatly attributed to walking. The first of its kind human beings travelled large distances through walking mode. They tramped, patrolled and wandered across continents on foot. Since the advent of 20th century, the craze of this sport drops drastically due to lack of interest of public, but still in vogue in certain countries. The only difference is that it no longer catches the crowd as it used to be in the 18th century. Dave Kunst became the 1st person to roam around the world in 1974.

1.2 Why to study pedestrian behaviour

The paths allocated and allotted to pedestrians for use are called as foot-paths, in some countries side – walks. The bridge which is only meant for pedestrian use is known as foot- Bridge. Sometimes on some places of importance foot over bridges are constructed for pedestrian safety. They study pedestrian behaviour because:

1. Pedestrians are the most vulnerable and unprotected road user group or class.
2. Above 20% of accident victims on roads are the poor pedestrians, in India more than the global percentage.
3. Usually pedestrian crashes occur at crossings

1.3 Objective of current investigation

Pedestrian walking speed naturally varies with age of pedestrian, whether male or females and better facilities provided. Pedestrian walking speed is more on wide-sidewalk and less on sidewalks having less width. Male pedestrians walking speed is more in comparison with female pedestrians walking speed. Keeping in mind the above lines, the objectives of current study are as under:

1. To relate various pedestrian parameters like speed, density.
2. Study of pedestrian characteristics
3. Comparisons of unidirectional flows with fundamental diagrams.
4. To study different levels of service, in order to provide better facilities for pedestrians

2.1 Introduction

Two types of experiments are to be conducted. The first kind is to establish contact and influence of gender based on speed, flow and density of pedestrians. The study will result in basis/ fundamental diagrams. Many researchers have been working on the said subject but this area needs extensive and vast studies.

2.2 Experiments on impact of pedestrian gender on pedestrian characteristics

In this particular part of the work investigations were carried out in Amritsar city to find out the fundamental diagrams along the sidewalks. It may be pointed out that the similar types of research have been taken place before this in other parts of the country and the world abroad.

2.3 Data Collection

Data collection is a tedious job regarding this and the same was collected at three places viz: putligarh chowk, hall gate entrance and near railway station.

Data collection on these places will be on both sides.

Fig 1 shows section of putligarh chowk where unidirectional data was collected. The first location in Amritsar city was having section length 3 meters and width of section as 1.8 meters. the camera was adjusted at a distance of 2 meters from the interior of section under consideration. On the tripod stand is the camera fixed.



Fig: 1 location 1 pultigarh chowk



Fig: 2: location 2 near Hall Gate Amritsar

2.4 DATA DECODING

After completion of data collection data will be decoded by me. First calculate how many number of pedestrians cross the section after that note down pedestrian entering time and pedestrian exit time after that calculate each pedestrian speeds using bellow equation.

$$u_p = \frac{L_o}{T_{in} - T_{out}}$$

Where

u_p = pedestrian speed, l_o = observation length of site, t_{in} = pedestrian entry time,

t_{out} = pedestrian exit time, $t_{in} - t_{out}$ = pedestrian crossing time. Units of pedestrian speed = m/sec.

Number of pedestrians cross the section in a particular time period is called pedestrian flow, now flow will be calculated minute wise in each section.

Pedestrian flow, $q = \frac{n}{t}$

Units of pedestrian flow = ped/sec (or) ped/min.

Units of pedestrian density = ped/m². (ped/m for meter width.)

Where n = number of pedestrians present in the section, l_o = length of observed section. The pedestrians' density has calculated another process that is using bellow equation.

$$q = u * k$$

In this section next have been calculating pedestrian distance head way, this is the inverse of pedestrian density. The pedestrian distance head way or pedestrian space is known as the average space provided for each pedestrian with in the walk way section.

Distance head way = 1/density

Units of distance headway/ pedestrian space = m²/ped.

Capacity is the maximum number of pedestrians cross the section in a unit of time after that flow will be decreased with increased density of pedestrian with in the walk way. In this study capacity has calculated using flow-density diagram, in this diagram consider peak of the curve after that take a corresponding value of flow, the corresponding flow is called the capacity of this section.

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These pedestrian characteristics will be used to classify LOS of each section in various aspects like speed/average space/ (V/C). The Z-test is a method in which we select samples to learn more about characteristics in a given population is called "hypothesis testing". Hypothesis testing is really a systematic way to test claims or ideas about a group or population.

3. Four parameters to hypothesis testing:

State the hypothesis: total pedestrians at any locations mean (μ_1) is equal to some sample mean (μ_2) at that same location ($\mu_1 = \mu_2$)

we can use null hypothesis (H_0), if null hypothesis is wrong at that time we can use alternative hypothesis (H_a/H_1). Alternative hypothesis (H_1) will come in these three cases there is $\mu_1 \neq \mu_2$; $\mu_1 > \mu_2$; $\mu_1 < \mu_2$.

Formulate a study scheme: to state criteria for decision, we state the “level of significance” for a test. Probability of obtaining a statistic measured in a sample if the value stated in the null hypothesis were true. The criteria or level of significance is typically set at 5%. When the probability of obtaining a sample mean is less than 5% if the null hypothesis were true.

4. Experiments on impact of pedestrian flow direction on pedestrian characteristics.

This is the second experiment was conducted in this study; the study was how pedestrian characteristics will be changed in Uni-directional flow. In this study first of all bi-directional flow data was already collected from three locations, putlighar chowk, hall gate road and station road in Amritsar city. Uni-directional flow data will be collected from putlighar chowk section. In this study after completed data collection have found pedestrian speed, flow, density and their relationships. After completion of pedestrian characteristics have been drawing fundamental diagrams for Uni-directional flow after that to find capacities of Uni-directional flow, using the above data have found pedestrian distance head way after that draw the fundamental diagram between distance head way to speed, using this fundamental diagram have been calculated slope and intercept of these lines.

5. Simulation

It has three parts, 1st part deals with study on free flow speed, the 2nd part deals with the various fundamental diagrams, and the third part deals with the LOS assigned to the sections under study.

5.1 Study on free flow speed

In this thesis pedestrian free flow speed will be calculated in different locations in Amritsar city. The free flow speeds will be

- Mean speed of total pedestrians at **location (Putlighar Gali Towards Khalsa College)** is 1.17m/s, mean speed of male pedestrians at location 1 is 1.24m/s and mean speed of female pedestrians is 1.09m/s.
- Mean speed of total pedestrians at **location (Putlighar Gali Towards Main Road)** is 1.24m/s, mean speed of male pedestrians at this location is 1.34m/s and mean speed of female pedestrians at this location is 1.14m/s.

5 NOTE; the above two locations have not been incorporated graphically because they have a little variation. our main of these studies is to show that how a pedestrian obstruction can vary the speeds and other parameters of pedestrians

- Mean speed of total pedestrians at **Putlighar chowk** is 1.30m/s, mean speed of male pedestrians at this section is 1.40m/s; mean speed of female pedestrians at this location is 1.21m/s.
- Mean speed of total pedestrians at **Hall gate** is 1.24m/s, mean speed of male pedestrians at this section is 1.27m/s, mean speed of female pedestrians at this location is 1.20m/s.

Pedestrian speed will be more at **putlighar chowk** after that Hall gate. In Amritsar maximum mean speed of total pedestrians is 1.30m/s. Minimum mean speed of female pedestrians is 1.17m/s and maximum mean speed of male pedestrian is 1.40m/s at

Putlighar chowk.

5.1 Study on comparison of pedestrian speeds using hypothesis test.

Hypothesis test was conducted to show the pedestrian speed comparisons between different combinations in above three locations in Amritsar In this study first hypothesis test was done to illustrate the pedestrian speed difference between male and female in above all three sections. The combinations was male and female pedestrians at section1 (m1&f1), same as section2 and section3 (m2&f2; m3&f3), male pedestrian speeds between different sections (m1&m2; m2&m3; m3&m1), female pedestrian speeds between different sections (f1&f2; f2&f3; f3&f1), total male speeds in all three locations and total female speeds in all three locations (M&F), all pedestrian speeds between these three locations (section1§ion2; section2§ion3; section3§ion1).

Table: 1 Z test results for all the above three conditions

Location	Gender	Mean Speed (m/s)	Standard Deviation (m/s)	Z-Test Result
Putlighar Gali Towards Khalsa College	Male	1.24	0.15	0.05
	Female	1.09	0.12	0.05
Putlighar Gali Towards Main Road	Male	1.34	0.18	0.05
	Female	1.14	0.14	0.05
Putlighar chowk	Male	1.40	0.20	0.05
	Female	1.21	0.16	0.05
Hall gate	Male	1.27	0.17	0.05
	Female	1.20	0.15	0.05

Table: 2 A Random Sample chosen from location 1. The speeds are in m/s.

Male pedestrian speeds	Female pedestrian speeds
1.50	1.18
1.52	1.29
1.27	1.09
1.22	1.21
1.43	1.24
1.29	1.20
1.21	1.16
1.70	1.41
1.26	1.21
1.60	1.30
1.31	1.26
1.41	1.11
1.59	1.16
1.31	1.21
TOTAL= 19.62	TOTAL= 17.83

6. Study of fundamental diagrams

6.1 Comparison of male and female pedestrian speeds

Below shall be given three fundamental diagrams in which there is comparison of male and female pedestrian speeds at locations 1, 2, and 3

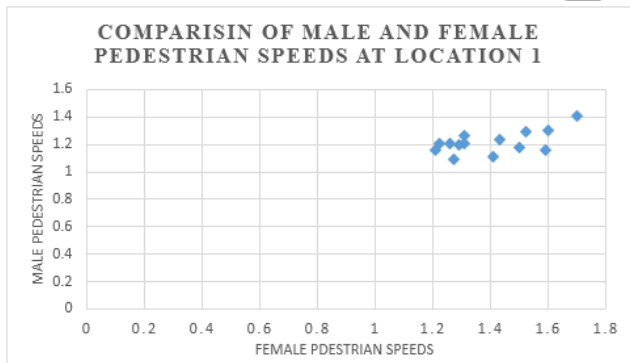


Fig: 3 Comparison of male and female pedestrian speeds at location 1

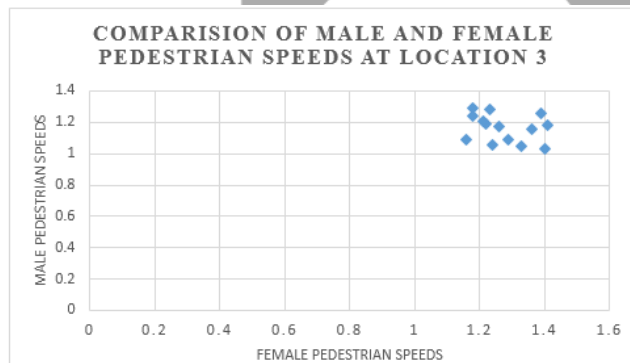


Fig: 4 Comparison of male and female pedestrian speeds at location 2

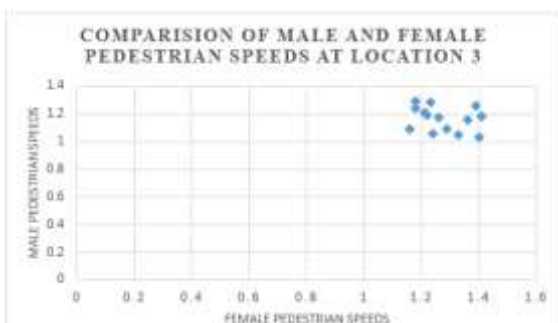


Fig: 5 Comparison of male and female pedestrian speeds at location 3

It has been observed from the above three fundamental diagrams of pedestrian speeds that male and female pedestrian speeds vary from location to location. Highest male as well female pedestrian speed was observed at location 1. The average male pedestrian speed at location 1 was 1.40 m/s and average female pedestrian speed was found to be 1.21 m/s.

7. comparison of pedestrian flow with male and female pedestrian speeds.

The following fundamental diagrams represent the relationship between pedestrian flow and pedestrian speeds at various locations, in our case it is location 1, 2 and 3. Pedestrian flow can be calculated simply from density and pedestrian speeds. Pedestrian flow is represented by q and is given as the product of densities and pedestrian speeds at intervals. The units of pedestrian flow are ped/sec or in ours case it is ped/min

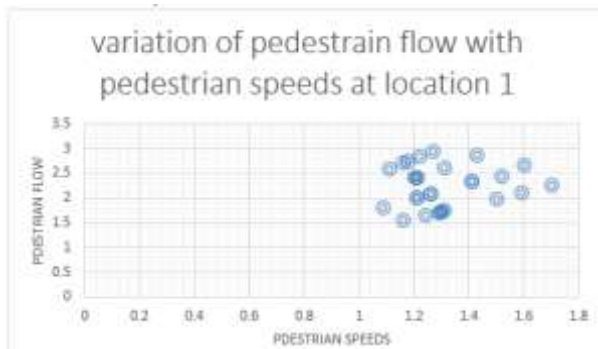


Fig 6 Comparison of pedestrian flow with pedestrian speeds at location 1

8. Comparison of pedestrian distance headway with pedestrian speeds.

The following graphs shall establish a relation between pedestrian distance headway and pedestrian speeds.

Pedestrian distance headway is defined as the average space provided for each pedestrian within the walk way section. It is the inverse of density of pedestrians

Distance head way= $1/\text{density}$

Units of distance headway/ pedestrian space = m^2/ped .

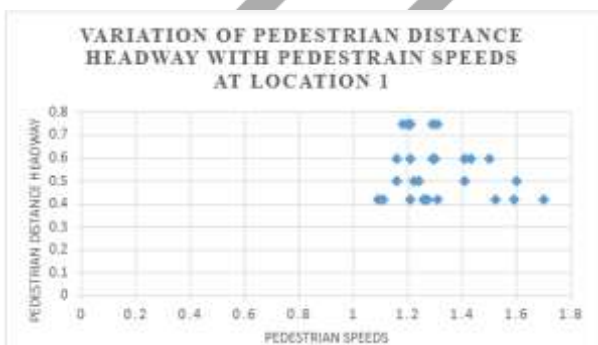


Fig 7 Comparison of pedestrian distance headway with pedestrian speeds at location 1

9. Study on capacity and level of service

Pedestrian capacity and level of service have been explained by using above fundamental diagrams. From the density verses flow diagram, we have able to find capacity of pedestrian flow in these three locations represented above.

Capacity of pedestrians at location 1 is 28ped/min. maximum density at location 1 is 1.8ped/m.

- Capacity of pedestrians at location 2 is **30ped/min**. maximum density at location 2 is 1.6ped/m.
- Capacity of pedestrians at location is **36ped/min**. maximum density at location 3 is 0.85ped/m.

From above three locations capacity will be more in the third section and capacity will be less in the first section. After calculating capacity, level of service is a main criterion for design of better facility, because have been calculating level of service in different aspects.

10 CONCLUSIONS AND FUTURE SCOPE

In this thesis, three experiments were conducted on pedestrian sidewalks at putligarh chowk , hall gate chowk and at railway station road to show the pedestrian flow behavior along sidewalks and also pedestrian characteristics variation in terms of gender and different facility. Hypothesis test also conducted for calculating comparison of pedestrian speeds of different combinations. In this study we have calculated comparison of pedestrian fundamental diagrams between uni-directional flow. In the study experimental set-up will be select the section after that put a tripod perpendicular direction to the section with some distance from edge of the

section, after that video camera will be placed above the tripod, next will take video of sometime interval. This video will be decoded after that calculates fundamental relations and hypothesis test also conducted for comparison of pedestrian speeds.

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