ANALYSIS OF PEDESTRIAN PERCEPTION TOWARDS PEDESTRIAN FACILITIES

RANKAVAT Shalini, Research Scholar, Civil Dept, Indian Institute of Technology, Delhi, India
TIWARI Geetam, Professor, Civil Dept, Indian Institute of Technology, Delhi, India
SINGLA Nikita, Student, Civil Dept, Indian Institute of Technology, Delhi, India

ABSTRACT

In urban areas of developing countries, where high rates of urban growth, large poor populations, and high densities prevail and walking is the only option available to a significant portion of the population. In an attempt to manage high speed traffic in the city and safety of pedestrians a large number of pedestrian subways and foot over-bridges have been constructed. However their usage is poor. The objectives of this study are to identify and analyse the factors for underutilization of pedestrian facilities. The paper includes the study of the perceptions of pedestrians and the attributes to which they give priority. Perception is a key component of the relationship between the environment and its user because it is the perception rather than the environment per se that affects behaviour.

A survey was undertaken at seven sites to assess the pedestrian perceptions in Delhi. The survey locations were selected based on different pedestrian facilities available, which consisted of zebra crossing, subway and foot over-bridge. Five hundred pedestrians responded to this survey.. The data were analysed to know safety and convenience perspective of pedestrians with respect to a specific facility.

The results indicate that usage of footpaths, subways, zebra crossing and foot over-bridge decreases with increase in age. It was also found that usage of zebra crossing tends to increase with the increase in convenience perspective of the pedestrians. Results also show that female respondents find the state of street lighting less adequate as compared to their male counterparts. Also, it is seen that majority of the people do not find it safe to walk in Delhi with the present state of street lighting.

The findings can be used to recommend design improvements for the pedestrian environment.

Keywords: Pedestrian Safety, pedestrian perception, built environment

INTRODUCTION

The goal of a transportation system is to provide safe and efficient mobility and access to different modes of travel to a wide variety of travellers with diverse needs. Walking is the most basic form of transportation, and it is important for city planners and designers to provide facilities that enhance safe movement for pedestrians along roads and streets. An individual's transportation needs, and his or her ability to meet them, are likely to vary not only according to the physical roadway environment, but also according to their socioeconomic situations and the proximity of potential attractors. Neighbourhoods have their own specific patterns of transportation and travellers within those neighbourhoods may be subject to different risks than encountered in other areas.

Walkability of a community may be conceptualized as the extent to which characteristics of the built environment and land use may or may not be conducive to residents in the area walking for either leisure, exercise or recreation, to access services, or to travel to work (Eva et al, 2007). There are many definitions and ways to consider "walkability". It can be simply defined as the overall support for pedestrian travel in an area. Walking, represents a significant proportion of person-miles daily but walking has been a minor mode of travel and little attention is paid by planning authorities (Litman, T.A, 2009).

Increasing urban air pollution stimulates the attention of walking as a green transport mode. Many research studies found that social and physical environmental factors correlate with walking behaviours of the people (Billie et al in 2003, Saelens et al,2003; Sallis et al, 2004).Planning pedestrian environments requires assumptions about how pedestrians will respond to characteristics of the environment as they choose their routes (Zacharias,2001).

Sisiopiku and Akin (2003) found a limited number of studies on pedestrian perceptions and attitudes towards facilities for pedestrians. Among these studies, there was only one study (Tanaboriboon and Jing, 1994) that included some results on pedestrian bridges. The authors noted that in Beijing pedestrians prefer signalised crossing to bridges and underpasses (Tanaboriboon and Jing, 1994). In their study, Sisiopiku and Akin (2003) investigated many crossing types but not foot over bridges for pedestrians. A study by Sharples and Fletcher (2001), dealt with pedestrian perceptions of different road crossing facilities including bridges. The majority of respondents felt that: (a) convenience (easy to use and no time delay), (b) the fact that the crossing was on their route and (c) safety were the reasons for their use of the formal crossing points.

Pedestrian Perception

Convenience and time saving are the most commonly followed perception factors.
Butchart et al., 2000 and Landiset al., 2001 stated that perception may also affect pedestrian crash-risk. Butchart et al. used perception to examine the implications for crash prevention. They find that people believe inadequate signage, inadequate traffic lights and alcohol involvement to be associated with pedestrian crashes and that increased enforcement and traffic calming can help prevent these crashes.
It is very likely, however, that pedestrians would not use bridges, because using a bridge often increases the walking distance compared to level crossing. Already in 1953, Moore (1953) studied the use of pedestrian bridges and underpasses in London and noted tentatively that roughly 80% of pedestrians would use the safe path, if it takes the same time as across the road. Later Moore and Older (1965) showed that no pedestrians used the bridge if the travel time was 1.5 times or higher compared to the travel time at level crossing.

Pedestrian Behaviour

From a safety point of view, most pedestrian injuries tend to occur when people are crossing traffic lanes. Unlike drivers, who have to keep to a certain route, pedestrians are free to move around more. It shows that pedestrians, as users, are not really controlled by regulations, and their behaviour is often unpredictable. About pedestrian attitude towards risk, Holland and Hill (2007) looked at pedestrians' attitudes when faced with danger and sought to explain gender and age-related differences in exposure to risk. By comparing participants' intentions to cross the road in several different situations, they showed that decisions were not taken according to perceived risk, but according to how difficult it was to complete the task. Among these factors it has been found that an important factor – pedestrian perceptions and preference towards facilities are very important factors to be taken care of during planning.

This paper reports the results of pedestrian preferences about the pedestrian facilities, across and along the road, in Delhi, India to understand how built environment could be improved to facilitate pedestrian movement.

METHOD

Site Selection

Pedestrians account for nearly 51% of total fatal accidents in Delhi (Delhi Police, 2009).

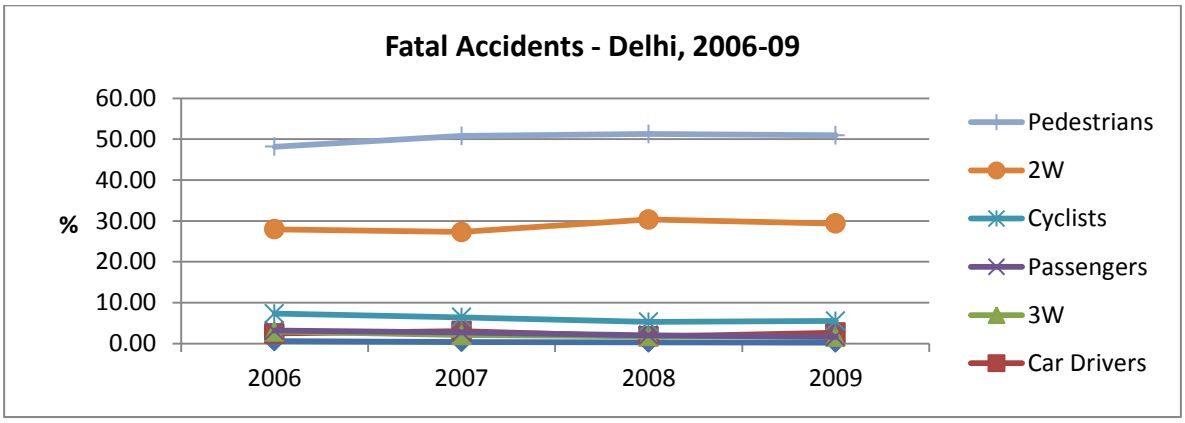

Figure 1 Road Traffic Fatalities in Delhi, 2006-09

Figure 1 shows the share of pedestrian fatalities in Delhi from 2006-09 (Delhi Police, 2009). Such data indicates the absence of adequate pedestrian facilities.

According to National Crime Records Bureau (NCRB) report titled "Accidental Deaths and Suicides in India 2009"), the population growth during the corresponding period was 18.5% whereas the increase in the rate of accidental deaths during the same period was 10.7%. All India average of accident death rate is 30.5% but in Delhi it is 46.7%.
The road network in Delhi is based on notional hierarchy of roads, ranging from arterial roads designed to carry fast through traffic to collector and residential roads. However, pedestrians are present on all roads regardless of the hierarchy and designated functions (Tiwari,2002).

The existing road design does not provide adequate facilities for pedestrians, bicycles, or any other slow moving traffic. Service roads, if present are not maintained well. Footpaths are either not present or poorly maintained.
In this paper two kinds of pedestrian facilities have been analyzed namely “along the road” and “across the road” pedestrian facilities.

Along the Road facilities

There are two kinds of along the road facilities: footpaths and street lighting.

Footpaths
Issues of non-existent or unreasonably narrow footpaths, obstructions on footpaths due to various reasons such as junction boxes, garbage containers, parked vehicles, vendor stalls, broken tiles etc. are of particular concern.

Street Lighting
The issue of street lighting requires due consideration. It affects the pedestrian’s decision of using or not using the footpaths.

Across the road facilities

There are three kinds of across the road facilities: zebra crossing, subways and foot over bridge.

Zebra Crossing
There are times when zebra crossings are occupied by vehicles or vehicles do not stop for pedestrians to cross. This issue needs to be addressed.

Subways
The condition of subways is not up to the mark. They are not in a state, safe enough to be used by pedestrians. Moreover subways have become garbage bins and their maintenance is not taken care of.

Foot over bridge
Overhead bridges are mostly far away from the main locations which the pedestrians need to access the most. These bridges form an important part of the analysis of the pedestrian facilities.

Survey

Seven different kinds of sites were selected based on the different pedestrian facilities available. Respondents for this study were 500 pedestrians. A questionnaire was designed to obtain pedestrian perceptions of crossing facilities, why they had or had not used them. A pilot study was carried out and necessary changes in the questionnaire were made accordingly. Survey was undertaken to assess the pedestrian perceptions in Delhi. It consists of interviewing people to find out their opinion on the pedestrian facilities. The measures were as follows.

Familiarity of the Site and Use of Pedestrian Facilities

Familiarity of the site and area was measured by questions “How often do you use this crossing facility in this location”? Answers were recorded in four-point scale: 1 (“Never”), 2

("Sometimes"), 3 ("Frequently"), 4 ("Always").

Convenience

Respondents' views about convenience of pedestrian facilities were measured by asking them how well the existing facilities were "Easy to use" and "Save time" in scale: 1 ("Never convenient") to 5 ("Always convenient").

Safety Beliefs

Respondents were asked to estimate how well the word "Safe" describes the pedestrian facilities concerned. Again, the response scale was based on condition from safety point of view: 1 ("Poor") to 5 ("Excellent").

Background Variables

In addition to their scores on the variables above, respondents reported their age and sex (1=Male, 2=Female).

The aim of the questionnaire was to know if people in the city are satisfied with the facilities provided across and along the road based upon their safety and convenience point of view, views about street lighting of delhi and also to know how pedestrians rank their conditions from poor to excellent

Data Analysis

The data were analysed to know safety and convenience perspective of pedestrians with respect to a specific facility. The data has been analysed in 2 parts as follows:

Mean Analysis – to know safety vs. convenience perspective of pedestrians and to correlate them with the usage of the respective pedestrian facility.

Ordinal Regression – to interpret the usage of a particular pedestrian facility depending on demographics: Age and Gender, safety and convenience perspective.

Mean Analysis

Mean Analysis of all the pedestrian facilities at all locations have been done using SPSS. In the present study, usage of each pedestrian facility has been taken as the dependent variable and demographics, safety and convenience perspective as the independent variables. This can give a broad idea of the dependence of usage on other variables. Also, safety and convenience perspective can be compared with each other.

Mean analysis for all pedestrian facilities including footpaths, zebra crossing, subways, foot over bridge and street lighting has been done with respect to Age, Gender, Safety and Convenience perspective as shown in Table 1 to Table 6 respectively.

Table 1 Mean analysis of usage of facilities with respect to age

		Use of			
		Foot Paths	Subways	Zebra Crossing	FOB
Age	N	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
<18	63	3.37 (0.707)	3.82 (0.641)	3.34 (0.651)	3.79 (0.977)
18-50	384	3.3 (0.756)	3.59 (0.62)	3.13 (0.769)	3.51 (0.961)
>50	53	2.87 (0.785)*	3.57 (0.602)*	3.09 (1.137)^	3.33 (0.583)*

* Kruskal–Wallis test yields statistically significant with $p < 0.05$
^ Kruskal–Wallis test yields statistically significant with $p < 0.10$

Table 1 shows that the use of footpaths, subways, zebra crossing and foot over bridge (FOB) decreases with increase in age.

Table 2 Mean analysis of usage of facilities with respect to gender

		Use of			
		FootPaths	Subways	Zebra Crossing	FOB
Gender	N	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
1	360	3.26 (0.733)	3.61 (0.505)	3.32 (0.661)	3.58 (0.867)
2	140	3.27 (0.847)	3.39 (0.819)*	2.72 (0.968)*	3.46 (0.955)
Total	500	3.26 (0.766)	3.55 (0.617)	3.15 (0.805)	3.55 (0.893)

* Kruskal–Wallis test yields statistically significant with $p < 0.05$

Table 2 shows that the usage of subways and zebra crossing is less by female respondents. Kruskal–Wallis tests have been conducted to assess whether differences in those mean values of males and females are statistically significant.

Perceptions about state of street lighting were to find out for upgrading its current state. Mean analysis of state of street lighting with respect to gender and safety perspective has been done as shown in Table 3 and 4.

Table 3 Mean analysis of state of street lighting with respect to gender

		State of Street Lighting
Gender	N	Mean (SD)
1	360	2.89 (0.699)
2	140	1.79 (0.869)*
Total	500	2.58 (0.897)

* Kruskal–Wallis test yields statistically significant with $p < 0.05$

Table 4 Mean analysis of state of street lighting with respect to safety condition

Safety Condition	N	State of Street Lighting Mean (SD)
1	105	2.0 (0.877)
2	168	2.68 (0.967)
3	217	2.81 (0.724)
4	10	2.0 (0)
Total	500	2.58 (0.897)

Table 3 shows that given state of street lighting are reported less adequate by female respondents as compared to their male counterparts. Table 4 shows that majority of the people do not find it safe to walk in Delhi with the present state of street lighting.

Table 5 and Table 6 are showing the mean analysis of usage of pedestrian facilities provided across and along the road with respect to safety and convenience conditions respectively.

Table 5 Mean analysis of usage of facilities with respect to safety perspective

Safety condition	Use of					
	Foot Paths		Subways		Zebra Crossing	
	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)
1	40	3.25 (0.870)	20	4 (0)	10	1 (0)
2	117	3.26 (0.700)	70	3.10 (0.980)	110	3.36 (0.483)
3	167	3.06 (0.827)	233	3.64 (0.506)	237	3.21 (0.649)
4	128	3.25 (0.687)	157	3.55 (0.499)	123	2.98 (1.052)
5	48	4 (0)	20	3.5 (0.513)	20	3.5 (0.513)

Table 6 Mean analysis of usage of facilities with respect to convenience perspective

Convenience condition	Use of							
	Foot Paths		Subways		Zebra Crossing			
	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)
1	10	2.60 (0.699)		-	20	2.5 (1.539)	1	-
2	12	3.67 (0.778)	20	2.50 (1.539)	20	2.5 (0.513)	122	3.31 (0.834)
3	114	3.18 (0.707)	130	3.62 (0.488)	120	3.12 (0.769)	198	3.64 (0.848)
4	258	3.40 (0.716)	230	3.50 (0.527)	250	3.25 (0.656)	110	3.45 (0.992)
5	106	3.04 (0.850)	120	3.75 (0.435)	90	3.22 0.921)	69	3.86 (0.845)

Standard deviations (SD) for different response ranges from ~0.4 to ~1.5. High SD was found in two cases - usage of subways & zebra crossing with respect to convenience perspective responses “1” and “2” due to lesser sample size. Sample size was less for the usage of footpaths also but the variance is lower (~20%). Table 6 shows that there is no clear trend between usage of all pedestrian facilities and safety or convenience perspective. To find out the relationship between the usage of all pedestrian facilities and safety, convenience perspective the data was further analysed using ordinal regression method.

Ordinal Regression

Ordinal regression is used for predicting a variable whose value exists on a scale where only the relative ordering between different values is significant. The two most common types of ordinal regression models are ordered logit and ordered probit. Ordinal Logit model has been used in this study.

One of the assumptions underlying ordered logistic regression is that the relationship between each pair of outcome groups is the same. In other words, ordered logistic regression assumes that the coefficients that describe the relationship between the lowest versus all higher categories of the response variable are the same as those that describe the relationship between the next lowest category and all higher categories. This is called the proportional odds assumption or the parallel regression assumption. Because the relationship between all pairs of groups is the same, there is only one set of coefficients (only one model) as shown in Equation (1).

$$Upf = \ln\{p/(1-p)\} = \beta 0 + \beta A * A + \beta G * G + \beta SP * SP + \beta CP * CP \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where-
Upf=Usage of pedestrian facilities (Footpaths, Subways, Zebra Crossing & FOB)
β0 = model constant
βA= parameter estimate for the Age of pedestrians
βG= parameter estimate for the Gender of pedestrians
βSP = parameter estimate for the Safety perspective of pedestrians
βCP = parameter estimate for the Convenience perspective of pedestrians
A = Age of pedestrians
G = Gender of pedestrians
SP = Safety perspective of pedestrians
CP = Convenience perspective of pedestrians
p= the probability of the dependent variable attaining a particular rank

When independent variable x1 increases by one unit, with all other constants remaining constant, the odds{p/ (1−p)} increases by a factor of exp (β).

Such a model is applicable where the dependent variable is discrete – count data, a series of qualitative rankings, and categorical choices are examples. In the present study, the dependent variable is ranked on Likert scale and thus, ordinal logit regression analysis has been used.

Table 7 Analysis of usage of facilities

	Use of			
Dependent Variables →	**FootPaths**	**Subways**	**Zebra Crossing**	**FOB**
Independent Variables ↓	**Estimate (sig)**	**Estimate (sig)**	**Estimate (sig)**	**Estimate (sig**
Age	**-1.372 (0)**	-0.248 (0.514)	**-0.872 (0.04)**	-0.129 (0.764)
Gender	-0.1 (0.611)	-0.369 (0.174)	**-1.552 (0)**	-0.422 (0.169)
Safety Perspective	**0.377 (0)**	-0.146 (0.328)	0.009 (0.957)	-
Convenience Perspectiv	-0.09 (0.382)	**0.399 (0.014)**	**0.297 (0.041)**	**0.306 (0.029)**

In the Parameter Estimates column for footpaths, age and safety perspective are statistically significant (at 95% CI). However, gender and convenience perspective are not statistically significant. So for age, it can be said that for a one unit increase in age (i.e., going from 1 to 2), we expect a 1.372 decrease in the ordered log odds of being in a higher level of use of footpaths, given all of the other variables in the model are held constant. For safety perspective, it can be said that for a one unit increase in safety perspective (i.e., going from 1 to 2), we would expect a 0.377 increase in the log odds of being in a higher level of use of footpaths, given that all of the other variables in the model are held constant. Thus, it is inferred that use of footpaths decreased with increasing age and it increased with increase in safety perspective of pedestrians. Convenience perspective which is statistically significant only to 70% also has a negative relationship indicating a decrease in use of footpaths with increase in convenience perspective, thereby implying a higher influence of safety perspective over convenience perspective.

For the use of subways, convenience perspective is statistically significant. However, age, gender and safety perspective are not statistically significant. Gender variable is approximately 82% significant. For gender, it can be said that for a one unit increase in gender (i.e., going from 1 to 2), we would expect a 0.369 decrease in the log odds of being in a higher level of use of subways, given that all of the other variables in the model are held constant. Thus, it is inferred that there was lesser use of subways by female respondents as compared to their male counterparts and use of subways was positively related with convenience perspective. As the pedestrians perceived subways as more and more convenient, they tend to use it more.

Age, gender and convenience perspective are statistically significant for the use of zebra crossing, while safety perspective is not statistically significant.

Convenience perspective is statistically significant for the use of FOB. However, age and gender are not statistically significant. Gender parameter is approximately 83% significant, implying that there was lesser use of foot over bridge by female respondents as compared to their male counterparts.

CONCLUSIONS

In conclusion, the study showed pedestrian perceptions of pedestrian facilities provided across and along the road. Although pedestrians are probably the most heterogeneous road user group, the study suggests that generally use or non-use of these facilities is a habit and not coincidental behaviour. The results indicate that usage of footpaths, zebra crossing, subways and foot over-bridge decreases with increase in age. This may indicate that risk taking habit decreases with increase in age. Making a safe or unsafe choice is probably a habit by pedestrians, which is supported and reinforced by their beliefs and attitudes (Evans and Norman, 1998). Usage of all crossing facilities across the road is less by female respondents as compared to their male counterparts. It was also found that usage of zebra crossing tends to increase with increase in convenience perspective of the pedestrians. Analysis shows that usage of subways is lesser by female respondents, zebra crossing is

convenient in usage but not safe and usage of the footpaths can be increased by increasing safety. The results indicates that majority of the people do not find it safe to walk in Delhi with the present state of street lighting. So, street lighting should be improved to increase the safety of pedestrians.

The findings can be used to recommend design improvements for the pedestrian environment.

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ANNEXURE

1) Age-

2) Gender (By observation) – Male Female

3) How frequently do you use footpaths?

4: Always	3: Mostly	2: Sometimes	1: Never

4) How do you rank the condition of footpaths in Delhi from safety point of view?

5: Excellent	4	3	2	1: Poor

5) Do you find it convenient to use footpaths in Delhi?

5: Always	4	3	2	1: Not at all

6) Do you find proper street lighting on the roads you take in Delhi?

4: Always	3: Mostly	2: Sometimes	1: Never

7) Given the present state of street lighting, do you find it safe to walk in Delhi?

5: Absolutely	4	3	2	1: Not at all

8) How frequently do you use Subways?

4: Always	3: Mostly	2: Sometimes	1: Never

9) How do you rank the condition of subways in Delhi from safety point of view?

5: Excellent	4	3	2	1: Poor

10) Do you find it convenient to use subways in Delhi?

5: Always	4	3	2	1: Not at all

11) How frequently do you use zebra crossing?

4: Always	3: Mostly	2: Sometimes	1: Never

12) How do you rank the condition of zebra crossing in Delhi from safety point of view?

5: Excellent	4	3	2	1: Poor

13) Do you find it convenient to use zebra crossing in Delhi?

5: Always	4	3	2	1: Not at all

14) How frequently do you use foot over bridge?

4: Always	3: Mostly	2: Sometimes	1: Never

15) Do you find it convenient to use foot over bridges in Delhi?

5: Always	4	3	2	1: Not at all

16) Which one of these has the highest impact on safety while walking on Delhi roads?

	5: Highest Impact	4	3	2	1: Least Impact
Street Hawkers					
Parked Vehicles					
Potholes					

17) Which one of these has the highest impact on your convenience while walking on Delhi roads?

	5: Highest Impact	4	3	2	1: Least Impact
Street Hawkers					
Parked Vehicles					
Potholes					