

## **Pedestrian Behavioral Pattern and Preferences in Different Road Crossing Systems of Dhaka City**

**Manik Kumar Saha<sup>1</sup>**  
**Tanjiba Rahman Tishi<sup>2</sup>**  
**Md. Sirajul Islam<sup>3</sup>**  
**Suman Kumar Mitra<sup>4</sup>**

### **Abstract**

As the population of Dhaka City is growing very fast, the sustainable transport policy for Dhaka should strive to retain and expand the modal share of walking trips, which share the majority of all short trips made. But unfortunately, pedestrian facilities may be the most neglected and unattended ones in transport planning of Dhaka city. This paper aims to analyze the effect of demographic factor which shape the behavioral pattern of the pedestrian towards following traffic rule in crossing a road. The paper also illustrates the pedestrian's preferences among different road crossing systems and the underlying factors of preferences through a conduction of 300 questionnaire survey. This paper also focuses on assessing the relative significance of different problems in different types of pedestrian road crossing systems in Dhaka city by Analytical Hierarchy Process (AHP) by means of an expert opinion survey. Finally it presents specific recommendations to ensure safe and efficient pedestrian movement in Dhaka city.

### **Introduction**

Dhaka, the capital of Bangladesh, has now been turned into the 19th mega city of the world in terms of population (Largest cities of the world, 2013). Due to this increasing population, the travel demand is also increasing very rapidly in the city causing enormous pressure on the existing transport infrastructure. As a result traffic congestion, delays, lack of traffic safety, poor pedestrian facility, inadequate and inefficient public transport, inadequate traffic management, conflicts of jurisdiction and poor coordination among agencies are becoming common characteristics of the transport environment of Dhaka City.

While walking is considered as the most sustainable and environment friendly transport mode, the policy makers are giving emphasis on private car, bus and pedestrian in the respective order in transportation planning of Dhaka City due to some incomprehensible reasons. The order should be reverse to minimize the transport problem to some extent. The latest surveys of people's movement in metropolitan Dhaka under Strategic Transport Plan showed walking as one of the predominant mode with a share of 22% of total person trips (STP, 2005). These huge amounts of pedestrian have to cross the road in different places in the road. They have to be given prospect to cross the road with their convenient opportunities.

However in the transport system of Dhaka city, the most vulnerable group is the pedestrian in case of safety issue which can be clearly understood by the data of Accident Research Institute, BUET. Pedestrian involvement in road accident is about 48.55% of all accident occurred during 1998 to

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<sup>1</sup> Young Professional, BRAC. Bachelor of Urban and Regional Planning, BUET. Email: manik.0415009@gmail.com

<sup>2</sup> Bachelor of Urban and Regional Planning, BUET. Email: tanjiba@yahoo.com

<sup>3</sup> Bachelor of Urban and Regional Planning, BUET.

<sup>4</sup> Assistant Professor, Department of Urban and Regional Planning, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh, E-mail: skmitra@uci.edu

2008 in Dhaka city (ARI, 2008). The scenario is much alarming in case of fatal accident where the pedestrian involvement is 73.8% (ARI, 2008). Moreover 50% of total pedestrian accident has been occurred while crossing the road during the above mentioned period (ARI, 2008).

To minimize the pedestrian fatality rate provisions have to be made for safe and efficient movement of pedestrian especially in case of crossing the road. For the improvement of road crossing system, it is necessary to know the considered factor of a pedestrian in crossing the road and their preference towards choosing a particular road crossing system (at grade, underpass and overpass). It is also very important to reveal the significance of different problems faced in different road crossing systems. In this context, this article has been focused to the following major objectives. Firstly, it analyzes the effect of demographic characteristics which shape the behavioral pattern in crossing a road. Secondly, it identifies the pedestrian's preferences among different road crossing systems and the underlying factors of preferences. And finally, it focuses on assessing the relative significance of different problems in different types of pedestrian road crossing systems.

### Literature Review

Numerous researches deal with the behavior and movement of pedestrians at junctions and/or at other crossing locations.

Rosenbloom et al. (2004) applied roadside observations to investigate the differences in pedestrians' behaviour by observing two entirely different urban places in terms of religion. Results showed that young and male pedestrians have a tendency to commit violations. Another study also supports the above results (Bernhoft and Carstensen, 2008) by concluding that older pedestrians appreciate sidewalks and crossing facilities much more than younger pedestrians.

Holland and Hill (2007) tested for age and gender differences in road crossing decisions within a theory of planned behavior analysis including intention, situation and risk perception effects on pedestrian. Another study showed that age differences have significant effects on pedestrian behavior at crosswalks and crossing speed is largely explained by age and gender (Avineria *et al*, 2012: 33).

Rosenbloom *et al.* (2008) studied crossing behavior of children and found that 'not looking' was the most prevalent unsafe behavior, followed by the combination of 'not looking' and 'not stopping', and 'not stopping' before crossing. They also found that children accompanied by an adult committed more unsafe behaviors, especially when not holding hands with the adult.

Another study (Lavalette *et al.* 2009: 1252) was carried out to determine the role that environmental factors play in pedestrians' violation of rules when crossing roads and to establish a hierarchy of these factors which act as constraints upon pedestrians. In some case it found that the rate of violation rises in the absence of crossing signals and in proportion to the number of lanes of traffic. But it is not uniform.

Evans and Norman (1985) developed hierarchical regression models for road crossing behavior, by means of completed questionnaires which included scenarios of three specific potentially dangerous road crossing behaviors. Pedestrians stated crossing behavior was then modeled in relation to measures of attitude, subjective norm, perceived behavioral control, self-identity and intention. Another study suggests that pedestrians waiting times and number of crossing attempts are strongly related (Hameed, 2001: 68). Moreover, in divided roads, pedestrians behave differently from one side to the median, than from median to the other side of the road (Hamed, 2001: 78).

There are few studies on pedestrian behavior in Dhaka City. Rahman *et al.* (2006) tries to measure the level of service (LOS) of walkways in Dhaka city. The study explores the qualitative level of comfort of the pedestrian in Dhaka city by offering six broad categories of roadside walking environment in terms of i) safety ii) security iii) convenience and comfort, iv) continuity of walkways, v) system coherence and vi) attractiveness by some specific facilities. On the other hand it focuses the choice of pedestrian regarding some prescribed criteria as mentioned before only on the walkways of Dhaka city.

The literature shows that lots of studies have been done to model pedestrian behavior in different sections of roadway in different cities of the world. Unfortunately no such study was conducted in Dhaka City which elaborated the behavior and preferences of pedestrian while crossing the road. So there is a knowledge gap in pedestrian behavior and preference at different types of pedestrian crossing (At grade, underpass and overpass) systems of Dhaka City. This study will focus to fulfill these knowledge gaps.

### **Methodology and Data**

There are three types of road crossing systems in Dhaka city. Dhaka City Corporation has 390 kilometers long footpath while it has 1900 kilometers long roads including arterial roads, alleys and lanes. It has a total of 52 foot over-bridges in the city (DNCC, 2013). And there are only four underpasses for pedestrian to cross the road at Gulistan intersection, Gabtoli Bus terminal, Sayedabad (Dhalpur) and Karwan Bazar (DSCC, 2013). Three intersections of three types have been considered as study areas which represent all types of road crossing systems of Dhaka City. The sample crossings are Shahbag Crossing (At Grade), Kawran Bazar Crossing (Underpass) and Newmarket Crossing (Overpass). The basic reason for choosing the above study area is due to their prominent location in the central Dhaka city and these are some of the busiest intersections in terms of pedestrian movement.

Initially 30 pedestrians were surveyed, 10 from each study area during pilot survey. After necessary modification from the feedback of pilot survey, 300 random questionnaire survey has been carried out, 100 from each of the crossing systems. Sample was collected in two categories- (i) pedestrian who obey the rules and (ii) pedestrian who violates the rules. For each of the system, 50 persons were surveyed for each type. From the field survey prominent problems for each system has been identified for expert opinion survey to carry out Analytical Hierarchical Process (AHP) which is one of the Multi Criteria decision making methods that was originally developed and applied by Professor Thomas L. Saaty. In short, it is a method to derive ratio scales from paired comparisons (Saaty, 1980).

### **Results and Discussion**

Impact of Demographic Characteristics in Pedestrian Behavior

#### ***Impact of Sex***

From the field survey, it has been found that, the percentage of women is relatively more than the men in case of using the existing system (At grade, underpass, and overpass). Out of the entire male respondent, 48.90% has been found as the follower of the existing system. On the other hand, 58.80% female respondents obey the rules.

#### ***Impact of Age Structure***

Tendency to obey traffic rules also changes depending on the age group. Young people intend to violate the rules more frequently than the older ones. According to the survey result, most rule violated group is 26-35 years old people (58.2%) whereas less than 15 years old and more than 65 years old people absolutely obey the rules.

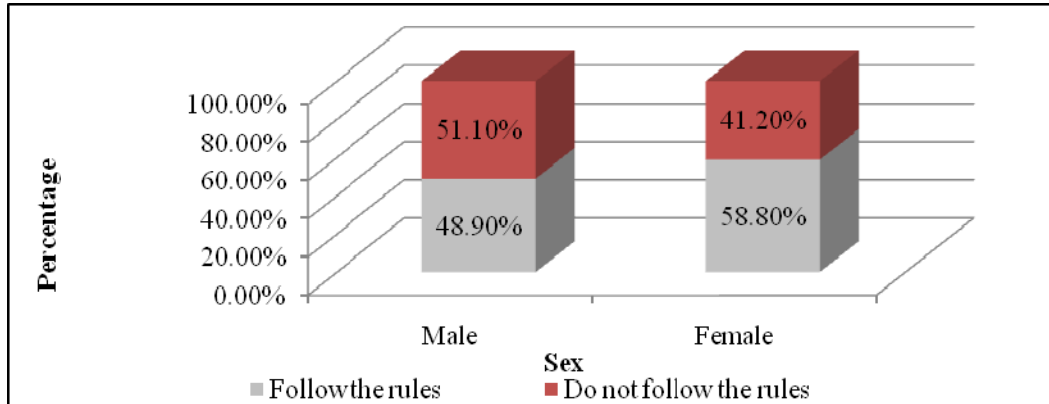


Figure 1: Violation of Existing Rules in Road Crossings According to Sex; Source : Field Survey 2009

**Impact of Occupation**

The tendency of violating traffic rules of road crossing system also varies across occupation. Hawker and small business man tend to violet the rules more where educated persons like teacher obey the rules more. Student and unemployed people have been found as 60% and 75% respectively of the sample, who obey the rules.

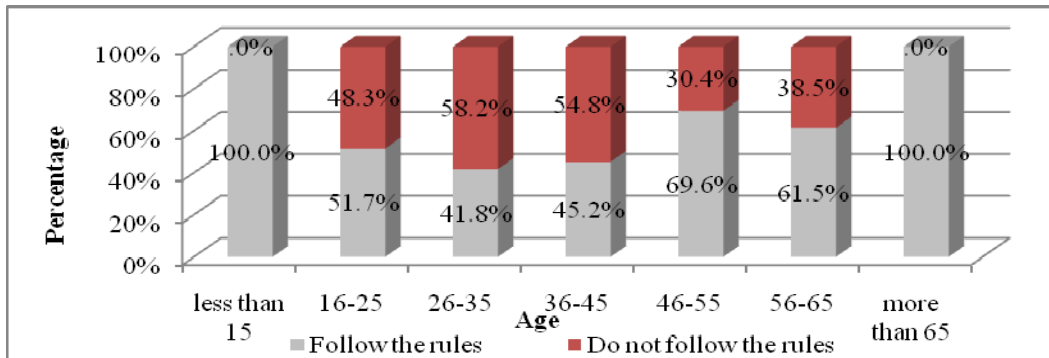


Figure 2: Violation of Existing Rules in Road Crossings According to Age group; Source : Field Survey 2009

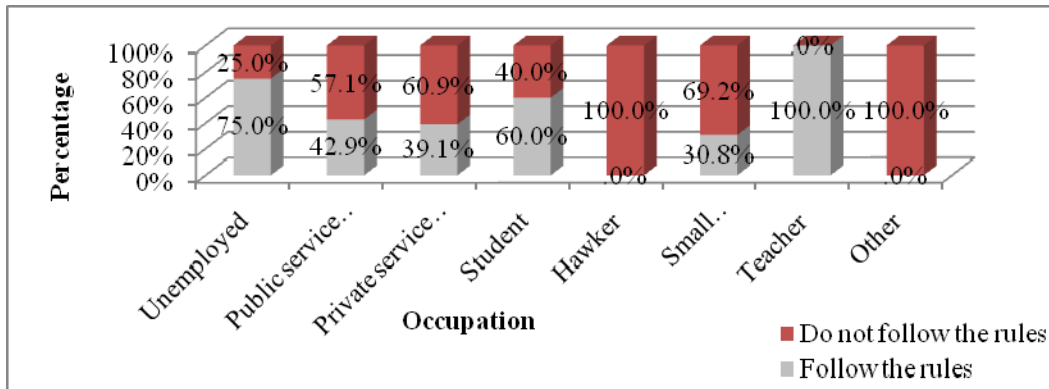


Figure 3: Violation of Existing Rules in Road Crossings According to Occupation; Source: Field Survey 2009

### Pedestrian's Preferences Among Different Crossing Systems

Before finding out the pedestrian's preferences among three types of road crossing systems, it is important to give a look to the factors which pedestrian consider during cross the road.

During the field survey, every pedestrian has mentioned some factors and ranked them on a priority basis and by weighted index method the weighted values of factors have been sum up to have the composite values of the factors. Depending on the composite values, the factors have been ranked in descending order (Table 1) in which safety is the most predominant factor considered by a pedestrian while crossing the road followed by required time.

Table 1: Ranking of the Factors Considered by Pedestrian during Crossing the Road

Priority	Weight Value (A)	Frequency of Factors			Weighted value of factors (A* Frequency of Factors)		
		Safety	Required Time	Comfort and Convenience	Safety	Required Time	Comfort and Convenience
priority 1	3	216	52	10	648	156	30
priority 2	2	45	111	54	90	222	108
priority 3	1	8	48	61	8	48	61
<b>Composite Value of factors</b>					746	426	199
<b>Ranking of the Factors</b>					<b>1<sup>st</sup></b>	<b>2<sup>nd</sup></b>	<b>3<sup>rd</sup></b>

Source: Field Survey, 2009

To find out the preference hierarchy of the pedestrian towards the different crossing systems in Dhaka city, they have been asked to scale the preference level of different crossing systems as Most Preferable, Preferable and Less Preferable. Then again the weighted index method has been used to find out the composite score of a particular crossing type (Table 2).

Table 2: Preference of Pedestrian among Different Types of Road Crossing Systems

Preference Level	Weight Value (A)	Frequency of Crossing Systems			Weighted value of Crossing Systems (A* Frequency of Crossing System)		
		At Grade	Overpass	Underpass	At Grade	Overpass	Underpass
Most Preferable	3	78	147	68	234	441	204
Preferable	2	109	103	70	218	206	140
Less Preferable	1	91	36	131	91	36	131
<b>Composite Value of Crossing Systems</b>					543	683	475
<b>Ranking of the Crossing Systems</b>					<b>2<sup>nd</sup></b>	<b>1<sup>st</sup></b>	<b>3<sup>rd</sup></b>

Source: Field Survey, 2009

#### First Preference-Overpass

As the overpass has been stood in first preference level, it has some positive characteristics which commensurate with figure 4. Safety (41%), security (23%), comfort (21%) and less time consuming (7%) have been identified as the major positive characteristics of overpass. It has been stated earlier (section 3.2) that, safety is the most predominant factor considered by a pedestrian

while crossing the road. And as in overpass crossing safety and security are ensured, it has been set first by the pedestrian.

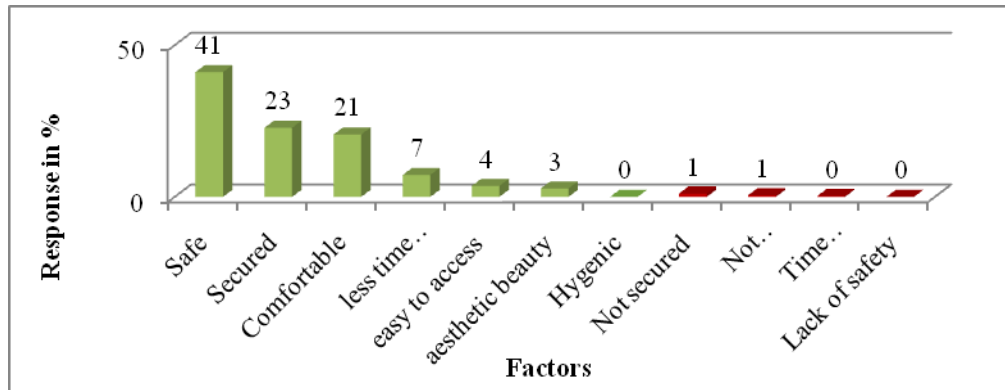


Figure 4: Percentage of Causes for Choosing Overpasses; Source: Author.

**Second Preference-At Grade**

From the composite score of the responses of the pedestrians, it has been found that, the at grade road crossing system is in the second preference level. Comfort (28%), security (12%) are the most prominent positive reasons acknowledged by the respondents (Figure 5). Though these positive factors are similar to the characteristics of overpass, lack of safety (36%) is the reason to be the 2<sup>nd</sup> preference because pedestrian considered safety as their major consideration while crossing the road.

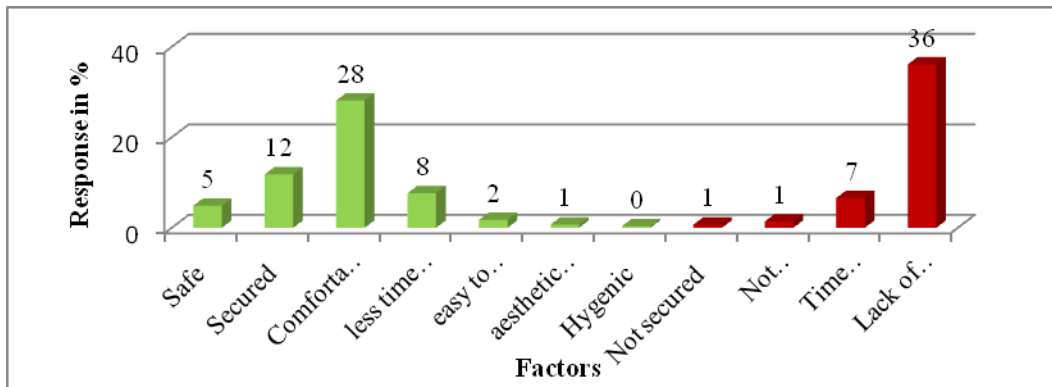


Figure 5: Percentage of Causes for Choosing Zebra/At Grade Crossing; Source: Author.

**Third Preference-Underpass**

Pedestrian considered underpass as the worst road crossing system among three types of road crossing systems of Dhaka city. Here, the most influencing factor is the lack of security (40%) which compel pedestrian for not choosing underpass. Lack of comfort and time consuming are another two reasons that make the underpass as the third preference (Figure 6).

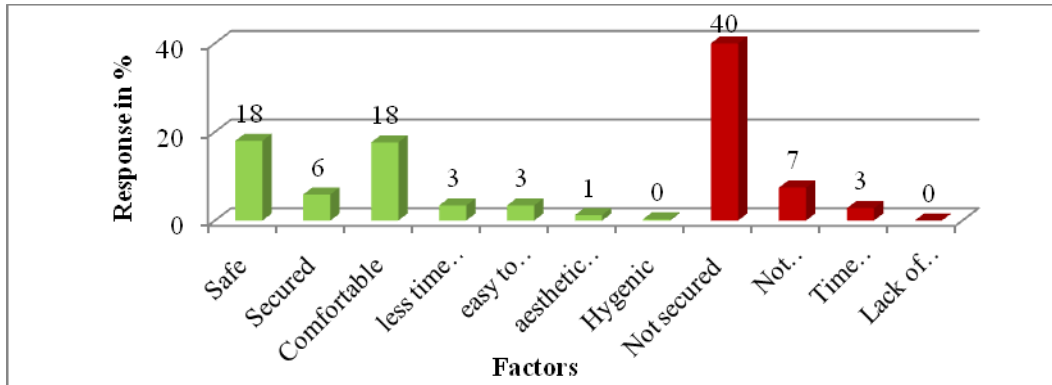


Figure 6: Percentage of Reasons for Choosing Underpass; Source: Author.

**Relative Significance Of Different Problems At Different Road Crossing Systems**

Problems faced by pedestrian in different types of road crossing are not only limited to various forms but also of different magnitudes. So to understand the proper ranking of the various problems it is necessary to have their normalized values. Relative significance of different problems in case of Dhaka city has been revealed by Analytical Hierarchy Process (AHP) with the help of expert opinion.

For the expert opinion survey, the problems have been sorted out from the responses of the field survey. From numerous problems associated with different pedestrian crossing systems, the respondents answer maximum seven problems for each type of crossing system separately on a priority basis. On the basis of this priority, first six problems of each crossing systems have been sorted out separately for the expert opinion by the value of composite score. Composite score of a problem is derived by giving highest weight to the first priority problem and lowest weight to the last priority problem.

**Relative Significance of Different Problems Faced In At Grade Crossing Of Dhaka City**

From the composite score, the first six problems (variables) have been selected for the Expert opinion to apply the AHP (Table 3).

Table 3: Selected Problems of Zebra Crossing of Dhaka City for Expert Opinion

Problems	Composite score
Lack of safety	1241
Too much waiting time	917
Blockage on crossing	679
Violation of rules by drivers	324
Unawareness of pedestrian	321
Absence of sign for pedestrian	286

Source: Field Survey, 2009

From table 3, a log sheet has been produced for the systematic collection opinion from five experts. After that, calculations have been done according to AHP to get the normalized value of problems in case of zebra crossing of Dhaka city for each expert. Finally by averaging the value of five experts the actual normalized value has been derived (Table 4).

Table 4: Normalized Value of Problems Faced in Zebra Crossing of Dhaka City

Problems Experts	Lack of safety	Too much waiting time	Blockage on crossing	Violation of rules by drivers	Unawareness of pedestrian	Absence of sign for pedestrian	Total
Expert 1	0.3890	0.0506	0.1728	0.0870	0.0659	0.2347	1
Expert 2	0.4727	0.0867	0.1122	0.1584	0.1088	0.0611	1
Expert 3	0.4172	0.0716	0.2857	0.0800	0.0355	0.1099	1
Expert 4	0.4456	0.0483	0.1213	0.2253	0.0925	0.0670	1
Expert 5	0.0454	0.2427	0.0358	0.1115	0.4666	0.0980	1
<b>Average</b>	<b>0.3540</b>	<b>0.1000</b>	<b>0.1456</b>	<b>0.1325</b>	<b>0.1539</b>	<b>0.1141</b>	<b>1</b>
<b>Percentage</b>	<b>35.40%</b>	<b>10%</b>	<b>14.56%</b>	<b>13.25%</b>	<b>15.39%</b>	<b>11.41%</b>	<b>100%</b>

Source: Field Survey, 2009

From the aforementioned table it is clear that lack of safety (35.4%) is the major problem faced by the pedestrian while using the zebra crossing to cross the road which has been also mentioned by the pedestrian. Other than safety rest of the problems are at same level to some extent. This normalized value justifies the preference of the pedestrian in which at grade crossing is their second preference mainly due to the lack of safety.

#### **Relative Significance of Different Problems Faced in Underpass Crossing of Dhaka City**

By calculating the composite score the following problems of underpass crossing have been sorted out from seven major problems identified by the pedestrian which have been selected for the expert opinion to apply the AHP (Table 5).

Table 5: Selected Problems of Underpass Crossing of Dhaka City for Expert Opinion

Problems	Composite score
Presence of unwanted people (mugger, pic-pocket etc.)	1027
Lack of security	954
Insufficient light and ventilation	849
Unhygienic	820
Little room for pedestrian to move	603
Extra walking to access the facility	339

Source: Field Survey, 2009

By using the same procedure mentioned in section 3.3.1 normalized value of problems faced in underpass crossing of Dhaka city has been derived (Table 6).



Table 6: Normalized Value of Problems Faced in Underpass Crossing of Dhaka City

Problems Experts	Presence of unwanted people	Lack of security	Insufficient light and ventilation	Unhygienic	Little room for pedestrian to move	Extra walking to access facility	Total
E1	0.0737	0.4410	0.2690	0.1248	0.0456	0.0458	1
E2	0.2024	0.2614	0.2481	0.1582	0.0976	0.0323	1
E3	0.1560	0.3462	0.0947	0.0992	0.0963	0.2076	1
E4	0.1777	0.3376	0.2143	0.1539	0.0752	0.0413	1
E5	0.1748	0.1881	0.2236	0.0386	0.0146	0.3602	1
<b>Average</b>	<b>0.1569</b>	<b>0.3149</b>	<b>0.2099</b>	<b>0.1149</b>	<b>0.0659</b>	<b>0.1375</b>	<b>1</b>
<b>Percentage</b>	<b>15.69%</b>	<b>31.49%</b>	<b>20.99%</b>	<b>11.49%</b>	<b>6.59%</b>	<b>13.75%</b>	<b>100</b>

Source: Field Survey, 2009

According to the experts opinion people face lack of security (31.49%) vigorously in using underpass followed by insufficient light and ventilation (20.99%), extra walking to using the underpass (13.75%) and hygienic problem (11.49%) in Dhaka city. According to the pedestrian, presence of unwanted people is the most intensive problem instead of lack of security which has got the highest normalized value (.3149) from expert opinion. Actually both of the problems are identical as presence of unwanted people is one of the component for which people feel lack of security. If these two problems merge into one, then the result is much more reflective both for the pedestrian and for the experts.

#### **Relative Significance of Different Problems Faced In Overpass Crossing Of Dhaka City**

Following the same manner, from the composite score, first six problems (variables) associated with overpass crossing have been selected for the expert opinion to apply the AHP (Table 7).

Table 7: Selected Problems of Overpass of Dhaka City for Expert Opinion

Problems	Composite score
Presence of unwanted people (mugger, pic-pocket etc.)	922
Uncomfortable for physical trauma	844
Lack of cleanliness and unhygienic	611
Too steep stair	532
Time consuming	473
Extra walking to access the facility	416

Source: Field Survey, 2009

In the next step, using the aforementioned procedure in section 3.3.1 normalized value of problems faced in overpass crossing of Dhaka city has been derived (Table 8).

Table 8: Normalized Value of Problems Faced in Overpass Crossing of Dhaka City

Problems Experts	Presence of unwanted people	Uncomfortable for physical trauma	Lack of cleanliness and unhygienic	Too steep stair	Time consuming	Extra walking to access the facility	Total
E1	0.3281	0.1892	0.1892	0.1476	0.0573	0.0885	1
E2	0.3212	0.1193	0.1404	0.2096	0.1126	0.0970	1
E3	0.1622	0.2241	0.0422	0.2138	0.1583	0.1993	1
E4	0.3315	0.1657	0.1657	0.1657	0.0957	0.0756	1
E5	0.3281	0.1892	0.1892	0.1476	0.0573	0.0885	1
<b>Average</b>	<b>0.2942</b>	<b>0.1775</b>	<b>0.1454</b>	<b>0.1768</b>	<b>0.0962</b>	<b>0.1098</b>	<b>1</b>
<b>Percentage</b>	<b>29.42%</b>	<b>17.75%</b>	<b>14.54%</b>	<b>17.68%</b>	<b>9.62%</b>	<b>10.98%</b>	<b>100</b>

Source: Field Survey, 2009

Table 8 explains that among all the problems, presence of unwanted people is the most significant (29.42%) whereas lack of comfort (17.75%) and steepness of stair (17.68%) are the most prominent problems in case of overpass in Dhaka city which conforms with the hierarchy defined by the pedestrian.

### Recommendation and Conclusion

The main considered factor in crossing a road is the safety followed by security. Among the three road crossing systems (at grade, overpass and underpass), overpass is preferred by most pedestrian followed by at grade and underpass. And the rationales behind pedestrian preference are revealed in this study. Moreover, it has identified some shortcomings associated with the pedestrian crossing systems in Dhaka city and it has acknowledged some positive characteristics of the road crossing systems that influence the pedestrians to use the systems. Based on the previous discussions and analysis some recommendations have been given here.

- Lack of safety is one of the main problems in zebra crossing system. To solve the problem at first the signal system must be maintained properly either by the electronic signal system or manually by the traffic police. Besides people's awareness about the crossing systems have to be increased so that they can be respectful to the rules and regulations. Pedestrian crossing signs have to be provided at intersection and at link depending on the particular situation.
- Though underpass using is relatively a new culture in our country it can be an effective solution in pedestrian road crossing system. To make this system more effective at first the security of the pedestrian must be ensured. Guards must be assigned to provide security to the pedestrian and to maintain the proper use of underpasses. At the same time, it should be properly designed to avoid the water logging inside due to rainfall. Regular maintenance must be ensured as well as sufficient light and ventilation must be ensured.
- It is obvious that rising up to use overpass is difficult for the aged pedestrian and children. So it should be designed carefully with minimum height of the risers so that it can minimize the physical trauma of the pedestrian especially for the children, older and physically

handicapped persons. At the same time, security systems have to be provided to ensure security of the pedestrian after sundown. Proper use of overpasses must be ensured by prohibiting the presence of unwanted people like hawkers. Overhead shed should be given over the overpass to protect the pedestrian from rainfall as well as sun ray. Generally people feel more secured if they can be viewed by others. In Dhaka city, some over passes are curtained by the advertisement banners which create insufficient light as well as a sense of insecurity. So the advertisement banners must be allotted properly so that the views of pedestrian are not interrupted.

In Dhaka city, highest percentages of trips are made on foot. But the pedestrian hardly get any importance in formulating transport policies. As a result, the pedestrian have become the most vulnerable group. They are mostly the victims of fatal road accidents in Dhaka city. Though some pedestrians are following the existing system they are facing so many problems in using the recommended system. These problems include mainly lack of safety, lack of security, lack of comfort and convenience, lack of cleanliness etc. Moreover there is lack of awareness among the pedestrians and the drivers. At the same time, the authority is not so strict to maintain and manage the system properly. And day by day, all these negligence are contributing more and more to the deterioration of the existing systems. So the identified problems and the preference should be considered while proposing a new road crossing system whether it is zebra crossing, underpass crossing or overpass crossing. And the pedestrian issue should be integrated into the transport planning process to ensure safe, secure and convenient pedestrian movement in Dhaka city.

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