

1. Design and Safety of Pedestrian Facilities in Dhaka City, Bangladesh

東京大学大学院工学系研究科都市工学専攻 37051 Khan Rubayet Rahaman

Abstract

A comfortable environment makes a journey by foot pleasant and enjoyable. However, in Dhaka city, about 60% trips are making on foot everyday but the pedestrians are facing many problems while using the walkways. A lot of research works are going on for assessing the pedestrian's level of services in the developed nations but in developing countries like Bangladesh, it is not a significant one for the transport planners. For instance, this paper tries to emphasize the problems of pedestrians and to explore the qualitative level of comfort of the pedestrians in Dhaka City by offering a method. Six broad categories have been observed during the field survey to assess the roadside walking environment in terms of i) safety, ii) security, iii) convenience and comfort, iv) continuity of the walkway, v) system coherence and vi) attractiveness by some specific facilities.

1. Introduction

Dhaka is a metropolis of 1528 square kilometers (BBS report, 1998). Population density in Dhaka is over 10,000 per square kilometer in the city area. Being the capital, Dhaka is one of the least motorized cities in the world. Number of all vehicles per 100,000 population is only 2,630 vehicles, among them 2,195 are non-motorized vehicles (Manna Md. Shafiqul, Karim Md. Masud, Current State of the Mobility of the Urban Dwellers in Greater Dhaka, Proceedings of 94th Annual Conference of Air and Waste Management Association, June 24-28, 2001, Orlando, Florida, The USA). It is observed that rickshaws and other NMT (Non-Motorized Transports) account for 50% or more of the overall traffic flow on roads. After pedestrians, the rickshaw is the most preferred mode of transport in Dhaka. About 60% of trips are on foot while almost half of the remaining trips are on non-motorized vehicles (Shafiqul and Mannan et. al). Though urbanites of Dhaka are depending highly on foot, any significant improvement of the walkways did not notice for the last decade. After the devastating flood in 1988, some road improvement projects have been taken by the government which was the major significant improvement for the walkways. Besides, walkers are the most vulnerable users of the road space but lack of safety promotions or measures also offer the walkers very dangerous situation. For example, discontinuation of the walkway alignment provides inconvenience for the older walkers and lack of separation of the walkways from the road-space offers threat to accident for the school going children. As a result, to know the level of service (LOS) of the walkers is an important part so that the policy makers or the transport planners can understand the extent of problems that the pedestrians are facing in their daily life. Transportation plans no longer focus solely on roadway solutions. In the quest for improved quality of life, researchers now strive for livable communities. A common theme of any livable community is its pedestrian and bicycle friendliness (Carry Comprehensive Transportation plan, pp. 3-1). This research is an attempt for emphasizing the pedestrian's problems in Dhaka City as well as quantifying the LOS of the walkways. For instance, city dwellers can depend more on foot to save their money and time as well as it will surely increase the fitness of health at the same time.

2. Objectives of the research

There are 3 specific objectives of this study. Those are as:

- To explore the existing problems that encountered for safe and convenient pedestrian movements in Dhaka City;
- To examine the level of services with some parameters to show the extent of the problems in qualitative aspect; and
- To recommend policies and options for better pedestrian facilities of Dhaka City.

The first objective explores the existing problems of the pedestrians in the study area after careful reviewing of some related literatures and through field survey and interviewing with the stakeholders. It relates the investigation of the walkways of Dhaka City and to know the present status at the same time. After reviewing the problems, the criteria and sub-criteria for assessing the LOS could be possible. For instance, the second objective is a continuation of the first one to know the LOS of the walkways with some prescribed criteria and sub-criteria. This will help understand the situation of the walkways in depth as well as the walkers views have been reflected for the present service facilities. Lastly, the recommendations or some policies have been cited so that the situation can be uplifted by using the same resources with better design or with through better management.

3. Questionnaire survey and field investigation

Questionnaire surveys have been conducted to get the information of walkers' qualitative assessment of different services as well as for socio-economic information. On the other hand, observation surveys have been conducted to get the real information in Dhaka city so that it can relate with the subjective evaluation from the pedestrians.

Table 1, Summary of Questionnaire Survey

Questionnaire Survey	Year of Survey	Purpose	Sample Size
Survey 1	January 2004	Socio-Economic data Collection from the walkers	500
Survey 2	March 2005	Evaluation of the criteria from the walkers	500
Survey 3	Same time	Preferences of some prescribed criteria from the walkers	500

This table shows the different time segments of questionnaire survey to get the primary data.

Figure 1 shows the field survey procedure. Both sides of the roads, there were surveyors who were asking some information to the pedestrians. All the pedestrians did not feel interest to answer the questions. If the selected person did not answer the questions then the next person had been surveyed. Survey was conducted 3 times a day (morning peak, off peak in the noon and evening peak time segments).

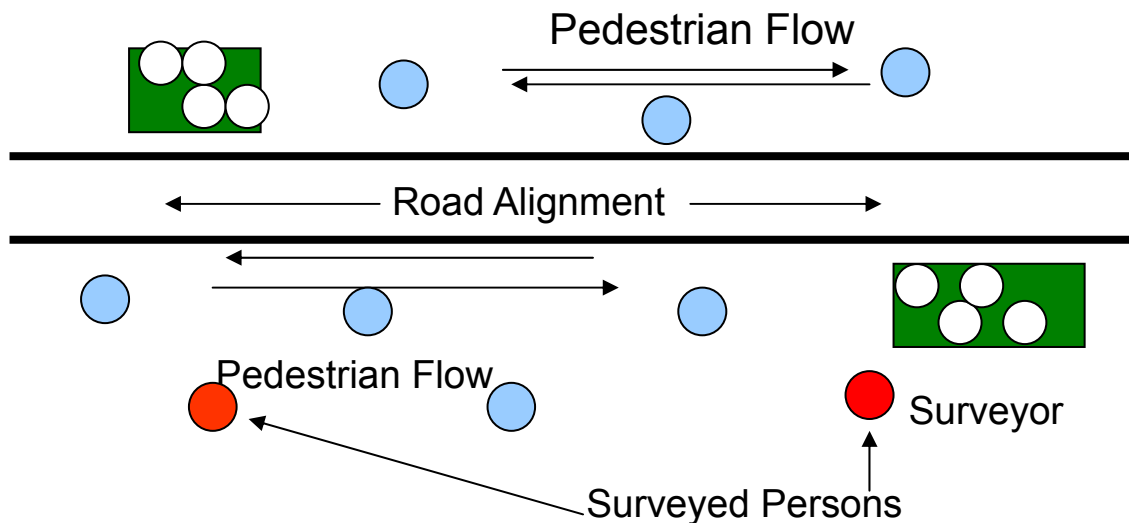


Figure 1, Procedure of Survey of questionnaires in the field during survey

4. Study Area

Dhaka, the capital of Bangladesh, has been selected as the study area for this research. Five different blocks have been selected too to get different information and Level-of-Services on the walkways. Farmgate, one of the major junctions of Dhaka City is considered as a major commercial and transit block in this study. The other blocks are: New Market: one of the major shopping areas, Motijheel: the CBD or the central business district, Malibagh: the residential and shopping mix, lastly, Mohakhali: the major transit area. Problems are also different in the respective blocks which have been included in the research work.

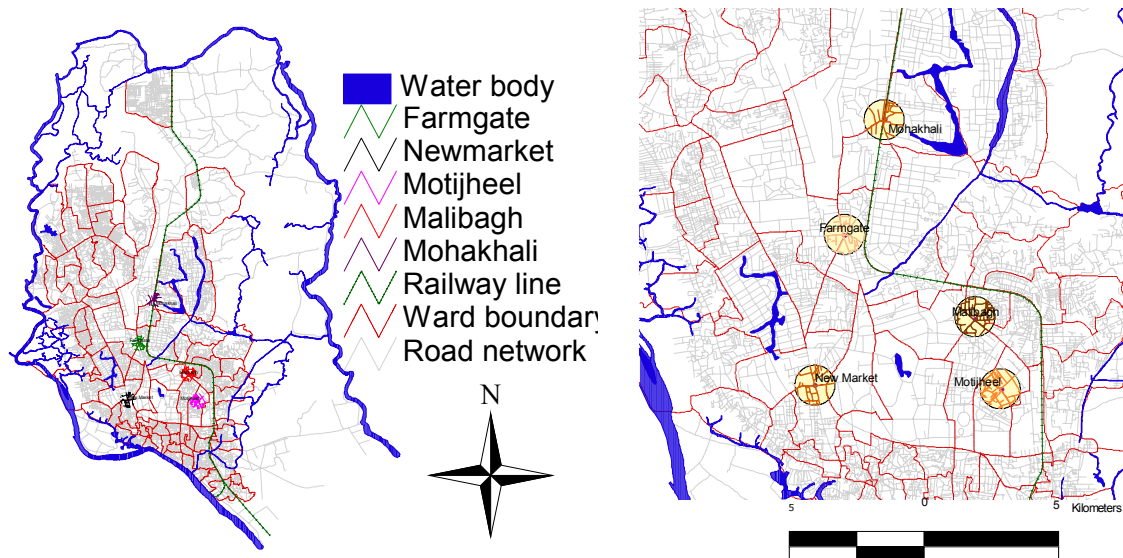


Figure 2, Map of Dhaka City Area

5. Roads and Walkways in Dhaka City

In general, total right of way of major roads in 5 studied areas is 120 feet (width). 120 feet is allocated for

walkway (about 20 feet), carriage way (about 90 feet), median (3 feet) and the rest is for further expansion. The property line is used to allow 3 to 4 feet width for any further expansion of the roads or the walkways. For instance, the City authority called DCC has the right to take this 3 to 4 feet place from both the sides of the walkways when it is needed to make further expansions or to use this place for any other temporary or permanent matters. For example, placing the dustbins or placing the card phone booths can be in place if the DCC wants to introduce to the urbanites.

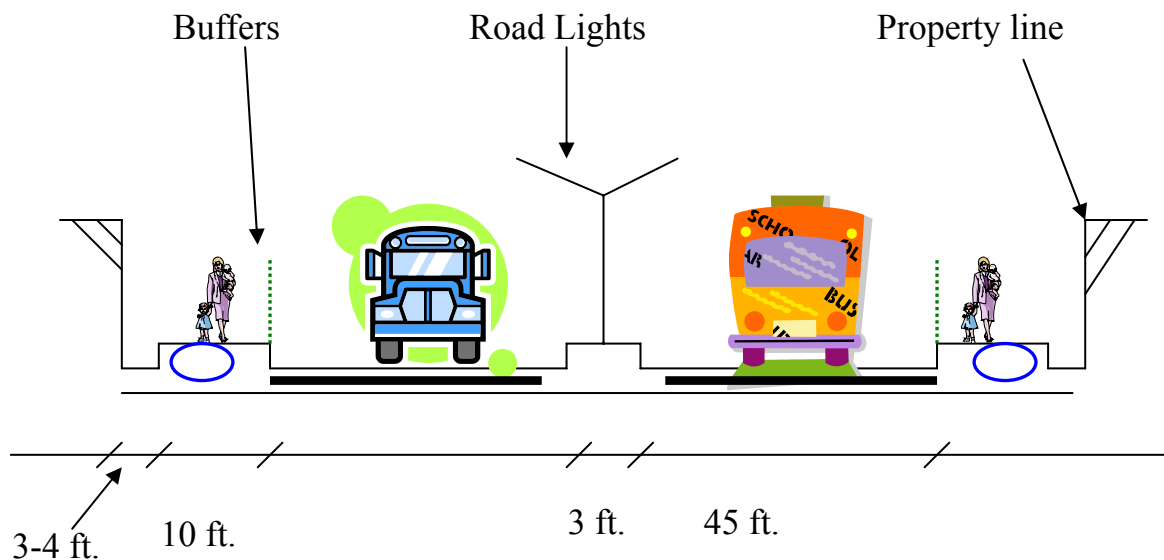


Figure 3, Typical Cross Sections of the roads in Dhaka City as Prescribed in city road design papers

6. Pedestrians' Purpose of Walking in Dhaka

In Dhaka City, pedestrians are walking for different purposes. Among them, going to the workplace is the most important purpose. Afterwards, people prefer to walk for shopping. The most important matter is that walkers also walking for saving time and money due to heavy congestion in the central part of city.



Figure 4, Pedestrians' Purpose of walking in Dhaka City (Source: field survey)

7. Walking Distance and Walkers Sex in Dhaka City

Male pedestrians are higher in number (almost 60%) in Dhaka City. Female walkers are mostly walking for bringing their kids from the schools and also for shopping. However, some female walkers are walking for going to work place (especially the garments workers). At the same time, higher income groups are walking less than the lower income groups. This is because; pedestrians want to save money by not using the motorized vehicles in Dhaka. The following graphs will represent the current situation of Dhaka Walkers.

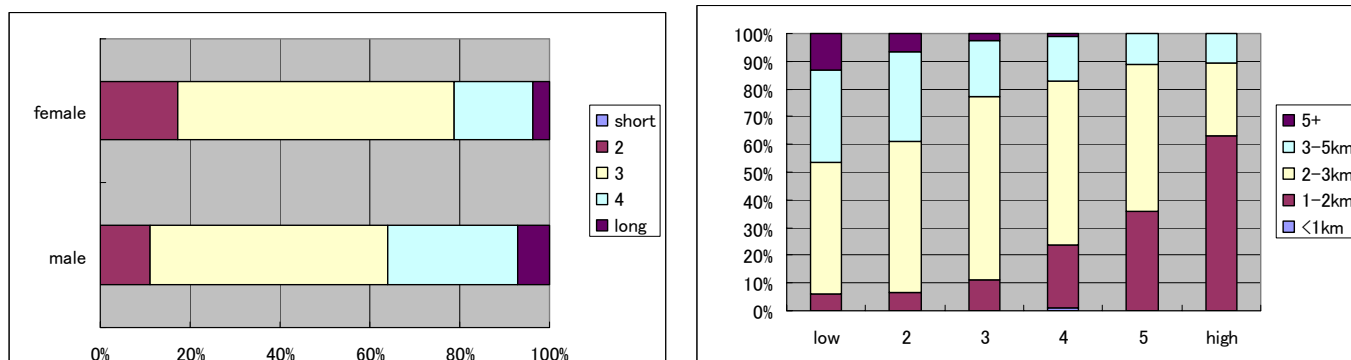


Figure 5, Male and Female Walkers as well as distance traveled by walkers in Dhaka

8. Pedestrian's Problems in Dhaka City

Lots of problems can be identified through the observation survey in different aspects at the moment in Dhaka city, especially the five studied blocks. However, walkers also responded to their prime and foremost problems in the respective areas. Mainly observation survey and questionnaire survey to the walkers give the idea of walker's problem in Dhaka City.

In the figure 6, it can be seen that most of the areas get the same problems of illegal vendor's occupancy on the walkway surface. Besides it, construction activities and discontinuity of the walkways also offer severe problems to the pedestrians in Dhaka City.

9. Major Problems Identified from Field Survey

There are lot of problems have been found in the study area regarding the pedestrians' convenience. Some of them are:

- Vendors occupied the path space illegally that forms a barrier to the pedestrians;
- Illegal vehicle parking on footpaths and resulting hindrance to the passerby for their easy movement;
- Establishment of the dustbins on footpath which also create problems with spreading bad odor and germs;
- Discontinuation of the walkway alignment also creates problems to the older persons and to the disabled persons for walking conveniently. For this instance, they use the carriage way and the propensity to accident with the fast traffic becomes higher indeed.

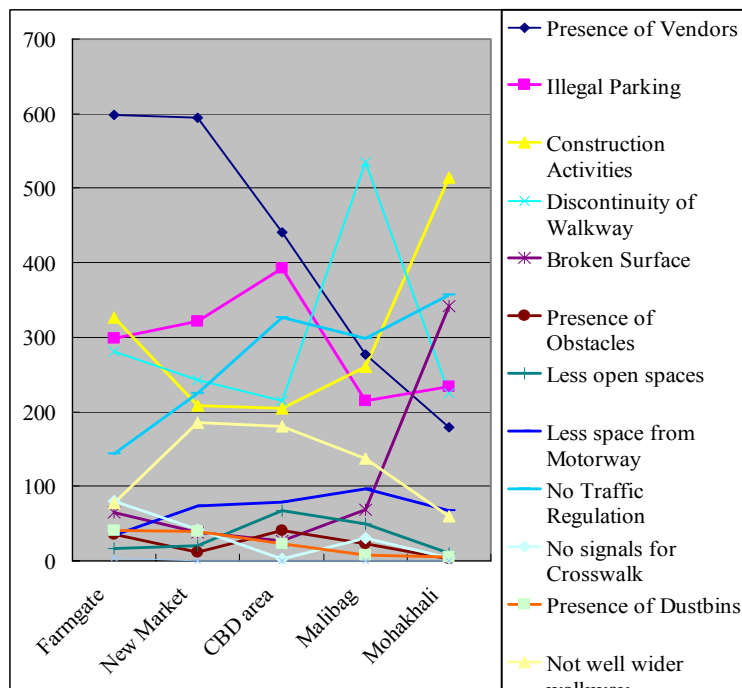


Figure 6, Pedestrians' problems and responses from the walkers in Dhaka

- e) Poor pavement design and construction materials allow muddy situations to arise during the rainy season (monsoon) over the footpath surface causing people not to use the footpaths rather using the carriage way of the roads.
- f) During the rainy season, the roads are water logged with the rain water and make the walkways a dangerous place to walk as man-wholes are quite often absent in some places.

Besides it, there are many other problems can be found after visiting the field with the photographs. Physical, social and economic problems on pedestrian ways or sidewalks have been observed in the study area too. Acute problems can be seen with the design considerations of the pedestrian facilities as for example, creating of buffer zone with the motorized lanes and sidewalks could be seen only in some specific areas. Pictures show that the illegal vendors are operating their business on the walkway surface in Motijheel area and offer almost no space for the walkers to use the surface. This situation deteriorates the safety and convenience of the walkers on the walkway surface too.



Figure 7, Pictures of illegal vendors on walkways in Dhaka City

10. Social Security – A major Problem for the walkers

This is one of the unique problems that has been identified in Dhaka Case. The following figure shows the pedestrian's responses regarding some social problems in Dhaka.

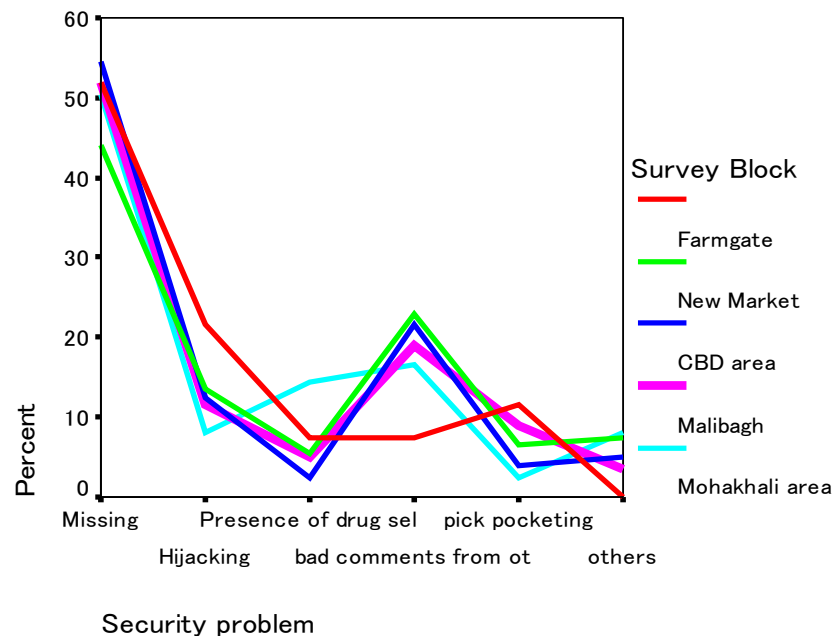


Figure 8, Security, A major concern for Dhaka's walkers

Almost 50% walkers responded to this concern while interviewing to them. Five major crimes on the walkways have been identified as: Hijacking, Presence of Drug Sellers on the walkways, throwing bad comments to the lady walkers, pick pocketing and snatching the bags from the walkers. The most interesting problem here was throwing bad comments to the lady walkers by some young people at the major intersections of the studied blocks.

11. Using Ordered Probit Model to Make Relationships among the Variables

Ordered probit models were calibrated for investigating factors to affect the socio-economic as well as the observation data for getting the relevant output. Probabilities of dependent variables (for example Y) are formulated as follows:

$$P(y=1) = \Phi(-\beta x)$$

$$P(y=2) = \Phi(\mu_1 - \beta x) - \Phi(-\beta x)$$

$$P(y=3) = \Phi(\mu_2 - \beta x) - \Phi(\mu_1 - \beta x)$$

$$P(y=4) = \Phi(\mu_3 - \beta x) - \Phi(\mu_2 - \beta x)$$

.....

$$P(y=n) = 1 - \Phi(\mu_n - \beta x)$$

The μ 's are unknown threshold parameters to be estimated with β . Explanatory variables x were identified by both the observation and the questionnaire survey conducted in the field. Based on this analysis, there are

almost 25 output models in this study. But all of them are not included here in this part to explain the effects of different variables rather they are placing in the appendix for further discussions. However, the important variables and the relationships with other dependent variables and estimation of those models are included in this chapter only to show the present situation of Dhaka City. Rest of the model output will be included in the Appendix to see the result and the relations. A software named as TSP (Time Series Processor) has been used for necessary calibration of data to build the model and the relations as well for this study.

12. Estimating model for Buffer

Buffer is the stuff that used for separating the road space and the walkways from each other. In Dhaka, the walkway space is almost 1 to 2 feet high than the road space so that it can easily be distinguished. However, walkers are very often coming to the main streets to avoid crowd and illegal vendors. For instance, placement of Buffer is very much useful to force the walkers to walk on the walkway and also it guides the non-motorized vehicles to enter on the walkways during the congestion. Picture of several buffer type used in Dhaka can be found in chapter 5 in this thesis. Estimation of the model for buffer can be seen in the following table:

Table 6.1, Model estimation for buffer in Dhaka

Variables	Coefficient	t – value
Constant	2.21482	5.25504
Sex	-0.100326	-0.813661
Age group 0 to 15	-0.374512	-1.84648
Age group 16 to 45	-0.372692	-2.23561
Income less than 1500 taka	0.529391	1.55312
1501 to 3000 taka	0.841317	2.44640
3001 to 5000 taka	0.764200	2.21868
5001 to 7501 taka	0.421805	1.19289
7501 to 10000 taka	0.591591	1.66156
Buffer Material (steel)	-1.35490	-7.70770
Broken Buffer at every 20ft.	1.07581	6.12073
Broken Buffer at every 30 ft.	-0.148214	-0.909240
μ_1	1.69877	14.6898
μ_2	4.03580	21.7675
L(c)	-586.49	
L(θ)	-419.79	
Sample Size	500	

From the above table, the dependent variable was taken as Buffer to estimate the model and socio-economic variable was taken as sex, age groups, income and observatory variables were taken as buffer material and average breaking length of buffer (in feet). Buffers are not a continuous phenomenon for Dhaka city as

mentioned in previous chapters while discussing the variable named as continuity.

13. Using AHP (Analytical Hierarchical Process) for Analyzing Pedestrian's Choice

AHP has been used for analyzing the data and summarizing the results of the questionnaires. Here, the choices among the criteria have been segregated in a set of pairs each time and asked it to the walkers to put their own choice. For example, a questionnaire (can be seen in the appendix) with a set of choices has given to the walkers and they put their own choice regarding the specific criteria in compare with the other one in the specific study block. A set of option can be seen (in between safety and security) as:

- a) Safety > Security ----- value = 0
- b) Safety = Security ----- value = 1
- c) Safety < Security ----- value = 2

From this method, a pair is set up to compare with other criteria in Dhaka City. Walkers either put 0 if they think safety is more important than security in the area or put 2 if they think that the security is more important in the place. If they think both safety and security have same importance then they put the value 1 in the respective area. With this notion, every criteria and sub-criteria have assessed and plotted in a matrix. As there were 6 criteria, so a 6*6 matrix has plotted with the average value in each cell for further analysis. After analyzing the data, the following equation of pedestrian's choice can be formulated for Dhaka City:

$$\text{LOS of Dhaka City} = f(0.1416611363\text{safety} + 0.39241411\text{ security} + 0.200622799\text{ Convenience and comfort} + 0.125121242\text{ Continuity} + 0.002552453\text{ System Coherence} + 0.137628261\text{ Attractiveness}) \text{ ----- (iv)}$$

From the above equation, it can be seen that the security is the worst among 6 different criteria in Dhaka city according to the pedestrian's evaluation. However, some socio-economic data and observation survey would also support this equation as well. The walkers also think that security is the main important factor among the six broad criteria. Besides, from this equation, it can be seen that total Pedestrian LOS of Dhaka City depends mostly on the security issues on walkways (0.39 at a 1.00 scale). However, convenience and comfort is another major preference that is highly influencing the walkers' LOS evaluation in the case of Dhaka City. This equation thus helps the policy makers, researchers and the city officials to know the exact choice of walkers in Dhaka city to provide the specific facilities while doing some improvements.

14. Conclusion

A series of analysis have been taken place to find the problems of the walkers in Dhaka City and to get the impressions of the pedestrians. First of all, field survey and observation survey have given the primary idea to fix up some criteria for further analysis. Afterwards, it has been seen that in Dhaka City, almost 40% people are walking to go for workplace everyday from higher to lower income category. Besides, a very good portion of the women walkers can be found (almost 30%) in Dhaka City. At the same time, it has been observed that female walkers are walking for shortest distance in most of the time. A significant observation from the finding was that pedestrians often feel insecure on walkways because of social problems and crimes at a regular interval. For instance, problems with security are one of the major issues in case of Dhaka City.

The analyzed results also show that among social security problems, throwing bad comments to the women walkers is very new and uncommon with other cities of developing countries. However, illegal vendor's occupancy on the walkway is also one of the major responses from the pedestrians at Dhaka City. It has also been experienced that the problems are not similar in each studied areas. From the walker's point of view, New Market, Farmgate and Motijheel (CBD) areas are the most vulnerable with illegal vendors. Whereas, in Malibagh and in Mohakhali the problem seem different as break of continuity and presence of construction materials get the highest options respectively.

After identifying the composition of walkers and their problems, another series of analysis have been taken under consideration to build up some models. Itemized data have been collected for the second survey with a satisfaction level of the walkers. At the same time, observation survey was carried out to get the related information for estimating the model. However, the ordered probit model helps understand the relations among socio-economic compositions of the walkers, subjective evaluation through the questionnaires and the observation survey from the field. Influences can be observed through the model for what exact objective value influenced more for subjective evaluation. For example, no lights on the walkways had a very poor evaluation from the walkers. At the same time, presence of lights on the walkways had better evaluation. At the same time, types of light had influenced the subjective evaluation which could be seen from the co-efficient value in the estimated models.

After estimating the relations among several dependent and independent variables, the main stakeholder, the walker's choice about the prescribed criteria index is estimated by using the analytical hierarchical process and with pair-wise comparison of the criteria. It has been found very much interesting result for Dhaka city as: Security is the main factor that the walkers consider here (0.39 at a 1.0 scale). Then comes to convenient and comfort on the walkways (0.20 at the same 1.0 scale). This result implies decision makers, planners and the engineers must consider the security problems and measures while designing the walkways. This result not only refers the design considerations but also implies the social security and safety on the walkways as a whole. At the same time, it has been found that system coherence (basically considered; connectivity of walkways among services and visibility of the services from the walkways) has very poor weight among 6 prescribed criteria. For instance, a simple conclusion can be drawn that, researchers can now eliminate this criterion while studying the walkways in Dhaka city.

Lastly, some recommendations, mostly dominated by some policies and options in light with the discussed models and findings have been included. Evicting the vendors is not a good solution at the moment as walkers also like to buy some daily necessary goods on their way back home from the walkways. At the end, it can be said that this research is an attempt to make people aware about the importance of walkways and about the problems at the same time. This research can be further useful for more research and the data will surely help stakeholders for new area to be focused.