HBRP PUBLICATION

Journal of Transportation Engineering and Traffic Management
Volume 1 Issue 2

Walkability and Pedestrian Settings in Dhanmondi R/A, Dhaka City: Approach of Sidewalk Condition Index (SCI) and Perception

Mohammad Mizanur Rahman[1*], Mst. Tanzila Aktar Shawon[2], Sabrina Sharmin[3]
[1]Assistant Professor, [2]Postgraduate Researcher
Department of Urban and Regional Planning, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh.
[3]Assistant Professor, Department of Computer Science and Engineering, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh.

[*]Corresponding Author
E-mail Id:-*mizanurp@gmail.com*

ABSTRACT
In Dhaka the capital city of Bangladesh, most of the short trips are making on foot but the pedestrians are facing many problems while using the walkways. Recent years there have been initiatives in city corporation areas in Bangladesh to create more livable communities where walking are encouraged and accepted as a legitimate form of transportation and for smart city. In Dhaka city walking is encouraging day by day but the condition of the pedestrian way is fair and poor in all over the part of the city. The aim of this study is to assess the walkability of the footpaths in Dhanmondi area of Dhaka and to evaluate the perception of pedestrians regarding the Sidewalk Condition Index (SCI). A questionnaire survey among 150 pedestrian users was conducted to assess the pedestrian's perception of the existing pedestrian way conditions. The overall pedestrian satisfaction level was 3.20 out of 5 scales and that means less than moderate satisfaction. SCI is a numerical indicator that rates the pedestrian surface condition. The SCI index was calculated in Dhanmondi residential area footpath and majority pedestrian way was fair in condition.

Keywords:-*Pedestrian way, walkable city, Sidewalk Condition Index (SCI), perception*

INTRODUCTION

Walking is the beginning of sustainable city [2] and a basic requirement of mobility [19]. It promotes social interaction between people that in turn can progress their psychological well-being [9, 13, 30]. It contributes to the reduction of air pollution [17] and it is a sustainable indicators in a residential neighborhood [18, 27, 29]. Walking at the same time is sustainable and environmentally responsive [12] that rises the quality of life for all residents. With rapid urbanization in low and middle income countries, walking is high demand for low cost, sustainable urban transport [25]. The quality of the pedestrian way can affect the probability of walking [23, 24, 31, 34]. But pedestrian facilities is neglected in spite of significance of the pedestrian [32, 35]. Everybody gets benefits from walking, so we need to make it safe, convenient and easy [15].

Dhaka, the capital city of Bangladesh with estimated population in 2020 of roughly 2.1 million with density of 23,234 people per square kilometer [33]. In many respects, the distribution of modal choices in Dhaka is unique among cities of

comparable size in Asia. Almost 60 percent of the 8.5 million weekday person trips are walk trips, and about 19.2 percent are by rickshaw (tricycle). For the remaining 20 percent of trips on motorized modes, 1.4 percent uses an auto rickshaw (three wheelers), 9.2 percent traveled by bus, 4.1 percent travel by private car, and 5.7 percent travel by various other modes [11, 22]. The 76% of all trips are under 5 km, and 50% under 2 km [3]. This shortest length of trip indicate that walking may both improve traffic conditions [5, 6] and improve the conditions of the poor [14]. In spite of the commonness of walking in Dhaka, there is inadequate pedestrian way and pedestrian facilities.

In an ideal situation, roads in Dhaka available for use stands at 2230 km where more than 900 thousand vehicles ply every day of which 420 thousand are motorized vehicles [10]. Dhaka city has 436 km of four lane roads, 1408 km of two-lane roads, 386 km of lanes/ by lanes and 220km of footpath. Smooth traffic system demands roads and lanes to be constructed on 25% of the city's surface area, but unfortunately for Dhaka city it is only 8% [20, 21] as Dhaka grew from a provincial capital to a national capital in an unplanned way. With the shortage of road network and other facilities the city's traffic problems increasing day by day [11] and creating different problems like congestion. About 3.2 million working hours wastes by congestion every day and costs the economy billions of dollars every year [8].

A pedestrian safety is decreasing as most of the victims from road casualties are pedestrians [26]. Statistics showed that from 2007 to 2011, 60 per cent of the road accident and fatality victims were among the pedestrians of Dhaka [1, 16]. Now day by day the percentage share of walking mode is decreasing and the main reason is the lack of effective pedestrian facilities and safety promotions or measures [26]. Some of the reasons that is causing the poor walking conditions include-lack of continuous sidewalks, poorly maintained sidewalk, unclean condition, obstructions in the sidewalk due to illegal occupancy on the sidewalk. Lack of pedestrian facilities discourage pedestrian who want to walk in short distance in the because of unfavorable walking conditions and environment [4]. To encourage people to walk the sidewalk management issue should be considered in planning development process by the responsible authority.

This paper studies the walkability situation in the Dhanmondi residential area, Dhaka, Bangladesh. There is also make an evaluation of pedestrian's perception regarding the sidewalk condition index in Dhanmondi residential area.

OBJECTIVE OF THE STUDY

To assess the walkability of the footpaths of the study area.

To prepare a database of footpaths of the study area.

To evaluate the perception of pedestrians regarding the Sidewalk Condition Index (SCI)

STUDY AREA

Dhanmondi is one of the most affluent residential areas in Dhaka city. Dhanmondi is located in between 23°43' and 23°45' north latitudes and in between 90°21' and 90°23' east longitudes.

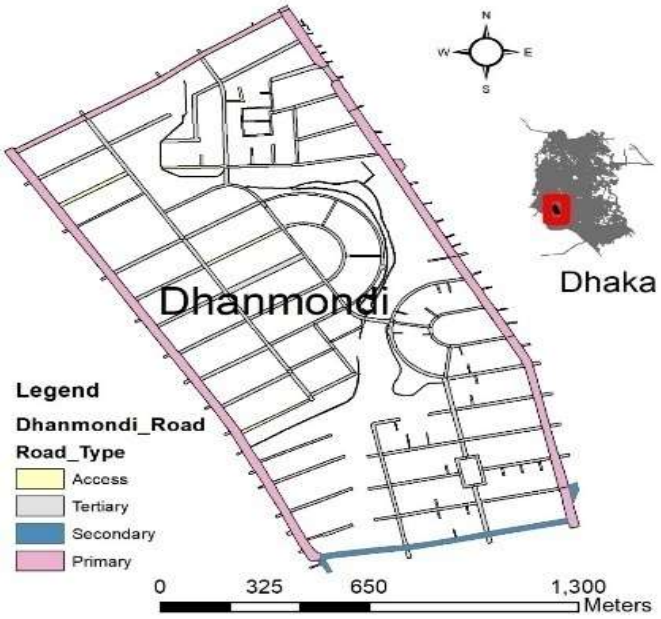


Fig.1:-*Map of Study Area*

Table 1:-*Study Area Demographic Data*

Items	Thana	
	2011	2001
Population	Total: 1,47,643 Male:79465 Female: 68178	Total: 2,52,519 Male: 146831 Female: 105688
Annual growth rate	-5.15	-2.28
Area sq. km	4.34	6.23
Density per sq. km	34019	40533
Households (HH)	33169	47642
Average HH size	4.45	5.27

Source: Population and Housing Census, 2011 [7, 28]

In the study area total primary road is 5022 meter and secondary road is 1281 meter. There have side walking facilities or pedestrian way both side of the primary and secondary road of the study area. (Figure 1)

Table 2:-*Road and Pedestrian way in the study area*

Road Type	Length in meter	Pedestrian way
Primary	5022	Both side
Secondary	1281	Both Side
Tertiary	17055	Not available
Access	9520	Not available

Source: RAJUK, 2019 [28]

METHODOLOGY

Data collection was conducted in two phases for this research. First part questionnaire field survey. In the field survey various information regarding pedestrian way and the respondent's opinion were collected through the questionnaire survey. 150 questionnaire surveys were conducted to collect the primary information of pedestrian users. Various features of the pedestrian ways were collected by several existing means of surveying modes; questionnaire is the precise option to investigate the user preferences. Second part was for Side walk Condition Index (SCI). SCI is developed based on visual inspection and observation. The surveyors conducted survey for the frequency and severity of specific distresses on the checklist. The SCI provides a numerical rating for the condition of road where 0 is the worst possible condition and 100 is the best. Finally the SCI score were calculated and the rating of the pedestrian way was given by the calculated score. SCI is a numerical indicator that rates the pedestrian surface condition. The SCI expressed the distresses of the pedestrian way.

RESULTS AND DISCUSSION

Wider footpaths increase the ease of walking as they accommodate more people. The Indian Road Congress recommends footpaths on both sides of the road with a minimum width of 1.5 meters (5 feet). Some road segments had footpath of Less than 4 ft. (9%). It is very short in terms of road function, road capacity and pedestrian volume of the study area. Most of the roads had footpath of 4ft.-6ft. (28%) (Figure 2). Some roads had footpath of 6ft.-8ft. (26%). The percentage of road segment having footpath of 8ft.-10ft. is 24%. Only a few roads had footpath of 10ft.-12ft. (5%). However, the primary roads, such as Mirpur Road, Satmasjid Road and Dhanmondi-27 (Old) had footpath more than 12 ft. wide. Their percentage is 8%.

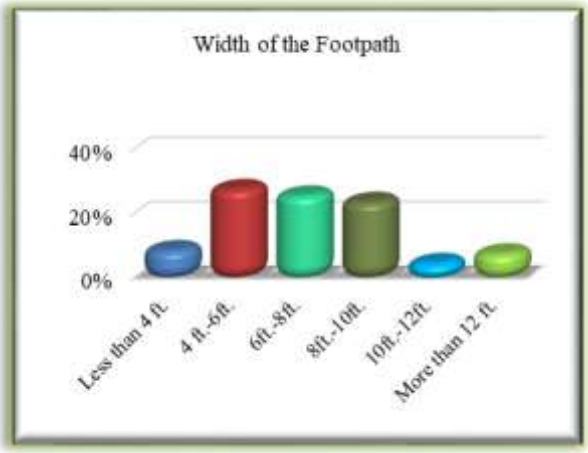


Fig.2:-*Width of footpath*

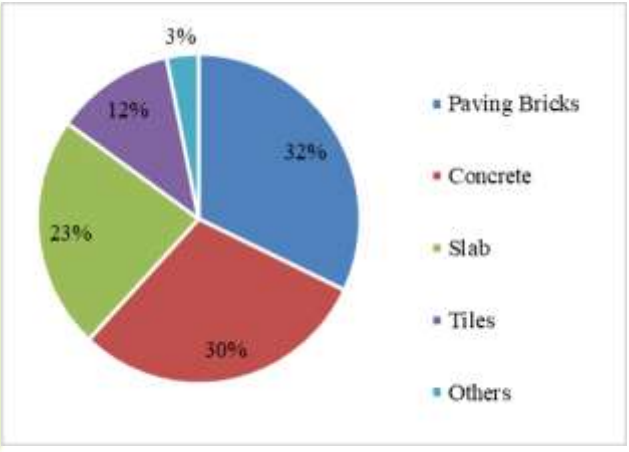


Fig.3:-*Type of materials used*

Source: Field Survey, 2019

The Figure 3 shows the percentage of materials used in constructing the footpaths of the study area. The most common material is Paving Brick which amounts for about 32%. The second highest used material is Concrete which is used in 30% footpaths. Slab is used in 23% footpaths whereas Tiles sis used in only 12% footpaths. However, Bitumen-which is another widely used material in construction of footpath all over the world, was not used at all. And, the most important part, Dirt/Sand was not used at all in the study area which is cost effective. Though the use of Dirt/Sand is not desired, it is widely used in our country. Other

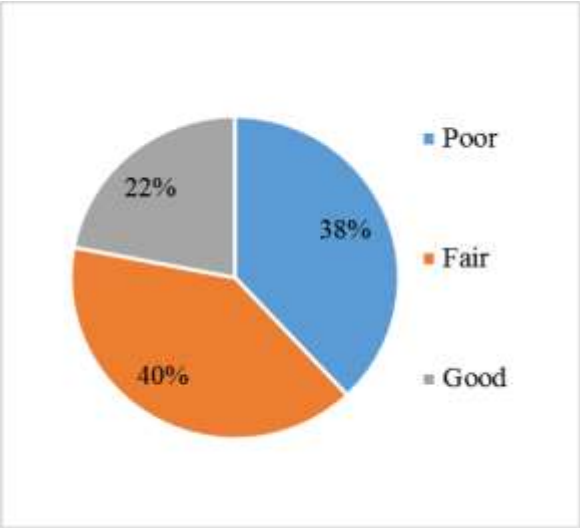
materials constitute 3% of the flock.

Safety measures will reduce pedestrian/vehicle conflicts and thereby reduce the number of injuries and fatalities. Lack of traffic calming measures, inadequate or missing footpaths and crossing points and lack of enforcement of laws all create an environment that is unsafe for pedestrians. The study analyzed the barriers for crossing, crossing aids, traffic calming methods and enforcement strategies.

The barriers were found in crossing the streets. Almost 43% road had mixed traffic. Mixed traffic is a barrier in a sense that, the speed of vehicles in mixed traffic streets is not uniform. As a consequence, the pedestrian can't determine the actual timing and speed of crossing. About 21% streets had more than 2 lane traffic. It increases the crossing distance thereby reduce the chance of safe crossing. About 22% roads had trees in the medians which made it difficult for the pedestrians to cross. There were High medians and Barbed wires in some segments too.

The overall cleanliness of the footpaths was not good. Most of the walkways (footpaths) had multiple physical disorders. Physical disorders include Cans/Bottles, Cigarette/Bidi, Urine smell, Garbage, Broken Glass, Graffiti, Paper/Tissue etc. It is found that about 38% streets were in poor condition. On the other hand, only 22% (Figure 4) streets were in good condition. However, 40% streets were fairly clean.

Fortunately, trees were present in some roads (56%). Among them, 8% road segments had only a few trees. And, 44% segments had many trees (Figure 5).



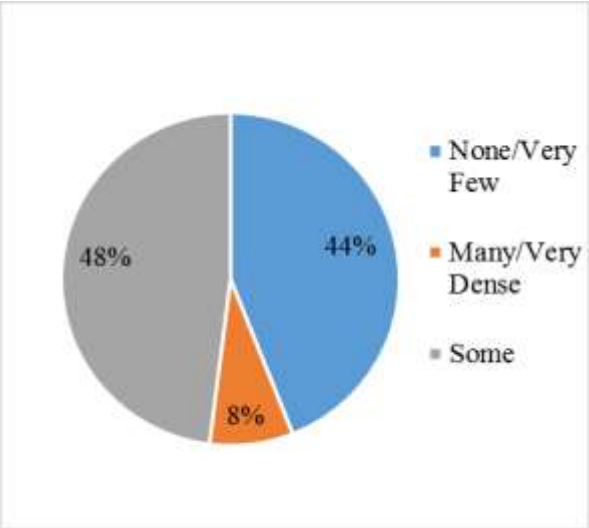


Fig.4:*-Cleanliness of footpath Figure*

Fig.5:*-Availability of trees*

Source: Field Survey, 2019

There are 1673 structures in the study area and majority of the structures are residential although the land use classification, Dhanmondi area is defined as residential area. In the study area about 53% buildings are residential area, 6% are the educational and 12% are (Figure 6) the commercial buildings. There are also 14% are the mixed building structures. Among the structures about 46% buildings are 6 storied. Besides these 3 storied, 4 storied and 5 storied buildings are respectively 15.64%, 8.52% and 8.26%.

Table 3:-*Use of Structures [28]*

Structure Type	Number	Structure Type	Number
Commercial	197	Miscellaneous	236
Community Facil.	48	Mixed Use	120
Educational	91	Residential	873
Health Facilities	14	Restricted	7
Institutional	7	Under Construction	78

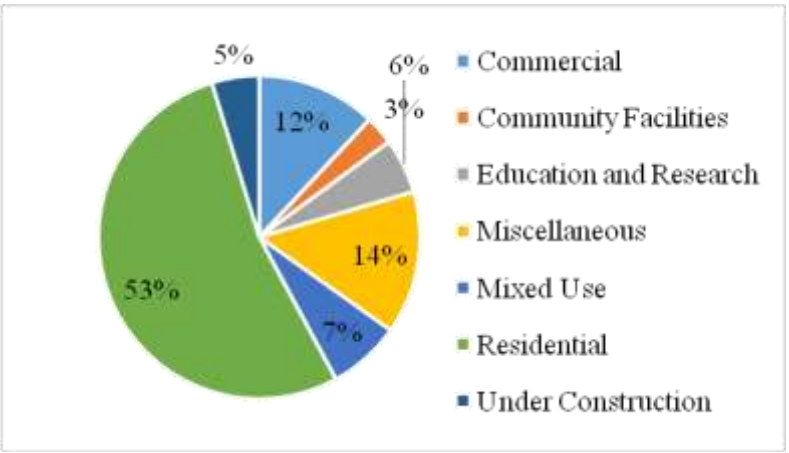


Fig.6:-*Types of structure*

From Figure 7 it is seen that almost all of the commercial, educational and health facilities are situated along both side of the Satmosjid road and Mirpur road and this two road are also the primary road of the study area. There are two sided pedestrian way of these two road and the pedestrian volume is also very high in these two roads comparative than other road in Dhanmondi residential area.

Fig.7:-*Map of Structures and Roads*

The studies observed parking of vehicles, whether legally or illegally, have in every streets of the study area. Legal parking refers to parking in specified areas and places which do not affect the mobility of pedestrians and other vehicles. Illegal parking refers to vehicles parked on footpaths, in specified no parking areas and on the side of the road blocking the traffic. Seventy-five road segments had cars/microbus parked illegally. Total of 1673 structures only 591 structures have (35.33%) the self-parking facilities in the study area. Among them only parking has 482 structures (81.56%), 5.92% (35 structures out of 591) have the parking and guard room both. The 35.33% structures have the self-parking facilities and it is not enough as the demand basis need and Almost all of them are residential parking facilities. The parking in the roadside or adjacent to the pedestrian way make the trouble to the freeway of the pedestrian sidewalk.

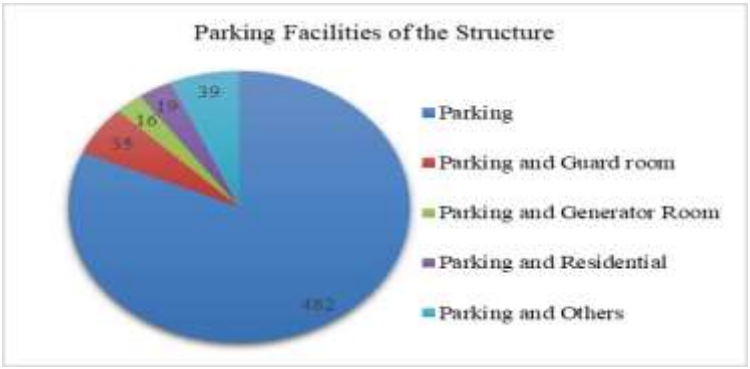


Fig.8:-*Parking Facilities Structures (%)*

From the Figure 7 it is seen that most of the commercial, educational and other major used building are besides the two major road and these are the Satmosjid road and the Mirpur road. But from Figure 9 it is seen that the parking facilities are absent along the both side of the two major roads. As a result the on street parking are seen there besides the major roads as the consequences the pedestrian way is occupied in a congested situation and these problems make different problems to the pedestrian.

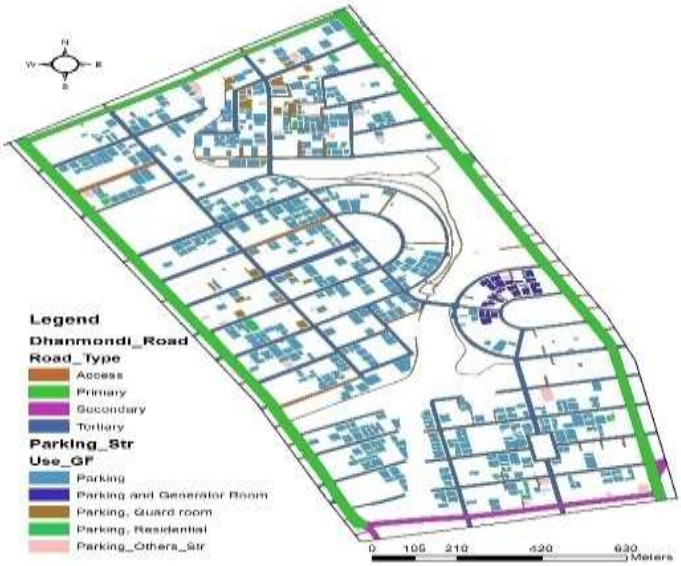


Fig.9:-*Map of Parking Facilities Structures*

Table 4 shows that different peoples' perception about the facility and condition of footpaths in Dhanmondi thana. For sufficient space peoples are 7% not satisfied, 4% less satisfied, 31% Moderate, 44% satisfied and 14% more satisfied. For footpaths are free from hawkers' peoples are 22% not satisfied, 13% less satisfied, 38% moderate, 24% satisfied and 3% more satisfied. For footpaths are free from construction materials peoples are 6% not satisfied, 2% less satisfied, 46% moderate, 33% satisfied and 5% more satisfied. There are no sitting arrangements at footpaths in Dhanmondi thana. For free from wastages peoples are 8% not satisfied, 2% less satisfied, 47% moderate, 29% satisfied and 14% more satisfied. For sufficient street lighting peoples are 12% less satisfied, 56% moderate, 22% satisfied and 10% more satisfied.

***Table 4:**-Different facilities and condition of footpaths*

Statement	Percentage of Respondents				
	Not Satisfied	Less Satisfied	Moderate	Satisfied	More Satisfied
Sufficient Space	7%	4%	31%	44%	14%
Free from hawkers	22%	13%	38%	24%	3%
Free from construction materials	6%	2%	46%	33%	5%
Free from wastages	8%	2%	47%	29%	14%
Sufficient street lighting	-	12%	56%	22%	10%

Source: Field Survey, 2019

In the Likert scale ranging from 1 to 5 the satisfaction level about the pedestrian elements and its functional condition is described in Figure 10. The pedestrian is associated by hawkers that creates problem for the movement of the pedestrian and the satisfaction level on that issue is lowest ant it is 2.73 that means dissatisfied for the hawkers functioning by their goods in the pedestrian way.

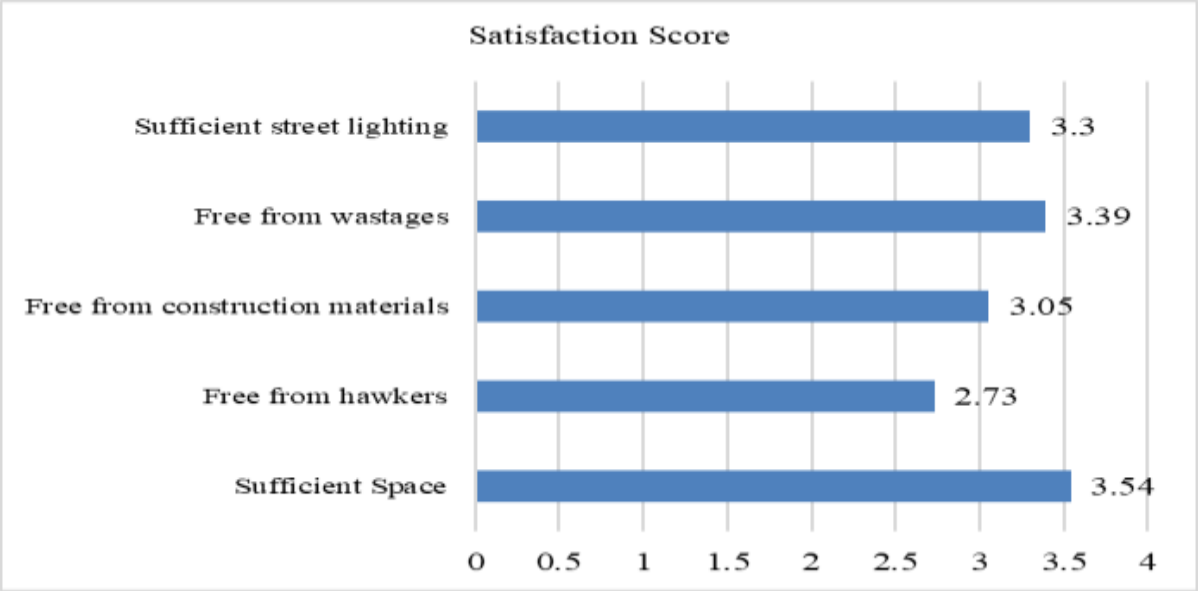


***Fig.10:**-Satisfaction level about pedestrian way*

The overall score on the satisfaction level is 3.20 and it expressed less than moderate satisfaction level of the pedestrian ways services for the sidewalk.

Figure 11 represents the origin of journey of the people of the study area. This figure shows that almost 73% people started their journey from home. Only a few people (12%) started their journey from their work place. On the other hand, 5% people started their journey from their relatives' houses. Some people started their journey from Mosque or Temple. Their percentage is also 3% and lastly, only a fraction of people (7%) started their journey from some places of Entertainment.

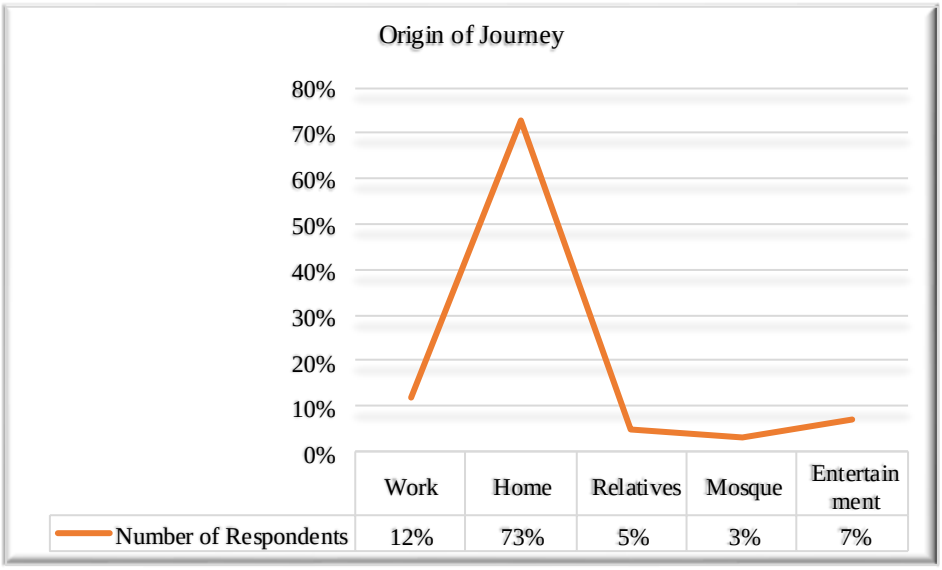


Fig.11:- *Origin of journey*
Source: Field Survey, 2019

Figure 12 shows the Destination of the respondents. Note that, the surveys were conducted mostly at mornings so as to find the peak hour scenario. Almost 53% peoples' destination of journey was work place. It indicates the first priority. Then the second priority goes to the school. This figure shows that almost 16% peoples' destination of journey is to the school. The lowest priority of the destination of journey is relatives. Its amount is only 6%. The other destination is entertainment.

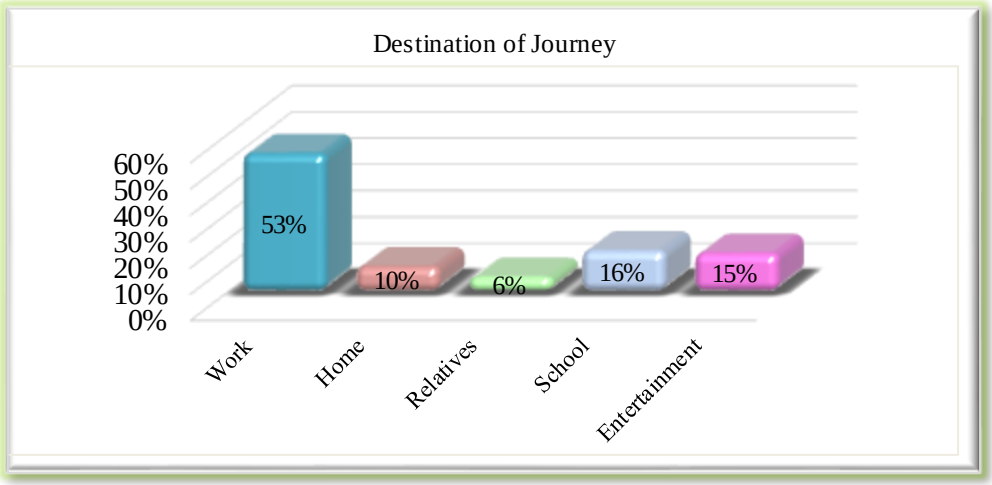


Fig.12:-*Destination of journey*
Source: Field Survey, 2019

Table 5 shows that the different problems which faced by people in Dhanmondi area. We made a table about these problems. We gave the opportunity to the respondents to multiple choices. Respondents could choice multiple. Almost 25.3% respondents said that in study area inadequate and indiscriminate use of footpath is available. On the other hand, 72% peoples said that pedestrian crossing managements are uncontrolled. Few numbers of people said about the overpass problem. Bad surface of footpath condition was chosen by 43% respondents. Most respondents were agreed about the absence of separate lane for people. 87% peoples said that in bad weather they fall in trouble using footpath.

Table 5:-*Different Problems of Footpaths*

Problems	% of Respondents Opinion	Ranking
Inadequate and indiscriminate use of footpath	25.3	5th
Uncontrolled Pedestrian crossing	72	2nd
Problem in overpass	12	7th
Bad surface condition of footpath	42.67	4th
Absence of separate lane for disable peoples	65.33	3rd
Family restriction for walking	15.33	6th
Bad weather conditions	86.67	1st

Source: Field Survey, 2019

Figure 13 show the preferable distance for walking. The figure shows that most of the people agreed for 0.5 KM. It is 42%. Then 31% people preferred 1KM for walking. Few numbers of people preferred 1.5KM for walking. Lastly the figure shows that very few numbers of people (9%) preferred 2KM distances.

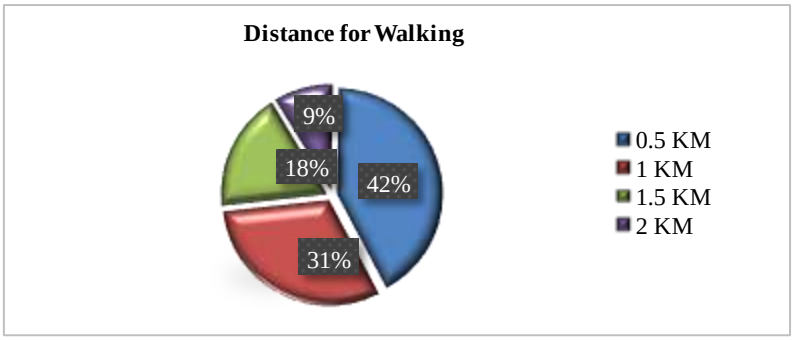


Fig.13:-*Preferable distance for walking*
Source: Field Survey, 2019

The Figure 14 represents that 45% people hadn't had any experience of abuse from motorists while crossing the roads or in similar situation. On the other hand, 22% people agreed they have rarely had the experience of abuse from motorists. Almost 21% people said they experienced abuse often. However, 12% people said they have had the experience many times.

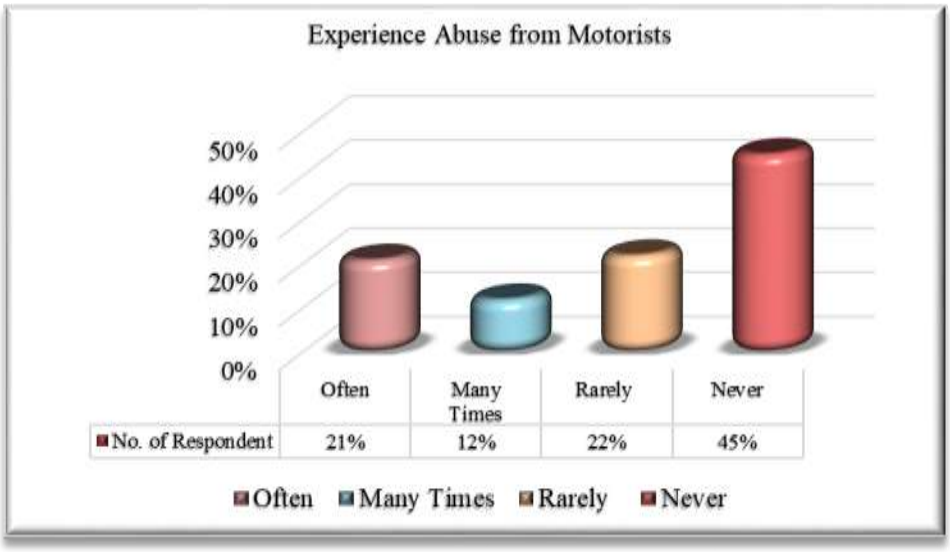


Fig.14:-*Experience abuse from Motorists*
Source: Field Survey, 2019

The respondents were asked if they were injured because of the poor quality of walkway or not (in the last 3 months). If they were injured, how many times it happened. The figure 15 shows that among 100 people 54% people was not injured in the study area during past three months. 37% people have been injured for 1-2 times. 5% people have injured for 3-4 times and only 2% people have injured for at least 5 times or above. However, 2% people refused to answer (could not remember).

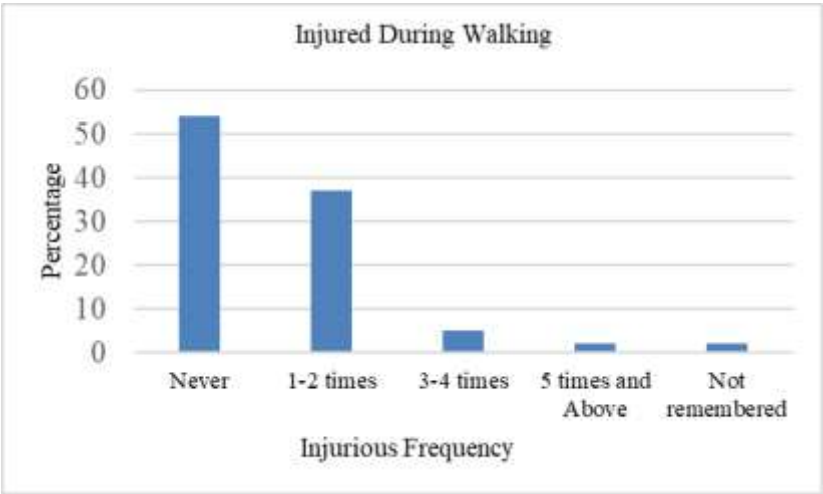


Fig.15:-*Times injured during walking*
Source: Field Survey, 2019

The following Figure 16 represents the percentage of view of the people for improving the pedestrian facilities. In this case about 47% people think that there should be easy access for disabled person. 12% people think that in the road there should be elements that can reduce and slow traffic. Almost 9% people think that there should be enforcement of laws that can improve the pedestrian facilities in the street. The other options include Improved Street Lighting (23%), Wider and Level Footpaths (38%), Clean Footpaths (62%),

Removal of Obstructions (18%), More and Safer Crossing Points (11%).

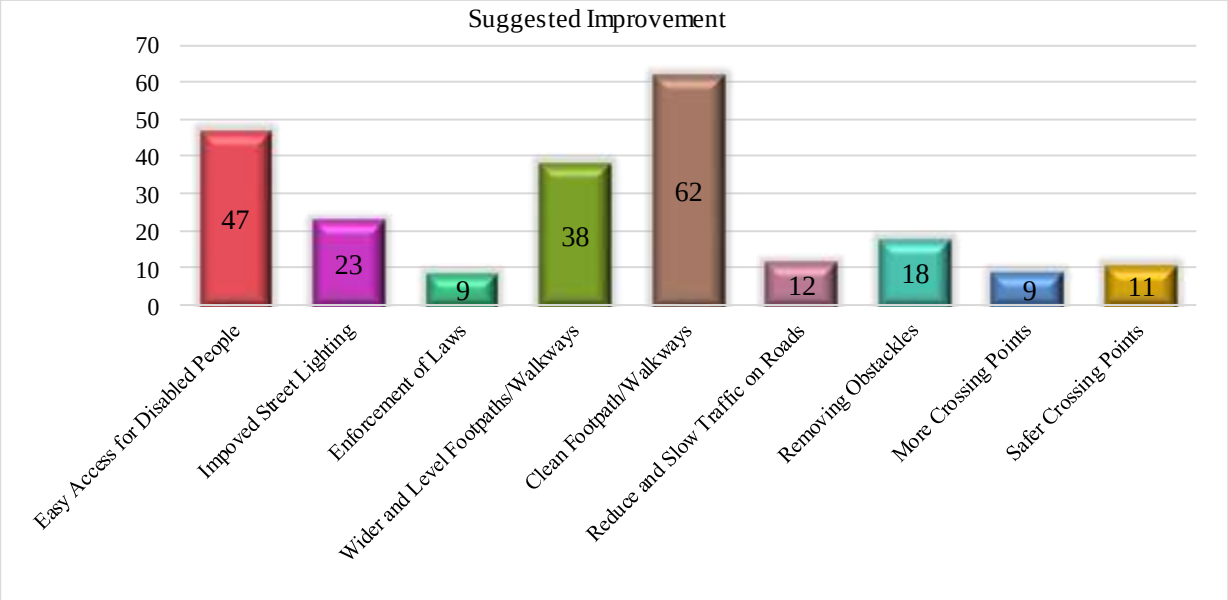


Fig.16:-*Improvement in the pedestrian facilities.*
Source: Field Survey, 2019

SIDEWALK CONDITION INDEX

Bari et al. (2018) developed the equation for Raw Deduct Value (RDV) [4].

Raw Deduct Value, RDV = $\sum W_i * (S_i+D_i)$

Here, Summation of weightage, $\sum Wi$, Raw Deduct Value, RDV =$\sum Wi*(Si+Di)$

Si =Severity of Distress,

D_i = Density of Distress

Factorized Deduct Value, FDV = $\frac{RDV}{\frac{Wi}{10}}$

Calculated Sidewalk condition index (SCI) =100 – FDV

Sidewalk Condition Range

Initially ranges of SCI were proposed for different sidewalk conditions, as shown in Table 6.

Table 6:-*Sidewalk Condition Range*

SCI Range	Average SCI	Sidewalk Condition
85to100	93	Excellent
70to85	77.5	Very good
55to70	62.5	Good
40to55	47.5	Fair
25to40	32.5	Poor
Below25	12.5	Failed

Source: Bari et al. (2018) [4]

Adjustment of Calculated SCI

The adjustments of the calculated SCI are shown in Table 7.

Table 7:-*Adjustment of Calculated SCI*

Calculated SCI	Rating		Final SCI	Actual Deduct Value ADV= (100-Final SCI)	Corrected Deduct Value Factor CDVF= (Final SCI /Cal. SCI)
	Visual inspection				
	Public	Expert			
	Average or mean value of SCI range designated by the respondent	Average or mean value of that SCI range designated by the Surveyor	Arithmetic mean of Calculated SCI, respondent rating		

Source: Bari et al. (2018) [4]

The SCI value is considered here for the respondent's opinion and the Surveyor's visual inspection. Then the average or mean value of SCI were calculated. This was done by conducting a survey on road of the study area. The mean value of SCI was calculated for each road of the study area. The mean value is the final SCI.
.

So the final Sidewalk Condition Index (SCI) is the arithmetic mean of Calculated SCI. For Adjusting the Calculated SCI this following Linear Equation should be used: Adjusted SCI = 1.1768 X Calculated SCI – 37.532. This linear equation is developed from the Calculated SCI and Final SCI

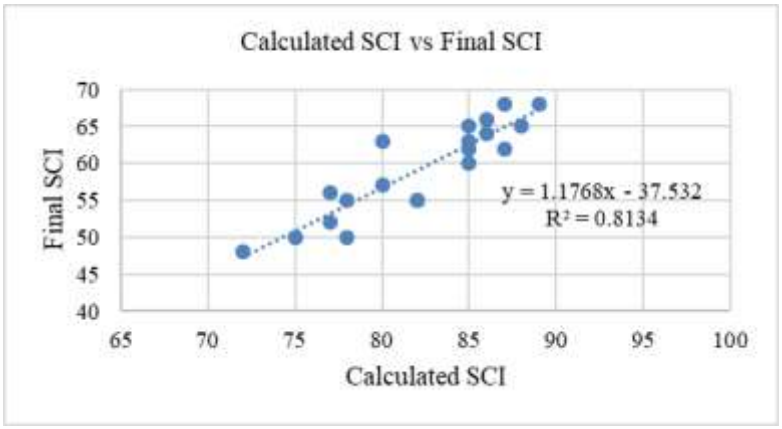


Fig.17:-*Calculated SCI vs. Final SCI*

The Adjusted SCI= 1.1768 X Calculated SCI – 37.532. This Regression SCI will be termed as "The Side walk condition Index (SCI)" for that particular road.

The validated Sidewalk Condition Index (SCI) ranges are shown in Table 8.

Table 8:-*Validated SCI Range*

SCI Range	Rating
0-28	Failed
28-45	Poor
46-55	Fair
56-71	Good
72-85	Very Good
86-100	Excellent

Source Bari et al. (2018) [2]

Validation of SCI Index in the study area, 20% of each road were selected randomly for the validation of SCI Process. Table 9 shows the validation of SCI process [4].

Table 9:-*Validation of SCI Index*

Location	20% of each road	Sidewalk Condition Index (SCI)			Rating		Cross Check
		Calculated SCI	Final SCI	y = 1.1768 X Calculated SCI – 37.532	Visual Inspection (Expert)	Predicted Rating (equation)	✓=matched x=not matched
Satmosjid Road	✓	78	50	54	Fair	Fair	✓
Mirpur Road	✓	72	48	47	Fair	Fair	✓

Relationship between walkability, pedestrian settings and walking hour

A hypothesis could be stated that there is a relationship between walkability,

pedestrian settings and walking hour of pedestrian.

The hypothesis statement:
Null hypothesis (H_0): There is no relation between walkability/pedestrian settings and walking hour of pedestrian.

Alternative hypothesis (H_1): There is a relation walkability/ pedestrian settings and walking hour of pedestrian.
To test the statement of the hypothesis the linear regression procedure was applied.

From the SPSS analysis of the respondents it is shows that the value of R square is .782. This value represents very powerful relation between neighborhood built environments and total walking hour of the respondents. The significant level is .000 that indicates the result is significant and the Null hypothesis is rejected. It accepted the alternative hypothesis that there is a relation walkability/pedestrian settings and walking hour of pedestrian.

PROBLEMS FINDINGS

Overall condition is relatively better than any other areas of Dhaka City. There are some problems of footpath/ Walking ways of Dhanmondi. Here we mention the problems which are identified from our survey-
Poor-quality (cracked) walking surfaces.
Waste disposal on footpath.
Obstacles on the footpath.
Lack of lane for disables.
Lack of interesting features on the route.
Lack of shelter from inclement weather.
Vehicles wrongly parked on the footpaths.

CONCLUSION

In this research, the issue of walkability and pedestrian facilities in Dhaka city particularly Dhanmondi was examined. The research sought to extend earlier research by undertaking pedestrian preference surveys, field walkability survey, pedestrian activity mapping and on walkability planning in Dhaka. This research therefore draws upon a diffuse and multidisciplinary body of previous scholarship and writing in the area. Many of these earlier efforts, however, were aligned with a limited disciplinary perspective or were derived from Western settings where walking constitutes only a small fraction of urban trips and where urban conditions vary substantially from that of Asian and majority world cities. The walkability condition of the study area is fair in the two major road, Satmosjid road and Mirpur road and other pedestrian way is almost fair in the Dahnmondi residential area. The Dhanmondi residential area is quiet well from any other area in Dhaka city but in Dhanmondi areas pedestrian way's condition including all the facilities and other environments is not good satisfactory to the pedestrian users. The walking condition of the study area is not as per the expectation of the inhabitants till now. To improve the sidewalk condition all the facilities should improve by following the sidewalk condition index. This research will be helpful for the Planners and Policymakers in understanding the actual need of the pedestrians and taking the first step in making the city a pedestrian friendly sustainable city.

REFERENCES

1. Ahmed, I., Ahmed, B., & Hainin, M. R. (2014). Road Traffic Accident Characteristics in Dhaka, Bangladesh. *Jurnal Teknologi*, *71*(3).
2. Ariffin, R. N. R., & Zahari, R. K. (2013). Perceptions of the urban walking environments. *Procedia-Social and Behavioral Sciences*, *105*(2013), 589-597.
3. Barkat, A., Karim, W., Sarker, A. H., Hoque, S., & Poddar, A. (2004). After study on the impact of Mirpur demonstration corridor project (Gabtoli-Russel Square). *Human development research centre (HDRC)*

report for Dhaka transport coordination board (DTCB).
4. Bari, J., Sunny, M. H., Nag, S. K., Tushar, S. H., & Haque, M. T. (2018). Development of Sidewalk Condition Index (SCI) of Dhanmondi R/A, Gulshan & Bashundhara R/A of Dhaka City.
5. Bari, M., & Efroymson, D. (2005). Efficient Use of Road Space and Maximisation of Door-to-Door Mobility: Suggestions for Improvements in Dhaka. *WBB trust*.
6. Efroymson, D., & Bari, M. (2005). *Vehicle Mix and Road Space in Dhaka: The Current Situation and Future Scenarios*. WBB Trust.
7. BBS, (2011). Bangladesh Population Census 2011: Community Series, Zila Dhaka, Bangladesh Bureau of Statistics, Government of Bangladesh, Dhaka
8. Bird, J., Li, Y., Rahman, H. Z., Rama, M., & Venables, A. J. (2018). *Toward great Dhaka: A new urban development paradigm eastward*. The World Bank.
9. Coffee, N. T., Howard, N., Paquet, C., Hugo, G., & Daniel, M. (2013). Is walkability associated with a lower cardiometabolic risk?. *Health & place*, *21*, 163-169.
10. DCC (2006), "Profile of Dhaka City Corporation", yearly publication, published by Dhaka City Corporation (DCC), January 2006.
11. Dhaka Transport Co-ordination Board, Ministry of Communications, (2006), Strategic Transport Plan for Dhaka. Dhaka: Government of the People's Republic of Bangladesh
12. Dörrzapf, L., Kovács-Győri, A., Resch, B., & Zeile, P. (2019). Defining and assessing walkability: a concept for an integrated approach using surveys, biosensors and geospatial analysis. *Urban development issues*, *62*(1), 5-15.
13. Edwards, P., & Tsouros, A. D. (2006). *Promoting physical activity and active living in urban environments: the role of local governments*. WHO Regional Office Europe.
14. Efroymson, D., &Rahman, M. (2005). *Transportation policy for poverty reduction and social equity*. WBB Trust
15. ESAF, (2013). Walkability and Pedestrian Facilities in Thrissur City.
16. Fabian, H., Gota, S., Mejia, A., Leather, J. and Center, A. C. (2010). Walkability and pedestrian facilities in Asian cities: state and issues Asian Development Bank, Manila, Philippines
17. Frank, L. D., Saelens, B. E., Powell, K. E., & Chapman, J. E. (2007). Stepping towards causation: do built environments or neighborhood and travel preferences explain physical activity, driving, and obesity?. *Social science & medicine*, *65*(9), 1898-1914.
18. Forsyth, A., Oakes, J. M., Lee, B., & Schmitz, K. H. (2009). The built environment, walking, and physical activity: Is the environment more important to some people than others?. *Transportation research part D: transport and environment*, *14*(1), 42-49.
19. Grob, D. & Michel, U. (2011) Grundlagenfür den Fußverkehr, Eidgenössisches Departementfür Umwelt, Verkehr, Energie und Kommunikation UVEK, Bundesamtfür Strassen, Zürich [in German].
20. Hossain A. M. (2005). Interaction of Land Use and Transportation. Training Course Material on Land Use Planning, Urban and Regional Planning (URP), Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh.

21. Hossain, Z. (2009). Prioritizing the Pedestrian. *The Daily Star*.
22. Hoque, M. M., Khondokar, B., & Alam, M. J. B. (2005, May). Urban transport issues and improvement options in Bangladesh. In *Proceedings of 2005 Canadian Transport Research Forum Conference, Hamilton*.
23. Jaskiewicz, F. (2000). Pedestrian level of service based on trip quality. *Transportation Research Circular, TRB*.
24. Lotfi, S., & Koohsari, M. J. (2011). Neighborhood walkability in a city within a developing country. *Journal of urban planning and development*, *137*(4), 402-408.
25. Montgomery, B., & Roberts, P. (2008). Walk urban: demand, constraints, and measurement of the urban pedestrian environment.
26. Nasrin, S., & Afifah, F. (2019, May). Walkability assessment tool for a developing country. In *IOP Conference Series: Materials Science and Engineering* (Vol. 527, No. 1, p. 012073). IOP Publishing.
27. National Research Council (US); Committee on Physical Activity, Transportation, Land Use, Transportation Research Board, and Institute of Medicine. Does the Built Environment Influence Physical Activity? Examining the Evidence; Transportation Research Board: Washington, DC, USA, 2005; Volume 282.
28. RAJUK, (2019). Rajdhani Unnayan Kartipakkha. Ministry of Housing and Public Works, Govt. of Bangladesh. Dhaka, Bangladesh.
29. Richardson, E. A., Mitchell, R., Hartig, T., De Vries, S., Astell-Burt, T., & Frumkin, H. (2012). Green cities and health: a question of scale?. *J Epidemiol Community Health*, *66*(2), 160-165.
30. Saelens, B. E., & Handy, S. L. (2008). Built environment correlates of walking: a review. *Medicine and science in sports and exercise*, *40*(7 Suppl), S550.
31. Southworth, M. (2005). Designing the walkable city. *Journal of urban planning and development*, *131*(4), 246-257.
32. Shah, M. Z. (2010). Rating pedestrian facilities with P-index and the application of google map (F. o. B. Environment, Trans.). *Malaysia: Universiti Teknologi Malaysia*.
33. UN (2020). UN World Urbanization Prospects. Retrieved from https://worldpopulationreview.com/world-cities/dhaka-population/. Accessed on 08/06/2020.
34. Xi, H., & Son, Y. J. (2012). Two-level modeling framework for pedestrian route choice and walking behaviors. *Simulation Modelling Practice and Theory*, *22*, 28-46.
35. Shah, M. Z., & Silva, A. N. R. D. (2010). Pedestrian Infrastructures and Sustainable Mobility in Developing Countries: The Cases of Brazil and Malaysia. *XVI PANAM, Lisbon, Portugal*

.