Questionnaire Approach on Walkability Index: A Potential Method Towards Pedestrian Safety Measures

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ABSTRACT: In this research, walking facilities and scopes for improvement of a major urban arterial of Dhaka city has been investigated. In order to ensure Progati Sarani as an ideal walkable area, walkability needs to be enhanced as walking is an essential and effective medium of sustainable urban transport. The supreme aim of this research is to determine the walkability indices of these particular areas and to find appropriate pedestrian safety measures for the sake of better and safe environment for pedestrians. A short field survey and a brief questionnaire survey were carried out for the completion of this study. The research identifies the most vulnerable areas for pedestrians in commercial areas of eastern part of Dhaka city. Notable hazards are roadway obstructions, road infrastructure deficiency, crossing facilities, motorists behaviours, safety and security etc. Finally, the overall walkability index has been calculated which is found to be approximately 38.8 out of total 100, considered as less walkable. This result is not satisfactory if it is compared to other major Asian cities. However, a huge volume of pedestrian movement is observed in the study area, most of whom are working class people and students. In such a situation, efforts should be given in formulating policies to promote walking as a priority mode of sustainable transportation system. Achieving a safe and congenial environment by incorporating road environmental safety measures along with road user's behavioural improvement is fundamentally important for the betterment of all sorts of pedestrians, particularly for ensuring their legitimacy and safety.

Keywords: Walking, Pedestrian safety, Walkability Index, Sustainable urban transport.

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1. INTRODUCTION

A smart, sustainable environment friendly city's one of the main priorities is to reduce carbon emission as much as possible [1]. But a developing country like Bangladesh is growingly reliable on motorization which is one of the major causes of carbon emissions resulting in global warming [2]. Asian Development Bank (ADB) [3, 4] argued that given its scale and significance for global climate change, urban transport provision and urban development in the developing cities in the Asia and Pacific region need to be closely coordinated to create more liveable cities with shorter journey times and journey distances with the provision of improved non-motorised transport facilities. The principles of non-motorised transport to be incorporated within integrated urban transport solutions and should make provision for non-motorised transport infrastructure together with pedestrian zones and walkways, segregated cycle paths and bicycle parking and rental programs. Hence a smart congenial city concept obviously could start from the concept of walking. As an engineer or urban planner, to grow up a green, sustainable and healthy mentality we have to start with walking.

From the other perspective, walking is generally beneficial for health, social and economic aspects of every person living in a society [5]. But unfortunately, Walking is not prioritized in Bangladesh. Huge road infrastructures are being built all over the country but no steps are taken on the pedestrians and their safety measures [6]. In the developed countries, a lot of research works are going on for assessing the pedestrian level of services but in Bangladesh the number is only a few. Pedestrians are not willing to walk in sidewalks either due to huge dust generation from streets and vehicles. They are also more concerned about their safety and security issues while walking. But the trends have to be changed. Therefore, in this paper the walkability of footpaths for pedestrians will be assessed and strategies will be recommended in a comprehensive way by a field investigation and a brief questionnaire survey. This research is also a part of the promotion of walking among the common people of the society.

2. THE CONTEXT OF WALKABILITY INDEX

The ADB [4] argued that "Asian cities have traditionally been cities of walkers, and many urban dwellers rely on walking, cycling and public transport for their daily travel. However, with the exponential increase in motorization, limited attention has been paid to pedestrian and public transport facilities. A change in focus is required which will allow people, not vehicles, to reclaim the urban environment". Bangladesh is

experiencing a great population boom centring the capital Dhaka. Rapid urbanization has led to severe congestion along with great number of pedestrian fatalities in Dhaka city. Just like other areas of the capital, the serene environment of Badda, Bashundhara and Vatara commercial areas in Dhaka city are gradually being disrupted by the evolution of massive urban growth, which eventually degraded the overall walkability of these commercial are as located at the eastern zone of Dhaka. As a megacity, Dhaka is expanding with a huge pace. It is the 11[th]largest megacity in the world by population and the city is going to climb up to 3rd place by the year 2050.

So its prospect of rapid congested expansion is very obvious. Hence, a proper urban planning creating supportive pedestrian friendly environment is an urgent necessity to improve the overall walkability of Dhaka as a whole. Improving walking path infrastructure is crucial for safe and sustainable way to better the walking environments in the city. Motorist Behaviours are very poor in Dhaka. Arrogant driving already caused a couple of deaths, all of whom were the pedestrians. Using International Road Assessment Programme (iRAP), a study by Hoque et el. [7] found that major pedestrian roads are rated as 2-star, indicative of very high level of risk of pedestrian deaths and injuries and are attributable to serious road road infrastructural hazards. It is argued that engineering safety on roads is clearly a priority issue and pedestrian fatalities cannot be prevented until safety treatments are built on road infrastructure. Route specific road infrastructural measures are fundamentally important for improving pedestrian safety.

3. METHODOLOGY

The principal concept of the study is mainly based on the formats and parameters used in the survey accompanied by the research paper 'Walkability and Pedestrian Facilities in Asian Cities- State and Issues'. The study includes a field walkability survey to gather people's sentiments on their walkability environments. The steps of the study are as follows:

(i) The selection of the study area.

(ii) Some preliminary studies for the survey.

(iii) Picking out the survey parameters.

(iv) A questionnaire survey on the study area according to the selected parameters.

(v) Additional data collection from relevant reliable sources.

(vi) Therefore, a final conclusion and recommendation from data analysis.

3.1 Study Parameters

The study area was surveyed based on the parameters set by the Asian Development Bank [4] (ADB, 2011) with slight modifications to make it more applicable with the socio economic context of Bangladesh. The stake holders were asked to rate the pedestrian facilities along the road from 1 to 5 for each parameter (1 for being lowest and 5 for highest). Table 1 and 2 describes the survey parameters and applied weightage, respectively.

Table 1: Questionnaire Survey Parameters.

Parameter	Description
Walking Path Modal Conflict	The extent of conflict between pedestrians and other modes, such as bicycles, motorcycles and cars on the road.
Availability of Walking Paths	This parameter is added to the original Global Walkability Index (combined with the original parameter "Maintenance and Cleanliness"). It reflects the need for, availability, and condition of walking paths.
Availability of Crossings	The availability and distances between crossings to describe whether pedestrians tend to jaywalk when there are no crossings or when the distances between crossings are too long.
Grade Crossing Safety	This refers to the exposure of pedestrians to other modes while crossing, the time spent waiting and crossing the street, and the sufficiency of time given to pedestrians to cross signalized intersections.
Motorist Behaviour	The behaviour of motorists toward pedestrians, which may well indicate the kind of pedestrian environment there is in that area.
Amenities	The availability of pedestrian amenities such as benches, street lights, public toilets, and trees. These amenities greatly enhance the attractiveness and convenience of the pedestrian environment, and in turn, the city itself.
Disability Infrastructure	The availability, positioning, and maintenance of infrastructure for the disabled.

Obstructions	The presence of permanent and temporary obstructions on the pedestrian pathways. These ultimately affect the effective width of the pedestrian pathway and may cause inconvenience to the pedestrians.
Security from Crime	The general feeling of security from crime in the street.

Source: Krambeck H, Virginia (2006) [8]

Table 2: Weights Applied on the Selected Parameters.

Parameter	Walking Path Modal Conflict	Availability of Walking Paths	Availability of Crossings	Grade Crossing Safety	Motorist Behaviour	Amenities	Disability Infrastructure	Obstructions	Security From Crime	Total
Weights applied	15	25	10	10	5	10	10	10	5	100

Source: S. Gota et al. 2014[9].

3.2 The Study Area

Some major locations of Dhaka City is selected for performing this study based on rapid pedestrian congestion. The study area included most part of Progati Sarani and Bir Uttam Rafiqul Islam Avenue. The starting point of the Survey was Kuril Bishwa Road and the end point was Rampura Bridge which comprises a total length of 6.2 km of walking paths.The largest shopping mall of Bangladesh Jamuna Future Park stands just beside Progati Sarani. Moreover, many nationalized business organizations and private companies opened their hub in this eastern center of the Dhaka megacity. Some notable higher educational Institutions have to singly rely on Progati Sarani/Bir Uttam Rafiqul Islam Avenue. North South University (NSU), University of Information Technology and Sciences (UITS), United International University (UIU), Independent University Bangladesh (IUB), Dhaka International University (DIU) and East West University (EWU) are mentionable among them. Hence, all employees, students and other common people of Badda, Baridhara & Bashundhara areas are relying on Progati Sarani and Bir Uttam Rafiqul Islam Avenue for walking. The local people are mostly habituated to walking as they have to travel very short distance to reach their important destinations located in the eastern part of Dhaka City. Figure 1 depicts the study area.
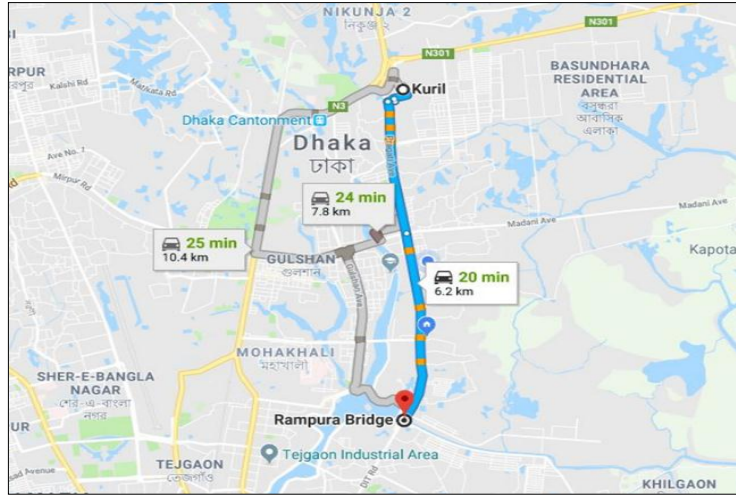
Figure 1: Map of Study Area Collected from Google Maps**.**

University of Information Technology and Sciences (UITS)
Department of Civil Engineering
Questionnaire Survey on Pedestrian Walkability
Survey Location:_____

Age:_____   Gender:_____

Parameter	Very bad	Bad	Moderate	Good	Very good
Walking path modal conflict					
Availability of walking path					
Availability of crossings					
Grade crossing safety					
Motorist behavior					
Amenities					
Disability Infrastructure					
Obstructions					
Security from crime					

Figure 2: Sample questionnaire survey data sheet.

4. DATA COLLECTION AND QUESTIONNAIRE SURVEY

The following procedure was adopted for collecting data:Data were collected basing on nine parameters across the 4 locations of Gulshan, Vatara and Badda Areas. The parameters were rated by the pedestrians on 5 marks.Good pedestrian facilities were marked more in number and vice versa. For example: 50 pedestrians were surveyed in Nodda-Natun Bazar area. Ratings of 50 pedestrians on a particular parameter were summed up

and taken on average. Then the output was multiplied by 20 as the Walkability Index is marked out of 100.Figure 2 represents a sample data collection sheet.Here is the formula which is used to find out the walkability Index on a section of the study area:

$$w = (m \div N) \times 20 \qquad (1)$$

Here, Walkability index for a definite parameter= w, Total marks provided by the pedestrians= m, No. of pedestrians involved in the survey= N.

Similar formula is used for determining walkability for different age groups.A mean value is calculated using the general ArithmeticMean formula for 4 sections which is denoted as W.

$$W_w = (W \div 100) \times W_t \qquad (2)$$

Where, Weighted walkability value for a parameter= W_w; Walkability percentage found from an individual parameter= W; Weight of the individual parameter= W_t.

After that, the values found putting all other percentages of respective parameters by using this formula is summed up. Therefore, overall walkability index of the particular area is determined. i.e

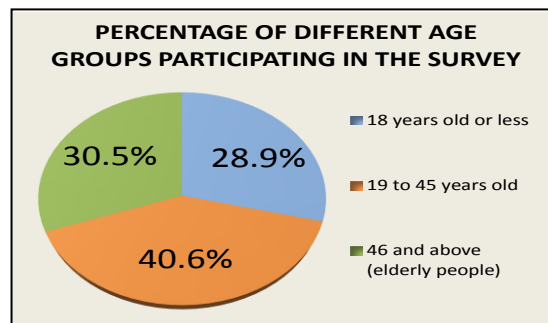Overall Walkability Index= $\sum W_t$ (3)

Figure 3: No. of people in the survey.

A structured questionnaire survey was conducted to assess the extent of risk factor associated with pedestrians. In total 266 respondents participated in the questionary survey process. Among them 77 respondents were below the under 18 years old, 108 respondents were between 19 to 45 years old and 81 respondents were above 46 years old.

A large group of working class people walks in the area we studied. They were often found walking within 7 to 9 AM in the morning. Natun Bazar, Uttar Badda and Nodda were most crowded areas for working class

people and students. Students aged below 18 were seen walking in a group most of the time. Elderly & disabled people were very rare on the foot paths. From figure 3, we can observe the number of pedestrians who helped us participating in the questionnaire survey by answering 9 different questions on 9 parameters As the study area is a commercial area and some well established universities is located, most of our respondents approximately 70% are young students and middle aged working class people.

5. DATA ANALYSIS

The walkability index for male and female pedestrians are expressed in Figure 4.We observed that female respondents rated all the parameters lower than the male respondents. Overall walkability index is approximately 35 percent which is very poor than the other cities in developing country. Female pedestrians felt less secured than male pedestrians while walking in the footpaths. That's why the parameter 'Security from Crime' was graded lower by female than the male persons. Same cases are found while surveying on the parameter 'Grade Crossing Safety'. From Figure 5, middle aged people feels that the infrastructures for the disabled people should be improved as they rated 'Disability Infrastructure' as the lowest one. Disabled and Elderly pedestrians expressed as the least secured while walking in the street as they rated 'Security From Crime' as the lowest among all class of people. They also complained on the temporary stalls set up on the middle of the walking paths. Figure 5 also shows that all pedestrians felt 'Motorist Behaviour' as wretchedly. They complained on reckless driving of the motorists. The pedestrians also seemed to dislike the temporary obstructions upon the walking paths in most cases. As well as they underrated the parameter named 'Amenities', 'Disability Infrastructure' and 'Obstruction'. 'Disability Infrastructure' and 'Amenities' are other fields where there are huge scopes for improvement.
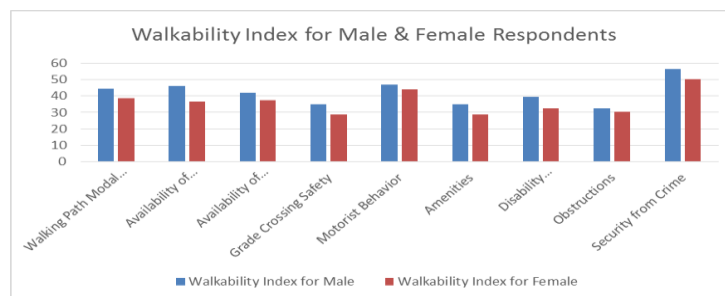

Figure 4: Walkability Index for male and female respondents**.**
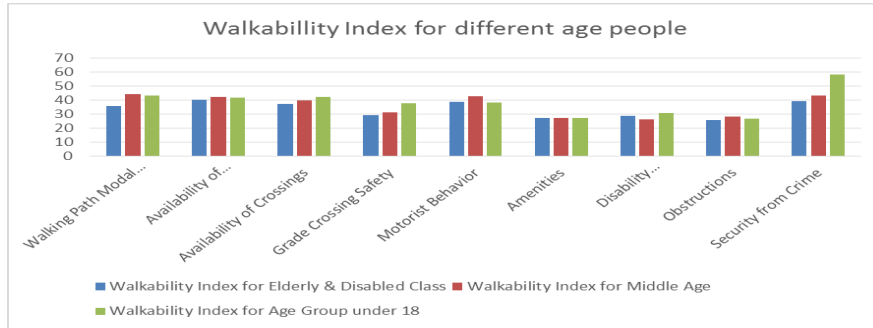
Figure 5: Walkability Index for different age people.

Figure 6 express the overall walkability index at progatiSarani for different aged group and gender. Male and female respondents of different aged group felt trouble to walk in the footpath at ProgatiSarani due to lack of adequate amenities for the pedestrian. As well as frequent obstructions are seen on the footpath for which motor bike drivers and street hawkers are prime responsible.
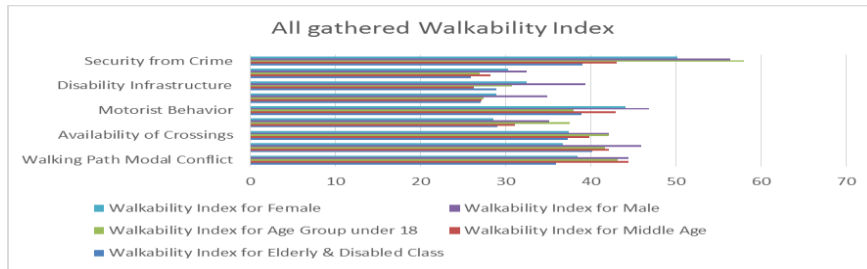

Figure 6: All gathered overall walkability index for different aged group and gender.

Table 3: Overall walkability index calculation.

Parameters	Walkability indices of study areasw (%)				Avg. W (%)	Weights applied, W_t	Individual Walkability W_w
	Kuril-Bashundhara	Nodda - Natun Bazar	Bashtola - Uttar Badda	Link Road-Rampura			
Walking Path Modal Conflict	38.4	32.5	42.7	31.5	36.2	15	5.430
Availability of Walking Paths	48.1	49.6	47.3	50.9	49.0	25	12.243

Availability of Crossings	26.1	43.9	34.8	31.2	34.0	10	3.4
Grade Crossing Safety	27.3	50.4	29.2	33.4	35.1	10	3.508
Motorist Behavior	33.1	32.6	35.3	**19.3**	30.1	5	1.504
Amenities	38.7	**15.6**	48.7	36.7	34.9	10	3.493
Disability Infrastructure	41.3	34.7	**32.1**	39.2	36.8	10	3.683
Obstructions	**25.4**	28.1	25.8	40.1	29.9	10	2.985
Security from Crime	56.9	52.4	55.9	42.3	51.9	5	2.594
Total						**100**	$\sum W_w$= **38.84 %**

Table 3 presents the results of the walkability indices for the individual sections of the Progati Sarani. It shows that highest rated parameter in Bashundhara-Kuril area was detected to be the 'Security From Crime'.

Figure 7: Nasty odours from wastes hamper pedestrians who walks in Badda area.

Figure 8: Wastes are kept just beside the walking path in Natun Bazar.

But as there is no over bridge in the Bashundhara gate area so the number of pedestrians arrogantly crossing the street in there is quite high to be exact. Undoubtedly, that's why the area gets inferior ratings in the 'Availability of Crossings' parameter. 'Amenities' in Nodda area proved to be deficient especially in the Nodda intersection. There are various inter district bus counters in Nodda. As a result a lot of passengers gather in the walking path which hampers the walking flexibility of the pedestrians in Nodda. Pedestrians in Uttar Badda gave a different feedback on pedestrian facilities in there. Pedestrians in there felt highly safe while walking due to lesser security concerns.

On the other hand, 'Obstructions' were rated as the lowest parameter. Because of the highly integrated and congested commercial area the parameter 'Obstructions' were given a poor rating. The overall walkability of the study area we found is 38.84. Detailed discussion about it is provided in the "Results and Discussions" section distinctly. Figure 9 shows the overall walkability ratings of Progati Sarani. It can be seen that Pedestrians rated 'Obstructions' as the nethermost parameter which was found to be 29.9. The pedestrians in the footpaths typically find different temporary shops and even waste carrying trucks as their obstacles while walking. Especially the temporary cloth shops are set up at night which hampers the working class people while they return back home from work. Walking path availability was seen to be enough in most of the study area but proper utilization of those were not observed in most cases. 'Availability of Walking Paths' and 'Security From Crime' were found to be the higher rated parameters than others. (48.97 & 51.9 respectively).
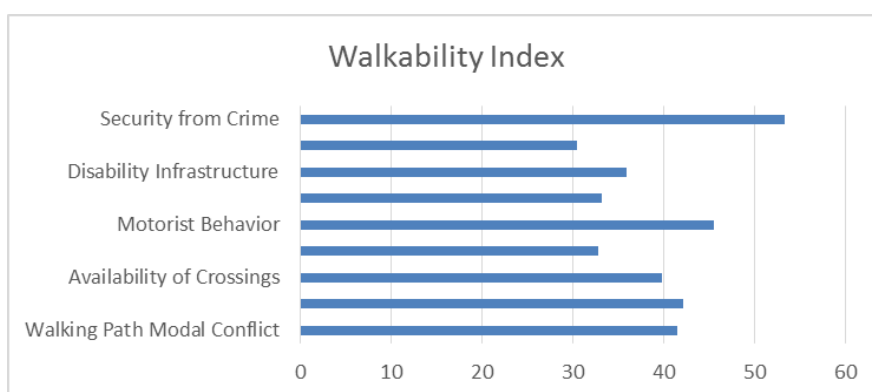

Figure 9: Overall Walkability Index by parameter at Progati Sarani.

6.   RESULTS AND DISCUSSION

Table 4: Walkability Index Categorization.

Walkability Index	Remarks
90-100	Walking Paradise
60-89	Very Walkable
40-59	Walkable
20-39	Less Walkable
0-19	Not Walkable at all

The overall walkability of the study area is found to be 38.84 which is comparatively lower than most of the Asian cities like Ho Chi Minh City, Hong Kong, Lanzhou and even our neighbouring city of Kathmandu. Parameters like 'Obstructions' and 'Motorist Behavior' were mostly responsible for being rated this low although none of the parameters showed good standard in this survey. Our survey locations included mainly commercial areas of Eastern part of Dhaka City. But still the rating is too low compared to other south Asian cities. Hence, Theprogatisarani area can be remarked as 'Less Walkable'.

We would like to summarize our discussion by comparing the walkability of Dhaka City's commercial area withthe other Asian cities. From Table 7 it can be realised that Dhaka is the least walkable city among 14 surveyed cities from different Asian countries while most walkable city in the list is Metro Manilla. Dhaka is only close to its South Asian counterpart Kathmandu in terms of walkability rating. Therefore, It is no wonder that Dhaka was ranked as the 2nd least liveable city among 140 major cities around the world in 2018 according to Economist Intelligence Unit's annual global survey.

Table 5: Comparison of Dhaka City's Walkability with Other Surveyed Asian Cities.

City Name	Metro Manila, Philippines	Ulaanbaatar, Mongolia	Ho Chi Minh, Vietnam	Davao, Philippines	Cebu, Philippines	Hong Kong, PRC	Lanzhou, PRC	Colombo, Sri Lanka	Kota, India	Jakarta, Indonesia	Karachi, Pakistan	Ha Noi, Vietnam	Kathmandu, Nepal	**Dhaka, Bangladesh**
Walkability Index in Commercial Areas	78.52	76.48	72.84	69.07	68.18	63.89	63.61	56.16	51.39	50	49.63	49.56	44.44	**38.84**

Note: The data for other Asian cities except Dhaka are from Leather et al. 2011[10].

It is to be noted that by individual parameters Kota, city of India had the lowest ratings in terms of the parameters like 'Obstructions' and 'Disability Infrastructure' (26.25 and 20 respectively) [10]. By comparison, however, Dhaka rated slightly better in respect to the parameters like 'Obstructions' and 'Motorist Behavior' which are 29.9 and 30.1 respectively.

7. CONCLUSIONS AND RECOMMENDATIONS

The data analysis and results clearly demonstrated that hazards associated with roadway environment, road user behaviour, road design deficiencies, inadequacy of pedestrian facilities, indiscriminate road use etc. are the notable obstacles in making a safe walking environment for pedestrians. Therefore, road design engineers, urban planners and law enforcing professionals have to take cognizance of all these challenges to ensure the legitimacy of urban pedestrian communities. The striking observations and recommendations are outlined below:

- The walking paths are very narrow in most of the parts of the study area. In our study, we found that most of the respondents underrated the parameter amenities that were below than the average. Especially the side walk width of Bashundhara and Nodda area were inadequate. The footpath leading to Bashundhara residential area is too congested to walk. The footpaths are recommended to be maintained properly. Adequate space is required for ensuring the comfort, safety and security of the pedestrians.

- It is observed that obstructions in the footpath are a common phenomenon in Dhaka city. Most of the respondents rated it below 30 out of 100. According to the walkability catagorization, it is less walkable. Due to many temporary foods, clothes and tea stalls are located in the Bashundhara gate, pedestrian gatherings are excessively high in those temporary shops. It is creating a great blockage for other pedestrians while walking in that area. Laws should be enforced on the temporary obstructions present in the walking area. Signboards indicating 'Obstruction Free Area' may work in solving this problem.

- Amenities in Nodda area are very poor especially in the Nodda intersection. There are various inter-district bus counters in Nodda. As a result a lot of passengers gather in the walking path. Properly maintained bus bay can be installed in Nodda Area to separate the waiting passengers and pedestrians.

- Noddaarea is a highly pedestrian orientated zone.As most of the pedestrians are in short cut motive, generally they cross the road using unsignalized section of road and try to avoid the uses of overpass. This arrogant behaviour really can be dangerous for them. So, pedestrian barriers with high elevation are recommended to be installed in the road divider.Strict enforcement measures need to be in place to deter indiscriminate crossings in the intersection area.

- Natun bazar is another busy intersection of Progati Sarani. It is one of the most important intersections too. Wastes were kept open beside the walking path of Natun bazar. It created a huge disturbance to the pedestrians of that area. These dustbins and associated hazards are also a leading factor of environmental pollution. So, the sedustbins are recommended to replace. So proper management of waste disposal is fundamentally important for ensuring clean walking facilities.

- Uttar Badda is a quite congested commercial area. Elimination of the temporary shops are recommended for unobstructed movement of pedestrians.

- Badda link road is rated badly in terms of 'Motorist Behaviour' parameter. Law enforcing agencies need to work effectively to manage the huge traffic in Rampura and Badda Link road.

It is expected that the above road environmental measures together with road user's behavioural improvements will help to promote pedestrian friendly walkability environment in Dhaka.

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