

Unveiling Urban Vulnerabilities: Analysis of Pedestrian Safety and Experience at 2 No Gate, A Major Arterial Road in Chittagong, Bangladesh

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Abstract

In developing countries such as Bangladesh, pedestrian safety is a pressing concern due to inadequate infrastructure and increased vehicular traffic resulting in frequent conflicts between pedestrians and vehicles in urban areas. Chittagong is the second-largest city in Bangladesh where, in addition to road accidents, pedestrians also encounter challenges due to the prevalent issue of water clogging caused by the inadequate drainage system. The study aims to analyze the experience and the multifaceted risks faced by pedestrians in Chittagong which include road safety concerns as well as the threats during monsoon seasons. The research gathers data leading to twofold investigations on 2-no. gate area, based on the physical infrastructure and the road users' behavior using human perception analysis, an in-depth questionnaire survey, and examining the previously occurring accidents. Analyzing the data, the paper has attempted to shed light on the major causes and factors of pedestrian accidents in the area and suggested appropriate guidelines to reduce accidents and enhance pedestrian movement facilities in similar scenarios.

Keywords: Pedestrian Safety, Pedestrian Accident, Water Clogging, Inadequate Infrastructure, Chittagong

1. Introduction

Walking has long served as a traditional means of transportation, transcending urban and rural landscapes alike. Individuals prefer walking for various reasons, particularly in developing nations. The quality of sidewalks, characterized by high safety and comfort standards, holds considerable importance in promoting walking as a viable mode of transportation, ultimately yielding health and environmental advantages. (Martin, 2006). Enhanced pedestrian facilities enable greater accessibility and mobility throughout the communities. Thus, considering the importance of walkways as places for social interaction, the gathering of shared memories, and the need for establishing a structured approach to implementing safe walkways, it is essential to encourage people to engage in urban environments. (Bahreini, 2007).

However, Bangladesh faces numerous challenges in creating pedestrian-friendly environments due to rapid urbanization and high population density in urban centers and growing nodal points. (Mahmud, Ahmed, & Hoque, 2014; Zinia, Mamun, & Sultana, 2016). The Road Safety Foundation reports that 1,627 pedestrians lost their lives in road accidents in 2022. Of these fatalities, 48.74% occurred while walking on streets lacking sufficient pedestrian walkways, and 51.25% happened while crossing roads. (Tajmim, 2023). Specially in Chittagong city, there is almost no walkway that can be called safe. In most parts of the city, the sidewalks are taken up either by parked vehicles or vendors with their makeshift stalls. Main highways and walkways in the port city are blocked due to ongoing construction for a number of development projects. As a result, sidewalk space is scarce throughout the city, especially along some busy roads including New Market, Teri Bazar, Chowk Bazar, Muradpur and Bahaddarhat. Despite a large number of daily pedestrian trips in the CBD areas of Chittagong, there is a significant shortage of pedestrian-friendly facilities and walkways on both sides or even one side of the roads. (DAP, 2009). Although walking is recognized as the most eco-friendly and sustainable mode of transportation, policymakers in Chittagong City prioritize private cars, buses, and then pedestrians in their transportation planning for reasons that are incomprehensible reasons. The prevailing emphasis on vehicular infrastructure has led to city streets being predominantly designed to accommodate high-demand vehicular flow, with inadequate consideration for pedestrian safety. Hence, pedestrian accidents occur frequently which leads to injury, and even their death. Some efforts should be paid attention.

This study aims to explore the existing pedestrian walkway conditions in a specific area of Chittagong city, identifying the factors that affect pedestrian safety and comfort within the urban context. The specific objectives of this study are given below-

- **Assessing the Current Situation.** This involves a comprehensive analysis of the existing pedestrian walkways in the chosen area of Chittagong city. The focus will be on evaluating various factors that influence the safety and comfort of pedestrians, such as presence of walkway, presence of obstacles, lighting, buffer with the main road etc.
- **Clarifying the needs for developing a safe and comfortable sidewalk experience** from the pedestrian perceptions.
- And lastly by interpreting key findings of studies **proposing guidelines aimed at improving pedestrian safety** and creating viable, pedestrian-friendly streets.

2. Literature review

A walkable environment necessitates certain physical elements to create a successful urban space (Amen, 2021; Amen et al., 2023; Jacob, 2023; Moretti, 2023). An improperly designed environment, lacking well-designed sidewalks, attractive scenery, and diverse destinations, will lead pedestrians to walk only as far as necessary from their cars, even if pedestrians are present. Researchers and practitioners have conducted numerous studies to explore pedestrians' perceptions of the comfort level of pedestrian paths and to propose various suggestions for creating a safe and comfortable pedestrian environment. Villaveces, et al. conducted a study on Pedestrians' Perceptions of Walkability and Safety in relation to the built environment and how the built environment affects walking and ideal walking conditions. (Villaveces, et al, 2012). Park and Garcia conducted a study revealing that proper street lighting significantly enhances feelings of safety on the road. This was followed by the morphological complexity of roads, characterized by various types of businesses, outdoor eating areas, street performers, and other pedestrian activities. (Park and Garcia, 2019). According to Funk, Factors such as street connectivity, sidewalk width, roadway width, street furniture, and the articulation of building facades are some physical characteristics thought to impact the walkability of a street and neighborhood. (Funk, 2012). Another study revealed that the majority of respondents were hesitant to use sidewalks because of the deteriorated road surfaces and untidy pathways, with many also perceiving the side roads as being too narrow. (Rahman, et al, 2015). Lehman and Boyle included three subtitle to make a walkable built environment, they are; "Network, Environment and Destination". (Lehman et al., 2007)

Table 1: Effective parameter of built environment on Walkable pedestrian environment (Lehman et al., 2007)

Variables of user-friendly concept	Definitions	Parameters
Network	Similar to how cars need a consistently maintained road network to travel, pedestrians also require a well-designed network that ensures safe and comfortable walking.	<ul style="list-style-type: none"> ● Sidewalks ● Crosswalks ● Directness
Environment	At the level of human interaction and walking speed, strolling enables individuals to fully appreciate the neighborhoods or urban surroundings. Pedestrians are inclined to walk when they are confident that their journey will be secure and enjoyable.	<ul style="list-style-type: none"> ● Aesthetics ● Security ● Building Orientation
Destination	While walking for leisure can be enjoyable, for most people, walking serves as a means to reach a destination. Even if a street system is highly walkable, it may not be utilized if it doesn't offer access to desired destinations.	<ul style="list-style-type: none"> ● Daily Functions ● Land Use Pattern

Furthermore, recent research has demonstrated that creating pedestrian-friendly environments is integral to enhancing livability and fostering sustainable communities. (Shamsuddin, et al. 2012). Additionally, pedestrianization plays a crucial role in advancing the goals of a livable city by facilitating sustainable access and connectivity for all residents within a neighborhood. Therefore, adopting pedestrian-oriented design serves as an effective strategy for enhancing the city's livability, improving accessibility, mobility, safety, and overall environmental quality, thus ensuring a high-quality living environment for all its inhabitants. (Soni, 2016). Moreover, the function of a pedestrian street extends beyond merely facilitating movement; it also serves as a public space where social interaction, various activities, and accessibility are integrated. (Jou, 2011). Su et al. stated that sustainable mobility creates the ability for community interaction and reduces the use of automobiles for improvement in public health and safety (Su et al., 2017). It also reduces transit costs and provide other economic benefits (Marquet & Miralles-guasch, 2015).

3. Research Methodology:

The research methodology involves a twofold investigation to gain practical and grounded knowledge about the existing conditions of the study area, users' perceptions and their need for the future development of the existing situation.

a) Reconnaissance Survey: An initial survey was conducted to gather data on the existing situation guided by the parameters outlined in the literature review. This involved documenting the physical infrastructure present or absent in the study area and reviewing of published professional reports, newspaper reports on drainage and water logging with particular reference to 2 no gate area.

b) Questionnaire Survey: A comprehensive survey was conducted using a set of 42 questions directed at pedestrians walking on streets or walkways from the 2 No. Gate node to the Muradpur junction, leading to the Bohoddarhat circle. The survey included:

- Nearly 450 respondents.
- Conducted over three weekdays.

3.1 Selection of Study area

For analyzing the existing condition of the pedestrian walkways and issues affecting the users comfort and safety, we have taken 2 no gate. road to bohoddarhat area of Chittagong city as our main study area. This area contains major three intersections: 2 no gate, Muradpur and Sholoshohor. Two very important roads named Chawkbazar and Hathazari road is connected with 2 gate junction and Muradpur junction that leads to Bohoddarhut junction. The selected area is one of the major public gathering hub of Chittagong because of these important junctions and activities (e.g. shopping area, bazar, hospital area, schools, industries).

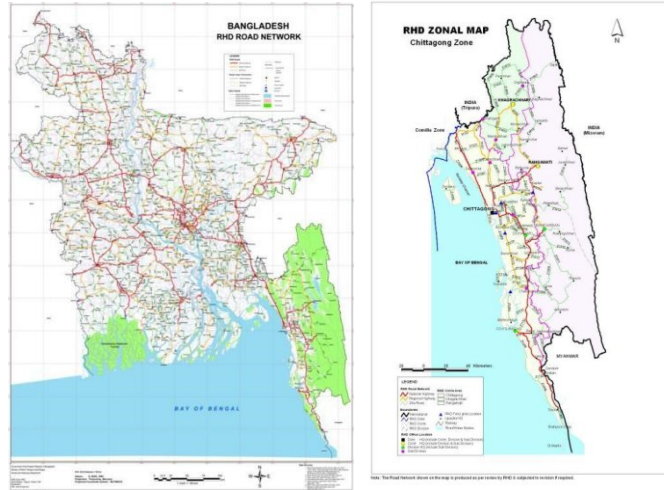


Figure 1: Location map of Study Area (Source: Road and Highway Department, Bangladesh)

The primary land use in the study area is commercial, predominantly located alongside the main road. Major commercial buildings of this area are Chittagong Shopping Complex, Sanmar Ocean City, Almas shopping Mall, Finley Square shopping market, different types of banks, offices etc. There is a large population accumulation in these commercial establishments. This excessive population encourages excessive vehicle and pedestrian traffic as well as stalling along the sides of the road. In addition, commercial institutions do not have enough parking spaces. Here, it is quite common for vehicles to park on both the street and pedestrian walkways.

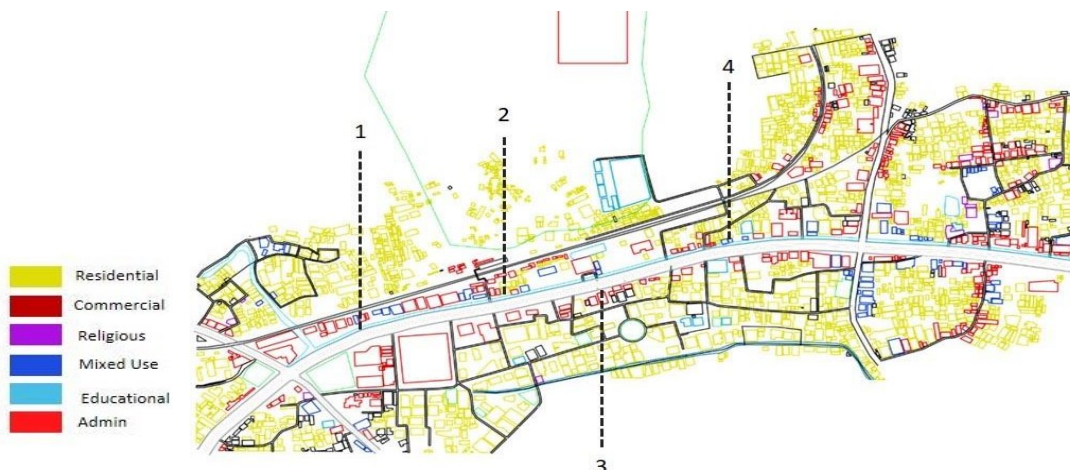


Figure 2: land-use pattern of the study area

3.2 Existing Condition

1. Piling of Garbage on Pedestrian Walkway

The escalating issue of garbage accumulating on pedestrian pathways has become a pressing concern for the community. As refuse continues to mount, pedestrians find their walkways obstructed, causing inconvenience and hazards for those on foot. Frustrated by the impediment, many individuals are reluctantly resorting to using the road for walking, adding an additional layer of risk to their daily commute. Addressing this challenge is essential to ensure safe and accessible public spaces for everyone.

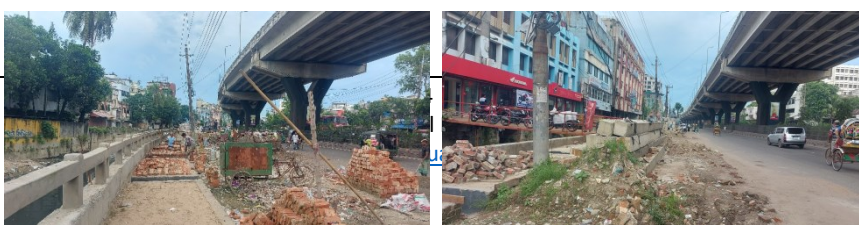


Figure 3: Existing condition of the study area

2. Intrusion on Pedestrian Space

Shops, parking, and various other elements occupy and reduce the available pedestrian space, limiting the areas designated for walking and posing impediments to foot traffic. This encroachment not only diminishes the accessibility of sidewalks and footpaths but also hampers the safety and convenience of pedestrians navigating through these congested areas.

Open Drain Beside of Footpaths and Sidewalks

Dangerous open drains situated alongside footpaths and sidewalks pose a serious hazard to pedestrians. These uncovered channels not only disrupt the smooth flow of pedestrian traffic but also pose a risk of accidents, particularly in low-light conditions or when visibility is poor. Individuals, especially children and the elderly, are vulnerable to falling into these drains, potentially resulting in injuries.



Figure 4: Existing condition of the study area

3. Lack of Proper Pedestrian Walkway

One of the primary issues affecting pedestrian safety along 2 No Gate Road is the insufficient provision of proper footpaths and uninterrupted walkways in many areas. The absence of adequate sidewalks often compels pedestrians to walk on the arterial roads, exposing them to vehicular traffic and increasing their vulnerability.



Figure 5: Water clogging during rainy season (Tajmim, 2023)

4. Water Clogging During Monsoon Season

The inadequacy of the drainage system in this region has given rise to a significant issue during the monsoon season, particularly for pedestrians. The accumulation of water has reached a critical level, posing a serious challenge to those on foot. A moderate to heavy rainfall is enough to inundate main roads, lanes and by-lanes with water levels reaching knee-deep. Consequently, the situation has transformed into a hazardous scenario for pedestrians, resembling a potential death trap. The absence of proper drainage covers has led to instances where pedestrians inadvertently fall into uncovered drains, facing catastrophic consequences. In the last two years, six people, including women and children, have drowned due to waterlogging in Chattogram. (Tajmim, 2023)



Figure 6: Inadequate road crossing scenario (Jewel, 2022)

5. Inadequate Road Crossing Provision

During the survey availability of pedestrian crossing signs, pedestrian traffic signals and conditions of crosswalk markings have been observed. Due to absence of adequate median barriers allowed pedestrians to cross the road haphazardly instead of using the designated crossing facilities. Moreover, there is only one overpass in the Muradpur junction found in the whole selected area. Unfortunately, the accessibility of this overpass is often hindered by the encroachment of hawkers creating a significant challenge for the pedestrians to cross the road.

3.3 Data analysis

As the data collection for this research was performed in two distinct phases., where the first phase involved a field survey focusing on pedestrian infrastructure and the second phase consisted of a questionnaire survey. This study utilized the questionnaire survey to identify various factors that contribute to the overall safety and comfort of pedestrians. From various literature surveys, these factors can be defined as 1) Comfort of sidewalks, 2) Position of signs and signals, 3) Provision of road crossing, 4) Presence of street lights 5) Safety from traffic vehicles 6) Condition of pedestrian during Monsoon season, and 7) Pedestrian Visibility 8) Crime rate in the area. (Arifah & Hidayah, 2021) The present condition of these factors of safe pedestrians was surveyed through in-depth questionnaires on people of various ages, gender, and professions. The focus group of people was primarily done based on age since the pedestrian walkway and road are used by all age groups throughout the day. We conducted the survey on 3 age groups: 1) children and young teenagers (6-19 years of age) 2) young and mid-aged adults (20-49 years of age) 3) old adults (50 and more).

We conducted the survey based on 42 questions asked to the pedestrians walking on streets or walkways from 2 no. Gate node to Muradpur junction leading to Bohoddarhut circle. They were asked to rate the various conditions of the road and the walkway from 1 to 5 where 1 indicated the lowest score where respondents completely disagree, and 5 indicated the highest score where they agree to the matter. There were almost 450 respondents in the survey carried out for 3 days of the weekday. The number of respondents for each group of people was counted as 115 people from Group 1; 257 people from Group 2 and 84 from Group 3.

Every day, thousands of people of all ages walk through the sidewalks from 2 no. gate to Bohoddarhut circle. People visit the site either for crossing the area, or for transportation, or for their daily activities. Analyzing the results, we find out that the most affected people by the condition of the pedestrian are the elderly ones. The rates given by the different age groups of the targeted population are shown in chart 1. Here, it is seen that the youngsters rate the sidewalk safety category as the lowest. According to this group, pedestrians are not comfortable walking, and especially during monsoon season, they are not safe. It was reported by a 16-year-old school-going boy, "I have to cross the road every day at least two to four times. The road contains heavy traffic vehicles and dust, so it's not convenient to cross the road as I can't see what is appearing in front." It was also reported that even though the crime rate is less in the daytime, oftentimes hijacking occurs at night and dawn, Pick-pocketing occurs in busy hours in the nodes during the daytime also.

The elder group of people, however, faces lesser difficulty in crossing roads, probably because they have experienced the road for a longer time, but the hazards are no different in the rainy seasons. There is also a lack of pedestrian lights, borders on streets, traffic signs and signals, and properly constructed pedestrian walkways which is making the road more difficult to walkability. Thus, it is evident that the surveyed site area is not safe for pedestrians according to the user's perspective. It is regarded as unsafe, or not safe for people of all ages and genders using it on a daily basis.

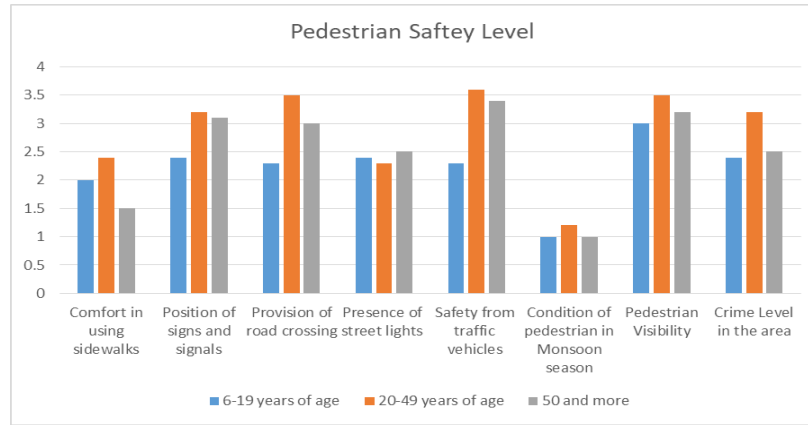


Figure7: Comparing Questionnaire survey analysis for the selected area

The perception of the pedestrian by the surveyors was taken along with the exact condition of the pedestrians at present. Information on various features of the sidewalk, its major deficiencies and suitability, etc. were collected, and a mapping was developed based on it showing the level of comfort that pedestrians feel on the streets.

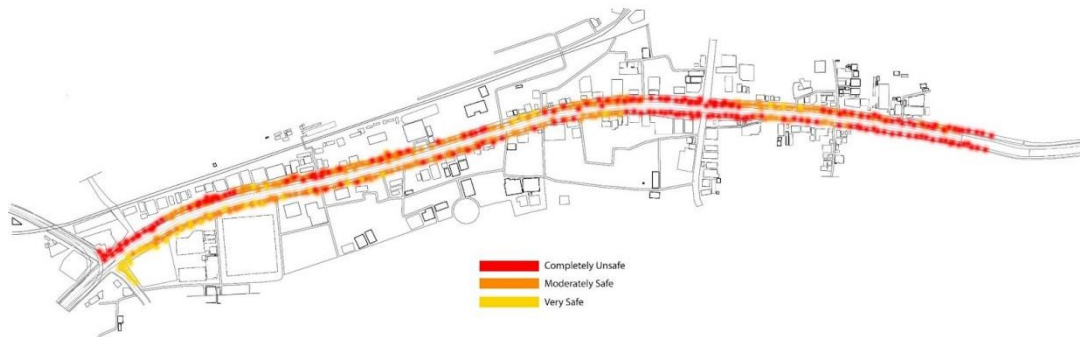


Figure 8: Safety level mapping from 2 no. Gate to Muradpur Fly-over junction from the user's experience

Feedback from pedestrians from the survey showcases that, the areas that are not at all safe (red marked) contains the following characteristics:

1. The pedestrian walkways are not present / well-defined.
2. There are no barrier or buffer between the walkway and the 30' canal.
3. The walkways are not continuous and they lead to forcing people to walk on busy heavy-traffic roads.
4. There are no buffer between the busy road and the walkways
5. Unauthorized vehicles parked on streets
6. Illegal hawkers settled on walkways and blocking the regular integration.

4. Recommendations

The survey results highlight significant opportunities for enhancing the walkability and safety of the 2 no gate pedestrian area. World Health Organisation (WHO) has established a manual to raise concern about pedestrian safety and strengthen national and local capacity to implement pedestrian safety measures in settings worldwide. By Following the guidelines, some strategies can be adopted to transform the 2 no gate area into a safe, comfortable destination for the pedestrians.

Table 2: Framework for safe walking (developed and modified from WHO, 2013 ; Walk 21,2013)

A comprehensive framework for safe walking	Improved Integration of Networks	-Connected , safe and functional walking networks -Integrated Public Transport
	Increased Inclusive Mobility	-Accessible Streets -Accessible Squares -Accessible Public Transit
	Supportive Land-use and spatial planning	-planning that gives priority to people on foot -pedestrian access for new developments
	Less crime and fear of crime	-Building with views onto and activity at street level -Brighter, lighter streets with clear sightlines
	Well designed and managed spaces and places for people	-Clean, well-lit streets and paths, free from obstruction -Paths should be wide enough to accommodate maximum usage and offer ample opportunities for safe and direct road crossings without requiring level changes or detours.

Table 3: Recommendations based on the WHO and from pedestrian feedback mapping

Safety measures established by WHO	Criteria followed on questionnaire survey (Arifah Hidayah, 2021)	Average grade obtained from the survey	Recommendations based on the WHO and from pedestrian feedback mapping
Integration			
Accessibility	Pedestrian Visibility	3.5	
Proper Planning	Safety from traffic vehicles	3.5	Increasing public awareness
Safety and security	Position of signs and signals Provision of road crossing Presence of street lights Crime rate in the area	2.5	Storm-water management Modern crossing facilities
Walking pleasure	Comfort of sidewalks Condition of pedestrian during monsoon season	1.5	Infrastructure development

From the data gathered from the survey, it is evident that the study area lacks adequate pedestrian infrastructure. To address this, it is essential to provide wide and well-paved sidewalks with designated spaces for pedestrians on both sides of the road. Additionally, effective management of hawker encroachments is essential to maintain these pedestrian walkways. This involves not only providing safe footpaths but also implementing strategies to regulate and address the issue of unauthorized occupation by street vendors. Balancing the needs of both pedestrians and vendors while ensuring clear and unobstructed walkways is key to fostering a pedestrian-friendly environment. Tress, Planter box should be provided to separate the sidewalks from the main road. Pedestrians are generally reluctant to walk alongside fast-moving traffic because it feels unsafe. The reduction of buffer zones is one reason why walking is less common in urban areas. This lack of buffers also makes an area appear harsh, presenting a bland expanse of pavement instead of a welcoming and aesthetically pleasing natural strip. The buffer zone will vary according to the street type. Streetscapes can be designed to create a vibrant and functional pedestrian walkway. The combination of streetscape features including lighting, street furniture, public art, and landscaping makes the area more welcoming and enjoyable for pedestrians. A well-thought-out streetscape improves the whole impression and entices users to use and enjoy the pathway.

Moreover, the surveyed region reveals evident encroachments on pedestrian pathways, which impede accessibility. Enhancing accessibility necessitates prioritizing pedestrian visibility. Clean, clear and visible pedestrian walkways will greatly improve accessibility. Waterlogging poses a significant concern in the surveyed area, particularly during the monsoon season. Implementing solutions such as porous concrete, permeable pavers, and pervious asphalt can mitigate this issue by allowing rainwater to infiltrate the ground rather than running off into storm drains. These materials help to reduce surface water runoff and lessen the burden on storm-water systems. Rain gardens, bioswales, or vegetated strips alongside sidewalks can capture, filter, and absorb storm-water, reducing the volume of water entering the drainage system. Researches should be conducted to find proper plantation type in the context of Chittagong city’s weather to serve the purpose. The existing open drainage should be covered and buffers should be provided to separate the walking area from the drain during water clogging.

It is imperative to increase public knowledge of pedestrian safety issues since walkers and drivers alike frequently do not understand the need of pedestrian signals. To make sure kids understand how to use these signals correctly, there is an urgent

need for more education, especially aimed at them. Furthermore, it would be advantageous to place pedestrian flags at intersections that schoolchildren regularly use.

5. Conclusions

Pedestrians need facilities that are secure, aesthetically pleasing, practical, and easy to use for their comfort and safety; walking infrastructure in cities is particularly important for this. When pedestrian facilities are poorly designed, they can cause long-term issues, discourage use, and make people feel uncomfortable, exposed, or unsafe. Unfortunately, urban planning and design initiatives in Bangladesh frequently overlook pedestrian needs in their plans. This paper examined the current scenario of the pedestrian walkway between 2 no gate to Bohoddarhat Area of Chittagong city through a two-phase data collection process. Both the findings of the physical survey and the user responses emphasize the critical need for actions to improve pedestrian safety in the selected area. There are several reasons for this insufficiency, such as poor infrastructure, shortage of features that are conducive to pedestrian movement and policymakers' neglect towards the people on foot. This situation is similarly happening in other parts of the city as well. A multifaceted strategy including public awareness campaigns, improvements to infrastructure, and city planning is required to address these problems. Based on observational studies, several strategies were proposed to address pedestrian safety issues. This study focused solely on the pedestrian environment, providing recommendations for its improvement without taking other factors, such as automobile traffic, into account. Further research should be conducted throughout different times of the year to better understand the factors contributing to pedestrian safety and comfort, as well as to evaluate the effectiveness of various initiatives. This approach is essential to addressing issues comprehensively and fostering a vibrant, pedestrian-friendly urban environment in the city.

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Conflict of Interests

The Author(s) declare(s) that there is no conflict of interest.

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