Pedestrian Behavior and Footpath Service Quality in Hilly Tract Region in Bangladesh

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ABSTRACT

Pedestrian level of service is an important parameter to understand the walking condition of footpath. This study evaluates pedestrian behavior and footpath service quality in hilly tracts region in Bangladesh. Analyses show that most of the pedestrian (about 35%) would like to walk for 15-20 minutes. Average walking speed of pedestrian is highest for single man and lowest for man and women with good interaction. Pedestrian level of service is highest in the Marine Drive road and lowest in the Teknaf Bus stand road. Existing footpath facilities is also poor in the study region. Findings of this study will help the city planners and engineers in making future polices to improve pedestrian facilities.

***Keywords*:** Footpath, Pedestrian, Teknaf, Hilly Tract Region.

1. INTRODUCTION

Footpath is an important part of complete road systems. It is considered as the important mode of transport in the developed countries [1]. Footpath can be used for different types of activities like cycling, animal movement, recreation activities etc. However, developing country like Bangladesh the term footpath is not well defined. Most of the footpaths are not properly designed and well-connected and this causes destruction of pedestrian flow in Bangladesh [2]. Insufficient number of footpaths in this country causes pedestrian to use main road that causes series of accidents in road [3]. Measures taken to ameliorate the issue has failed to perform effectively [2-3].

Reviewing existing literatures suggest that lots of importance were given on pedestrian behavior and footpath service quality. Daniel et al. (2016) studied pedestrian footpath level of service (FOOT-LOS) and found several attributes like mobility, comfort and safety are affecting pedestrian service quality. They developed FOOT-LOS (pedestrian footpath level of service) model to facilitate the LOS measurement which depend on the footpath width (meter), road width (meter), surface damage (% of area), number of obstructions (number per 100 meter), pedestrian flow (pedestrians/minute/meter), and traffic volume (vehicles/hour) [4].

Furthermore, Kelly et al. (2011) studied on pedestrian walkability environment using three statistical method. They found pavement cleanliness, safe crossing places, connectivity and security, and found the walking experiences are affected by cumulative impact of multiple interactions (both positive and negative) as people walk in the pedestrian environment [5]. Ahmed and Islam (2020) accessed roadside walkway environment in Gazipur city.

They determine footpath LOS based on HCM (Highway Capacity Manual). They found several unsocial activities (Hijacking, Pick-pocketing and Bad comments) occurs specially for women and vendor activity reduces the width of footpath. It causes pedestrian to use road which causes road accident [6]. Furthermore, some studies give importance on LOS model development. Bivina et al. (2018) developed a Structural Equation Model (SEM) to access pedestrian service quality [7]. They found that police patrolling, street lighting, cleaner sidewalks, sidewalk obstructions, and sidewalk surface are affecting footpath service quality.

Back to country very few researches have been paid attention on pedestrian and footpath issues. Ahmed, Islam and Adetayo (2020) studied footpath service quality in a major industrial zone in Bangladesh, using both qualitative and quantitative approaches. They consider the factors gender distribution during day and night, Age distribution of Responded, Gender wise of purpose of using footpath, Footpath use in terms of purpose, Hourly flow of pedestrian, and Personal Insecurity level of using footpath for determining footpath service quality. They estimated people opinion score about footpath is 2.66 (out of 5). Which is unsatisfactory and undesirable for industrialized area [2]. Bhuiya et al. (2020) evaluated pedestrian level of service of selected footpath segments in Dhaka city.

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They found footpath level of service depends on path width, pedestrian volume, crossing facilities, availability of buffer, distance from vehicular traffic, surface quality, convenience, walkway environment, street light [8]. Siddique (2014) studied walkways in Dhaka City and proposed that eight factors had direct impact on the walkway level of service. The factors are width, surface condition, obstruction, roadway crossing facilities, buffer zone between footpath and roadway, presence of bicycle and motorcycle over footpath, walkway lighting, and queue of trees along the footpath [9].

Unfortunately, pedestrian and footpath service quality are still unknown in Teknaf. This encourages the authors to explore the actual condition of the pedestrian and footpaths facilities in Teknaf. It will help to develop a concession point to ameliorate the existing condition.

2. STUDY AREA

Teknaf is considered as a hilly tract region in Bangladesh. It is situated at Cox's Bazar District in Chittagong (Fig.1). The city shares it borders with Myanmar, which coordinate is 20.8667°N and 92.3000°E. Total 23,675 households are lived in the 388.68 km^2 area [10]. Teknaf had a population of 152,557 where males 51.81% and females 48.19%. Teknaf has 6 Unions, 13 Mauzas, and 133 villages. The six unions are Teknaf Union, Hnila Union, Baharchhara Union, Sabrang Union, Whykong Union, St. Martin Dip [11]. The area is selected based on the geographical importance and to explore the area for the first time (Fig.1). Though, Teknaf is enriched with tourist and different businesses but, no study has been done of pedestrian and footpath facilities. Those phenomena encouraged the authors to explore the area and find out different problems with its solution regarding pedestrian and footpath. The study will be a bench mark for pedestrian and footpath facilities development in Teknaf city [10-11].

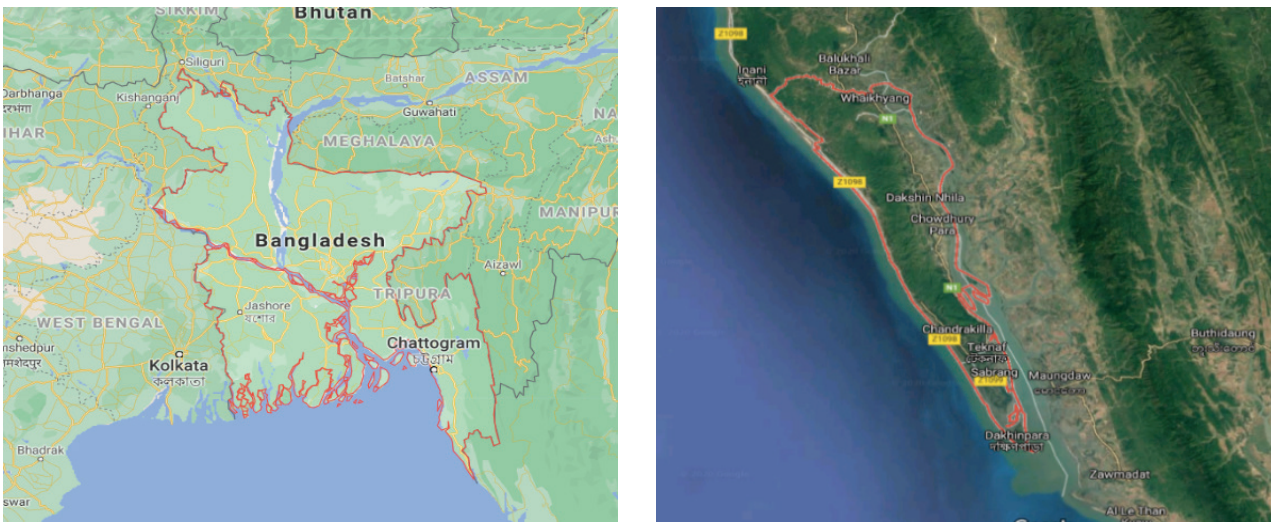

Fig. 1: Geographical view of Teknaf

3. METHODOLOGY

The methodology of this study is designed based on previous literature (Fig.2). The frame is started based on defining objectives. Reviewing previous literature helps to identify several factors which are related with our research topic. After that important locations were selected based on geographical importance. Preliminary concept of the study area was gained from reconnaissance Survey. Data was collected in the selected point where pedestrian movements are significant. MS Excel software has been used to analyze the survey data. Results are presented in a precise way in the results section. Finally, the frame end with the outcome of this study. Recommendation has been made based on the outcome of the study (Fig.2).

Pedestrian survey was carried out in three selected routes (Route 1: Teknaf-Cox's Bazar Road, Route 2: Old Marine Drive Road, Route 3: New Marine Drive Road) between 02/09/2020 to 03/09/2020 (Fig.3). Those routes are selected based on the geographic importance. However, Maximum number of pedestrian pass through those three

points (Location 1: Teknaf Bus Stand Point, Location 2: Parjatan Bazar Point, Location 3: Teknaf Beach Point) (Fig.4).

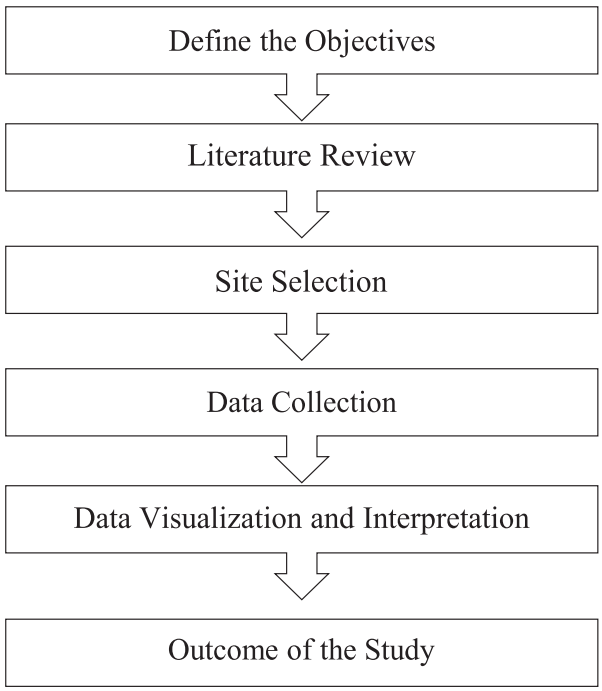

Fig. 2: Methodology of the study

Data were collected in three steps, 1. Pedestrian number was counted in the three important points using counting machine and video camera in a particular segment (5m), 2. Pedestrian speed was counted using speed gun in the three important places, 3. Public opinion about footpath service quality attributes were collected along with their demographic information (Fig.4).

(a) Study routes of Tenkaf

(b) Pictorial view of route 1

(c) Pictorial view of route 2

(d) Pictorial view of route 3

Fig. 3: Geographical view of study routes

(a) Survey at route 1

(b) Survey at route 2

(c) Survey at route 3

(d) Footpath measurement survey

Fig. 4: Pictorial view of pedestrian and footpath condition survey

3.1 Pedestrian Walking Speed

For calculation of average walking speed, a strip of 5m was considered and then the time of passing this strip for each category pedestrian was recorded. Average walking speed was calculated using the following formula:

$$V = S/t \quad (1)$$

Where,

S= Travel distance
V=Speed of the pedestrian
t =Time required for travel distance

3.2 Pedestrian Level of Service

Level of Service (LOS) for pedestrian is an important tools to evaluate overall measure of walkway conditions. LOS is directly related with mobility, comfort and safety, and reflecting pedestrian understand about different footpath facilities. Table I describes the HCM (Highway Capacity Manual) average flow criteria for assessing the LOS of pedestrian [12]. LOS A is considered as good condition and LOS F is considered as worse (Table I).

Table I: HCM average flow criteria for assessing the LOS of pedestrian.

LOS	Pedestrian Space (ft^2/Ped)	Pedestrian Flow Rate (Ped/min/ft)
A	> 60	< 5
B	>40-60	> 5-7
C	>24-40	> 7-10
D	>15-24	> 10-15
E	> 8-15	>15-23
F	< 8	Variable

4. RESULTS AND DISCUSSION

In Table II, shows the demographic characteristics of pedestrians where, in terms of gender, male is 69 % on the other hand female is 31%. It indicates, males are used footpath on regular basis compare with females. In terms of age, adult is the dominant one which is 55%. It means that, child and older age group are less user of footpath because they faced difficulties in using footpath.

Table II: Demographic characteristics of pedestrian

	Type	%
Gender	Male	69
	Female	31
Age(years)	Child (0-15)	36
	Adult (16-50)	55
	Older (50+)	9

4.1 Average Walking Speed of the Pedestrian

Fig. 5 shows that average walking speed is high for single male and its value is 1.18 m/s. Second highest speed has been observed 1.02 m/s for double male. Lowest Average speed of walking has been observed 0.85 m/s for Male and Female with good interaction (Fig. 5).

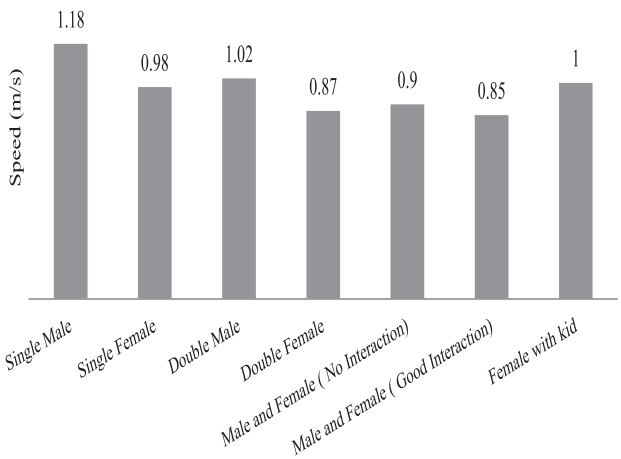

Fig. 5: Average pedestrian walking speed (m/s)

4.2 Average Walking time of the Pedestrian

Analysis shows that most of the respondents (about 35%) would like to walk for a period of 15-20 minutes. About 5% of the respondents would like to walk more than 30 minutes. About 13% of people would like to walk for a period less than 10 minutes (Fig. 6).

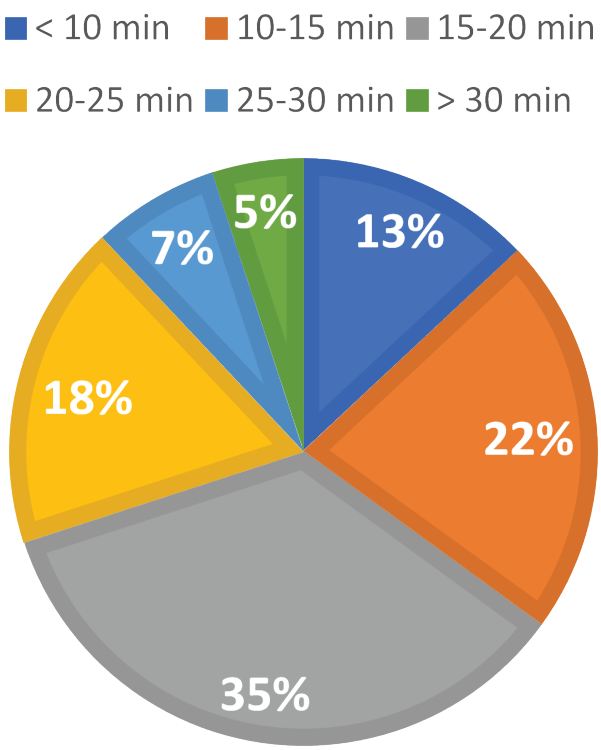

Fig. 6: Average Walking Time of Pedestrians (min)

4.3 Pedestrian Level of Services

4.3.1 Teknaf bus stand point

The analysis shows that the pedestrian level of services in A category at 7 am-8 am at this point. In the morning pedestrian flow rate is higher at 9 am-10 am and its value is 14 ped/min/ft because people of different professions use this time to reach their destination. In the afternoon pedestrian flow rate is more at 1 pm-2 pm (Fig.7). The average pedestrian flow rate is high in evening, and 6 pm-7 pm time contains the maximum flow rate with a value of 16 ped/min/ft. Working people go home and most of the non-working people go outside of the home at evening that's why the pedestrian flow rate is more at this time (Table III).

Table III: Level of services of pedestrian at Teknaf Bus Stand Point

Time	Pedestrian Flow Rate (ped/min/ft)	LOS
7am-8am	2	A
8am-9am	6	B
9am-10am	14	D
10am-11am	8	C
11am-12pm	6	B
12pm-1pm	11	D
1pm-2pm	13	D
2pm-3pm	9	C
3pm-4pm	5	B
4pm-5pm	9	C
5pm-6pm	12	D
6pm-7pm	16	E

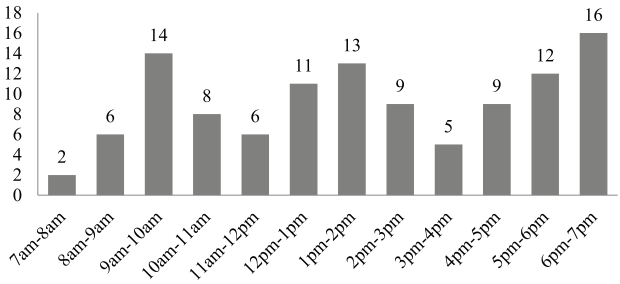

Fig. 7: Variation of pedestrian flow rate (ped/min/ft) at Teknaf Bus Stand Point

4.3.2 Teknaf beach point

The average level of services (LOS) of pedestrian in A category in morning in Teknaf beach point [13-14]. The pedestrian flow rate is highest at 5 pm-6 pm and its value is 10 ped/min/ft (Fig.8). The average level of service accomplishes C category in the evening because people of all classes come to this point for their refreshment in the evening (Table IV).

Table IV: Level of Services of Pedestrian at Teknaf Beach Point

Time	Pedestrian Flow Rate (ped/min/ft)	LOS
7am-8am	1	A
8am-9am	2	A
9am-10am	5	B
10am-11am	3	A
11am-12pm	2	A
12pm-1pm	4	A
1pm-2pm	3	A
2pm-3pm	1	A
3pm-4pm	6	B
4pm-5pm	9	C
5pm-6pm	10	D
6pm-7pm	8	C

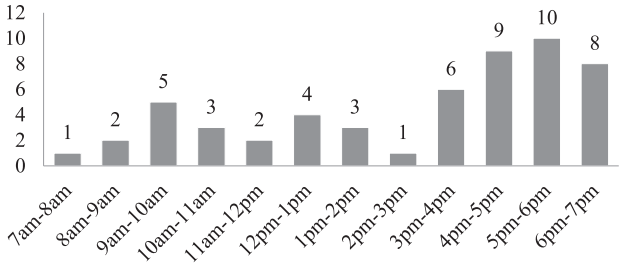

Fig. 8: Variation of pedestrian flow rate (ped/min/ft) at Teknaf Beach Point

4.3.3 Parjatan bazar point

Table V and Fig. 9 shows pedestrian level of service at Parjatan Bazar point. Results show, pedestrian flow rate is less in very morning time (Table V). Highest flow rate is 11 ped/min/ft at 1pm-2pm and 5pm-6pm (Fig. 9).

Table V: Level of Services of Pedestrian at Parjatan Bazar Point

Time	Pedestrian Flow Rate (ped/min/ft)	LOS
7am-8am	1	A
8am-9am	3	A
9am-10am	6	B
10am-11am	8	C
11am-12pm	5	B
12pm-1pm	9	C
1pm-2pm	11	D
2pm-3pm	6	B
3pm-4pm	4	A
4pm-5pm	5	B
5pm-6pm	11	D
6pm-7pm	8	C

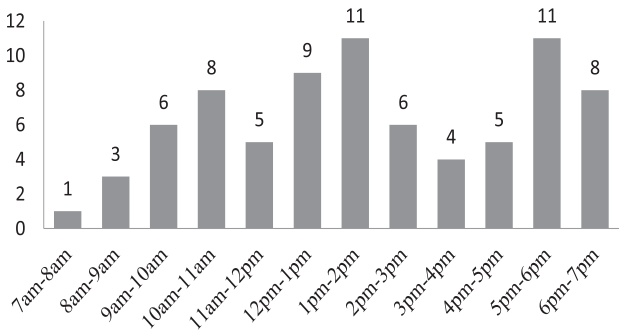

Fig. 9: Variation of pedestrian flow rate (ped/min/ft) at Parjatan Bazar Point

4.4 Footpath Facilities

Fig. 10 shows overall footpath condition from questioner survey. The footpath condition is much worse than road condition. Most of the cases the road has no footpath facilities. 71.14% respondents response that the footpath facilities are in poor condition. Field investigation revealed that most of the road has no footpath and people use the road as footpath which reduces the effective road width and causes severe road accident (Fig. 10).

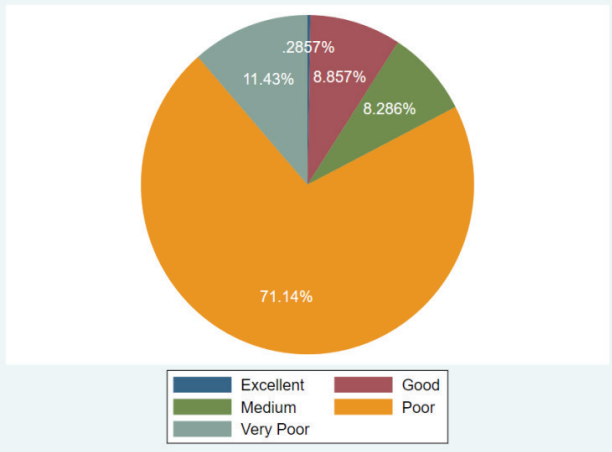

Fig. 10: Footpath overall condition

Fig. 11 shows the 16 footpath service quality attributes. The attributes were collected based on the Likert scale 1 to 5 rating, where 1 means very poor, 2 means poor, 3 means medium, 4 means good, and 5 means excellent. Movement of bicycles, bicycles and security for sexual harassment are good factors and surface condition, height of sidewalks, presence of barrier, and lighting facilities are in very poor condition. It means that, footpath several factors should be improved on importance basis.

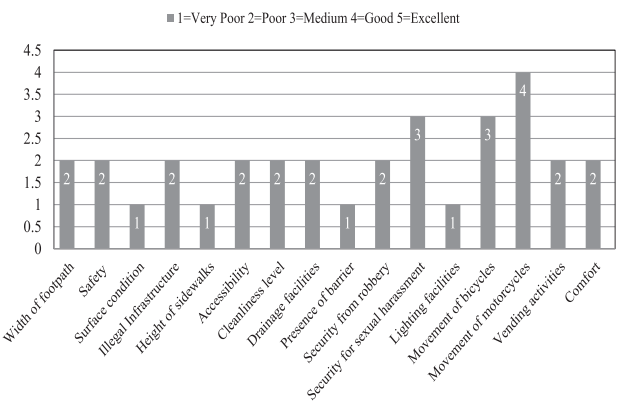

Fig. 11: Footpath attributes survey

5. CONCLUSION

Footpath is a major component of a complete road system. Service quality of any road mostly related with footpath facilities and pedestrian behavior. Footpath space can be utilized by rebalancing illegal activities on footpath space. In case of hilly region footpath facilities should be adequate because of narrow road pattern to avoid road accidents. The aim of this paper to evaluate pedestrian behavior and quality assessment of footpath in hilly region in Bangladesh. From result, it is seen that about 35% pedestrians walk about 15-20 minutes and only 5% pedestrians walk more than 30 minutes. Average walking speed is high for single male and its value is 1.18m/s. Male and female with good interaction contains less average walking speed with value of 0.85m/s. Pedestrians flow rate is high in Teknaf Bus stand point with average pedestrian level of service (PLOS) in D category and less in Teknaf Beach point with average pedestrian level of service in B category. Hence, it is seen that PLOS is satisfactory in all three roads of Tekanf, this scenario mainly due to less density of population at the area. Teknaf Bus stand road is the main route to travel for all types of vehicles and pedestrians from others parts of the country, so pedestrians flow rate is high in this road. Analysis of respondent's opinion most of the people responses that existing conditions of footpath is worst.

From the study outcomes, the following point can be put forward to improve the present footpath facilities. It will help to fulfill the future demand: 1. Surface condition of footpath need to improve. 2. Height of footpath should be separated from main road. 3. Presence of barrier should be removed on footpath (vendor activities, pothole, construction materials etc.). 4. Sufficient lighting for footpath should be provided especially for night condition.

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