MANTECH Publications

Journal of Transportation Engineering and Its Applications
Volume 5, Issue 1, January-April, 2020

Service Quality Assessment of Footpath in a Major Industrial Zone of a Developing Country: A Case Study of GAZIPUR City, Bangladesh

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Abstract

In industrial zones of developing countries, workers tend to live nearby places of their working zones and prefer to go to their working places by walking. Hence, footpath plays a crucial role in these areas, particularly in developing countries like Bangladesh, where garments worker have a penchant to save the transport cost for their livelihood by walking to their working places. Hence, level of service (LOS) of the footpath in these zones should be much higher to facilitate these heavy loads of pedestrians. However, LOS evaluation criteria for off-street pedestrian facilities are not well defined in the context of Bangladesh and a negligible number of studies have been performed on this subject of matter. This motivates the authors to assess the service quality of footpaths in heavy industrial zone like Gazipur city using both qualitative and quantitative approaches. In this study, a survey of 450 people were conducted to identify the key factors that attribute to the pedestrian's satisfaction and it is found that the average rating of the footpath is 2.66 (out of 5) which is unsatisfactory and undesirable. Such findings are effective for developing footpath design and maintenance policies, and provides guidelines for future improvement.

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Keywords: *Pedestrian footpath, service quality assessment, industrial zone, Developing Countries.*

INTRODUCTION

The world population has increased six times and the urban population has multiplied 100 times in the past 200 years, and by 2050 seventy percent of the world's population, that is, about 6.3 billion people, will live in the world's major urban areas[1]. This growth rate is more severe in developing countries like Bangladesh, particularly in industrial zones where people's density has crossed all the limits and destitute people from bourgeois class live in such areas in a more clustered way for their livelihood. These people normally live in an insalubrious and unhealthy places near their working zone and prefer walking to go to their work zone from their living place. Hence, in this regard, footpath plays a very important role in such zones, where working-class people almost always walk to their work zones and come back to their living places using footpaths [2].

This study has particularly focused on a major industrial zone of Bangladesh, Gazipur city corporation area, whose population density is 7587 people per square kilometers [3]. The specific objectives are to: Evaluate current footpath condition in Gazipur city; and recommend possible solutions for this existing situation.

With 1 million population, it is the fast-growing city in Bangladesh and its population has increased by almost 49% from 1991 to 2011 [4]. Several important national infrastructures along with major industrial zones, educational institutions, and religious establishments attract a larger number of populations from all over the country and this act as a catalyst for this growing population [3]. City authority is struggling hard to facilitate these booming populations with the basic needs of a city dweller which results into unexpected and undesired consequences i.e., chronic traffic congestion, tremendous water, air and noise pollution, disruptions in electricity and other power supply systems, failure of insufficient drainage facilities and so on[5]-[8]. Among transportation-related problems, traffic congestion, insufficient and poor condition of footpaths, unavailability of sufficient public transport is most common.

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Particularly, despite the frequent usage of footpaths by indigenous people along with huge incoming population to this city, their service quality is not up to mark in the view of general people. Ideally, footpaths should be smooth and even, with no uneven or dangerous footpath surfaces that can cause people to fall and injure themselves. Unfortunately, the current footpath facility is not sufficient to meet the demand of these city people. The national print and electronic media also focused on this issue several times; however, negligible efforts have been made to ameliorate the present condition of these footpaths [9]-[11]. This scenario doesn't escape the intuitive minds of the authors while passing through this area. Hence, this study has been carried out to assess the service quality of footpaths in Gazipur city, Bangladesh, find out the factors that are really attributing to the present state of service quality and put suitable recommendations to ameliorate the present condition for a better, well-developed modern city with a user-friendly sustainable green footpath system.

Literature Review

Review of existing literature suggests that a lot of attention has been paid to research on pedestrian footpath in developed countries from ancient time to modern period. Emphasis had been given on the factors influencing the structural design criteria for a perpetual footpath. Gellatly et al. (1986) assessed the effects of regular footpath trampling by studying a large area over a six-week period and highlighted the importance of interactive forces such as surface roughness, drainage, and natural obstacles with appropriate recommendations to prevent the phenomenon [12].Western Australian Planning Commission (2000) recommended that prior to the design of footpath, first need to communicate all members of the community and should give priority to the needs of the disabled, pedestrians, cyclists and public transportation as well as cars[13]. Later studies focused on the factors that basically attribute to the service quality of a footpath according to pedestrians perception and scored them according to different established methods. Kelly et al. (2011) compared among three methods for assessing the walkability of the pedestrian environment and found the pedestrian attributes i.e., pavement cleanliness, safe crossing places, good connectivity and sense of security, and concluded that the walking experience is affected by the cumulative impact of multiple interactions

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(both positive and negative) as people walk in the pedestrian environment[14].Whereas, Abaya et al. (2011) conducted a study to assess the pedestrian facilities in major cities of the Philippines and rated the pedestrian facilities according to the rating scale developed by Holly Krambeck [15].Ellis et al. (2016) discussed the aspects of the walkability index by using of a footpath network and exploring the implications of this for how connectivity can be measured[16]. Also, Aghaabbas et al. (2017) developed an assessment method to evaluate the neighbourhood sidewalks using the micro scale factors which is capable of identifying the drawbacks of neighbourhood sidewalks and also, this tool allows the residents to convey their needs to city planners and ask for improving existing sidewalks [17].

Later studies secured some advance level works through developing model to assess the service quality in terms of level of service (LOS). Daniel et al. (2015) developed a model named FOOT-LOS (pedestrian footpath level of service) to facilitate the LOS measurement. The model provided a methodology for determining LOS and determined the factors predominantly contribute to the LOS of pedestrian footpaths [18]. Raad et al. (2017) reviewed the past experience with PLOS measures and tools, and outlined a more robust approach and methods to develop an improved PLOS tool and measures using a Delphi process (online survey and a walkshop) with a panel of experts specialized in pedestrian issues, and intercept surveys with pedestrians[19]. Some studies have also been performed in the subcontinent and a like condition in India as Bangladesh.

Kadali at al.(2015) collected PLOS with respect to different land-use type such as shopping, residential and business areas using ordered probit (OP) model where number of vehicles encountered, road crossing difficulty, safety have been considered as primary factors along with pedestrian individual factors (gender and age), land-use type and roadway geometry[20]. Similarly, Sahani et al. (2017) developed a model for pedestrian to evaluate service measure at the roadside walking environment from the qualitative and quantitative analysis in developing countries and found that width of sidewalk; vehicle volume, pedestrian volume etc. is significantly influencing the pedestrian service measure [21]. Also, Jena et al. (2018) developed a model to

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assess the LOS delivered by urban street segments in developing countries and found out the overall satisfaction to show the present scenario and which modifications are required to improve the situation [22]. Rajendran et al. (2018) investigated the most influential factors of the built environment that affect perceived pedestrian level of service (PLOS) of sidewalks using Structural Equation Modelling (SEM) technique to assess pedestrian satisfaction and identified the influencing factors [23].

However, negligible number of studies has been performed to assess the service quality of footpathsin developing countries like Bangladesh. Zannat et al. (2019) presented a comprehensive framework to measure the influence of pedestrian facilities on perceived PLOS qualitatively and quantitatively for Chittagong Metropolitan Area in Bangladesh. They modeled triangular relationships among pedestrian facilities, perceived roadway conditions (accessibility, safety, comfort, and attractiveness), and perceived PLOS to identify pedestrian facilities, related to footpath, carriageway, and transit, influencing perceived PLOS. Finally they denoted accessibility and attractiveness and safety as important factors and concluded that achieving a better perceived PLOS is dependent on the availability, maintenance, and planning of different pedestrian facilities [24]. Whereas et al. (2015) determined the most suitable pedestrian level of service method for Dhaka city, Bangladesh from five PLOS methods through the integration of objective measurement and subjective assessment.

The perception ratings were scrutinized to identify any potential deviations that arose from participant age and gender. In the ratings, the Australian method prevailed over the other four methods and suggested to develop a new PLOS method that uses the factors identified in their study [25]. In addition to that, Salan et al. (2018) assessed the pedestrian behavior and the service quality of the footpath commercial, mixed use and residential area of Rajshahi city, Bangladesh. They found the highest pedestrian flow in the commercial area and recommended to emphasize on rehabilitation of illegal establishment, construct the footpath infrastructures and restriction on footpath parking in the commercial and mixed used areas [26]. Unfortunately, yet no study has been done to assess the service quality of footpath in the major and most important industrial

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zone of Bangladesh, Gazipur city. This motivates the authors to conduct this study to reveal the actual condition of the footpaths in this area, develop a concession point to ameliorate the existing condition and offer a framework which will be applicable in any industrial zone of the developing countries throughout the world.

Methodology

The study area of this research is Gazipur City Corporation (GCC), which is the largest City Corporation of Bangladesh. The area of the GCC is 329.53 sq. km and population is 2500000 among which 52.52% is male, and 47.48% is female [3], [4].

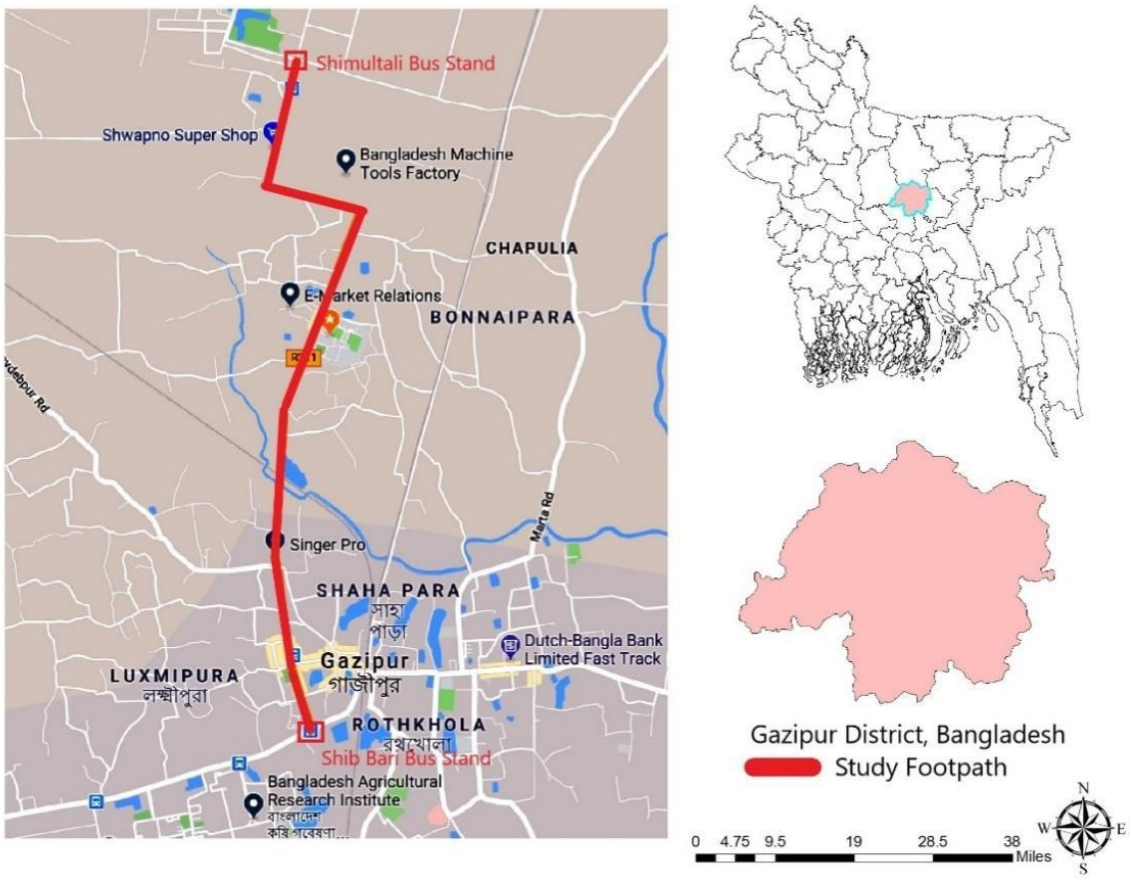


Figure1: Satellite View of the Study Area

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To conduct the study, primary and secondary level data were collected from the permanent residents of GCC as well as the people who have come here for temporary visits. To evaluate the level of service (LOS) of the footpath in GCC from people's perception, a questionnaire survey was conducted that not only included particular questions to be answered by the pedestrians but also their own opinions in the present state of the footpaths and how these situations can be ameliorated. Prior to finalize the questionnaire for data collection, a field investigation was performed to observe the actual field condition and a pilot survey was also conducted among the pedestrians to reflect their opinions in the final questionnaire. Then, the total length of 4.4 km of the studied footpath was divided into 6 sectors according to the geometric design and public social importance for better efficiency (as shown in Figure 1 and Table 1).

The divisions of footpath section render a clear view about footpath condition; where around 450walkway users were interviewed from 8 am to 5 pm with 1 hour break at 1 pm. The data collection days were chosen such that both public holiday and working day are encountered during the survey.

Table 1: Footpath length in the study area

Sector	Location	Estimated Length of Footpath
1	Simultoli Bus Stand to BMWTF High School	600 m
2	BMWTF to Bangladesh Machine Tools Factories	400 m
3	Bangladesh Machine Tools Factories to DUET	1000 m
4	DUET to Joydebpur Power Sub-station	600 m
5	Joydebpur Power Sub-station to Bilashpur Bottola	800 m
6	Bilashpur Bottola to Shib Bari	1000 m

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DATA ANALYSES AND RESULTS

Demographic characteristics of the responded

The data collected from the survey shows that footpath is used by 73% men and 27% woman for various purposes every day. This implies that men are using footpath at a higher proportion compared to women. The further analyses will reveal more information regarding its implications.

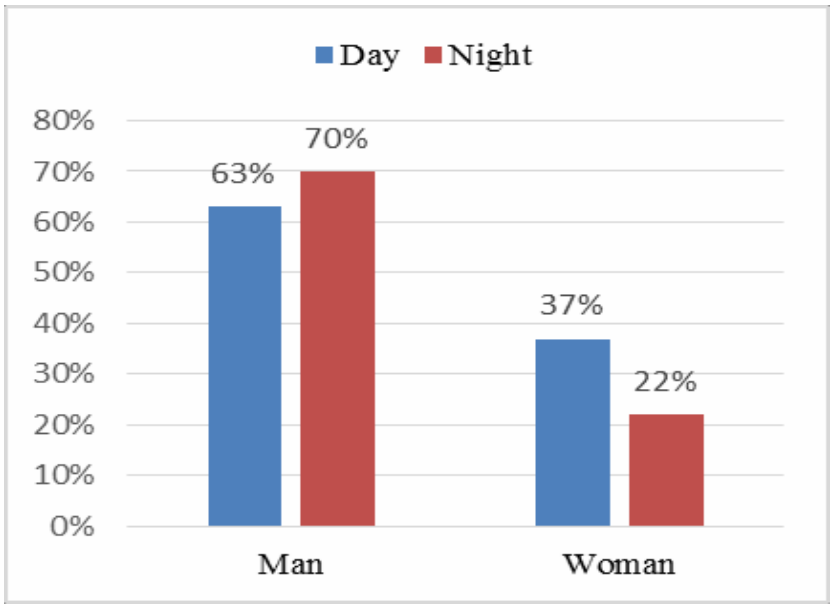


Figure 2: Gender distribution during day and night.

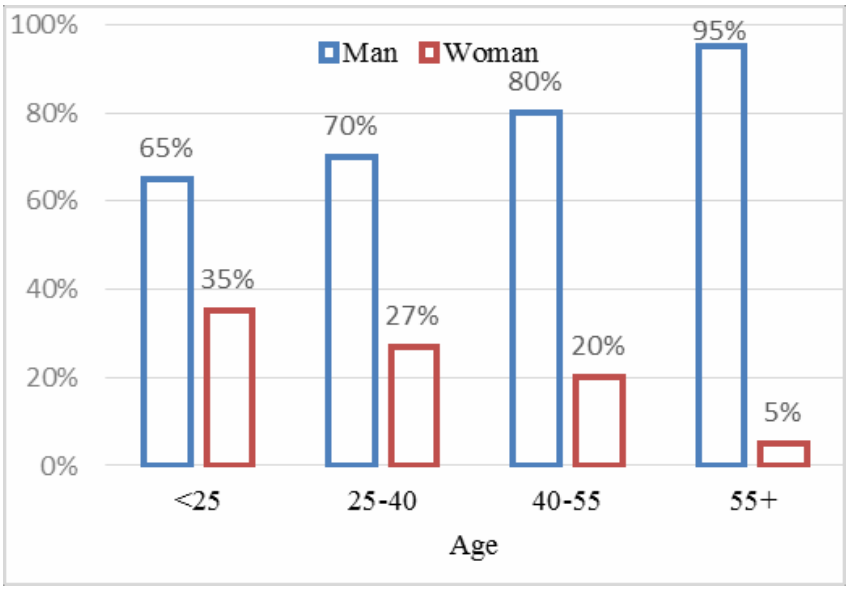


Figure 3: Age distribution of Responded

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Figure 2 shows an interesting observation regarding the number of male pedestrians and female pedestrians. The number of male pedestrians increased at night (from 63% at day to70% at night), whereas number of female pedestrians dropped at night (from 37% at day to22% at night). This implies that female pedestrian movement decreased at night since they go to market for buying their necessities from vendors and they prefer to move from one shop to another before buying anything. Another implication is that the studied area is besieged by number of factories, especially garment factories, which are run mostly by the female workers.

Figure 3 shows the age distribution of the responded and their corresponding percentage. Data analysis reveals that pedestrian from 25-55 years range use footpath mostly and their percentage is 46%. This is basically the working-class people. Also, a significant pedestrian's percentage has been observed for the people age below 25 years range and that is 40%. This basically represents the school, college and university going students and also, there a large number of female garments worker whose age is fewer than 25. They basically come here to survive their livelihood by escaping from extreme poverty. This survey also shows that only 4% of people above 55 years range use footpath where woman rate is almost little(Figure 4). This alludes that there is little provision for old people to use the footpath and hence, their negligible percentage resembles their levity to use the footpath.

Purpose of using footpath

Table 3: Gender wise of purpose of using footpath

Purpose of using footpath	Percentage of pedestrians (%)	Purpose wise male percentage (%)	Purpose wise female percentage (%)
Work	45	72	22
School	22	57	43
Market	6	80	20
Others	27	85	15

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Table 3 and Fig. 4 show that people like to use footpath mostly for work purpose 45%. This indicates lots of work facilities are available in this locality and people live here are mostly from working class. 22% of people go to educational an institution which indicates that there are number of schools, colleges, and universities in Gazipur and number of students compared to total population is significant. The number of people going to market is 6%, which indicates that markets are available and it is adjacent to the residential area and hence, people prefer to walk to go to market. People who use footpath for other purposes i.e., to go to religious establishments, enjoy sports, morning walk are 27% this indicates that there lots of religious establishments, travel spots and open lands for excursion are present in this area. Though woman doesn't use footpath frequently for other purposes, their participation in working purpose is significant.

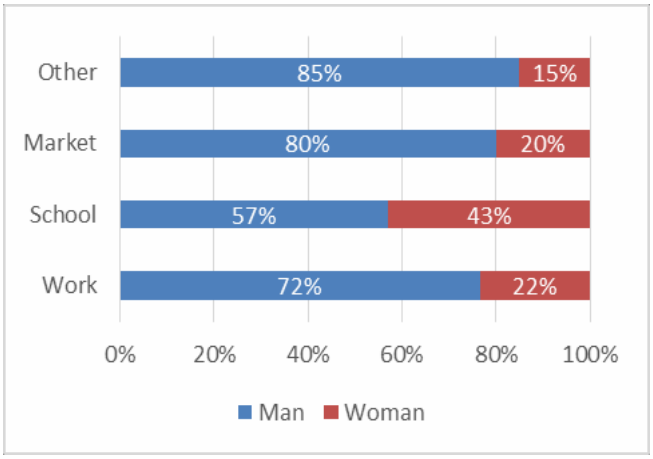


Figure 4: Footpath use in terms of purpose

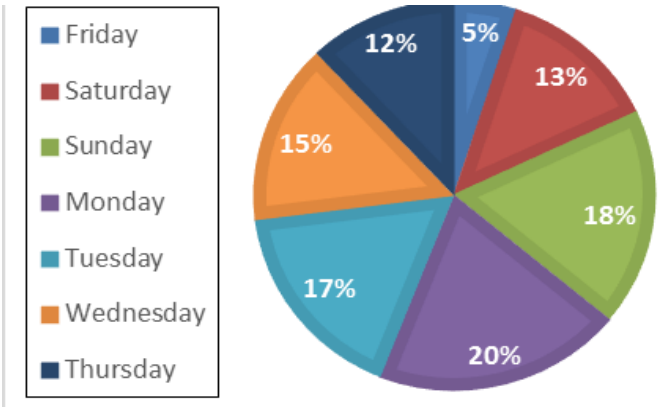


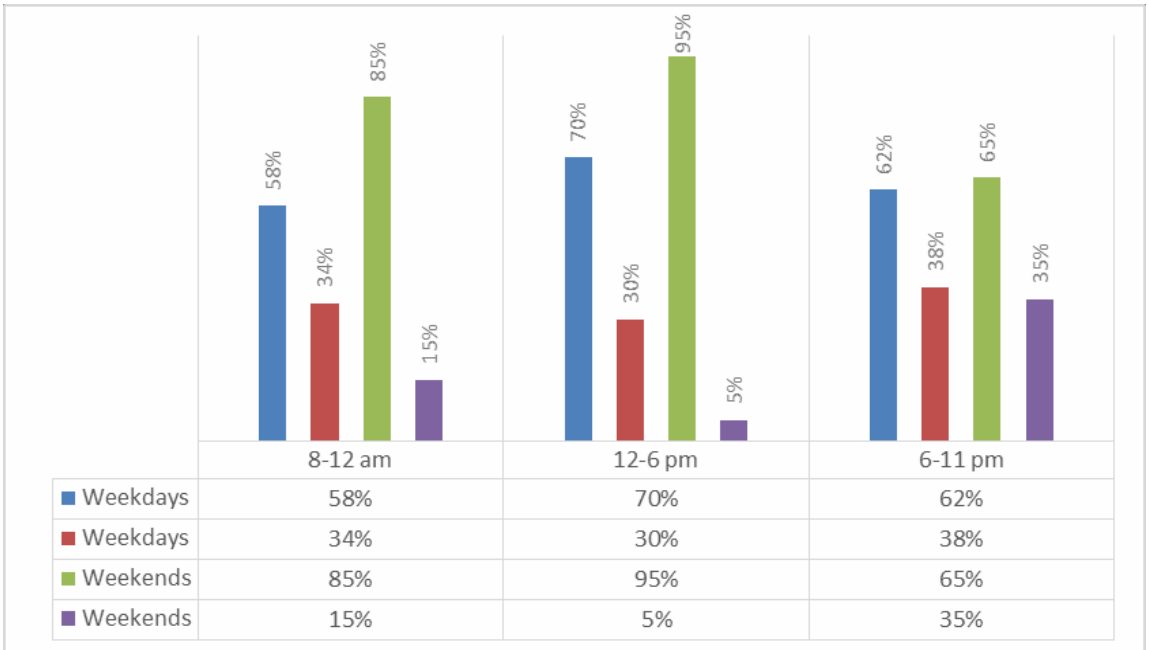
Figure 5: Daily use of footpath responded

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Temporal variation of usage

The daily use pattern in Fig. 5 shows that people less use footpath mostly on Friday (5%) and then, Thursday (12%) got the second less usage among seven days survey. Whereas, the height usage of footpath in weekdays days is 20% and 18% respectively (Sunday and Monday) based on the field survey. This implies that people prefer more to use footpath in week days rather than weekends. Field interview reveals that people in this area like to enjoy their holiday by doing recreational work through visiting cinema, shopping, parks, markets etc. and these may be the probable reasons for increasing the usage of footpath during weekend days compared to weekdays.

Figure 6 shows that in the context of the hourly flow rate, the survey shows that pedestrian flow at morning and night are much higher than noon. The rationale is that most of the industries run from 8 am to 9 pm in between workers have an hour little break at around 2 pm in two different shifts. Generally, they do not like to go their home in this compact break instead they do their lunch at workplace. At night, the woman's flow rate increases to 38%, where men's flow rate 62%. This is because women like to visit markets in the way to their returning home, while men basically get accumulated in tea stall or other places for gossiping, playing cards and other recreational purposes.



	8-12 am	12-6 pm	6-11 pm
Weekdays	58%	70%	62%
Weekdays	34%	30%	38%
Weekends	85%	95%	65%
Weekends	15%	5%	35%

Figure 6: Hourly flow of pedestrian

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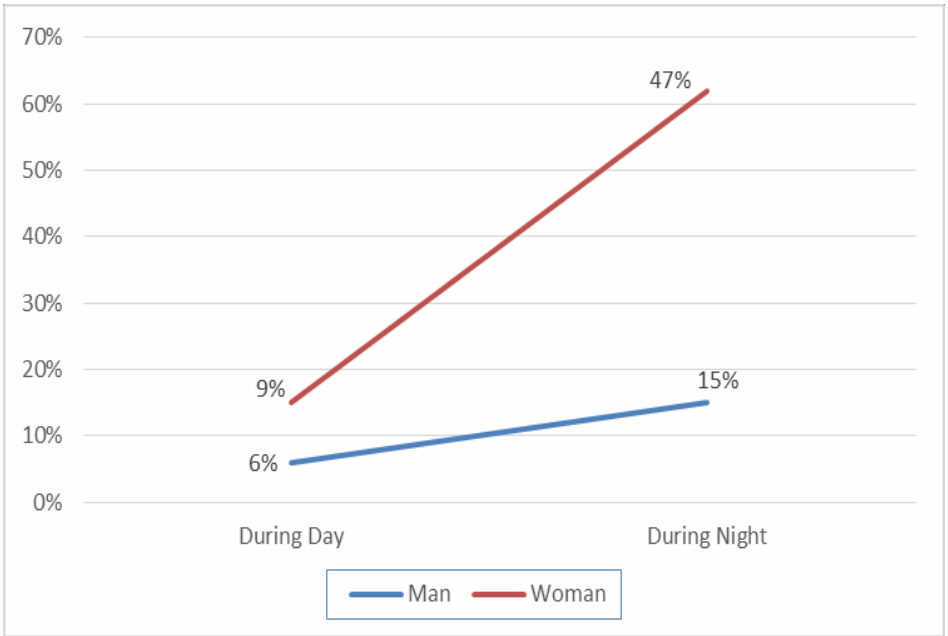


Figure 7: Personal Insecurity level of using footpath

Safety and Security

Regarding the safety issue, only 9% women rated footpath as unsafe to use and only 6% male pedestrian considered it as unsafe during day (Figure 7). However, the rate of insecurity among woman in night is very high which 47% is. Though this area is safe from late morning to at early night, there are some record of theft and hijacking activities in this area, particularly adjacent to the rail-road level crossing section, during late night to early morning.

Determination of level of service

The research conducted by both qualitative and quantitative approach to determine level of service (LOS) for footpath in Gazipur city. The footpaths in Gazipur city are used by different classes of people for various purposes. Hence, a questionnaire survey was conducted to carry out this study among 100 pedestrians from typical Thursday to Saturday about their purpose of footpath use, age, gender, safety and security. Table 4 shows a sample of questions that were asked to the pedestrians to get their perception on using footpath in the studied area.

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Table 4: Pedestrian perception on using footpath

Question	Yes	No
Do you use footpath in adverse condition	71%	29%
Do you like to use footpath during day	79%	21%
Do you like to use footpath during night	70%	30%
Are you satisfy in current footpath condition	26%	74%
Have you observed any illegal work on footpath	7%	93%

Table 4 shows that 79% people don't want to use the footpath during night time rather they prefer to use footpath during the day because most of the people in this city work in garments industry and they like to use footpath during morning, evening and afternoon. In addition to this, these people have no choice to stay at home during the adverse condition (heavy rain or cold) since they must have to go to their work and hence, 71% people prefer to use footpath in midst of adverse weather condition. Though people in this locality are not satisfied with the current footpath condition, one of the reasons they report that the footpath is not up to mark and sometimes at night pedestrian face criminal activities which is very common condition in this locality.

The pedestrians were also asked to rate the service quality of the footpath in a scale from 1 to 5, where 1 denotes worst condition, 2 denotes poor, 3 denotes Fair, 4 denotes Good, and 5 denotes excellent condition of the footpath. Then the survey data were analyzed by score method to evaluate the level of satisfaction of the pedestrians and to rate the footpath. Table 5 shows the corresponding rating value by the pedestrians.

Table 5: Pedestrian rating on footpath

Categories	Worst	Poor	Fair	Good	Best
Respondent	90	140	104	62	54

Hence, the average footpath condition by score method

=(1*90+2*140+3*104+4*62+5*54)/450= 2.66

This is between poor and fair condition and close to poor condition. It clearly indicates that LOS of the footpath is at very poor condition and people are not Satisfied with the present status of the service quality.

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Existing Field Condition



(a) Unauthorized vehicle parked on footpath



(b) Footpath occupied by vendors



(c) Footpath uses for commercial purpose



(d) Odd footpath with huge pit



(e) Broken segment of footpath



(f) Discontinuous footpath with zero slopes with road

Figure 8: Pictorial representation of existing footpath condition.

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During the field investigation and data collection, some corporeal discrepancies were observed that deviate from an ideal footpath characteristic, which have been shown in Figure 8. A common phenomena has been observed throughout the studied area is that unauthorized vehicles are parked here and there blocking the footpath as shown in Figure 8(a). This seriously inhibits the pedestrians to use footpath and thus, develop to a mentally to use road pavement for walking purpose, which results in severe road accidents. Also, another observation relates to the described one that vendors are keeping their products on the footpath and run their commercial activities destroying the walkway of the pedestrians [Figure 8(b)]. Also, local people keep their construction materials, in front of their houses, on the footpath, thus reducing the effective road width by forcing pedestrians walking over the road segment [Figure 8 (c)]. Eerily it found that there are large broken holes in the mid of the footpath, hazardous construction elements i.e., reinforcement are open and this induce a tremendous safety concern for the pedestrians as shown in the Figure 8(d-e). Field investigation revealed that 40% of the footpath in the studied area is earthwork footpath, of which10% is broken badly and 50% footpath is concrete base, of which 50% are very narrow and out of date condition. Sometimes tree roots can cause the footpath to become uneven, or rubbish or fallen leaves can make the footpath slippery. Occasionally pedestrians fall on footpath pit. In addition to this, Footpaths are much raised compared to the elevation of main road level and no or little slope has been observed to connect the footpath with the main road, which provides difficulty for the pedestrians, particularly for the old, disabled and children [as shown in Figure 8(f)].

Apart from these, no visible footpath furniture like seating arrangement for pedestrians, pedestrian shelters during adverse weather, bins for keeping wastes have been observed in the study area. Also, footpaths are not wide enough to be used by disabled and physically challenged people with wheelchair. Sometimes motor vehicles like motorcycle, auto and rickshaw are using footpath in case of traffic congestion on road. The guard rails for pedestrian safety are absent on the footpath. The lighting condition is not that much good on footpath that causes accident in road changing point and engenders illegal activities during night time. Besides modern footpath facilities

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like public telephones or latrines or water facilities are absent in the studied area. There is no signpost to guide walkers like different area indicator, speed meter, signal, etc. From aesthetic and environmental point of view, there are not enough trees or other things creating enough shade on footpaths to keep pedestrian comfortable on a hot day.

CONCLUSION AND RECOMMENDATIONS

Comfort, continuity, and safety are the governing criteria for the design and construction of pedestrian facilities. Well planned footpaths provide continuous space for walking. They also support other activities such as street vending and waiting arrangement at bus stoppage without compromising pedestrian mobility. However, the studied segments of the footpath show tangible deviances from this standard ideal situation. Deep analyses of the pedestrian's perception data clearly demonstrated that footpaths of this area provide less safety and pedestrian comfort. Unauthorized parking, appropriation of the footpath by vendors, broken potholes on the footpath, construction materials kept on footpath by the adjacent households, no special provisions for child, old and disabled people made the footpath a nightmare experience for the users and this results into a poor level of service of 2.66 out of 5, which gives a numerical evidence that clearly shows the poor state of the footpath.

Hence, the present state of footpath condition must be ameliorated to maximize pedestrian's satisfaction. In order to achieve this, the following are recommended:

1. The satisfaction of the pedestrians regarding a footpath depends on the integration of multiple elements in a coherent design.

2. Footpaths must be continuous even at property entrances for uninterrupted pedestrian movement. If walkways are to provide safe, easy, efficient and comfortable pedestrian movement for all members of the society, considerations must be given to the following basic principles of walkway development:

a. Illegal activities on footpath i.e., vendors occupying footpath, unauthorized vehicles on footpath, construction materials on the footpath

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must be stopped and take illegal steps against those who will be involved with those activities.

b. Footpath should be a smooth surface with no broken potholes or unnecessary hazardous elements. This must be ensured to give reliability to the pedestrians on using footpath.

c. Since pedestrian feel unsafe during late night and early morning, measures should be taken to ensure safety so that pedestrian can use footpath at any time on day and night.

d. Increase footpath furniture like lighting, seating, shelters, rubbish bins, etc.

e. The height of the footpath from the road level should remain same throughout. A footpath that constantly changes levels discourages pedestrians from using it. Pedestrians prefer to walk on the carriageway instead.

f. Finally, people awareness programs should be taken to apprise them the importance of walking and to use footpath instead of roadway since a large number of pedestrians have already been habituated to use road instead of footpath for walking purpose.

ACKNOWLEDGEMENTS

The authors would like to express thanks to the committee for advanced studies and research (CASR) of Dhaka University of Engineering & Technology (DUET) for financial support.

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