Walkability for Urban Sustainability: Study of Pedestrian Traffic in Chittagong

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Abstract

All the traffic starts and ends up as pedestrian, besides, short distance commuters prefer walking. But urban planning and design endeavors in Bangladesh seldom address pedestrians in their schemes. Urban activity nodes are more vulnerable. This study attempts to address this issue with Chittagong city as the focus, to demonstrate evidence based design undertaking. This study is an empirical investigation on current land use, pedestrians' perception of Chittagong city towards walking, using walk score and in-depth questionnaire survey to emphasize the selected driving factors which affect the pedestrian movement. The regression analysis was conducted to establish this correlation. The results showed that experiences of pedestrian activities and its physical features made inhabitants life measurable. The study also examined existing land use patterns by using GIS-map, but that did not reflect any significant diversity on pedestrian flow. The study identified policy implications for a walkable pedestrian way design and concluded that for city sustainability and to integrate urban planning and management, a pedestrian experience approach would be an effective tool.

Introduction

All the traffic starts and ends as pedestrian. Also, walking is the most fundamental mean of transportation that reduces the enormous environmental costs of the motorized vehicles (Özdemir & Selçuk, 2017). The recognition of these benefit and support for nonmotorized travel strategies have led land use planners around the world to promote sustainable walkability (Anciaes, Nascimento, & Silva, 2017; Su et al., 2017). The Buchanan Report of Sixties has already been documented, the application of walking into the transport system of any city (Galderisi & Ceudech, 2010). Over the last decades, researchers have studied on walkability in urban settings and identified or proposed various factors and indicators that had affected the advantages of walking (Anciaes et al., 2017; Kang, 2015, 2017), the studies were based on issues like accessibility, safety, comfort, population and employment density, land use mix or high density development, land use patterns, street layout, public transport supply, attractiveness, connectivity, proximity and urban design (Anciaes et al., 2017; Kang, 2015, 2017; Talavera-garcia & Soria-lara, 2015, Zakaria & Ujang, 2015, Carlotta et al., 2017; Özdemir & Selçuk, 2017, Marquet & Miralles-guasch, 2015; Gilderbloom, Riggs, & Meares, 2015; Su et al., 2017; Bahrainy & Khosravi, 2013; Oranratmanee & Sachakul, 2014; Rehan, 2013).

Bangladesh is experiencing several constraints in improving walkability due to the fast urbanization and population density in and around urban centers or moderate growth nodal points (Mahmud, Ahmed, & Hoque, 2014; Zinia, Mamun, & Sultana, 2016). In general about 60% of the urban traffic is composed of pedestrian but a higher percentages is observed in Chittagong city. A sizable percentage of daily pedestrian trips are noticed in CBD areas of Chittagong though, there is an acute shortage of pedestrian-friendly facilities and walk ways on both side or even on one side of the roads (DAP, 2009). As the incompatible relationship between design and policy planning is explored and it is seen that

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pedestrian environments has a mismatch (Jung, Lee, & Kim, 2015). The physical design did not follow the pedestrian flow needs (Talavera-garcia & Soria-lara, 2015) in the developing countries. In terms of physical designs like the quality of pedestrian facilities, roadway conditions and land use patterns that are influencing the walking environment had been consistently been ignored for a long time. Various studies have already documented that the land use pattern and physical design features have an effect on walkability. If the walking environment has served its purpose well, the pedestrians will tend to show a positive attitude towards walking (Talavera-garcia & Soria-lara, 2015) that will be a useful tool to enhance city sustainability agenda (Kang, 2017). In this context, policy, planning, and design have become an important instrument for promoting sustainable walking.

Recent literature has established methodological interpretation for assessing walkability by checklist or scoring, for instance, walk score which is typically structured by key informant interviews. However, the majority of walkability researches regarding land use planning that have been done in North America and Europe are not sensibly synchronized to the developing countries (Su et al., 2017). If the activities on pedestrian way and the daily experiences of pedestrian are not addressed and distributed effectively in the pedestrian design, it would show a critical miss match on balanced land use planning to develop sustainable walkability. This paper attempts to bridge this gap by addressing empirical evidence which links walkability and pedestrian behavior and minimizes the implicit level for decision maker and urban designer in the decision-making process, and maximizes pedestrian accessibility and positive behavior/experiences in walking. The objective of this study is to explore, how pedestrian’s experiences are being used to assess relevant factors and indicators (negative attitude) that are affecting the pedestrian environment in the context of Bangladeshi cities like Chittagong. Besides, this study has considered three factors ie. (1) Experiences of pedestrian activities, (2) configurations or physical features of pedestrian way, and (3) walking for land use mix patterns.

Several studies have identified driving factors that affect walking activities and its environment based on neighborhood, residential areas, commercial areas or even recreational aspects, but have no specific study in and around busy urban nodal points that perform as urban growth centers. To address these objectives, the mixed-methods approach advocated by Talavera-garcia & Soria-lara (2015) has been considered.

Setting the Study Context

Walkability : Litman (2016) stated walkability is ‘the quality of walking situations, including safety, comfort, and convenience’. Transport for London in 2004 (as cited in Leather, Fabian, Gota, & Mejia, 2011) defines walkability as “the extent to which walking is readily available to the consumer as a safe, connected, accessible and pleasant activity”.

Walkability, the identifying factors, and indicators : Studies acknowledge that diversity of land use mix with countless pedestrian activities (Robertson, 1991) influences walkability (Anciaes et al., 2017; Özdemir & Selçuk, 2017; Su et al., 2017). Vehicular access is necessary for every land use mix patterns from main streets by making discontinuous pedestrian ways. Commercial activities including individual shops occupy pedestrian paths affecting barrier-free walkability (Zinia et al., 2016). This scenario is familiar in Bangladesh.

Walkability and experiences of pedestrian activities : Sung et al. (2013) stated that street areas should be vibrant 24 h a day with walking activities. In general, large part of population prefer walking for ease of access for routine works ie. street shopping or other household activities. In the rainy season, walking is become inconvenient due to the waterlogging, uncleanliness and debris (Anciaes et al., 2017). Conflict between street activities on pedestrian ways and pedestrian flow to catch transportation facilities creates an unfriendly conflicting walkable environment (Kang, 2017), in spite of this up to 61% of the traffic is found to be composed of pedestrians alone (Rahman et al., n.d.). Some researchers have demonstrated that pedestrian experiences is modified with the change in the configuration of walkways (Anciaes et al., 2017; Kang, 2017) keeping others indicators constant in the similar context and land use mix due with similar population density on pedestrian flow. The slower pace of pedestrian, gathers experiences in an environment that provides more visual details and diverse activities. A good quality of pedestrian environment can help improve user's satisfaction that plays a positive role on walkability (Talavera-garcia & Soria-lara, 2015).

Walkability and physical features of pedestrian way: Street configuration, pedestrian width, discontinuous pedestrian flow, paving materials affect the pedestrian volume to walk comfortably (Kang, 2017). Paving materials and pedestrian width were selected in accordance with the types of pedestrian flow that allows and the adjacent functional necessity to ease access (Talavera-garcia & Soria-lara, 2015). An accessible space to pedestrians of developing countries is significantly more than the developed countries, with respect to the motorized vehicular flow (Anciaes et al., 2017). Street connectivity, sidewalk width, roadway width, street furniture and articulations of building facade are examples of some of the physical characteristics believed to influence the walkability of a street and neighborhood (Funk, 2012). A minimum of 2.5 m to 4 m width walkway without frontage zone and furniture zone respectively in mixed-use to high-intensity commercial zone for barrier-free walking is recommended (Saeed & Furlan, 2017).

Walkability and land use mix patterns: In the west road is to connect two activity areas, whereas in the east or developing countries road is both connecting and socializing space (Mowla and Mozumder, 2017). Path should therefore address not only link one place to other, but also to have access to adjoining function or development and socialization. Urban neighborhoods prefer access for shopping, offices, schools, public amenities as pedestrian (Anciaes et al., 2017; Zinia et al., 2016). In the New Urbanism concept, land use zoning and planning strategies endorse pedestrian-friendly environment that promotes walkable neighborhoods through changing walkability with a high priority of land use plans (Su et al., 2017). Empirical studies have illustrated the relationship between land use mix pattern, walking behavior and configuration of pedestrian ways that fit relevant policies based on the importance of local contexts (Kang, 2017). In order to address sustainable walkability, Su et al. (2017) suggested a mixed land use schemes instead of traditional land use pattern for reducing travel time from near communities, and also mentioned to improve streetscape for enhancing pedestrian satisfaction level. Important day to day functions placed within ¼ mile walk encourages walkability (Williams, 2008). Kang (2017) recommended 0.5 km to be a primary marketing destination from the adjacent neighbourhoods.

Walkability and city sustainability: A walkable pedestrian path, as an alternative transport mode for short transit, can rebalance mobility in urban areas (Martincigh, 2003). Walkability shapes the fundamental character of a sustainable city as it encourages the walking ability of human being (Su et al., 2017). By the mid-Nineties, the Aalborg Charter, 1994 (as cited in Galderisi & Ceudech, 2010), signed by many European cities to promote sustainable urban development focused on the improvement of sustainable mobility, especially walking, cycling and public transport. Abu Dhabi has developed an Urban Street Design Manual where overall street composition incorporates the pedestrian realm. Other cities, particularly in Europe, have arranged strategies and incorporated sustaining policies to improve the walkability of the whole city (Leather et al., 2011).

Sustainable mobility creates the ability for community's interaction and reduce the use of automobiles for improvement in public health and safety (Su et al., 2017). It also reduce transit costs and provide other economic benefits (Marquet & Miralles-guasch, 2015). Accessible and walkable public realm provides sustainability to a nodal point (Fig.1)

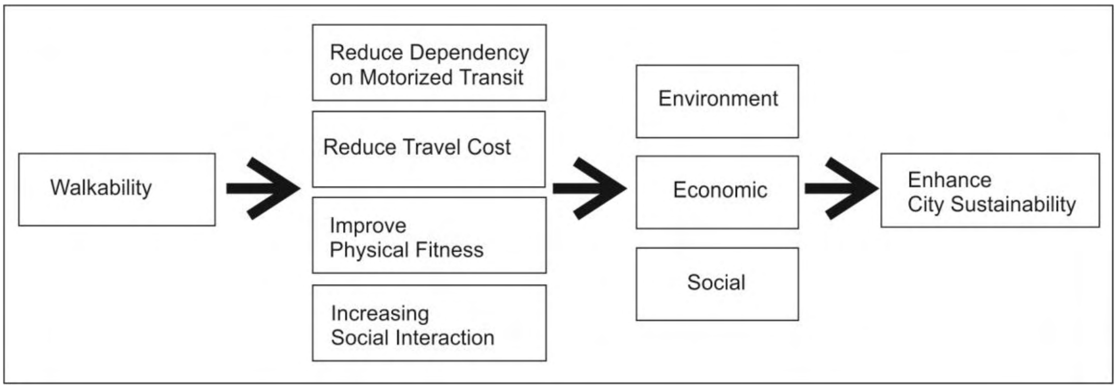

Fig.1. Conceptual integration between walkable pedestrian and city sustainability (adopted from Kang, 2017; Galderisi & Ceudech, 2010; Pojani & Stead, 2015).

Researchers have succeeded to measure walkability and used various tools that help to improve the quality of pedestrian environment through policymaker, land use planner and urban designer involvement. However, one common problem has been observed in the selecting of indicators arbitrarily and most approaches lack integration between pedestrian's perceptions and measuring structure (Su et al., 2017). A sustainable walkability issues might not be similar in every contexts and similar application might not be feasible everywhere, that is why understanding of the context is needed for remedial measures. An unpretentious and reliable approach of empirical studies can enable to verifying how pedestrians' behavior and demand, exactly contribute to various indicators that is needed to assess (Chiesura, 2004; Su et al., 2017). Recent researches have been conducted 'walk score' method to understand and measure walkability, considering low to high value for setting indications from the most to least walkability (Su et al. 2017), and high to low value for the least to most walkability (Gilderbloom et al. 2015), where the indications are prepared by expert opinion and evaluation of urban designers, development authorities and academician. From Bahrainy & Khosravi (2013) employed regression analysis to assess pedestrian environments by independent variables on the macro level which play a significant role in urban design. Unfortunately, no studies have addressed pedestrians' perceptions for selecting contextual indications and assessing walkability in urban design and planning. Besides, the quantitative findings, the empirical studies also alternatively fill up the gap between walkability measure and pedestrians' behavior explicitly. It reduces social inequalities and optimize location-based implication.

Methodology

The study aims aim to: first, measure and modify walking score in terms of appropriate indicators; second, how to correlate test research hypothesis on factors affecting walkability; third, compare each of the variables with walkability in order to provide more explicit policy and design; lastly, interpret key findings of studies to address new application. To address those aims, the research mainly applies mixed-method research through data triangulation approach divided into four steps: (1) selection of driving factors and associated indicators affecting walkability; (2) review existing land use policy for pedestrian plan; (3) understand land use mix patterns that influence walking flow at selected node points and surrounding; and (4) analyze selected factors regarding current phenomenon on pedestrian ways. This study focuses on the six different nodal points in the Central Business Area (CBA) of Chittagong, Bangladesh. Following steps are expected to help achieve the objective:

Step 1: Selecting more relevant driving factors and associated indicators (Table 1), were evaluated, and the findings shows several indicators for walkability. The indicators were grouped according to the selected driving factors. In addition, the value of indicators (labelling) were measured by a Likert scale that represented the respondents' perceptions and experts' opinions. For instance, the labelling 1 represent worst pedestrian experiences mostly observed by pedestrians that affect walkability. Consequently, higher numbers have shown less effect on walkability by some of the pedestrians.

Table 1

Summary of selected factors and indicators

Groups	Factors	Indicators (negative attitude)	Labelling
01	Experiences of pedestrian activities	Hawkers activities	1
		Storage of window shopping	2
		Unsafe walking beside road	3
		Crowded for quick transit access	4
		Encroached small Tea stall/ food shop	5
		Obstacle by construction materials	6
		Unclean pedestrian way	7
		Waterlogging	8
02	Configurations or physical features of pedestrian way	Pedestrian width	1
		Discontinuous pedestrian circulation	2
		Uneven level changes	3
		No roadside barrier for safety	4
		Broken surface	5
		Waste deposal area	6
		Obstacle by electric post & billboard	7
		Sloping walkway	8
		Quality of paving materials	9
		No universal access	10
03	Walking for Land use mix patterns	Public amenities (e.g. shopping, restaurant, hospital, hotel)	1
		Educational activities (e.g. school, college, university))	2
		Residential connectivity	3
		Commercial activities (e.g. office, business area, bank)	4

Labelling: it is the empirical results of leading question format by using a Likert scale.

Step 2: To understand existing land use plan for pedestrian way, the policies were reviewed according to current land use plan of Chittagong Metropolitan Area (CMA) as documented in DAP (2009). To discover the decision-making problems, a semi-structured interview was conducted with two experts (1) Chief Town Planner of Chittagong Development Authority (CDA), and (2) a Member of Bangladesh Institute of Planner (BIP).

Step 3: To understanding the walking need and land use mix pattern of selected nodes, the spatial analysis with the specific area of 0.5 Km radius from each node points is taken to assess 'ease of accesses'. The spatial analysis is with (1) Agriculture; (2) Community

Activities, (3) Community Service; (4) Education & Research; (5) Governmental Services; (6) Manufacturing and Processing; (7) Miscellaneous; (8) Mixed Use; (9) No Information; (10) Residential; (11) Service Activity; (12) Transport & Communication. Secondary data and GIS map have also been used to understand land use mix patterns. From the land use (Fig. 2), the studies could infer a co-relation between the density of land use mix and functional necessity of pedestrian on different days (Kang, 2015).

Step 4: For analyzing adverse effects on pedestrian circulation, a data triangulation approach was taken using a close-ended questionnaire survey as per selective indicators that affect walkability. A total of 180 samples were collected node points ie 30 from from each CBA node points. The selected respondents were grouped into three categories by age ie. (1) youth: 15-24; (2) adult: 25-44; and (3) senior adult: 45-64 years old, and and by occupations level or purpose of pedestrian use. The occupation and purpose of use were considered in the same criteria due to the age difference, for instance, youth and adult users mostly use pedestrian way for going to school, university and stationary market etc whereas adult and elder persons walk down to office, business, shopping, hospital, and for public functions. This survey covered 0.5 Km radius in each node points to cover maximum land use diversity and proximity to adjacent neighborhoods. The random sampling was used for selecting respondents during the two different peak working hours in the same day. 8:00 am -12:00 pm, and 4:00 pm - 8:00 pm where considered peak pedestrian movement periods from the reconnaissance survey.

Table 2

Walking score for walkability measure

Walk Score	Indication	Labelling
0	Not suitable for walking (most unpleasant experience on pedestrian activities, negligent pedestrian configuration, and improper land use plan)	1
1	Less suitable for walking (less pleasant experience on pedestrian activities, worse pedestrian configuration, and not much attention on land use plan)	2
2	Moderately suitable for walking (pleasant experience on pedestrian activities, upright pedestrian configuration, and slightly consideration on land use plan)	3
3	Very suitable for walking (very pleasant experience on pedestrian activities, better pedestrian configuration, and more organize land use plan)	4
4	Highly suitable for walking (Highly pleasant experience on pedestrian activities, most user-friendly pedestrian configuration, and most satisfactory land use plan)	5

Labelling: it is the empirical sequence of leading question format by using a Likert scale. Source: Adopted from Su et al. (2017).

An unstructured questionnaire survey was conducted to gather information regarding the consequence of the driving factors of walkability. A correlational analysis was done to measure relationship with various factors and walkability with Pearson correlation coefficient. From the interview, the walkability level represented by walk score and the performance of existing pedestrian circulation for walking (Table 2) is prepared.

A multiple regression analysis of walkability and correlation was conducted for predicting possible main factors, where one dependent variable (e.g. walkability) and three independent variables (e.g. experiences of pedestrian activities, configurations or physical features of pedestrian way, and walking for land use mix patterns) is considered.

Study area: The study areas were pinpointed all over the city context of Chittagong located in the extreme southeast of the country. For the selection of empirical survey area, the six nodes (Fig.2) were chosen based on similar types of public activities (e.g. shopping area, bazar, hospital area, schools), traffic congestion (e.g. bus stand, nodal points, street crossing point) and commercial areas, to identify how pedestrians have faced difficulties to use pedestrian ways in present condition. The six nodes were respectively named 1) GEC Circle-Node 01; 2) Bahadarhat Circle-Node 02; 3) Chawkbazar Area-Node 03; 4) Prabartok Node-Node 04; 5) New Market Area-Node 05; and 6) Anderkilla Node-Node 06.

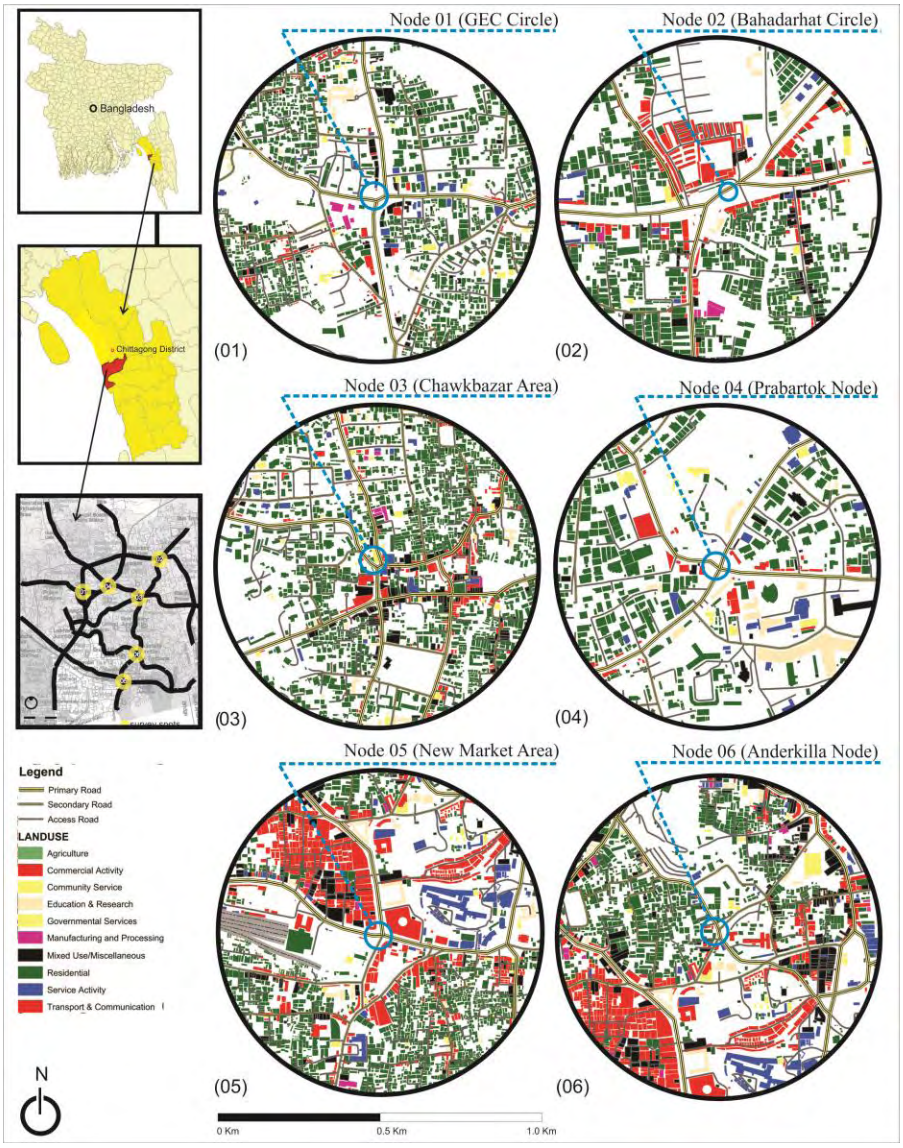

Fig.2. Location Map of Chittagong city and Land use type six study spots.

Results

Identifying the factors affecting walkability: In order to find out the current status of pedestrian circulation, the study analyzed the feedback of users from questionnaire survey at six different nodal points. The indicators calculated for each factor were analyzed in terms of labelling.

Table 3 shows analysis for each indicator, where experiences of pedestrian activities, physical features and walking for land use mix pattern measure positive relationship with walkability. First two indicators show more correlation with walkability. So, it is assumed that walking through pedestrian experiences is more desirable than physical characteristics of the pedestrian way and purpose of mobility to land use.

Table 3

Correlation results of driving factors and walkability

	Experiences of pedestrian activities	Configurations or physical features of pedestrian way	Walking for land use mix patterns.	Walkability
Experiences of pedestrian activities	1			
Configurations or physical features of pedestrian way	0.491118945	1		
Walking for land use mix patterns.	0.124543628	0.20541915	1	
Walkability	0.677214383	0.471844421	0.129153834	1

Table 4

Multiple regression results for three driving factors

Regression Statistics	
Multiple R	0.696078637
R Square	0.484525469
Adjusted R Square	0.475738971
Standard Error	0.455137143
Observations	180

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	34.269	11.423	55.144	0.000
Residual	176	36.458	0.207		
Total	179	70.728			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.793	0.099	7.983	0.000	0.597	0.989	0.597	0.989
Experiences of pedestrian activities	0.166	0.018	9.436	0.000	0.131	0.201	0.131	0.201
Configurations or physical features of pedestrian way	0.043	0.015	2.855	0.005	0.013	0.073	0.013	0.073
Walking for land use mix patterns.	0.012	0.036	0.346	0.729	-0.058	0.083	-0.058	0.083

Significance level: $P<0.05$; Dependent variable: Walkability

For the correlation of walkability, the multiple regression is used. It is to explore the in-depth relationship of driving factors with walking. From Table 4, the regression statistics gives the overall goodness of fit whereas $R^2 = 0.48$ that represents almost 50% of correlation (moderate fit) with independent and dependent variables. In addition, this study test is significant because the '*p*-value' = 0.000 is less than 'alpha' = 0.05 which is typically used in the regression analysis. The group variables are significant variance in walkability. So, the overall model was significant, where $F(3, 176) = 55.144$, $p < 0.05$, $R^2 = 0.48$. The study has shown that individual significance where 'alpha' = 0.05 and assessed with '*p*-value'. Firstly, the '*p*-value' of experiences of pedestrian activities is 0.000 which is less than 0.05, so it is significant. Similarly, configurations or physical features of pedestrian way is 0.005 which is also less than 0.05, so it is also significant. The study has identified that the effect of land use mix pattern has insignificant influence on walkability due to higher '*p*-value'. All the variables show positive relationship from the beta-coefficient which means walkability could be affected by all those three variables.

The matrix is structured by using the multiple regression equations (Eq. 1) for multiple independent variables.

$$Y = a + b_1X_1+b_2X_2 \text{ -- } (1)$$

Where, Y = predicted value (dependent variable); a = the Y-intercept; b_1 = slope (rate of predicted value for experiences of pedestrian activities) and b_2 = slope (rate of predicted value for configurations or physical features of pedestrian way); X_1 = experiences of pedestrian activities (independent variable), and X_2 = configurations or physical features of pedestrian way (independent variable). According to data from Table 4, the Eq. 1 has represented possible indicators influencing interrupted walking environments. That is:

Y = 0.793 + 0.166 (any indicator: experiences of pedestrian activities) + 0.043 (any indicator: configurations or physical features of pedestrian way), -------------- (2)

In the Eq. 2, the dependent (target) value *1.002* is presented as not suitable for walking based on walking score index (Table 2) where consider X_1=1 (hawkers activities), and X_2=1 (pedestrian width) is considered. This finding could be explained by the experiences of more hawker's activities in a pedestrian way, and the insufficient pedestrian width for walking during rush hours compared with rest of the time. A similar scenario has been found by X_1=2 (outdoor storages in shops), and X_2=2 (discontinuous pedestrian circulation), and that could be interpreted as shortages of walking space due to illegally occupied storages and continuous interruption of pedestrian circulation frequency.

Instead of inserting the highest response of respondents (Fig.3), the study has calculated each of all the variables according to indicators levelling (e.g. select 1-8 for the first factor, and 1-10 for the second factor from Table 1), and the maximum value of Y has been estimated by 2.551 which represents less suitable for walking, where X_1=8 (waterlogging), and X_2=10 (no universal access) is considered. In this outcome of less suitability, is perhaps 'waterlogging' occurs due to sessional or occasional raining and was not frequently observed and another point on "no universal access" was not realized by pedestrians.

In Fig. 3, pedestrian width is the major indicator of the unfriendly walking environment on the pedestrian way, which is observed by 49% of local respondents, while 14% thought discontinuous pedestrian circulation affected the ease of movement, but, have no significant relationship with other indicators of physical features. Based on empirical evidence and observation (Fig. 4), the study has noted the different pedestrian width of range 1m to 2m. But, in land-use mix factors, pedestrian movement is influenced by the different type of public amenities than rest of the land use mix of 49%, which are found close to adjacent neighborhood. In most of the cases, adults, and elder persons prefer to use walkway for various daily necessities, whereas students prefer to go to institutes by secondary streets and pedestrian paths that represent 22% educational facilities. Uncontrolled hawkers activities of 29% is highlighted in the experiences of respondents resulting in 'unable to walk', even in the wider path. The occupied areas by storages and goods area alongside shops, unsafe walking beside road, unexpected crowd for getting transport services, and illegally occupied spaces by tea stall/food shops have been indicated by pedestrians, respectively as 22%, 17%, 11%, and 10%.

Policy for improvement of pedestrian way: The Detail Area Plan of Chittagong Metropolitan Area has proposed few strategies for improving pedestrian facilities based on current issues on pedestrian environment (Table 5). These policy planning and implementation levels have a strong differences and inconcistencies, for instance, CDA is responsible for policy making to develop pedestrian facilities of CMA, but, CCC the implementing authority has no initiatives on that issues (Hossain, 2009; Khan, 2017)

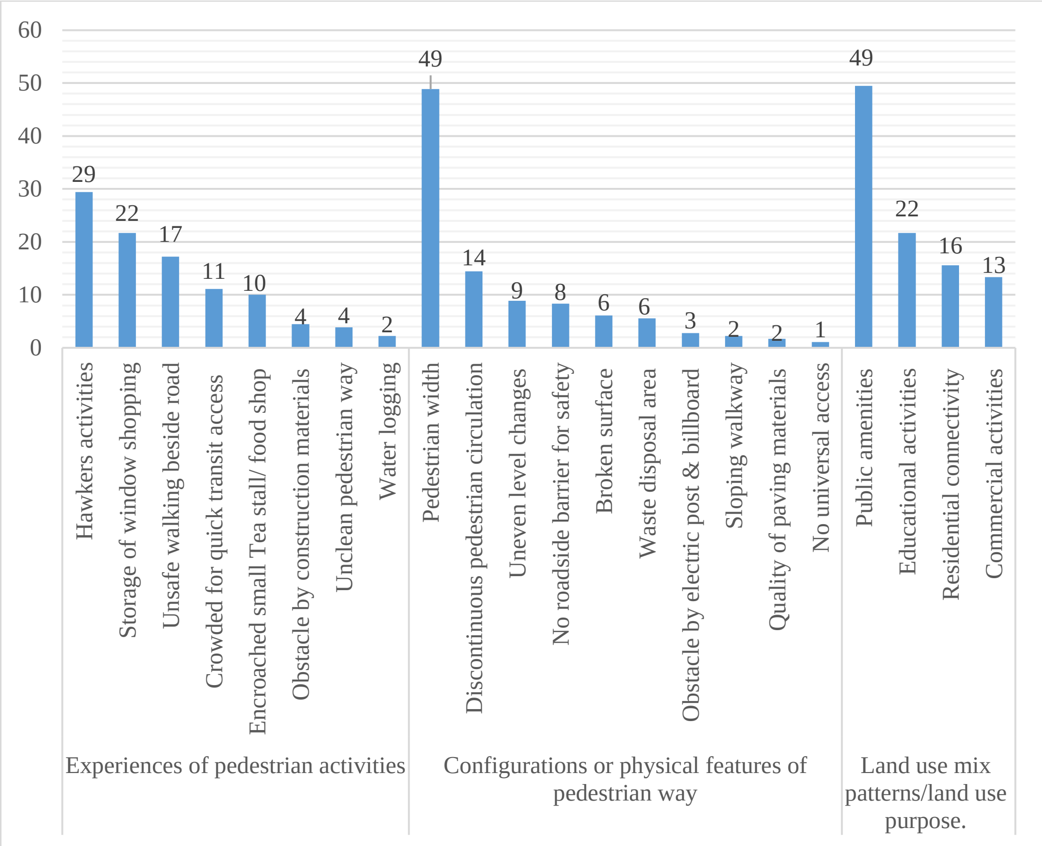

Fig.3 The number of Respondent's perceptions

Table 5

Selected policy guidelines for pedestrian development

Section	Policy	Issue (s)	Guideline (s)	Implementation authority
The policy-TR/9 under transportation network	Pedestrian facilities to be improved in the Central Business District / Central Business Area of Chittagong city	1. A large number of resident use foot for walking in daily purpose. 2. In CBD/CBA has the extra pressure of pedestrian. 3. Shortages of pedestrian way. 4. Most of the road have no footpath, some road has one side and both side footpath. 5. Priority in main CBD/CBA intersection road 6. Enhance the safety of people moving on foot.	1. Build 1.8m wide footpath (pedestrian way) along major roads in CBD/CMA. 2. Wider footpath around major intersection and shopping area would be desirable.	Chittagong Development Authority (CDA) should take initiative to motivate Chittagong City Corporation (CCC) for implementing.

Source: DAP (2009)

Discussions

The walkability assessment study was conducted to identify pedestrian experiences that can help to overcome problems in the pedestrian environments and encourage more walking and pedestrian activities which in turn would enhance the sustainability of a city. The overall model has shown a sensible relationship of walkability among variables which were correlated with each other and linked with walk score. From the multiple regression analysis, experiences of pedestrian activities, the higher impact on walkability than physical features is evident and walking because of land use mix patterns has no significant influence. The qualitative findings show that all the factors have positively performed and affected pedestrian movement. The study also has sorted the five major findings to illustrate, how walkability was affected. First, the walking score was presented to below standard of indications stated by experts opinion that has consistency with previous studies by Gilderbloom et al. (2015) and Su et al. (2017) showing that the existing condition is not encouraging pedestrian to walk. Second, on-site pedestrian activities are not positively performed by urban inhabitants eg. hawkers' activities and extended outlet of shop have created barrier for walking and that scenario is commonly interpreted for other developing countries (Anciaes et al., 2017). In spite of undesirable experiences, the study has noticed that a reasonable number of people use pedestrian spaces for their daily needs and to get quick access to desirable location. Third, configurations of pedestrian ways are not up-to-the-mark to the users and is presented as the most significant issue having no consideration in the design. Notwithstanding a limited space and insufficient width of pedestrian way for establishing small tea stalls and street foods services, pedestrians were satisfied to have easy access to cheap food and gathering space for recreational purpose, though creates problem to pedestrian. The universal accessibilities were interrupted and difficult to implement due to discontinuity of pedestrian way, moreover, level variation and sloping walkway generates uncertainty to the walkway users. The pedestrian widths did not follow standard measurement as per need of a specific context. Fourth, the study has identified that the adjacent urban land use effects mass pedestrian flow. The empirical observations show that pedestrian movement is more influenced by public amenities and educational activities of the adjacent areas and is similar to many cases in other countries (Anciaes et al., 2017; Kang, 2015; Su et al., 2017). Fifth, Reviewing the existing land use plan and policies on CMA (DAP, 2009), it is indicated that a significant percentage of daily trips are made on foot, mostly in the central business area and civic places, but adequate provisions for the traffic is not made creating a shortage of pedestrian way and facilities. The existing pedestrian ways are also not effectively usable due to reasons mentioned above. In general, only 1.8m width pedestrian is considered along major streets and nodes that was below standard and recommended to be minimum 2.5m to 4m. Despite large width of walkway empirically, an unplanned and ineffective use of pedestrian spaces are creating discomforts for a shorter trip. Lastly, social justices were absent in order to encourage pedestrian-friendly movement. This study discovers that pedestrian behavior as well as public participation itself acts as a mediator between walkability and selected three driving factors collectively enhance the sustainable development of a city.

Conclusion

This results support the initial hypothesis of current research. The major findings of the study are strongly relevant and suggest a number of implications in policy and design level for key stakeholders (e.g. urban planners, urban designers, landscape architects, architects) to create pedestrian-friendly walk way commensuration to the need of a sustainable city. Firstly, a walking score tool is recommended to be used to understand the current status of pedestrian environment before making any sustainable pedestrian way design. This tool will not only link with pedestrians' attitudes but also associated to measure the suitability of walking in a given context. The study also identifies lower walking score which represents more negative attitudes on walkability assessment, therefore, the study also argues to prioritize public participation in walkability design by land use planner and pedestrian designers. Secondly, in order to improve pedestrians' behavior, pedestrian path layout and pedestrian flow pattern is recommended to be assessed. However, with the necessity of daily needs and scope of income sources for low-income residents, on-site pedestrian activities may be addressed in detail urban layout plan. Otherwise, the effects of general pedestrian width would make an unwelcoming walking environment with the increasing pedestrian flow pattern. Thirdly, land use mix patterns especially public amenities and educational facilities around urban center are needed to encourage pedestrian movement. Finally, study reveal that the pedestrian ways have no attractive features for walkers in the local level. For future research scopes, the study believes that the empirical observation and multiple regression analysis methods are not only sufficient for analyzing and finding sustainable walkability but needs more analytical and comparative study in the similar context.

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Appendix

Fig. 4 Photographs of existing survey spots (01: represent common scenario of nodal point; 02: people are walking on streets, hawkers area, and extension of adjacent shops; 03: hawkers, food shop, tea stall on pedestrian way; 04: Van parked on pedestrian way; 05 & 06: dumping and storing area of construction material).