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A Model for Assessing the Level of Walkability in Urban Neighborhoods in Sri Lanka

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ABSTRACT

The quality of the neighboring environment plays a major role in encouraging people to walk when attending their daily needs. Although past studies have identified a relationship between neighborhood design factors and the level of walkability, this interdependence is poorly understood in urban planning in Sri Lanka. The purpose of this study is to determine factors and conditions that influence walkability in a selected neighborhood in the town of Panadura and develop a model to predict what design factors enhance walkability in the neighborhood area. Ninety three (93) factors that affect the walkability in urban neighborhood were identified as the findings of the literature review of this study. Seventy six (76) walkability factors identified through perception surveys were examined within a 100m radius of 70 buffered circles representing 140 participants' residences through a questionnaire survey and field observations. Chi-square and Bivariate correlation analysis were carried out to identify the most decisive factors for walkability. Multiple Linear Regression analysis was applied to develop a model to assess the level of walkability of residents in the selected area based on the most significant factors. The study has identified main nine variables that determine the level of walkability. Based on the significant values the model can be used to assess the level of walkability of the people in Sri Lankan context.

1. Introduction

Numerous studies have informed that residents of higher-density, mixed -use neighborhoods tend to walk more and drive less than do the inhabitants of lower-density, suburban areas (Cervero and Duncan, 2003, Crane and Crepeau, 1998, Frank et al., 2007). Pedestrianization has become an integral part of the sustainable modern urban design, where pollution-free, convenient, safe, and comfortable pedestrian facilities are ensured. Though the influence of attributes of the built environment on habitual behavioral patterns such as walking are not yet well understood by behavioral scientists (Sallis and Owen, 1999), but community design disciplines (particularly transportation and urban planning research) have identified some strong patterns of association (Frank et al., 2003). Some studies have reported the associations between perceived environmental variables and walking (Owen et al., 2004; Frank and Pivo, 1995); however, only a limited number of studies have done so far investigated the relationship between factors and conditions of the built environment and walkability in Sri Lankan urban neighborhoods. This paper discusses definitions and concepts of walkability, built environment and neighborhood. Further, it elaborates factors that affect the level of walkability. Hence, by identifying design factors that affect the walkability in a Sri Lankan urban neighborhood, the primary aim of this research study is to develop a model to measure the level of walkability which can be utilized in planning policy frameworks that guide new development and changes in already developed areas. Chi-square and Bivariate correlation analysis were used to identify the most significant factors out of seventy six (76) factors gleaned from literature review considering on Panadura urban area as a case study.

2. Literature Review

2.1 Concepts of Walkability, Built Environment and Neighborhood

'Walkability' is becoming a buzzword in planning today that is circulating around the new urbanism banner. Many individuals define walkability using different terms (e.g., proximity, accessibility, and suitability). Walkability is a measure of how friendly an area is for walking. It takes into account the quality of pedestrian facilities, roadway conditions, land use patterns, community support, security and comfort for walking (Ariffin and Zahari, 2013). Walkability is the measure of the overall walking and living conditions in an area and is defined as the extent to which the built environment is friendly to the presence of people walking, living, shopping, visiting, enjoying, or spending time in an area (Abley, 2005). The built environment refers to the physical form of communities (Brownson et al., 2009), which has been operationalized according to six dimensions: residential density, street connectivity, accessibility to services and destinations, walking and cycling (Leslie,2005) defines neighborhood as a physical environment in which all basic community facilities such as school, playground and local shop is provided within walking distance; it is an environment in which community may have an easy walk to a shopping center where they could get their daily household goods, employed people may find convenient transportation to and from work. Foesyth et al. (2007) show that neighborhoods can create and use network, interaction and connection to improve the quality of life as well as help in getting information, ideas, influences and resources. Accordingly, built environment of a neighborhood plays a major role to enhance the walkability by creating networks among the physical forms of communities.

2.2 Factors of Built Environment that Affect the Walkability in Urban Neighborhood

Researchers in planning and transportation have identified diversity of land uses, access to facilities and street connectivity as key aspects for promoting walkability in urban neighborhood (Krizek et al. 2010). Similarly, the proximity of destinations, good weather conditions, safety and well-designed pedestrian facilities can significantly contribute to better perceptions of the walking environment (Ariffin and Zachary, 2013). Frank and Pivo, (1995) demonstrate that population density and to a lesser extent, pedestrian infrastructure can affect the rate of walking. As Leslie (2005) mentions more varied and interesting environments creating neighborhoods are conducive to walking. Park and Schofer (2006) show that grid networks, sidewalks, setbacks and parking can play a role in creating a pedestrian friendly area. Furthermore, they show that large setbacks increase the effort required to reach buildings from the street; small building setbacks make commercial establishment and residences easily accessible to pedestrians. Nankervis (1999) shows that weather variables such as temperature and total precipitation impact on walking. According to the study done by Campos et al. (2003), street lighting, width of walk ways, gradient of walk ways, weather conditions, proximity to main transport facilities and signage show a higher degree of importance in encouraging people to walk. At the same time, safety is also a point of concern for pedestrian's walkability. Individuals who live in areas that are more walkable and have lower crime rates get more encouragement to walk more (Doyle et al., 2007). In a similarly vein, Schofer (2006) illustrates that pedestrian activity is associated with the level of personal safety within a neighborhood. Table 1 summarizes identified ninety three (93) factors of the built environment that affect the walkability in urban neighborhood as the findings of the literature review of this study.

2.3 Models Applied so far to Measure Level of Walkability

Many researchers have developed models to measure level of walkability using different variables. Lwin and Murayama (2011) developed urban green space walkability model to identify how people use the shortest or greenest walking route for different activities by specifying their start and end points. They show that the shortest route is ideal for shopping activities while the greenest route is ideal for walking as a recreational activity. Mitra and Buliung (2014) have used Multinomial (conditional) logistic model to explore correlates of walkability with four travel modes (walk, transit, school bus, and car).Socio-demographics, travel distance, household travel interactions, connectivity and built environment are the criteria used for this model.

Manaugh and El-Geneidy (2011) have used Binomial logistic model to examine walkability scores with household travel behavior. It shows that walkability indices are highly correlated with most non-work trip purposes. Additionally, households with more mobility choices are more sensitive to their surroundings. Moreover, Bahrainy and Khosravi (2013), using Iranian new town (Hashtgerd) as case study, have applied multivariate regression analysis to study how under construction environment and urban design qualities (formal–spatial) affect to the walkability and residents' health considering. Maleki and Zain (2011), through partial least square regression model, have identified density, employment, non-residential land use and land diversity as the factors that influence to the distance to facilities in a sustainable efficient residential site design. Furthermore, Cervero (2003) has developed a Walking-choice model to explore the association between walkability and the factors related to street and urban design such as trip purpose, trip distance, slope, rainfall, neighborhood quality and built environment factors. In this manner past studies inform how various factors influence walkability. It appears that past studies have used social, demographic, and environmental factors separately in their models. To our knowledge, past research has not informed us how to different conditions and factors together influence and predict walkability. In the study, we use a combination of social, demographic, design, and other possible environmental factors to predict walkability in a selected neighbourhood in the town area of Panadura, Sri Lanka.

3. Methodology

The validity and the consistency of ninety three (93) factors that affect the walkability in urban neighborhoods identified above through literature review were ascertained by applying the Delphi technique. Randomly selected town planner, architect, engineer, urban planner, transport engineer, urban designer, project manager & a doctor were the experts who were interviewed to refine the factors. In addition, randomly selected ten members of the general public were interviewed to get their perception regarding the factors that affect walkability.

As a result of the perception survey, seventeen (17) factors were ignored since they were not affect much the walkability in the context of Sri Lankan urban neighborhood. Those factors were regional accessibility, price of parking, 24 hour convenience stores, walking trail length, covered walkways, places for casual contacts, street furniture, quality amenities in public parks, presence of back lanes, volume/noise safety, availability of plazas, park intensity, visual complexity, transparency of fronting structures, coherence of built form and presence of sidewalks.

The data concerning the selected seventy six (76) factors were collected by conducting questionnaire survey, direct interviews and field observation survey. For this study, Panadura town area in the Western Province of Sri Lanka was selected as the case study area. The residential land uses dominate the town's activity pattern in Panadura, where high proportions of old residential bungalows occupy large blocks of lands, predominantly indicating more residential land uses (UNDP / UN-Habitat - Sustainable Cities Programme 2002). There is a trend of conversion of agricultural lands for residential activities enhancing the urban neighborhood character of the area.

Litman (2010) states that it is more flexible to walk through a shorter distance like 100m, as a longer distance requires a combination of walking and usage of public transport. Walking link is often ignored, if the involvement of motorized link has taken place on public right-of-way. Therefore, 100m radius buffered circles were drawn around randomly selected 70 houses in Panadura urban neighborhood excluding main arterial and city center (Figure 1). Accordingly, from 70 buffered circles140 participants' residences were selected for the questionnaire survey.

Time spent for walking to places during a week was calculated considering walking time for each place daily. The total time spent for walking during a week is considered as a dependent variable being a

Table 1: Factors that affect Walkability in Urban Neighborhood

Factors	Source	Factors	Source
Socio demographic factors		**Convenience & Comfort**	
1.Age			
2.Gender		44. Cleanliness of the roads	
3.Ethnicity		45.Variety of activities within buffer	
4.Education level of the respondent	Lawrence et al (2007), Ester et al (2006), Lilah et (2005), Ayşe & John (2012)46.	46. Number of houses with opened windows facing either side of the road	
5.Employment		47.Way finding signage	
6.Per capita income		48.Walking path modal conflict	
7.Household size		49. Ambient sound	
8.Number of employees		50.Foul air	Lawrence et al (2007), Kevin (2010), Southworth (2005), Krambeck & Shah (2006), Ester et al (2006), Saelens & Handy (2008), Ayşe & John (2012), Steven (2005),Litman (2005),
9.Physical Ability to walk		51.Continuity of sidewalks	
10.Auto ownership		52.Sidewalk width	
Mixed land use diversity		53.Paving treatment of sidewalk	
11.Residential Commercial Educational & recreation Administrative Agricultural	Cervero & Kockelman (1997), Sallis et al. (2005), Steven (2005), Lawrence et al. (2007), Forsyth et al. (2007), Saelens & Handy (2008), Ewing & Cervero (2010), Ayşe& John (2012)	54.Width of Home access road	
		55. Maintenance of walking path	
		56.Shade & cover from harsh climate	
		57.Clear route	
		58.Vehicle parking facilities	
		59.Price of parking	
		60.24hour convenience stores	
Accessibility		61.Walking trail length	
12.Number of foot paths	Lawrence et al (2007), Ester et al (2006), Lilah et al (2005), Steven (2005), Sapawi & Said (2012), Krizek et al (2010)	62.Covered walkways	
13.Condition of foot paths		63.Places for casual contacts	
14.Covered access from fences		**Safety**	
15.Number of significant barriers		64.Personal safety	
16.Development patterns		65.Number of crime watch signs	
17.Regional accessibility		66.Reported crimes	
Connectivity		67.Road accidents	
18.Street connectivity (number of intersections within buffer)		68.Undesirable land use & activities	Krambeck& Shah (2006), Saelens & Handy (2008), Ayşe & John (2012), Steven (2005), Sapawi & Said (2012) Ariffin & Zahari,(2013), Southworth,(2005), Foster & Giles, (2008), Leslie et al.,(2005), Troy & Grove, (2008),
19.Street pattern	Lawrence et al (2007), Kevin (2010), Southworth (2005), Krambeck (2006), Ester et al (2006), Saelens & Handy (2008), Ayşe & John (2012)	69.Abandoned buildings & lands	
20.Connectivity between uses		70.People present in streets	
21.Number of bus services per day		71.Vehicle speed	
22.Linkage of transport modes		72.Noise mitigation signals	
23.Efficiency of transport service		73.Unattended dogs within buffer	
24.Block size		74.Enough street lighting	
25.Block length		75.Level of entrapment	
Density		76.Level of visibility	
26.Residential density		77.Canopies which block the view	
27.Employment density	Lawrence et al (2007), Ayşe & John (2012), Steven (2005), Southworth (2005)	78.Presence of back lanes	
28.Road density		79.Volume/ noise safety	
29.Population density		**Aesthetic**	
30.Retail Floor Area ratio		80.Attractive architectural design	
Company		81.Presence of street trees	
31.Walking with another person		82.Number of places to exercise	
32.Walking with pets	Troy & Grove, (2008),	83.Variety in routes	Lawrence et al (2007), Kevin (2010), Southworth (2005), Saelens & Handy (2008), Steven (2005), Sapawi & Said (2012)
33. Number of relatives within the buffer		84.Narrow & crowded streets	
Pedestrian facilities		85.Landscaping treatments either side of road	
34.Presence of sidewalks		86.Naturally attractive places	
35.Disability infrastructure	Lawrence et al (2007), Ayşe & John (2012), Steven (2005), Schlossberg et al.,(2007), Ariffin & Zahari, (2013), Senevirathna & Morrall, (2013)	87.Availability of plazas	
36.Availability of crossings		88.Park intensity	
37.Feed bus service		89.Visual complexity	
38.Public park within neighborhood		90.Transparency of fronting structures	
39.Street lighting		91.Coherence of built form	
40.Number of bus halts		**Weather**	
41.Open sewers along walking path		92.Preferred walking time	Lawrence et al (2007), Saelens & Handy (2008)
42.Street furniture		93.Rainy	
43.Quality amenities in public parks			

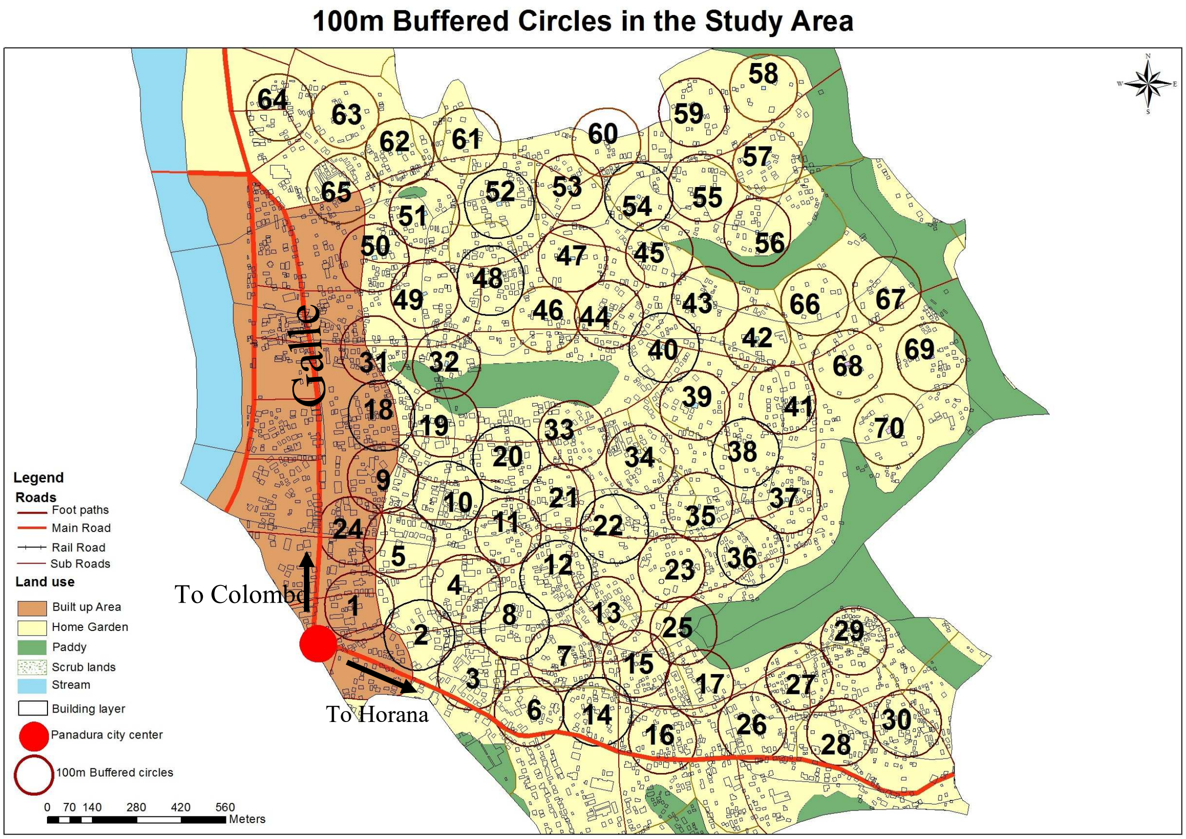

Figure 1: *Sample of 100m buffered circles within the Panadura neighbourhood*
Source: 1:10,000 Digital data base (2006), Survey Department, Sri Lanka

continuous variable. Seventy six (76) factors refined above were considered as independent variables that affect the level of walkability in urban neighborhood of which eighteen (18) factors are categorical variables, thirty eight (38) factors are continuous variables and twenty (20) factors are ranked variables.

Mixed land use diversity was examined calculating 'entropy' values within 100m buffered circle of selected 140 houses. "Entropy" value was calculated by applying the following formula developed by Cervero and Kockelman (1997) to assess the similarity in the proportion of the area in parcels devoted to residential, commercial, educational and recreational, administrative and agricultural purposes.

$$H = -1\left[\frac{\sum (P_j) * \ln (P_j)}{\ln (K)}\right]$$

Where: H is the Entropy Value, K is the number of different types of land use in the buffer. P_j indicates the proportion of land area in the j^{th} land use type and ln is natural logarithm using e (approximately 2.718) as its basis. Entropy values range between 0 and 1, with 1 representing equal proportion (20%) among the five uses in the neighborhood and 0 representing the presence of a single dominant land use.

Auto ownership, ambient sound in area, foul air , bus service, open sewers, attractive and pleasant architectural designs, variety in routes, narrow and crowded streets, covered access from fences, development pattern, connectivity between uses, linkage of transport modes, efficiency of transport facilities, vehicle parking facilities, walking path modal conflict, continuity of sidewalk, quality and maintenance of walking path, shade and cover from harsh climate, clear route, disable facilities, personal safety, unattended dogs, enough street lightings, entrapment, enough visibility, canopies and landscaping treatment either side of the road existed within the buffer were measured on the basis of their 'availability'.

Age of the respondent, income level, family members, number of employees, entropy, population density, residential density, employment density, retail density, road density, number of bus services per day, bus halts, foot paths, significant barriers, intersections, block length, block size, vehicle parking, number of houses with opened windows facing either side of the road, way finding signage, sidewalk width, width of home access roads, variety of activities, public park, street light, undesirable lands, abandoned buildings, people present, crime watch signs, reported crimes, vehicle speeds, road accidents, pedestrian crossings, noise mitigation signals, street trees, places for exercises, naturally attractive places and number of relatives within the buffer places were measured as 'numerical values' within the buffer.

Correlation analysis was conducted to ascertain whether the relationship between two continuous variables is linear (as one variable increases, the other also increases or as one variable increases, the other variable decreases) or not. In this empirical study, correlation analysis was used to identify the degree of relationship between walking time and each independent factors and the strength of the relationship between each factors for one and another. For the analysis two types of correlation analysis were used; Pearson correlation analysis and Spearman correlation analysis. Pearson correlation analysis

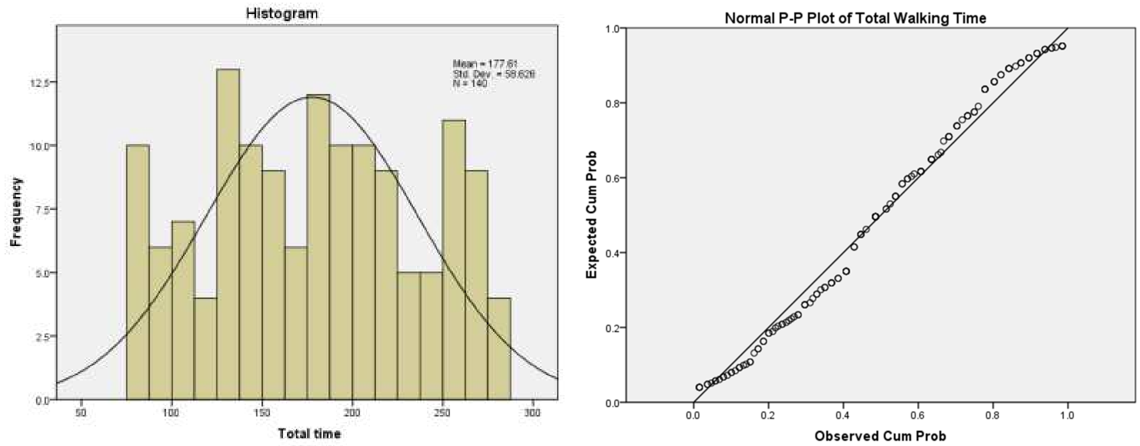

Figure 2: *Histogram & P-P Plot for total walking time*

was carried out for thirty eight (38) continuous variables only. Spearman correlation analysis was used only for the twenty (20) numbers of ranked variables (ordinal data).

Chi-square analysis and Bivariate correlation analysis were applied to identify the most effective factors that affect walkability in the selected case study area. Chi-square analysis was the statistical test used to compare observed data with data expected to be obtained according to specific hypothesis. Further, chi-square test was used to find the relationship between the level of walkability and other categorical variables. This is normally used to investigate the relationship between two categories of variables in order to find out whether they are independent or dependent. Here the dependent variable of the total time spent for walking during a week was categorized into two categories as 75-175 minutes and 176- 276 minutes. This is normally tested based on two hypotheses. They are,

H_0 = Two categories of data are independent

H_1 = Two categories of data are dependent

If the value is < 0.05, H_0 is rejected. It shows variables are dependent

Finally, Stepwise Multiple Linear Regression Analysis was used to develop a model to assess the level of walkability (time spent for walking per week by minutes) in Panadura Urban Neighborhood based on seventy six (76) multiple independent variables. The independent variables are categorical, continuous and ranked.

4. Analysis and Discussion of Results

The assumption of normality of the dependent variable of total time spent for walking was identified through Histrogram and the corresponding P-P plot (Figure 02), coefficients of skewness (0.001), Kurtosis values (-1.007), Kolmogrorov Smirnov Test {D(140)=0.072, p=.073} and SharpioWilk Test (0.960,sig .000). These diagrams and test values evidence that time spent for walking is normally distributed and does not deviate significantly from normal.

Mainly, thirty eight (38) continuous variables were considered including the total time spent for walking to calculate the correlation coefficient. Based on the results of the calculation, the relationship between dependent variable and independent variables was mapped. A summary of the correlation analysis presented in Table 2 reveals that ten (10) variables have a strong relationship with total time spent for walking during a week. According to our findings, twenty eight (28) numbers of attributes were not up to the expected sign and level of relationship. It means these variables have no significant relation with total time spent for walking.

Spearman correlation analysis was used to analyze twenty (20) ranked variables and only six (6) variables were associated with total time spent for walking during a week at 0.05 significant level. They are efficiency of transport facilities, paving treatment of sidewalk, quality and maintenance of walking path, clear route, unattended dogs and feelings of personal safety. The Table 3 illustrates the summary of the Spearman correlation analysis.

Chi-square test was used to analyze the eighteen (18) categorical variables and only four (4) variables were related to total time spent for walking during a week at 0.05 significant level. They are covered access from fences, variety in routes, walking path modal conflict and foul air. The Table 4 illustrates the summary of the Chi-square analysis.

After identifying the factors which had recorded high significant level to walking time a model for assessing the walkability time was developed based on value of other independent factors to be used in future in the Panadura neighborhood area. Level of walkability measuring model was developed by applying step-wise regression analysis for significantly correlated factors. As shown in the Table 5, the model number nine is the selected model for assessing the level of walkability out of summarized total number of nine models derived from the stepwise regression.

Multiple Linear Regression Analysis indicates that out of the twenty (20) correlated factors selected through correlation and chi square analysis, it was found that nine (9) factors that significantly contribute in deciding the level of walkability in the Panadura UC area. Those factors were significant at 0.05 level. The contributing factors were 'number of street trees within buffer, number of relatives' or friends' houses within buffer feel personal safety when walk surround area, availability of covered access from fences, unattended dogs within the buffer, age of the respondent, reported road accidents within buffer, people present on street within the buffer, number of houses with

Table 2: Summary of the Pearson Correlation Analysis

No	Code	Spearman co-efficient of cor-	Significant value	Strength of the rela-tionship
1	Educational level of the respondent	-0.046	.592	Negative weak
2	Condition of the foot path	-0.050	.556	Negative weak
3	Connectivity between uses	0.009	.917	Positive weak
4	Linkage of transport mode	-0.041	.633	Negative weak
5	Efficiency of transport service	0.845	.000	Positive strong
6	Cleanliness of walking path	-0.009	.917	Negative weak
7	Paving treatment of sidewalk	0.696	.000	Positive strong
8	Maintenance of walking path	0.723	.000	Positive strong
9	Shade & cover from harsh climate	0.015	.860	Positive weak
10	Clear route	0.952	.000	Positive strong
11	Disability infrastructure	0.037	.662	Positive weak
12	Personal safety	0.816	.000	Positive strong
13	Unattended dogs within the buffer	-0.790	.000	Negative strong
14	Enough street lighting	0.121	.154	Positive weak
15	Level of entrapment	-0.046	.589	Negative weak
16	Level of visibility	0.089	.296	Positive weak
17	Canopies which block the view	-0.019	.823	Negative weak
18	Landscaping treatments either side of the roads	0.018	.836	Positive weak
19	Preferred walking time	0.073	.389	Positive weak
20	Rainy	-0.076	.375	Negative weak

Table 4: Summary of the Chi- Square Analysis

Code	Pearson's Chi-square value	Significant value	Status of the relationship
Gender	1.167	0.280	H_0 is accepted
Occupation	2.435	0.487	H_0 is accepted
Ethnicity	2.230	0.526	H_0 is accepted
Physical condition	1.758	0.185	H_0 is accepted
Auto ownership	0.120	0.729	H_0 is accepted
Covered access from fences	136.040	0.000	H_0 is rejected
Development pattern	0.080	0.778	H_0 is accepted
Street pattern	0.179	0.672	H_0 is accepted
Walking path modal conflict	46.179	0.000	H_0 is rejected
Ambient sound	0.329	0.566	H_0 is accepted
Continuity of sidewalk	0.010	0.919	H_0 is accepted
Foul air	33.257	0.000	H_0 is rejected
Feed bus service	1.609	0.205	H_0 is accepted
Open sewers along walking path	0.697	0.404	H_0 is accepted
Attractive architectural design	0.905	0.341	H_0 is accepted
Variety in routes	8.529	0.003	H_0 is rejected
Narrow & crowded streets	0.003	0.954	H_0 is accepted
Walking with another person (Company)	1.102	0.294	H_0 is accepted

opened windows facing either side of the road'. Finally based on those selected variables and using values, walkability model was developed as shown below:

Level of walkability (Minutes) =129.388 + (1.313 * Number of street trees within the buffer) + (5.636 * Number of relatives or friends houses within buffers) + (11.031 * Personal safety when you walk surround area) – (12.197 * Availability of covered access from fences) – (5.911 * Unattended dogs within the buffer) – (0.282 * Age of the respondent) – (8.514 * Number of reported road accidents within buffer) + (1.434 * Number of people present on street within the buffer) + (1.597 * Number of houses with opened windows facing either side of the road)

It is important to assess how well this model fits into the actual data (goodness of fit of the model). R^2 represents the 99.2% of variance in the total walking time explained in above nine variables. The F-statistic of 106.05 for the model shows that R^2 is significant. Pearson's correlation coefficient of 0.996 indicates that there is a perfect relationship between the values of the total walking time predicted by the model and the values of the total walking time actually observed. F

Table 5: *Model Coefficient Values*

Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig
		B	Std. error	Beta		
9	(Constant)	129.388	8.884		14.565	.000
	Number of street trees within the buffer	1.313	.690	.170	1.901	.000
	Number of relatives or friends houses within buffers	5.636	.613	.177	9.192	.000
	Personal safety when you walk surround area	11.031	1.881	.129	5.863	.000
	Availability of covered access from fences	-12.197	2.311	-.104	-5.278	.000
	Unattended dogs within the buffer	-5.911	1.320	-.080	-4.478	.000
	Age of the respondent	-.282	.068	-.051	-4.158	.000
	Number of reported road accidents within buffer	-8.514	1.786	-.118	-4.766	.000
	Number of people present on street	1.434	.531	.188	2.703	.008
	Number of houses with opened windows facing either side of the road	1.597	.646	.070	2.471	.015
Dependent Variable: Total Walking Time						

ratio of 1868.897 (>1,sig .000) for this model indicates that the improvements in prediction due to the model is expected to be large and the difference between the model and the observed data expected to be small.

The t-statistic tests the null hypothesis that the b-value is 0. All t-statistic values relevant to the above mentioned nine variables contribute significantly (sig value <0.05) to estimate total walking time and indicate that the corresponding b-values are significantly different from 0. The standard error values relevant to b-values under above nine variables are comparatively very small and it implies that most samples are likely to have b-values similar to the one in this sample.

It is important to assess whether a model can be used to make inferences beyond the sample of data that has been considered here. This model can be generalized since it has been met assumptions of additivity and linearity (total walking time is correlated with 20 predictor variables), independent error (Durbin-Watson test value =1.950), homoscedasticity, normally distributed error (sample size=140), variable types (continuous and categorical), no perfect multi-collinearity (all variance inflation factor <10), non-zero variance and predictors are uncorrelated with external variables. Sample size of 140 is adequate to test the overall regression model under 20 correlated factors since it indicates medium effect (Cohen's benchmark R^2=0.14).Further, a stepwise regression approach was used, because at the beginning it included all the independent variables and the variables which did not play a significant role to the walking time were discarded step by step. Finally, the best one which has lowest standard error was selected. Our findings show that model 9 has the lowest standard error (5.305) and it is more accurate than other eight models (Table 6). Adjusted R^2 value indicated that 99.2% variance in total walking time would be accounted for, if this model had been derived from the population of Panadura urban area which the sample was taken. Histogram of the standardized residuals and normal probability plot indicated that the residuals in the model are normally distributed. Number of relatives or friends houses within buffer is making a significant contribution to the model since it has smaller the value of Sig. largest beta value and the largest the value of t. From the magnitude of the t statistic, unattended dogs within the buffer, age of the respondent and number of reported road accidents within the buffer have a similar impact, whereas number of people present on street and number of houses with opened windows facing either side of the road have a less impact. Partial correlation values of all other excluded variables indicate less than 0.1 that imply their contribution would be very less if they were entered into the model.

5. Conclusion

The study has identified main nine variables that determine the level of walkability. Based on the significant values the model can be used to assess the level of walkability of the people in Panadura area. The findings of the case study inform that people's level of workability depends not only on built environment factors but also on some factors such as feelings of personal safety, age of the respondent and availability of unattended dogs. One of the important findings of the present study is that a significant number of people concern about their safety. Out of the finally selected nine variables, five variables namely feeling of personal safety, unattended dogs, reported road accidents, people present on street and houses with opened windows facing either side of the road are directly linked to "Safety". Second priority was given to the factors related to the "convenience and comfort", which can be listed as paving treatment of sidewalk, sidewalk width, quality of maintenance, less foul air, clearance of the route. McNally (2010) has also stated that 'by creating areas where pedestrians feel safety, welcoming, and comfortable, there is a greater opportunity for lively and walkable streets to become a reality'. The people who live in Panadura area reported high walking time if they have efficient transport facilities, less model conflict and less covered access from fences which are directly related factors to the "accessibility". Most of

Table 6: *Summary of the model*

Mod-el	R	R Square	Adjust-ed R Square	Std. Error of the Estimate
1	.976[a]	.954	.953	12.719
2	.988[b]	.976	.976	9.202
3	.992[c]	.984	.984	7.469
4	.994[d]	.988	.988	6.442
5	.995[e]	.990	.989	6.118
6	.995[f]	.991	.990	5.807
7	.996[g]	.991	.991	5.567
8	.996[h]	.992	.992	5.409
9	.996[i]	.992	.992	5.305

the people use public bus service as their main transport mode. They have to walk to main bus halts from their homes. It appears that availability of efficient transport facilities motivate people for walking to transit points on their daily trips. This study supports the findings of previous studies (Cerin et al., 2006 and Owen et al., 2004), that factors related to "Aesthetic" has a great concern for encouraging walkability. Also, "social company" particularly, presence of relatives and friends within the area concerned contributes to the level of walkability in the selected case study area. The findings of the study further reveal that the common factors related to the land use diversity, density, weather and pedestrian facilities could be treated as contributive factors, but not significant enough to affect the level of walkability. It proves that this Walkability model can be used to assess the level of walkability in already developed urban neighborhood areas in Sri Lanka. However, we believe that this model needs to be applied in similar neighbourhoods in different context (e.g., at night) in Sri Lanka to confirm the validity.

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