International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 07 | July -2017 www.irjet.net p-ISSN: 2395-0072

WALKABILITY INDEX BY GLOBAL WALKABILITY INDEX METHOD

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Abstract – *This study aims to suggest the Walkability values and a qualitative analysis undertaking case study of Lovely Professional University(LPU)-India's largest single campus private university. The paper includes an extensive study of important criteria such as the pedestrian facilities, safety, accessibility and aesthetic appearance. The survey applies the principle of Global Walkability index developed by H.Krambeck together for the World Bank along with the Clean Air for Asian cities (CAI-Asia). The methodology is qualitative as it provides insight to the several key parameters and enables the identification of areas for improvement. Walkability indicates the quality and safety of the walkways and sidewalks. LPU has student strength of approximately 25000. All of them have to either use private vehicles in large number causing congestion, bicycles or have to walk to their destinations inside the campus area. Therefore, it is necessary to find the safety, comfort and convenience of pedestrians for which the evaluation of GWI of LPU is needed.*

Key Words: **Walkability index, pedestrian, walkway, crosswalk, built environment, congestion, urban planning**

1. INTRODUCTION

What is Walkability? Well it's not just about the physical walking but also how walk able i.e. safe, convenient, comfortable, accessible and healthy the built environment is. A gas-belching, time-wasting, life threatening prosthetic device- how can we free ourselves from the dependence on the car and make our vicinity more walk able and more pleasant for people. A walk can be useful in many ways. It can initiate economical brilliance, better health and environmentally sustainable. Recently the urban planners have been working on the 3D's of the built environment – density, design and diversity. The density of an area plays a vital role and is acknowledged by planners whereas the other two factors have just been ignored. It deals with the idea of how compact the built environment can be, mixed use of land, walking friendly design to degenerate vehicle trips and encourage people to walk, bike or take public transit as substitutes for automobile travelling particularly. Basically walk ability is of quite significance in an era where the congestion has become one of the main outbursts of the century. Population explosion is one of the major factors responsible for such a chaotic situation leading to congestion. This problem has lead to an intense pressure on the transport network along with the exhaustion of the energy resources. So it's important not only for the urban planners and the transport engineers but also for the people that owning vehicles and discarding the cheapest and healthiest mode of transport i.e. walking isn't the best solution to the problem. Promoting public transport such as buses, metro etc will help not only conserve the non-renewable source of energy but give efficient time to come with best possible solutions as its replacement.

The Urban design philosophies include- new urbanism, transit oriented development and traditional town planning which have gained popularity in recent years as a way to boost the travel demand. These three have common transportation objectives which are: (1) reduced number of motorized trips, also called trip generation, (2) trips which are produced, hike the non-motorized part (i.e. by foot or bicycle); and (3) the motorized trips that produce reduced level of travel distances and increases the vehicle occupancy level (i.e. by encouraging shorter trips by transit, Para transit, and ride sharing). An expected outcome of degenerating trips will have a lessened negative consequences of an automobile oriented society such as – reduced pollution, fossil fuel consumption and; class and social segregation (Banister and Lichfield, 1995; Ditmar, 1995).

In municipal planning and budgets often services related to pedestrian, infrastructure and amenities are neglected. Hoe desirable a vicinity can be based on safety, security and convenience of their pedestrian environments are all associated to walk ability and its significance in urban planning and design.

1.1 WALKABILITY INDEX

Basically, Walkability reflects the built environment health, economics and over all livability of the area. Its not just about physical walking but also the factors like: safe, convenient, secure, attractive and connected the area is. Places undesirable of walking include: separated land use, dead end streets and poorly designed arrangement of developments.

According to Brad Shaw Walkability can be defined as:
A foot-friendly, easy to use and built environment friendly with leveled sidewalks, safe intersections, narrow streets,

proper disposing facilities, proper lighting a total absence of obstructions. A local culture inhibiting more carefree and a built in environment must be involved.

Clean air initiative (2011) is an organization involved in finding the Walkability in Asian cities. For a pedestrian survey, they have recommended the following attributes to be considered:

i) Sidewalks/footpaths cleaner and wider
ii) Low traffic volume on road
iii) Obstacle free footpaths
iv) Increased crossing points
v) Effective street lighting
vi) Easy access for disabled persons

They also calculated the walk ability index in 30 major cities in India. The average Walkability of India was reported as 0.52. The best Walkability in the country according to this ranking was in Chandigarh (=0.92).

Table 1.1: Walkability of 30 cities in India (Source: "Walkability in Indian cities", Clean Air Initiative for Asian cities (CAI-Asia) centre, 2011)

Sl.No	Cities	Walkability index score
1	Shimla	0.22
2	Bhubaneswar	0.28
3	Gangtok	0.3
4	Panaji	0.32
5	Pondicherry	0.37
6	Hubli Dharwad	0.39
7	Guwahati	0.39
8	Amritsar	0.31
9	Thiruvananthapuram	0.34
10	Agra	0.38
11	Varanasi	0.33
12	Bikaner	0.43
13	Raipur	0.41
14	Madurai	0.40
15	Bhopal	0.47
16	Kochi	0.57
17	Kanpur	0.59
18	Patna	0.65
19	Bangalore	0.63
20	Nagpur	0.66
21	Jaipur	0.64
22	Hyderabad	0.68
23	Surat	0.62
24	Chennai	0.77
25	Kolkata	0.81
26	Pune	0.81
27	Mumbai	0.85
28	Ahmadabad	0.85
29	Delhi	0.87
30	Chandigarh	0.91
31	National	0.52

The walk score is a number between 00 -100. Below are the general guidelines to evaluate the walk score:
90-100= walker's paradise: owning a car isn't necessary and most of the errands can be done by walking.
70-90= very walk able; owning a car isn't important.
50-70= some walk able locations; some amenities might be at a walk able distance but everyday errands must require proper transportation facilities.
25 - 50 = Not Walkable; only a few destinations are within easy walking range. For most errands, driving or public transportation is a must.
0 - 25 = Driving only; virtually no neighborhood destinations within walking range. You can walk from your house to your car.

Using this scoring system, Chandigarh (walk score = 91) in India was considered as walker's paradise. Although walkscore.com measures how easy it is to live a car-free life style and considers how dense the land use is (which can reduce trip lengths), it does not include a qualitative assessment of pedestrian facilities like walkway width, walkway height, street lights, traffic and crime safety, etc.

The main objective of calculating the Walkability index may be summarized as follows:

1) Generating awareness of Walkability as an important issue in developing cities.
2) Providing city officials with an incentive to address Walkability issues.
3) Helping city planners understand scope and extent of local pedestrian conditions, relative to other cities
4) Providing city planners with the information necessary to identify specific pedestrian-related shortcomings, as well with recommendations for next steps.

Walkability of an area has been estimated by various researchers and organizations. Three of such methods are presented here.

1.1.1 GLOBAL WALKABILITY INDEX (GWI) (Krambeck & Shah, 2006)

This method is used by the World Bank which provides a qualitative analysis of the walking conditions including safety and security, convenience and degree of policy support for the pedestrian environment. Related aspects covered under the above three components are listed below:

a) Safety and Security
   i) Proportion of road accidents that resulted in pedestrian fatalities
   ii) Walking path modal conflict
   iii) Crossing safety
   iv) Perception of security from crime
   v) Quality of motorist behavior
b) Convenience and Attractiveness
   vi) Maintenance and cleanliness of walking paths
   vii) Existence and quality of facilities for blind and disabled persons
   viii) Amenities (e.g., coverage, benches, public toilets)
   ix) Permanent and temporary obstacles on walking paths
   x) Availability of crossings along major roads
c) Policy Support
   xi) Funding and resources devoted to pedestrian planning
   xii) Presence of relevant urban design guidelines
   xiii) Existence and enforcement of relevant pedestrian safety laws and regulations
   xiv) Degree of public outreach for pedestrian and driving safety etiquette

The method comprises two kinds of surveys — a public agency survey, to be administered to department(s) responsible for urban and transportation planning, and a field survey. These surveys may be conducted in any order. It is important that these surveys are conducted within local populations to prevent undue bias in results. The public agency survey is used to collect important data that is not obtainable through physical infrastructure surveys, such as pedestrian fatality statistics and pedestrian-related laws and regulations. The field survey is used to collect pedestrian perceptions on facilities and to suggest improvements if there. Thus Walkability index is the summation of the scores obtained from pedestrian facility ratings and a public agency ratings.

Survey areas are selected in the study area such that the entire major and important roads are covered. One sheet per survey area is used. Within each survey area only main public roads are surveyed. For consistency, all surveys should be conducted during local peak travel times.

The total number of people walking in the street (alongside other traffic modes) and on walking path are counted on one side of the street over a period of 5 minutes using a traffic counting method. The surveyed length of the street is measured in kilometers and it varies between 0.2 - 0.4 km.

A public agency survey involves the administrators in the selected area. The survey questionnaire is shown in Appendix-A. The GWI implementation guidebook has allotted marks for each of those above questions. Based on the responses, for each area, the public agency rating is obtained. A field survey is carried out which involves the pedestrians of the each segregated area. The Performa is given in Appendix-B

Field surveyors will ask the pedestrians to rate the selected road stretches on a scale 1 to 5 for each variable (1 being the lowest, 5 being the highest) in each of the selected areas. The average for each of the variables is translated into a rating system from 0 (lowest score) to 100 (highest score). Walkability ratings in the different area types in each city are derived by taking the average of the individual variable averages.
Thus the summation of the public agency rating and field survey rating gives the Global Walkability Index (GWI). This method identifies pedestrian preferences and analyzes government policies.

1.1.2 MINISTRY OF URBAN DEVELOPMENT (MOUD) METHOD

This method was developed by Ministry of Urban Road Development (MOUD), Government of India. They especially developed this method based on the Indian conditions. According to this method walk ability index is a function of availability of footpath and pedestrian facility rating. This can be calculated using equation 1.1.

Walkability Index = [(W1 x Availability of footpath) + (w2 x Pedestrian Facility rating)] - (1.1)

Where, w1 and w2 are weights (assumed 50% for both)
Availability of footpath = Footpath length / Length of major roads in the city - (1.2)
Pedestrian Facility Rating = Score estimated based on opinion on available Pedestrian facility

- (1.3)

Using this walk ability index, MOUD assessed the quality of pedestrian infrastructure across 30 cities in India and found an average index of 0.52 (out of 1 point scale). Chandigarh scored a maximum of 0.91. Small and medium towns have scored less which is ironical as these towns have high pedestrian flow. All larger cities have scored better than smaller cities. This may be due to higher investments being made in providing road infrastructure in these cities. The hill towns have scored lower values, indicating poor condition and availability of pedestrian facilities. Clearly, smaller cities and hill towns have higher pedestrian volumes but poorer pedestrian facilities.

The limitation of this methodology is that it is difficult to assess that which parameter needs improvement such as safety, disability infrastructure, comfort, convenience,

amenities, etc. The method considers the length of only those footpaths which are wider than 1.2m. The length of the major roads in the city is calculated using the city plan or a tape or Google maps.

For finding the pedestrian facility rating, a pedestrian survey is to be carried out. The pedestrian survey enables residents most impacted by the walk ability of a city, to voice their opinion on current conditions of the pedestrian facility and to suggest improvements if there. It is important that these surveys are conducted within local populations to prevent undue bias in results. Topics covered in this survey include:

1) Footpath width
2) Footpath continuity
3) Availability of crossings
4) Maintenance and cleanliness
5) Security from crime
6) Disability infrastructure
7) Amenities
8) Obstructions
9) Footpath surface

Using the above mentioned pedestrian facility factors, a survey form is prepared in which the pedestrian has to evaluate the listed attributes on a 5 point usability scale where '1' defines 'not at all usable' and '5' define 'highly usable'. Survey is to be done for a minimum of 50 people (pedestrians). The average of the pedestrian facility factors is calculated. By using the equation 1.1, the walk ability of index of an area is calculated.

1.1.3 WALKSCORE.COM METHOD

Walkscore.com calculates an area's walk ability based on the distance from resident's house to nearby amenities. Walk Score helps people find walk able places to live. Walk Score calculates the walk ability of an address by locating nearby stores, restaurants, schools, parks, etc. It is based on:

1) The distance to walk able locations near an address.
2) Calculating a score for each of these locations.
3) Combining these scores into one easy to read Walk Score.

The Walk Score may change as the data sources are updated or as the algorithm used is improved.

Walk Score is a number between 0 and 100. Below are general guidelines for interpreting the walk score.

1.2 WALKABILITY ECONOMICS

Walking means to solve many social ills such as global warming, traffic congestion, oil dependency and other health issues. The importance of urban planning for sustainable development is important. Quality of air we breathe and water we drink all comes under the issue of planning and development. Consequences on: climate-change, bio-diversity, transportation development pattern.

Challenges to build green communities and their objectives are:

1. Better scientific community
2. Relief from high petrol prices
3. Reduction in green house gas emissions
4. Rely on energy efficient buildings
5. Reduce distances from origin to destination
6. Reduce the need for costly roads and infrastructure

2. EXPERIMENTAL DESIGN AND SETUP

2.1 AREA SURVEY

For the case study purpose the method of global Walkability index (GWI) has been considered. LPU is a private university and has its roots in Jalandhar, India setup in 2005. It presides over an area of 600 acres of green land on NH-1. It comprises of 25000 students from 28 states and 26 countries. It is a residential university with separate hostel facility for boys and girls housing more than 15000 students.

Surveyed Area Data:

Roads in LPU= 15040 ft.
4.5 kms of total road stretch in LPU
Footpath Length= 27040 ft
8.24km of total side walk length
Covered footpaths= 3470 ft
1.05km of covered footpath

Table -2.1: Zoning of Study Area

S.NO.	ZONE	DESCRIPTION
1.	I	LIM, Campus café, SBRM Auditorium, LIT, Pharmacy, Architecture, Hospital
2.	II	GH 1-4, Business block, Lovely mall, Hotel Management, Education Block, LSB, GH 5-6
3.	III	Block- 25, 26,27,28,29,30,31,32,33,34,35,36,37,38
4.	IV	Block- 39,40,41,42,43,44, BH-1,2,3,4,7
5.	V	Block- 55,56,57,58, BH 5-6

2.2 GLOBAL WALKABILITY INDEX

For calculation of GWI there are two types of surveys for conducted for the pedestrian facility rating: public agency form and field survey.

The public agency survey is conducted respectively for each zone but in case of LPU campus survey only one is conducted because it has one area planner.

The attributes such as: adequate funding and resources devoted for pedestrian-related urban design guidelines, and available data on pedestrian fatalities, pedestrian safety programs and law or regulation enforcement.
The field survey: (1) Material map, camera, extra data collection form, measuring tape, (2) survey area selection zone , (3) time of the day- local peak travel, (4) filling in data collection form and performing calculations, (5) quality assurance-photography of cross sections to be surveyed.
A field Walkability survey was conducted which involves the following attributes:

(1) Carriageway modal conflict
(2) Walking path availability
(3) Crossings availability
(4) Safety of grade crossing
(5) Behavior motorists
(6) Amenities availability
(7) Disabled infrastructure
(8) Obstructions and barriers
(9) Safety to crime

The pedestrians will be asked to rate the factors of design on a scale of 10 point of each attribute 1 being the lowest and 10 being the highest in each of the selected areas. The average of each of the parameters will then be converted into a rating system from 0(lowest) and 100(highest). Thus, the summation of these surveys will give the GWI. Field Walkability survey will be carried out in each zone. Now, the length of sidewalk will be multiplied with length of surveyed road and pedestrian count (*10) for simplicity. The field survey rating shall be calculated with the help of GWI implementation guide book.

3. ANALYSIS, RESULT AND DISCUSSION

LPU campus is divided into 5 zones for the GWI method. LPU campus is managed by Chief Architect (CA) and his team. A public agency survey was carried out in each zone. Responses were taken from CA in the prescribed Performa.
Based on their answers for each question, the public agency rating for each zone was calculated with the help of weightage given in table 3.

Table -3.1: Points assignment for public agency survey

QUESTION	POINTS ASSIGNMENT
1	1-5 scale; Non-Existent=1
2	One point for each box checked
3	Divide percentage by 10
4	Yes=5, No=1
5	3 for each 'usually' to 1 for each 'rarely', divided by 2.

Table -3.2: Public agency ratings for zones in LPU campus

ZONE	DESCRIPTION	RATING(ON 30 POINT SCALE)
A	LIM, Campus café, SBRM auditorium, LIT, Pharmacy, Architecture, Hospital	08
B	GH 1-4, Business block, Lovely mall, Hotel Management, Education Block, LSB, GH 5-6	06
C	Block- 25, 26,27,28,29,30,31,32,33,34,35,36,37, 38	04
D	Block- 39,40,41,42,43,44, BH- 1,2,3,4,7	2.5
E	Block- 55,56,57,58, BH 5-6	01

The variations in the public agency ratings is due to the changes in the sidewalk widths, parking on sidewalks and degree of funding and resources devoted for pedestrian planning. The overall ***average*** public agency rating of LPU campus is found to be 4.3 on a 30 point scale.

Filed Walkability survey was carried out in each of these zones. To normalize the LOS inputs, each LOS was multiplied by the length of surveyed road and the pedestrian count (x10). The resulting number was divided by 10 for simplicity. For each zone a separate road stretch was considered such that the entire area is properly represented. The length of the road stretch was measured in kilometers. The number of pedestrians walking in that stretch along one side of the road was recorded for an internal of 5 minutes. So using the pedestrian ratings, length of the road stretch and pedestrian count, the field survey rating was calculated with the help of GWI implementation guidebook. The results of field Walkability survey are given in table below

Table 3.3: Field Walkability survey of LPU Campus

SURVEYED ROAD STRETCH	ZONES					∑(EACH LOS* LENGTH OF SURVEYED ROAD*10*PEDESTRIAN COUNT)/10
WALKING PATH MODAL CONFLICT	3.6	3.4	4.5	4	4.6	53.01
SECURITY FROM CRIME	4.5	4.2	3.4	4	3.8	53.76
CROSSING SAFETY	3.5	4.1	3.5	4.7	3.8	52.92
MOTORIST BEHAVIOR	3.8	3.7	4.1	3.5	3.7	49.85
AMENITIES(COVER, BENCHES,	3	3.5	3.6	3.1	4.1	45.59

PUBLIC TOILETS, STREETLIGHTS)						
DISABILITY INFRASTRUCTURE AND SIDEWALK WIDTH	3.8	4	3.8	3.8	4.1	52
MAINTENANCE AND CLEANLINESS	3.7	4.2	4.5	4.5	4.8	57.6
OBSTRUCTIONS	3.2	4.5	3.5	2.8	4.5	48.61
AVALIBILITY OF CROSSINGS	3.6	3.3	3.7	3.7	4	48.80
PEDESTRIAN COUNT	17	16	11	18	11	
LENGTH OF SURVEYED, KM	0.2	0.18	0.2	0.2	0.25	

UNWEIGHTED AVERAGE= 51.34

The average field walk ability of LPU campus was found to be **51.34**.

GWI= Average of public agency survey+ Average of field Walkability survey

=4.3+51.34

=55.64

Therefore, **GWI of LPU campus comes out to be 55.64**(on a 100point scale). Therefore, 50-70 holds for some walkable locations, some stores and amenities are within walking distance but many every day trips still requires a bike, car or public transport.

Walkability of the LPU campus was evaluated based on GWI method. The method was developed by World Bank. Apart from pedestrian perception regarding use of a facility, it also gives emphasis to pedestrian count in a stretch, pedestrian facility design & values and regulations under enforcement. It is affected more by the length of the stretch and the number of pedestrians walking on a facility on one side, the score increases proportionally with the increase in these attributes.

3. CONCLUSIONS

According to the calculated results the expected outcomes can be drawn:

(1) The attributes considered to evaluate Walkability of an area should also include design attribute height of a walkway with respect to direction of movement on the carriageway.

(2) On the whole, the pedestrians have rated the facilities in LPU as satisfactory level (55.64 on a scale of 100).

(3) Major areas of concern are no provision of traffic separators, absence of pedestrian friendly crossing facility and ramps connecting to the carriageway (disability design feature) and missing continuity of walkways. These need to be given proper consideration.

(4) Main users like students have found the pedestrian facilities lacking on many accounts and on the overall rate them near satisfactory level. The desired need to be given due considerations (based on peak hour traffic).

(5) Female pedestrians have same level of satisfaction as that of male pedestrians, except for obstruction free width of the walkway.

(6) GWI method does **not** consider the design factors like footpath height and availability of walkway on appropriate side of carriageway. This method also gives equal weight age to both the parameters; availability of footpath and pedestrian perception ratings. This method will be more subjective and qualitative if it considers pedestrians characteristics like gender, age, occupation and household income.

(7) It is found that based on public agency survey there are rules being enforced in the campus related to safe and convenient movement of pedestrians but somehow prove to be deficient.
These aspects need immediate attention.

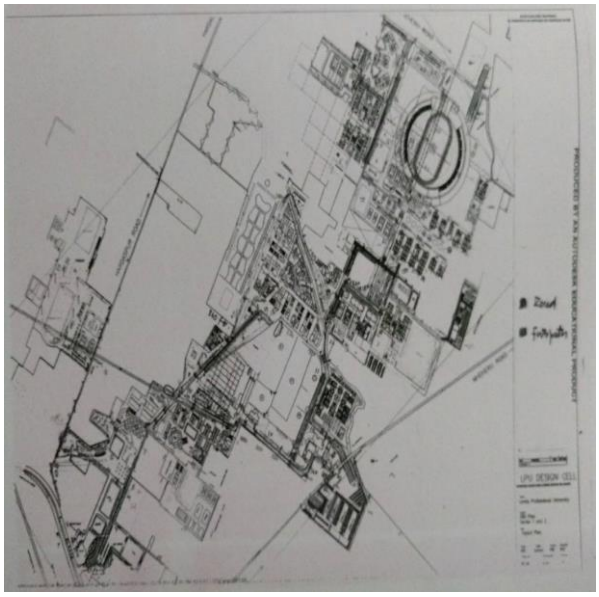
(8) The average GWI of campus implies that proper and sustainable steps should be taken to improve the design structure hence significantly improving the road-user facilities like walkover bridges, increasing the width of sidewalks (wherever applicable and possible), provide maximum parking spaces and reducing the black spots.

Last but not the least, in previous years studies have shown that its quite relevant to include social interactions or the neighbourhood effects also known as the social network effects in the transportation modeling. These models included in studies of Brock and Durlauf (2001, 2002). Some of the latest articles in transportation modeling tend to move explicit towards each other creating a spatially autoregressive structure of social network effects (Dugundi and Walker 2005). It's not at all surprising that spatial econometrics is an emerging modeling method across social science disciplines. According to the urban planning theory, pedestrianism is a more realistic theory founded by Michael E. Arth in 1990, an American designer, futurist, and an author, The problems associated with urbanism are covered by pedestrianism and gives an attempt to solve various ill effects such as health, energy, aesthetics and environmental problems with special focus on reducing the role of automobiles. A pedestrian village is defined as a neighbourhood or town utilizing pedestrianism. These range

from being car free to having automobiles access behind nearly every house but pedestrian lanes are always in front. Walkability can also be defined as a way of extent to which built in environment can be friendly to use for the people such as for living, shopping, visiting, rejuvenation purposes in an area. There's also another way of assessing and evaluating Walkability via undertaking walking audit. PERS (pedestrian environment review system) is being used extensively in UK. Basically walk score is derived algorithmically based on its distance to other amenities within 5 minutes of walking distance is awarded maximum points while a decay function is assigned to amenities up to 30 minutes walking distance, scores are then normalized on a scale of 0 to 100. Three customizable set of walking indices sum up with an algorithm which considers numerous factors not really considered in other rating solutions such as street type, intersection complexity, PQI accessibility, population density, freeways and bodies of water. A web application that combines open data and crowd sourcing together to rate and review the accessibility of each street is termed as walkonomics. The factors which comprise to influence Walkability are quality of footpaths, pedestrian right of way, traffic and road conditions, land usage patterns and building accessibility along with safety.

Hence, it can be concluded that Walkability is an essential and influential factor in sustainable urban design.

FIG.1 SITE PLAN OF LPU



ACKNOWLEDGEMENT

The success and final outcome of this paper required a lot of guidance and assistance from many people and am extremely fortunate to have got all this all along the completion of the case study. I would like to express my profound gratitude and deep regard to my mentor Asst. Prof. Arunava Poddar, School of Civil Engineering, LPU for him guidance, encouragement and monitoring throughout the study.

I am highly indebted to the School of Civil Engineering and the administration of LPU for constant supervision as well as providing necessary information regarding the project.

Last but not the least, thankful to Almighty and my parents for their blessings.

REFERENCES

1. Bradshaw C. 1993," Creating and use of rating system for neighbourhood walk abilities towards an agenda", 14th International Pedestrian Conference.
2. Cervero R and Kockleman," Travel Demand and the 3D's".
3. CLC Lecture series by Sanjeev Sanyal on Global Walkability index.

(Source: https://www.youtube.com/watch?v=lxXD4BtP7Tg)

4. http://link.springer.com/chapter/10.1007/978-3-540-69417-5_7
5. https://en.wikipedia.org/wiki/walkability#mapping_walkability
6. http://www.walkable.org
7. http://www.lpu.in/about_lpu/lpu_at_a_glance.php
8. "Krambeck Holy V and Jitendra Shah (2006)", The Global Walkability index".
9. Litman T.A. (2011)," Economic value of Walkability".
10. Understanding physical activity environmental correlates: increased specificity for ecological models by B Giles-Corti, A Timperio, F Bull-Exercise and sport-2005 journals.
11. Walkability in Indian Cities (2011), Clean Air Initiatives for Asian Cities.