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## City sustainability: the influence of walkability on built environments

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### Abstract

A vital issue in community is providing an easy access to the transport network for different range of community members such as; very young, old, children and disable people. The functions that walking and walkable area can be support includes community involvement, health, meeting and gathering and recreation which has positive effects on sustainability and vice versa. Walkability is the basis of sustainable city. The same as bicycling, walking can be known as ‘green’ type of transportation which except crowding reduction and also has low level of environmental influence, energy conserving without any air and noise pollution. It can be more than a purely useful type of travel to shopping, school and work. Also have both social and recreational importance.

This research aims at supporting urban design knowledge and practice and contributing to the broader field of “walkability” by refining the methods and measures used to analyse the relationship between walking behaviour and physical environment and its impacts on city sustainability. In order to integrate knowledge from theories and research on walkability from different fields and of different perspectives, it is crucial to first build a broader view and a more comprehensive understanding of how the built environment influences walking. What has been done during the earlier part of this project, and will be shown in this research, is to provide a better understanding of the complexity of the relationship between the built environment and walking and also the complexity that lies in both of these entities, the urban form and walking activity.

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### 1. Introduction

Walking mostly has been known as a sustainable types of transportation. It has numerous social and individual benefits i.e. has positive effects to increasing the health improvements and social equity as well as reducing the greenhouse gas emissions. Moreover, it has been reduced to use as a general types of travel mode for different purposes as day-to-day travelling or leisure. One of the main factors that effects on declining of walking is transformations of the built environment of cities. Spreading of the cities, towards increasing of urban sprawls leading to use more vehicles which increase the car travel and vehicles transportation as well.

As Brownson (2009) stated, the examination of built environment for the appropriateness and attractiveness of the walking has been considerable for many decades in various fields of science such as urban planning, psychology, geography and public health as well. In each fields walking introduced by individual definitions. For instance according to Ewing and Handy (2009), urban planners defined walking as a factor to the decreasing of vehicle travels, urban sprawls and greenhouse gas emissions. Moreover, public health researchers are interested in walking as an important factor to decreasing of the obesity, cancer and chronic diseases according to daily amount of exercise has been recommended by USA government.

Research on walkability and built environment is consist of representing of the correlation of walking with “the D’s” (density, destination accessibility, design, diversity, and distance to transit). (Badland & Schofield, 2005, Fitzhugh. et al. 2010)

Many studies have down about urban issue and built environment’s effects on green types of transportation (biking and walking). Some researchers believe factors of density, diversity, and street design have much impact on biking behaviour (Barnes & Krizek, 2005, Owen. et al, 2010). Moreover several studies mentioned the relationship between walking and built environment is vary across the different classes, race and also socioeconomic status (Lovasi et al, 2009). Though socioeconomic factors and individual superiority has major influence, the built environment also has a significant effects on people’s walking. (Lee & Moudon 2006). One of the main research questions of this study is how assess the built environment and walking behaviour to find the relationship between them through walking. To investigate the influence of walkability on the built environment, we need to understand the meaning of walking and walkability’s concept, the relationship between built environment and walking behaviour and explaining the environmental features influencing walkability as well.

## 2. Walking and Walkability

Walking generally recognised as a movement which is one types of the man’s transportation. Generally in urban context walking defined as short distance moving from one point to the other point.

Walkability is a concept which is known as measurement of the pedestrian-friendly’s degree of an area. This term recently have been focused by urban designer and planners to make a sustain environment to communicating, recreation, and shopping by pedestrian base.

Burden states walkability 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” (2010).

The first concept of walkability that identified in scientific paper back to the early in nineties which introduced by urban designers and spatial planners (Southworth, 1997; Southworth and Ben-Joseph, 1995; Southworth and Owens, 1993). It was about the elements of the built environment and factors which contributed to walkability issue (Southworth et al., 2005, 1995, 1993).

Much studies from the earliest terms of walkability until now worked on the concepts of walkability in various areas such as; architecture, transportation, urban design and planning, and public health. Each of scientific research described walkability in different terms and characteristics by different variables and measurements (Fitzsimons, 2013). “Making London as walkable city” is one of the researches have down in 2004, the mayor of the London defined walkability as “the extent which walking is readily available to the consumer as a safe, connected and pleasant activity”. The research stated, walkable city is:

- 1) Connected,
- 2) Convivial (friendly, lively and enjoyable),
- 3) Conspicuous (attracting notice or attention),
- 4) Comfortable and
- 5) Convenient.

Therefore, walkability is more than physical activity in order to health term in a physical environment, it also include “social environment”, “perception of the area” and also “comfort of pedestrian” (Lo, 2009).

### 3.1. Walkability and the benefits

Walking more than a transportation type has specific effects on community health condition. Beside by health researchers who believe walking is a kind of physical activity, urban designers introduce walking as a kind of social

recreational activity as well (Gehl & Gemzøe, 2001; Gemzøe et al, 2006).

According to various scholars, walkability of a place not only has positive effects on public health, even decreasing the level of social, economic, and environmental stress (Giles-Corti & Donovan, 2002; Handy et al, 2002; Pucher, & Dijkstra, (2003) ; Vojnovic et al, 2006).

Therefore walkability classified as a general issue involved both physical infrastructure and quality of walking environment. “In other words, it is not confined to the provision of physical infrastructure such as walkways or sidewalks and pedestrian crossings that have a direct influence on the quality of walking environments. It also links to non-physical elements, local climate and culture considerably influence the quality of walking environments” (Seng Fatt, 2011).

#### a) The health benefits

The most noticeable advantage of walkability in a community is health benefit of exercise for the citizens. According to the Centres for Disease Control and Prevention (CDC), walking at least 30 minute per day decrease the level of obesity which makes risk for cardiovascular disease, diabetes, high cholesterol, cancer, and higher amounts of anxiety and depression for people. A walkable community can easily offer 30 minutes of daily physical activity by create a culture of walking which encourage and support daily life.

#### b) The quality of life benefits

According to physical health’s benefit, walking has a major impact on increasing the level of man’s quality of life. Due to the CDC, walking is an exercise which can improve the quality of life and psychological wellbeing by increasing the level of daily physical activities. Walking can change the moods of human, decrease depression, and increase the sense of community feeling and well-being. A walkable community gives a unique identity to the built environment and make a sense of belonging for the residents and the users as well.

#### c) The safety benefits

A walkable community can create a safe environment for the residents. The major safety benefits of walkability is increasing the number of pedestrians to makes a culture and an alert for drivers to see the pedestrians more than before (sidewalks and crosswalks). It makes a safe place for adult and specifically children by decreasing number of pedestrian injury through low speed running of vehicles. According to Ernst (2006), “Pedestrian injury is the third-leading cause of unintentional injury-related death among children ages 5 to 14”. Due to “*Pedestrian and Streetscape Guide*” a safer streetscape also made by enhancing the level of physical infrastructure through lighting, signing, and clear lines of sight.

“Other methods of increasing safety include slowing traffic in residential neighbourhoods and near schools, maintaining safe walkways separate from the road, providing ample, well-designed crosswalks, and teaching children to cross the street safely” (Lehman& Boyle, 2007).

### 3.2. Measurement of walkability

Walkability measurement is a specific concern which connected to physical aspects of built environment. In order to measuring the walkability, it is necessary to measure the effective physical variables of built environment on walkability. Perception of the built environment is one of the indirect built environment attributes that impacting walkability as well. Ewing (2006), classified measurement of walkability into direct or indirect of objective, subjective or mix of both categories (table 1). He classified walkability audit as direct field observations, and evaluation of secondary data using geographic information system (GIS) techniques and indirect method of objective measurement.

In subjective measurement interviews or surveys by pedestrians are direct and evaluation of the built environment attributes related to perceptual response (i.e. design qualities classified) as indirect measurement (Ewing et al. 2006).

Table 1: Measurement of Walkability

Walkability measurement	Direct method	Indirect method
<b>Objective measurement</b>	Direct field observations, called a walkability audit.	Evaluation of secondary data using geographic information system (GIS) techniques.
<b>Subjective measurement</b>	Interviews or surveys with pedestrians or potential pedestrians in a study area.	Evaluation of built environment attributes related to perceptual response, such as design qualities.

There are many scholars who are working on the measurement of built environment and use unique measurement for evaluations. Various tools and methods have used to measuring the built environment and the eligibility of using of them which depends on existing variables, the purpose, and scale of the contextual measuring. Brownson and colleagues in 2009 categorised measurement of built environment as;

- perceived measures from interviews and self-report questionnaires
- observational measures from audits
- archival data sets which are often layered and analysed using Geographical Information Systems (GIS)

Measuring the built environment the same as walkability measurement can be classified to objective or subjective measurement.

Fitzsimons (2013) in her research reviewed the Measurement of built environment (built environment and walkability) in seven main methods which are;

- Self-report or interview questionnaires
- Environment audits
- Qualitative neighbourhood measurement
- Geographical information systems (GIS)
- Composite GIS Indices
- Comparison of indices/ measures
- Consideration for spatial definitions

### 3.3. Elements of walkability

Strategy of the research at this section is to providing a list of influential elements of built environment which have been associated with the walking behaviour and walkability.

Therefore, reviewing of these elements require a multidisciplinary research to provide a certain picture on influential and the most general identical factors.

Many researches are exist to point out the elements of walkability from different points of view. One of the most general studies is “*A multidisciplinary examination of walkability: Its concept, assessment and applicability*” which have down by Fitzsimons in 2013. He classified the elements of walkability in two main groups in his study, by reviewing around 27 books and scientific papers, which are:

- Functional environment
- Street scape

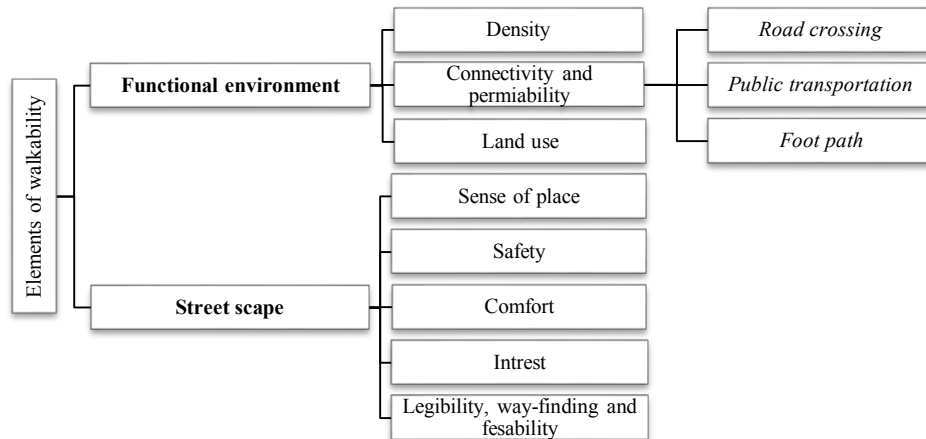


Figure 1. Correlated elements of walkability and built environment (Fitzsimons, 2013)

#### a) Functional environment

According to Fitzsimons (2013), functional environment which consist of density, connectivity and permeability, and land use, “refers to the structural, constructed environment that forms a city or town structure and its streetscapes”. Contribution elements of functional environment include road, buildings, foot path and connectivity of them which impact on walkability of the urban area (Fig 1). Three main categories of functional environment have been shown in;

- Density
- Connectivity and permeability
- Land use

#### b) The streetscape

The streetscape in the preliminary meaning is visual elements of the street like adjacent buildings, road, sidewalk, open spaces, green area and street furniture that create a general characteristics of the street.

Southworth (2005), described the streetscape as micro level environment which defined by critical environment scale for walkability.

The streetscape present as an urban area when pedestrian will be inside it, they will act and behave according to their environmental perceptions.

The concept of the streetscape have been interested by transportation and public health which mostly focused on physical walking facilities such as; foot path, level of the essential services and protection of the pedestrian from traffic (Hoehner et al., 2005, Pikora et al., 2003;. Lo, 2009)

From other point of view, urban designer and planners have more concentrate on design concepts like; diversity, path context, comfort, interest, architectural and urban design, sense of place, scale, protection and etc. (Southworth, 2005; Gehl, 2006).

According to figure 1, the street scape classified into five subtitled which are;

- Sense of place
- Safety
- Comfort
- Interest
- Legibility, way-finding and feasibility

### 3. Built environment

The built environment has been introduced in many definitions by different scholars. Most generally, built environment refers to manmade surrounding (cities, neighborhoods, greenery and etc.) that provided by humans for human's activity (living, work, entertainment, etc.) which include interdisciplinary elements. It has been correlated by various subject that walkability is the most recent one.

#### a) The relationship between the built environment and walkability

As it mentioned in previous parts, there is a direct correlation between the built environment and walkability. The relationship between built environment and walking classified into two main fields; "1) urban planning (including geography and transportation) with a focus on walking as a mode of transportation, and 2) health and preventive medicine, in which walking is deemed a manifestation of physical activity and therefore includes both transport-related as well as recreational walking" (Vale & Pereira, 2016).

Cervero (2009), identified five major dimensions of the built environment which are determined for walking and walkability. They have known as the five Ds; "*density, diversity (land use mix), design (including street connectivity), distance to transit, and destination accessibility*".

According to the five Ds, it is clear to understand that built environment factors determined as an effective parameters to defined walkability of an area. A dense area with the high level of diversity and short distance access to the services and public transit stop has more potential to be a walkable and sustainable area.

#### b) Impact of physical environment on walkability

A walkable environment required a minimum level of physical elements which make a successful space. A wrong designed environment without well-designed sidewalk, pleasant scenery, diverse place to go even with the present of pedestrian make a walk only as far as possible from their car.

Table 2: Effective parameter of built environment on Walkability, (Lehman and Boyle, 2007).

Variables of User-friendly concept	Definitions	Parameters
Network	Just as cars require a continuous, well-maintained road system to travel, pedestrians require a network suitable for safe, comfortable walking.	Sidewalks Crosswalks Directness
Environment	At the human scale and the pedestrian pace, a walk allows for maximum enjoyment of the neighbourhood or city environment. Pedestrians are more likely to walk if they know the journey will be safe and pleasant	Aesthetics Security Building Orientation
Destination	Walking for its own sake is nice, but most people walk to get somewhere. The most walkable street system may not be used if the network does not provide access to destinations.	Daily Functions Land Use Pattern

According to table 2, The IPA (Institute for Public Administration) planning service group, organized concept of "user-friendly" called NED that include three subtitle to make a walkable built environment, they are; "Network, Environment and Destination" (Lehman and Boyle, 2007).

### 4. Discussion and conclusion

The origin of the walking behaviour is back to the preliminarily humans behaviours which walking was the main types of transportation for man. Later on by the advent of advanced technology, walking replaced by motorized transportation models. By increased the usage of this kinds of transportation, some problem for the sustainability of the cities such as; air pollution, crowding, reduced walking and health problems take placed to build environment and humans. In this case, to reach a sustain environment scientists (urban planners, designers, environment, health care and etc.) started to find the relationship between walking behavior and built environment by transforming the cities to more walkable. The result of the research reveal that walking and built environment are in correlation together directly. Previous scholars, mostly focused on physical factors of built environment which has high impact on walking behavior

and walkability. To be walkable, a built environment must have a sufficient pedestrian network to make accessible area. However pedestrian accessibility is an important factor to make an area walkable, but there are many environmental factors such as; safe and pleasant environment, plentiful destinations, divers functions and activity, sufficient walking infrastructure and etc. which impacts on walkability.

According to the main aim of the research to find out the effects of walkable environment on sustainability, it is considerable that walkability has been known as a foundation for a sustainable city. Walking and bicycling are known as green types of transportation has low impact on environment and has an important role on congestion reducing. According to fig 2, walkability and built environment have strong relationship together by social and physical variables which make a vital and sustainable space.

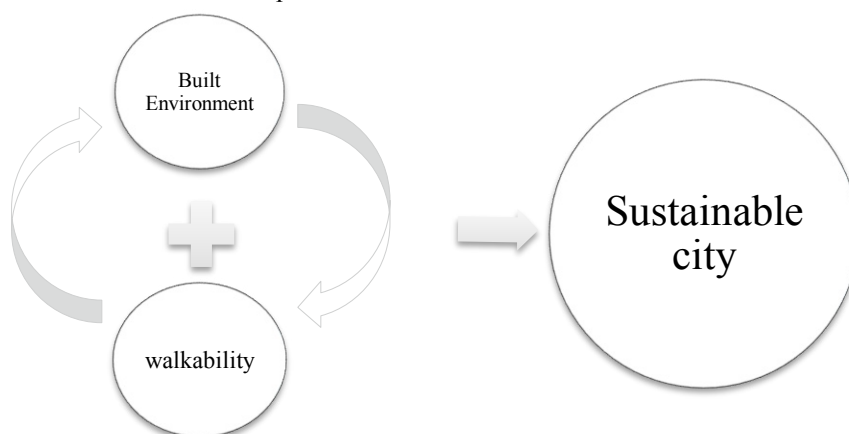


Figure2. the relationship between walkability and built environment

A well designed built environment without present of pedestrians is not an active social place with high level of communication. It will caused to lose vitality and livability of area. Moreover, a built environment without any designed walking infrastructure could not be present as a successful urban space. In general it could not be a sustainable built environment.

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