

e-Proceeding

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"SUSTAINABLE ENVIRONMENT, RESILIENCE AND SOCIAL WELL-BEING"

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IDENTIFICATION OF BUILT ENVIRONMENT FACTORS IN ENHANCING BIKEABILITY ACTIVITIES IN NEIGHBOURHOODS

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Abstract

The cycling activity has been determined as an active and environmentally-friendly mode of travel and a solution for the urban issues. However, the relationship between the built environment and cycling behaviour is less associated with increasing the bike-ability of the resident's physical activities. The main aim of this research is to identify specific factors that can enhance the level of bike-ability. The objectives of this research are listed as: 1) To designate a particular characteristic of attributes factors that can improve the level of bike-ability; 2) To identify the natural environment factor that influences bike-ability behaviour and 3) To assess the social factor that influences bike-ability behaviour. The questionnaire was derived from the Theory of Planned Behavior from previous studies. The selection of survey variables was determined after a review of several papers published in referenced periodicals. Face validity of the questionnaire was conducted from the selected six experts in cycling development. Four hundred and fifty respondents were selected for this survey. The questionnaire comprised seven personal factors, nine built environment factors, and the respondents are asked to assess the perspectives for cycling behaviour. A Likert scale was used ranging from "Strongly disagree" 1 to "Slightly agree" 5. An in-depth analysis of the cyclist's perceptions was attempted using confirmatory factor analysis. The Structural Equations Model was estimated to find relationships among variables. The research has found that built environment factors are the essential elements to understand the cycling perceptions and behaviour towards cycling activity.

Keywords: *cycling; behaviour; built environment; neighbourhood factor*

1.0 INTRODUCTION

The cycling activity has been recognized and widely defined as an environmentally-friendly and healthy benefit mode of transport. From one spot of places to another that can encompass distances long enough to efficiently cover many urban and suburban trips. Most of the users for cycling activity have been recognized with a list of effects among residential, commercial and social facilities areas. All these effects have recently become an aspect of interest in the development of cycling infrastructures. The effects are not only for individuals, but also reflect the advantages to society, the economy, and the environment. It is starting to receive increasing attention as a sustainable transport mode by many countries worldwide (Koh, Wong & Zhong, 2014). As listed by the European Commission (2000), the neighbourhood effects of cycling include social benefits, positive ecological aspects, economic factors, and political aspects. In order to profound the effects of cycling, most of the studies realized and identified the major factors that affect the individual's choice to choose cycling behaviour. Some of the policies for cycling promotion are based on the identification of factors affecting bicycle use. Based on Wang, Chau, Ng and Leung's (2015) study, they listed the factors influencing an individual's physical activity. The factors include social factors, personal factors, natural environment factors and built environment factors. Among all the factors, the main contributors for cycling behaviour is built environment factors because it is becoming basic motivators for choosing physical activities.

Cycling is among the most effective, efficient and sustainable means of transport. From all the related research on cycling benefits, they can be concluded as listed; First, cycling is suitable for all age groups and does not require special skills of major development. Secondly, it allows people to choose their favorite routes and is thus suitable for longer trips. Thirdly, it allows low-income people to remake their lifestyles towards reducing sedentary and inactive lives (Brownson, et al., 2015). It is an active, environmentally-friendly mode of travel, that can encompass distances long enough to efficiently cover many urban and suburban trips (Vernez et al., 2014). Cycling activities and non – motorized transportation are also related to the significant impacts of physical activities and physiological health. It is more common as an exercise or recreational activity. Vernez et al., (2005) mentioned about 15% of American adults and 24% of Canadian adults report cycling at least once a week for recreation or exercise purposes. Even though previous research has shown that cycling can become a travel mode and is a form of exercise and recreation that is well organised, a comprehensive understanding of cycling behaviour and its environmental correlates is lacking. More bikes means less congestion. Figure 1.0 below recognises and composes the benefits of cycling activity.

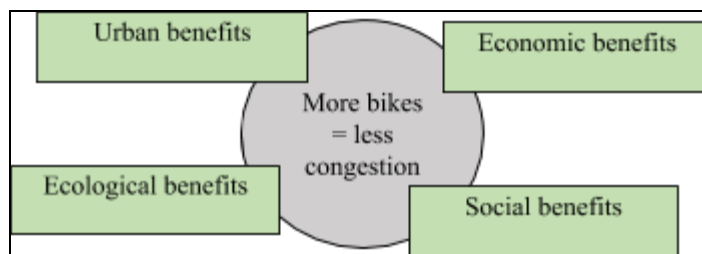


Figure 1.0: Benefits of cycling

Source: Brownson et al. (2015)

There are 4 problem statements listed among residential areas and communities. First, the study and planning of cycling facilities is well organized by local authorities and private sectors, but there is a lack of better understanding on the relationship between physical condition and behaviour. Most of the development of cycling infrastructure only focuses on physical developments such as route quality, traffic conditions, signals, cycling lane design and cycling lane. The most important is to recognise the mix of a relationship between physical factors and behaviour. Secondly, there still lacks people's decision factors to choose either to bike or not. The list of major factors that affect an individual's choice to cycle is still unexplored during the developing and planning stages of cycling facilities. Thirdly the main contributing factors to enhance cycling behaviour among residents are the social factors, personal factors, natural environment factors and built environment factors (Wang et al., 2015).

In this study, the research objectives are to provide a comprehensive review to identify specific focus on the planning and designing of cycling infrastructure by identifying the specific factors affecting cycling behaviour in residential areas. The second objective is to identify general and specific characteristics of factors that can enhance the level of cycling. The third objective is to identify the major environmental barriers that hinder cycling activities along the proposed cycling infrastructures. The last objective is to develop a framework of influencing factors on cycling behaviour among users.

2.0 LITERATURE REVIEW

2.1 The Effect Factors of Cycling Behaviour

Several previous research have determined the factors associated with cycling activities and behaviours among residents in neighbourhoods. Mostly, the existing and development of cycling facilities are significant factors in attracting cyclists (Dill and Carr, 2003). Several studies have also confirmed that individuals are willing to increase their travel time in order to switch from on-road facility to an off-road bicycle trail. Cyclists also prefer off-street bike paths,

and bicycle boulevards, and are sensitive to distance, frequency of turns, slopes, and traffic volumes (Broach et al. 2012). Other effect factors associated with bicycling frequently include demography, residential locations, the season, bicycle amenities at work, and the cyclist's perception of the overall quality of bicycle facilities. Heinen et al. (2011) also indicated the attitudes effect on the benefits of cycling such as convenience, costing and health have a strong impact on choosing cycling activity. The integrated infrastructure, provision and planning of bike lanes, paths, traffic calming and parking have been identified as the effect factors to increase the programs and activities of cycling improvement. Handy et al. (2010) suggested that if an individual or resident lives in a community with an integrated bicycle culture and facilities, his / her preferences for choosing cycling activities may increase. The 2012 OSU Transportation Survey shows the dates related with attitudes towards mode choices, the factors that encourage people to bicycle and the deterrents to cycling. The list of data is related with status, gender, proximity to bicycle infrastructure, residential locations, and attitudes towards cycling. The list below summarises the importance for individuals to find certain factors to make a choice. Commute time factor, weather, and flexible departure are three most important effects. Unfortunately, the environment factor is the least important to respondents.

Table 1: Factors Affecting Mode of Choice

| Factors Affecting mode of choice | Very Important |
|---|----------------|
| Commute time More time flexibility in departing Ability to stop on the way to / from Safety from crime Weather Cost Concern for the environment | Less Important |

Table 2.: Factors Encouraging People to cycle.

| Factors encouraging people to cycle | Very Important |
|--|----------------|
| More secure covered bicycle parking A bicycle station Dedicated bicycle lane Better lighting for traveling safety Prohibiting car traffic on some road A convenient place Greater enforcement on traffic law for bicycle and car More convenient bicycle trails | Less Important |

3.0 RESEARCH METHODOLOGY

The research methodology has been separated and classified by stage. There are three stages in conducting the study. Stage one focuses on establishing the literature review. The comprehensive literature review centred on studies related to cycling activities. It is also related to cycling behaviours and types of people who cycle. The other review is to identify the determinant factors that affect and enhance cycling activity. Stage two in this research develops the research methodological design. From the affecting factors listed, those influencing cycling behaviour were developed. The findings from these factors reviews were extracted from journal papers embracing the studies related to cycling activities and cycling behaviours.

4.0 RESULTS AND DISCUSSION

The attribute factors of cycling behaviour has been determined by the criteria in general built environment factors. All the criteria have been listed and compiled from previous research and literature.

General built environment factors have become a list of major effects on the behaviour of people to choose whether to cycle or not. Pucher, Peng, Mittal, Zhu and Korrattyswaroopam (2007) identified a list of affecting factors such as climate, transport policies, land use pattern, transit services, cycling facilities, and car availability. Table 3 below lists and summarises the factors from different types of research findings. These factors make up the list of attributes to enhance the level of cycling activities.

Table 3: Built environment factors attributes to enhance cycling behaviour

| Factors | General Characteristics |
|---|--|
| Land use pattern | It influences the mode of transport, the density of development, and affects the public transport usage. |
| Availability and suitability of design facilities | The suitable design facilities for cycling affect the choice of cycling activity especially the development of bicycle paths |
| Opportunities | Opportunities factors reduce the likelihood that an individual will undertake activities that can substitute cycling |
| Distance | Shortening the distance |
| Accessibility | Increasing accessibility |
| Security | Improving personal security |
| Safety | Improving personal safety Improving transport safety |
| Injury reduction | Reducing fear of injury, accidents and dog attacks |
| Physical setting | Aesthetic appearance, sceneries and environmental quality, Comfort level |

Source : Y. Wang, Chau, Ng, Leung (2015)

4.1 Land use pattern and transport

These two factors are co-dependent and mutually influencing to each other in a complex and dynamic way. Land use pattern influences the transport mode choices to a large extent (Meng et al., 2014). The density and mixture of land uses can affect public transport usage. In the US, there is a huge dependency on vehicles because of sprawling suburban land use patterns of the major metropolitan regions. But in European countries, there are stronger urban planning and design controls to make them more compact and higher density urban forms, and hence increasing the use of public transport. Cervero and Duncan (2003) have found that urban landscapes can generally affect walking and cycling such as in San Francisco Bay.

4.2 Availability and suitability of design.

Planning for cycling and walkable paths especially within the neighbourhood is the most important factor that affects the levels of cycling activities. Bikeable paths, sidewalks, and cycling trails could increase and make a suitable determination for residents to cycle. The provision of all the facilities will increase the level of cycling activity (Leslie and Cerin, 2008). The design suitable for the facilities and conditions also influences the resident's motivation to undertake cycling activities. The cycling paths and network lanes must be well connected and continue to induce more individuals to adopt cycling as a regular physical exercise. The cycling paths must be well organized where the local authority must ensure their maintenance and supervision aspects. Plain road configuration (King et al., 2005) could also increase the cyclists' determination and encourage more cycling activities, especially for elders.

4.3 Individual Opportunities

Other than cycling and walking among residents in the neighbourhood, there are other activities like running, playing sports related to the field and courts like football and tennis. Adding trails and bike lanes within the scale of suitable distances for residents will increase the opportunities to be involved in cycling. The small area of the neighbourhood with the allocation

of a nearby convenience store, restaurants, shops and public facilities may also support cycling (Moudon et al., 2014). The nearby suitable and effective facilities also influence the residents' motivation to undertake walking and cycling facilities. Most of the residents will take a shortcut if they have been offered a choice of route and lane. More people will choose cars than walking and cycling for traveling even for a short trip (Lopez & Hynes, 2006). It is critical to plan and design a built environment in such a way to create opportunities for the residents to choose cycling activities over the other activities that can substitute cycling activities.

4.4 Shortening the distance.

The multi planning and development of land use has been determined as major representations for the residents to use the facilities and space. The locations within walking distances of shop offices, convenience stores, fast food outlets, schools, mosques, and housing may also support cycling. The distances and spaces in land use areas must be within walking radius and cycling route. People who already have the intention of cycling will locate themselves in areas that offer substantial bicycle infrastructure and related land use within suitable distances. These types of infrastructures provide incentives for people to cycle more. Gabriel & Ahmed (2015) found that distance was a significant and important event on a small scale. It also indicates that access to services for bicycles (shop) should be considered at a relatively small scale because respondents find bicycles convenient and flexible only within a relatively small area. Distance factors also influence cycling activity levels despite their influences on transport cycling activities (Owen et al., 2007). The distance between the house and the trail, or open space did not have a significant association with leisure walking and cycling activities because a shorter distance is less important as a consideration for people to walk and cycle. The other facilities and land use like shopping malls, bus stations, and others within 400m – 1500m were associated with regular transport by cycling. The facilities or public spaces should be located near the resident's home (15-minute walk and cycling) to ensure frequent visits. The geographical location and scenario also produce positive and negative effects. Increase in distance of neighbourhoods from urban development boundaries will increase the levels of cycling and walking activities whereas increasing their distances from the central business district reduces the levels of cycling and walking activities (Brown et al., 2014).

4.5 Increasing accessibility

Accessibility is one of the major elements in developing and planning facilities in a neighbourhood area. Most of the ideas in residential density highlight accessibility for a determined level of usage among residents. Increasing the accessibility of walking and cycling facilities will definitely increase the usage rate (Wang et al, 2015). Walking trails and cycling routes that could be easily reached by foot or bicycle are visited more frequently than those that could only be reached by car. This approach to accessibility can enhance the walking and cycling activity level. Rimmer, Riley, Wang, Rauworth & Jurkowski (2004) proposed that the criteria for facilities must be designed to be fully accessible for both healthy people and people having an impairment to encourage participation in physical activities. Asadi Shekari, Moeinaddini and Shah (2013) found that cyclists are sensitive and alert to different kinds of cycling routes. Street connectivity in route and lane design has always been linked with better-planned intersections and pedestrian crosswalks. Patterns and criteria concepts for cycling lanes are related to types of road patterns for vehicles. Grid street patterns, short block lengths, and few cul-de-sacs have been considered to be some of the important signs for high access walkability and bike neighbourhoods (Saelens et al., 2008).

4.6 Improving Safety Network

Safety and design for walking and cycling facilities have been listed as general characteristics for built environment factors. The safety criteria are divided into personal security, personal safety, transport safety, and reduction of injury and accident (Wang et al.,

2005). The crime rates and the perception of crime situations also have stronger impact than real crime on walking and cycling activities (Mason & Kearns, 2012). From the traffic situation in residential areas, the traffic safety impact has been increasingly considered by people in order to commence any physical activity. Classification of road, density, and capacity of vehicles on the road, mixed land uses and facilities along the road can control the traffic accidents (Yu, 2014). Traffic volume capacity and conditions could also reduce the chances of people and cyclists from colliding with motor vehicles. The safety features also reflect the need to provide safe physical environments for people. Burden et al. (1999) combine the elements of safety thus: personal (presence of lighting and level of passive surveillance), and traffic (availability of crossings). The situation of safety within the residential areas was also listed by Pikora et al. (2003). The safety preferences are recognised by crossing aids on the road design.

4.7 Physical setting

Ana B et al. (2014) have finalised the physical setting by criteria into five categories. The physical elements criteria are divided into the factors that influence the choice of routes for a cyclist. Table 4 below lists the factors by physical setting.

Table 4: Factors that influence the choice of routes for cyclists (physical setting)

| Group | Factors |
|------------------------------------|---|
| Characteristics of the roads | Width / Number of traffic lanes Type and condition of pavement |
| Characteristics of the traffic | Traffic volume and speed Sharing the road with motor vehicles Functional classification of the road |
| Characteristics of the environment | Perception of security Adjacent of land use |
| Characteristics of the trip | Length and duration |
| Characteristics of the route | Number of roundabouts, intersections Physical barriers |

Source : Ana B. et al. (2014)

5.0 CONCLUSIONS

The study points in this paper are to identify the built environment factors that influence cycling behaviour in Putrajaya. The relative specific built environment factors apparently influence the determination of residents to choose cycling activity. The identification of this list of factors can help overcome the barriers and create an environment with supportive facilities to cycling. Based on previous research a few research gaps were found. Firstly, the previous study only focuses on physical factors but in order to enhance the cycling behaviour among residents, the relationships among the factors must be correlated and interconnected. For example, the physical factors must be tested with data from social factors. The socio-economic data of the residents must be compared with the physical factors. Secondly, the decision to choose to cycle not only depends on physical developments but also on other factors such as costs. The decision to develop a detailed and holistic design of cycling facilities must be adequate within a body of knowledge on informing the most important and critical planning.

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“BERKHIDMAT UNTUK NEGARA”

Saya yang menjalankan amanah,

SITI BASRIYAH SHAIK BAHARUDIN
Timbalan Ketua Pustakawan

nar

Setuju.

27.1.2023

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