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BUILT ENVIRONMENT AND SOCIAL FACTORS ASSOCIATED WITH CYCLING BEHAVIOUR IN PUTRAJAYA

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Abstract

Cycling as a mode of transport has been identified as one of the solutions to traffic congestion, high carbon emission, and health issues in both urban and residential areas. Lately, cycling is growing in popularity among residents, and many are involved in cycling activities for various personal reasons: now, bicycle is not only for transport, but it is also used for sports' training, exercise, and recreation. This cycling trend offers multiple benefits, and to help increase the momentum, some forms of intervention should take place. Two intervention factors that contribute to cycling behaviours are the built environment and social factor. Thus, this study seeks to explore the built environment and social factors that influence cycling behaviour in Putrajaya area. The respondents were selected among cyclists in Putrajaya using snowball and convenience sampling procedures. Through the use of descriptive analysis and after finalising the suitable variables by Factor Analysis, the finding reveals the suitable and reliable factors for future intervention. The implications and recommendations from this research contribute to the existing body of knowledge on cycling behaviour.

***Keywords**:* Cycling Activity, Behaviour, Built Environment, Social Factor

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INTRODUCTION

Cycling is considered to have an increasingly important role in transport development due to its environmental and health benefits (Anthony, 2020; Alexandros et al., 2021). It is found that cycling activity is highly concentrated in the areas that are provided with supporting facility and infrastructure. It is also necessary to understand the behaviour of the individuals and their reasons in choosing a particular mode of transport (Marcus et al., 2021).

In Malaysia, sedentary and physically inactive lifestyles have become major issues among the public, especially adults. Such lifestyle has caused the increasing number of people with obesity and chronic illness including coronary heart diseases, stroke, diabetes, as well as colon and breast cancer (Thomas, Jan, & Billie, 2015). Previously, the Malaysians' level of physical inactivity was the highest at 16.5% compared to all of the Western Pacific Region countries. In 2019, World Health Organization (WHO) reported 75.2% of Malaysians were physically inactive (World Health Organization, 2020). The relationship between built environment characteristics in community areas and different dimensions of physical activity has been recently documented. It was found that the general attractiveness of the physical environment, enjoyable scenery, degree of greenness, and perceived levels of safety are significantly correlated with physical activity. Apart from human factors (personal and social factors), it was also reported that natural and built environment characteristics play an important role in an individual's physical activity including cycling. The list of built environment factors drawn from previous research and the situation in Putrajaya are chosen to be used in identifying the suitable situation for people in this community. The main aspect to determine the interaction between all factors will be based on the cycling behaviours of cyclists and their personal characteristics. The objectives of this paper are (i) to identify attributes factors that can enhance the level of cycling activity, (ii) to identify the built environment and social factors that can enhance cycling behaviour and (iii) to analyse the most suitable intention factors that influence cycling behaviour. The outcome of this paper will identify the built environment factors and whether the measurement used is reliable and able to sustain the behaviour of cyclist in Putrajaya.

LITERATURE REVIEW

Cycling Behaviour

Cycling activity has been widely recognised as an environmentally friendly mode of transport and linked to a healthy lifestyle. The activity includes a myriad of advantages for the society, economy, and environment, especially in the transition of motor vehicles era to sustainable mode of transport (Meng et al, 2014). The European Commission (2000) listed four main benefits of cycling: a) social benefits - the social advantages of mobility, greater access and accessibility of all facilities; b) positive ecological impacts - such as opening of new land,

notion of the environment especially for habitat and biodiversity; c) economic benefits - such as reducing household expenditure for vehicles dependant, reducing working hours caused by traffic jams, and reduction of health cost from regular cycling exercise; and finally d) political benefits - reduction of dependency on non-renewable energy. Most of the variables that influence cycling activity will increase urban cycling mobility levels and subsequently this behaviour will give positive impact as it is a great strategy for healthy lifestyle and sustainable cities (Brian et al., 2003). The built environment factors become the major component factors to influence the cycling behaviour and cycling activity. Related items and conditions like surrounding development, existing facilities for cycling, current circulations of road traffic, and conditions of infrastructure within the cycling lane are the list of built environment factors that influence the willingness of people to cycle. A previous study on cycling and built environment factors conducted by Anne, Chanam, and Allen (2005) proved that the characteristics of built environment factors can influence people's selection and choice to cycle (or not) in the selected and dedicated lane. The relation, benefits, and impact of cycling activity behaviour are related with three main purposes and detailing of cycling behaviour: 1) recreation and physical activities, 2) impact and benefit for health among cyclists, and 3) the consequences of transportation aspect.

Category of Cyclists

Cycling behaviour can be classified by the category of cyclist. There are five (5) categories of cyclists namely Non-Cyclist, Lapsed Cyclist, Occasional Cyclist, Regular Sport Cyclist and Utility Cyclist (Fiona et al, 2015). The understanding of cycling behaviour is best explored from the views and experiences from different categories of cyclists using the Social Practice Theory. Table 1 describes details in the categories of cyclist that have been grouped and synchronised by related factors.

Table 1: Group of Cyclists and Description

Type of cyclists	Description
Non-cyclists	Generally male, pro-car, anti-cycling
Lapsed cyclists	May have cycled as children or more recently but do not cycle now. Know the benefits but have no plan to do it. Have low level of contemplation. Non leisure cyclists.
Occasional cyclists	Occasional leisure cyclists (ride once a month/every two-month/during holiday). Have not experienced utility cycling but are contemplating to cycle more. More to having an aspiration at this stage.
Regular sports cyclists	Regular leisure/sport cyclists. Possibly join weekend club riders or regular family outing. Similar but little or no regular cycling.
Utility cyclists	Utility cyclists (cycle to work and daily routine) who are contemplating utility cycling more/using their cars.

Sources: Fiona, Tim, Alan, & David (2015).

Cycling behaviour in Malaysia gained popularity in 2020, when Malaysia was ranked second in Asia in terms of the number of bicycles sold (WHO, 2021). This pattern keeps growing especially after the Covid-19's Movement Control Order (MCO) ended in 2021. The number of cyclists has increased especially for two categories of cyclists namely the occasional cyclists and the regular sports cyclists.

Influential Factors on Cycling Behaviour

Cycling behaviour is fluctuating and has been found to be mainly influenced by Personal Status, Built Environment and Cycling Purpose. Figure 1 shows the ecological model of cycling behaviour by Brian et al. (2003). There are three (3) variables for Personal Status, five (5) variables for Built Environment elements, and two (2) variables for Cycling Purpose. The author also identifies psychological factors such as self-efficacy, perceived benefits, barriers, social support, and enjoyment of cycling activity as factors influencing cycling behaviour. Focusing on the Built Environment Elements such as density, connectivity, and land use mix can significantly influence cycling for mode of transport. However, cycling for recreation or exercise is highly influenced by Safety (traffic, crime, animals), aesthetic and topography. In addition, Personal Status, namely vehicle ownership also influences cycling as a transport mode while income, age and gender are factors which influence cycling for both purposes that are cycling as transport mode and for recreation or exercise. From this model, a more comprehensive investigation of non-built environmental factors is required.

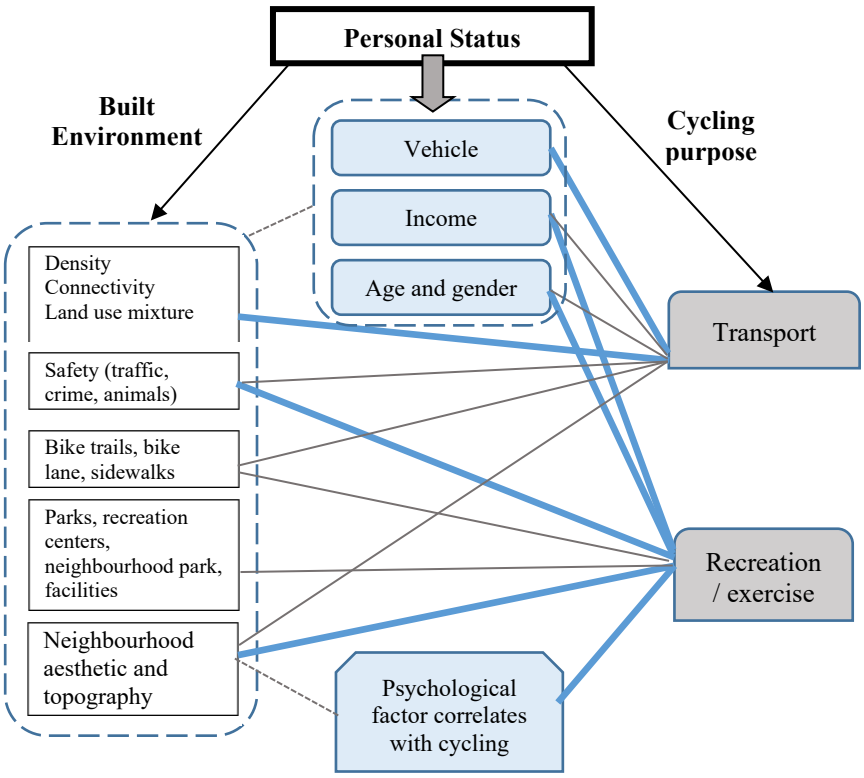

Figure 1: The Ecological Model of environment influences on cycling activity.
(Brian, 2003)

Built Environment Factors

Research conducted by John and Ralph (2008) highlighted that the built environment factors correlate with cycling behaviour. The presence of trail or cycling lane, in the nearest neighbourhood will increase the behaviour of cycling. Other related factors such as small areas with convenient stores, commercial buildings, offices, and employment centres around that areas also support cycling behaviour. Amiruddin (2014) stated that traffic condition like route related, cycling lanes, traffic speed, traffic volume, number of lanes, topographical conditions, and block size also play a role in cycling behaviour. The facilities that support cycling activity must be associated with cycling-oriented facilities. Investigating the perceptions of people is believed to be important to correlate the reasons for residents or people to cycle. Psychological correlation of physical activity and environmental variables or factors are closely related to the behaviour.

Built environment factors which are the key attributes of cycling behaviour are found to differ by category of cyclist and characteristic of land use and infrastructure (Frank et al, 2005), aesthetic of the surrounding environment (Owen et al., 2004), accessibility to facilities (Leslie et al., 2008), and recreational facilities (World Health Organisation, 2010). All these built environment factors in urban and residential areas are believed to influence the levels of cycling activity. According to Lee and Mouden (2004), cycling activity is also influenced by the existence of built environment barriers factors. Table 2 summarises the general-built environment factors and their relationship with the main barriers. The listed barriers create a lack of high-quality route-related facilities which has an impact on the cycling behaviour among residents. These barriers have been evaluated and defined by several research especially for residential, commercial, and selected community area.

Table 2: General built environment factors in relation to different types of barriers.

Type of barriers	General characteristics activities (Factors)
Opportunity	- Availability of facility design suitability - Reducing individual's opportunity to cycle - Shortening the distance
Access and distance safety	- Increasing accessibility - Improving personal security - Improving personal safety - Improving transport safety - Reducing fear of injury, accident, and animal attack
Physical setting	- Improving aesthetics appearance, natural sceneries, and environment quality - Increasing comfort level - Provision of supporting facilities

Source: Lee and Mouden (2004)

SOCIAL FACTORS THAT INFLUENCE CYCLING BEHAVIOUR

Prior studies and existing literature highlight on physical factors which affect the selection for cycling as physical activity. There is an urgency and need to assess not only factors that can be observed physically but also those that are related to cyclist's emotions, feelings, and personal perceptions. In any study on this matter, the focus and intention has to be to identify the social factors, personal factors that stem from the cyclists' actual behaviour (Ajzen, 1991). Such approach is relevant and useful to gain a better understanding of user's behaviours towards cycling and determined action for bicycle use. From these factors, the relevant Theory of Planned Behaviour (TPB) is the most important and it concerns with an investigation of human behaviour.

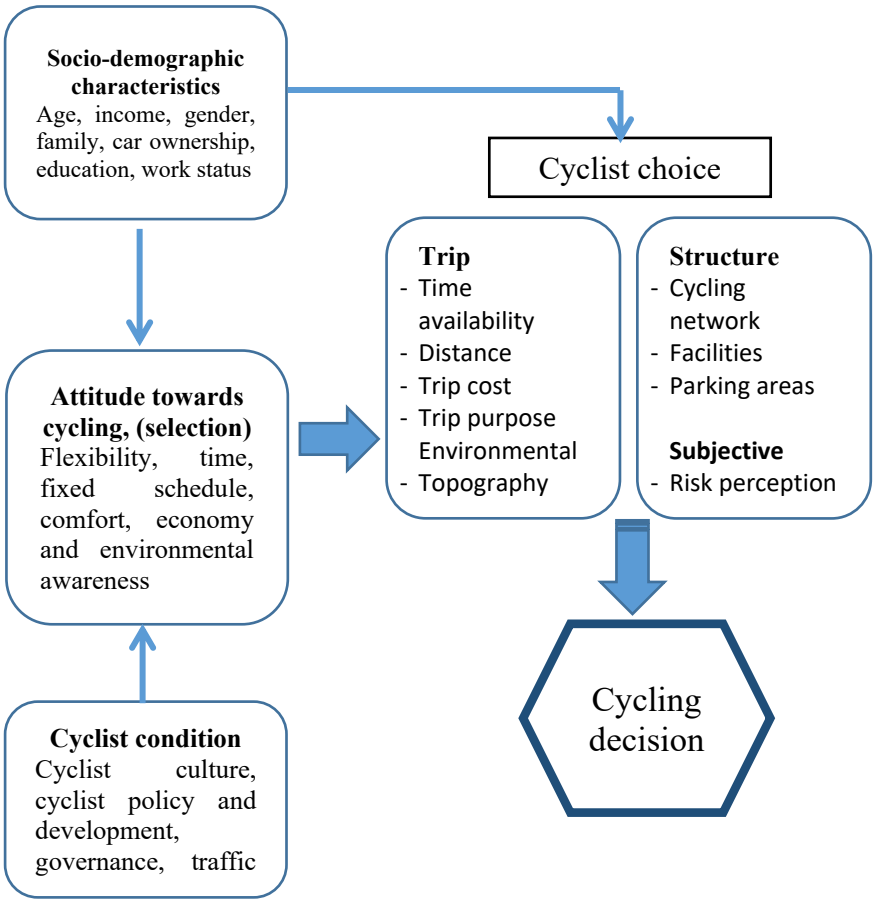

Figure 2: Conceptual Model of Factors affecting cycling use related with Theory of Planned Behaviour (TPB) (Alvaro F.H., et al 2014)

Three independent determinants will be discussed based on the people's perception of their selection to take up cycling. 1) The attitude toward the behaviour, 2) Subjective norms which determine the perception of others to adopt the behaviour of cycling. 3) the perceived behaviour control, or the ability to perform the behaviour of cycling. (Ajzen, 1991).

RESEARCH METHODOLOGY

To suit the research aim, this study uses an explanatory research design and focuses on collecting primary and secondary data. The techniques used in this study are focus group survey, pilot studies, and experience surveys. A focus group survey was conducted among the respondents of the selected cycling clubs.

The collection of data via group survey is easier as the researcher could meet the respondents at a specific location in Putrajaya, right at the cycling station and check points of cyclists' gathering. Using social media tools such as WhatsApp application and Facebook Messenger, the respondents could send their responses easier and faster to the researcher. Detailed practice of using social media application in the process of collecting data is explained in the next paragraph. This technique is related to the technique used in a study conducted by Vivienne et al. (2015). The questions from the survey are also the most prominent data collection tool to validate the collection of data from survey. Survey technique is believed to be a suitable way of assessing people's perception, meanings, and definitions of situations (Jones, 1985).

Phase 1 of the data collection relates to the specific individual personal characteristics as the influential factors for cycling activity. It was measured using the frequency and the scenario of cycling activity in terms of time, distance, and memberships of cycling club. In Phase 2, interviews were conducted to identify the constitution of legitimate problems, solution, and criteria of proof for all the list of identified factors (Cresswell, 2003). The data also supports the validity of questions and instrument used in the survey. The collected suggestions, additional items, and survey content become the reference in the data analysis. Finally, the result from the survey and interview conducted are presented to identify the attributes and the main factors of cycling behaviour that affect cyclists.

ANALYSIS AND DISCUSSION

Built Environment Factors That Influence Cycling Behaviour

Based on the analysis and variables for built environment factors, the factors identified are functional features, trail surface and path, safety and traffic condition, aesthetic, destination, bicycle facilities, views and visibility, and maintenance. All these variables and factors must be measured by considering overall cycling behaviour. The cycling activity situation among respondents was estimated based on the total of cycling per minutes and days per week engaged in any place. The estimation for cycling in neighbourhood areas is based on purpose, distance, and destination. Built environment factors are listed with eight items and divided into several sub-items. The detailed selection of reliable factors is measured similarly with the personal factors based on the value of mean and reliability of sub-items by Std Deviation. Functional features are divided into four sub items like specific route for cycling, type of gradient, intersection design and distance, and lastly the access point between places. The survey results from the respondents were measured according to the Factor Analysis, by using the Kaiser-Meyer Olkin (KMO) sampling adequacy, alpha coefficient for listed items, and sorting from the deleted items by previous analysis. The value of KMO by sample was factorable (KMO = .919). 29 items (sub factors) have been sorted by previous analysis, with the alpha coefficient .701. and the items have relatively high

internal consistency (Creswell, 2008). After Factor Analysis (FA) was carried out, the items were sorted from 42 items to 29 items based on the value of Std. Deviation. Table 3 shows the items for Factor Analysis of built environment. By using the Principal Component Analysis (PCA) to support the FA, 29 items were selected. The FA procedure was conducted repeatedly and returned with a KMO value of .919. This KMO value is more than .50 and suitable for factor analysis. The first factor obtains the largest eigenvalues because it gave the largest contribution to the changes in the total variance in the variables. The results for the factor analysis brought eight factors in a group which together reached at KMO value of 74.95.

Table 3: Items for Factor Analysis for Built Environment

Items	Component			
	1	**2**	**3**	**4**
Sub Factor 1: Functional Feature – cycling lane				
Specific route				.502
Type of gradient	.673			
Access point between places	.725			
Sub Factor 2: Trail surface and path				
Continuity of path	.744			
Comfort, suitable path design	.800			
Location of trail and path	.815			
Level of maintenance	.838			
Sub Factor 3: Safety and Traffic Condition				
Easy crossing between lanes		-450		
Safe from trees and shrubs		-.443		
Good lighting	.702			
Safety camera and surveillance		.381		
Safe from water ponding		-424		
Illegal parking		-.386		
Sub Factor 4: Aesthetic				
Cleanliness of cycling lane	.838			
Presence and size of trees	.814			
Diversity on natural sight	.661			
Sub Factor 5: Destination				
Commercial facilities			.539	
Bicycle parking facilities			.492	
Public Facilities			.609	
Public Park	.699			
Sub Factor 6: Bicycle Facilities				
Cycling Signage		.331		
Bicycle storage park	.816			
Shelter protection		.415		
Sub Factor 7: Views visibility				
Visibility road and cycling lane	.827			
Presence of hilly area	.581			
Presence of trees, landscape		.391		

Items	Component			
	1	**2**	**3**	**4**
Sub Factor 8: Maintenance				
Clean and clear cycling lane	.826			
Barrier from vehicles	.796			
No overgrown grass and bushes				-.369
Percentage Variance Explained	24.7	21.3	15.4	13.6
KMO	.919			
Bartlett's Test of Sphericity	3868.945			
Total Variance Explained	74.95			

Social Factors That Influence Cycling Behaviour

Social factors are listed with nine items, and this analysis of the situation is based on the cyclist perception. The detailed selection of reliable factors has been measured similarly with the personal factors. Based on the value of mean and reliability of subitems by Std. Deviation, the highest mean for these subfactors is 4.56, which complies with traffic laws. The value for Std. Deviation that has been measured and found to be reliable for six subfactors are: bicycle lane maintenance; traffic laws; feel safe; using cycling lanes; familiar with bicycle lanes; and equipped bicycle lanes. The results for social factors among respondents have been measured by previous analysis. The survey results from the respondents were measured according to Factor Analysis, by using the Kaiser-Meyer Olkin (KMO) sampling adequacy, alpha coefficient for listed items, and sorting from the deleted items by previous analysis. The value of KMO by sample was factorable (KMO = .778). Seven items (subfactors) were sorted by previous analysis, with the alpha coefficient .701. and the items have relatively high internal consistency (Creswell, 2008). After FA was carried out, the items were sorted from nine items to six items based on the value of Std. Deviation. Table 4 shows the items for Factor Analysis of social factor.

Table 4: 20 Items for Factor Analysis for Social Factor

Items	Component	
	1	2
Social Factor		
Bicycle lanes maintenance	.774	
Feeling safe using bicycle lane	.758	
Feeling to use bicycle lane	.748	
Familiar with bicycle lane	.724	
Comply with traffic laws		-.541
Equipped bicycle lane		.716
Percentage Variance Explained	35.3	32.3
KMO	.778	
Bartlett's Test of Sphericity	215.817	
Total Variance Explained	67.61	

By using the Principal Component Analysis (PCA) to support the Factor Analysis (FA), the items were sorted to seven items. The FA procedure was done repeatedly, and it returned with a KMO value of .778. This KMO value is more than .50 and suitable for factor analysis. The first factor obtained the largest eigenvalues because it gave the largest contribution to the changes in the total variance in the variables. The results for the factor analysis have been grouped into eight factors which together explained the KMO value of 67.61. The findings provided sufficient elements and proofs based on the objectives of the study. A confirmatory factor analysis was conducted to identify the specific and various factors that are quite reliable and influential towards the behaviour of the people to cycle in Putrajaya. Using factor analysis, eight main factors have been listed in terms of Perceived Towards Behaviour. For functional features, from the four listed items, only three were selected. For trail path factors, all four listed items were used to evaluate and test for their reliability. In safety factors, seven items from ten factors were selected. Other factors were removed due to the poor and insufficient value for reliability and validity. Aesthetic features listed five items, but only three were selected. Of six items for destinations features, only five were selected. Additionally, three from five items in bicycle facilities were selected. Three from five items were selected in views and visibility features. Lastly, three maintenance factors were selected from six items. The total number of listed built environment factors for evaluation are 45 items (Table 5). Only 31 items remained for hindrance and influential for cycling behaviour. Table 5 presents the results that indicate all of the selected and suitable factors in the conceptual framework that are retained.

Table 5: Reduction of Items

Factors	**Independent Variables**	**Dependent Variable**
Built Environment Factors (45 items)	Functional Trail path Safety Aesthetic Destination Bicycle facilities View and visibility Maintenance	Intention and choice for cycling activity
	Items	Items
	45	1
	reduction	reduction
Factor Analysis	31	1

CONCLUSION

The findings and results from this research have provided new information in the discussion on development, strategies, and concepts to enhance cycling behaviour among cyclists in Putrajaya. This study adopted and applied the Theory of Planned Behaviour (TPB) that includes individual characteristics, personal factors, built environment factors, and social factors. The findings from Factor Analysis have added to the existing body of knowledge and represent the scenario of cycling behaviour. This study validates the viewpoint that in the context of built environment factors, there is a need to use the listed types of factors that promote cycling behaviour. Items for each reliable factor can be added with a different set that influences cycling behaviour. The interpretations of this study have contributed to an understanding of the relationship between cycling behaviour and the reliable influential factors for cyclists. The discussion and findings have contributed to the growing body of knowledge, particularly to the understanding of cycling behaviour. Overall, the research findings show that the listed factors are related to the TPB and Factor Analysis implementation. These factors become the guidance for future research and studies in terms of preparation of guidelines of cycling infrastructure, cycling provision of development, and cyclist demand factors.

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