INTERNATIONAL JOURNAL OF SUSTAINABLE CONSTRUCTION ENGINEERING AND TECHNOLOGY
VOL. 13 NO. 4 (2022) 121-133

IJSCET

http://publisher.uthm.edu.my/ojs/index.php/ijscet

ISSN : 2180-3242 e-ISSN : 2600-7959

International Journal of Sustainable Construction Engineering and Technology

Subjective Factors Influencing Students to Use Bicycle on Campus: A Case Study in Universiti Tun Hussein Onn Malaysia

Nursitihazlin Ahmad Termida[1,2*], Noor Haliza Zaperi[3], Basil David Daniel[1,2], Dimas Bayu Endrayana[4], Probo Hardini[5]

[1]Department of Civil Engineering, Faculty of Civil Engineering and Built Environment, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, 86400, MALAYSIA

[2]Smart Driving Research Center (SDRC), Faculty of Civil Engineering and Built Environment, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, 86400, MALAYSIA

[3]ITG Electronics Malaysia Sdn. Bhd., 3 & 10 Jalan Hasil, Kawasan Perindustrian Jalan Hasil, Tampoi, Johor Bahru, 81200, MALAYSIA

[4]Department of Civil Engineering, Faculty of Engineering, Universiti Teknologi PETRONAS, Seri Iskandar, Perak Darul Ridzuan, 32610, MALAYSIA

[5]Department of Civil Engineering, Engineering Faculty, Universitas Jenderal Soedirman, Purwoketo, 53122, INDONESIA

*Corresponding Author

DOI: https://doi.org/10.30880/ijscet.2022.13.04.010
Received 31 October 2022; Accepted 31 October 2022; Available online 13 November 2022

Abstract: Malaysia's energy consumption is predicted to grow over time and the main contributor to the energy consumption is in transport sector. It is also predicted that energy for transport may expand significantly for the next 25 years. Therefore, it is vital to create sustainable development in every energy-produced sectors, especially in transport sectors, nationally and globally. One of the measures to reduce energy consumptions in transport sector is to promote sustainable transportation particularly in promoting active transportation mode such as bicycle. This study aims to investigate subjective factors that influence the students' decisions to use a bicycle for moving on campus. Probability sampling method using stratified sampling technique was applied since the study was conducted among Universiti Tun Hussein Onn Malaysia postgraduate students. Survey method via online questionnaire was used and quantitative method in conjunction with relevant statistical approaches such as descriptive statistics and regression analyses was applied to analyse the data. Theory of Planned Behaviour (TPB) was applied to test the relationships between the factors. It is found that very few students have used bicycle for movement on campus for participating in mandatory, maintenance and leisure activities in both weekdays and weekends. Regression results show that subjective factors which are subjective norm, perceived behavioural control, and attitude are strongly influence students' decisions to use bicycle for daily travels in campus significantly. In addition, the perceived behavioural control that is ease of bicycle use on campus is significantly influenced the behaviour of cycling on campus with similar weightage found with the intention variable.

Keywords: Active transportation, sustainable transportation, campus, Theory of Planned Behaviour, regression

Corresponding author: hazlin@uthm.edu.my

1. Introduction

Malaysia's energy consumption is predicted to grow at annually rate of 4.8% for the period of 2000 to 2030 in which the main contributor to the energy consumption is from transport sector [1]. It is predicted that during the next 25 years, energy for transport may expand at an annual rate of 5.3%. If nothing has been done to lower the energy consumption, thus, Malaysia's final energy requirements are expected to triple by the year 2030 from current conditions [2]. Therefore, it is an urgency to create a sustainable development in every energy-produced sectors especially in transport sector. One of the measures to reduce energy consumptions in transportation sector is to promote sustainable transport among Malaysians so that car-dependency can be reduced in their daily travel routines, thus reduce gas emissions rate resulting in much cleaner environment. In particular, promoting the use of active transportation modes such as walking, cycling or other non-motorized modes such as skateboarding, roller skating and foot-powered scooters can benefit both environments (e.g. reduce congestion, air pollution, etc.) and people itself (e.g. health and well-being).

The concept of Green Campus has been introduced in national level. This concept means that every facility and infrastructure should be connected to each other and facilitates people movements in and around campus under safe and comfortable conditions. Since 1970's, many universities in Malaysia have expanding their campus areas and undergone physical changes to accommodate demand, thus contributing to the increasing number of car-dependency among university students and staff [3]. This has been major issues and there is a need to promote active transport in campus areas among university students and staff because higher education has been seen as a role model to outside community and has its own impact to community, socially and economically.

Numerous numbers of research have investigated the link between objective factors such as land use factors (e.g. population density, mix land-use and connectivity, urban design, accessibility, proximity, etc.) and active transport [4], [5], [6], [7]. However, limited research has been done to investigate the effects of subjective factors (e.g. perceptions, motivations, enjoyment to commute, etc.) on active transport, especially on biking choice for travel. In addition, most of the studies regarding active transportation have been done in developed countries (e.g. [8], [9], [10], [11], [12]). In contrast, very few studies have been done in developing countries particularly in Malaysia (e.g. [13], [14]). Therefore, the aim of this study is to fill in the gap of limited knowledge on subjective factors affecting active transport particularly in biking choice in order to promote and encourage sustainable transport among university students and staff by applying attitude theory to model the motivations to choose bicycle as a main travel mode within campus areas.

2. Literature Review

2.1 Features of Malaysia's Transport Sector

The number of registered vehicles in Malaysia is increasing every year in which the rate of increment is much higher than the increased in the population rate. Fig. 1 shows that growth in the number of vehicles in the country has been much faster than population growth. It can be seen that the number of vehicles increased by 7.3% per year whilst the total population increased by 2.2% per year between the year 1990 to 2015 [15]. In addition, the cumulative number of registered vehicles in the country on second quarter of the year 2021 has increased around 4.38% as compared to the second quarter in year 2020. Moreover, passenger car registration cumulatively has increased around 4.35% in the second quarter for the year 2021 compared to the second quarter in the previous year [16]. This shows that the cumulative number of vehicles registration in Malaysia is still in increasing trends during the Covid-19 pandemic condition. Due to this reason, the carbon emission in the transport sector is largely comes from land transport, constituting 90% (48,200 kilo tonnes) and 67% from the emission is from cars [17]. This can be seen in Fig. 2 that shows transport sector has an increasing trend over time in general and being as major contributor to the energy consumptions between the year 1990 to 2016 [15]. It is known that the transport sector in this country is heavily rely on non-renewable products (e.g. petrol and diesel) and this is a worrying trend for the future in terms of energy security and CO2 emissions contribution that may impacts our environment, thus affecting people's health and well-being in a negative way. Due to these reasons, actions need to be done and National Transport policy 2019-2030 [17] has shifting towards environmentally sustainable transports. One of the sustainable transports is active transportation modes such as bicycles, skateboards, roller skates and foot-powered scooters that is considered as clean modes [13]. Thus, it is crucial to understand what are the factors that may influence people to cycle for travels, especially for short-distance travels so that the decision-makers and policymakers can get some insights on what are the factors that may motivate people to cycle for travels.

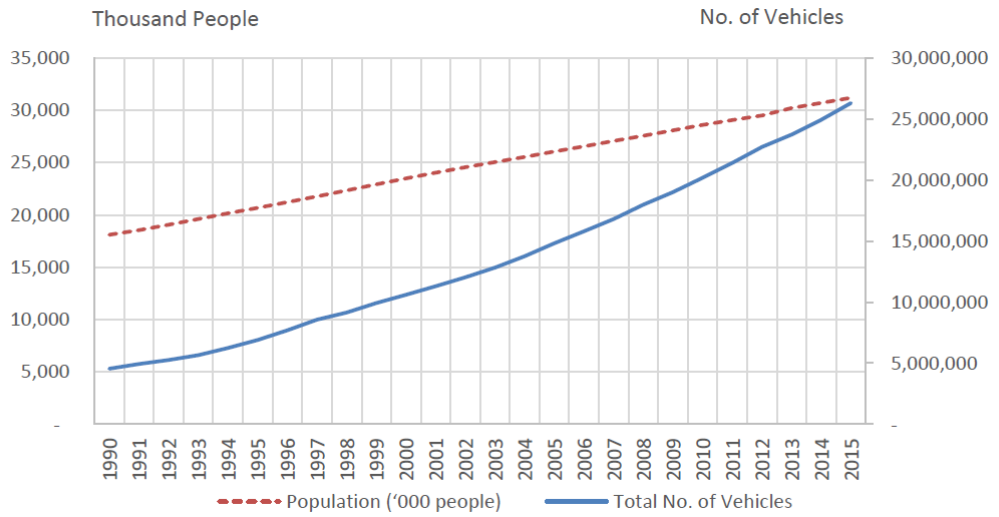


Fig. 1 - Trends in vehicle numbers and population growth in Malaysia for the year 1990 – 2015 [15]

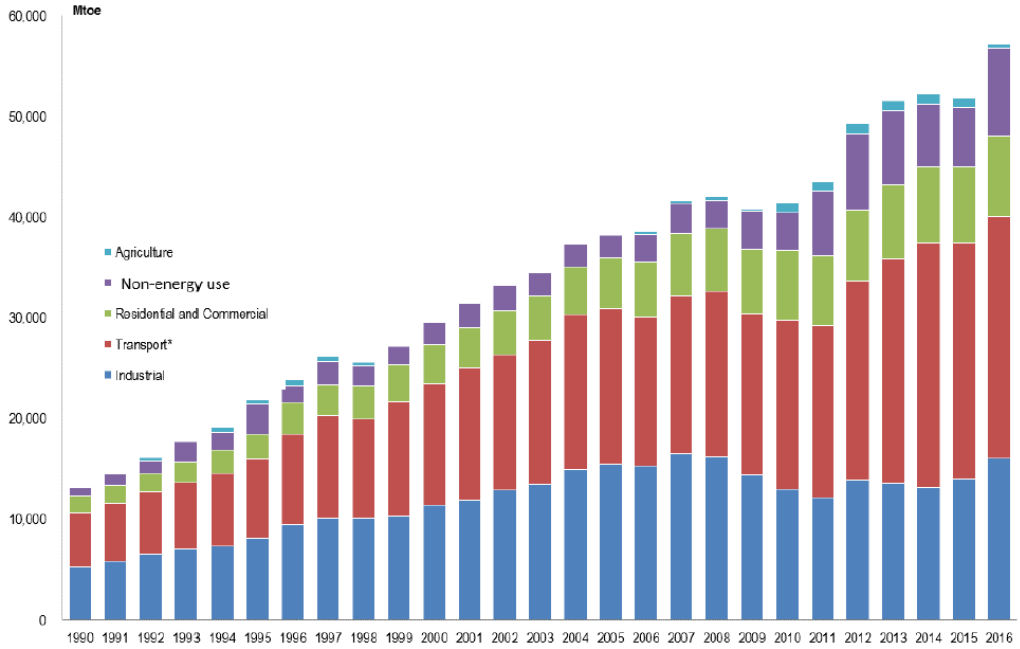


Fig. 2 - Trends in final energy consumption by sector in Malaysia for the year 1990 – 2016 [15]

2.2 Overview of the Active Transportation Modes in Campus Community

It is undeniable that active transportation modes are seen as low costs transport, effective (e.g. fast) and healthy travel modes for short distance travels compared to motorized transportation [3], [18], [19]. University campus has been seen as a place that can reduce car dependence and promoting active transportation as a daily travel mode, especially walking and cycling [20]. By choosing to walk or cycle instead of driving, campus community may help minimize greenhouse gas emissions in campus [21]. If campus can start encouraging walking and cycling as fun activities, healthy, safe and environmentally mode of travel, the campus will definitely have the potential to be a cycle-friendly campus [22]. Thus, it is expected that university students will be among the people who are most likely to use active transportation modes to travel in campus areas since most of the travel distance in campus are considered short and it is fast and cheaper to use compared to motorized modes as we know that students have time and budget constraints compared to workers (e.g. university staff). However, in university campuses, students and staff are continued to rely on cars for travel. One of the possible reasons is that the campuses are seen as distinct communities and the implementation of the green transport system is mainly focuses in urban areas. In addition, although the university makes effort in environmental awareness program, however, the infrastructure built are still encouraging driving, instead of built for encouraging active transportation use [23], [24]. This may contribute to the poor

development of active transportation infrastructure in campuses, especially for cycling facilities, thus resulting in poor perceptions of cycling for travel in campus among students.

2.3 Factors Influencing Bicycle Choice

Provision of bicycle facilities such as cycling paths, lighting at night and clean environment are some of the factors that influenced the use of bicycles since it may provide safety for cyclists by reducing likelihood of accidents involving them. In addition, university policy for instance charging parking for university staff and students, also contributes to the use of active transportation modes [25], [26]. Wang et al. [27] has highlighted the five factors that influenced people to use bicycles in Auckland which are safety, cycling facilities (e.g. provision of cycleways), convenience, policies to discourage car use and a good public transportation system integrated with cycling facilities. It is undeniable that safety is a very important factors that shape the people's decision to cycle for travels [28], [29], [30]. Unsafe road patterns such as the existence of several main intersections, heavy traffic frequency, many cars parking on the street and condition of night lighting is not good are considered unsafe for people to cycle [28], [31], [32], [33]. Since safety is the most important aspect considered by people to choose for bicycle use, thus the presence of well-maintained bicycle lanes is also important factors to persuade people to use bicycle [30], [31]. In terms of route selection, it is desirable to have the most direct route and continuity of the route, a segregated bicycle lane with a smooth surface quality and route infrastructure [31], [32], [33], [34]. These preferences are applied for general travels, but it may be different for sport or leisure purposes. For example, cycling routes that are steep and hilly are desirable for cyclists that intend to exercise [33], [35], increasing the enjoyment of cycling [35] and providing scenic views [35]. As in the convenience factor, the provision of safe and sufficient parking for bicycles are on top priority among others such as flexible working hours and locker and shower facilities [31], [34]. Wardman et al. [36] found that providing financial incentives through taxes or subsidies can encourage commuters to cycle in the U.K. While Pucher and Buehler [37] found that providing free bicycle use during the day for short business trips are effective in motivating commuters to use bicycle in the Netherlands, Denmark and Germany. In terms of policies to discourage car use factor, Dill and Voros [31] found that the presence of motorised modes is negatively associated with the decision to bicycle use. Furthermore, lowering speed limits for motorised modes are possible to increase the number of cyclists on the road [27] since it is perceived to be safe to cycle. Thus, to discourage the car use, various solutions are made such as high taxes levied against the purchase and ownership of automobiles in cities in the Netherlands, Denmark and Germany [37] and introducing high parking fees and limited number of car parks in the city [38]. It is also found that converting car parking facilities to bicycle parking has resulted in a reduction of the car use [37]. Other measures are included car-free zones, police cameras at intersection and advance warning signals for cyclists such as a stop line are also implemented in other countries [37]. To make cycling irresistible, the combined use of bicycle and public transport is considered necessary [39]. It is found that secure and extensive bike parking facilities in the stations, bike racks on public transport and quick and cheap rental bikes at station is proved to be successful, at least in the Netherlands, Denmark and Germany [39]. However, it is worth noting that this factor is not considered in this study due to the fact that distance travels to most places of interests in the campus areas are considered short, resulting in no necessity to link the cycle facilities with public transport facilities within campus areas.

3. Methods and Materials

3.1 Theory of Planned Behaviour (TPB)

In this study, Theory of Planned Behaviour (TPB) by Ajzen [40] since it is the most widely used by many researchers in explaining the human intentional behaviours. The notion of behavioural intention is central to the TPB; a person's intention to engage in a particular behaviour is the best predictor of whether or not that person will actually engage in that behaviour [40]. A person's actual intention to do something is considered to be the best predictor of their actual behaviour, and this is the foundation of the theory. Fig. 3 shows five components of TPB which are attitudes, subjective norms, perceived behavioural control, intention and behaviour and how they are related to one another. Attitude refers to one's attitude toward a specific act or behaviour. The subjective norm is our belief about what others expect us to do in order to be respected. When it comes to perceived behavioural control, it refers to the degree to which a person believes they can control their behaviour. According to TPB, more favourable attitudes toward a specific act, more favourable subjective norms, and greater perceived behavioural control all contribute to a stronger intention to perform the behaviour in the first place [40]. In this study, attitudes relate to the extent to which the person assesses the specific behaviour which is the use of bicycle in campus, favourably or unfavourably. The subjective norm refers to the social presence of pressures from relatives and friends on cycling on campus. Finally, the perceived behavioural control refers to the perceived ease or difficulty of conduct (use bicycles in campus) and reflect past and anticipated barriers. Similar to Ajzen [40], the favour the attitudes towards bicycle use in campus, the higher the social pressure in bicycle use on campus and the lower the constraints or difficulties in using bicycle in campus will produce high intention in using bicycle in campus, thus will reflect the real behaviour of interest which in this case is the frequency of cycling in campus.

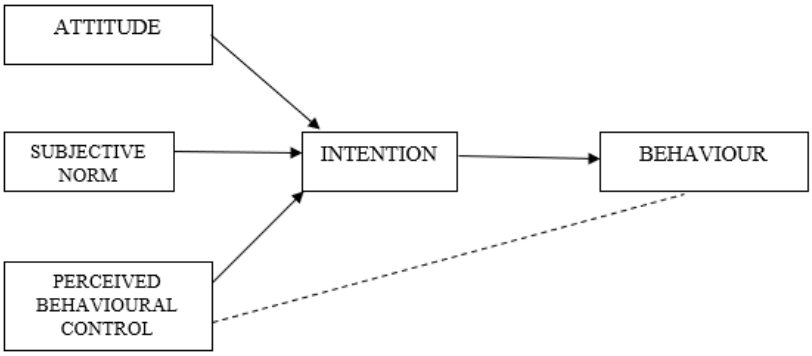


Fig. 3 - Theory of Planned Behaviour [40]

3.2 Survey Design and Pilot Study

This study applied quantitative method due to the nature of the data collected which is numerical data and using various statistical analyses to analyse the data. The survey method via stated-preference questionnaire is applied in this study. The questions are adopted from previous studies and modified to reflect the relevant information that is related to the objectives of the study which are to investigate the bicycle use (in terms of frequency and trip purpose) in campus among UTHM postgraduate students, to identify students' perceived current bicycle facilities in campus areas, and to determine subjective factors affecting students' decisions to use bicycle in campus. Note that the results of the objective regarding the students' perceived current bicycle facilities in UTHM campus areas has been published in Zaperi and Ahmad Termida [41]. Thus, this paper analysed and discussed the results of the other objectives mentioned in detail, particularly on the subjective factors that influencing the students' decisions to cycle in campus.

The questionnaire in this study consists of four Sections. Section A consists of socio demographic data of the respondents and Section B consists of the questions regarding the bicycle use (in terms of frequency and trip purpose) in campus among students in order to understand who they are and how many of them cycle in campus. The measurement scales of Section A and Section B were nominal and ordinal. Section C consists of the questions on students' perceived current bicycle facilities in campus areas, meanwhile Section D consists of the questions on subjective factors affecting students' decision to use bicycle in campus based on the TPB. The questionnaire in Section C and Section D was measured using five-point Likert scale from 1 = strongly disagree to 5 = strongly agree. All Section B, Section C and Section D questions have been checked for reliability test during pilot study stage that involved 33 samples using Alpha Cronbach values before being distributed to the respondents. The coefficient of Alpha Cronbach for Section B, Section C and Section D is 0.901, 0.928 and 0.937 respectively. Thus, all the Cronbach Alpha values are considered excellent in terms of internal consistency [42].

3.3 Sampling, Data Collection and Analysis Methods

The respondents in this study are similar with Zaperi and Ahmad Termida [41] study and explained in detail in their paper on the reasons of choosing the respondents. Thus, a total of 328 postgraduate students of Universiti Tun Hussein Onn Malaysia (UTHM) were chosen by applying probability sampling method using stratified sampling technique. The stated-preference questionnaires were distributed in a Google Form and posted online via social media platforms such as Facebook and WhatsApp since the data was collected during the pandemic Covid-19 is still on peak, which was in a month of April 2021. Descriptive statistics, correlation analysis and regression analysis using Least Square Method were applied in this study. Both simple and multiple linear regressions are involved in this study: (1) Model 1 tests the relationship between the TPB elements of Attitude, Subjective Norms and Perceived Behavioural Control with Intention to use bicycle in campus, (2) Model 2 tests the relationship between Intention and Behaviour (the frequency of using bicycle in campus), and (3) Model 3 tests the relationship between Perceived Behavioural Control with the Behaviour. All these models are portraying the TPB relationship shown in Fig. 3 previously. All the analysis were done using Statistical Packages for Social Sciences (SPSS) version 26. Equation 1, 2 and 3 show the formula for regression analyses of Model 1, Model 2 and Model 3.

$$Y' = A + B_1X_1 + B_2X_2 + B_3X_3 \quad (1)$$

$$Y = a + bY' \quad (2)$$

$$Y = a + bX_3 \quad (3)$$

Where,
Y' = The predicted value of dependent variable Intention
A = Y intercept for multiple regression
X_1, X_2 and X_3 = Independent variables of Attitude, Subjective Norm and Perceived Behavioural Control
B_1, B_2 and B_3 = Regression coefficient of independent variables
Y = The dependent variable of Behaviour
a = the intercept for simple regression
b = slope of the regression line

4. Data Analysis and Results

4.1 Descriptive Statistics

The respondents' profiles are shown in table 1 and their characteristics also explained in Zaperi and Ahmad Termida [41]. The respondents of this study are mainly among female, adult ages between 25 to 40 years old, single, have no children, Malaysians, Malays, living in a rental home, lives in Parit Raja, enrolled in master's degree program in UTHM and mostly in Year 1 and Year 2 duration of study. Many of them owned at least a car but no motorcycle and bicycle owned in their households. Fig. 4(a) – (j) show the percentage of transportation modes used to travel from/to respondents' home to/from campus and travel within campus areas in general, and by trip purposes (mandatory, maintenance and leisure activities) including during weekdays and weekends. In this study, mandatory activities include attending lectures, classes, laboratory works and courses in the campus, meanwhile maintenance activity includes regular sport activities such as cycling and leisure includes cycling for self-enjoyment. Based on the Fig. 4, it can be seen that majority of the students (more than 50%) were using cars and around 20% were using motorcycles to travel between their homes and campus, and also to travel within campus areas, regardless of period of the week. Unfortunately, only 2.7% were using bicycle to travel between their homes and campus and 4.3% were using bicycles to travel within campus areas, in general. The use of bicycles for all trip purposes, regardless of period of the week, are considered very low in which less than 12% were using bicycle at least 1 time per week for mandatory activities, less than 20% were using bicycle at least 1 time per week for both maintenance and leisure activities. On average, only 9.8% were using bicycle at least 1 time per week on weekdays and 16.2% on weekends.

Table 2 shows the mean and standard deviation of the TPB components (Attitudes, Subjective Norm, Perceived Behavioural Control, Intention and Behaviour). The components have a mean value ranging from 2.75 to 4.18. Note that the maximum possible mean score is 5.00, and the minimum possible mean score is 1.00. It can be seen that students mostly agree that bicycle use is a good idea for travels on campus (Attitudes), however, they are not using bicycle to travel on campus (Behaviour) in which this is parallel to the results shown in Fig. 4.

Table 1 - Respondents' profiles (N = 328)

Characteristics	Percentage (%)
Gender	
Male	42.4
Age (years)	
Below 24	15.5
25 - 40	84.2
Above 40	0.3
Marital status	
Single	89.9
Married	10.1
Single parent	0
Number of children in a household (persons)	
None	90.9
1 - 4	8.5
More than 4	0.6
Nationality	
Malaysian	96.6

Race	
Malay	87.2
Chinese	4.6
Indian	0.3
Others	7.9
Residential type status	
Student's dorm/hostel	10.7
Rent	57.0
Owned	5.8
Family-owned	26.5
Home poscode	
86400 (Parit Raja)	94.2
86000 (Kluang)	4.0
83000 (Batu Pahat)	1.8
Education level enrolled	
Master's degree (by course)	45.7
Master's degree (by research)	41.5
Master's degree (by mixed mode)	4.0
Doctor of philosophy (PhD)	8.8
Year of study	
Year 1	44.2
Year 2	48.5
Year 3	7.0
Year 4 and above	0.3
Car ownership	
None	32.3
1-3 cars	62.8
4 cars and above	4.9
Motorcycle ownership	
None	50.3
1-3 motorcycles	43.6
4 motorcycles and above	6.1
Bicycle ownership	
None	68.0
1-3 bicycles	29.9
4 bicycles and above	2.1

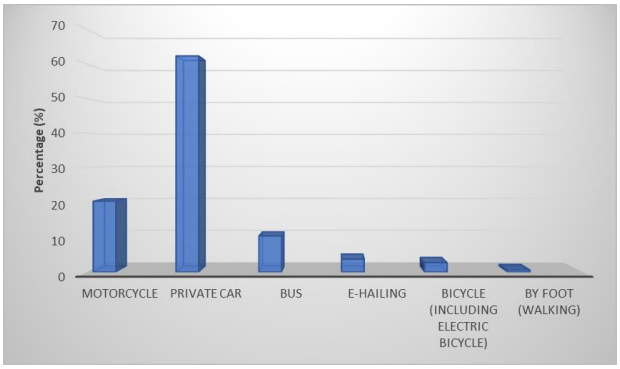


Fig. 4 (a) - Mode of transport from home to campus (N=328)

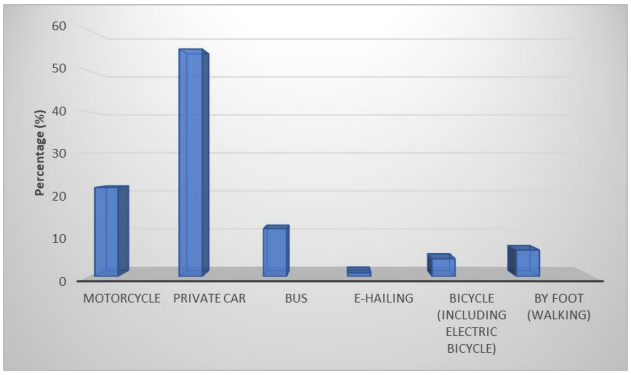


Fig. 4 (b) - Mode of transport to travel in campus areas (N=328)

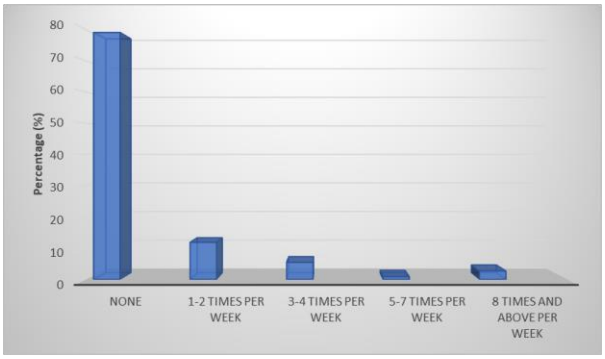


Fig. 4 (c) - Bicycle use for participating in mandatory activities in weekdays (per week) (N = 328)

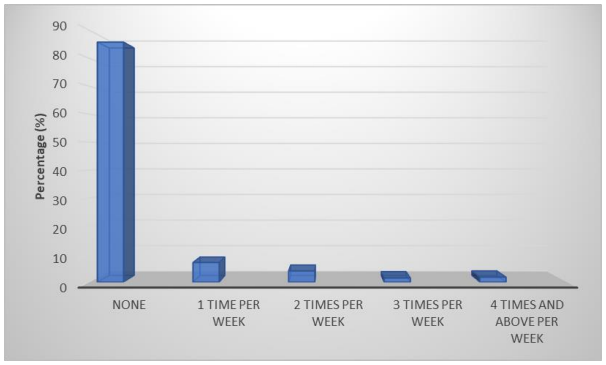


Fig. 4 (d) - Bicycle use for participating in mandatory activities in weekends (per week) (N = 328)

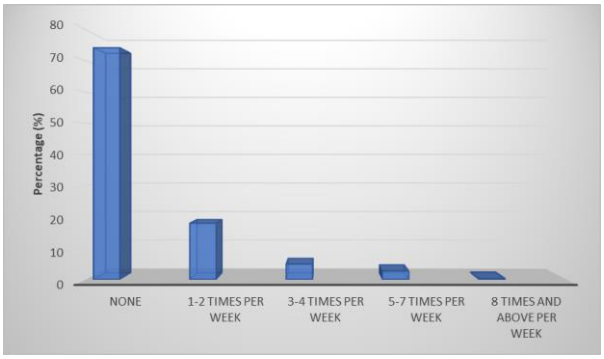


Fig. 4 (e) - Bicycle use for participating in leisure activities in weekdays (per week) (N = 328)

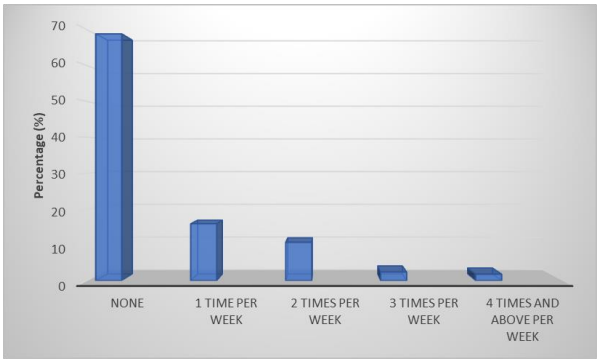


Fig. 4 (f) - Bicycle use for participating in leisure activities in weekends (per week) (N = 328)

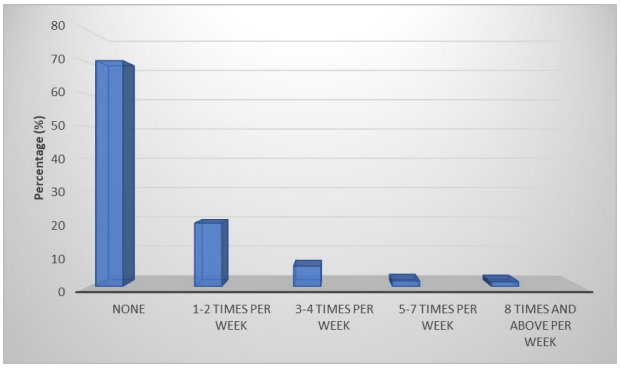


Fig. 4 (g) - Bicycle use for participating in maintenance activities in weekdays (per week) (N = 328)

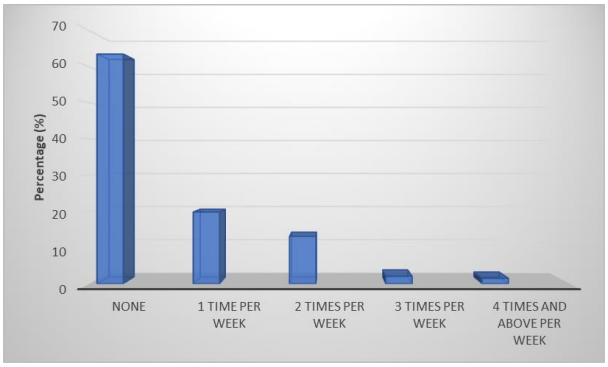


Fig. 4 (h) - Bicycle use for participating in maintenance activities in weekends (per week) (N = 328)

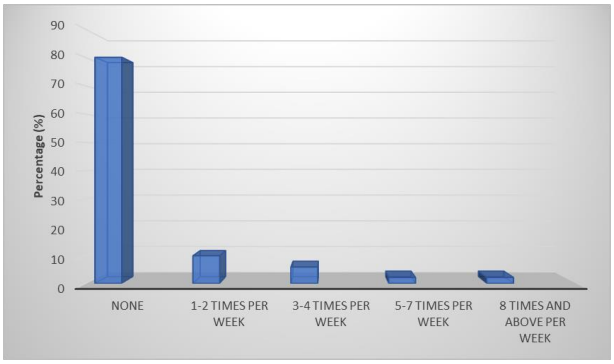


Fig. 4 (i) - Average bicycle use for travels in campus during weekdays (per week) (N = 328)

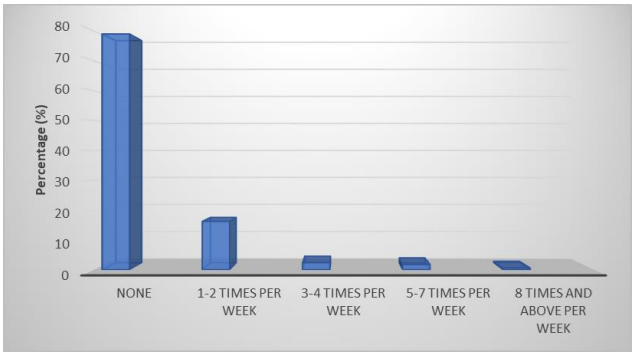


Fig. 4 (j) - Average bicycle use for travels in campus during weekends (per week) (N = 328)

Table 2 - Descriptive statistics for TPB components (N = 328)

Item	Mean	Standard Deviation
Most people who are important to me use bicycle in campus affect me to use it	3.43	1.16
Most people who are important to me thinking use bicycle is a good idea	3.78	0.98
My family who are important to me would think I should use bicycle in campus	3.27	1.16
The people around me whose opinion of use bicycle in campus would affect my opinion of use bicycle in campus	3.44	1.06
Most people around me who do not use bicycle in campus. I also do not use bicycle in campus.	3.80	1.11
I think that it is good to use bicycle in campus	4.18	0.83
I like to use bicycle in campus	3.65	1.07
I feel that use bicycle in campus is a good idea	4.14	0.88
I enjoy those aspects of my life that require me to use bicycle in campus	3.84	0.96
I think use bicycle in campus is important to me	3.55	1.12
Cycling in campus provide convenience for my daily travelling	3.63	1.02
I would find the bicycle is easy to use in campus	3.78	1.03
It makes me feel happy when use bicycle in campus	3.63	1.04
Cycling in campus can help me to relax	3.81	1.08
My willingness to use bicycle in campus is very high	3.60	1.13
Assuming around me use bicycle in campus, I intend to use it	3.75	1.01
Assuming around me use bicycle in campus, I predict I would use it	3.79	1.01
In near future, I would considered continue use bicycle in campus	3.70	1.07
I have used bicycle in campus	3.11	1.36
I often/regularly use bicycle in campus	2.90	1.41
I have been used bicycle in campus for a long time	2.75	1.44
I will continue use bicycle in campus	3.17	1.28

4.2 Correlation Analysis

Table 3 shows the coefficient of correlation between the dependent variable and the independent variables, respectively. The components are evaluated in accordance with the TPB model. First, there is a strong correlation between Attitude and Intention (r = 0.805). This demonstrates that there is a positive linear relationship exists between the two variables, as expected. Second, the relationship between Subjective Norms and Intention is considered moderate positive correlation (r = 0.594). This indicates that there is a positive linear relationship between the two variables, as expected. Third, the correlation coefficient between the Perceived Behavioural Control and Intention is the strongest (r = 0.821), indicating that both variables are in a strong positive linear relationship. Fourth, the relationship between Intention and Behaviour reveals a moderate positive relationship (r = 0.595). Finally, the relationship between Perceived Behaviour Control and Behaviour, reveals that the two variables have a moderate positive correlation (r = 0.579). As a result, all correlations are in the positive directions and significant, as expected.

Table 3 - Coefficient of correlations between each TPB components

TPB components	Attitude	Subjective Norm	Perceived Behavioural Control	Intention	Behaviour
Attitude	1				
Subjective Norm	.567**	1			
Perceived Behavioural Control	.801**	.563**	1		
Intention	.805**	.594**	.821**	1	
Behaviour	.520**	.510**	.579**	.585**	1

**Correlation is significant at the 0.01 level (2-tailed)

4.3 Model Results

In this study, three models are developed to tests the relationships and determine the contributing factors to the bicycle use in UTHM campus among students, as mentioned in the methodology section previously. Model 1 applied multiple regression analysis to test the relationships between Attitude, Subjective Norm and Perceived Behavioural Control towards Intention. Model 2 applied simple liner regression by testing the relationship between Intention and Behaviour. Model 3 applied simple linear regression by testing the relationship between Perceived Behavioural Control and Behaviour. Table 4(a) – (c) shows the results of Model 1. Based on the R-square value (Table 4(a)), the model demonstrates that the variation in the Intention variable of 74.6 % occurred as a result of the combination of the variations in the three components which are Attitude, Subjective norm and Perceived Behavioural Control, indicating the model is fit. Moreover, the F-value is significant indicating that the model is significant (see Table 4(b)). A statistically significant positive relationships exist between the Intention and the independent variables Attitude ($\beta1$ = 0.130, t = 3.737, $p < 0.01$), Subjective Norm ($\beta2$ = 0.368, t = 7.650, $p < 0.01$) and Perceived Behavioural Control ($\beta3$ = 0.453, t = 9.428, $p < 0.01$) as shown in Table 4(c). As for Model 2, there is a significant positive relationship between the Intention (intention to cycle on campus) with the Behaviour (the cycle frequency per week) (b = 0.76, t = 13.024, $p < 0.01$) as shown in Table 5. Meanwhile, in Model 3 results indicated that there is a significant positive relationship between the Perceived Behavioural Control (the ease to cycle on campus) and the Behaviour (the cycle frequency per week) (b = 0.81, t = 12.811, $p < 0.01$) as shown in Table 6. For both models 2 and 3, the R-square value is considered low due since there is only two variables involved in a model, but the model is considered good based on the significant value of F. Thus, all the three models are accepted. Fig. 5 shows the structural model of TPB for subjective factors affecting UTHM Postgraduate Students' Decisions to use bicycle on campus. All the components have positive correlations and effects, as expected. Moreover, all the components of TPB thus significantly contributing to the use of bicycle to travel in campus among students, at least in UTHM.

Table 4 (a) - Model summary of Model 1

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.863[a]	.746	.743	.47227

Table 4 (b) - Analysis of variance (ANOVA) of Model 1

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	211.722	3	70.574	316.422	.000[b]
	Residual	72.264	324	.223		
	Total	283.986	327			

Table 4 (c) - Parameter estimates of Model 1

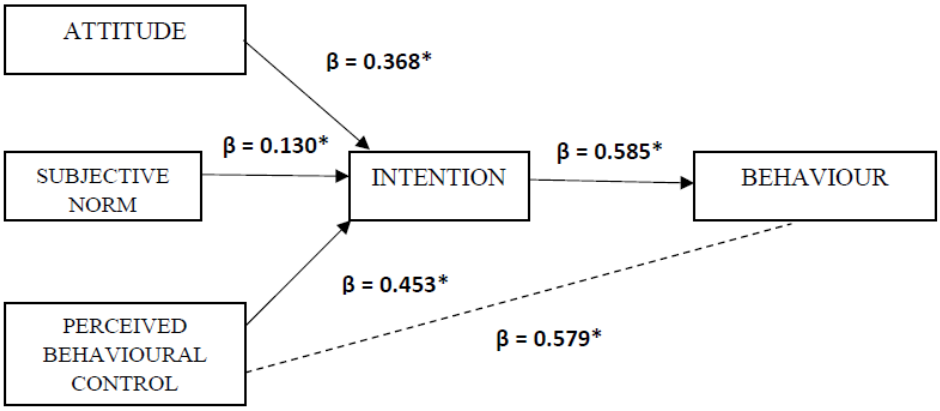
		Unstandardized Coefficients		Standardized Coefficients		
Model		**B**	**Std. Error**	**Beta**	**t**	**Sig.**
1	(Constant)	-.336	.142		-2.368	.018
	Attitude	.154	.041	.130	3.737	.000
	Subjective Norm	.435	.057	.368	7.650	.000
	Perceived Behavioural Control	.488	.052	.453	9.428	.000

Table 5 - Model summary and parameter estimates for Model 2

Model	Model Summary					Parameter estimates			
	R square	**F**	**df1**	**df2**	**Sig.**	**Constant**	**b**	**β**	**t**
2	.342	169.627	1	326	.000	0.165	0.76	0.585	13.024

Table 6 - Model summary and parameter estimates for Model 3

Model	Model Summary					Parameter estimates			
	R square	**F**	**df1**	**df2**	**Sig.**	**Constant**	**b**	**β**	**t**
3	.335	164.111	1	326	.000	-0.025	0.81	0.579	12.811



**significant at $\alpha < .001$*

Fig. 5 - Structural model results based on TPB

5. Discussion and Conclusions

Based on the descriptive statistics of bicycle use in campus, it can be concluded that most of them travel from home to campus by using motorized transport and few of them travel from home to campus by using active transport (walk or cycle). It shows the same results for respondent's mode of transport in campus area which is most of the respondents use motorized transport compared to non-motorized transport in campus areas even though they travelled in a short distance in a campus area. This is a major concern and actions need to be taken to promote and increase active transportation in campus. The study done by Zaperi and Ahmad Termida [41] on students' satisfaction towards bicycle facilities in UTHM campus found that students perceived that some of the bicycle facilities which is considered important in campus need to be improved in order to attract and give them comfort to use bicycle in campus. Good condition of bicycle lanes will improve the level of satisfaction among students, lighting at night will ensure safety of cyclists among students and an increase in the number of bicycles will have an impact on students' attitudes toward bicycle facilities. All of these are considered as objective factors that contributing to UTHM students' choices of using bicycle to travel on campus.

Meanwhile, in this study, it is found that the TPB model was an appropriate model to analyse the behaviour of cycling on campus. In fact, the variables intention of cycling on campus has explained 34% of the variance towards bicycle use behaviour. The combination of three predictors (Attitude, Subjective Norm, and Perceived Behavioural Control) resulted in 75% variations in the Intention variable, which was explained by variations in the three predictors. The findings are consistent with other studies that show the TPB's model is good in explaining the bicycle use behaviour [43], [44]. This finding is particularly similar to those of Milković and Štambuk [45], who discovered that the three components of TPB explained that intention with attitudes and perceived behavioural control have stronger relationship than the subjective norm. Moreover, the relationship between behaviour and intention, and behaviour with perceived behavioural control have not much different. It shows that they have stronger relationship and significantly influenced students to use bicycle for their daily travels in campus, as found as in this study. To conclude, the positive the attitude towards bicycle use on campus, the high the social pressures from the family and friends on bicycle use, and the high perceived ease of bicycle use on campus, the high the intention of students to cycle on campus, and thus contributing to the real behaviour of cycling on campus. Moreover, the high the perceived ease of bicycle use in campus will influence the real behaviour of cycling on campus.

This study emphasised the importance of attitudes as predictors of bicycle use, particularly among young people. As a result, it is much easier to change attitudes than it is to change the environment or to influence perceived behavioural control, both of which are difficult tasks. Increasing bicycle use through such measures is highly reliant on external factors, such as existing infrastructure. However, to increase the perceived behavioural control (ease of bicycle use on campus), the use of technology through smart applications via mobile phone in renting a bicycle in campus may be applied to ease the access and use of bicycle among students, and these need a lot of parties to collaborate with the university authorities. This could be potential future research on how technology can ease the use of bicycle, thus increasing the use of bicycle to travel, particularly in campus. Meanwhile, changing attitudes is a more direct way of increasing bicycle use. It is suggested to implement continual promotion of the bicycle as a practical, environmentally friendly, inexpensive, and healthy mode of transportation may result in more positive attitudes, which may in turn lead to stronger intentions and more frequent bicycle use in the future.

Acknowledgement

This research was supported by Universiti Tun Hussein Onn Malaysia (UTHM) through TIER 1 (vot H745).

References

Lopez, G. & Laan, T. (2008). *Biofuels—At what cost? Government Support for Biodiesel in Malaysia*, International Institute for Sustainable Development: Geneva, Switzerland. Retrieved August 16, 2022, from https://researchrepository.murdoch.edu.au/id/eprint/26416/1/biofuels_at_what_cost.pdf

Fulton, L. Mejia, A., Arioli, M., Dematera, K. & Lah, O. (2017). Climate change mitigation pathways for Southeast Asia: CO2 emissions reduction policies for the energy and transport sectors. *Sustainability*, 9(1160), pp. 1-16

Balsas, C. J. L. (2003). Sustainable transportation planning on college campuses, *Transport Policy*, 10(1), pp. 35–49

Sallis, J. F., Frank L. D., Saelens, B. & Kraft, M. K. (2004). Active transportation and physical activity: opportunities for collaboration on transportation and public health research, *Transportation Research Part A: Policy and Practice*, 38(4), pp. 249-268

Duncan, M. J., Winkler, E., Sugiyama, T., Cerin, E., duToit, L., Leslie, E. & Owen, N. (2010). Relationships of land use mix with walking for transport: do land uses and geographical scale matter? *Journal of Urban Health*, 87(5), pp. 782–795

Saghapour, T., Moridpour, S. & Thompson, R. G. (2018). Enhancing active transport demand modelling by incorporating accessibility measures. *Cities*, 78, pp. 206-215

Majumdar, B. B. & Mitra, S. (2018). Analysis of bicycle route-related improvement strategies for two Indian cities using a stated preference survey, *Transport Policy*, 63, pp. 176-188

Fernández-Heredia, Á., Jara-Díaz, S. & Monzón, A. (2016). Modelling bicycle use intention: The role of perceptions, *Transportation*, 43, pp. 1–23

Páez, A. & Whallen, K. (2010). Enjoyment of commute: A comparison of different transportation modes, *Transportation Research Part A: Policy and Practice*, 44(7), pp. 537-549

Barberan, A. Silva, J. de A. e. & Monzon, A. (2017). Factors influencing bicycle use: A binary choice model with panel data, *Transportation Research Procedia*, 27, pp. 253–260

Gabrhel, V. (2019). Feeling like cycling? Psychological factors related to cycling as a mode choice. *Transactions on Transport Sciences*, 10(1), pp. 19-30

Grabow, M. L., Bernardinello, M., Bersch, A. J., Engelman, C. D., Martinez-Donate, A., Patz, J. A., Peppard, P. E. & Malecki, K. M. C. (2019). What moves us? Subjective and objective predictors of active transportation, *Journal of Transport Health*, 15, pp. 100625

Norzalwi, N. & Ismail, A. (2011). Public approach towards sustainable transportation in UKM's campus, *Australian Journal of Basic and Applied Sciences*, 5(5), pp. 1332-1337

Zainal, S. K., Borhan, M. N., Hakimi Ibrahim, A. N., Tuan Yaakub, N. M. I. & Mat Yazid, M. R. (2019). Assessment of university campus cycling facilities: The students' perceptions, *International Journal of Engineering and Technology*, 8(1), pp. 46–49

Economic Research Institute for ASEAN and East Asia (ERIA). (2022*). Chapter 2: Energy and Transport Policy in Malaysia.* Jakarta, Indonesia. Retrieved on August 16, 2022, from https://www.eria.org/uploads/media/11.ERIA_RPR_2017_10_Chapter_2.pdf

Ministry of Transport Malaysia (MOT). (2021). *Transport Statistics Malaysia 2021 Edition 03*. Retrieved on August 16, 2022, from https://www.mot.gov.my/en/Statistik%20Tahunan%20Pengangkutan/Transport%20Statistics%20Malaysia%202021%20Edition%2003.pdf

Ministry of Transport Malaysia (MOT). (2018). *National Transport Policy 2019-2030.* Retrieved on August 16, 2022, from https://www.pmo.gov.my/wp-content/uploads/2019/10/National-Transport-Policy-2019_2030EN.pdf

Myers, J. (2003). Exercise and cardiovascular health, *Circulation*, 107(1), pp. e2-e5

Goodman, A., van Sluijs, E. M. F. & Ogilvie, D. (2015). Cycle training for children: Which schools offer it and who takes part? *Journal of Transport Health*, 2, pp. 512-521

Wright, C. & Egan, J. (2000). De-marketing the car, *Transport Policy*, 7(4), pp. 287-294

Zahran, S., Brody, S. D., Maghelal, P., Prelog, A. & Lacy, M. (2008). Cycling and walking: Explaining the spatial distribution of healthy modes of transportation in the United States, *Transportation Research Part D; Transport and Environment*, 13(7), pp. 462-470

Karanikola, P., Panagopoulos, T., Tampakis, S. & Tsantopoulos, G. (2018). Cycling as smart and green mode of transport in small touristic cities, *Sustainability*, 10(1), pp. 268

Khorheh, M. A., Moisiadis, F. & Davarzani, H. (2015). Socio-environmental performance of transportation systems, *Management of Environmental Quality: An International Journal*, 26(6), pp. 826-851

Namgung, M. & Jun, H. J. (2019). The influence of attitudes on university bicycle commuting: Considering bicycling experience levels, *International Journal of Sustainable Transportation*, 13(5), pp. 363-377

Kaplan, D. H. (2015). Transportation sustainability on a university campus. *International Journal of Sustainability in Higher Education*, 16(2), pp. 173–186

Rybarczyk, G. & Gallagher, L. (2014). Measuring the potential for bicycling and walking at a Metropolitan Commuter University, *Journal of Transport Geography*, 39, pp. 1-10

Wang, J. Y. T., Mirza, L., Cheung, A. K. L. & Moradi, S. (2014). Understanding factors influencing choices of cyclists and potential cyclists: A case study at the University of Auckland, *Road and Transport Research: A Journal of Australian and New Zealand Research and Practice*, 23(4), pp. 37 – 51

Winters, M. & Teschke, K. (2010). Route preferences among adults in the near market for bicycling: Findings of the cycling in cities study, *American Journal of Health Promotion*, 25(1), pp. 40-47

Winters, M., Davidson, G., Kao, D. & Teschke, K. (2011). Motivators and deterrents of bicycling: Comparing influences on decisions to ride, *Transportation*, 38, pp. 153-168

Akar, G. & Clifton, K. J. (2009). Influence of individual perceptions and bicycle infrastructure on decision to bike, *Transportation Research Record*, 2140, pp. 165-172

Dill, J. & Voros, K. (2007). Factors affecting bicycling demand: Initial survey findings from the Portland, Oregon, region, *Transportation Research Record*, 2031, pp. 9-17

Hunt, J. D. & Abraham, J. E. (2007). Influences on bicycle use, *Transportation*, 34(4), pp. 453-470

Stinson, M. A. & Bhat, C. R. (2003). Commuter bicyclist route choice: Analysis using a stated preference survey, *Transportation Research Record*, 1828, pp. 107-115

Dill, J. & Carr, T. (2003). Bicycle commuting and facilities in major U.S. Cities: If you build them, commuters will use them, *Transportation Research Record*, 1828, pp. 116-123

Antonakos, C. L. (1994). Environmental and travel preferences of cyclists, *Transportation Research Record*, 1438, pp. 25-33

Wardman, M., Tight, M. & Page, M. (2007). Factors influencing the propensity to cycle to work, *Transportation Research Part A: Policy and Practice*, 41(4), pp. 339-350

Pucher, J. & Buehler, R. (2008a). Cycling for everyone: Lessons from Europe, *Transportation Research Record*, 2074, pp. 58-65

Stinson, M. A. & Bhat, C. R. (2004). Frequency of bicycle commuting: Internet-based survey analysis, *Transportation Research Record*, 1878, pp. 122-130

Pucher, J. & Buehler, R. (2008b). Making cycling irresistible: Lessons from the Netherlands, Denmark and Germany, *Transport Reviews*, 28(4), pp. 495-528

Ajzen, I. (1991). The theory of planned behaviour, *Journal of Organizational Behaviour and Human Decision Processes*, 50, pp. 179-211

Zaperi N. H. & Ahmad Termida, N. (2022). Students' perceptions on bicycle facilities in campus. A case study at Universiti Tun Hussein Onn Malaysia, Johor, *IOP Conference Series.: Earth and Environment Sciences*, 1022, pp. 012027

Gliem, J. A. & Gliem, R. R. (2003). Calculating, interpreting and reporting Cronbach's Alpha Reliability coefficient for Likert-type scales, 2003 Midwest research to practice conference in adult, continuing, and community education, The Ohio States University, Columbus, October 8-10, 2003. pp. 82-88

Frater, J. & Kingham, S. (2020). Adolescents and bicycling to school: Does behaviour setting/place make a difference? *Journal of Transport geography*, 85, pp. 102724

Acheampong, R. A. (2017). Towards sustainable urban transportation in Ghana: Exploring adults' intention to adopt cycling to work using Theory of Planned Behaviour and Structural Equation Modelling, *Transportation in Developing Economies, 3* (18), retrieved August 16, 2022, from https://doi.org/10.1007/s40890-017-0047-8

Milković M. & Štambuk, M (2015). To bike or not to bike? Application of the Theory of Planned Behavior in predicting bicycle commuting among students in Zagreb, *Psihologijske Teme*, 24, 2015(2), pp. 187-205