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Factors that Affect Cycling Transportation Mode for Postgraduate Students at Universiti Kebangsaan Malaysia by Logit Method

(Faktor-faktor yang Memberi Kesan Mod Pengangkutan Berbasikal untuk Pelajar Pasca Siswazah di Universiti Kebangsaan Malaysia dengan Kaedah Logit)

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ABSTRACT

The main aim of this study is to investigate the factors that affect cycling transportation mode and give suggestions to encourage students to use these facilities to decrease the use of motorized transportation. Firstly we chose the Universiti Kebangsaan Malaysia (UKM) campus as an example for our study which focused on shifting from motorized transport to non-motorized especially to cycling transport. Our study involved conducting a survey on postgraduate students at 1st semester (2013-2014). A total of 169 questionnaires were distributed personally inside the campus and interviews were done with the students. Our survey showed that the majority of postgraduate students were tending to use car with percentage of 45.5% and 38.4% prefer using the bus followed by 12.4% using motorcycle and the least percentage using bicycles with percentage of 3.5%. The most effective factor in shifting postgraduate students who use cars and motorcycles to use bicycles is imposing fees on parking inside UKM and limiting the space for parking. The decrease in the number of buses inside campus and imposing fees on buses have high effectiveness in switching students who use the bus to cycling transportation.

Keywords: Shifting; cycling; postgraduate students; logit method; UKM

ABSTRAK

Tujuan utama kajian ini adalah untuk meninjau faktor-faktor yang memberi kesan kepada mod pengangkutan berbasikal dan memberikan cadangan-cadangan untuk menggalakkan pelajar menggunakan kemudahan-kemudahan tersebut bagi mengurangkan penggunaan pengangkutan bermotor. Pertama sekali kami memilih kampus Universiti Kebangsaan Malaysia (UKM) sebagai contoh dalam kajian kami, yang memberi tumpuan kepada peralihan daripada pengangkutan bermotor kepada yang bukan bermotor, terutama sekali kepada pengangkutan berbasikal. Kajian kami telah melibatkan tinjauan ke atas pelajar pasca siswazah di semester 1 (2013-2014). Sebanyak 169 soal selidik telah diedarkan secara sendiri di dalam kampus dan temu bual telah dilakukan dengan para pelajar. Kaji selidik kami menunjukkan bahawa majoriti pelajar pasca siswazah telah cenderung untuk menggunakan kereta dengan peratusan 45.5% dan 38.4% cenderung menggunakan bas diikuti oleh 12.4% menggunakan motosikal, manakala peratusan yang paling kurang ialah yang menggunakan basikal dengan peratusan 3.5%. Faktor yang paling berkesan bagi menganjak pelajar pasca siswazah yang menggunakan kereta dan motosikal untuk menggunakan basikal ialah mengenakan bayaran di tempat letak kereta di dalam UKM dan menghadkan ruang tempat letak kereta. Pengurangan jumlah bas di dalam kampus dan mengenakan yuran ke atas bas mempunyai keberkesanan yang tinggi bagi mengalihkan pelajar yang menggunakan bas kepada pengangkutan berbasikal.

Kata kunci: Peralihan; berbasikal; pelajar pasca siswazah; kaedah logit; UKM

INTRODUCTION

Cars are the second most common mode of transportation in Malaysia. The rapid increase in the use of personal transportation has its roots in the weak public transport system in Malaysia (Yazida et al. 2011). Non-motorized transportation (NMT) includes all forms of travel that do not rely on an engine or motor for movement, including walking, cycling, and using small-wheeled transport (e.g., skates, skateboards, push scooters, and hand carts) and the wheelchair (Xinhua News Agency 2007). Cycling not only decreases the problems that cause global warming, such as pollution and increasing energy usage, but also improves the health and well-being of individuals (Austroads 2005).

In addition to sports and other physical activities, regularly cycling to work (and to school and other regular destinations) is one of the most effective ways to improve health. Several scientific studies that assess the effects of bicycling on levels of physical activity, obesity rates, cardiovascular health, and morbidity have shown that bicycling is healthy (Anderson et al. 2000; Bassett et al. 2008). Modern people have high levels of mobility, travel often over long distances, and go on complex trips (i.e., they undertake several activities in one trip) (Jensen 1999;

Knowles 2006). These changes exert various negative effects on society and the environment, such as congestion, air pollution, noise, vibrations, health problems (e.g., due to a lack of physical activity or the inhalation of polluting agents), accidents, growing infrastructure costs, and accessibility problems for low-income groups.

Cycling is also a space- and energy-efficient mode of transport that is affordable for many households (Pucher et al. 1999; Piet 2001; Gatersleben and Appleton 2007; Woodcock et al. 2007). Thus, a substantial shift from using cars to using bicycles can reduce urban congestion and the environmental harm caused by air and noise pollution.

The aim of this study is to determine the factors effecting on transport inside UKM and its effect on the transportation in UKM.

LITERATURE REVIEW

In 2009, the Irish government introduced a tax relief scheme whereby employees can purchase a bicycle through their employer. This scheme was introduced to encourage workers to regularly cycle to work and to promote sustainable transport. A study was conducted to show how individuals who had never owned a bicycle in the past five years changed their perceptions of cycling and improved accessibility to bicycles and cycling after using this scheme. The results demonstrate how successful the scheme has been in improving perceptions of cycling, especially among individuals who have not owned a bicycle in several years. In Ireland, as in other countries, young males are traditionally likely to commute by bicycle. Improving the attractiveness and accessibility of cycling to females and older-age groups is a key policy area for developing cycling in Ireland. That study demonstrated that the scheme has successfully encouraged many females and older-age groups to cycle regularly. Similar cycle-to-work schemes have been implemented in other countries, and the study quantified several benefits from the Irish experience. In Ireland, young males are traditionally likely to commute by bicycle. Improving the attractiveness of cycling to females and older-age groups is a key policy area for developing cycling. That study demonstrated that the scheme has successfully encouraged many females and older-age groups to cycle regularly. Similar cycle-to-work schemes have been implemented in other countries, and the study quantified several benefits.

In terms of accessibility, the scheme has successfully encouraged individuals to cycle regularly for work and non-work trips (Caulfield and Leahy 2011). Walsh et al. (2008) proposed that such a view fails to consider such factors as the increase in carbon dioxide exhaled as a result of increased physical activity or the emission of the manufacture of bicycles. The study estimated emission factors for various forms of commuter transport in Ireland that allow comparison against emissions from cycling. When indirect energy is considered, the results indicate that a cyclist that commutes an equivalent distance to work releases a nearly equal amount of carbon dioxide to that attributed to a passenger of an electrically propelled train at full occupancy during peak service times. Traveling by bicycle is less carbon-intensive than traveling at off-peak times. Transport by car and sports utility vehicle is the most carbon-intensive of the commuter modes of transport studied; however, traveling in a fully occupied car has an emission factor close to that of off-peak bus transport.

METHODOLOGY

Figure 1 shows the methodological analysis and the processes followed to achieve the goals of this research and show the concept used for data collection and interpretation. A survey was conducted to examine the impacts of the Cycle Scheme. The Microsoft excel 2010 model as well as logit choice model was used to analyze the data. The framework for developing the models on car user's mode choice behavior and potential mode shift from motorize transport to cycling transport is as illustrated below.

DATA COLLECTION

Stated Preference (SP) Stated preference (SP) methods are widely used in travel behavior research and Practice to identify behavioral responses to choice situations. An attitudinal survey asks the respondents for their response to various situations (e.g. would they switch to cycle if the service improved) and /or to rate their liking for various changes. Hypothetical choice surveys require the respondents to choose between hypothetical alternatives with varying attributes, for data with which to develop behavioral models.

Revealed Preference (RP) RP data were collected on socioeconomic, mode attributes and trip characteristics .The socioeconomics data included the respondents' income, age, gender, vehicle ownership, and household income, total members in the household and their occupations and education levels. Trip information (both mode attributes and trip characteristics') included the purpose, mode of travel and total trip.

Sample Size The credibility of data collected depends on the sample size. Sample size helps to correlate the fluctuation that exist different sample. The sample reflects the characteristics of the population from which postgraduate student in Universiti Kebangsaan Malaysia preferential choice to the available transportation medium is drawn. The probability methods used for data collection include random sampling, systematic sampling, and stratified sampling. The difference between the sample and the real population is called the sampling error. If the sampling error is ±3%, the confidence level involves the risk we are willing to accept that our sample is within the average or "bell curve" of the population. A confidence level of 90% means that, were the population

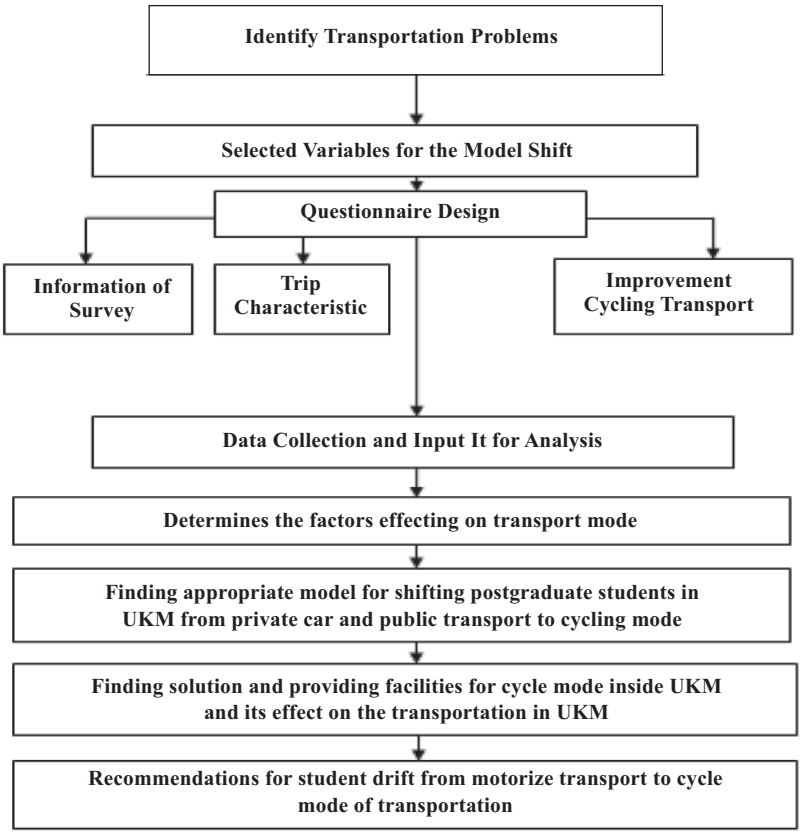

FIGURE 1. Design illustration of strategies used for data collection and analysis

sampled 100 times in the same manner, 90 of these samples would have the true population value within the range of precisions specified earlier, and 10 would be unrepresentative samples. Higher confidence levels require larger sample sizes. Variability is the degree to which the attributes or concepts being measured in the questions are distributed throughout the population (Watson 2001).

Table 1 shows the numbers of sample size with ±3 margin of error and as it is illustrated above that the numbers are so high and it will be difficult to collect, therefore 5% error will be good enough for our survey. We take our sample size according to Table 1 with ±5% margin of error. From the table at population of 9.000 the sample size needed is 169 at variability of 30%, at population of 10.000 the sample size is 169 at variability of 30%. The total number of the postgraduate students is 9155, therefore we take the sample size equal to 169.

LOGIT MODEL

The logic model was used as a final model to investigate mode choice behavior of travelers to highlight the trend of the travelers when considering their mode of transport (Abdullah 2007). The proposed model used to predict the relationship between dependent variables is evaluated based on the following equation.

$$y = \frac{1}{1+e^{-f(x)}} \tag{1}$$

where $f(x)$ is an analytic function in x. With this choice, the single–layer network is identical to the logistic regression model. This function has a continuous derivative, which allows it to be used in back propagation. The following functional form is used in this paper to determine the variables where e is Euler's number. For values of x, it is in the range of real numbers from $-\infty$ to $+\infty$.

$$p = \frac{1}{1+De^{\alpha(\text{variable})}} \tag{2}$$

LOGIT FUNCTION

An explanation of logistic regression begins with an explanation of the logistic function:

$$F = (z)\frac{1}{1+e^{-z}} \tag{3}$$

The above equation investigates the calibration process based on the values of D and α values which were extracted from ANOVA table using Microsoft Excel. These results applied to the final equation (1) and then the results were

TABLE 1. Finding a base sample size with ±5 margin of error

	Sample Size Variability				
Population	50%	40%	30%	20%	10%[d]
100[e]	81	79	63	50	37
125	96	93	72	56	40
150	110	107	80	60	42
175	122	119	87	64	44
200	134	130	93	67	45
225	144	140	98	70	46
250	154	149	102	72	47
275	163	158	106	74	48
300	172	165	109	76	49
325	180	173	113	77	50
350	187	180	115	79	50
375	194	186	118	80	51
400	201	192	120	81	51
425	207	197	122	82	51
450	212	203	124	83	52
500	222	212	128	84	52
600	240	228	134	87	53
700	255	242	138	88	54
800	267	252	142	90	54
900	277	262	144	91	55
1,000	286	269	147	92	55
2,000	333	311	158	96	57
3,000	353	328	163	98	57
4,000	364	338	165	99	58
5,000	370	343	166	99	58
6,000	375	347	167	100	58
7,000	378	350	168	100	58
8,000	381	353	168	100	58
9,000	383	354	169	100	58
10,000	385	356	169	100	58
15,000	390	360	170	101	58
20,000	392	362	171	101	58
25,000	394	363	171	101	58
50,000	397	366	172	101	58
100,000	398	367	172	101	58

Source: (Watson 2001). How To Determine a Sample Size

used for model validation according to the following equation (Axler, 2006) and you should write reference.

RESULTS AND DISCUSSION

FACTORS INFLUENCE ON SHIFTING TO CYCLING FOR CAR AND MOTORCYCLE USERS

If UKM Increased Parking Fees Figure 2 shows that about 10.2% of postgraduate students would turn to bicycle when UKM impose RM 2 per hour on parking. This percentage continuous in increase when fees increase ,until it reach to 95.91% when the fees reach to RM 20 per hour.

$$P = \frac{1}{1+8.3325e^{-0.27419(\text{parking fees per hour})}} \quad (4)$$

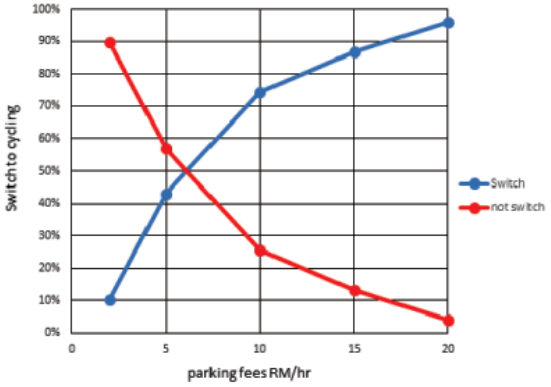

FIGURE 2. Increasing parking fees

Results for the process of calibration comparing with the survey results are indicated in Table 2a. It is as given in the table that the model resulted from ANOVA and regression statistics is highly correlated with survey results obtained from questionnaire and analyzed. The high correlation between survey results and logit model is clarified in Figure 3 where both of the survey results and the modeled one for were increased with the increasing of parking fees per hour.

TABLE 2a. Survey result and data calibration

Parking fees	Survey results	(1-p)/p	Ln(1-p)/p
RM2	0.102	8.803	2.175
RM5	0.4285	1.333	0.287
RM10	0.7448	0.342	-1.072
RM15	0.8673	0.153	-1.877
RM20	0.9591	0.042	-3.170

From this results shown and after regression analyses in excel we got the ANOVA, ln D = 2.120171, D = 8.3325, α = -0.27419

TABLE 2b. Survey results and logit model results

Parking fees per hour	Survey results (P)	Logit model
RM2	0.102	0.1719
RM5	0.4285	0.3209
RM10	0.7448	0.6506
RM15	0.8673	0.8800
RM20	0.9591	0.9665

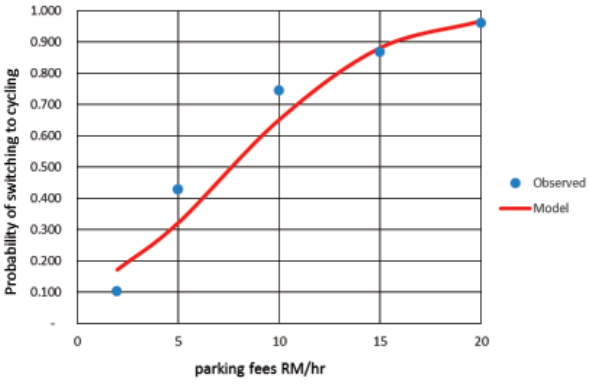

FIGURE 3. Parking fees per hour that will support cycling

If UKM Limited the Space of Parking If we limit the spaces for parking, students will prefer to shift to cycling by 3.06% at decreases rate of 10% and this percentage increased when the reduction increased. In reduction of 50% around 61.22% of postgraduate students would like to switch to cycle and when the reduction reaches to 90%, 92.85% of students will leave their cars or motorcycles and change to use bicycle as shown in the figure.

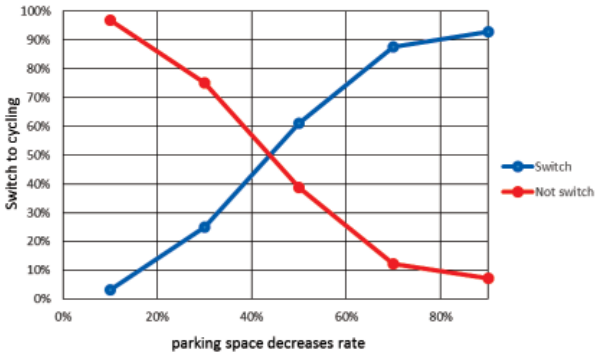

FIGURE 4. Limited the space of parking

$$P = \frac{1}{1 + 40.10295e^{-7.5565(\text{parking space decrease rate})}} \quad (5)$$

Results for the process of calibration are indicated in Table 3a along with results obtained from survey. It is as given in Table 3a that the model resulted from ANOVA and regression statistics is highly correlated with survey results obtained from questionnaire and analyzed. The high correlation between survey results and Logit model for reduction parking spaces for the private cars is clarified in Figure 5 where both of the survey results and the modeled one showed high agreement from students to be shifted to

TABLE 3a. Survey result and data calibration

Parking space decreases rate	Survey results(P)	(1-p)/p	Ln(1-p)/p
10%	0.0306	31.679	3.455
30%	0.2489	3.017	1.104
50%	0.6122	0.633	-0.457
70%	0.8775	0.139	-1.973
90%	0.9285	0.077	-2.563

From this results shown and after regression analyses in excel we got the ANOVA, ln D = 3.69145, D= 40.10295, α = -7.5565.

TABLE 3b. Survey results and logit model results

Parking space decreases rate	Survey results(P)	Logit model
10%	0.0306	0.05044
30%	0.2489	0.1939
50%	0.6122	0.5216
70%	0.8775	0.8317
90%	0.9285	0.9572

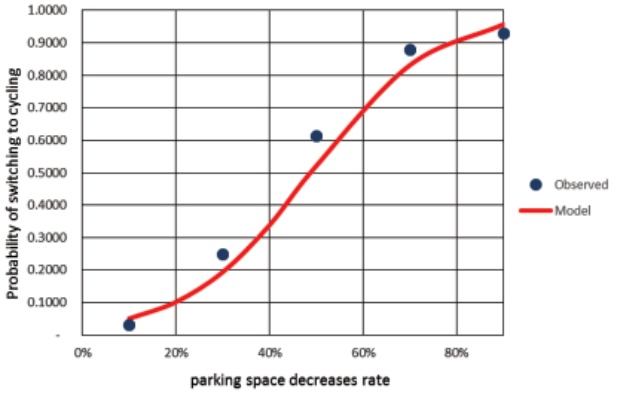

FIGURE 5. Parking space reduction that will support cycling

cycle mode of transportation when the limited parking spaces are increased.

FACTORS INFLUENCE ON SHIFTING TO CYCLING FOR BUS USERS

If UKM Imposed Fees on Bus As the survey results about 38.4% from the postgraduate students choose bus inside UKM, therefore we suggest to the university to imposed fees on bus to support shifting to cycle. At RM 2 about 4.61% of postgraduate students will switch while the other students thought that this fee is affordable. This percentage increased when the fees increased. At fee of RM 20 most of postgraduate students would like to change because they feel that this fees is so costly and cannot pay it.

$$p = \frac{1}{1 + 21.8401e^{-0.27893(\text{bus fees})}} \quad (6)$$

Results for the process of calibration which then imported to Excel to get the ANOVA are indicated in Table 4a. From ANOVA and Regression table our model got the value of *P* equals to (0.005) which somehow acceptable to

TABLE 4a. Survey result and data calibration

Bus Fees Per Trip	Survey results(P)	(1-p)/p	Ln(1-p)/p
RM2	0.0461	20.6919	3.0297
RM5	0.2920	2.4246	0.8856
RM10	0.3538	1.8264	0.6023
RM15	0.7538	0.3266	-1.1190
RM20	0.9230	0.0834	-2.4841

From this results shown and after regression analyses in excel we got the ANOVA. ln D = 3.083749, D=21.8401, α = -0.27893

TABLE 4b. Survey results and logit model results

Bus Fees Per Trip	Survey results(P)	Logit model
RM2	0.0461	0.07406
RM5	0.2920	0.15589
RM10	0.3538	0.4269
RM15	0.7538	0.7502
RM20	0.9230	0.9237

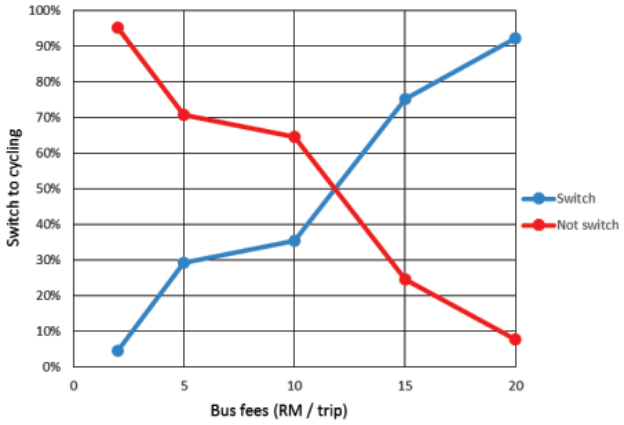

FIGURE 6. Imposing fees on bus

be significant (significant value < 0.05) while is *R* Square (0.97). The high correlation between survey results and Logit model is demonstrated in Figure 7 where both of the survey results and the modeled were increased with the increasing bus fees.

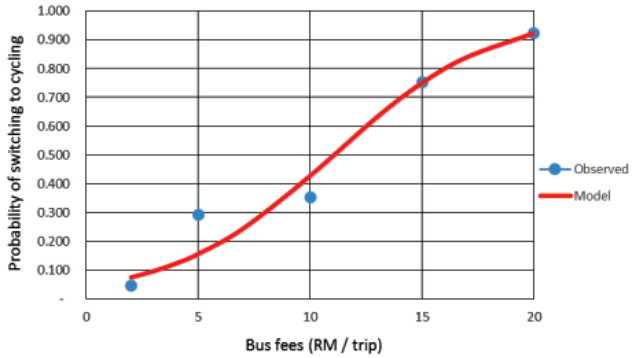

FIGURE 7. Bus fees that will support cycling

Decreased Frequency of Bus Figure 8 shows the results of our suggestion to decrease the number of buses travelling inside the campus it cleared around 15.38% will agree to shift to cycling if decreases number of buses to 10%, meanwhile 35.38% will agree to shift if the decreasing rate reaches to (30%).when the decreasing rate reaches to 50%, 70% and 90% around 58.46%, 89.23% and 95.38% will shift respectively.

$$p = \frac{1}{1+11.13951e^{-6.09215(\text{reduction rate})}} \qquad (7)$$

It is demonstrated from Table 5a that the model used in this study is got the value of *P* equals to 0.0004 which somehow acceptable to be significant (significant value <0.05). This fact is more identified in Figure 9 which illustrates high correlation between survey results and the modeled one that they showed increasing shifting when reductions of buses increase.

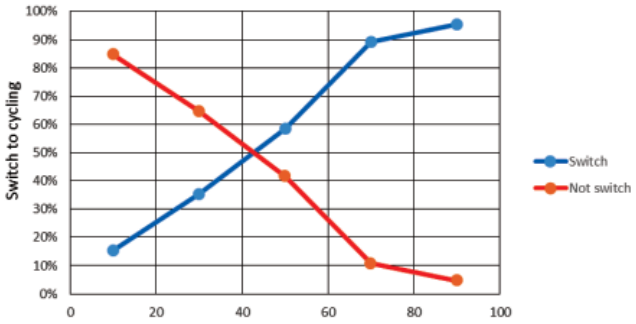

FIGURE 8. Decreasing frequency of bus

TABLE 5a. Survey result and data calibration

Reduction rate	Survey results(P)	(1-p)/p	Ln(1-p)/p
10%	0.1538	5.5019	1.70509
30%	0.3538	1.8264	0.60234
50%	0.5846	0.7105	-0.34178
70%	0.8923	0.1206	-2.11527
90%	0.9538	0.0484	-3.02825

From this results shown and after regression analyses in excel we got the ANOVA, ln D = 2.410499, D=11.13951, α = -6.09215

TABLE 5b. Survey results and logit model results

Reduction rate	Survey results(P)	Logit model
10%	0.1538	0.141694
30%	0.3538	0.358276
50%	0.5846	0.653752
70%	0.8923	0.86459
90%	0.9538	0.95574

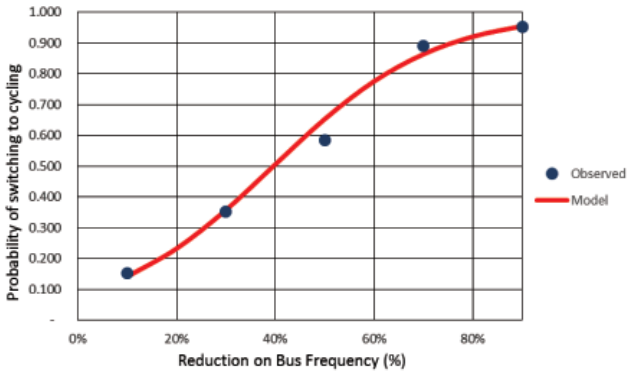

FIGURE 9. Reductions of buses inside UKM that support cycling transport

CONCLUSION

In this paper, we study the factors that encourage postgraduate students for using private cars and motorcycle also the factors that encourage students using bus. We use logit method for analyses the data that we obtained it from the questionnaire. The postgraduate students in UKM is a good sample and

effective sample to do good shifting from private car and bus to use bicycle. The most effectiveness factor which influence on students and make them prefer using bus is free charging factor with percentage 23.6%.The effective factor in shifting cars user and motorcycles is imposing fees on parking and limiting the space for parking. Decrease in number of buses and imposing fees on buses have high effectiveness in switching bus user. Our suggestions are limiting parking space and imposing parking fees because in our survey we cleared that most of postgraduate students affected on these factors and accept shifting from car and motorcycle mode to bicycle mode. For students who using bus inside campus the travel time and cost is most important factors on student's mode choice so if UKM decreases bus frequency (number of buses inside campus) this will make students prefer using bicycle mode also imposing fees on bus inside the campus will encourage bus users to use bicycle also Availability of stations in front of each hostel and nearby KTM stations and faculties to borrow or rent bicycles for going to other places on campus provided by employers and community organizations will encourage some postgraduate students to change their mode.

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