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FACTORS THAT AFFECT TRANSPORT MODE PREFERENCE FOR GRADUATE STUDENTS IN THE NATIONAL UNIVERSITY OF MALAYSIA BY LOGIT METHOD

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Abstract

A study was carried out to examine the perceptions and preferences of students on choosing the type of transportation for their travels in university campus. This study focused on providing personal transport users road transport alternatives as a countermeasure aimed at shifting car users to other modes of transportation. Overall 456 questionnaires were conducted to develop a choice of transportation mode preferences. Consequently, Logit model and SPSS were used to identify the factors that affect the determination of the choice of transportation mode. Results indicated that by reducing travel time by 70% the amount of private cars users will be reduced by 84%, while reduction the travel cost was found to be highly improving the public modes of utilization. This study revealed positive aspects is needed to shift travellers from private modes to public. The positive aspect contributes to travel time and travel cost reduction, hence improving the services, whereby contributing to sustainability.

Keywords: Park and ride, Car reduction, University, Logit model, Modal shift.

1. Introduction

Park and Ride (P&R) is a supply-side measure in which is internationally used as a mean of dealing with congestion and traffic-related pollution. P&R is used to persuade motorists to transfer to public transportation mode by offering price or time saving against the alternative of driving for the whole journey and parking in

the host centre's urban core [1]. In an attempt to reduce the parking space demand and the environmental impacts of private cars, universities around the world are implementing strategies to reduce dependence on private vehicles and increase the use of alternative modes of transport [2]. In general, the private cars are the most attractive mode of transport due to their convenience, speed; comfort and individual freedom are just part of the list that has been frequently promoted in car commercial. That public mode of transportation needs to adjust the service to the attributes required by consumers in order to become more attractive [3, 4].

The private car is one of the major modes of personal transport in Malaysia [5] mainly because it is affordable and more reliable than the other transport available [6]. Thus, about 40% of the registered vehicles in the country are private cars. Therefore, numbers of registered private cars have recently increased from 911,752 in 1990 to, 1,811,141 in 2004 [7]. Consequently, private car accidents have also increased from 79.642 to 380.589 [8]. The economic toll from private car use, such as accidents, traffic jams and environmental pollution has encouraged the Malaysian government to explore various measures to control it [9]. The use of public transport as bus and train was found to be the sustainable solution [10]. The ever-increasing societal cost of private transport has made it imperative to encourage more use of public transport. Moreover, many measures can be used to minimize the utilization of private cars such as banning cars in certain areas, rising the minimum driving age, increasing the cost of parking, improving public transport and create other convenience types of public transportation such as Park and Ride system [11].

The Park-and-Ride System is an intermodal staging location for transfers between numerous transport modes, Park-and-ride facilities have traditionally been viewed as only a component of the larger transit or highway auto-oriented modes [12]. From a system perspective, a park-and-ride network can be recognized as having unique modal characteristics neither shared by the traditional transit nor by the highway modes [13]. Characteristics including demand patterns, service area concepts, patron attributes, transit operating concepts, and modes of access provide opportunities over other modes of transit for private investment and private-public partnering [14]. A healthy park-and-ride system can be used to encourage urban development in lower density suburban environments However, It may cause sprawl to be continued, upon the location and design of the individual facilities within the system [15]. This monograph has been written largely from the perspective of the park-and-ride lot as a unique facility, to a modal system. However, keeping in mind the unique modal characteristics of the park-and-ride system will provide the transportation planner with valuable insights into the specific facility-related attributes explored herein [16].

2. Study Methodology and Model Structure

The study methodology in this paper is based on the primary and secondary data. A case study was performed in the national university of Malaysia and analytical Model choice behaviour and the shift from private to public transportation mode were analysed through data collection in which it is interpreted by Using SPSS and logit model choice. Data collection was done by the survey based on a questionnaire that collected different attributes including age, race, and Number of members of the household and level of education either master or PhD, study

cost, university bus service, thus giving a clear image of their socioeconomic and demographic profiles. Other information collected includes: level of knowledge (of public transport), travel time, travel cost, number of trips and the preferred mean of transportation A total of N = 456 questionnaires were distributed and collected throughout the process of data collection. The data was collected by personal interview with car users because they are the target of the study. Details of the road user's behaviour that were got from the data collection and the procedure of the data analysis to establish the model is illustrated in Fig. 1.

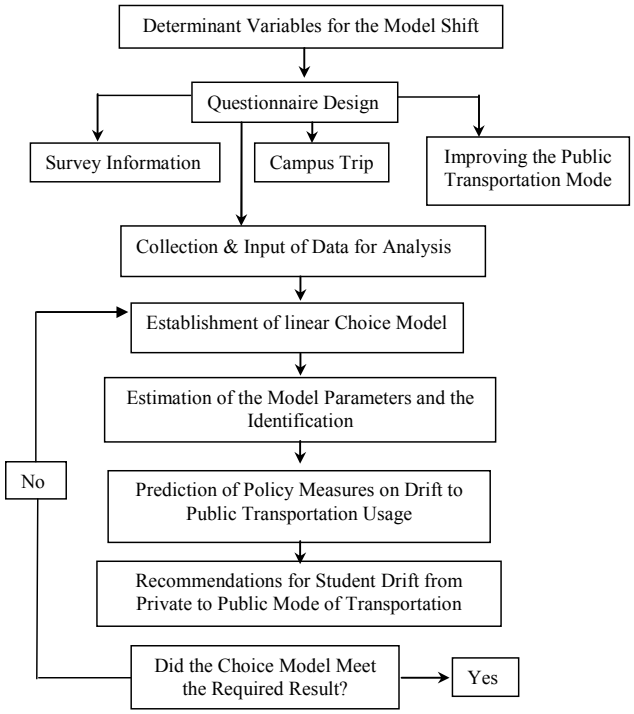

Fig. 1. Design Illustration of Strategies Used for Data Collection and Analysis.

SPSS analytical system used to determine which parts of the questionnaire were relevant and which were not to each other. The procedure used for the variables assesses the number of commonly used measures and also provides information on the relationships between the individual items in the scale such as gender, nationality, age, household size and mode of transportation and the walking ability the explanatory variables of data collection.

The logic model was used as a final model to investigate mode choice behaviour of travellers to highlight the trend of the travellers when considering their mode of transport [17]. The proposed model used to determine the dependent variables is evaluated based on the following equation.

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

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 [18].

The following functional form is used to determine the dependent variables

$$P = \frac{1}{1 + D\, e^{\alpha(\mathrm{var}iable)}} \tag{2}$$

$$P(t, a, m, n, \tau) = a \frac{1 + m\, e^{-t/\tau}}{1 + n\, e^{-t/\tau}} \tag{3}$$

The special case of the logistic function with $a = 1$, $m = 0$, $n = 1$, $\tau = 1$, namely

$$P(t) = \frac{1}{1 + e^{-t}} \tag{4}$$

for real parameters a, m, n, and τ. These functions find applications in a range of fields, including economics [19].

A logistic function or logistic curve is the most common sigmoid curve. It models the "S-shaped" curve (abbreviated S-curve) of growth of some set: P denotes a set. P will be used to denote a function which varies over time. Normally such a function is written $P(t)$. However, such a function may also be read as a set of ordered pairs of the form $< t, P(t) >$. The initial stage of growth is approximately exponential; then, as saturation begins, the growth slows, and at maturity, growth stops [6]

$$P(t) = \frac{1}{1 + e^{(-t)}} = \frac{1}{1 + exp^{(-t)}} = (1 + exp(-t))^{-1} \tag{5}$$

$$P` = p(1 - p) \tag{6}$$

The function P has the intuitively appealing quality that

$$1 - P(\mathrm{t}) = p(-t) \tag{7}$$

Pilot survey data obtained from question related to proportion of people board on minibus with respective to a series of proposed travel time reduction has been used to calibrate the Logit model with variable = time factor [20].

$$P = \frac{1}{1 + D\, e^{\alpha(\mathrm{var})}} \tag{8}$$

$P(t)$ is the probability of success when the value of the predictor variable is t.

$$P = \frac{1}{1 + D\, e^{\alpha(r)}} \tag{9}$$

Algebraic manipulation shows that

$$\frac{1 - P}{P} = D\, e^{(\alpha \cdot r)} \tag{10}$$

$$\ln\left[\frac{1 - P}{P}\right] = \ln D + \alpha^{(r)} \tag{11}$$

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 shown below and then the results were used for model validation according to the following equation [21]

$$P = \frac{1}{1 + D\, e^{\alpha(\mathrm{variable})}} \tag{12}$$

3. Results and Discussion

Results for travel time improvement for the mini bus analyzed by SPSS are indicated in Tables 1 and 2. Table 1 shows a time reduction of (30%) in current bus transportation servicing in university will attract (34%) of students to the bus while, a time reduction of (70%) will attract (84%) of students to use the public bus service (Park and Ride) as indicated in Fig. 2.

Table 1. Improving the Travel Time for the Minibus.

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
10%	70	15.350	15.350	15.350
30%	85	18.640	18.640	33.991
50%	151	33.114	33.114	67.105
70%	79	17.324	17.324	84.429
90%	71	15.570	15.570	100.0
Total	456	100.0	100.0	

Table 2. Illustration of Cumulative Percent %.

Travelling Time Reduction	Survey Results (P)	$(1-P)/P$	$\ln(1-P)/P$
10%	0.153	5.514	1.707
30%	0.186	4.364	1.473
50%	0.331	2.019	0.703
70%	0.173	4.772	1.562
90%	0.155	5.422	1.690

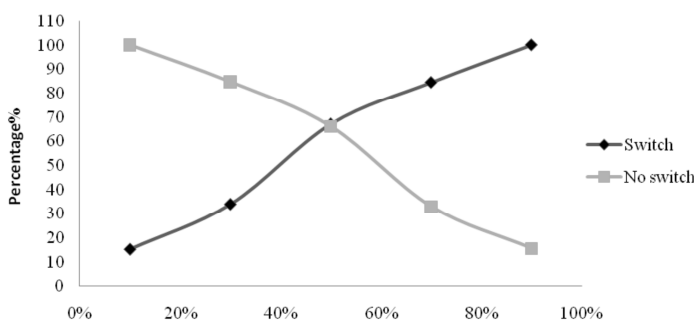

Fig. 2. Relationship between Percentage and Travel Time Reduction.

Results for the process of calibration which then imported to Excel to get the ANOVA are indicated in Table 3. From ANOVA and Regression table our model got the value of *P* equals to (5.66E-05) which somehow acceptable to be significant (significant value < 0.05) while is R Square (0.99652) [22, 23]. The high correlation between survey results and Logit model is demonstrated in Fig. 3 where both of the survey results and the modelled ones were increased with the reduction of travel time.

Table 3. Illustration of Survey Results and Logit Model Results.

Travelling Time Reduction	Survey Results (*P*)	Results from Logit model
10%	0.153	0.156
30%	0.339	0.338
50%	0.671	0.670
70%	0.844	0.842
90%	1	0.999

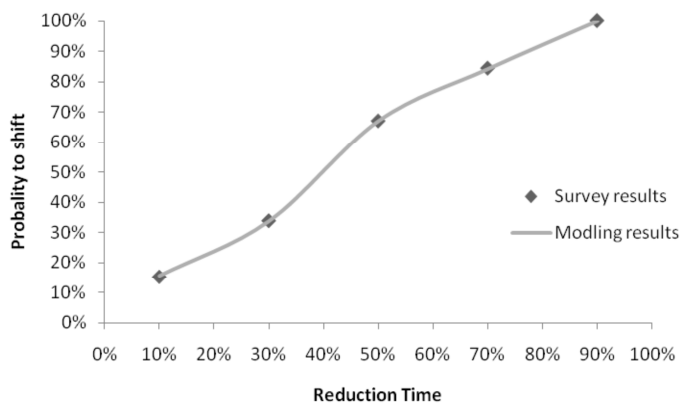

Fig. 3. Relationship between Probability to Shift and Reduction Time.

Results for improving the waiting facility at the bus stop are indicated in Table 4 and Fig. 4. It is as shown from Table 4 that (29%) of the people prefer using minibus if there is (60%) reduction on the regularity of schedules while, reduction of (36%) on the regularity of schedules will be sufficient to encourage (68%) of the common to use minibus.

Table 4. Improving the Waiting Facility at the Bus Stop.

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
5 minute	240	52.631	52.631	52.631
10 minute	81	17.763	17.763	70.394
15 minute	59	12.938	12.938	83.333
20 minute	29	6.359	6.359	89.692
25 minute	47	10.307	10.307	100
Total	456	100	100	

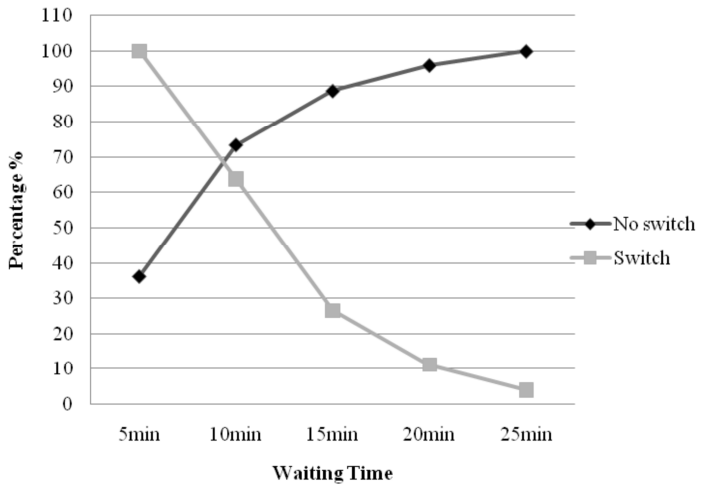

Fig. 4. Switching to Public Transport Based on Comfortable Waiting Time.

Results for the process of calibration imported to excel to get the ANOVA table are shown in Table 5 comparatively with results obtained from survey (shown in Table 6). It is demonstrated from Table 5 that the model used in this study is got the value of *P* equals to (0.009099) which somehow acceptable to be significant (significant value <0.05) [22, 24]. This fact is more identified in Fig. 5 which illustrates high correlation between survey results and the modelled one that they showed dramatic reduction with the increase of waiting time in bus station.

Table 5. Illustration of Survey Results and Data Calibration.

Waiting time	Survey Results (*P*)	(1-*P*)/*P*	ln(1-*P*)/*P*
5 minute	1	0	0
10 minute	0.638	0.567	-0.567
15 minute	0.265	2.768	1.018
20 minute	0.111	7.941	2.072
25 minute	0.039	24.333	3.191

Table 6. Illustration of Survey Results and Logit Model Results.

Waiting Time	Survey Results (*P*)	Results from Logit model
5 minute	1	0.997
10 minute	0.638	0.916
15 minute	0.265	0.241
20 minute	0.111	0.068
25 minute	0.039	0.035

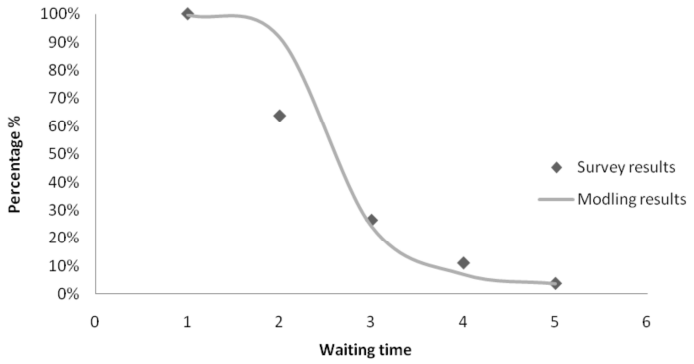

Fig. 5. Relationship between Percentages with Waiting Time.

Results for reduction in travel cost analyzed by SPSS are given in Table 7. It is shown from Table 7 that about 39% of the students prefer using public bus if there is 30% reduction in travel cost. However, reduction of 70% on the travel cost will encourage around 88% from students to start using the public bus. Relationship between percentages and reduction in travel cost is shown in Fig. 6.

Table 7. Illustration of Survey Results and Data Calibration.

Reduction Travel Cost	Survey Results (*P*)	(1-*P*)/*P*	ln(1-*P*)/*P*
10%	0.210	3.75	1.321
30%	0.184	4.428	1.488
50%	0.335	1.980	0.683
70%	0.157	5.333	1.673
90%	0.111	7.941	2.072

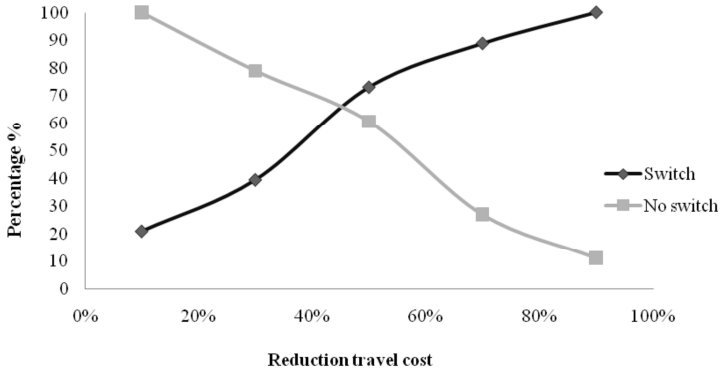

Fig. 6. Relationship between Percentage and Reduction of Travel Cost.

Results for the process of calibration comparing with the survey results are indicated in Table 8. It is as given in Table 8 that the model resulted from

ANOVA and regression statistics is highly correlated with survey results obtained from questionnaire and analyzed by SPSS. The high correlation between survey results and logit model is clarified in Fig. 7 where both of the survey results and the modelled one for were increased with the reduction of travel cost.

Table 8. Illustration of Survey Results and Logit Model Results.

Travel Cost Reduction	Survey Results (*P*)	Results from Logit model
10%	0.210	0.200
30%	0.394	0.376
50%	0.730	0.723
70%	0.888	0.877
90%	1	0.999

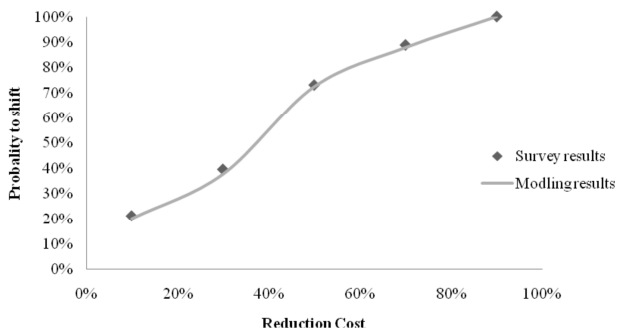

Fig. 7. Relationship between Probability to Shift and Reduction Travel Cost.

Results for charging fees on the parking spaces obtained from survey and analyzed by SPSS are illustrated in Table 9. Students were asked if an increase in parking cost would shift them to public transport, for example a parking charge of 1RM will result in switching around 52% from students to the public mode of transportation whereas around 83% from the students will start using the university bus if the parking charge being 3RM. Relationship between percentages and charging fees on parking lot is given in Fig. 8.

Table 9. Illustration of Survey Results and Data Calibration.

Charging Fees	Survey Results (*P*)	(1-*P*)/*P*	ln(1-*P*)/*P*
RM1	0.526	1	0
RM2	0.177	4.629	1.532
RM3	0.129	6.728	1.906
RM4	0.063	14.724	2.689
RM5	0.103	8.702	2.163

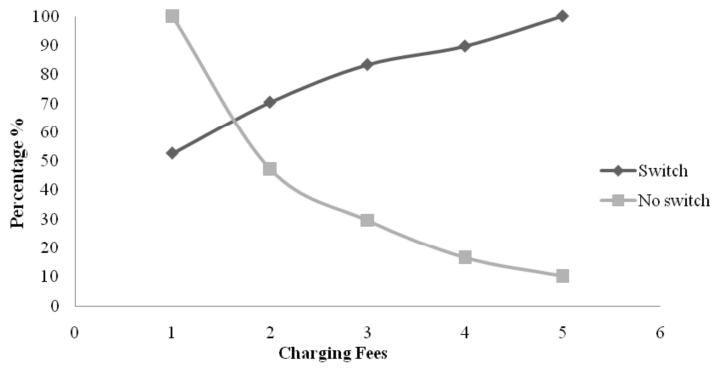

Fig. 8. Relationship between Percentage and Charging Fees on Parking Lot.

Results for the process of calibration are indicated in Table 10 along with results obtained from survey. It is as given in Table 10 that the model resulted from ANOVA and regression statistics is highly correlated with survey results obtained from questionnaire and analyzed by SPSS. The high correlation between survey results and Logit model for imposing fees on parking spaces for the private cars is clarified in Fig. 9 where both of the survey results and the modelled one showed high agreement from students to be shifted to public mode of transportation when the fees on parking spaces are increased.

Table 10. Illustration of Survey Results and Logit Model Results.

Charging Fees	Survey Results (*P*)	Results from Logit model
RM1	0.210	0.545
RM2	0.703	0.691
RM3	0.833	0.807
RM4	0.896	0.891
RM5	1	0.992

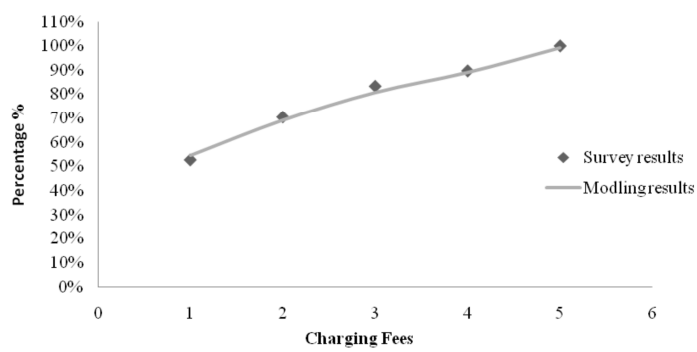

Fig. 9. Relationship between Percentage and Charging Fees.

The sensitivity of the modelling has been tested by taking the public transport services into a calibration in Table 11. It is indicated that a further 70 % of travel time reduction for travel public transport attract 30 % of students to use the public bus service; this indicates the possibility of an increase in the use of buses service with 0.4 sensitivity ratio. Reduction of 70 % on the fare will encourage 30% of students to be shifted to public transportation and the sensitivity ratio is 0.4. Subsidizing of 69 % on the bus fare will encourage 50% of private car users to be shifted to public bus and the sensitivity ratio is 0.72.

Table11. Results for Sensitivity Ratio for Independent and Dependent Variables.

Changes in Independent Variable	Changes in Dependent Variable	Sensitivity Ratio
70% Travel Time Reduction	30% Model Shift	0.4
70% Travel Cost reduction	30% Model Shift	0.4
69% Subsidized the Bus Fare	50% Model Shift	0.72

3. Conclusion and Future Works

Conclusion based on the aforementioned investigation is addressed accordingly:

- It was concluded that the factors that play significant role in shifting private cars owners to public mode are reduction in travel time, reduction in travel cost, charging fees on parking spaces, reduce the waiting time in bus station and improve the bus stop services. By improving those factors high proportions of postgraduate students of UKM University will shift to public mode of transportation whereby contribute to environmental protection and ecological balance.
- Results for Logit model were considerably approximated to survey results in which indicated high correlation between survey results and modelled one, hence indicated high level of results confidential.
- Recommendations for future work can be drawn by suggesting universal design of transportation provide the common with their need and disabilities, providing the pedestrians with comfortable services separate them from motorized mean of transportation for instance, cross bridges, zebra lines and sign boards. A protection system is needed to sway darkness and drain and protect the pedestrians from wild animals in order to encourage the public mode of transportation.

References

1. Mohamad, J.; and Kiggundu, A.T. (2007). The rise of private car in Kuala Lumpur, Malaysia: Assessing the policy options. *IATSS Research*, 31(1), 69-77.
2. PPS. (2009). Universiti Kebangsaan Malaysia, 43600 Bandar Baru Bangi, Selangor, Malaysia. *Research* 25(6), 433-438.

3. Mohammed, A.A.; Alelweet, O.A.; Karim, M.R.; and Shams, O.A. (2012). An optimization solution by service science management and engineering (SSME) for using minibuses service as an alternative for private cars around Hentian Kajang in Malaysia. *Journal of Civil Engineering and Construction Technology*, 3(1), 25-41.
4. García, R.; and Marín, A. (2002). Parking capacity and pricing in park'n ride trips: A continuous equilibrium network design problem. *Annals of Operation Research*, 116(1-4), 153-187.
5. Rahmat, R.A. (2004). Urban transport management system: A case study in National University of Malaysia. A project at *UKM*, Malaysia.
6. Hull, A. (2008). Policy integration: What will it take to achieve more sustainable transport solutions in cities? *Transport Policy*, 15(2), 94-103.
7. Nurdeen, A.; Rahmat, R.A.; and Ismail, A. (2007). Modelling of transportation behaviour for coercive measures for car driving in Kuala Lumpur. *ARPN Journal of engineering and Applied Sciences*, 2(2), 18-24.
8. Donnelley, RR (2009). Buses for Scotland Park and ride for buses. A national framework. *The Scottish Government*, Scotland.
9. Szimba, E. (2002). Passenger transport market: Segmentation, trends and policy conclusions - Results from Think-up. Think-UP Seminar "*Potentials for modal shift*: *A segmented Approach for the European transport market."*
10. Nor, N.G.M.; Nor, A.R.M.; and Abdullah, A.Z. (2006). Predicting the impact of demand- and supply- side measures on bus ridership in Putrajaya, Malaysia. *Journal of public transport*, 9(5), 57-70.
11. Ortuzar, W.; Juan de Dios, Ortuzar; and Luis, G. Willumsen (2006). *Modelling transport*. Third edition, John Wiley and Sons, Canada.
12. Garvill, J.; Marell A.; and Nordlund A. (2003). Effects of increased awareness on choice of travel mode. *Transportation*, 30(1), 63-79.
13. Balsas, C.J.L. (2003). Sustainable transportation planning on college campuses. *Transport Policy*, 10(1), 35-49.
14. Bando, M.; Hasebe, K.; Nakanishi, K.; and Nakayama, A. (1998). Analysis of optimal velocity model with explicit delay. *Physical Review E*, 58(5); 5429-5435.
15. Parkhurst, G. (2000). Influence of bus-based park and ride facilities on users' car traffic. *Transport Policy*, 7, 159-172.
16. Spillar, R.J. (1997). *Park-and-ride planning and design guidelines*. New York: Parsons Brinckerhoff Inc.
17. Abdullah, N.; Rahmat, R.A.; and Amiruddin, I. (2007). Effect of transportation policies on modal shift from private car to public transport in Malaysia. *Journal of applied Sciences*, 7(7), 1013-1018.
18. Patterson, Z.; Ewing, G.; and Haider, M. (2005). Gender-based analysis of work trip mode choice of commuters in Suburban Montreal, Canada, with stated preference data. *Transportation Research Record*, 1924, 85-93.
19. Ahern, A.A.; and Tapley, N. (2008). The use of stated preference techniques to model modal choices on interurban trips in Ireland. *Transportation Research Part A: Policy and Practice*, 42(1), 15-27.

20. Taylor, D.; and Mahmassani, H. (1996). Analysis of stated-preferences for intermodal bicycle-transit facilities. *Transportation Research No. 1556*.
21. Axler, R.; Chang, W.; Gan, J.; and Kembhavi, S. (2006). Out of cars and onto bikes: Encouraging a modal shift from cars to bicycles at the University of Toronto. *Applied Research Seminar*, 2005-2006.
22. Beale, J.; and Bonsall, P. (2007). Marketing in the bus industry: A psychological interpretation of some attitudinal and behavioural outcomes. *Transportation Research Part F: Traffic Psychology and Behaviour*, 10(4), 271-287.
23. Mohammed, A.A. (2010). *An optimization solution for using minibuses service as an alternative of using private Cars around Hentian Kajang in Malaysia*. M.Sc. thesis, University Kebangsaan Malaysia.
24. Mohammed, A.A.; and Rahmat, R.A. (2012). An optimization solution for utilization minibuses service as an alternative of utilizes private cars: A case study around Hentian Kajang in Malaysia. *International Organization of Scientific Research Journal of Engineering*, 2(5), 1032-1039.