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Determining Travel Behaviour in Petaling Jaya, Malaysia

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ABSTRACT

Petaling Jaya is a Malaysian city in the Petaling district of Selangor, over the past few years it has witnessed a dramatic growth in terms of population size and geographical importance. This has led to constant congestions throughout the city. A significant reduction in the annual cost of road accidents, congestion, energy consumption and pollution in the city can be obtained by implementing a modal shift from private vehicles to public transport. Urban transportation problems are highlighted in this study as well the factors that influence the use of private and public transportation. A survey was carried out on users of private and public (both bus and urban train transport) (n = 400). Two Binary logistic models were developed for the three alternative modes, Car, Bus and Train.

KEY WORDS: public transport, private car, congestion, Petaling Jaya, Binary Logit model

1. INTRODUCTION

Rapid increase in the use of the private vehicles in Malaysia has resulted in increased traffic congestion, accidents, limitations on parking space and air pollution, among other problems. The economic toll from private car use has prompted the Malaysian government to explore various measures to control it: a modal shift from private cars to public transportation is the obvious solution. This might prove to be difficult, as owning your own private car in Malaysia is very popular due to the relatively cheap vehicles market and the appeal it represents to the driver. There are, numerous known methods to control car use: banning cars in certain areas, imposing driving taxes, increasing parking cost and improving public transport. This study seeks to determine the methods and their likely effectiveness in reducing private car use.

Whether a modal shift is successful or not depends on many factors, such as the supply and quality of public transport, the availability of the parking lots and parking conditions (Turnbull, 1995). Other important factors are time and cost. This supported by previous finding by Bos *et al.* (2004), the willingness of car drivers to use public transport increases if the travel time is low. Meanwhile, Hamid *et al*. (2008) concluded, there need to be cost savings as well as time savings while using public transport compared to other alternative mode of transportation.

1.1.Background of Study

Petaling Jaya is a Malaysian city originally developed as a satellite township for Kuala Lumpur comprising mostly residential and some industrial areas. It is located in the Petaling district of Selangor with an area of approximately 97.2 square kilometres and population of 613,977 (Department of statistics, 2012) which is located about 11 km south west of the capital Kuala Lumpur. It was first developed by the British on the former 486 hectares Effingham Estate (Majlis Bandaraya Petaling Jaya, 2014) as an answer to the problem of overpopulation in Kuala Lumpur in 1952 and has since witnessed a dramatic growth in terms of population size and geographical importance.

1.2.Urban Transport Problems

The economic rise in large cities in developing countries over the past few decades has caused a high demand for transportation needs, which is in line with the increase in population in urban areas due to migration from rural areas to urban areas. Most urban areas in developing countries such as Malaysia and other Asian countries are made up of high-density urban areas and urban transport systems based on land and generally operate with different types of transport (cars, motorcycles and commercial vehicles). Travel expenses in urban areas have taken as much as 5 to 15% of household income (Tangphaisankun et al., 2010).

Development and improvement of public transport service is much slower than the increase of private vehicles (Barter 2000). This situation has resulted in an increased rate of private car ownership in the last three decades and vehicle ownership in many developing countries such as Brazil, Indonesia and Taiwan rose two times faster than the income per capita, or more than two times faster than income per capita for some other developing countries such as India, Korea, Thailand, Mexico and Malaysia. Increased car ownership will continue this tends to increase in the future as depicted in Figure 1 (Dargay & Gately 1999 Dargay et al., 2007).

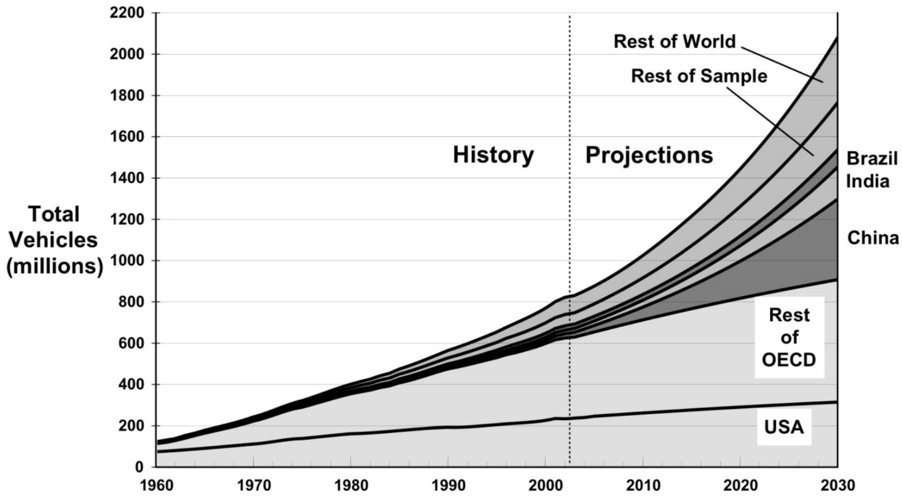

Fig 1: Historical and projected regional values for total vehicles.
Source: Dargay & Gately 1999 Dargay et al., 2007

The increased use of private vehicles has increasingly affecting the environment, such as noise and emission of carbon dioxide from vehicle exhaust (Abrahamse et al. 2009; Buehler 2010; Cameron et al. 2004; van Exel et al. 2010; Wall & McDonald, 2007). The problems that arise due to the use of private vehicles has caught the attention of politicians, city planners and the public to find a solution that is effective for reducing the damage caused by private vehicles entry into the city centre.

1.3.Automobile Dependency

Automobile use is clearly related to numerous advantages such as on demand mobility, comfort, status, speed, and convenience (Rodrigue, 2013). These advantages collectively show why automobile ownership continues to expand globally, especially in urban areas. When given the choice and the opportunity, most individuals will prefer using an automobile (Rodrigue, 2013).

According to Newman & Kenworthy (1999) automobile dependency is defined as high levels of per capita automobile travel, automobile oriented land use patterns and reduced transport alternatives. The opposite of automobile dependency is a balanced transportation system with more mixed travel patterns. Automobile dependency is a matter of degree (Wickham and Lohan, 1999). In its extreme, nearly all local trips are made by personal automobile because alternatives are so inferior.

Due to the economic blooming Malaysia is having, more and more are finding it easy to own a car, where during the last five years alone the number of registered cars has risen from 17,971,901 in 2008 to 23,376,716 in June 2013 (Road Transport Department, 2013). That's more than 5.4 million extra cars with no significant road expansion. Figure 2 shows the total number of register vehicles in Malaysia

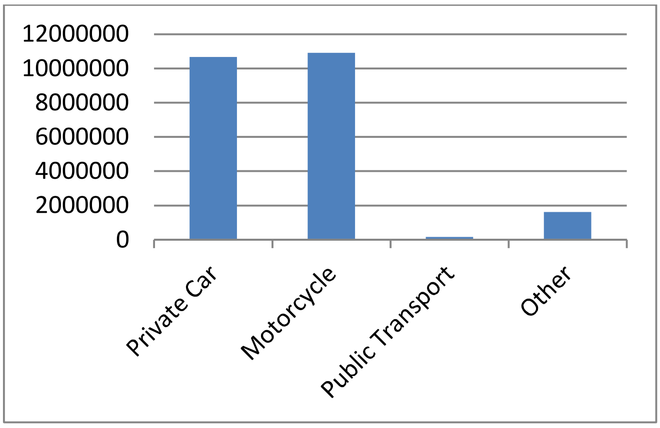

Fig. 2: The number of registered vehicles in Malaysia in 2013

1.4.Public Transport in Petaling Jaya

Transportation facilities and infrastructure are well developed in Petaling Jaya. The introduction of the Putra LRT service in 1998 saw the addition of the Putraline feeder bus services. The combination of Putraline and Putra LRT brought a relief to many Petaling Jaya residents especially those who had had to rely on public transportation. Today, public transportation is provided by RapidKL in the form of buses as well as the KL Light Rail Transit System - Kelana Jaya Line, which extends slightly into Petaling Jaya. There are five Kelana Jaya Line stations in Petaling Jaya.

The most serious issue concerning the public transportation system in Petaling Jaya is a lack of focus and coordination at all levels throughout the system. At the national level the government does not actively promote public transportation and there is a lack of government focus on the issue. No single ministry or department oversees or is in charge of public transportation. Several agencies oversee various parts of the system, but there is no coordination between them and the state and local governments have no formal authority in this area (Schwarcz, 2003).

2. METHODOLOGY

This study was carried out to examine the system of public transport available in Petaling Jaya and to determine reasons for travellers' mode choice from among three transport modes: private cars, bus and train. Methods of data collection conducted on the respondents through a questionnaire distributed in commercial and residential areas in Petaling Jaya as well as few local companies. Some of the data was collected through a series of one on one interviews. In residential areas copies of the questionnaire was placed in mailboxes of residents and were collected later on from the management office. Also, after discussions with the administration of some of the local companies, the distribution was done by submitting the questionnaire to the management and the results were collected after a few days. The data was collected in about three months. A total of 400 questionnaires were distributed.

Table 1 shows the demographic, socioeconomic and travel characteristics of the respondents. Male percentage (57.8%) was slightly higher than that of women (42.3%). The majority of participants were less than 37 years old (56.9%). Most of respondents had a college degree (42.5%). The majority of monthly income was between RM2000 – 3000/month (36.3%). The sample representation is somewhat similar of that of official statistics: male percentage 51%, female percentage 49%. 67% of total population are less than 40 years old (Department of statistics, 2012). 34% of the population went to college or a university (UNESCO Institute for Statistics).

Table 1
Profiles of respondents

	Attribute	**Percentage**
Gender	Male	57.8
	Female	42.3
Age	18-22	2.3
	23-27	14.3
	28-33	22.3
	34-37	18
	38-43	12.5
	44-47	12.5
	48-53	6.8
	54-57	6.3
	58-63	4.5
	64-67	0.5
	68-70	0.3
Education	Primary School	4.8
	Secondary School	18.8

	Diploma	24.8
	Degree	42.5
	Higher Education	9.3
Household size	1-2 Persons	29.8
	3-4 Persons	40.5
	5 or more	29.8
Income	Less than 1000	10.3
	1000-2000	22.8
	2000-3000	36.3
	3000-4000	18.5
	More than 4000	12.3
Transportation mode	Car	59.3
	Motorcycle	13.3
	Train	14.8
	Bus	12.8

Revealed preference data were collected for the socioeconomic characteristics. Socioeconomic data collected included the respondents' income, age, gender, vehicle ownership, income, household size and education levels.

3. RESULTS

Two binary logit models for car vs. bus and car vs. train were developed to explore the factors affecting car/bus and car/train use and to predict the probability of changing from car to bus and car to train. The models examined the demographic and socioeconomic characteristics of bus, train and car trips to determine their influence in the choice of transport mode.

In the models, the dependent variable was "1" for bus use in the car vs. bus mode and "0" for car use. While, "1" was used for the train in the car vs. train mode and "0" for car use. The explanatory variables were: age, gender, race, educational level, income, household number, car ownership, home to work distance, journey time, home to station distance and work to station distance. For estimation, the car was taken as the base case. Thus, a negative coefficient for a variable in bus or train choice implies a decrease in bus or train use the higher the negative value the lower the bus or train use.

A summary of the estimations from the model are presented in Tables 2. The coefficients for the explanatory variables were mixed, age, gender, race, educational level, income, car ownership, home to work distance, journey time, home to station distance were all significant, while household number and work to station distance were not significant at P < 0.05.

3.1.Car Vs. Bus

Table 2 Estimations from the binary mode choice model (car vs. bus) (n = 400)

Constant	**Coefficient**	**S.E.**	**Wald**	**df**	**Sig**	**Exp (B)**
Age	0.251	0.102	6.067	1	0.014	1.286
Gender	1.047	0.465	5.068	1	0.024	2.848
Education	-0.619	0.256	5.856	1	0.016	0.538
Income	-1.845	0.336	30.11	1	0.000	0.158
Car ownership	-0.954	0.306	9.703	1	0.002	0.385
Home-work distance	-0.633	0.279	5.15	1	0.023	0.531
Journey time	1.231	0.373	10.878	1	0.001	3.423
Home-station distance	-0.793	0.219	13.123	1	0.000	0.452
Constant	4.716	1.762	7.168	1	0.007	111.769
Summary of statistics						
(-2) log likelihood	128.857					
Model chi-square	140.101					
Cox & Snell's R^2	0.385					
Nagelkerke value	0.635					
Number of observations	400					

Model:

$$P = \frac{1}{1+e^{u}}$$

Where:
P = probability of private car users' shift to public transport
u = utility function for bus mode
e = the base of natural logarithms (approximately 2.718).

u = 4.716+ 0.251*age + 1.047* gender - 0.619* education - 1.845* income - 0.954* car ownership – 0.633* home-work distance + 1.231* journey time - 0.793* home-station distance.

(1)

To assess how well the model fitted the data, Hosmer and Lemeshow's Goodness-of-Fit test statistic was calculated and a chi-square test between the observed and expected frequencies done (see Table 3). There was little difference between the observed and predicted values for both modes of transport as evidenced by the chi-square value not being significant.

Table 3 Hosmer and Lemeshow's Test (car vs. bus)

	Car		**Bus**		**total**
	Observed	Expected	Observed	Expected	
1	29	28.992	0	0.008	29
2	29	28.96	0	0.04	29
3	29	28.896	0	0.104	29
4	29	28.765	0	0.235	29
5	28	28.468	1	0.532	29
6	26	27.675	3	1.325	29
7	27	25.59	2	3.41	29
8	23	22.254	6	6.746	29
9	14	14.392	15	14.608	29
10	3	3.007	24	23.993	27
Chi-square		df		Sig.	
3.820		8		0.873	

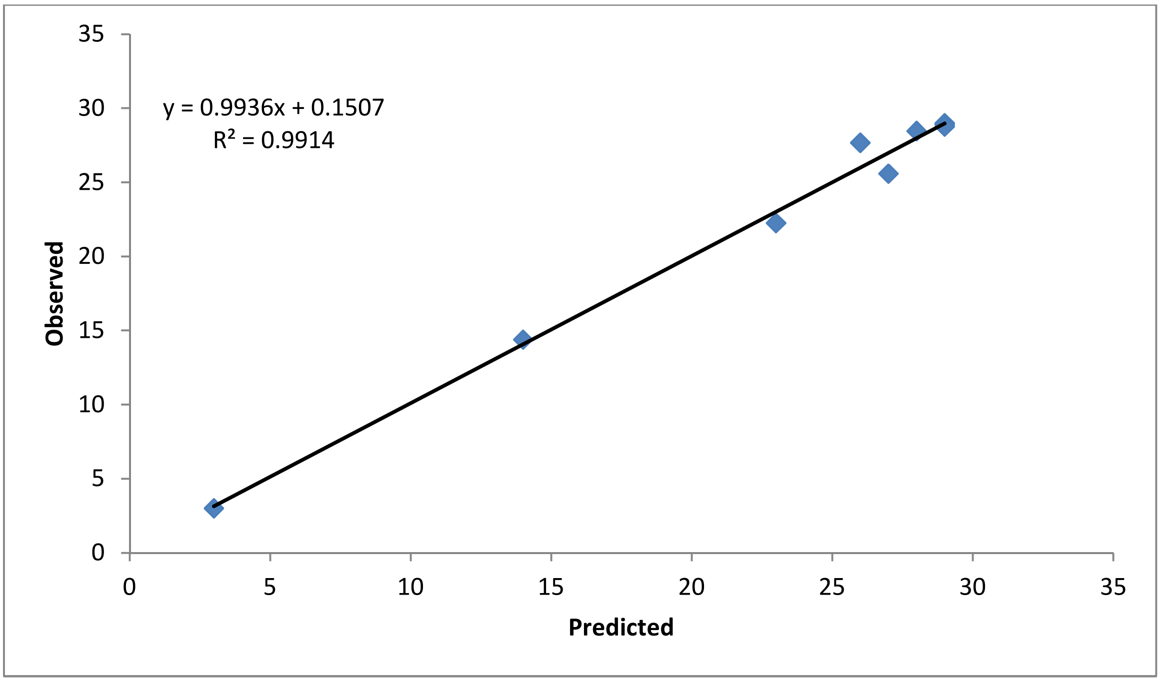

Fig 3: Predicted vs. observed by car

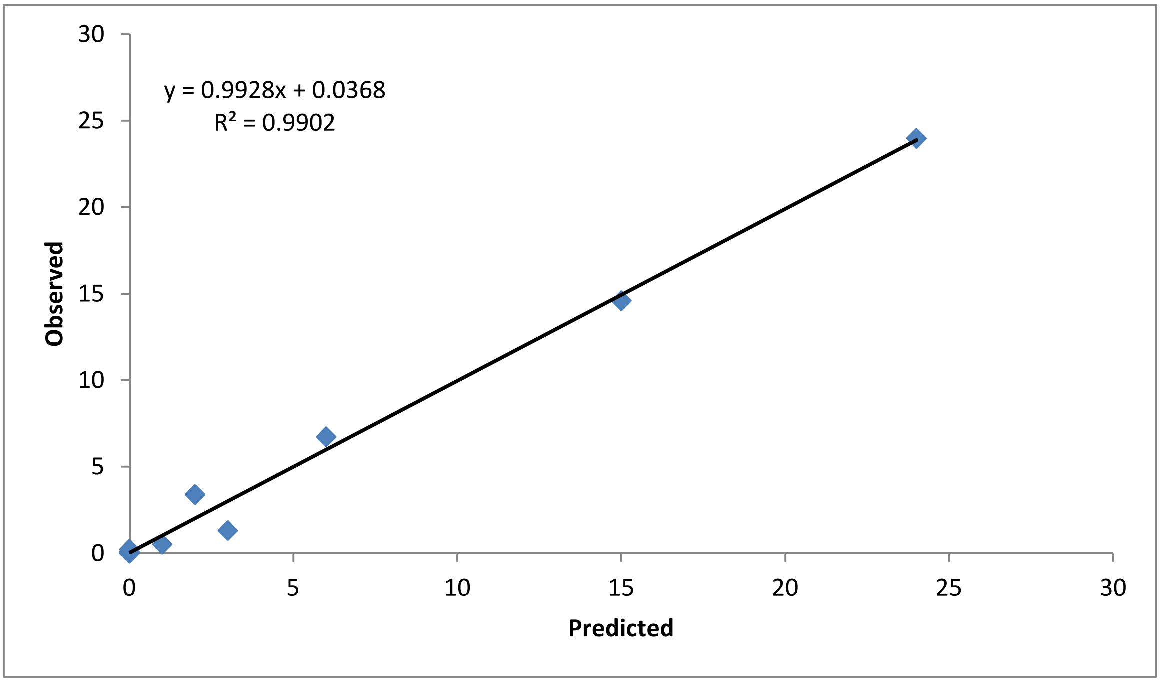

Fig 4: Predicted vs. observed by bus

The observed and predicted values were very close, indicating the good fit of the model. Since -2LL reflects the prediction deviation (error) by the model, the smaller the value the better the fit. Besides the measures of "goodness of fit", another important criterion for logistic regression model is the pseudo R2. SPSS presents two R2 measurements to estimate how much of the variation is accounted for by the model. Cox and Snell's R2 imitates the linear regression R2 based on the likelihood, and Nagelkerke's R2 is a modification of the Cox and Snell's coefficient to ensure that it varies only from 0 to 1. As Table 2 shows, the model has a Nagelkerke value of 0.635.

Classification matrices were also calculated to assess how well the model fitted the data (Table 4). It correctly classified 97% of the car cases and 64.7% of the bus cases. The predictions were 91.3% accurate.

Table 4 Predicted vs. observed outcomes for car vs. bus

Observed	**Predicted**		
	Car	Bus	Percentage correct
Car	230	7	97
Bus	18	33	64.7
Overall percentage			91.3

3.2.Car Vs. Train

Table 5 Estimations from the binary mode choice model (car vs. train) (n = 400)

Constant	**Coefficient**	**S.E.**	**Wald**	**df**	**Sig**	**Exp (B)**
Age	-0.330	0.117	7.925	1	0.005	0.719
Gender	1.098	0.432	6.454	1	0.011	2.997
Education	-0.566	0.240	5.557	1	0.018	0.568
Income	-1.336	0.270	24.565	1	0.000	0.263
Car ownership	-0.875	0.325	7.268	1	0.007	0.417
Home-work distance	-0.564	0.274	4.242	1	0.039	0.569
Journey time	1.102	0.327	11.367	1	0.001	3.011
Home-station distance	0.748	0.241	9.62	1	0.002	2.112
Constant	0.865	1.600	0.292	1	0.589	2.374
Summary of statistics						
(-2) log likelihood	146.643					
Model chi-square	149.040					
Cox & Snell's R^2	0.396					
Nagelkerke value	0.626					
Number of observations	400					

Model:

$$P = \frac{1}{1+e^{u}}$$

Where
P = probability of private car users' shift to public transport
u = utility function for bus mode
e = the base of natural logarithms (approximately 2.718).

u = 0.865- 0.330* age + 1.098* gender - 0.566* education -1.336* income - 0.875* car ownership - 0.564* home-work distance + 1.102* journey time + 0.748home-station distance. (2)

To assess how well the model fitted the data, Hosmer and Lemeshow's goodness-of-fit statistic was calculated and a chi-square test performed to compare the observed and expected frequencies (Table 6). From the Hosmer and Lemeshow's test, there were very little differences between the observed and predicted values for both modes of transport, while the chi-square was also not significant.

Table 6 Hosmer and Lemeshow's Test (car vs. train)

	Car		**Bus**		**total**
	Observed	Expected	Observed	Expected	
1	31	30.977	0	0.023	31
2	29	29.896	1	0.104	30
3	31	30.770	0	0.230	31
4	29	29.506	1	0.494	30
5	28	28.751	2	1.249	30
6	29	27.764	1	2.236	30
7	27	25.587	3	4.413	30
8	21	20.926	9	9.074	30
9	11	10.973	19	19.027	30
10	1	1.850	23	22.15	24
Chi-square		df		Sig.	
10.706		8		0.219	

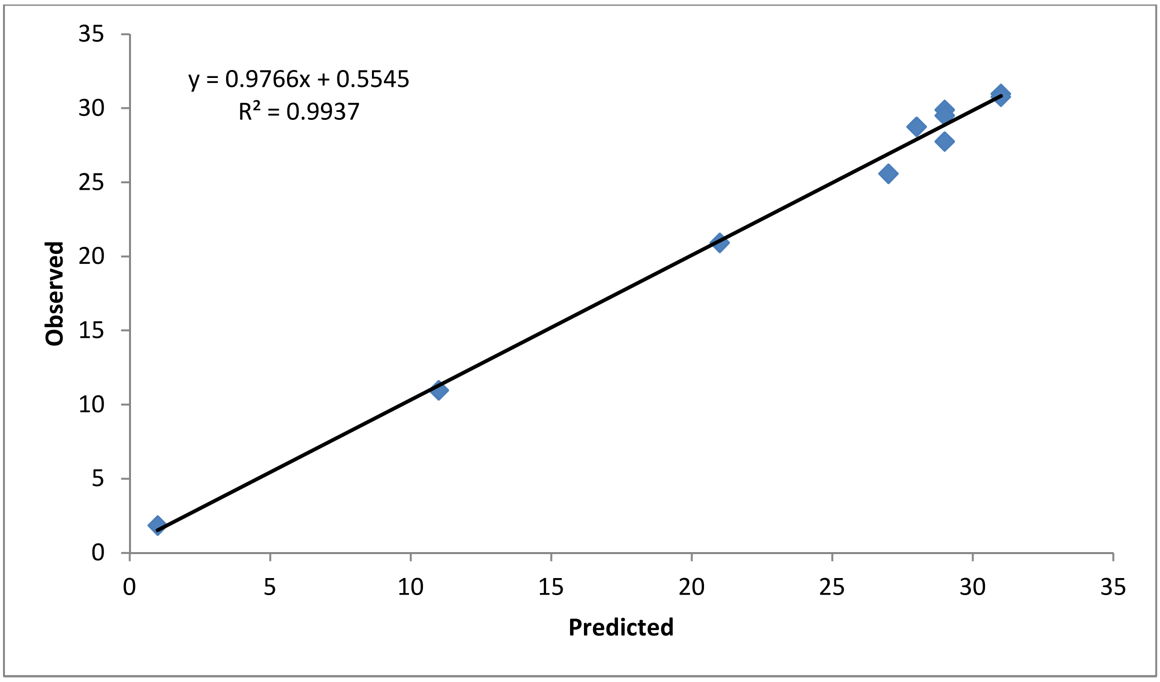

Fig 5: Predicted vs. observed by car

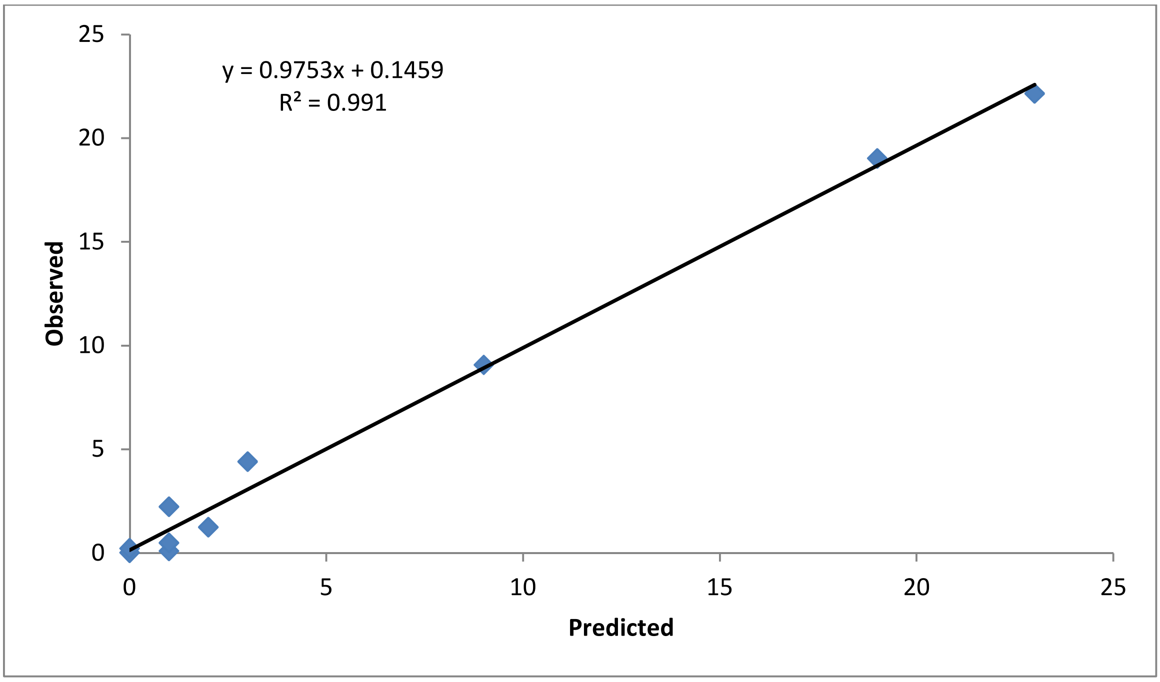

Fig 6: Predicted vs. observed by train

The observed and predicted values were very close, indicating that the model fitted the data well (Figures 4 and 5). As shown in Table 5, the model's Nagelkerke value was 0.626, indicating that the model explained more than 60% of the variation in the dependent variable.

The classification matrices of predicted vs. observed outcomes were calculated (Table 7), and the model found to correctly classify 97% of the car cases and 67.8% of the train users. The predictions were 91.2% accurate.

Table 7 Predicted vs. observed outcomes for car vs. train

Observed	**Predicted**		
	Car	Train	Percentage correct
Car	230	7	97
Train	19	40	67.8
Overall percentage			91.2

4. DISCUSSION AND CONCLUSION

For the car vs. bus model, the coefficients for education, income, car ownership, home-work distance and home-station distance were all negative, implying that an increase in them would increase car use. The coefficient of journey time was unexpectedly positive implying that travellers may have ignore the journey time factor. This might be caused by how people react negatively towards being on the road for a long time, it might be caused by dislike of driving for long periods of time or the frustrations of facing constant traffic on the road. In the model, demographic variables such as age, gender and race contributed significantly to explaining the mode choice behaviour. Females were more likely to take the bus than drive – the odds ratio for females being approximately two times for females compared with males. This difference is likely due to two reasons: firstly, women have less access to the family vehicle(s) than men, and, secondly, they perceive driving to be more dangerous than men. Therefore, even with access to a car, women may still prefer not to drive. These gender differences are well supported by various studies. Turner and Fouracre (1995) cited research in Brazil which revealed that women make only a third of the work trips but half of the non-work trips. Research in Kenya revealed that women's travel is mostly local and on foot (Turner and Fouracre 1995). In these two studies, women reported a higher transit mode share than men. Peters (2001) reviewed case studies from cities in India, Mali, Bangladesh, Turkmenistan, and Peru and concluded that women have less access than men to individual mechanized modes of transit ranging from bicycles to automobiles and that women who do have access to public transit are more dependent on it than men with similar access. The older one gets, the more likely he is to drive, so the elderly are more likely to drive than take a bus. This finding agrees with European results. Mackett and Ahen (2000) also found that the young drive less, being more willing and able to cycle and take the bus than the elderly. There are several reasons why the car is so popular among older people in Malaysia. It is a convenient and comfortable way to travel, travellers have privacy, feels secure and saves time. The descriptive analysis showed that about 16% of drivers were < 27 years old and 84% older. The education level is statistically significant to explain mode choice behaviour. The negative coefficient sign implies that people with high education level are less likely to use public transport. The distance between respondents' residence and their work is statistically significant. The negative coefficient sign assigned to it implies that the larger the distance between one's residence and place of work the more likely the individual will own a car. We can say the same thing about the distance between respondents' residence and the nearest transport station, it is statistically significant with a negative coefficient sign, implying that the larger the distance between one's residence and transport station the more likely the individual will own a car. While the distance between work and the transport station was found to be insignificant in influencing people's attitude towards owning a car.

While for the car vs. train model, demographic variables such as age and gender were found to significantly explain the mode choice behaviour. Females preferred the train to car, their odds ratio being about 2.69 times that for males. A possible reason for this is that women tend not to have the same access to family-owned vehicles as men, and are more sceptical about driving safety. Therefore, even with a car, women may prefer not to drive. These gender differences are well supported by various studies. Wachs (1987) found that women made shorter work trips and took transit more than men. Women also made more trips to provide services to others, and drove less than men. The 1990 Southern California commuting data showed that women carpooled more than men (Brownstone & Golob 1992), although they did so mostly with household members than other people (Teal 1987). An increase in age only brought about a marginally greater likelihood to drive. Thus, the elderly are more likely to drive than take public transport. The odds ratio for the young was 0.717 that for the older commuters. The coefficient of journey time was unexpectedly positive implying that travellers may have ignored the journey time factor. This is probably due to people's aversion of long driving and frequent congestion. The estimated coefficients for car ownership, income and education for train mode were all negative, implying that increases in them would reduce train use, or increase car use. The negative coefficient sign of education implies that people with high education level are less likely to use public transport. The distance between respondents' residence and the nearest transport station is statistically significant. The negative coefficient sign assigned to it implies that the larger the distance between one's residence and the transport station the more likely the individual will own a car. While the distance between respondents' residence and work and the distance between work and the transport station was found to be insignificant in influencing people's attitude towards owning a car.

The study attempted to conduct mode choice behaviour of travellers of three modes of transport namely train, car and bus and determined the trade-offs travellers make when considering choice of their mode of transport. Utility of the three modes were compared to determine the important reasons behind the choice of a particular mode and the circumstances, which might cause travellers to change their choice for the car. The binary models examined trip characteristics of bus, train and car users such as travel time, travel distance as well as demographic and socio-economic characteristics to determine the influence of demographic, socio-economic variables and mode attributes on mode choice behaviour.

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