

SSI (ICRA):
"Comparative Analysis of Motorcycle Utilization and Forecasting Model of Motorcycle Ownership of Eastern Asian Countries"
6th International Conference of the Eastern Asia Society for Transportation Studies,
21-24 September 2005,
Queen Sirikit National Convention Center,
Bangkok, Thailand.

MODELLING MOTORCYCLE OWNERSHIP IN MALAYSIA

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ABSTRACT

High composition of motorcycles in a mixed traffic situation is common in most Asian countries. In Malaysia, there are approximately 5.8 million motorcycles on the roads and on the same note, accidents rate involving motorcycles are almost half of the total road fatalities recorded. However, regardless of the high accident rate involving motorcycles, motorcycle ownership in Malaysia has increased from 0.13 in year 1990 to 0.24 motorcycles per person in year 2002. Therefore, the fast growing rate of motorcycle ownership in Malaysia has become a critical issue especially with regards to safety and the management of traffic system in Malaysia. Hence, in this research, issues concerning motorcycle ownership will be investigated. A general survey was conducted to determine the significant factors influencing the ownership of motorcycles. Once the factors are identified, a disaggregate choice model describing motorcycle ownership will be derived by means of statistical analysis. Development of this model will give an indication on the expected trend of motorcycle ownership. Thus, future development of traffic system, upon taking into the consideration the role of motorcycle could be properly planned.

INTRODUCTION

Motorcycle is one of the major transportation modes in Malaysia. In Malaysia, the common type of motorcycles found on the road is that of small size motorcycles that is in the range of 70 cc to 115 cc. It is estimated that approximately 85% of all motorcycles in Malaysia are under 115 cc. Due to its small size, the mobility of motorcycles on the road is high. During traffic congestion, motorcycles often weave in and out between queuing vehicles to get to the front. Hence, traffic becomes more hazardous due to the interruption caused by motorcycles. And according to Hsu et al (2003), in developing countries where the motorcycles volume is high, the hazardous situation caused by motorcycles under mixed traffic flow is much more significant. This has been proven by the accident data in Malaysia where motorcycle fatalities are approximately 45% of the total road fatalities recorded in year 2000 (Radin et al, 2004 and Harnen, 2003).

However, regardless of the high accident rate involving motorcycles, motorcycle ownership for Malaysia continue to grow from 0.13 in year 1990 to 0.24 motorcycles per person in year 2002. In terms of vehicles composition, the percentage of

motorcycles registered annually in Malaysia is about 50% - 60%, that is approximately 5.8 million motorcycles, with an average annual growth rate of approximately 7% (Highway Planning Unit, Ministry of Works Malaysia, 2003). Therefore, the fast growing rate of motorcycle ownership and its subsequent usage in Malaysia has become a critical issue in the safety and management of traffic system in Malaysia.

Currently, there have been many researches conducted around the world on car ownership such as the studies conducted by Button et al (2003) on the factors influencing the ownership of vehicles in low income countries, Dargay (2002) on the factors determining car ownership for households living in rural and urban areas, Medlock and Soligo (2002) on developing a model that predicts the relationship between economic development and the per capita rate of private ownership of cars. Dissanayake and Morikawa (2002) also have conducted a study on household travel behavior variations relating to vehicle ownership particular car and motorcycle ownership, mode choice and trip-chaining considerations by using Bangkok metropolitan region as a case study. However, not much research has been conducted to investigate the characteristics of motorcycle ownership particularly in Malaysia. Hence, in this research, a disaggregate choice model describing motorcycle ownership will be developed. Development of this model will give an indication on the future trend of motorcycle ownership in Malaysia.

MOTORCYCLE MARKET IN MALAYSIA

Motorcycle ownership in Malaysia

In Malaysia, the composition of vehicles registered annually consists mainly of passenger cars, motorcycles, buses, medium and heavy lorries with almost 50% of registered vehicles are motorcycles. The estimated number of motorcycles on the road in year 2002 was approximately 5.8 million, compared to 5 million passenger cars (Highway Planning Unit, Ministry of Works Malaysia, 2003). Motorcycle ownership in Malaysia has also increased rapidly from 0.13 motorcycles per person in year 1990 to 0.23 motorcycles per person in year 2001. Conventionally, Malaysians prefer to purchase smaller motorcycles in the range of 70 cc to 115 cc. Large motorcycles are available but not very practical because during traffic congestion there is simply not enough space for large motorcycles to weave in and out of queuing vehicles to get to the front. Majority of motorcycle owners do not own a car and belong to the lower and middle-income group. Figure 1 shows the traffic composition in Malaysia from year 1963 to year 2002. However, for other types of motorized vehicles such as lorries, trailers and buses, the data available are only for year 1987 to year 2002.

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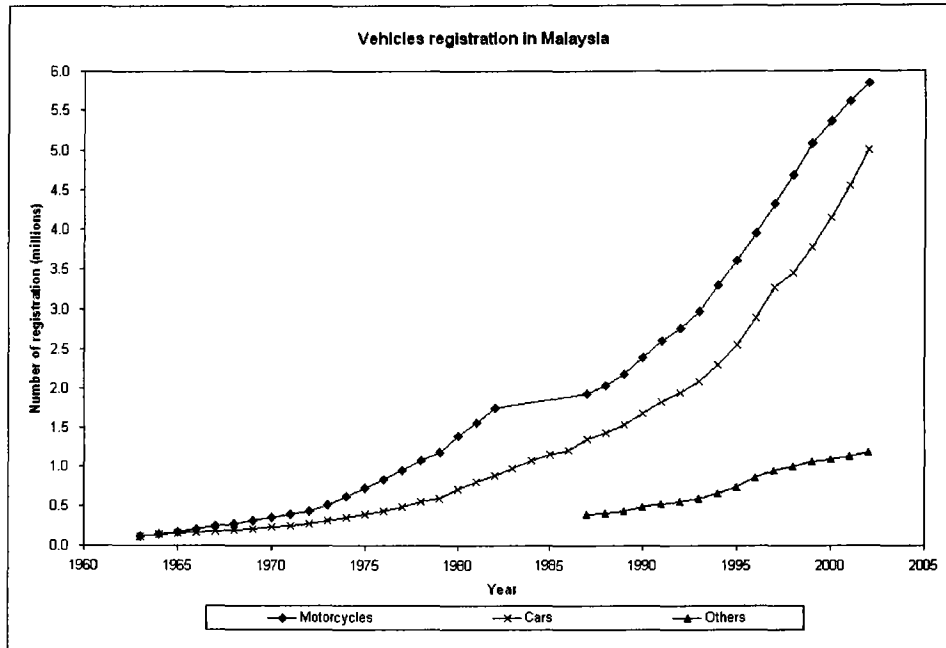


Figure 1: Ownership levels in Malaysia

Initially, an attempt was made to develop an aggregate model of motorcycle ownership based on time series data such as vehicles registration data, population data and Gross Domestic Product (GDP). Two of the best models developed were power model and multiple linear regression models as shown in Figure 2. However, there were some uncertainties in the motorcycle ownership trend that cannot be explained by both the models especially in the period of 1979 to 1987 and from 1991 to 2002 for the power model. Nevertheless, from the two models, the multiple linear regression model yields better results. This paper will illustrate the attempts made to come up with disaggregate ownership models.

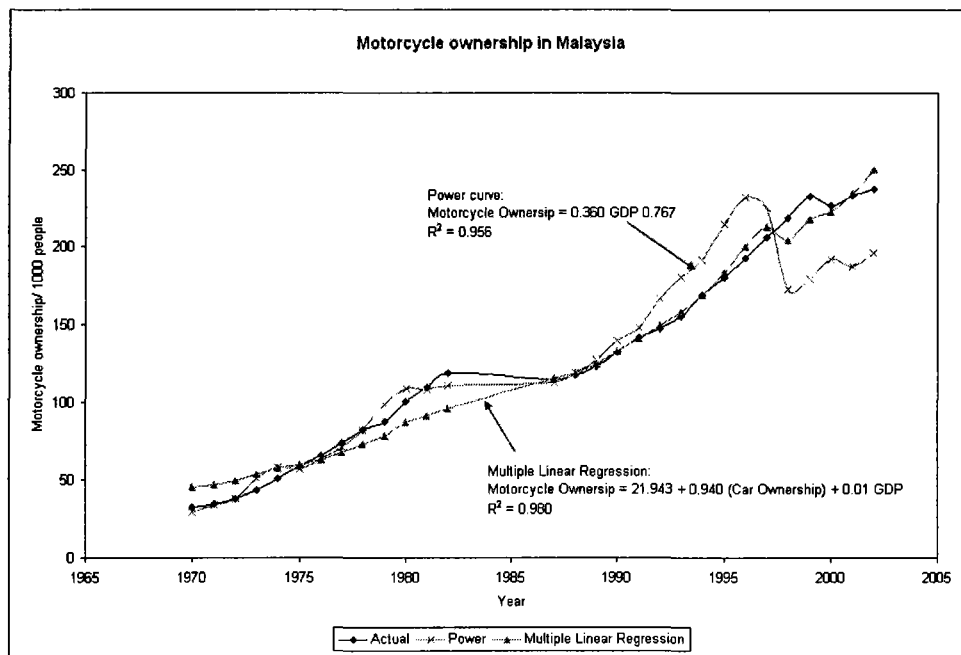


Figure 2: Aggregate motorcycle ownership forecast models

Factors affecting motorcycles demand in Malaysia

It is anticipated that the motorcycles market in Malaysia will sustain and continue to grow in the future due to several factors. One of the main contributing factors is traffic congestion. As a result of the increasing number of vehicles on the road every year, traffic congestion has reached a critical level especially in the city center. Hence, motorcycles are a useful mode of transportation for commuting within the city area especially during traffic congestion due to its small size and high maneuverability. Furthermore, many roads in Malaysia are very narrow due to space constraint especially in states such as Penang and as well as in rural areas, where the roads are small and less developed. Therefore, motorcycles are the preferred mode of transportation in those situations. Apart from that, the lower income group still depends heavily on motorcycles for transportation to save cost. Parking rates for motorcycles in most of the buildings within the city areas are usually cheaper and sometimes free of charge as compared to parking rates for cars. Besides that, parking spaces for motorcycles are a lot easier to find as compared to cars. Inefficient public transportation also prompted higher motorcycles demand among the lower income group.

DATA CHARACTERISTICS

Survey

The data used in this research were collected from the interview survey conducted in the state of Penang from October 2004 to July 2005. The survey consists of just one page of questions, divided into two sections. In the first section, personal background

data such as gender, race, age, marital status, monthly income, motorcycle and car ownership data, commuting purpose, destination and distance traveled using either a car or motorcycle or both were asked. Apart from that, monthly expenses on transportation as well as major factors influencing the decision to purchase either a car or motorcycle or both were asked. In the subsequent section, household information was collected. In this section, the household data such as number of family members that reside together, total household monthly income, total number of cars owned, total number of motorcycles owned and number of family members having car and motorcycle driving license were required. Details of the questionnaire are as shown in Appendix A.

Characteristics of survey data

In the survey conducted, data from a total of 547 respondents were collected. Upon discarding the uncompleted surveys as well as surveys with too much misleading data or data with errors, 435 surveys were retained for an overall response rate of 79.5%. Table 1 shows the number and percentage of three motorcycle ownership levels stratified by gender, race and marital status. Based on Table 1, the results showed that majority of motorcycles owners are Malay male while marital status does not have a significant impact on motorcycles ownership.

Table 1: Number and percentage of three motorcycle ownership levels stratified by gender, race and marital status

	Gender				Race						Marital Status					
	Male	%	Female	%	Malay	%	Chinese	%	Indian	%	Other	%	Single	%	Married	%
0 motorcycle	67	25.97%	104	58.76%	102	33.89%	53	57.61%	14	35.90%	2	66.67%	84	39.07%	87	39.55%
1 motorcycle	173	67.05%	65	36.72%	179	59.47%	35	38.04%	23	58.97%	1	33.33%	123	57.21%	115	52.27%
2 plus motorcycles	18	6.98%	8	4.52%	20	6.64%	4	4.35%	2	5.13%	0	0.00%	8	3.72%	18	8.18%
Total	258	100.00%	177	100.00%	301	100.00%	92	100.00%	39	100.00%	3	100.00%	215	100.00%	220	100.00%

Table 2 and Table 3 show the number and percentage of three motorcycle ownership levels stratified by age and monthly personal income respectively. Based on Table 2 and Table 3, majority of motorcycles owners are in the range of 20 to 29 years old with a monthly income of less than RM 1000.

Table 2: Number and percentage of three motorcycle ownership levels stratified by age

	Age											
	Under 20	%	20 - 29	%	30 - 39	%	40 - 49	%	50 - 59	%	60 and above	%
0 motorcycle	1	10.00%	96	43.64%	40	39.22%	25	36.76%	8	25.00%	1	33.33%
1 motorcycle	9	90.00%	113	51.36%	55	53.92%	39	57.35%	20	62.50%	2	66.67%
2 plus motorcycles	0	0.00%	11	5.00%	7	6.86%	4	5.88%	4	12.50%	0	0.00%
Total	10	100.00%	220	100.00%	102	100.00%	68	100.00%	32	100.00%	3	100.00%

Table 3: Number and percentage of three motorcycle ownership levels stratified by personal monthly income

	Monthly Income									
	< RM 1000	%	RM 1001 - RM 1500	%	RM 1501 - RM 2500	%	RM 2501 - RM 5000	%	> RM 5001	%
0 motorcycle	31	24.60%	59	45.38%	52	44.44%	22	44.90%	7	53.85%
1 motorcycle	89	70.63%	65	50.00%	56	47.86%	23	46.94%	5	38.46%
2 plus motorcycles	6	4.76%	6	4.62%	9	7.69%	4	8.16%	1	7.69%
Total	126	100.00%	130	100.00%	117	100.00%	49	100.00%	13	100.00%

From the questionnaire survey conducted, based on a total of 435 respondents, 264 of the respondents owned at least 1 motorcycle. The main factor that influences motorcycle ownership is that motorcycles are more convenient and save time especially during traffic jams. Figure 3 shows other factors that influences motorcycles ownership.

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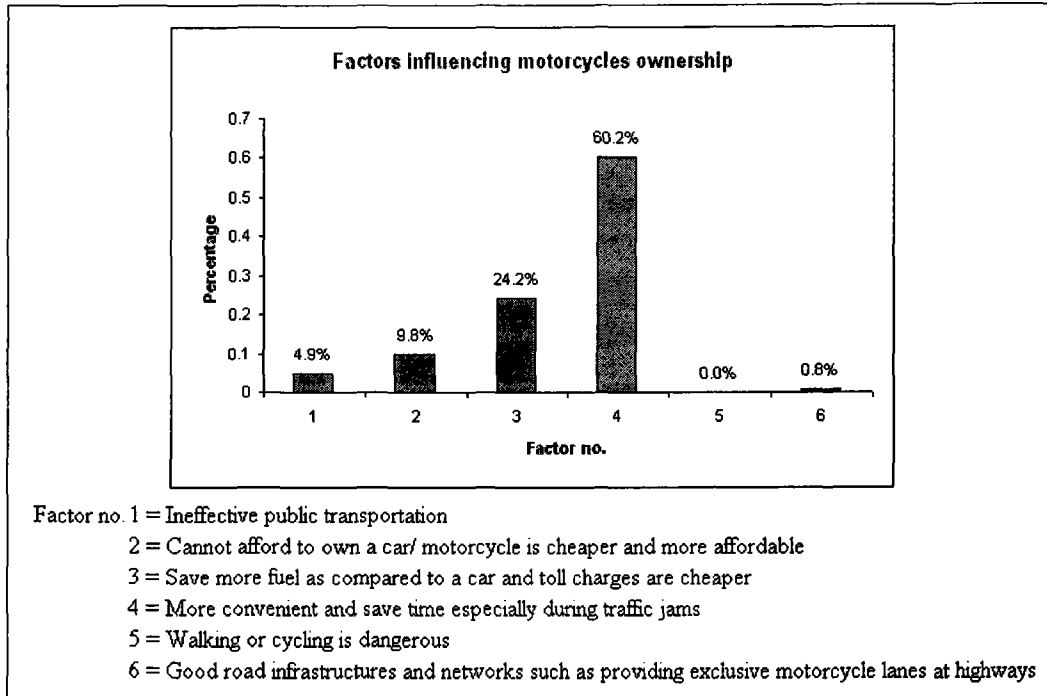


Figure 3: Factors influencing motorcycles ownership

Table 4 shows the number and percentage of three motorcycle ownership levels stratified by three levels of car ownership. From the survey conducted, as many as 394 respondents (90.6%) have car driving license and 337 respondents (77.5%) have motorcycle driving license.

Table 4: Number and percentage of three motorcycle ownership levels stratified by the number of cars owned individually

	Car Ownership					
	0 car		1 car		2 plus car	
		%		%		%
0 motorcycle	37	27.41%	118	45.04%	16	42.11%
1 motorcycle	95	70.37%	130	49.62%	13	34.21%
2 plus motorcycles	3	2.22%	14	5.34%	9	23.68%
Total	135	100.00%	262	100.00%	38	100.00%

From the questionnaire survey conducted, based on a total of 435 respondents, 300 of the respondents owned at least 1 car. According to the surveys, the main factor that influences car ownership is due to the hot and rainy weather in Malaysia. Figure 4 shows other factors that influences cars ownership.

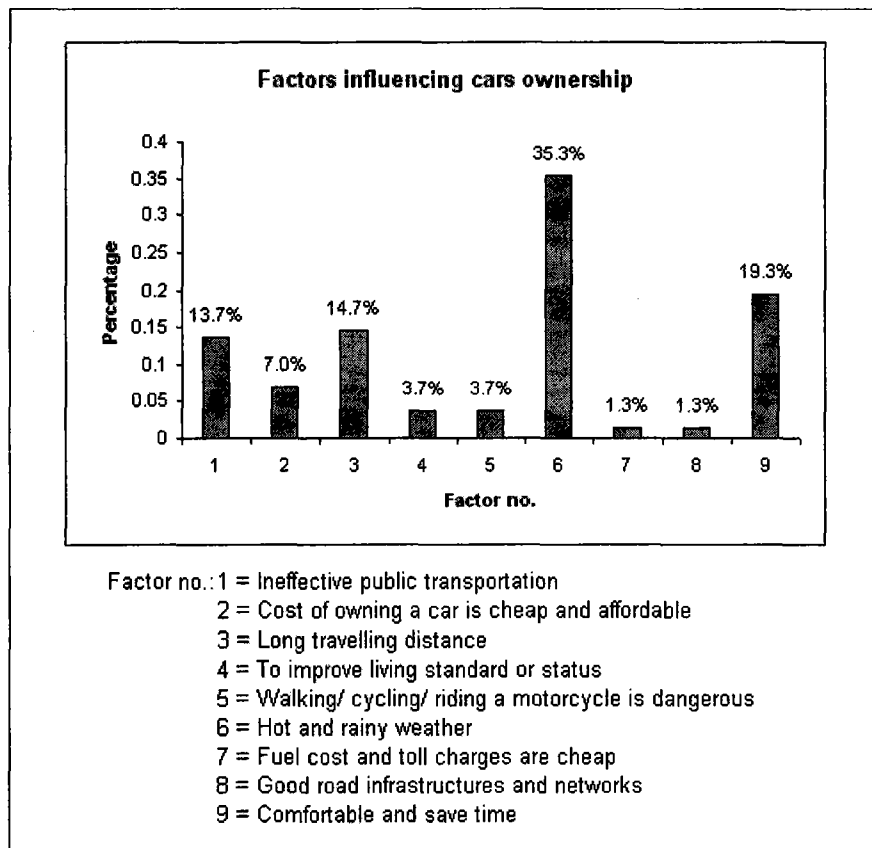


Figure 4: Factors influencing motorcycles ownership

Based on the survey conducted, generally Malaysians prefer to purchase a car once they have enough income and will keep the motorcycle purchased earlier as a secondary mode of transportation. Based on the questionnaire survey conducted, from 264 respondents that owned at least 1 motorcycle, 90.9% of them responded that they will not sell their motorcycles even if they want to purchase a new car. From the 171 respondents that do not own any motorcycles, only 29.9% of them will consider to purchase a motorcycle in the future and the reasons given are convenient, cheap, save money, save time especially during traffic jam whereas 70.8% of them responded that they will never consider purchasing a motorcycle in the future. The main reasons given for not purchasing any motorcycles are not interested particularly for those with high income who already owned a car, which constitute about 82.6%, motorcycles are dangerous, do not have a motorcycle driving license and lastly, due to low income. Figure 5 shows the relationship between motorcycles and cars ownership with income.

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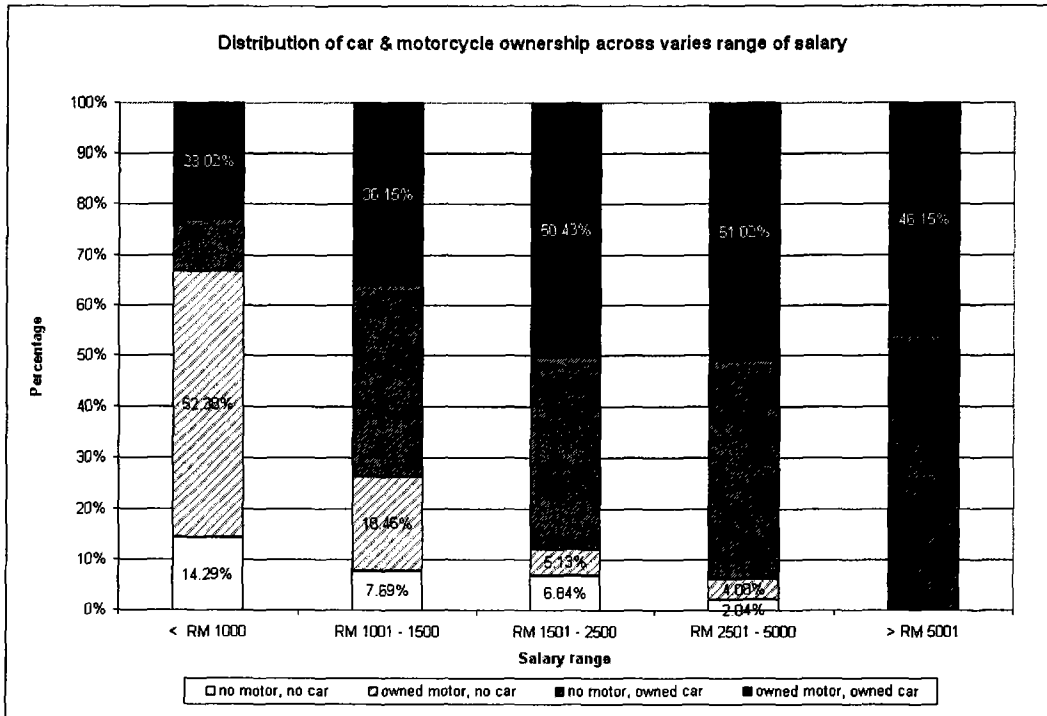


Figure 5: Distribution of motorcycles and cars ownership with income.

Figure 6 shows the total monthly expenditures on transportation. Majority of those surveyed spent less than 10% of their monthly income of transportation.

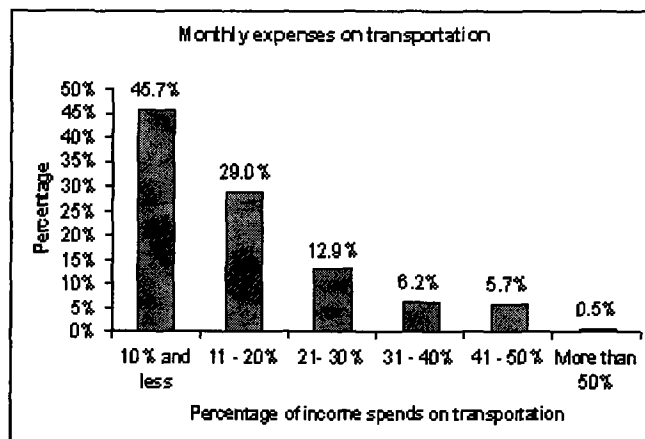


Figure 6: Monthly expenses on transportation

From the questionnaire survey conducted, based on a total of 435 respondents, 135 respondents (31.0%) do not own a car and 171 respondents (39.3%) do not own a motorcycle. Therefore, from 69% of the respondents who own at least 1 car and 60.7% respondents who own at least 1 motorcycle, the comparisons between car and

motorcycle usage are as shown in Figure 7. Based on Figure 7, the main commuting purpose is to travel to work and followed by recreation.

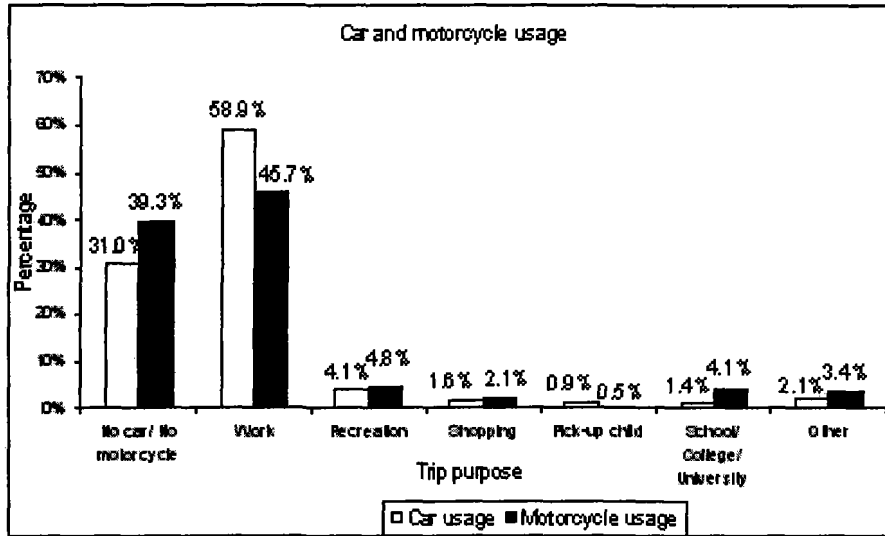


Figure 7: Car and motorcycle usage

Figure 8 shows the commuting distance for car trips and motorcycle trips. Based on Figure 8, majority of the respondents traveled less than 10 km which means to say that most of the respondents live near the workplace.

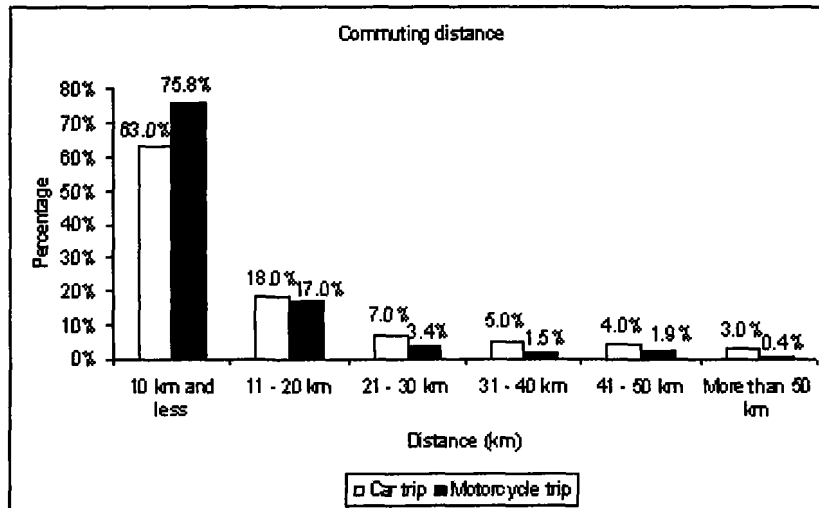


Figure 8: Commuting distance

Figure 9 shows the total number of family members in the household. Based on Figure 9, majority of the households surveyed have 4 to 5 family members and on the average, the household size is 4.4 people.

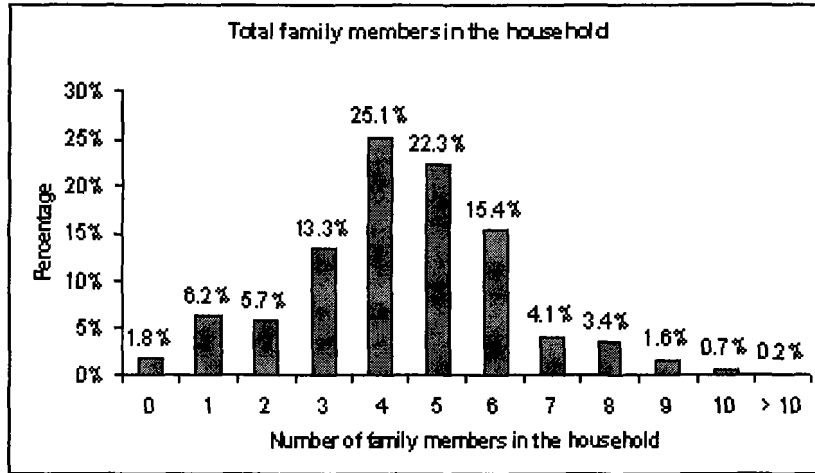


Figure 9: Total family members in the household

Figure 10 shows the total monthly income in the household. Based on Figure 10, majority of the households surveyed have a total income of RM 2501 to RM 5000.

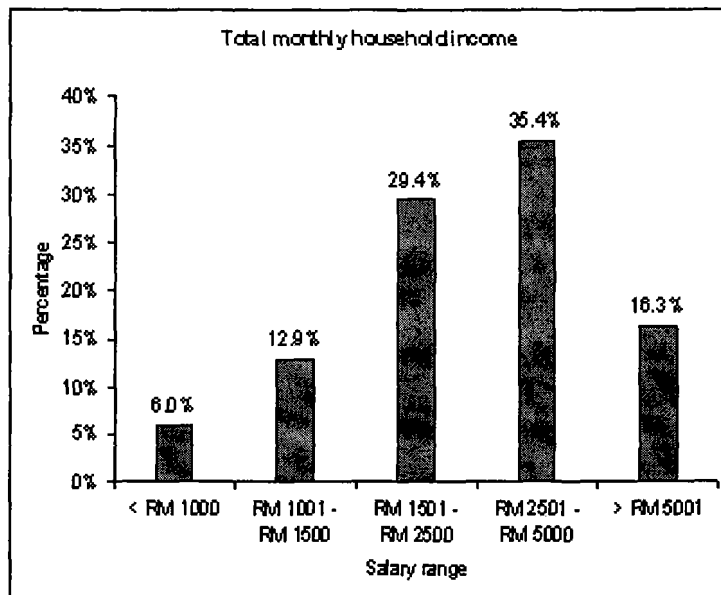


Figure 10: Total monthly household income

Figure 11 shows the total number of cars in the household. Based on Figure 11, majority of the households surveyed have 1 to 2 cars and the average number of cars in a household is 1.62 cars per households.

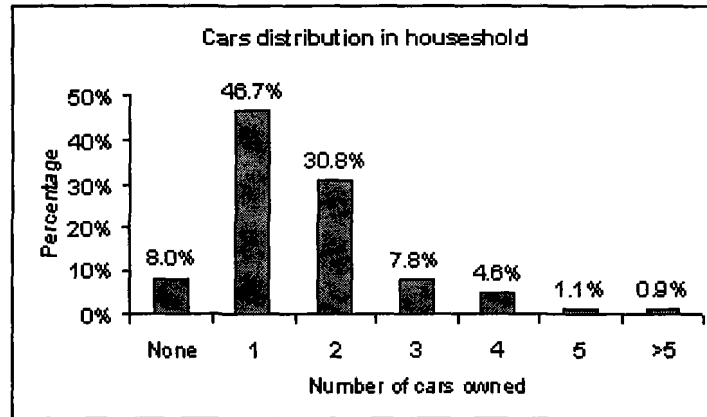


Figure 11: Total number of cars in households

Figure 12 shows the total number of motorcycles in the household. Based on Figure 12, majority of the households surveyed have 1 to 2 motorcycles and the average number of motorcycles in a household is 1.43 motorcycles per households.

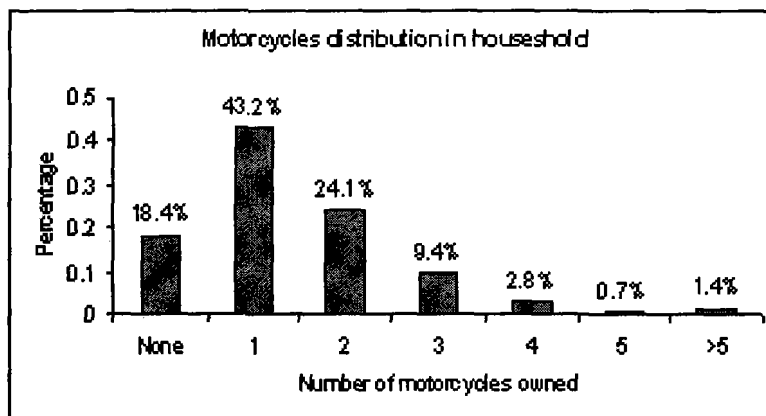


Figure 12: Total number of motorcycles in households

Figure 13 shows the total number of family members in the surveyed household that have car driving license. Based on Figure 13, on the average, there are 2.53 car driving license holders in the households.

Figure 14 shows the relationship between motorcycles and cars ownership with income for the households surveyed.

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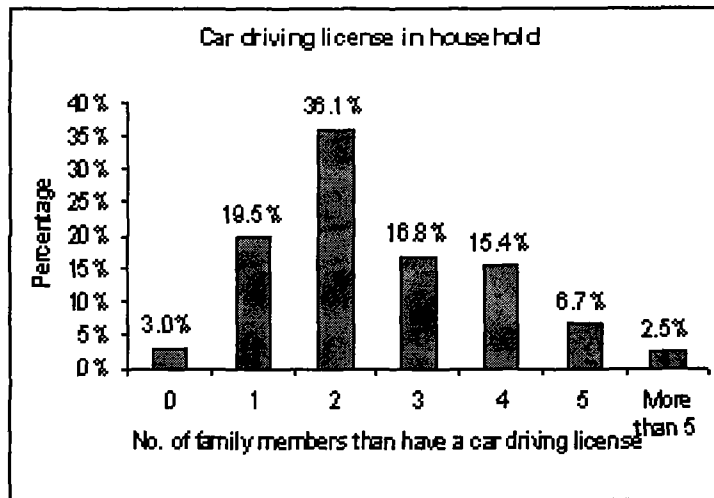


Figure 13: Total number of car license holders in households

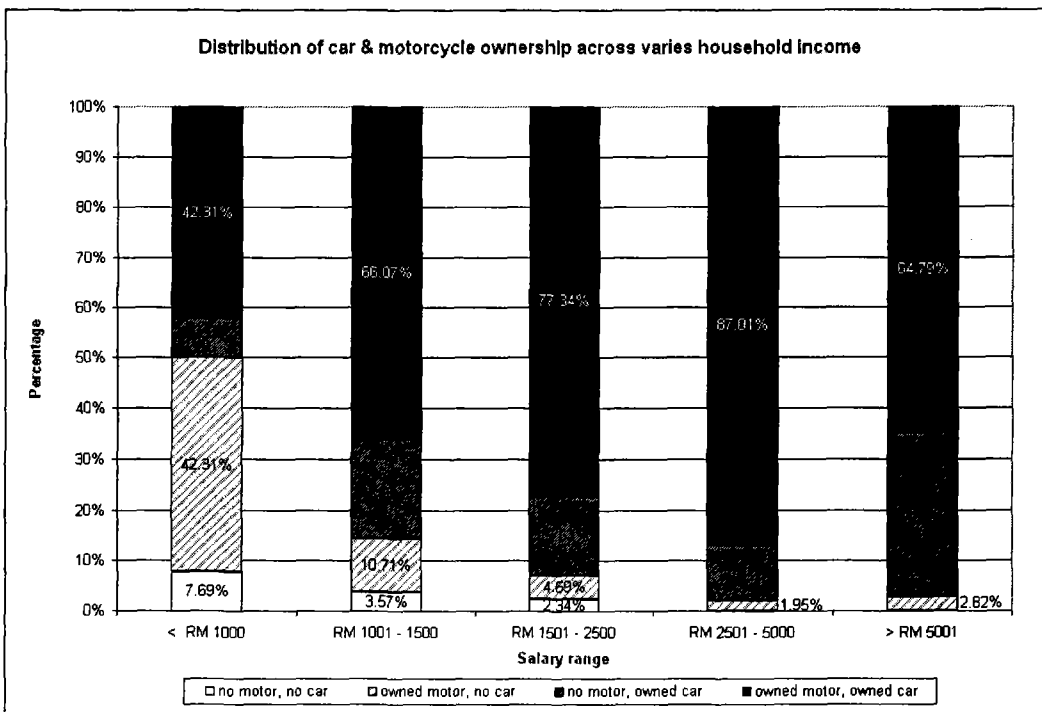


Figure 14: Distribution of motorcycles and cars ownership with total household income.

Figure 15 shows the total number of family members in the surveyed households that have motorcycles driving license. Based on Figure 14, on the average, there are 2.06 motorcycles driving license holders in the households.

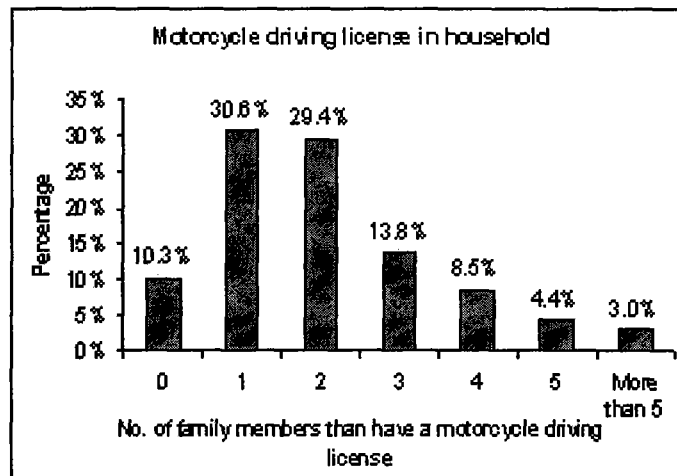


Figure 15: Total number of motorcycle license holders in households

Therefore, based on the results obtained from the survey, disaggregate choice models for motorcycle ownership were developed using the statistical software known as SPSS.

DISAGGREGATE CHOICE MODELS FOR MOTORCYCLE OWNERSHIP

Disaggregate choice models using multinomial logistic regression for motorcycle ownership was developed separately for individual motorcycle ownership and household motorcycle ownership. This is to explore the differences of explanatory variables used to develop the individual motorcycle ownership and household motorcycle ownership models.

Disaggregate choice model for individual motorcycle ownership

The explanatory variables used in the model and the coefficients obtained are as shown in Table 5 and the reference category is no motorcycle. The explanatory variables have been chosen to maximize model fit. Commuting distance and marital status was found to be insignificant and therefore were removed from the model. In this model, upon conducting various analyses using different combinations of income groups, it can be concluded that only 3 income groups that are significant. They are the low income (< RM 1000), medium income (RM 1001 – RM5000) and high income (>RM 5001).

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Table 5: Individual motorcycle ownership results

Terms on the 1 motorcycle alternative	Coefficients	Sig.
Intercept	-1.721	0.038
Age	0.031	0.016
Monthly expenditure on transportation	-0.029	0.002
Individual income: Low (<RM 1000)	1.466	0.038
Individual income: High (> RM 5001)	0*	-
Individual car ownership: 1 car	-0.593	0.048
Individual car ownership: 2 plus cars	-1.105	0.031
Individual car ownership: No car	0*	-
Race: Bumiputras	0.547	0.028
Race: Non-bumiputras	0*	-
Gender: Male	1.518	0.000
Gender: Female	0*	0*
Terms on the 2 plus motorcycles alternative	Coefficients	Sig.
Intercept	-5.585	0.000
Monthly expenditure on transportation	-0.040	0.046
Individual income: Low (<RM 1000)	2.141	0.094
Individual income: High (> RM 5001)	0*	-
Individual car ownership: 2 plus cars	2.530	0.006
Individual car ownership: No car	0*	-
Gender: Male	1.014	0.034
Gender: Female	0*	0*
Pseudo R-square		0.288

Note: * This parameter is set to 0 because it is redundant given the intercept term.

In Table 5, only parameters with significance values less than 0.05 (at 95% confidence interval) were shown. If the significance level is small (less than 0.05) then the parameter is different from 0. Therefore, parameters with significance values more than 0.05 were removed from the model.

Parameters with positive coefficients increase the likelihood of that response category and parameters with significant negative coefficients decrease the likelihood of that response category with respect to the reference category. Therefore, based on Table 5, for the one motorcycle alternative, negative coefficients were observed for both groups of car ownership. This shows that car ownership decreases the likelihood of owning a motorcycle. However, for the case of two plus motorcycles alternative, coefficients for the 2 plus cars are positive which means that for an individual who owns 2 or more cars, they are more likely to own 2 or more motorcycles. This situation occurred may be because this group of individuals belongs to the high income group. Apart from that, monthly expenditure on transportation also decreases the likelihood of motorcycle ownership.

Disaggregate choice model for household motorcycle ownership

The explanatory variables used in the model and the coefficients obtained are as shown in Table 6 and the reference category is no motorcycle. Household car ownership was found to be insignificant and was removed from the model.

Table 6: Household motorcycle ownership results

Terms on the 1 motorcycle alternative:	Coefficients	Sig.
Intercept	-2.228	0.000
Household income: < RM 1000	1.997	0.007
Household income: RM 1001 – RM 1500	1.299	0.031
Household income: RM 1501 – RM 2500	1.197	0.009
Household income: RM 2001 – RM 5000	1.178	0.007
Household income: > RM 5000	0*	-
Household members: > 6 persons	2.104	0.003
Household members: 3 – 6 persons	1.647	0.000
Household members: 1 – 2 persons	0*	-
Household car license holder: 1 person	-1.595	0.002
Household car license holder: 2 persons	-0.977	0.017
Household car license holder: 3 persons and more	0*	-
Household motorcycle license holder: 1 person	2.489	0.000
Household motorcycle license holder: 2 person	2.177	0.000
Household motorcycle license holder: 3 persons and more	0*	-
Terms on the 2 plus motorcycles alternative:	Coefficients	Sig.
Intercept	-2.335	0.000
Household income: < RM 1000	2.399	0.004
Household income: RM 1001 – RM 1500	2.666	0.000
Household income: RM 1501 – RM 2500	1.756	0.000
Household income: RM 2001 – RM 5000	1.739	0.000
Household income: > RM 5000	0*	-
Household members: > 6 persons	2.941	0.000
Household members: 3 – 6 persons	2.528	0.000
Household members: 1 – 2 persons	0*	-
Household car license holder: 1 person	-1.539	0.003
Household car license holder: 2 persons	-1.399	0.001
Household car license holder: 3 persons and more	0*	-
Household motorcycle license holder: 1 person	-1.172	0.026
Household motorcycle license holder: 2 person	1.084	0.010
Household motorcycle license holder: 3 persons and more	0*	-
Pseudo R-square	0.451	

Note: * This parameter is set to 0 because it is redundant given the intercept term.

As mentioned before, parameters with positive coefficients increase the likelihood of that response category and parameters with significant negative coefficients decrease the likelihood of that response category with respect to the reference category. Hence, the negative coefficients for household car license holder categories in Table 5 shows that households with at least one person having a car driving license will decrease the likelihood of owning any motorcycle. As well as for the 2 plus motorcycles

alternative, if there is only one motorcycle license holder in a household, the likelihood of owning two motorcycles will decrease.

CONCLUSION

Motorcycles, due to its small size and high maneuverability are a useful mode of transportation for commuting within the city area especially during traffic congestion. In Malaysia, there are approximately 5.8 million motorcycles on the roads as compared to 5 million passenger cars. Motorcycle ownership has also increased from 0.13 in year 1990 to 0.24 motorcycles per person in year 2002. Based on the survey conducted, motorcycles will continue to be one of the major modes of transportation in the near future especially among the low and middle income group people. Therefore, development of a motorcycle ownership model based on local travel demand is essential in order to have a better understanding on the trend of motorcycles ownership and the nature of motorcycle travel demand. By having this information, a better perspective to the future planning and development of traffic system could be carried out. This will assist in the identification of suitable strategies and countermeasure to address motorcycles traffic issues thus improving the safety and performance of traffic system in Malaysia.

REFERENCES

- Button, K., Ngoe, N. and Hine, J. (2003) "Modelling Vehicle Ownership And Use In Low Income Countries. In: *The Automobile*", Classics in Transport Analysis, pp 238 – 254.
- Dargay, J.M. (2002) "Determinants Of Car Ownership In Rural And Urban Areas: A Pseudo-Panel Analysis", *Transportation Research. Part E: Logistics & Transportation Review*, Vol. 38, No. 5, pp 351-366.
- Dissanayake, D. and Morikawa, T. (2002) "Household Travel Behavior In Developing Countries: Nested Logit Model Of Vehicle Ownership, Mode Choice, And Trip Chaining", *Transportation Research Record* 1805, pp 45 – 52.
- Harnen Sulistio (2003) "Modelling of Motorcycle Accidents at Non-Exclusive Motorcycle Lane Junctions in Malaysia", Ph.D. Thesis, Universiti Putra Malaysia.
- Highway Planning Unit, Ministry of Works Malaysia (2003) "Road Traffic Volume Malaysia 2001".
- Hsu, T.P., Dao, N.X. and Ahmad, F.M.S. (2003) "A Comparative Study on Motorcycle Traffic Development of Taiwan, Malaysian and Vietnam", *Journal of the Eastern Asia Society for Transportation Studies*, Vol. 5, pp 179 – 193.
- Medlock, K.B. and Soligo, R. (2002) "Car Ownership And Economic Development With Forecasts To The Year 2015", *Journal of Transport Economics and Policy*, Vol. 36, No. 2, pp 163 – 188.

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Radin Umar R.S., Billyamin I. and Ibrahim S. (2004) "Motorcycle Safety Program in Malaysia", Road Safety Seminar, 29 – 30 March 2004, Legend Hotel Kuala Lumpur.