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The Analysis of Household Car and Motorcycle Ownerships
Using Poisson Regression
(Case Study: Denpasar-Bali)

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Abstract

This study examines household factors which influence car and motorcycle ownerships in the city of Denpasar, Bali using a Poisson regression model. The study found that the increase in number of workers and students in a household may affect the probability of owning motorcycle by the household. Meanwhile, the increase in number of family member and total travel distance may affect household preference to own a car. In addition, car capacity and other factors may increase household preference to own a car. None of these variables, however, significantly influenced on both car and motorcycle ownerships. In other words, the household had a separate preference when purchasing either a car or a motorcycle. The sensitivity analyses show a-50% increase in number of workers and students may increase motorcycle ownership by 1 unit and a-50% increase in total travel distance by all household members may increase car ownership by 1 unit.

Keywords: *Motorcycle ownership, car ownership, household characteristics, poisson regression.*

Abstrak

Pada studi ini digunakan regresi Poisson *untuk menyelidiki faktor-faktor lokal rumah tangga yang dapat mempengaruhi kepemilikan mobil dan sepeda motor di kota Denpasar, Bali. Dari studi ini disimpulkan bahwa pertambahan jumlah pekerja dan pelajar/mahasiswa dalam satu rumah tangga secara signifikan dapat meningkatkan peluang kepemilikan sepeda motor. Sementara itu kepemilikan mobil secara signifikan dapat dipengaruhi oleh jumlah anggota keluarga, total jarak tempuh perjalanan oleh semua anggota keluarga, dan kapasitas mobil. Akan tetapi tidak ada faktor-faktor lokal rumah tangga yang berpengaruh sekaligus pada kepemilikan mobil dan sepeda motor. Dengan perkataan lain, satu rumah tangga mempunyai preferensi masing-masing di dalam keputusan untuk membeli sepeda motor atau mobil. Analisis sensitifitas memperlihatkan bahwa pertambahan sebesar 50% dari jumlah pekerja dan pelajar/mahasiswa dalam satu rumah tangga dapat meningkatkan kepemilikan sepeda motor sebesar satu unit dan peningkatan sebesar 50% total jarak tempuh perjalanan oleh semua anggota keluarga dapat meningkatkan kepemilikan mobil juga sebesar satu unit.*

Kata-kata Kunci: *Kepemilikan sepeda motor, kepemilikan mobil, karakteristik rumah tangga, regresi poisson.*

1. Introduction

As with any developing countries, Indonesia faces transportation problem including road congestion and high number of accidents. In order to sort such transportation problem out is to better understand the current situation, what is likely to happen in the future of the travel market and how the demand and supply in transportation work together (Sillaparcharn, 2007). In so doing, transport models are required to carry out traffic and travel demand forecasting. The majority of the models, however, have been derived from developed countries which frequently were not appropriate for use in developing countries. One particular problem found is that motorcycle is often disregarded or is not well considered in such models.

In Indonesia, motorcycle is widely used in several cities including the city of Denpasar in Bali Province. Due to the small size and the engine capacity of 100-150cc, motorcycles have higher mobility, particularly on the congested road. People use motorcycles for either short or long distance trips over many trip purposes including work, shopping, leisure, and education. There are two main reasons for this situation, firstly poor services of the existing public transport and secondly motorcycle is more practical to cope with traffic congestion and more efficient compared to either private cars or public transport.

In Bali, annually the registered motorcycles are almost 85% of the total vehicles with an average annual growth rate of approximately 11%. In 2007 there were 1,166,694 motorcycles in Bali among the 1,377,352

total registered vehicles (Statistics of Bali Province, 2008). In the capital city of Denpasar, the number of registered motorcycles in 2007 was 445,710 of the total of 549,668 registered vehicles (81%). During the daytime on weekdays, number of vehicles would be doubled about 1,000,000 units considering commuters and students trips to and from Denpasar (Statistics of the City of Denpasar, 2008).

There are three main modes in Bali including private cars, heavy vehicles (bus and truck) and motorcycles, and they share together the roadways including on arterial roads. This generates a variety of conflicts amongst the three modes quite frequently and particularly leads to high proportion of motorcycle accidents (State Police of Bali Province, 2008). Despite the fact that high proportion in motorcycle accidents, motorcycle ownership in the capital city of Denpasar remains high while the number of registered cars in 2007 was accounted only for 15% of total registered vehicles. During the period of 2003-2007, motorcycle ownership in the city of Denpasar in average rose by 14% (Statistics of the City of Denpasar, 2008) while car ownership accounted for 7%.

The high number of motorcycle ownership as well as motorcycle accident indicates the importance of a study focused on motorcycle particularly in developing countries. In order to deal with traffic problem, the interaction effect among car and motorcycle ownership should be investigated by understanding the household owning behaviour. Moreover, sort of substitution between cars and motorcycles may present and public transportation condition may affect car and motorcycle ownership in the city (Hsu and Lin, 2007; Hsu, et.al, 2007).

Therefore, a study on car and motorcycle ownerships based on local household characteristics is essential in present and future study of mode choices. Within a local boundary, a study on private vehicles especially car and motorcycle is required in order to identify solution and regulation concerning car and motorcycle in the traffic system, while a study on mode choice analyses a mode shift to/from car and motorcycle and their effect on the road network (Leong and Sadullah, 2007).

This paper examines car and motorcycle ownerships in the city of Denpasar, Bali using Poisson regression model. The model is constructed to analyse local household factors which influence on car and motorcycle ownerships. The model results would identify car and motorcycle ownerships pattern which could be used as an input for a future travel demand forecasting.

2. Previous Studies

Factors influencing motor vehicle ownership including car and motorcycle ownerships differ from one country to another. This is particularly concerned with the local traffic system and total income. In theory, there has not been a standard to determine a motor vehicle ownership. However, due to limited references on this subject, several important factors that may influence motorcycle ownership were considered from previous studies conducted in Taiwan and Malaysia. These two countries and Indonesia similarly have a high motorcycle ownership per 1000 population (Hsu and Lin, 2007; Hsu, et.al,, 2007, Leong and Sadullah, 2007). This condition rarely happened in western countries where motorcycle ownerships were very low.

A study investigating on motor vehicle ownership characteristics was conducted in Indonesia (Putranto, 2003). More specifically, the study focused on the influence of wealth level on motor vehicle ownership at municipality and regency levels. The wealth level was represented by the Gross Regional Domestic Product (GRDP). The data was collected in several provinces in Indonesia and analysed using linear regression. The predictor and dependent variables were the GRDP and number of registered motor vehicles at municipality and regency levels respectively. The study concluded that the GRDP at municipality level is more likely to influence motor vehicle (car and motorcycle) than at regency level. This may due to the fact that there have been a discrepancy of road network development between urban and rural areas.

A previous study conducted in Penang, Malaysia using multinomial logit model to examine motorcycle ownership (Leong and Sadullah, 2007). The study found that total monthly household income, car ownership, total number of driving licences in the household and number of household members influencing motorcycle ownership. In addition, motorcycle will remain as the main mode of transport in the near future, particularly in the group of low and middle income households.

A study has been conducted in Taipei (Taiwan) investigating on car and motorcycle ownerships with 336 samples using multinomial logit model (Hsu and Lin, 2007). This study is based on the assumption that when both a car and a motorcycle owned by the household, each will have a relation of substitution. The study concluded that the main reason for motorcycle and car ownerships was not cost, but utility factors. The increase in reliability as well as convenience of a car may increase car ownership and reduce motorcycle ownership. The increase of both reliability and convenience of a car may increase car ownership between 12%-29%.

Another study which also conducted in Taiwan used Poisson regression to investigate on car and motorcycle ownerships characteristics in three different cities, namely Taipei, Taichung and Kaohsiung (Hsu, et.al, 2007). The data is collected by household interviews for the three cities. There were 350, 200 and 194

household samples collected in Taipei, Taichung and Kaohsiung respectively. The study concluded that, in Taipei, due to the supply of Mass Rapid Transport (MRT), many people used public transportation instead of motorcycles and cars. As the result, in Taipei, both car and motorcycle ownerships were less than those motor vehicles ownerships in the other two cities. Meanwhile, income has different impact on car and motorcycle ownerships in the three cities. Income affected car ownership in Taipei and affected both car and motorcycle ownerships in Taichung. However, income has been found to have a negative influence on both motorcycle and car ownerships in Kaohsiung.

3. Case Study Area and Data Description

3.1 Case study area

Province of Bali has an area of 5,634.40 km^2 with the population is about 3.4 million. The island is widely known as a tourist destination. Most of popular tourist destinations are located in southern areas including Kuta, Sanur, and Nusa Dua. Therefore, these areas are the most densely populated areas than the other parts of Bali. The capital city Denpasar as shown in **Figure 1** is also located in the Southern Bali. It has an area of 127 km^2 with the population of 608,595 (Statistics of the City of Denpasar, 2008).

3.2 Data description

The study variables were based on local household characteristics in the city of Denpasar and several previous studies (Hsu and Lin, 2007, Hsu, et.al, 2007, Leong and Sadullah, 2007). The variables including total household income, factors influencing car and motorcycle ownership, numbers of family members, number of workers in a household, number of students in a household and total travel distance in a day by all family members at the households were used as the reference for primary data collection. The questionnaires were distributed with the stratified random sampling technique for the households which own motorcycle in the city of Denpasar, and 315 samples were effective.

Figures 2 showed all local household characteristics surveyed in the city of Denpasar. The figure indicated that almost half (46%) the households own 2 motorcycles or at least 1 car. However, this was not necessarily suggested that there 46% of the household own both 2 motorcycles and a car at once. Meanwhile, more than half (54%) of the respondent (household) did not own a car while less than 1% did not own a motorcycle. In addition to that, the minimum and maximum travel distance by all households members were 4 km and 360 km respectively and with an average travel distance of 38 km.

The high proportion of household members were 3, 4 and 5 person which accounted for by 27%, 34% and 20% respectively. This indicated that about 81% of the household at least had 1 child. Meanwhile, about 98.7 % members of household were working while the number of students in the household were about 69.2%. This showed that most of household members were working while the household with no students were accounted for by 30.8%.
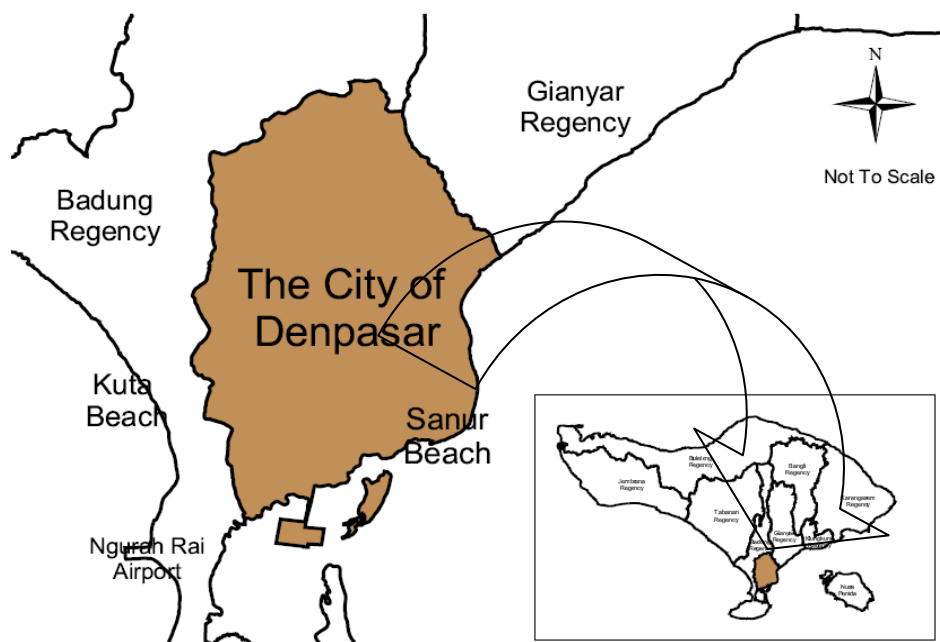

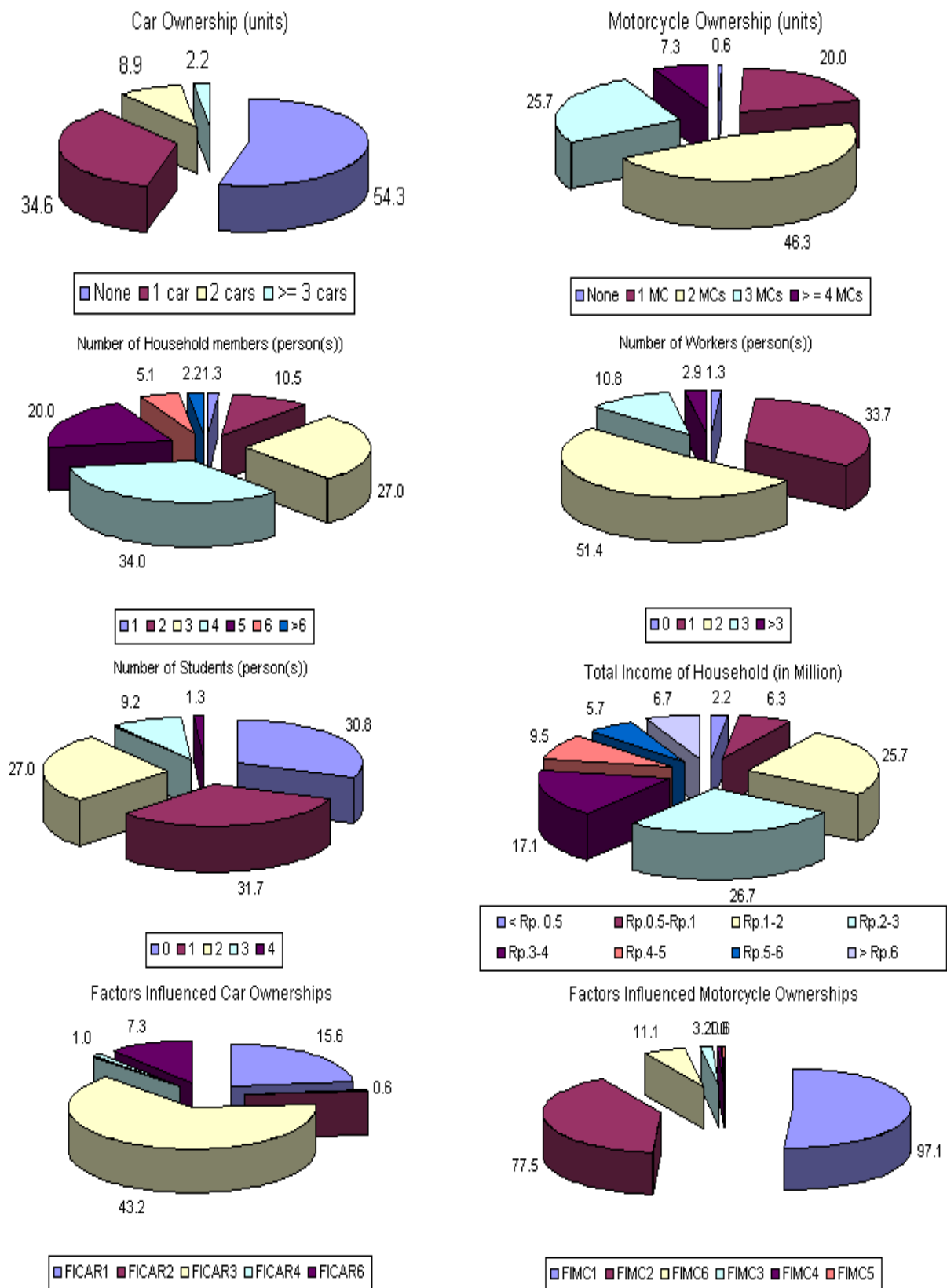**Figure 1. Case study area - the City of Denpasar**

Figure 2. Local household characteristics in Denpasar

Most of the household (87.6%) had total income less than Rp. 5 million per month while only 12% of the households earned more than Rp.5 million per month. For the reference, the cheapest price for a new car is about Rp. 100 million and for a new motorcycle is about Rp. 12 million.

Respondents or head of households which represented household's preferences were allowed to choose more than one answer for both factors influencing car and motorcycle ownerships. As the results, about 43.2% and 16% of households preferred to own a car because of its capability to accommodate more passengers and more convenience than a motorcycle respectively. Interestingly, only 1% respondent chose to purchase a car because no access to public transports and none because of high public transport fare. Most of the respondent (97.1%) preferred to own a motorcycle because of it was more efficient and low maintenance costs and about 77.5% because of its high mobility in both congested road and in an alley. These respondent preferences showed that public transports were not considered as the main mode of transport amongst the household members in the city of Denpasar.

4. Model Development

4.1 Poisson regression model

The Generalised Linear Model (GLM) technique is selected in this study due to its applicability over the normalization facility of non-linear data. The response or the dependent variable can be non-normal, and does not necessarily have to be continuous. In linear regression models, a dependent variable Y is linearly associated with a series of independent of explanatory variables (X). In the GLM, the relationship between $E(Y)$ and μ is specified by a non-linear link function called $g(\mu)$, and it can be in any form of Poisson, Normal, Gamma, Inverse Normal, Binomial and Multinomial distribution.

In order to estimate the GLM, the values of the parameters (β_0 through β_j and the scale parameter) are obtained by maximum likelihood estimation (MLE). Statistically, parameter estimation involves two stages, firstly, estimation of the parameter numerical value (the point estimate) and secondly, assessment of the parameter accuracy (standard error) by establishing a level of confidence in interval estimates. In estimating model parameter, an iterative weighted least squared algorithm was used. This algorithm is described as follows:

1. The raw data observations are used as a first approximation to mean (μ), which is then used to estimate model parameters β.

2. Significant improvement on those estimations may be made on these first approximations by recalcula-

tion. This is needed since μ and β are actually functions of each other. Therefore, it is not possible to estimate either of these simultaneously.

3. Alternatively, an iterative sequence of successive approximation is used until the differences in estimates between steps are too small to be significant. At this point, the algorithm is convergence and the coefficient estimations are presented.

Meanwhile, the ownership data used in this study came from actual observations, not from experimental observations. There may be either no car or motorcycle owned by the household during the time of observation. As a result, motor vehicle ownership are generally explained to be a discrete variable. Thus the values of dependent variables, i.e numbers of car and motorcycle owned by the household, belongs to count data. Therefore, the distribution of car and motorcycle ownerships at a site with respect of time was non normal, and the Poisson process was the best way to explain the data distributions (Dobson, 1997, Mc Cullagh and Nelder, 1989).

Under such circumstances, the standard least square regression would not fit to model the data. It was necessary, therefore, to examine in detail the alternative statistical distribution using a statistical technique such as the GLM with a quasi-Poisson. As with regression analysis, the GLM describes the existence of the relationship among various observable quantities. The GLM extends linear models to accommodate both non-normal response distributions and transformations to linearity (Mc Cullagh and Nelder, 1989; Dobson, 1997; Washington, et.al, 2003).

Car and motorcycle ownership rate (car or motorcycle owned by a household) were collected by home interview surveys in the city of Denpasar. To model such circumstances, Poisson regression, in which number of household is offset, is fitted to all models in order to estimate the deviance (dv) and degree of freedom (df). In this study a household is considered as a unit. In the initial model, in both equations, (1) and (2) motor vehicles (i.e. car and motorcycle) were assumed proportional to number of household, in which the Natural Logarithm (Ln) of sample size (N) was used as the offset. In this study, the offset value was fixed to be 1. The models had the general form that the logarithm of the hypothetical mean ownership rate in a household (μ) was equal to a linear combination of the explanatory variables with the logarithm of sample size (Ln (N)) as an offset.

$$\mathrm{Ln}\left(\frac{\mu}{N}\right) = \beta_0 + \beta_1 X_1 \ldots + \beta_i X_i \qquad (1)$$

or

$$\mathrm{Ln}(\mu) = \mathrm{Ln}(315) + \beta_0 + \beta_1 X_1 \ldots + \beta_i X_i \qquad (2)$$

where:

μ : Expected mean value of car and motorcycle ownership

N : Sample size / number of household (315)

β_i : Model Parameter

X_i : Explanatory/Independent Variables

4.2 Car and motorcycle ownership models

Independent (predictors) variables including income and factors influencing car and motorcycle ownerships were categorical, but numbers of family members, number of workers in a household, number of students in a household and total travel distances by all members of a household in a day were continuous as shown in **Table 1**.

Multicollinearity test were carried out for all independent continuous variables. **Table 2** shows that the correlation values were less than 0.8. This indicated that no strong correlation was found among these independent variables.

Categorical variables were represented using dummy variables following the coding system in SPSS, software used in this study. Study variables and their codes are shown in **Table 1**. Considering the data proportion shown in **Table 2**, some predictor variables

Table 2. Multicollinearity test

	Family	**Worker**	**Students**	**Travel_dist**
Family	1			
Worker	0.43	1		
Students	0.56	0.02	1	
Travel_dist	0.07	0.05	-0.02	1

can be neglected because of their small proportion. The hypothesis testing technique for proportions was used in this study to decide whether a classification could be eliminated or merged. The following typical test was used H_0: $p_i = 0$ and, H_a: $p_i \neq 0$, in which p_i is the proportion of a variable, H_0 = Null hypothesis and H_a = Alternate hypothesis.

Based on the test, FICAR2, FICAR4, FICAR5, FICAR6, FIMC3, FIMC4 and FIMC5 (marked with star in **Table 3**) were eliminated from the model development stage. This because they were statistically insignificant at the 5% level or at the 95% confidence limits including 0. Meanwhile, some categories were merged to generate a new category. Income1, Income2 and Income3 were merged together and generated a new category that is Income3 (total income < 2 million rupiahs). Categories Income8, Income7 and Income6 were merged together and generated a new category

Table 1. Study variables

No.	Dependent Variables	Variable Name and Coding
1.	Motorcycle ownership	MC
2.	Car ownership	Car
No.	**Independent Variables**	
1.	Numbers of family members in a household	Family
2.	Number of workers in a household	Worker
3.	Number of students in a household	Students
4.	Total travel distances by all member of the household in a day	Travel_dist
5.	Total household income per month	Income1 = Total income < Rp. 0.5 million rupiahs Income2 = $0.5 \leq$ total income < 1 million rupiahs Income3 = $1 \leq$ total income < 2 million rupiahs Income4 = $2 \leq$ total income < 3 million rupiahs Income5 = $3 \leq$ total income < 4 million rupiahs Income6 = $4 \leq$ total income < 5 million rupiahs Income7 = $5 \leq$ total income < 6 million rupiahs Income8 = Total income $\geq$ 6 million rupiahs
6.	Factors influencing motorcycle ownership in the household	FIMC1 = more efficient and low maintenance costs (1 = yes, 0 = no) FIMC2 = high mobility in congested road and in an alley (1= yes, 0 = no) FIMC3 = substitute to a car (1 = yes, 0 = no) FIMC4 = no access to public transport (1 = yes, 0 = no) FIMC5 = high public transport fare (1 = yes, 0 = no) FIMC6 = others (1 = yes, 0 = no)
7.	Factors influencing car ownership in a household	FICAR1 = more convenience than a motorcycle (1 = yes, 0 = no) FICAR2 = safety aspect (1 = yes, 0 = no) FICAR3 = accommodating more passenger (1 = yes, 0 = no) FICAR4 = no access to public transport (1 = yes, 0 = no) FICAR5 = high public transport fare (1 = yes, 0 = no) FICAR6 = others (1 = yes, 0 = no)

Table 3. Hypothesis testing

Description	X	N	p-value	95% Confidence Interval	
				Lower	Upper
Total income of household per month (Income)					
Total income < Rp. 0.5 million rupiahs (Income1)*	7	315	0.022	0.0	0.0
0.5 total income < 1 million rupiahs (Income2)*	20	315	0.063	0.0	0.1
1 ≤ total income < 2 million rupiahs (Income3)	81	315	0.257	0.2	0.3
2 ≤ total income < 3 million rupiahs (Income4)	84	315	0.267	0.2	0.3
3 ≤ total income < 4 million rupiahs (Income5)	54	315	0.171	0.1	0.2
4 ≤ total income < 5 million rupiahs (Income6)	30	315	0.095	0.1	0.1
5 ≤ total income < 6 million rupiahs (Income7)*	18	315	0.057	0.0	0.1
Total income ≥ 6 million rupiahs (Income8)*	21	315	0.067	0.0	0.1
Factors influencing motorcycle ownership by a household					
FIMC1	306	315	0.971	1.0	1.0
FIMC2	244	315	0.775	0.7	0.8
FIMC3*	10	315	0.032	0.0	0.1
FIMC4*	3	315	0.010	0.0	0.0
FIMC5*	2	315	0.006	0.0	0.0
FIMC6	35	315	0.111	0.1	0.1
Factors influencing car ownership by a household					
FICAR1	49	315	0.156	0.1	0.2
FICAR2*	2	315	0.006	0.0	0.0
FICAR3	136	315	0.432	0.4	0.5
FICAR4*	3	315	0.010	0.0	0.0
FICAR5*	0	315	0.000	0.0	0.0
FICAR6*	23	315	0.073	0.0	0.1

Note:
1. Respondents were allowed answering more than 1 factors which influence motorcycle and car ownerships
2. X = number of occurance (yes =1)
3. N = sample size

Income6 (total income ≥ 4 million rupiahs). Considering these results, two separate models were developed as follows:

$Ln(\mu_{car}) = Ln(315) + \beta_0+\beta_1 Family+\beta_2 Worker+\beta_3 Students+\beta_4 Income+\beta_5 Travel\_dist+\beta_6 FICAR1+\beta_7 FICAR3$, which represents car ownership model and,
$Ln(\mu_{mc}) = Ln(315) + \beta_0+\beta_1 Family+\beta_2 Worker+\beta_3 Students+\beta_4 Income+\beta_5 Travel\_dist+\beta_6 FIMC1+\beta_7 FIMC2+\beta_8 FIMC6$, which represents motorcycle ownership model.

Table 4 shows that both Poisson regression models were statistically fitted to the data. These were indicated with the ratio between *deviance* (dv) and degree of freedom (df) for the two models were less than 1.

Table 4. Goodness of fit

Model	Deviance (dv)	Degree of Freedom (df)	dv/df
Car Ownership (Car)	89.620	305	0.294
Motorcycle Ownership (MC)	83.389	304	0.274

5. Results and Discussions

Table 5 shows the model results. There were 3 (three) significant variables influencing motorcycle ownership at 95% confidence interval, including number of workers in a household, number of students in a household and high mobility of motorcycle in the congested road and in an alley. These variables were positively related to motorcycle ownership indicating that the increase in number of workers and students in a household may affect the probability of owning motorcycle by the household. In addition, the increase in congested roads in the city may affect household preference to own motorcycles.

For car ownership model, there were 4 (four) significant variables at 95% confidence interval including total household income less than 2 million rupiahs and between 2 and 3 million rupiahs, total travel distance by all family members in a day, and due to car capability to accommodate more passenger than a motorcycle. The (two) household income variables, however, were negatively related to car ownership. This is logical because a household with such range of income would not afford to purchase a car. A previous study conducted in Taiwan (Hsu, et.al, 2007), however, found that higher household income were negatively related to motorcycle

Table 5. Model results

Parameter	Motorcycle Ownership			Car Ownership		
	β	Std. Error	Sig.	β	Std. Error	Sig.
(Intercept)	-5.628*	0.1569	0.000	-2.655*	0.4190	0.000
[Income=3]	-0.121	0.0619	0.050	-0.746*	0.2528	.003
[Income=4]	-0.111	0.0594	0.063	-0.459*	0.2139	.032
[Income=5]	-0.075	0.0629	0.235	-0.318	0.2149	.139
Family	0.032	0.0231	0.167	0.123	0.0733	.094
Worker	0.152*	0.0307	0.000	-0.045	0.1034	.661
Students	0.107*	0.0251	0.000	0.006	0.0934	.950
Travel_dist	0.000	0.0007	0.630	0.005*	0.0018	.006
[FIMC1=1]	0.078	0.1315	0.552	-	-	-
[FIMC2=1]	0.172*	0.0508	0.001	-	-	-
[FIMC6=1]	0.029	0.0625	0.646	-	-	-
[FICAR1=1]	-	-	-	0.079	0.1741	0.651
[FICAR3=1]	-	-	-	2.464*	0.3048	0.000

where:

Income3	:	total income < 2 million rupiahs
Income4	:	2 ≤ total income < 3 million rupiahs
Income5	:	3 ≤ total income < 4 million rupiahs
Family	:	Number of family membes
Worker	:	Number of workers in a household
Students	:	Number of students in a household
Travel_dist	:	Total travel distance in a day by all family members
FIMC1	:	More eficient and low cost maintenance
FIMC2	:	High mobility in a congested road and in an alley
FIMC6	:	Owning motorcycle due to other factors
FICAR1	:	More convenience than a motorcycle
FICAR3	:	Accomodating more passenger than a motorcycle

1. * = Significant at 95% level of confidence
2. Reference categories:
   Income6,
   FIMC1=2,FIMC2=2, FIMC6=2,FICAR1=2,FICAR3=2

ownerhsip. This indicated that a household with higher income in Taiwan would prefer purchasing a car to a motorcycle.

The rest of significant variables shown in **Table 5** indicated that the increase in total travel distance by all family members, and car capacity may increase household preference to own a car. None of these significant variables significantly, however influenced on both car and motorcycle ownerships. In other words, the household had a separate preference when purchasing either a car or a motorcycle. In addition, the large constant coefficient (i.e.-5.628 and -2.655) in both models indicated that there will be some other factors which have not been considered in the models that may influence on motorcycle and car ownerships.

Sensitivity analyses were applied to these significant continuous variables that positively related to either car or motorcycle ownership. These include total travel distance by all family members for car ownership and number of workers and students in a household for motorcycle ownership (refer **Table 5**). Sensitivity analysis is essential to examine any significant distinction amongst local household use factors, which influences car and motorcycle

ownerships. An increase of 50% in these three significant variables is used to estimate the increase of car and motorcycle ownerships. The reason such increase taken is because high proportion of number of workers and students exists in the household. In fact, they were 51% and 32% of 2 workers and 4 students respectively in the household (refer **Figure 2**). Hence, such a-50% increase in number of workers and students suggests that at least 1 person of a household member becoming either a worker or a student.

Considering that other significant variables were held constant the equation, $Ln(\mu_{car}) = +0,152*Worker$, gives the result $\mu_{car} = exp.^{(0,152*0,5)} = 1,08$. This indicated that a-50% increase in number of workers in the household would increase motorcycle ownership by 1 unit. As summarised in **Table 6**, a-50% increase in number of students and total travel distance by all household members in a day, would also increase car and motorcycle ownerships respectively by 1 unit. Consequently, these will contribute more on road congestion and number of road accidents in the future.

Table 6. Sensitivity analyses

Models	Variables	Unit Changed
Motorcycle ownership	Worker	1,08
	Students	1,05
Car ownership	Travel_dist	1,00

Where:

Worker	:	Number of workers in a household
Students	:	Number of students in a household
Travel_dist	:	Total travel distance by all household members in a day

6. Conclusions

This study investigates household factors which influence car and motorcycle ownerships in the city of Denpasar, Bali using a Poisson regression model. The analyses show that the increase in number of workers and students in a household may affect the probability of owning motorcycle by the household. Meanwhile, the increase in number of total travel distance may affect household preference to own a car. In addition, car capacity may increase household preference to own a car. None of these significant variables significantly influenced on both car and motorcycle ownerships. In other words, the household had a separate preference when purchasing either a car or a motorcycle. The sensitivity analyses show a-50% increase in number of workers and students may increase motorcycle ownership by 1 unit and a-50% increase in total travel distance by all household members may increase car ownership by 1 unit.

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