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Car Ownership of Households in Sub-Urban Area in Makassar City

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Abstract The present study aims to grasp the car ownership characteristics of households in the sub-urban area in Makassar City, Indonesia. The study considers some exogenous characteristics of the households, such house types, family size, income, motorcycle ownership, trip number, and worker number. To construct the relationship between those characteristics and the car ownership, we applied the multinomial logit model approach. This study surveyed seven residential areas in the sub-urban area of the city. The survey conducted an interviewing method using a questionnaire sheet. The survey respondents as representative of the households, which selected randomly from the residential areas. The results show that the goodness of fit of the car ownership model is acceptable enough. Further, all of the exogenous variables significantly influence the households in car ownership. We expected that the results provide a basis for further studies such time valuation of car riders, mode choice model of the households, etc.

1 INTRODUCTION

In the last decade, the motor-vehicle ownership such car and motorcycle has increased rapidly in many cities in developing countries. For instance, the average annual growth rate approximately of the motorcycle is 11% in Bali, Indonesia [1], and 14% in Hanoi City, Vietnam [2].

The phenomenon leads to the road traffic problem such as traffic congestion increasing, traffic behavior changing from homogeneous to heterogeneous traffic, increasing of a traffic accident, etc. For example, regarding the traffic accident, motorcycle safety constitutes an increasingly significant in the cities. For example, motorcyclists contributed more than 60% of the road injuries on Malaysian roads [3]. In Thailand, 76% of the injured accident victims are either motorcycle drivers or passengers [4]. Especially in Indonesia, during 2003-2007 there were 70% of road accidents involved with motorcycles in Bali [1, 5].

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Essensially addressed to find a solution for the high growth auto-car, firstly we have to more attention to the car ownership. However, only a few previous studies have focused on this matter for Asian developing countries. For instance, Verma et al. [6] have studied car ownership behavior for urban young adults in India. Also, Luke [7] spent attention for car ownership of student in South Africa. For Indonesia case, Susantono et al. [8] have studied the the car ownership which related to trip pattern for Jabodetabek Area, as well as, Senbil et al. [9] have studied the motorcycle ownership and use in Jabotabek (Indonesia) Metropolitan. Putranto et al. [10] have explored characteristics of the private car and motorcycle ownership using aggregate data (1990-2000) by the quasi-logistic model. Also, Asri et al. [11] have focused on motorcycle ownership of households in Makassar City.

In contributing to the research field, the present paper attempts to grasp the car ownership of households in Makassar City, Indonesia. In this regard, this study applies the multinomial logit (MNL) model approach in constructing the relationship between the car ownership and some household characteristics. The rest of this paper is presented as follows. The next section presents the methodology, then result in presentations. Finally, the paper provides a discussion and conclusion.

2 THE STUDY METHODS

2.1 Multinomial Logit (MNL) Model Construction on the Car Ownership

The multinomial logit model is one of the models approaches to represent the relationship between endogenous (dependent) variable (Y) that categorical and one or more exogenous variables (X) that categorical and or continual. The multinomial logit model could be applied, when the endogenous variable consists of more than two categories.

The model has the assumption that the categories of the dependent variable result in Y follow the Bernoulli distribution. The probability function of the Y with the parameter □ is stated as below:

$$P(Y=y)=\gamma^{y}(1-\gamma)^{1-y} \tag{1}$$

Where y = 0, 1. Then, probabilities of each categories are P(Y=1) = and P(Y=0) = 1 – with E(y) = □, for 0≤□≤1.

The probability of the logistic regression that deals with n exogenous variables could be formulated as follows [12, 13]:

$$P(y|x)=\frac{e^{-(\beta_0+\beta_1x_1+\beta_2x_2+\ldots+\beta_nx_n)}}{1+e^{-(\beta_0+\beta_1x_1+\beta_2x_2+\ldots+\beta_nx_n)}} \tag{2}$$

Where, Xn is the exogeneous variables which have the relevant attributes to the endogeneous variable, Y, while In is the parameter of Xn have to estimate, and 0 is the specific constant of the model.

Regarding the above MNL model conception, this study constructs the MNL model to grasp the relationships between the car ownership as response variable (Y) and some identifying characteristics of households as exogenous variables (X). The following subsection will explain the specification of each variable that taking account into the MNL model.

2.2 Variable specification

Table 1 shows the attributes or attitudes and types of the model variables that taking account in this study. The table shows that the endogenous variable (car ownership of households) consists of four car ownership categories, i.e., 0, 1, 2, and > 2 units. Further, the exogenous variables that considered in this study include house type, family size, income, motorcycle ownership, worker number, and trip number.

Table 1. Variables and their attitude

Variables	Symbols	Attributes/Attitudes of the Variables
1. Car Ownership (Unit)	Y	a. 0 b. 1 c. 2 d. 3
2. House Type (m^2)	X_{HT}	a. ≤ 40 b. 40 – 50 c. 50 – 60 d. 60 – 70 e. 70 – 100 f. 100 – 150 g. > 150
3. Family Size (Person)	X_{FZ}	a. ≤ 2 b. 3 – 4 c. 5 – 6 d. 7 – 8 e. > 8
4. Income (IDR $1x10^6$)	X_{Inc}	a. ≤ 0.5 b. 0.5 – 1.0 c. 1.0 – 1.5 d. 1.5 – 2.0 e. > 2.0
5. Motorcycle Ownership (Unit)	X_{MCO}	a. 0 b. 1 c. 2 d. > 2
6. Worker Number (Person)	X_{WN}	a. 0 b. 1 c. 2 d. 3 e. > 3
7. Trip Number (Time/Day)	X_{TN}	a. 0 b. 1 c. 2 d. 3 e. > 3

2.3 Parameters estimation of the MNL model

This study adopts the maximum likelihood theory in estimating the parameter values of the MNL model. The procedure to estimate maximum likelihood value involves the development of a joint probability density function of the observed sample, called the likelihood function, through estimation of parameter values which maximize the likelihood function. The likelihood function in case of T observation face j categories results is defined as follows [14]:

$$L(\beta) = \prod_{\forall_t \in_T} \prod_{\forall_j \in_j} \left(P_{jt}(\beta)\right)^{\delta_{jt}} \tag{5}$$

Where δ_{jt} is chose indicator (=1 if j is occurred by observation t and 0, otherwise) and Pjt is the probability when the observation t gives event j. The solution to maximize the log-likelihood function is the second derivation of the function. In this study, the parameters values of the model are estimated by using statistical package software, i.e., STATA 12.0.

2.4 Data Collection

This study collected data from seven residential areas in the northern part of Makassar City, Indonesia. The data collection purposed to grasp the household characteristics in the residential areas. The survey implemented an interviewing method using a questionnaire sheet which involves questions about the household characteristics, such as house types, car and motorcycle ownership, family size, the trip number in a day, worker number of family

member, and income of households. In the survey, there were 686 respondents as representative of the households (±10% – 30% of the population), which selected randomly from the residential areas. Table 2 shows the characteristics of the residential areas such as name, location, house number and sample size in this survey.

Table 2. Characteristics of the residential areas

The Residential Areas	District	Width Area (Ha)	House Number (Units)	Number of Samples (Households)
1. Bukit Baruga (BB)	Tello	50.0	750	200
2. Bukit Khatulistiwa (BK)	Biringkanaya	10.0	425	116
3. Citra Sudiang Indah (CSI)	Biringkanaya	50.0	900	92
4. Griya Mulya Asri (GMA)	Biringkanaya	3.4	175	36
5. Nusa Tamalanrea Indah (NTI)	Tamalanrea	25.0	1055	110
6. Sudiang Nusa Indah (SNI)	Biringkanaya	5.0	98	11
7. Telkomas	Tamalanrea	10.0	315	121

3 RESULTS AND DISCUSSION

3.1 Data Description

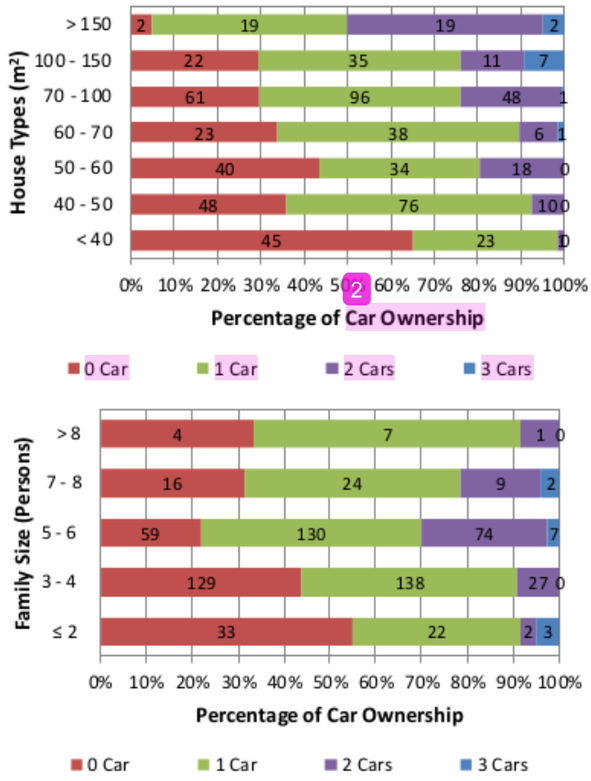
Table 3 shows the summary description of the survey data, such mean, standard deviation, skewness, and kurtosis of each the household characteristic. In further, Figure 1 shows the characteristic of car ownership which related to each household characteristic.

Table 3. Statistical descriptions of the household characteristics

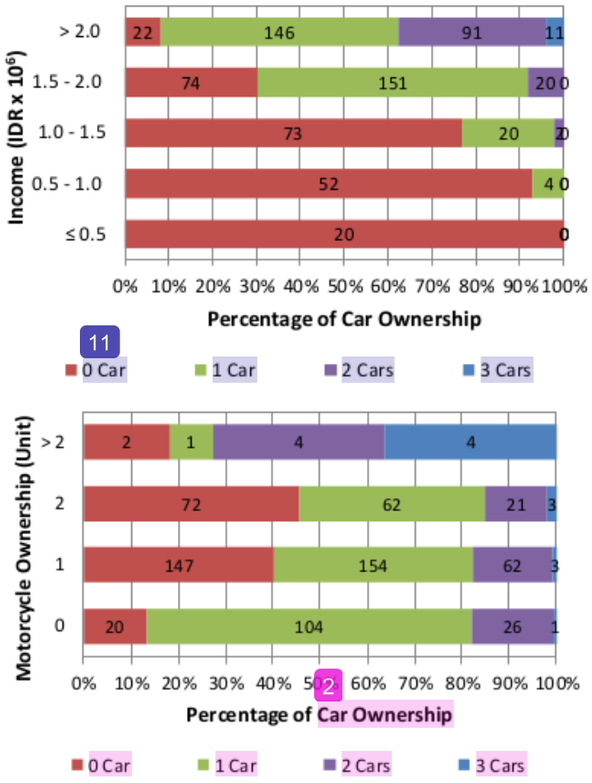
Household Characteristics	Symbols	Mean	Std. Deviation
1. Car Ownership (Unit)	Y	0.8455	0.7166
2. House Type (m^2)	X_{HT}	69.4723	35.96724
3. Family Size (Person)	X_{FZ}	5.0175	1.6451
4. Income (IDR $1x10^6$)	X_{Inc}	1.7590	0.5104
5. Motorcycle Ownership (Unit)	X_{MCO}	1.0423	0.7464
6. Worker Number (Person)	X_{WN}	1.5350	0.7175
7. Trip Number (Time/Day)	X_{TN}	1.1137	1.0975

Table 3 indicates that all of the household characteristics as the exogenous variables have a pattern in following the normal distribution. Therefore, we include all of those variables in calculating of the multinomial logit model for the car ownership model.
Figure 1a shows that mostly the households have at least one-unit car for each various type of the households. However, for the house type less than 40 m2, mostly the household did not have a car. In the other side, the households which their house type more than 70 m2,

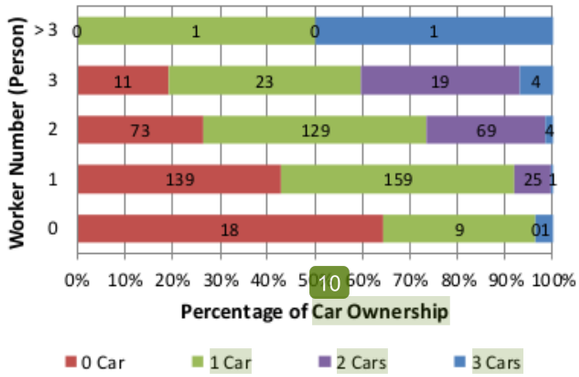
dominated car ownership for one until two cars. The phenomena of the car ownership are mostly similar when the car ownership is correspondence to income and worker number of the household as shown in Figure 1c, and Figure 1e. For income categories, the households which have income more than 1.5 million rupiahs, have one until two-unit cars, as well as, the households which have equal or more than two worker number categories. Regarding the family size and the trip number characteristics of the households, Figure 1b and Figure 1f show that here is no different proportion among categories of the family size and trip number when related to the car ownership. Also, Figure 1d describes the relationship phenomena between the car ownership and the motorcycle ownership of the household. In this regard, the more the household have a motorcycle, the more the households do not have cars. However, the households having more than two motorcycles are dominant having two units cars or more.

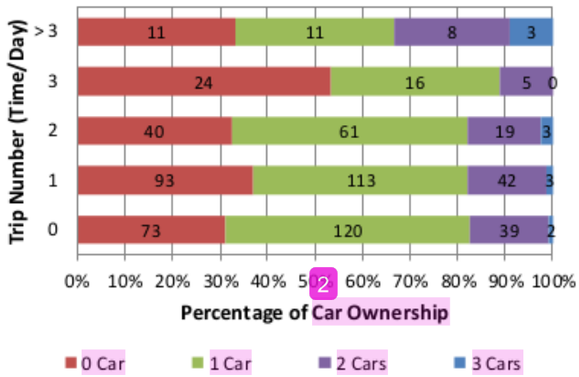


a. House Types vs. Car Ownership b. Family Size vs. Car Ownership



c. Income vs. Car Ownership d. Motorcycle Ownership vs. Car Ownership





e. Worker Number vs. Car Ownership f. Trip Number vs. Car Ownership

Fig.1. The Relationship Among Car Ownerships, and Characteristics of the Households

3.2 Model Estimation Result

Calibration and validation of the MNL model in estimating and assessing the parameters values of the car ownership model utilized statistical method approach. There were two kinds of statistical test which adopted, i.e., significant test (i.e., p value) to evaluate the contribution of each variable itself to the model, and the goodness of fit statistic test to validate the goodness of fit of the model. Table 4 presents the parameters values and statistical indicators of the model.

Table 4 shows that the car ownership model has enough acceptable level overall statistical fit indicator. The Likelihood ratio or pseudo-_2 indicators provided values 0.5141. Regarding Ramli et al., [12], and Asri et al., [13], the values indicate that the model is acceptable in enough significant level. In providing additional insight, Table 3 also shows the hit ratio value, correct percentage between observed data and predicted model, more than 50% that indicated the model is acceptable to describe the relationship between motorcycle ownership variable and the household characteristics variables.

Furthermore, Table 4 shows that all variables of the model have significantly influenced the car ownership of the households for the categories the households have a one-unit car and two-unit cars. However, all the variable influences ignored for the household have more than two-unit cars category. The ineffectiveness of the household income level on the car ownership due to the car purchasing agent proposes a very easy system for buying a car, nowadays.

Table 4. Calculation results of the model's parameters values

Variables	Parameters	Parameter values of utility functions of each car ownership category								
		1 Unit Car			2 Units Cars			> 2 Units Cars		
		B	Std. Err.	P>[z]	B	Std. Err.	P>[z]	B	Std. Err.	P>[z]
HouseTypes	β_{XHT}	0.0116	0.004	0.003	0.0229	0.006	0.000	0.0604	41.632	0.999
FamilySize	βX_{FZ}	0.4480	0.086	0.000	0.1557	0.122	0.200	0.3904	429.868	0.999
Income	βX_{Inc}	-3.8736	0.417	0.000	5.9441	0.885	0.000	49.5205	2308.742	0.983
MCOwn	βX_{MCO}	-0.9882	0.178	0.000	1.2622	0.292	0.000	-1.8309	1001.501	0.999
Family Work	βX_{WN}	0.5910	0.209	0.005	1.1408	0.341	0.001	0.5316	1174.271	1.000
NoTrip	βX_{TN}	-0.2692	0.117	0.022	-0.4394	0.192	0.022	-0.6903	652.223	0.999
Constant	β_o	3.5298	0.624	0.000	-11.9481	1.752	0.000	-127.1584	6919.613	0.985
Number of observation										658
Likelihood ratio, ρ^2:										0.5141

Note [1] Significant at 95%; The reference category is the car ownership = 0

4 CONCLUSSION

The influenced of household characteristics such house type, family size, income, motorcycle ownership, number of worked family member, and trip number in a day, on the car ownership of the households in the sub-urban area have been explored in this paper. Through utilization of multinomial logit (MNL) model approach, the relationship between the exogenous and the endogenous variables has been evaluated and assessed in case the car ownership of the residential households in Makassar, Indonesia.

The household characteristics such house types, family size, income, motorcycle ownership, number of worked family member, and trip number in a day, have become the variables which influenced the car ownership of the households. Finally, the results may lead to the influence on the time valuation of the drivers and travel mode choice of the households, two subjects for continuous studies of this paper in further.

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