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MOTORCYCLE IN THE PROVINCE OF WEST JAVA:

ITS GROWTH AND CHARACTERISTICS

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ABSTRACT

Motorcycle provides several positive aspects in providing mobility, but its rapid increase in ownership and usage should be anticipated. This study aims to develop a prediction model of motorcycle number and to develop a model of motorcycle ownership. Two simple linear regression models are able to predict the motorcycle growth in the Province of West Java, i.e. gross regional domestic product and number of population as the independent variables. Moreover, four ordered probit models are able to explain the motorcycle ownership in the capital city of West Java Province based in economic, personal, user's travel behavior, and motorcycle characteristics. This study explains that the phenomenon of the increase of motorcycle ownership was not influenced only by economic condition, but also by people's travel behavior and their activity. Thus, the anticipation will not be sufficient when focusing on economic aspect only, but also on travel and activity changes of the user.

Keywords: Motorcycle, Ownership, Modeling, Linear Regression, Ordered Probit.

INTRODUCTION

The Province of West Java is one of the areas with the highest population density in Indonesia after the DKI Jakarta. In 2005, the Province of West Java has a density as much as 1,126 people per square km, while DKI Jakarta has 13,344 people per square km [1]. This high population density is followed by rapid pace of development. As the need to travel will increase along with the development of the region [2], thus the Province of West Java faces a high increase in number of mobility demand. The increased demand is shown by the increase of vehicle ownership including motorcycle.

Motorcycle becomes an alternative transport mode for people in developing countries, including Indonesia. The low performance of public transport, high mobility of motorcycle, and affordable price of motorcycle become a reason for people to choose motorcycle as their mode of transport [3]. It occurs as people buy motorcycles before buying the car when the incomes become higher [4]. As a matter of fact, the ownership of motorcycle in the Province of West Java is eight people per unit [1], while the share of motorcycle is 71.69% compared with all motorized vehicle [5]. The proportion of two wheel and four-wheel vehicles in the City of Bandung were 57.17% (296,230 units) and 42.83% (221,942 units), respectively [4].

Sillaparcharn [6] says that in countries with rapid economic growth, e.g. Thailand, the problem of motorcycle growth becomes an important issue. The growth of the number of motorcycle affects the interaction of various types of vehicles and interaction of travel as well. Moreover, this significant increase of motorcycle causes many problems, namely the increase of accidents rate [7] including decreasing speed and increasing time delay for other road users [8].

There are several studies in modeling the growth of vehicle ownership, which mainly focused on car, e.g. Sillaparcharn [6], Potoglou and Kanaroglou [9], Dargay et al. [10], or Deng [11] among others. In modeling the growth of motorcycle, several studies have been done in

Asian countries. As an example, comparison of motorcycle ownership behavior in Hanoi City, Vietnam with other countries by Hai and Susilo [12]; dynamic discrete choice models to express the motorcycle ownership behavior and household response to policy by Tuan and Shimizu [13]; documentation of the changes in motorcycle ownership, motorcyclist mortality, and injury rates in China since 1987 by Zhang et al. [14]; investigation of the characteristics of motorcycle ownership and car ownership in three typical cities in Taiwan by Hsu et al. [15, 16] among others. In Indonesia, there are very limited studies focused on motorcycle ownership, while Petragradia et al. [4] and Putranto et al. [17] are the exception. As a matter of fact, comprehensive research has not been conducted in Indonesia [17].

With this background, this study aims to build a prediction model regarding the number of motorcycle in the province of West Java, Indonesia. This study will also elaborate the motorcycle ownership using dataset from the city of Bandung, as the capital city of the province of West Java.

Following this introduction, a brief description regarding motorization is provided in section two. Description regarding the study area and explanation regarding model development of the number of motorcycle in the province of West Java is explained in section three. Data description as an input for developing the motorcycle ownership and model estimations are provided in section four. The last section concludes this study.

THE GROWTH OF MOTORCYCLE

In developing countries of Asian region, the most significant growth is motorcycle. Number of motorcycle sales in Indonesia reached 5,851,962 million units in 2009, while at previous years

the number was 6,215,865 units [18]. That was 98% of the total number of vehicles with a growth rate as much as 33.3% [8].

It is a result of the increasing income in developing countries [19], and the low performance of existing public transport. Lubis [20] said the reasons for people to use motorcycle are because of saving, flexibility, poor quality service of public transportation, and the easiness to obtain. Saving is the main reason for people to choose motorcycle, as its fuel consumption is really efficient compared with other motorized mode of transport. It is easily understood that economic aspect becomes the main consideration, as Indonesia has a high proportion of low income group. Since the ratio of motorcycle ownership in Indonesia is still relatively low in ASEAN region and motorcycle industry in Indonesia is a growing industry, so that the potential growth of production is still very good in the future [20]. Moreover, Leong and Sadullah [21] and Petragradia et al. [4] stated that the significant affecting factors in the increase of motorcycle ownership are monthly household income, car ownership, number of family members who have car driving license and or motorcycle driving license, and number of family members. Senbil et al. [22] also stated that the increasing amount of income is followed by the increasing of private car ownership together with the increasing of motorcycle ownership.

Special attention needs to be addressed to the growth of motorcycle, since the growth of motorcycle results several transportation problems. First problem is high increase of congestion which causes the other problem, namely air pollution. The third problem is a long distance and high travel cost paid by the community with low income. Even though not all problems exist at present, but it becomes a big problem in the future [23]. Beside those effects, Ingram and Liu [24] also stated that motorcycle ownership can also reduce the use of public transport. Leong and Sadullah [21] described the interruption caused by motorcycle, while Gentile [25] explained the

weak ability of motorcycle in avoiding accident. Data published by the Police of Republic of Indonesia showed that the number of accidents caused by motorcycles increased threefold in 2000-2005, as much as 19,000 cases [20]. In Denpasar the capital of Bali Province, motorcycle accident contributes to about 80% of total road accidents. Out of those motorcycle accidents, 32% are fatal accidents [26]. Zhang et al. [14] reported that in China, motorcyclist fatalities and injuries increased 5.5-fold and 9.3-fold, respectively, between 1987 and 2001. Health data show that motorcycle accidents, which are more than car accidents, results significant mental health problems, from depression up to disorders due to trauma and stress [27].

STUDY AREA

Population of the Province of West Java was 42,693,951 peoples, where 50.39% of them were men [28]. From 1990 up to 2009, the population has increased from 31 million to 42 million (see Figure 1). Gross Regional Domestic Product (GRDP) per capita at current prices in 2007 reached IDR 14,309,520.21 with mid-year population as much as 42,099,284 people. In the last twenty years, the GRDP per capita has increased around 16-fold (see Figure 2). On the other hand, the growth of motorcycle in the last five years shows a drastic change as appears in Figure 3, while the growth rate of automobile does change much slower than motorcycle. As a note, these data has excluded Banten.

Bandung, as the capital city of the Province of West Java, has an area as much as 167.29 km^2. In 2009, 1,210,164 people out of 2,374,198 people were male. The population growth rate (PGR) was 1.90% and the average population density of Bandung City was 14,190.41 people/km^2 [28].

Figure 1 Number of Population in the Province of West Java [28]
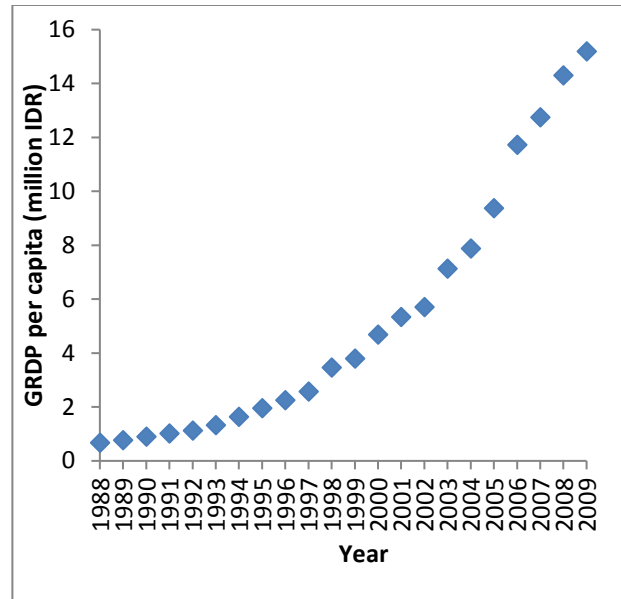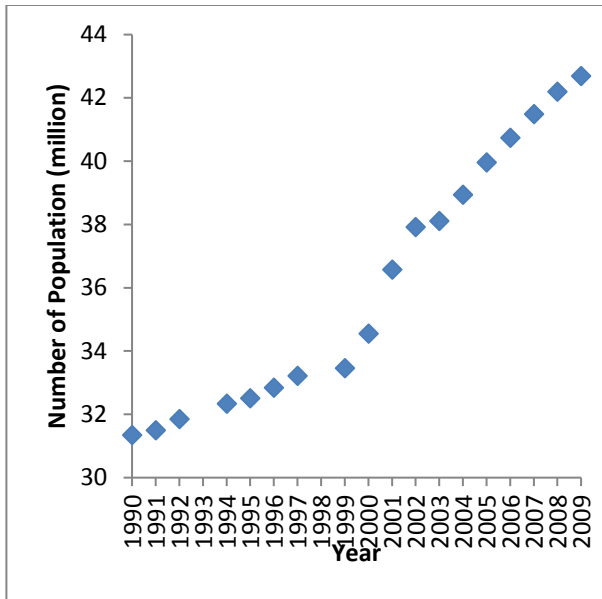

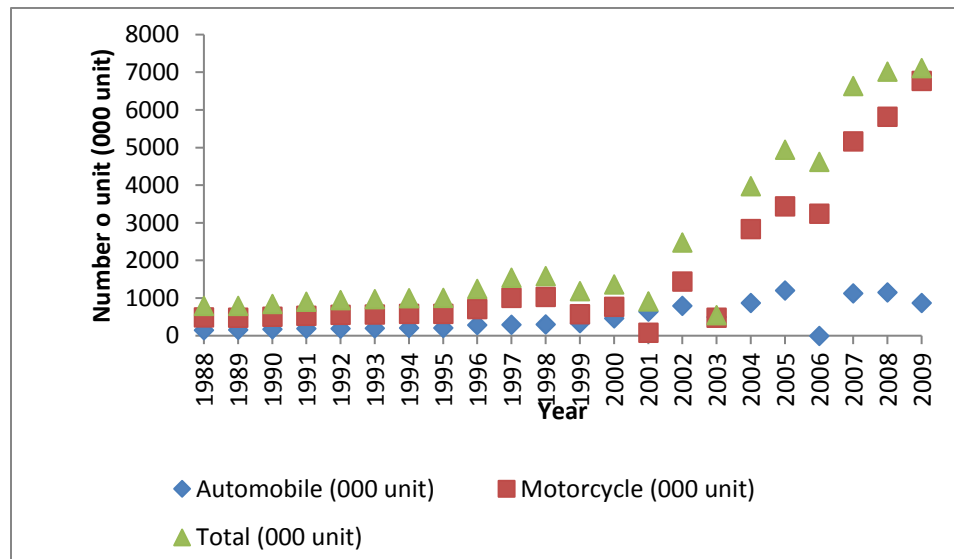Figure 2 GRDP per capita in the Province of West Java [28]

Figure 3 Number of Automobile in the Province of West Java [28]

MODEL ESTIMATION OF NUMBER OF MOTORCYCLE

According to several studies on the growth of motorcycle (for example Petragradia et al. [4], Sillaparchan [6], Putranto et al. [17], and Acharya [29]), there are many influencing factors to the

growth of motorcycle, e.g. GRDP, road length, annual rainfall, number of family members, income per capita, distance, and population [30]. As a matter of fact, there is a limitation on data availability to explain the motorization. This study was only able to collect time series data on number of motorized vehicle, population, and GRDP [30].

Using the available aggregate data of all cities and regencies from *Badan Pusat Statistik* of the Province of West Java in the period of 1988-2009 [28], a multiple linear regression was built. Several models with different specification have been estimated, while the best three were presented in Table 1. It shows that model with single predictor have a better result. Moreover, based on the value of Mean Square Error (MSE), model with population as dependent variable seems as performs better. Based on the model estimates, it can be inferred that number of motorcycle in the Province of West Java will increase by 55 for an addition of 1000 people. The number of motorcycle in this province will increase by 356000 units when there is an increase of GRDP as much as one million IDR.

Table 1 Estimation Results of Motorcycle Growth in the Province of West Java

Model	Variable	B	t	Sig.	*95% Confidence Interval for B*	
					Lower Bound	*Upper Bound*
1	Population	0.055	4.780	0.000	0.031	0.078
	$R^2 = 0.546$; p-value (F-test) = 0.000; MSE = 3.420×10^{12}					
2	GRDP	0.356	14.452	0.000	0.305	0.408
	$R^2 = 0.917$; p-value (F-test) = 0.000; MSE = 6.281×10^{12}					
3	Population	-0.008	-0.928	0.366	-0.025	0.010
	GRDP	0.388	9.203	0.000	0.299	0.476
	$R^2 = 0.920$; p-value (F-test) = 0.000					

MODEL ESTIMATION OF MOTORCYCLE OWNERSHIP

In order to develop a model regarding the ownership of motorcycle, this study collected data by distributing questionnaire to the user of motorcycle only. The questionnaires were distributed randomly in five regions of Bandung, namely Gede Bage, Ujung Berung, Tegalega, Bojonagara, and Cibeunying. A total of 1000 sets of questionnaires were distributed, where 200 sets were distributed for each region. The questionnaires were distributed by ten surveyors in ten days, i.e. from 22nd September until 2nd October 2010 [31].

Table 2 shows respondent's characteristics regarding social demographic. Respondent captured in this study was dominated by male with around 80%, which young user with an age range between 17-29 years old (65%) and 30-39 years old (20%). Main users have senior high school (49%) and undergraduate (31%) as their highest education. In this study, respondent are mainly student (52%), entrepreneur (18%), and worker in private sector (17%). Structure of household is young family with father, mother, and child (40%), which is followed with live alone (15%). This is in line with respondent's structure of age, which mainly is young user.

Most people who participated in this study have monthly income or allowance less than five million IDR (90%). Most of them has a half up to one million IDR (30%) and one up to 2.5 million IDR (29%). It confirms the number of motorcycle available in household, where around 47% and 36% of the respondent have one unit and two units, respectively. Respondent with three units or more is around 16%. This condition is also confirmed with the number of automobile, where 35% have no automobile and 39% have one unit. Economic characteristic of the respondent appears in Table 3.

Table 2 Respondent's Demographic Data

Variables		Proportion	Variables		Proportion
Gender	Male	82.16	Occupation	Student	52.30
	Female	17.84		Civil servant or military	7.65
Age	17 years old or younger	3.52		Private	16.72
	17-29 years old	64.82		Entrepreneur	18.13
	30-39 years old	19.80		Housewife	3.73
	40-49 years old	8.94		Retired or other	1.41
	50-59 years old	2.71	Structure of Household	Alone	14.50
	60 years old or older	0.20		Husband and wife only	8.06
Highest Education	Elementary school or less	1.80		Husband, wife, and child	40.18
	Junior high school	7.62		Husband, wife, child, and parent	10.17
	Senior high school	48.80		Husband, wife, and parent	1.71
	Diploma	7.11		Live with relative or friend	11.58
	Undergraduate	31.06			
	Graduate	3.61			

Table 3 Respondent's Economic Data

Variables		Proportion			Proportion
Monthly Income (million IDR)	less than 0.5	12.32	Number of Motorcycle	Not own	1.51
	0.5 - 1	29.26		One unit	46.83
	1 - 2.5	28.96		Two units	35.58
	2.5 - 5	18.44		Three units or more	16.08
	5 - 7.5	6.61	Number of Automobile	Not own	35.15
	7.5 - 10	1.60		One unit	39.38
	more than 10	2.81		Two units	19.74
				Three units or more	5.74

Travel characteristic of the respondent is presented in Table 4. Working and education are the main purpose in using motorcycle. Three main reasons for choosing motorcycle are time efficiency (39%), suitability with need (17%), and cheap operation cost (14%). Respondent mainly use motorcycle two times per day (36%), while one and three times per day have the same percentage (17%). Motorcycle was used for short to medium trips, i.e. up to eight

kilometers, as much as 56%. But, 40% of them used motorcycle for long trip also (more than eight kilometers). Around 75% of respondents used motorcycle in a range between 15 minutes up to two hours travel.

Table 4 Travel Characteristic Using Motorcycle

Variable		Proportion	Variable		Proportion
Activity when using motorcycle	sight seeing	19.36	Number of MC's usage per day	once time	17.59
	working	31.09		two times	35.78
	education	37.61		three times	16.38
	family and friend visits	2.71		four times	7.34
	other	8.22		more than four times	22.91
Reason to choose motorcycle	motorcycle is cheaper than car	8.71	Average distance using MC per day	less than 1 km	4.91
	time efficiency	38.64		1-2 km	10.82
	distance efficiency	5.61		2-4 km	17.33
	cheaper in operation cost	14.01		4-6 km	16.03
	suitability with need	17.32		6-8 km	11.42
	only able to buy motorcycle	4.80		more than 8 km	39.48
	cheap installment	2.70	Average travel time using MC per day	less than 15 min.	5.41
	other	7.61		15-30 min.	20.44
				30 min. - 1 hour	27.35
				1 -2 hour	28.46
				more than 2 hour	18.34

Model Estimation

For some polychotomous dependent variables, there is a natural order. The ordered logit or probit model is used for this case [32]. In this study, the number of motorcycle owned in each household has an ordered scale. The model is built around a latent regression in the same manner as the binomial probit model, $y^* = \mathbf{x'}\boldsymbol{\beta} + \varepsilon$, where y^* is unobserved. What we do observe is $y = 0$ if $y^* \leq 0$, $y = 1$ if $0 < y^* \leq \mu_1$, $y = 2$ if $\mu_1 < y^* \leq \mu_2$, . . ., $y = J$ if $\mu_{J-1} \leq y^*$. The μs are unknown parameters to be estimated with $\boldsymbol{\beta}$. For the same reasons as in the binomial probit model (which

is the special case of J = 1), we normalize the mean and variance of ε to zero and one. The probabilities are as follows, Prob (y = 0 | **x**) = Φ (**-x'β**), Prob (y = 1 | **x**) = Φ (μ₁ **- x'β**) **-** Φ (**x'β**), Prob (y = 2 | **x**) = Φ (μ₂ **- x'β**) **-** Φ (μ₁ **-x'β**), . . ., Prob (y = J | **x**) = 1 **-** Φ (μ_{J-1} **- x'β**) [33]. Estimation proceeds by maximum likelihood [32].

Four different models have been estimated, namely model based on economic characteristics, personal characteristics, travel characteristics, and motorcycle characteristics. The results of parameter estimation are provided in Table 5, Table 6, Table 7, and Table 8.

To test the goodness-of-fit of the model, the Deviance goodness-of-fit test was applied. The null hypothesis will be rejected, that the model fits, if the observed significance level for the goodness-of-fit statistics is small. Good models have large observed significance levels. In Table 5, Table 6, Table 7, and Table 8, the goodness-of-fit measures have large observed significance levels, so it appears that the models fit. Furthermore, the overall test of the null hypothesis of the model that the location coefficients for all variables in the model are 0, can be based on the change in -2 log-likelihood when the variables are added to a model that contains only the intercept [34]. From Table 5, Table 6, Table 7, and Table 8, it can be seen that the difference between the two log-likelihood – the chi-square – has an observed significance level much lower than 0.0005. It means the null hypothesis, that the model without predictors is as good as the model with the predictors, can be rejected. It also means that the models are fit.

Table 5 explains the relation between economic characteristics of user's household with the number of motorcycle owned. User with income less than a half million IDR seems to have less motorcycle. People with smaller number of autos owned in household are less likely to own higher number of motorcycle. This finding is in line with the status of house and motorcycle ownership. People who stay in house owned by parent and people who use motorcycle owned by

parent and user itself are more likely to have more motorcycle. This model explains that the owners of motorcycle are they who have medium to low economic status.

Table 5 Parameter Estimates of Motorcycle Ownership based on Economic Characteristics

Variables	Estimate	Std. Error	Wald	df	Sig.
Threshold					
[number of motor cycle = 1 unit]	-2.525	.213	140.483	1	.000
[number of motor cycle = 2 units]	-.228	.192	1.411	1	.235
[number of motor cycle = 3 units]	.891	.193	21.371	1	.000
Location					
Income [1 if less than a half million IDR, 0 otherwise]	-.211	.114	3.422	1	.064
House ownership [1 if owned by parent, 0 otherwise]	.269	.082	10.882	1	.001
Motorcycle ownership [1 if owned by user, 0 otherwise]	.551	.138	16.038	1	.000
Motorcycle ownership [1 if owned by parent, 0 otherwise]	.649	.145	19.930	1	.000
Number of auto owned [1 if not owned, 0 otherwise]	-1.117	.163	46.955	1	.000
Number of auto owned [1 if one unit, 0 otherwise]	-.842	.161	27.443	1	.000
Number of auto owned [1 if two units, 0 otherwise]	-.425	.170	6.252	1	.012
-2LL (0); -2LL (β); [χ^2; df.; p-value]		471.854; 344.033; [127.820; 7; .000]			
Deviance Goodness-of-Fit [χ^2; df.; p-value]		148.277; 122; .053			
R^2 [Cox and Snell; Nagelkerke; McFadden]		.121; .137; .060			
Test of Parallel Lines[χ^2; df.; p-value]		41.057; 14; .000			

The relationship between the number of motorcycle owned in household with personal characteristics of the users is explained in Table 6. Users with a range of age between 17-29 years old and 40-49 years old are likely to have more motorcycle. People with undergraduate as their highest education are less likely to have more motorcycle, while people who are student seem to own more motorcycle in their household. The model also shows that the smaller the amount of monthly income the smaller number of motorcycle they have. It is also interesting to note that people who own several types of driving license show tendency to have more motorcycle.

Table 6 Parameter Estimates of Motorcycle Ownership based on Personal Characteristics

	Estimate	Std. Error	Wald	df	Sig.
Threshold					
[number of motor cycle = 1 unit]	-2.259	.169	178.763	1	.000
[number of motor cycle = 2 units]	-.019	.137	.018	1	.892
[number of motor cycle = 3 units]	1.065	.140	57.839	1	.000
Location					
Age [1 if 17-29 years old, 0 otherwise]	.204	.105	3.789	1	.052
Age [1 if 40-49 years old, 0 otherwise]	.342	.140	5.978	1	.014
Education [1 if undergraduate, 0 otherwise]	-.204	.084	5.962	1	.015
Occupation [1 is student, 0 otherwise]	.471	.105	20.064	1	.000
Monthly income [1 if half million IDR, 0 otherwise]	-.760	.176	18.672	1	.000
Monthly income [1 if 0.5 – 1 million IDR, 0 otherwise]	-.457	.153	8.885	1	.003
Monthly income [1 if 1 – 2.5 million IDR, 0 otherwise]	-.495	.145	11.620	1	.001
Monthly income [1 if 2.5 – 5 million IDR, 0 otherwise]	-.327	.138	5.584	1	.018
Type of driving license [1 if owned more than one type, 0 otherwise]	.231	.078	8.847	1	.003
-2LL (0); -2LL (β); [χ^2; df.; p-value]			584.887; 509.636; [75.251; 9; .000]		
Deviance Goodness-of-Fit [χ^2; df.; p-value]			244.569; 231; .258		
R^2 [Cox and Snell; Nagelkerke; McFadden]			.074; .083; .036		
Test of Parallel Lines[χ^2; df.; p-value]			30.940; 18; .029		

Table 7 shows parameter estimates based on travel characteristics. People who make four or more trip per day are likely to own more motorcycle. When people traveled short distance, i.e. two kilometers or less, they are less likely to own more motorcycle. It is in line with travel time they spent per day, where people with shorter travel time are more likely to have less motorcycle. Moreover, this model reveals the decision to own many motorcycle are based on travel characteristics instead of price or operating cost.

From Table 8, it is found the significant variable of the characteristics of the motorcycle in explaining the motorcycle ownership. People who spent cost of ownership as much as 1 – 1.5

million IDR per year are more likely to have more motorcycle. Variable of operating cost shows that the higher operating cost the user spent the bigger number of motorcycles they have. On the other side, cheaper motorcycle seems as less interesting for people to select. It is surprising to know that people seems to have more motorcycle when they can pay by cash.

Table 7 Parameter Estimates of Motorcycle Ownership based on Travel Characteristics

	Estimate	Std. Error	Wald	df	Sig.
Threshold					
[number of motor cycle = 1 unit]	-2.535	.130	380.749	1	.000
[number of motor cycle = 2 units]	-.298	.076	15.324	1	.000
[number of motor cycle = 3 units]	.781	.079	97.753	1	.000
Location					
Usage per day [1 if four times or more, 0 otherwise]	.223	.080	7.804	1	.005
Distance traveled per day [1 if 2 km or less, 0 otherwise]	-.530	.108	24.035	1	.000
Travel time per day [1 if 0.5 – 1 hour, 0 otherwise]	-.240	.090	7.108	1	.008
Travel time per day [1 if 1-2 hour, 0 otherwise]	-.161	.090	3.202	1	.074
Reason [1 if mc is cheaper, 0 otherwise]	-.579	.102	32.568	1	.000
Reason [1 if mc's operating cost is cheaper, 0 otherwise]	-.246	.104	5.556	1	.018
-2LL (0); -2LL (β); [χ^2; df.; p-value]			325.958; 252.594; [73.365; 6; .000]		
Deviance Goodness-of-Fit [χ^2; df.; p-value]			87.760; 90; .547		
R^2 [Cox and Snell; Nagelkerke; McFadden]			.071; .080; .034		
Test of Parallel Lines[χ^2; df.; p-value]			19.127; 12; .086		

CONCLUSIONS

Two simple linear regression models show the significant variables affecting the growth of motorcycles in West Java Province are the population and GRDP. Analysis also show that for prediction purpose, model with population as dependent variable seems as performs better. Based on the model estimates, it can be predicted an increase of 55 unit of motorcycle for an addition of 1000 people in the Province of West Java. The number of motorcycle in this province will increase by 356000 units when there is an increase of GRDP as much as one million IDR.

Table 8 Parameter Estimates of Motorcycle Ownership based on Motor Cycle Characteristics

	Estimate	Std. Error	Wald	df	Sig.
Threshold					
[number of motor cycle = 1 unit]	-2.524	.159	252.253	1	.000
[number of motor cycle = 2 units]	-.281	.122	5.306	1	.021
[number of motor cycle = 3 units]	.820	.124	43.823	1	.000
Location					
Cost of ownership [1 if 1 – 1.5 million IDR, 0 otherwise]	.431	.138	9.734	1	.002
Operating cost [1 if 100K IDR or less, 0 otherwise]	-.213	.099	4.587	1	.032
Operating cost [1 if 200-300 K IDR, 0 otherwise]	.187	.093	3.997	1	.046
Operating cost [1 if 300-400 K IDR, 0 otherwise]	.258	.112	5.270	1	.022
Price of mc [1 if 10 million IDR or less, 0 otherwise]	-.730	.131	31.191	1	.000
Price of mc [1 if 10-20 million IDR, 0 otherwise]	-.354	.112	9.930	1	.002
Method of payment [1 if cash, 0 otherwise]	.190	.073	6.741	1	.009
-2LL (0); -2LL (β); [χ^2; df.; p-value]		419.811; 323.476; [96.335; 7; .000]			
Deviance Goodness-of-Fit [χ^2; df.; p-value]		130.492; 122; .283			
R^2 [Cox and Snell; Nagelkerke; McFadden]		.093; .105; .045			
Test of Parallel Lines[χ^2; df.; p-value]		25.131; 14; .033			

This study also reports four ordered probit models, where statistical measures of goodness-of-fit show the fitness of the models. Model about the relationship between economic characteristics of user's household with the number of motorcycle owned explains that the owners of motorcycle are they who have medium to low economic status. This finding is also supported by the findings found in second model, i.e. model based on personal characteristics. Young user and those who are in productive age seems to have more motorcycle. The model also found that it should be anticipated the migration from motorcycle user to auto's user, as people who owned motorcycle are those who own multiple driving license.

Based on model regarding travel characteristics, it reveals the reason to make a decision to own many motorcycle are travel characteristics instead of price or operating cost. It also suggests more consideration on people's captivity to motorcycle, as motorcycle provides better

benefit and higher suitability with people's travel activity. Moreover, the model based on the characteristics of the motorcycle reveals that cheaper motorcycle seems as less interesting for people to select and people seems to have more motorcycle when they can pay by cash.

This study explains the phenomenon of the increase of motorcycle ownership was not influenced only by economic condition, but also by people's travel behavior and their activity. Thus, it is understandable that people will still select to have more motorcycle when they become wealthier. Besides its flexibility and suitability with people's activity, to own a good motorcycle express a higher status in community also.

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