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Do Household Characteristics Influence Private Car and Motorcycle Ownership? Evidence From A Case Study in Yogyakarta Urban Area, Indonesia

Dewi Prathita Rachmi [a,c,*], Muhammad Zudhy Irawan [b], Dewanti Dewanti [a,b]

[a] Department of Civil Engineering, Faculty of Engineering, Universitas Negeri Yogyakarta, Yogyakarta 55281, Indonesia
[b] Department of Civil and Environmental Engineering, Universitas Gadjah Mada, Jalan Grafika No. 2, Sleman 55281, Indonesia
[c] Center for Transportation and Logistic Studies Universitas Gadjah Mada, Jl. Kemuning Blok M3, Sleman 55281, Indonesia

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ABSTRACT

Yogyakarta is listed among the cities with the worst congestion in Indonesia. Besides, the development of Yogyakarta has now expanded to the surrounding area and agglomerated into the Yogyakarta Urban Area (KPY). Private vehicle ownership is closely correlated to the characteristics of households. This study aims to analyze the correlation of the level of private vehicle ownership with the characteristics of households and the correlation of private vehicle ownership towards the responses of households with transportation policies that will be implemented in the future.

This study fully used secondary data. The total respondents were 8,810 households, and the research location was the Yogyakarta Urban Area (KPY). The path analysis was employed to find out the causal relation between variables and the contribution between variables in the analysis. The variables used were gender, age, education level of the heads of households, total household income, the number of adult family members (≥ 17 years old), the number of children (<17 years old), the number of working family members, total motorcycle licenses in a household, total driver's licenses in a household, total motorcycle ownership in a household, total car ownership in a household, and the responses of households to the transportation policies that will be applied.

The results of the study show that motorcycle ownership in a household is influenced by gender, age, the level of education of the heads of households, total household income, the number of adult family members, the number of children, the number of working family members, and total motorcycle licenses in a household. Meanwhile, car ownership in a household is influenced by age, total household income, the number of working family members, and total driver's licenses in a household. There is also a correlation between motorcycle and car ownership. Increasing car ownership in a household has a positive correlation with motorcycle ownership. Furthermore, motorcycle ownership has a good significance value and a positive correlation with pedestrianization policies prioritizing public transportation in the Mangkubumi-Malioboro-Kraton area.

1. Introduction

The number of vehicle sales in Indonesia dominates the Southeast Asian market [1]. In 2015, total motorcycle sales in Indonesia reached 70% (6,708,384 vehicles) of the total sales in Southeast Asia. Meanwhile, car sales amounted to 33% (1,013,191 vehicles) of the total sales in Southeast Asia. Indonesia's congestion is a level up three positions compared to the previous year, sixth place in Asia, below Thailand, Iran, the Philippines, Turkey, and India [2]. Five cities in Indonesia are included in the top one hundred cities with the worst traffic jams, and Yogyakarta is one of them [3].

In 2005, Yogyakarta City had 226,414 motorcycles and 32,069 cars [4]. Ten years later, data showed that vehicles reached 399,615 motorcycles and 54,548 cars [5]. During that period, motorized private vehicle ownership increased by more than 70%. On the other hand, public transportation in Yogyakarta has not shown good

*Corresponding author.
E-mail: dewiprathita@gmail.com

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performance. The evaluation performance of Trans Jogja (urban public transportation in Yogyakarta) showed that the average load factor was only 15%, the headway was 28 minutes, and the distance between bus stops was 1.8 km [6]. The evaluation results have yet to fulfil the technical instructions issued by the Ministry of Transportation. The recommendation mention that the distance between bus stops is around 200-400 meters [7], and the headway is around 2-10 minutes [8].

The data presented that the number of private vehicle owners is high and has become the primary mode of travel for people in Indonesia, especially in the City of Yogyakarta. Travel is associated with negative externalities such as congestion and pollution [9]. The existence of car mode as the leading choice in daily mobility has caused high congestion and environmental costs [10]. Also, the unavailability of effective and efficient public transportation exacerbates the condition. The congestion problem that has arisen still needs to be resolved.

Private vehicle ownership has closely related to the characteristics of the household. Understanding the relationship between household characteristics and private vehicle ownership can help decipher transportation problems. Private vehicle ownership is related to household characteristics [11]–[15]. Car ownership is increasingly recognized as an essential step in estimating travel demand [16]. Besides that, the phenomenon of urban sprawl occurs in cities in Indonesia, including the city of Yogyakarta. The Regional Spatial Planning Coordinating Board conveyed that the development of the City of Yogyakarta has now expanded to the surrounding areas and agglomerated into the Yogyakarta Urban Area (KPY) [17]. Urban areas have main non-agricultural activities and serve as urban settlements.

Through the path analysis method, this research was conducted to determine the relationship between household characteristics and private vehicle ownership in the Yogyakarta urban area. This study aims to analyze the relationship between the level of private vehicle ownership and household characteristics and the relationship between the level of private vehicle ownership and household responses to transportation policies that will be implemented in the future. Research related to private vehicle ownership and household characteristics in Yogyakarta is limited. The results of this study can be used as a reference for compiling and implementing policies in solving transportation problems that arise in the Yogyakarta urban area.

2. Method

The method of analysis in this study consists of the following:

a. Multicollinearity Test

The multicollinearity test aims to determine the correlation between exogenous variables. Exogenous variables are considered to have passed the test if the VIF value is not more than 10 (<10) and the tolerance value is greater than 0.1 (>0.1).

b. Path Analysis

Path analysis is used to determine household factors that influence motorized vehicle ownership. It is also to clarify the relation of the resident to alternative transportation policies.

2.1 Research Location

The research location covered Yogyakarta Urban Area (KPY). Based on the data from the Department of Land and Spatial Planning of the Special Region of Yogyakarta, Yogyakarta Urban Area consists of all areas of the City of Yogyakarta, some areas of Bantul Regency, and some areas of Sleman Regency. Yogyakarta Urban Area has an area of 19,651.8 hectares consisting of 71 villages.

2.1 Data

The data to be used in this study were entirely secondary data. The primary data used in this study were the characteristics of the commuters collected by the Department of Transportation of the Special Region of Yogyakarta in collaboration with the Center for Transportation and Logistic Studies Universitas Gadjah Mada in 2015.

The respondents in this study were people who lived and had activities in Yogyakarta Urban Area. The interview data in the Department of Transportation were general. Therefore, to meet the needs of the research analyses, data enrichment was needed. In addition to the secondary data mentioned above, other supporting data, such as population, population density, and the growth of motorized vehicles obtained from the Central Bureau of Statistics, were also needed.

The population in this study was households in Yogyakarta Urban Area. According to the data from the BPS, there were 330,407 households in Yogyakarta Urban Area in 2015. The respondents were taken proportionally from the households in each administrative village in Yogyakarta Urban Area. The samples were 8,810

respondents, which based on Yount's table, the minimum sampling is 1% of the population. In this case, the samples were as many as 3,305 respondents. The number of samples can also be calculated using Slovin's formula. If the error rate is 1.5%, the number of samples needed should be at least 8,063 household respondents. According to the calculation of the number of samples needed, it can be said that this research had sufficient samples to represent the population with a small error rate.

3. Result and Discussion

Analysis of the causal relationship between household variables and motor vehicle ownership uses path analysis on SEM AMOS version 23.

3.1 Model framework of the analysis

The exogenous variables used are the characteristics of the head of the household and the household. The head of the household characteristics consists of gender, age, and education level. The household characteristics consist of total monthly income, number of adults, number of children, number of working family members, car driver's license ownership, and motorcycle driver's license ownership. The endogenous variables used are the number of motorcycles and car ownership in each household and the option policy to reduce motorized private vehicle users.

The model framework can be seen in Figure 1. The model concept is head of household and household characteristics connected in one direction to the total motorcycles and car ownership. Furthermore, a two-way line connects the variable total motorcycle and car ownership. Motorcycle and car ownership variables are connected in one direction with household responses to the alternative policies. Two alternative policies are offered. The first alternative policy is limiting motorized vehicles at KPY and implementing a progressive parking system. The second alternative policy is the implementation of pedestrianization and prioritizing public transportation in the Mangkubumi-Malioboro Kraton area. The hypothesis of the analysis model shows in Figure 2. It is assumed that the results of the analysis of all variables are positively correlated.

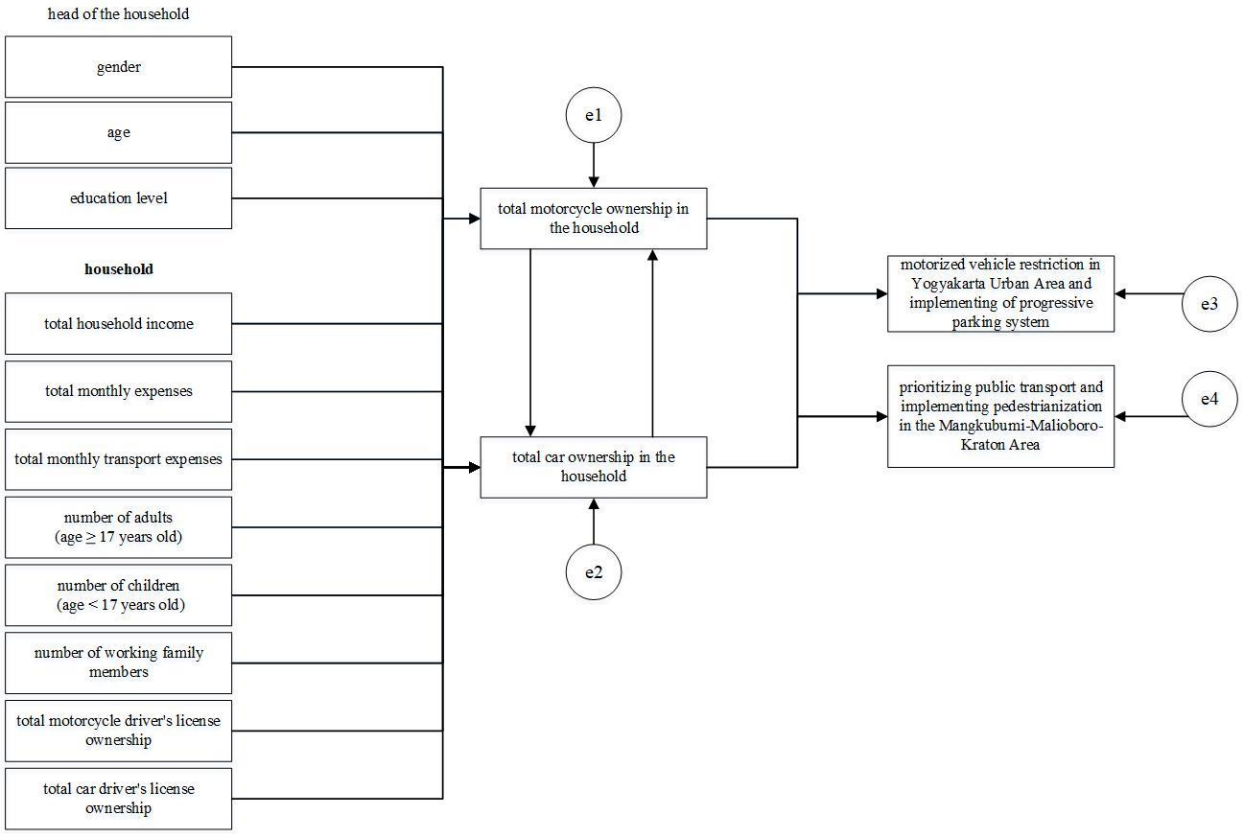

Figure 1. Model Framework

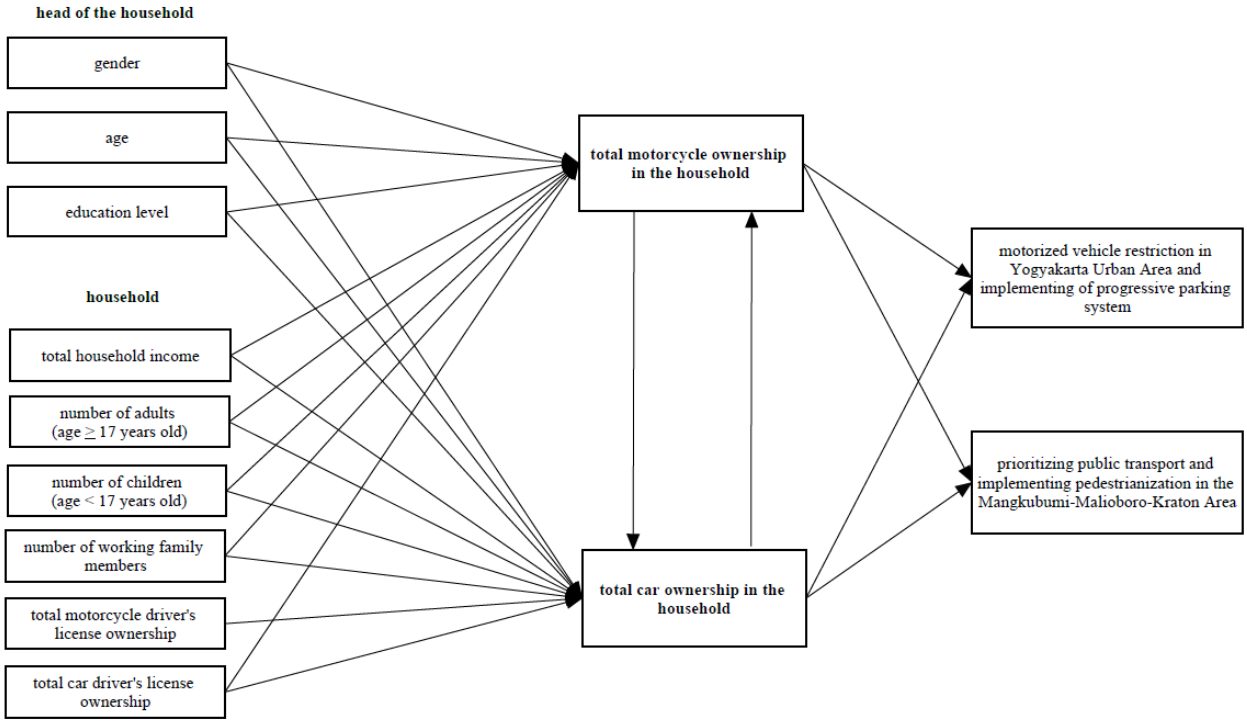

Figure 2. Hypothesis Result

3.2 Multicollinearity Test

The variable's value will pass the multicollinearity test if VIF (variance inflation factor) value is less than 10 (<10) and the tolerance value is greater than (>0.1). Table 1. shows that all variables have a tolerance value greater than 0.1 (> 0.1) and a VIF value less than 10 (<10). It can be concluded that all variables pass the multicollinearity test.

Table 1. Multicollinearity Test

Variable	Tolerance	VIF
gender	0.881	1.135
age	0.692	1.446
education level	0.627	1.595
total household income	0.729	1.371
total monthly transport expenses	0.890	1.124
number of adults (age ≥ 17 years old)	0.570	1.755
number of children (age < 17 years old)	0.783	1.278
number of working family members	0.755	1.324
total motorcycle driver's license ownership	0.567	1.763
total car driver's license ownership	0.770	1.298

3.3 Path Analysis

A model must fit the goodness of fit (GOF) test. According to Golob and Golob (2001) and Lewis (2017), there are several indicators used to assess the output of path analysis, such as the value of the goodness of fit index (GFI) > 0.9, the value of the root mean square error (RMSEA) <0.08, and the adjusted goodness of fit (AGFI) value> 0.9. The result of the GOF for the model is the GFI value of 0.975, the RMSEA value of 0.079, and the AGFI value of 0.943. Thus, it can be said that the model has passed the goodness of fit test. The technique used in the calculation of the analysis was asymptotically distribution free (ADF). The strength of path analysis can show the calculation results for direct, indirect, and total effects. Positive and negative relationships are part of estimated values, which can be compared in the analysis results. A positive estimation value means the dominant influence is in the data group with a large value code. A negative estimation value means the dominant influence is in the data group with a small value code. The method's weakness is only calculating a continuous relationship between associated variables without knowing the restriction. Table 2. shows the estimated value of the model calculation results.

Table 2. Estimated Value of Calculation Results Path Analysis

exogenous variable	endogenous variable											
	motorcycle			car			motorized vehicle restriction in Yogyakarta Urban Area and implementing of a progressive parking system			prioritizing public transport and implementing pedestrianization in the Mangkubumi-Malioboro-Kraton Area		
	indirect	*direct*	*total*	*indirect*	*direct*	*total*	*indirect*	*direct*	*total*	*indirect*	*direct*	*total*
head of the household												
gender	-0.02	0.155	0.135	-0.012	-0.014	-0.026	0.003		0.003	0.001		0.001
age	0.016	-0.052	-0.036	0.003	0.018	0.021	-0.002		-0.002			
education level	-0.005	0.036	0.031	-0.003	-0.003	-0.006	0.001		0.001			
household												
total household income	0.062	0.266	0.328	-0.028	0.107	0.079	-0.002		-0.002	0.002		0.002
number of adults (age ≥ 17 years old)	-0.012	0.281	0.268	-0.023	0.007	-0.016	0.003		0.003	0.002		0.002
number of children (age < 17 years old)	-0.008	0.054	0.046	-0.004	-0.006	-0.01	0.001		0.001			
number of working family members	-0.007	-0.052	-0.059	0.005	-0.014	-0.009						
total car driver's license ownership	0.197		0.197	-0.017	0.269	0.252	-0.014		-0.014	0.001		0.001
total motorcycle driver's license ownership	-0.014	0.401	0.387	-0.033	0.015	-0.018	0.004		0.004	0.003		0.003
total motorcycle ownership in the household	-0.063		-0.063	0.005	-0.086	-0.081	0.005	0.009	0.013		0.007	0.007
total car ownership in the household	-0.049	0.78	0.731	-0.063		-0.063	0.01	-0.064	-0.054	0.006	-0.003	0.002

Total Effect

The total effect results can be seen in Figure 3. The total effect on motorcycle ownership shows that the variables of gender, education level, income, number of adults (age > 17 years), number of children (age < 17 years), and motorcycle driver's license ownership have a positive relation. In contrast, the variables for age and number of working family members have a negative relation. A positive relation to the gender variable means that the male head of the household influences the increase in motorcycle ownership in the household. Positive relation for the education variable means that the increase in motorcycle ownership is affected by the education level of the head of the household. The age variable shows a negative relation, the younger age of the head of the household will tend to affect the increase in motorcycle ownership. The income variable shows that the higher the household income, the higher the number of motorcycle owners. The higher number of adults and children in households, the higher the number of motorcycle owners. Motorcycle driver's license ownership in the household also relates to motorcycle ownership. Based on the estimated value, variables that have a positive relation with significant value are motorcycle driver's license ownership, household income, number of adults, gender of the head of the household, number of children, and education level of the head of the household. Compared to others, motorcycle driver's license ownership has the most significant influence on motorcycle ownership. The number of children in the household has the least effect.

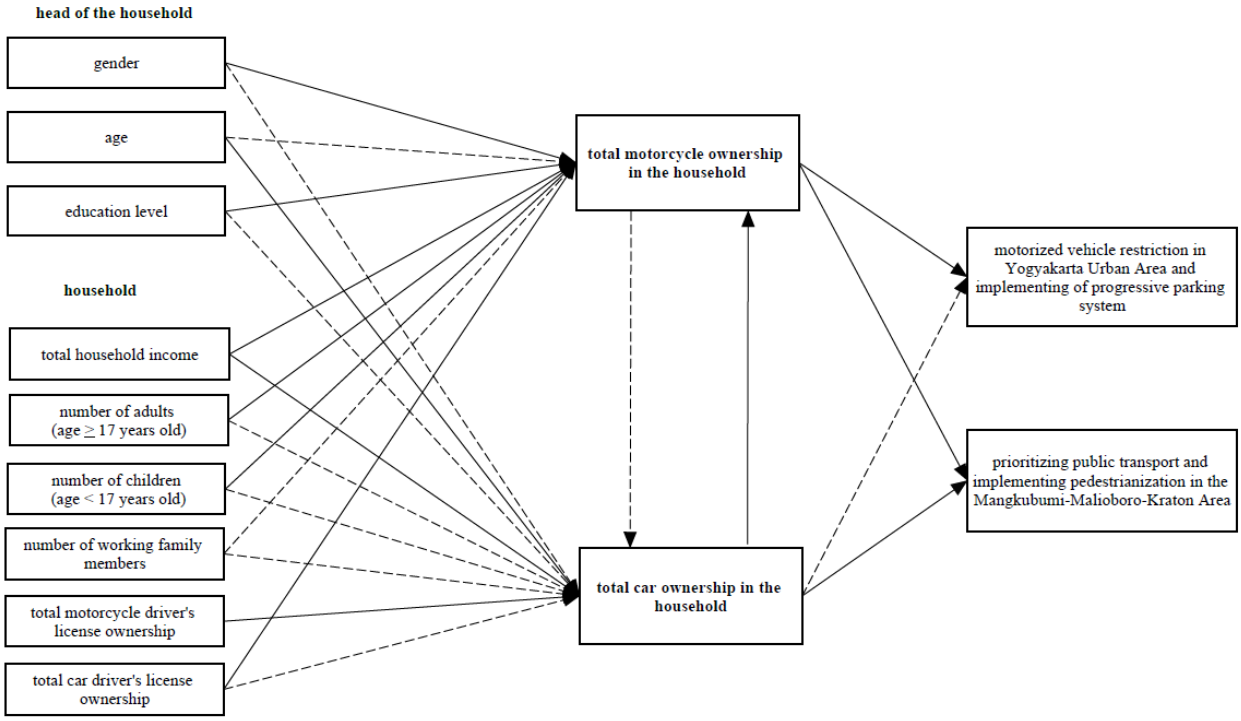

Figure 3. Total Effect

The estimated value of the total effect of car ownership shows slightly different results from motorcycle ownership. Positive relation is only indicated by age, total monthly income, and car driver's license ownership. The positive relation of the age variable means that car ownership increases with the addition of the age of the head of the household. The income variable shows that the higher the household income, the higher the number of car ownership. The car driver's license ownership variable also shows a similar relation. Based on the estimated value, variables that have a positive relation with significant value are car driver's license ownership, household income, and the age of the head of the household. Compared to others, car driver's license ownership significantly influences car ownership in the household.

The positive value of the relationship between total household car ownership and policy can be interpreted as households with higher total car ownership respond well to the policy of prioritizing public transportation and implementing pedestrianization in the Mangkubumi-Malioboro-Kraton area. The negative value on car ownership and policy can be interpreted as households with increasing total car ownership rejecting limiting motorized vehicles in the Yogyakarta Urban Area and applying a progressive parking system.

Direct Effect

The direct effect results can be seen in Figure 4. The direct effect is the direct relation between variables without being influenced by other variables. The result analysis shows that the direct effect between exogenous and endogenous variables is similar to the total effect. The difference is in the number of adults and total car ownership in the household, which shows a positive relationship. The increasing number of adults affected the increase in car ownership in the household. Other variables consisting of gender, education level of the head of the household, total household income, number of adults, number of children, car driving license ownership, and motorcycle driving license ownership in the household indicate a positive relationship to motorcycle ownership in the household. The variables of age and total working family members negatively relate to total motorcycle ownership. As explained in the results of the total effect, the male family head has more influence on the increase in motorcycle ownership in the household.

The education level of the head of the household influences motorcycle ownership. Meanwhile, the younger age of the head of household tends to affect the increase in household ownership of the motorcycle. The higher value of the total income variable correlates with increasing the number of motorcycle owners. The increasing number of family members with children affects the number of motorcycle owners. Total motorcycle driving license ownership in the household positively relates to total motorcycle ownership. The more household members have motorcycle licenses affected to increasing number of motorcycle owners. However, it is necessary to have a separate study on the mutually influencing relationship between the variable motorcycle driving license ownership and the number of motorcycle owners.

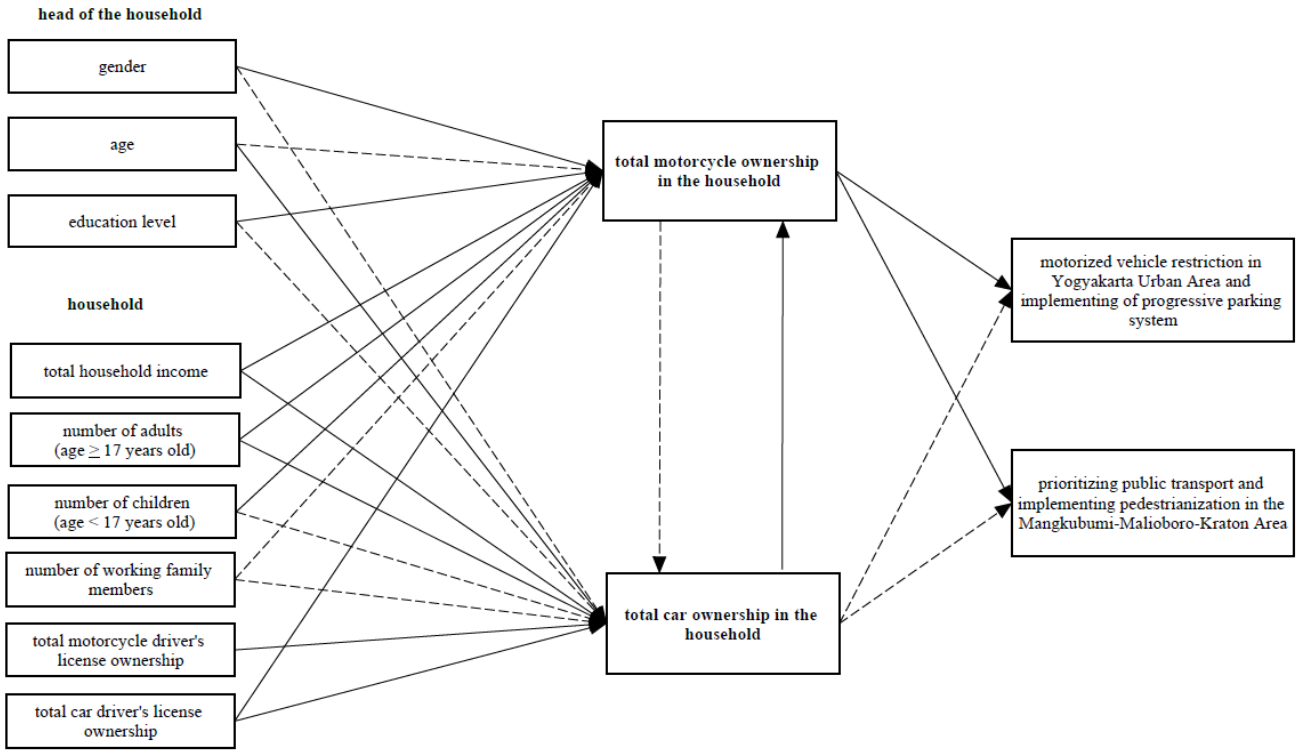

Figure 4. Direct Effect

The results for the household variable on the number of car owners show that the age of the head of the household, total income, number of adults, total motorcycle driver's license ownership and total car driver's license ownership in the household has a positive value to total car ownership. Variable gender, education level, number of children, and working family members have a negative value. In general, the result has a similar result to the total effect. The difference is in the household's variable number of adult and motorcycle driver's licenses. The increase in the number of family members will affect the increase in car ownership in the household. In addition, the relationship between total motorcycle ownership and total car ownership shows a similar relationship to the results of the total effect.

Meanwhile, positive relationships have been shown between total motorcycle ownership with the two policies offered. The negative result found on the relationship of household car ownership to pedestrianization policies and prioritizing public transport and the application of pedestrianization in the Mangkubumi-Malioboro-Kraton area shows a positive result.

Indirect effect

The indirect effect results are shown in Figure 5. The indirect effect analysis shows the indirect relationship of exogenous variables to endogenous variables caused by other exogenous variables. The variables of gender, age, education level of the head of the household, number of adults, number of children, and motorcycle license ownership have opposite values than the direct effect. The outcome of the female head of household has a greater influence value. The younger head of the household tends to increase the number of motorcycles owned by the household. The level of education has a positive relationship with motorcycle ownership. The estimated value of the variable number of adults, the number of children, and the total ownership of a driver's license in the family for motorcycle ownership has a negative value. Meanwhile, the value of the education level of the head of the family, household income, and the number of adults for car ownership has a negative value.

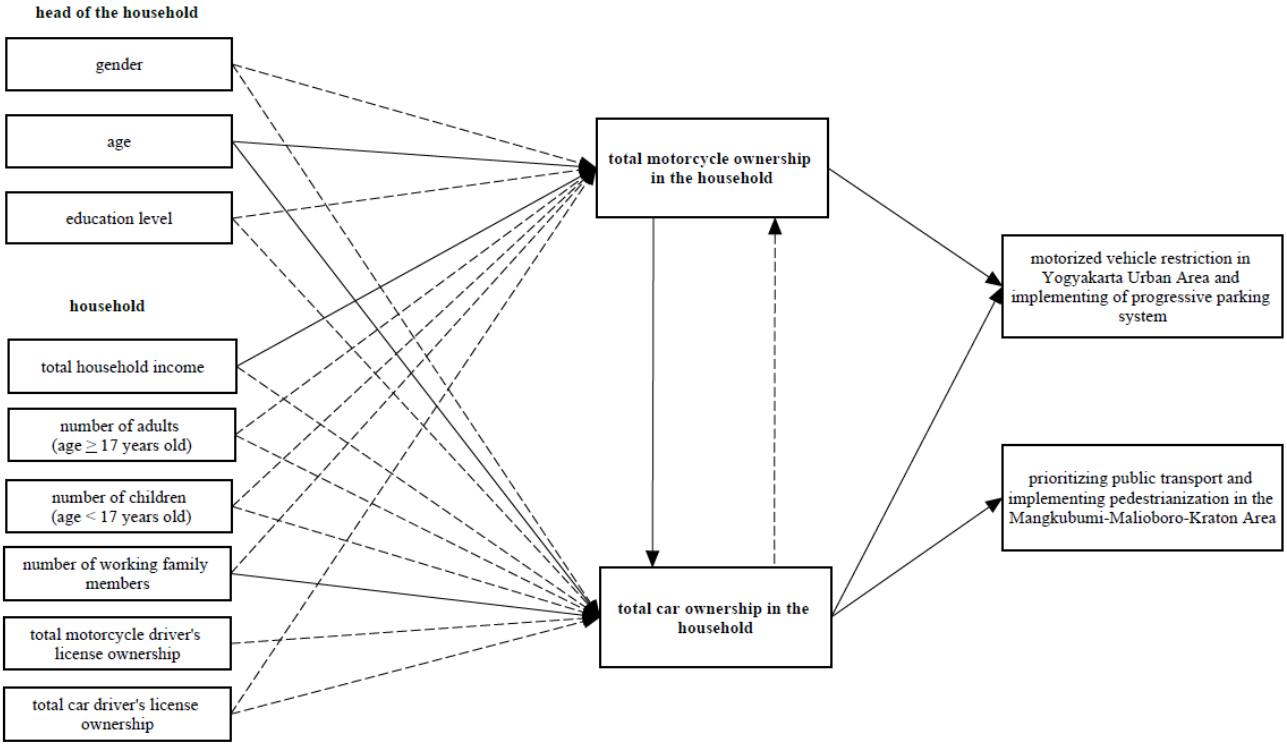

Figure 5. Indirect Effect

Negative values mean that the effect of other exogenous variables reduces the possible influence on the total private vehicle ownership variable, the endogenous variable. The value of the indirect effect is relatively low. The reduction value resulting from the indirect effect does not affect the direct effect value.

The Signification of Total Effect

Figure 6. shows the correlation between path analysis variables with a good significance value. A significance value is considered good if it has a value of less than 10%. The smaller the significance value, the higher the level of truth of the correlation between variables. Several variables with a good significance level can be obtained from the modelling that has been done. In the correlation between household characteristics and motorcycle ownership, the variables with a high level of truth are gender, age, the level of education of the head of the household, total household income, the number of family members aged 17 or more, the number of family members under the age of 17, the number of working family members, total motorcycles licenses in the household, and total driver's licenses in the household. Meanwhile, the variables in the household that have a good significance value on the car owners are less than the total motorcycle ownership. The variables in the household that have a significance value below 10% are the age of the head of the household, total household income, the number of working members, and total driver's licenses in the household.

The reciprocal relationship between motorcycle and car ownership variables in the household has a good significance value. Therefore, it can be interpreted that the ownership of both vehicles significantly influences each other. However, car ownership positively correlates with motorcycle ownership in the household, and motorcycle ownership negatively correlates with car ownership. An increase in household car ownership will affect a rise in household motorcycle ownership. Meanwhile, the increase in motorcycle ownership does not affect car ownership.

The correlation between motor vehicle ownership and the policies is significant. Motorcycle ownership has a good significance value and is positively correlated with the pedestrianization policy, which prioritizes public transportation in the Mangkubumi-Malioboro-Kraton area. Car ownership has a good significance value and negatively correlates with the vehicle restriction policy in the Yogyakarta Urban Area and the application of the progressive parking system. The growth of household motorcycle ownership is in line with the acceptance of alternative policies prioritizing public transportation and implementing pedestrianization in the Mangkubumi-Malioboro-Kraton area. Meanwhile, the growth of household car ownership rejection of an alternative policy limiting motorized vehicles in the Yogyakarta urban area and implementing a progressive parking system.

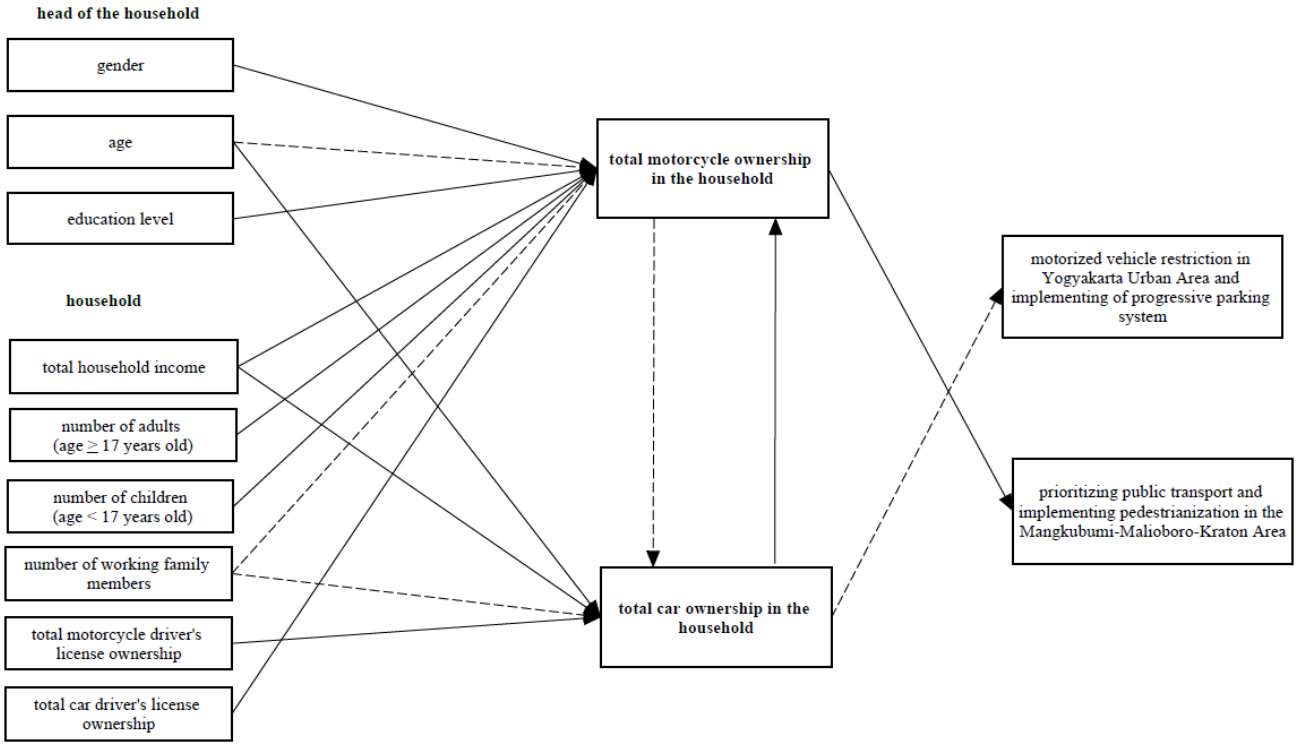

Figure 6. The signification of Total Effect

4. Conclusions

With the current number of private vehicles, applying private vehicle restrictions is urgent. In implementing the policies, the government can prioritize the car ownership restriction. The analyses show that increasing car ownership affects motorcycle ownership, but car ownership will continue to increase even though there is no increase in motorcycle ownership. Another fact also indicates that the higher the car ownership in a household, the stronger the rejection of the alternative policies of vehicle restriction in Yogyakarta Urban Area and the application of the progressive parking system. Nevertheless, reducing motorcycle ownership is also essential.

Based on the results of the analyses, it can be seen that the higher the motorcycle ownership in the household, the higher the possibility of the household agreeing to the alternative policies prioritizing public transportation and pedestrianization in the Mangkubumi-Malioboro-Kraton area. Therefore, the park-and-ride policies can be applied. The policies can integrate private vehicles and public transportation to realize pedestrian areas.

The analyses also show that the increasing motorcycle license ownership affects the total motorcycle ownership in the household. The increasing driver's license ownership also affects the total car ownership in the household. Therefore, the government needs to be stricter in issuing a driver's license

Age and total income variables positively correlate to the increase in car ownership in the household. Cars have a higher level of prestige and comfort. To reduce cars, the government needs to provide public transportation with a better comfort level than cars and campaigns to make public transport more prestigious than private cars.

The variable number of children has a positive relationship to motorcycle ownership in the household. It can be associated with the presence of children who do not have a driving license but ride a motorcycle. Therefore, taking action and educating underage motorcycle users is necessary. The government policy on the school zoning system can be justified. It is hoped that the students' distance to school will be closed and can be reached only by walking or cycling. If the distance to schools is too far, it is necessary to provide school buses so that school children are monitored by the mode they use when traveling to school and returning home.

The variable number of adults shows a positive and significant relationship to motorcycle ownership in the household. It can be interpreted that private vehicles are the primary transportation mode for people to fulfill their daily activities. It is necessary to provide comfortable and safe public transportation so that people are not dependent on private vehicles. In addition, it can be done with the Transit Oriented Development (TOD) approach. Mixed use of space, people can complete their daily activities in a radius that is still reachable by walking or by cycling. The dense

and mixed concept indirectly impacts reducing the use of private vehicles in supporting daily activities [18].

Acknowledgement

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