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The Fuel Consumption and Non Linear Model Metropolitan and Large City Transportation System

Mudjiastuti Handajani

Abstract**—**The national economy development affects the vehicle ownership which ultimately increases fuel consumption. The rise of the vehicle ownership is dominated by the increasing number of motorcycles. This research aims to analyze and identify the characteristics of fuel consumption, the city transportation system, and to analyze the relationship and the effect of the city transportation system on the fuel consumption. A multivariable analysis is used in this study. The data analysis techniques include: a Multivariate Multivariable Analysis by using the R software. More than 84% of fuel on Java is consumed in metropolitan and large cities. The city transportation system variables that strongly effect the fuel consumption are population, public vehicles, private vehicles and private bus. This method can be developed to control the fuel consumption by considering the urban transport system and city tipology. The effect can reducing subsidy on the fuel consumption, increasing state economic.

Keywords**—**city, consumption, fuel, transportation

I. Introduction

IN 1983, Indonesia has a total of 5 million units of vehicles; in 2003 the number grew quickly and reached over 20 million units or 7.2% each year [4]. The development of the national economy affects the vehicle ownership which will increase the fuel consumption [7]. The growth of vehicle ownership is dominated by motorcycles. [4] states that fuel consumption for transportation in Indonesia has risen sharply. If in 1993 fuel consumption was around 200 million oil-equivalent barrels (sbm), in 2003 it doubled to 400 million oil-equivalent barrels. The transportation sector is the largest fuel consumer [12], which is around 50% of the world fuel consumption, road transportation in developed countries consumes around 80% of the entire fuel consumption in the transportation sector. In developing countries, energy consumption in the transportation sector is 70 % [15]. The transportation sector is the largest fuel consumer and in the status quo, the need for fuel is bigger than the government's capability in providing subsidies [19].

Therefore, the fuel consumption for road transportation should be a concern, for example energy saving through more beneficial policies [1] or by raising awareness on the issue of sustainable energy consumption [14].

Point out that the concept of sustainable transportation is the foundation as well as the challenge in developing and implementing it effectively [13].

Mudjiastuti Handajani is the Civil Engineering Department Lecturer, University of Semarang, Indonesia (e-mail: hmudjiastuti@yahoo.co.id).

One of the challenges in sustainable transportation is the urban resource conserving mobility [2] and [3] or by developing a transportation mobility strategy in developing countries [20]. Improving the city transportation system, specifically those triggered by growing ownership and consumption of private vehicles, has a negative effect on the city, such as environment conservation (gas emission, air pollution, energy resource exploitation, space usage, traffic jams and traffic accidents, etc.). This occurs in large cities in developed countries and large cities in developing countries, like Jakarta, New Dehli, Bangkok, Mexico City, Rio de Jenairo.

In implementing the city transportation system, vehicles are direct consumers of the fuel (except for pedestrians and engineless vehicles). To repress the fuel consumption, there needs to be an attempt to find out the effect of the city transportation system on the fuel consumption. [18] state that there is a significant relationship between the city transportation system and fuel consumption with uncovered influencing factors.

The city transportation system and the city typology affect each other. The parameter of the city typology in this regard is a demand, including: population, population density, regional gross domestic product (RGDP) and land usage. Whereas the parameter of the city transportation system is divided into 2 (two) parts, which are: supply: road length, road network pattern, road condition, public transportation vehicles (bus n car), cargo vehicles and public transportation route length. There is also demand: private vehicles (car, motor vehicle, bus).

One thing rarely found in developing cities, especially in Indonesia is research on the fuel consumption using the city transportation system variable presented in the model. The *research that creates the model of the effect of the city* transportation system on the fuel consumption in developing countries, can hopefully be made into a macro model, which is a useful basis in making decisions and national policies, based on a strongly justified research. This research aims to create a tool to help the planner and designer of the city transportation system in examining the effect of the city transportation system on the fuel consumption. Both transport and fuel consumption is very strategic because they are related with the local, national and global-scale economy and environment. Therefore, the fuel consumption of road transport should be paid special attention.

II. Literature Review

The literature review in this research contains in detail varies theories and has three objectives. First, it presents the result of searching through various theoretical and conceptual knowledge considered relevant to the research, like the concepts of the city transportation system, city typology, fuel consumption, factors that influence the city transportation system on fuel consumption. The review is used as knowledge enrichment and background knowledge relevant with the research, explaining the theoretical and pragmatic knowledge from searching the city transportation system, city typology and fuel consumption both in the world (globally), in certain cities abroad and cities in Indonesia. Second, it presents theories and experience that clarify and strengthen what has been previously mentioned in the introduction (especially reaffirming the various backgrounds and reasons for choosing the research topic).

The literature review is used to gain information on: (a) the source and elements of the city transportation system; (b) city typology; (c) fuel consumption. The cross-reference review is to gain information on the parameter, factors, and variables, also to gain information and support (justification of researh) of research opportunities from parameters that have barely been touched and have not been done in developing countries, like the model for the effect of the city transportation system on the fuel consumption which is considered the key in the environmental transportation system and sustainable transportation.

A. The Concept of City Transportation System

Transportation is the attempt of transferring, moving, carrying, or transmitting an object from one place to another so the object will be more beneficial or can be useful for certain purposes. The above definition can mean that transportation is the proses of transferring, the process of moving, the process of carrying, and transmitting that can not be separated from supporting tools to ensure the process runs smoothly according to the desired time [8].

B. The Concept of City Typology

City is a very complex human-lead environment. A city seen as a container has very complex humans inside, have experienced interrelation processes between humans and the environment. The product of interrelation produces an orderly pattern in land usage which caused the city structure theory to rise [17]. City can be discussed through various perspectives. City morphology is the city public space, like downtown areas, city space, main roads. City forms basically occur due to interactions between inhabitants. Individuals in city societies are not isolated in individual activities, but interact in the form of city space.

C. The Concept of Fuel Consumption

Fossil energy is a form of unrenewable energy. This energy type has long been known as fossil fuel. Meanwhile, fossil fuel supplies are limited, because it is unrenewable energy, in time it will not meet the people's needs or run out altogether [5].

Therefore, there should be a national fuel consumption conservation especially in the land transportation sector. Fossil fuel is an organic substance needed in combustion to create energy or force which is the result of crude oil distillation into the desired fractions. The types of fossil fuel include: avgas, petrol, karosene, avtur, diesel oil as well as burning oil. The fuel consumption observed in this research includes petrol and diesel oil, because motor vehicles in the Java island (2007 and 2008 data) use more petrol and diesel oil.

III. Research Methods

This research includes many variables and data, so the focus is on multivariate analysis which is an application method related to the large number of variables made in each object in one or more data simultaneously, as stated in the theoretical study, whereas the development analysis for the nonlinear model is done with the help of software R (nonlinear least square). To determine which independent variable should be put into the nonlinear least square (nls) model, the Cobb-Douglas production function is used, which is a production function involving the influence of the input used with the output desired. The model of the city transportation system towards fuel consumption model is illustrated in Figure 1 [9].

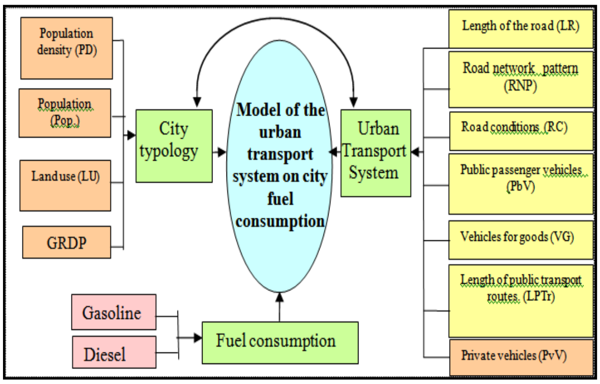

Fig. 1 Theoretical Framework, Factors of the Effect of Metropolitan and Large Cities on the Fuel Consumption

Fig. 2 Research sites

Research locations are metropolitan cities on Java. Metropolitan cities (5 cities) are: Semarang, Surabaya, Bandung, Bekasi, Tangerang.

Large cities (4 cities): Surakarta, Malang, Bogor, Tasikmalaya. The research location can be seen in Picture 2 below.

IV. Analysis

A. Data on Fuel Consumption

The data on the fuel consumption was collected in 2007 and 2008 based on petrol station purchases from Pertamina (Indonesian Oil Company) in each city each year. The fuel consumption (petrol + diesel) of large cities in Java 99.968 – 152.155 kl/year and fuel consumption (petrol + diesel) of metropolitan cities 292.923 – 650.260 kilo litres/year.

Petrol is used more by motor vehicles in Java island because the number of private vehicles is very high (6,384,406 units or 99.37% of the total number of passenger vehicles), the number of public transportation vehicles is low (40,726 units or 0.63% of the total number of passenger vehicles), the percentage of motorcycles is more than 82% of private vehicles [11].

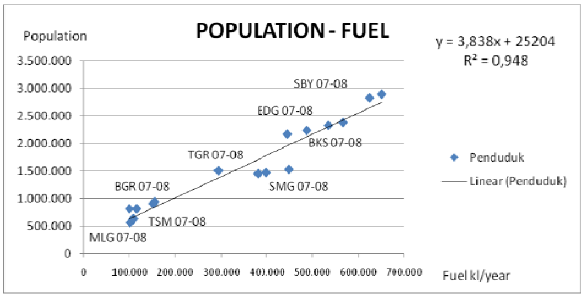

Fig. 3 Population - Fuel Consumption in Metropolitan and Large Cities/year (kilo litres/year) 2007-2008

The highest fuel consumption/year in 2008 was Surabaya (650,085 kilo litres/year), the lowest fuel consumption/year was in Malang in 2007 (99,968 kilo litres/year) [11].

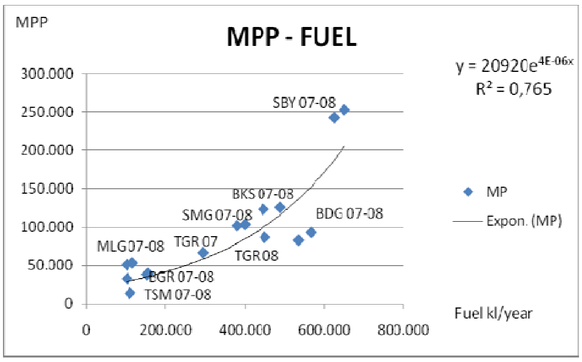

Fig. 4 Private Passanger Vehicle – Fuel Consumption of Metropolitan and Large Cities

B. Model Development

The Total City Fuel Consumption Model for total fuel consumption in metropolitan and large cities in Java is:

$$Lntot = A0 + A1lnpj + A2lnbu + A3lnmpu + A4lnmpp + A5lnbp + A6lnab + A7lnsm + A8lnkpdt + A9lnjp + A10lnpdrb + A11lnptr + A12lnldt$$

Note:

Tot= total; pj= length road; bu= public bus; mpu= public passenger vehicles; mpp= private passenger vehicles; bp= private buses; ab= goods vehicle; sm= motor cycles; kpdt= population density; jp= population; pdrb=GRDP; ptr= length of trayek; ldt= land use.

The above equation is analyzed using the R program [6]. Table I shows the VIF value for independent variables in the model 1 equation. Some VIF value of independent variables are more than 10 and some are less than 10, variables with a VIF value above 10 is the Lnbu variable of 20.3648. The next process is to remove the Lnbu variable, and produce a new model that does not include that variable.

TABLE I
VIF (Model 1) Metropolitan And Large Cities Total Fuel Consumption

vif(model 1) –Total Fuel of Metropolitan and Large Cities

lnpj	lnbu	lnmpu	lnmpp	lnbp	lnab
33.543	20,365	679.751	372,636	952,006	882,088
lnsm	lnkpdt	lnjp	lnpdrb	lnptr	lnldt
573.036	10,696.39	21,630.88	413.646	673.728	11,228.5

Once the Lnbu variable is removed, a new model is obtained like in Table II. Although the Lnbu variable has been removed, it is evident that the VIF value of independent variables is still big though not as big as it was previously (the non multicolinierity assumption has not been fulfilled). In the second model, the VIF value above 10 is in the Lnpj variable of 33,110. The next process is to remove the Lnpj variable, and produce a new model that does not include that variable.

TABLE II
VIF (model 2) Total Fuel Consumption of Metropolitan and Large Cities

Vif (model 2) –Total Fuel of Metropolitan and Large Cities

lnpj	Lnmpu	lnmpp	lnbp	lnab	Lnsm
33.110	450	184.758	688.542	634.852	551.59
Lnkpdt	lnjp	lnpdrb	lnptr	lnldt	
7,589.810	15,637.47	389.504	481.989	7,913.38	

Table III shows that the Lnpj variable has been removed.Although the Lnpj variable has been removed, the VIF value for independent variables is still big though not as big as it was previously (the non multicolinierity assumption has not been fulfilled). In the third model, the VIF value above 10 in the Lnsm variable is 160,394. The next process is to remove the Lnsm variable, and produce a new model that does not include that variable.

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TABLE III
VIF (MODEL 3) TOTAL FUEL CONSUMPTION OF METROPOLITAN AND LARGE CITIES

Vif (model 3) – Total fuel consumption of Metropolitan and Large cities

lnmpu	lnmpp	lnbp	lnab	lnsm
266.261	162.342	623.115	189.624	160.394
lnkpdt	lnjp	lnpdrb	Lnptr	lnldt
7,568.639	15585.662	318.707	434.085	7,905.928

Table IV shows that the Lnab variable has been removed. Although the Lnsm variable has been removed, the VIF value of independent variables is still big though not as big as it was previously (the non multicolinierity assumption has not been fulfilled). In the fourth model, the VIF value above 10 is the Lnab variable of 19.4452. The next process is to remove the Lnab variable, and produce a new model that does not include that variable.

TABLE IV
VIF (MODEL 4) TOTAL FUEL CONSUMPTION OF METROPOLITAN AND LARGE CITIES

Vif (model 4) – Total fuel consumption of Metropolitan and Large cities

lnmpu	lnmpp	lnbp	lnab	lnkpdt
31.662	56.389	129.626	19.445	3,467.539
lnjp	lnpdrb	lnptr	lnldt	
8,212.989	150.891	69.211	4,145.959	

Table V shows the Lnab variable has been removed. Although the Lnab variable has been removed, the VIF value for independent variables is still big though not as big as it was previously (the non multicolinierity assumption has not been fulfilled). In the fifth model, the VIF value above 10 is the Lnmpu variable of 25.06. The next process is to remove the Lnmpu variable, and produce a new model that does not include that variable.

TABLE V
VIF (MODEL 5) TOTAL FUEL CONSUMPTION OF METROPOLITAN AND LARGE CITIES

Vif (model 5) – Total fuel consumption of Metropolitan and Large cities

Lnmpu	lnmpp	lnbp	lnkpdt	lnjp
25.06	54.048	127.17	3,290.099	7,873.643
Lnpdrb	lnptr	lnldt		
143.39	64.879	3,919.69		

Table VI shows that the Lnmpu variable has been removed. Although the Lnmpu variable has been removed, the VIF value of independent variables is still big though not as big as it was previously (the non multicolinierity assumption has not been fulfilled). In the sixth model, the VIF value above 10 is the Lnptr variable of 12.55. The next process is to remove the Lnptr variable, and produce a new model that does not include that variable.

TABLE VI
VIF (MODEL 6) TOTAL FUEL CONSUMPTION OF METROPOLITAN AND LARGE CITIES

Vif (model 6) Total fuel consumption of Metropolitan and Large cities

lnmpp	lnbp	lnkpdt	Lnjp	lnpdrb
13.52	24.379	1,538.06	3,945.97	47.921
lnptr	lnldt			
12.551	2,055.80			

Table VII shows that the Lnptr variable has been removed. Although the Lnptr variable has been removed, the VIF value of independent variables is still big though not as big as it was previously (the non multicolinierity assumption has not been fulfilled). In the seventh model, the VIF value above 10 is the Lnpdrb variable of 13.181. The next process is to remove the Lnpdrb variable, and produce a new model that does not include that variable.

TABLE VII
VIF (MODEL 7) TOTAL FUEL CONSUMPTION OF METROPOLITAN AND LARGE CITIES

Vif (model 7) – Total fuel consumption of Metropolitan and Large cities

lnmpp	lnbp	lnkpdt	Lnjp	lnpdrb	lnldt
8.568	2.087	1,381.85	3,354.01	13,181	1,913.33

Table VIII shows that the Lnpdrb variable has been removed. Although the Lnpdrb variable has been removed, the VIF value of independent variables is still big though not as big as it was previously (the non multicolinierity assumption has not been fulfilled). In the eighth model, the VIF value above 10 is the Lnkpdt variable of 1,075.552. The next process is to remove the Lnptr variable, and produce a new model that does not include that variable.

TABLE VIII
VIF (MODEL 8) TOTAL FUEL CONSUMPTION OF METROPOLITAN AND LARGE CITIES

vif(model 8) – Total fuel consumption of Metropolitan and Large cities

lnmpp	lnbp	Lnkpdt	lnjp	lnldt
6.112	1.3887	1.075.552	2,612.087	1,499.221

According to Table IX (model 9), the VIF value of each variable is now lower than 10. This means the non multicolinierity assumption has been fulfilled, next the variable with the significant value is chosen. From Table X (model 10), JP variables (Population) have significant values and will be used in the Total Fuel Consumption of Metropolitan and Large Cities model.

TABLE IX
VIF (MODEL 9) TOTAL FUEL CONSUMPTION OF METROPOLITAN AND LARGE CITIES

vif(model 9) – Total fuel consumption of Metropolitan and Large cities

lnmpp	lnbp	lnjp	lnldt
5.877	1.3887	9.301	3.019

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TABLE X
VIF (MODEL 10) TOTAL FUEL CONSUMPTION OF METROPOLITAN AND LARGE CITIES

vif(model 10) – Total fuel consumption of Metropolitan & Large cities
lnjp
9.301

C. Model on the Effect of The City Transportation System – Fuel Consumption of Metropolitan and Large Cities

By using the R program the following output is produced:
lm(formula = lntot ~ lnmpu + lnmpp + lnjp)
Residuals:

Min	*1Q*	*Median*	*3Q*	*Max*
-0.35893	*-0.08631*	*-0.01411*	*0.09333*	*0.35729*

Coefficients:

	Estimate	*Std. Error*	*t value*	*Pr(>|t|)*	
(Intercept)	*-5.15397*	*1.11729*	*-4.613*	*0.000288*	**
lnjp	*1.25071*	*0.07941*	*15.750*	*3.67e-11*	**

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*Signif. Codes: 0'***' 0.001 '**' 0.01 '*' 0.05 '.'*
Residual standard error: 0.1891 on 16 degrees of freedom
Multiple R-squared: 0.9394, Adjusted R-squared: 0.9356
F-statistic: 248.1 on 1 and 16 DF, p-value: <3.667e-11

Based on the above output, the total fuel consumption model is:

$Lntotal = -5.154 + 1.2507 \, Lnjp$

This equation can also be written as:

$Total\ fuel\ consumption = e^{-5.154} . JP^{1.2507}$

or

$Total\ fuel\ consumption = 0.0058. JP^{1.2507}$

The total fuel consumption model of Metropolitan and Large cities in Java has a model accuracy of 0.9394, meaning 93.94% consumption. Total fuel consumption of Metropolitan and Large cities in Java is influenced by variables of population. The remaining 6.06% total fuel consumption of Metropolitan and Large cities in Java is influence by other variables. The resulting model of the influence of the city transportation system, cities in Java toward fuel consumption:

$Total\ fuel = 0.0058 * JP^{1.2507}$

Analog process for petrol and diesel oil

$Petrol = 20{,}4575 * MPU^{0.3726} * MPP^{0.5631}$

$Diesel\ Oil = 0.0012 * BP^{0.4055} * JP^{1.0696}$

From the model (1) above, the city typology variable which is the number of city people has a strong effect on the total fuel consumption. This strong effect is shown through the power value more than 1. This means that the cities with a bigger population will have higher total fuel consumption.

Elasticity is measuring the sensitivity of one variable to another variable. In detail, elasticity can be explained as a number which shows the percentage of change happening to one variable as a reaction to each 1 percent rise of another variable [16].

From the above definition, it can be interpreted that one percent change in public passenger vehicles by assuming that the values of private passenger vehicles and population remain constant will cause a change to the total fuel consumption of Metropolitan and Large cities in Java up to 0.1590 percent. One percent change of private passenger vehicles by assuming that the values of public passenger vehicles and JP remain constant, will change the total fuel consumption of Metropolitan and Large cities in Java up to 0.2148 percent. One percent of population by assuming that the values of private passenger vehicles and public passenger vehicles remain constant, will change the total fuel consumption of Metropolitan and Large cities in Java up to 0.7659 percent.

D. The Effect of Public Passenger Vehicles on Total Fuel Consumption in Metropolitan and Large Cities

The effect of public passenger vehicles on fuel consumption is measured by using elasticity. An increase of public passenger vehicles of 1 percent causes an increase in the fuel consumption prediction of up to 0.1590 percent. Figure 5 shows the simulation of the effect of the number of public passenger vehicles in the prediction of the Total Fuel Consumption of Metropolitan and Large Cities in Java [10].

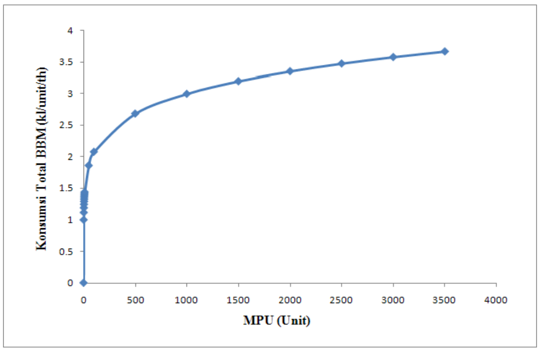

Fig. 5 Simulation on the Effect of Public Passenger Vehicles in the Prediction of the Total Fuel Consumption of Metropolitan and Large Cities in Java

E. The Effect of Public Passenger Vehicles on Petrol Fuel Consumption in Metropolitan and Large Cities

The effect of public passenger vehicles on petrol fuel consumption is measured by using elasticity. An increase of public passenger vehicles of 1 percent causes an increase in the fuel consumption prediction of up to 0.3726 percent. Figure 6 shows the simulation of the effect of the number of public passenger vehicles in the prediction on the petrol fuel consumption of metropolitan and large cities in Java [10].

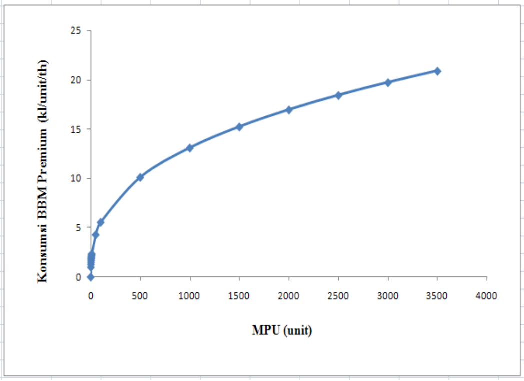

Fig. 6 Simulation on the Effect of Public Passenger Vehicles in the Prediction on the Petrol Fuel Consumption of Metropolitan and Large Cities in Java

F. The Effect of Private Passenger Vehicles on Total Fuel Consumption in Metropolitan and Large Cities

The effect of private passenger vehicles on the total fuel consumption can be measured using elasticity. An increase of private passenger vehicles of 1 percent causes an increase in the fuel consumption prediction of up to 0.2148. Figure 7 shows the simulation of the inflluence of the number of private passenger vehicles in the prediction of the Total Fuel Consumption of Metropolitan and Large Cities in Java [10].

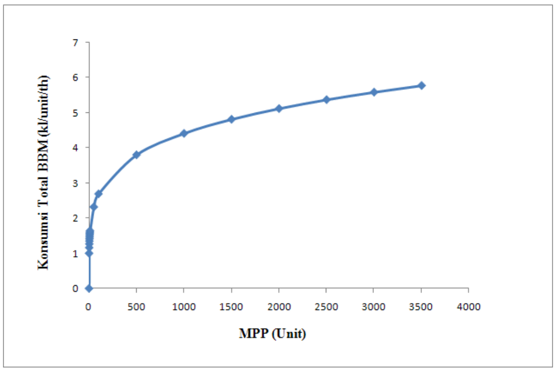

Fig. 7 Simulation on the Influence of Private Passenger Vehicles in the Prediction of the Total Fuel Consumption of Metropolitan and Large Cities in Java

G. The Effect of Private Passenger Vehicles on Petrol Fuel Consumption in Metropolitan and Large Cities

The effect of private passenger vehicles on the petrol fuel consumption can be measured using elasticity. An increase of private passenger vehicles of 1 percent causes an increase in the fuel consumption prediction of up to 0.5631. Figure 8 shows the simulation of the inflluence of the number of private passenger vehicles in the prediction of the petrol fuel consumption of metropolitan and large cities in Java [10].

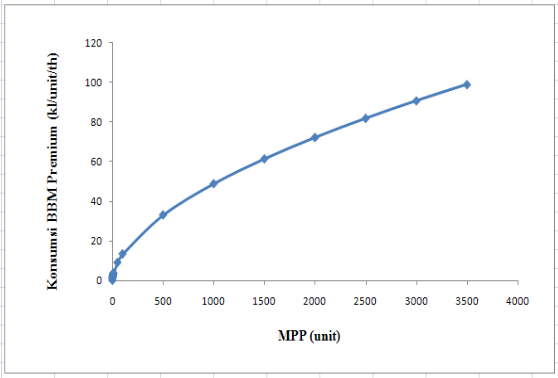

Fig. 8 Simulation on the Influence of Private Passenger Vehicles in the Prediction of the Petrol Fuel Consumption of Metropolitan and Large Cities in Java

H. The Effect of Private Bus on Diesel Fuel Consumption in Metropolitan and Large Cities

The effect of private bus on the diesel fuel consumption can be measured using elasticity. An increase of private bus of 1 percent causes an increase in the fuel consumption prediction of up to 0.4055. Figure 9 shows the simulation of the inflluence of the number of private bus in the prediction of the diesel fuel consumption of metropolitan and large cities in Java [10].

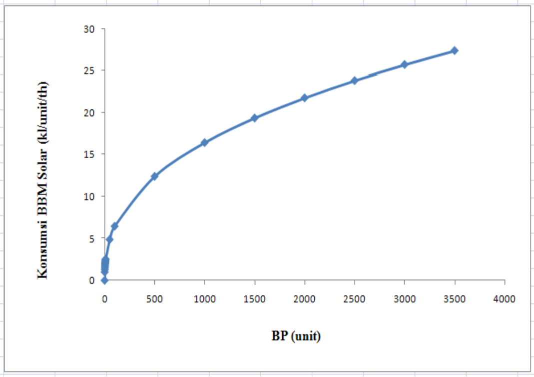

Fig. 9 Simulation on the Influence of Private Passenger Vehicles in the Prediction of the Diesel Fuel Consumption of Metropolitan and Large Cities in Java

I. The Effect of Population on the Total Fuel Consumption in Metropolitan and Large Cities

The effect of population on total fuel consumption can be measured using elasticity. An increase of population of 1 percent causes an increase in the fuel consumption prediction of up to 1,2507 Figure 10 shows the simulation of the inflluence of the number of population in the prediction of the total fuel consumption of metropolitan and large cities in Java [10].

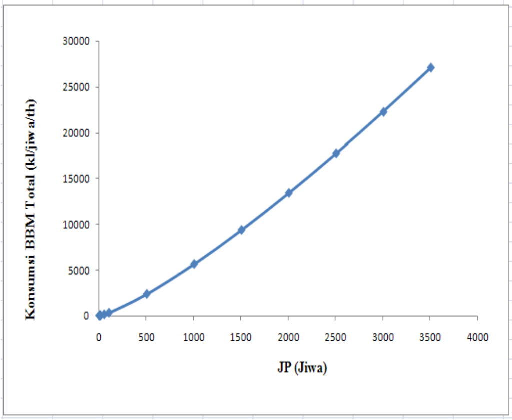

Fig. 10 Simulation on the Influence of Population in the Prediction of the Total Fuel Consumption of Metropolitan and Large Cities in Java

J. The Effect of Population on Diesel Fuel Consumption in Metropolitan and Large Cities

The effect of population on diesel fuel consumption can be measured using elasticity. An increase of population of 1 percent causes an increase in the fuel consumption prediction of up to 1,0696. Figure 11 shows the simulation of the inflluence of the number of population in the prediction of the diesel fuel consumption of metropolitan and large cities in Java [10].

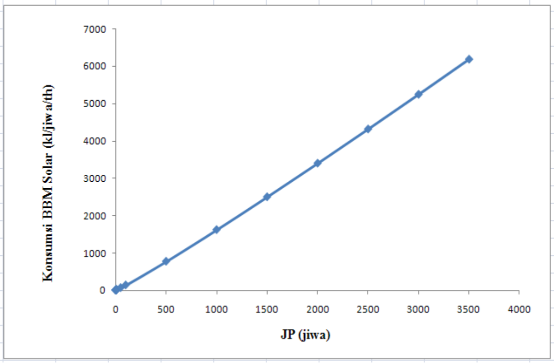

Fig. 11 Simulation on the Influence of Population in the Prediction of the Diesel Fuel Consumption of Metropolitan and Large Cities in Java

K. Controlling Fuel Consumption

From the results of the above model, the transportation system variables that influence fuel consumption include public passenger vehicles, private passenger vehicles, population. To control fuel consumption due to the public passenger vehicles variable is by changing public passenger vehicles with a larger capacity vehicle/buses/Bus Rapid Transit (BRT), if possible, use *Light Rapid Transit* (LRT) or *Mass Rapid Transit* (MRT). For the private passenger vehicles variable, it is by suppressing the growth of private vehicles (private passenger vehicles and motorcycles), using them as little as possible, providing reliable, qualified and cheap public transportation, setting an age limit on operating vehicles (private passenger vehicles + motorcycles), schools or work provide pick-up services, car-pooling.

The concept of moving people from one place to another from passenger vehicles is based on the people's need to move or the people's presence for certain purposes, not movement of vehicles. Nowadays the people's presence can be exchanged with voices, writing, pictures and activities can still be done. Therefore, to control the fuel consumption due to the population variable is by transforming transportation to information technology, especially passenger transportation. By transforming transportation to information technology, fuel consumers will reduce and activities can still be done in an even shorter time than the transporting process.

Some examples of transforming transportation to information technology are as below:

1) Invitation to various meetings: at the beginning paper invitations were used and sent to each place personally through transportation, later they have been shifted to inviting through short message service (SMS).
2) Booking traveling tickets: it was previously done by visiting personally to travel agents, now people can get tickets on-line without having to travel.
3) Using e-banking: to know the account or savings balance and do transactions can be done without having to go to the bank, but just by using the *e-banking* facility, so the purpose of checking the balance and doing transactions can be completed. The same goes for ATM, people do not have to go to the bank to withdraw money and do transactions, as well as pay monthly water, electricity and telephone bills.
4) Talking through SKYPE, communicating through Facebook and email, people do not need to travel or use transportation.
5) School or work registration, shopping can be done *on-line*.

V. CONCLUSION

The effect of the metropolitan and large cities transportation system on the fuel consumption:

1) Population has a very strong effect on the fuel consumption.
2) Personal and public vehicles affect the petrol consumption. Private bus and length road effect the diesel.
3) The model of the effect of the metropolitan and large cities transportation system on the total fuel consumption = $0.0058 * JP^{1.2507}$

   Analog process for petrol and diesel

   Petrol $= 20{,}4575 * MPU^{0.3726} * MPP^{0.5631}$

   Diesel $= 0.0012 * BP^{0.4055} * JP^{1.0696}$
4) Controlling fuel consumption: controlling the fuel consumption by improving qualified and reliable public transportation services and private bus, improving city potential, reducing the number of personal vehicles and *land use* arranging, transforming transportation to information technology.

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REFERENCES

[1] Breheny, M., *Sustainable Development and Form Europiean, Research in Regional Science*, 1992, vol 2.
[2] Carrol, T.A., *Calculating Community Energy Demand. In Energt and the Community*, edited by R.J. Burby and A. Flemming Bell. Cambridge, MA: Ballinger, 1977.
[3] Cheng-Min F., and Cheng-Hsien H., The Implicaion of Transport Diversity for Sustainable Urban Transportation, *Journal of The Eastern Asia Society for Transportation Studies*, 2007, Vol. 7, 1236-1249.
[4] Departement ESDM, *Konsumsi Energi di Indonesia*, 2004
[5] Departement Perhubungan Darat, *Perencanaan Umum Pengembangan Transportasi Massal di Pulau Jawa*, Jakarta, 2008.
[6] Fox John, *Appendix to An R and S-Plus Companion to Applied Regression, Structural Equation Models*. 2002.
[7] Marcotullio Peter J., Limited Provision of Roads as Botleneck on Vihecle, *Journal Environment and Pollutan vol.30*, no 1, Hunter college CUNY, NY, USA 2007.
[8] Miro Fidel, *Perencanaan Transportasi*, Erlangga, Jakarta, 2005.
[9] Mudjiastuti Handajani, Model of the Urban Transport System in Java on City Fuel Consumption, *World Academy of Science, Engineering and Technology, an International Journal of Science, Engineering and Technology*, WASET, Cemal Ardil, Paris, issue November 2011.
[10] Mudjiastuti Handajani, Model of the Urban Transport System in Java on City Fuel Consumption, Disertation, Diponegoro University, Semarang, Indonesia, 2012.
[11] Mudjiastuti Handajani, Non Linear Model City Transportation System and Control of Fuel Consumption, International Journal of Computational Engineering Research (IJCER) , 2012.
[12] Official Nebraska Government Website, *Energy Consumption Transportation Sector*, 2003, Nebraska.
[13] Pearece dan Warford, *World Without End*, World Bank, Oxford University Press pp 43-44, 1996.
[14] Regional Office for Europe, *Sustainable Consumption and Transport*, United Nations Environment Programme, 2002
[15] Robert Q. Riley Enterprise, LLC, *Energy Consumption and The Environment, Impact and Option for Personal Transportation*, Phoenix, 2006.
[16] Robert, S.P. and Daniel L.R., *Mikroekonomi*, Edisi 6, Jilid 1, P.T. Indeks, Jakarta, 2009
[17] Rodrigue Jean-Paul, Transportation and The Environment, Dept. of Economics & Geography Hofstra University, Hempstead, NY, 11549 USA, 2004.
[18] Stopher Peter R. dan Meyburg Armin H., Urban Transportation Modelling and Planning, Lexington books, London, 1987.
[19] Monitoring Team and the National Transportation Performance Evaluation (TPEKTN), Urgency and Policy Comprehensive Program in fuel of Transportation, 2008.
[20] World Bank, A Panorama of Urban Mobility Strategies in Developing Countries, Hubert Metge, Aurelie Jehanno, Systra 2006.