

Understanding Commuter's Motivation of Transportation Choice: A Case Study of Greater Jakarta

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Abstract

Among the various modes of transportation, road transport is one of the most common modes of transport due to the comfortability and ease of commute. It is no wonder that road transport has become the primary energy consumer, which also significantly contributes dangerous levels to the ever-increasing pollution. Jakarta as of the capital city of Indonesia, is undeniably the most massive contributor to pollution in the world, and its complex transportation problems led to the city ranks highest in CO2 emission. One of the leading causes of transportation problems in Jakarta is the low percentage utilization of public transport. Therefore, the primary purpose of this study is to explore the reasons behind the people's decision in selecting travel options, especially the adoption of green commuting behavior like public transportation; the analysis of which was explicitly taken from daily commuting using probit regression. The estimation results reveal that in Greater Jakarta, both educational attainment and population density have negative correlation with the people's decision to utilize mass transportation, since the unreliability of the transportation system lessens the benefit of using public transport in comparison with that of private transport.

Keywords : *Commuter's behaviour, mode-transportation choice, public transport, daily routine trips, Greater Jakarta*

A. Introduction

Among the various modes of transportation, road transport is one of the most common modes due to the comfortability and ease of commute. It is no wonder that road transport is the leading energy consumer which also leads to significant contributions to the ever-increasing pollution. The growth of the transport sector has undesirable effects such as environmental destruction, traffic congestion, air pollution, and natural life disturbance. In 2014, the transportation

sector accounted for 26% of the world's total energy consumption, and nearly 22% of the greenhouse gas carbon emissions (World Energy Council, 2016). Likewise, 64% of the demand for primary oil worldwide was used for 92% of the overall energy supply in the transport industry (IEEJ, 2019).

In developing countries such as Indonesia, a substantial increase in transport-related energy consumption is also expected. Therefore, it cannot be disputed that Jakarta, as Indonesia's capital, has become one of the world's largest metropolitan cities with a

population of 30.24 million in 2014 (World Bank, 2015). Moreover, Greater Jakarta (Jakarta Bogor-Depok-Tangerang-Bekasi) has 59 million journeys per day in 2010, making this region the most significant contributor to CO₂ pollution in the world (Jabodetabek Transportation Management Agency, 2015). In 2014, Indonesia's transport sector CO₂ emissions (percentage of overall burning) were 30,807; more than the global average of 20,449 CO₂ emissions (Lelono, Herdiansyah, Darmajanti, Edhi, & Soesilo, 2018). The transport sector in Indonesia contributes 70% to 80% of the total air contamination including toxic pollutants, and 23% of Green House Gases (GHG) emissions are from motor vehicles (Leung, 2016).

Poor transport system in Jakarta led to the highest rank in the city's list of CO₂ pollution. The carbon emissions correlated with traffic rose by 270% over a decade, producing almost 50 million tons of CO₂ in 2015 (Adhi, 2018). The road transport sector in Jakarta must be accountable for the 95% portion, primarily due to the highly inefficient combustion of fossil fuels on the road. Meanwhile, transport sector in Jakarta contributed 24% of national GHG emission from transportation sector (Adhi, 2018).

One of the leading causes of transportation problems in Jakarta is the low percentage utilization of public transport. In 2014, roads in Jakarta were dominated by motorcycles with a share of 74.67% led by an 18.64% private vehicle (Lelono et al., 2018), which means that only about 6.7% of mass transportation were in use. The use of private vehicles was favored due to the lack of integration and capacity of public transport as well as the poor quality of public transport vehicles. Based on the research conducted by the Jabodetabek Transportation Management Agency, until early 2019 the use of public transportation in the Greater Jakarta area only reached 30% of the 60% target in 2030 (Jakarta & Transport Authority, 2015).

Based on the above factors, the primary objective of this study is to explore

the main motives behind the commuter's decision in choosing the mode of transportation, including public transportation. Therefore, research question will be: which factors significantly affect the commuters' decision making in choosing travel modes? The result of this study will provide a better understanding of the travel options by commuters that can produce insights on factors that can help promote and maintain public transit behaviours.

A previous study found that environmental-friendly commute behaviour correlated with demographic attributes and those commuters who are under 30 and over 50 years of age with high educational backgrounds, low car ownership, and income-brackets were more enthusiastic about taking part in environmentally friendly travel behaviour (Golob & Hensher, 1997). Additionally, gender was also found to be an essential aspect of travel behaviour. Many surveys examined metropolitan daily commuter activity and found that women were more likely to choose walking or use public transport (Ng & Acker, 2018). In contrast, men were more interested in owning a private car than women (Polk, 2004; Prillwitz & Barr, 2011).

Furthermore, age was also perceived to be an inductive factor in green travel behaviour. The current research found that in younger age groups, the ability to care for the environment and introduce pro-environmental actions is higher than that of adults (Klineberg, McKeever, & Rothenbach, 2019). Moreover, past studies also found that demographic factors such as age and income have affected urban transport behaviours (Habib, Kattan, & Islam, 2011), while the current study from Liu (2017) reveals that income levels also influence transport options and indicates that individuals from lower income brackets may be discouraged from buying or using a vehicle (car or motorbike) due to financial restrictions.

In terms of the relationship between educational background and eco-friendly transportation motives, one literature indicates that the behaviour of the people is

equivalent to their academic background since their education might have a role in effecting behavioural change (Bengtsson, Barakat, Muttarak, Kebede, & Lutz, 2018). Education informs people of transport concepts, which contributes to the adoption of environmental attitudes and values, and the role of cognitive and social awareness on behavioral actions and decisions (Kiliç, Seymen, Malandrakis, Boyes, & Stanisstreet, 2013). Even though studies on the relationship between education and green commuter behaviour is limited, some studies have been conducted in this area. This has proven, for instance, that most students realize that car emissions lead to global warming and acid rain. (Boyes & Stanisstreet, 1997; Hillman, Stanisstreet, & Boyes, 1996).

More recently, research was developed to look at potential correlations between academic perceptions about how many activities will help mitigate global warming and the determination to take such action (Kiliç, Boyes, & Stanisstreet, 2011). The research reported that in Turkish students, the use of public transport is higher than private transport and it has been found that this behaviour has a relatively have a strong correlation with education. He indicated that education succeeded to encourage them to use public transport for the good of the environment, and it might enable them to use this mode of transportation.

Recent research (Hamidi & Ewing, 2014) has found that there is a strong positive relationship between urban population density and transit commute share to support his previous studies (Ewing & Cervero, 2010) that explained five elements that lead to well-organized public transport use which are: density of city, diversity (mixing use), design of city environment, distance to transit (distance to the nearest stop), and destination accessibility to form the concept of TOD (Transit Orientation Development). Another research also showed that residential location also has a more significant impact on people's choices about how to travel. For example,

individuals who are used to public transport tend to choose to live near public transit stations, such as train or bus stations. In contrast, private vehicle users tend to choose to live near express routes (Malaitham, Nakagawa, Matsunaka, Yoon, & Oba, 2013).

Additionally, this research will also emphasize on specific conditions such as the distance from the workplace, the total daily travel cost, and the length of time spent on routine trips as a variable of interest. The reason why these variables were chosen as the most crucial factors is because these three factors describe the exact conditions in Indonesia that might influence individuals whether to choose public transportation or not.

According to the principle of rational choice (Olson, 1965), people typically seek to maximize their utility by selecting options that will yield the most significant individual benefits or smallest losses. A critical feature that influence commuting decisions for most individuals is the travel time. Besides, previous research has clearly shown that the decisions by the commuters were affected by time considerations, where the choice offers a shorter average of time in transit, and where the choice is less costly, (M. Van Vugt, P.A.M. Van Lange, 1996). Furthermore, another research also found that travel distance has a significant influence on the commuter to choose their travel modes, not only the distance to the workplace but also the distance between the transit points (Scheiner, 2010).

In general, while existing research on the relationship of socio-economic demographic variables with eco-travel has offered ambiguous findings, interpretations of certain social demographic factors and processes are not always apparent due to various regional cultural disparities and social-economic growth. Consequently, this research will try to find the specific additional factor that can correlate with commuter's travel behaviour which is appropriate for Indonesian profile characteristics.

B. Methodology

First, as far as study methodology is concerned, the disaggregated model is known to be the most effective way to examine patterns of mode preference by daily commuters. Therefore, disaggregated models were able to determine the actions of a person in choosing from different modes available. Furthermore, concerning the variables, based on the literature (G. Liu, 2007) and personal findings, this research aims to identify multiple variables used to analyze commuters' travel preferences, as follows:

- Household characteristic factors (e.g. socio-economic and demographic), such as location, population density, income level, marital status, gender, age, education background, occupation or job status, and vehicle ownership
- Mode-specific factors such as comfortability, social effect, flexibility, and any experienced situation during commuting
- Trip characteristics factors such as travel time, travel cost, travel distance, availability of public transport's infrastructure, existing mode of working-trip option among participants.

Instead of using Linear Probability Model, which is simpler and more popular

$$\begin{aligned} commuter_{bhv} = & \beta_0 + \beta_1 edu_{backgr} + \beta_2 population + \beta_3 age + \beta_4 agesqr \\ & + \beta_5 income + \beta_6 incomesqr + \beta_7 travel_{cost} + \beta_8 travel_{time} \\ & + \beta_9 gender + \beta_{10} tech_{prob} + \beta_{11} incident + \beta_{12} marital_{stat} + \varepsilon \end{aligned} \quad (1)$$

Here, **commuter_bhv** is the dependent variable that describes the commuter behaviour, the variable was set to be 1 if the respondents use public transport and 0 if they use private vehicles. **Edu_backgr** is the dummy variable that indicates the highest education level completed by the commuters. The value is 1 when respondents possess a tertiary degree or higher and 0 for otherwise (finished Senior High School or lower).

among researchers, this research applies the non-linear probability regression, not only because the binary outcome of dependent variable but also the study tries to avoid the biased estimates of some variables of interest. Probit regression was found to be an adequate modelling system under discrete methods of preference, according to the intent of this analysis. Probit is a statistical model used to explain how people select various options (Ben-Akiva & Lerman, 1985).

Such empirical statistics blend economics with a psychological understanding of the selection process. Probit models are also used to predict the impacts of various interventions. The model also allows us to explain the choice of the individual based on many factors that affect the preference of behaviour. The numerical estimation method used is the maximum likelihood. The approach consists of determining the parameter values that are most likely to be consistent with the behaviour observed in the specific data set of the estimated model (Aldrich & Nelson, 1984). The probit model will be established for the preference of mode activity between travellers for two options: public transport and private vehicles to test the use of these modes of travel and evaluating variables that would have a significant impact on the transition from private vehicles to public transport in which empirical model will be:

Similarly, **population** is the dummy variable that indicates the number of populations from the commuter's original location. The value is 1 when respondents come from the region which has a population of more than 2 million people and 0 for otherwise (from the region with less than 2 million in population).

Then, **age** is the explanatory variable that indicates the age of the respondents and

agesqr is the explanatory variable that indicates the squared-age of the respondents to anticipate the non-linear relationship between age and commuter behaviour. **Income** is the explanatory variable that indicates the commuters' average monthly earning and **incomesqr** is the explanatory variable that indicates the commuters' squared- average monthly earning to anticipate the non-linear relationship between age commuter behaviour. Then, **travel_cost** is the explanatory variable that indicates the amount of commuter expense for commuting and **travel_time** is the explanatory variable that indicates the length of time spent by respondents in commuting.

Gender is the dummy variable that indicates the gender of the respondents. The value will be 1 for men and 0 for women. Also, **tech_prob** is the dummy variable to indicate the commuter's comfortability while commuting. The value is 1 when the respondents have experienced any of the technical problems in the transportation systems during commuting and value 0 for otherwise. **Incident** is the dummy variable to indicate any incident occurred during commuting. The value is 1 when the respondents have experienced an incident during commuting, and the value is 0 for otherwise and **marital_stat** is the dummy variable to show the marital status of respondents. The value is 1 when the respondent is still in-married status, and the value is 0 for other conditions.

This research applied the quadratic term of several variables such as age and income to look at non-linear relationships between these variables and the independent variable. By adding the square of the variable, this research allows the model to estimate more accurately the effect of age and income, which may have a non-linear relationship with the independent variable. Moreover, quadratic variables, allows the model to predict the effect of differing ages and incomes, rather than assuming the effect is linear for all ages and incomes.

The data used in the socio-demographic aspect is the data belonging to

the household member who commutes to represent as valid respondent. For this analysis, much of the data were obtained from the commuter survey results of Jabodetabek in 2014. The Jabodetabek Commuter Survey consisted of 13,120 households from 1312 census blocks, distributed across the Jabodetabek metropolitan region containing 13 districts/cities, which are Jakarta (North, South, Central, West and East Jakarta), five satellite municipalities (South Tangerang, Depok, Bogor, Tangerang, and Bekasi), and three local regencies (Tangerang, Bekasi, and Bogor).

The method of sampling is a stratified two-stage probability sampling process since the population is stratified and not homogenous. Multiple census blocks with the size of the total working population aged between 15 years and over were chosen as proportional to size likelihood in the first phase. Besides, ten households were taken with systematic sampling from the chosen census block after households had been previously modified.

C. Results

This study was applied both binominal and multinomial probit regression method to set the comparison effect between the variables. To obtain a robust conclusion, only explanatory variables that show the significance and consistent signs in both methods are declared to affect explained variables. Furthermore, the results of the analysis can be grouped into four groups, namely significantly positive, significantly negative, significant with different signs in several categories, and not significant.

After conducting the binomial probit regression and marginal effect estimation, as can be seen in Table. 1, significant factors that positively influenced people's decision to encourage mass-transit were travel time and squared income. Then, significant factors that negatively affected were education background, population, gender, income, incident, technical problem, and marital status. Whereas age, squared age, and

travel cost could not satisfy the criteria set to be said to be influential, hence stated as not significant.

Table 1 Estimation Results (Binomial Probit Regression)

Number of observations	5,702
Variables of Interest	Coefficient
<i>edu_backgr</i>	-0.0294**
<i>population</i>	-0.0341***
Control Variables	
<i>age</i>	0.0022
<i>agesqr</i>	3.9E-05
<i>income</i>	-2.2E-08***
<i>incomesqr</i>	1.76E-16***
<i>travel_cost</i>	-5.27E-07
<i>travel_time</i>	0.0027***
<i>gender</i>	-0.265***
<i>tech_prob</i>	-0.0541***
<i>incident</i>	-0.1522***
<i>marital_stat</i>	-0.0768***
_cons	-0.3677

Note: Level of Significance 0.01 (*), 0.05 (**), 0.1 (*)**

For comparison, the second regression using multinomial probit was conducted using three options of commuting mode, which are private vehicles (set as base outcome), public transport, and paratransit. Appendix B shows the first step in multinomial regression is conducting the estimation that sets the private vehicle (outcome 0) as a base outcome to see the sign of the coefficient in each variable. Afterwards, Appendix C shows the conditional marginal effect is conducted by estimating the predicted probability of public transport option (outcome 1) to see the value of coefficient.

Table 2 shows the probability of mass transit options using multinomial probit with

the private vehicle set as a base outcome and public transport option as predicted probability. As can be seen in Table 2, significant factors that positively influenced people's decision to use mass-transit were travel time and squared income. Then, significant factors that negatively affected the decision making of public transport utilization were educational background, population, gender, income, incident, technical problem, and marital status. Whereas age, squared age, and travel cost could not satisfy the criteria set to be said to be influential, hence they are stated as not significant.

Table 2 Estimation Results (Multinomial Probit Regression)

Number of observations	5,702
Variables of Interest	Coefficient

<i>edu_backgr</i>	-0.0254*
<i>population</i>	-0.0405***
Control Variables	
<i>age</i>	0.0047
<i>agesqr</i>	1.3E-05
<i>income</i>	-2.56E-08***
<i>incomesqr</i>	2.76E-16***
<i>travel_cost</i>	2.18E-07
<i>travel_time</i>	0.0024***
<i>gender</i>	-0.2456***
<i>tech_prob</i>	-0.0368***
<i>incident</i>	-0.1716***
<i>marital_stat</i>	-0.0961***
<i>_cons</i>	-0.845

Note: Level of Significance 0.01 (***), 0.05 (**), 0.1 (*)

D. Discussion and Conclusion

a. Discussion

From the results of both regression and the interpretation, there are several findings related to the initial hypothesis which can be further discussed. *edu_backgr* as a variable of interest with a marginal effect coefficient of 0.029 and a negative sign means that people with secondary education or lower are encouraged to utilize public transportation. This also means that more people with a tertiary education or higher educational background can be associated with the probability that the use of public transport will also decrease. From this, it appears that although education has a significant impact internally in the development of an individual's character, the external factors will also influence the final decision-making process (Bengtsson et al., 2018). In general, the formal education system will generate people with higher competencies, higher productivity, and higher efficiency (Ng & Feldman, 2009; Ozturk, 2001) it makes more educated people, in terms of work-commuting, tends to choose anything that makes it cheaper, faster, and more accessible.

From the general point of view, the level of education is proportional to the level of income, because, in general, people with higher education will get better jobs with higher wage levels (Berger & Fisher, 2013; French & Fisher, 2009). This will also affect

their social status and lifestyle. Consequently, the rise in standards of living and social status leads to more private vehicles being bought (Dargay, 2001; Lescaroux, 2010). These two things are the main reasons why higher education is negatively associated with the use of public transportation.

Considering the fact that transportation in Greater Jakarta is not reliable enough in term of accessibility (Marks, 2016), the use of private vehicles is more beneficial. One research in 2013 stated that the comparison of the total cost of using public transport was 5,000 to 15,000-rupiah cheaper than the use of private vehicles for one-time commuting trips (Herawati, 2013). This value certainly is not a big problem for educated people when compared to the benefits of using private vehicles such as being faster and more practical (if using a motorcycle) or more comfortable (if using a car).

From the social status aspect, for the Indonesian community, ownership of personal property (such as private vehicle and private house) is not only a necessity but also a prestigious component of value, besides having a permanent job and regular salary. Therefore, in Indonesia, a person is generally said to be successful and established if he already has these things (Hendratno, 2009). Besides the aspect of lifestyle, people in Greater Jakarta in middle to upper economic levels tend to find the most practical alternatives to fulfil their

needs including going to work or commuting (Raharjo Jati, 2015).

Population as a variable of interest with a marginal effect coefficient of 0.029 and a negative sign which means the probability of using public transportation is negatively associated with people living in areas with high population densities (more than 2 million people). This also means that the probability of using public transportation will have a greater tendency in less densely populated areas (less than 2 million people).

Two things can be explored from this; the first is that although the investment embedded by the government in the transportation sector is already quite large, in reality, it has not been able to encourage people to switch modes because not all people can access Transjakarta, MRT or LRT. As can be seen in Table 3, the total service area of public transport only covered 49% of the population and the actual location where they live is not near to bus stops or stations (ESCAP, 2017; Marks, 2016).

Table 3 Public Transport Service Area

Districts	Total Served Area (kms)	Assumed Served Population (ppl)
South Jakarta	144	2,049,088.43
East Jakarta	156	2,456,764.88
Central Jakarta	51	948,160.34
West Jakarta	112	2,222,822.38
North Jakarta	95	1,221,704.77
Bogor Regency	164	899,878.47
Bekasi Regency	82	559,526.51
Bogor City	60	604,988.31
Bekasi City	73	1,180,666.94
Depok City	93	1,062,996.60
Tangerang Regency	105	206,458.31
Tangerang City	87	1,054,938.09
South Tangerang City	80	840,183.19
Total		15,308,177.23
Estimated population in Greater Jakarta (2017)		31,000,000
Ratio to total Greater Jakarta population (%)		49.38

Source: ESCAP, 2017. Sustainable Urban Transport Index (SUTI) for Asian Cities Greater Jakarta Area

Meanwhile, city transportation, which is expected to be the feeder for mass transportation, is not able to provide excellent service. As a result, people tend to use their private vehicles to get to the locations they want to go to, such as offices or schools. Secondly, in the buffer zone of the capital, public awareness regarding the use public transportation is quite broad as the connecting transport infrastructure to Jakarta (activity centre) is quite adequate (KRL and APTB) and when viewed from the cost and travel time, the use of public transportation modes (especially commuter line trains) are much faster and more efficient as compared

to the use of private vehicles especially cars (Hizhwati, 2016; Lestari, 2013).

On the squared variables, only income and squared income generated significant results while both age and squared age yielded insignificant results. From the coefficient's sign, it can be seen that the relationship between commuter behaviour and income is a U-relationship, which means the increasing level of income will reduce the probability of using mass transit. However, at some income level, people with a high-level income has an interest to utilize mass transit more than low-income people. This is because people with high-level

income usually live in the central city of Jakarta, which undoubtedly has adequate transportation system infrastructure and high accessibility to use public transportation. On the other hand, age factor does not affect the use of public transport since, in Greater Jakarta, both young people and the elderly have a random distribution in the selection of transportation modes so that the data in the survey do not have enough information to explain the effect of age on commuter behaviour.

The results also revealed that control variables such as gender, marital status, and factors that explain any experienced situation during commuting (incident and technical problem) have a significant effect on people's decision to use public transport. The finding that women typically utilize mass transit more than men could be explained by the household members' time costs. The most cost-effective person who earns the highest money per hour loses the least time for transport, since transport is most costly for him. Therefore, other household members should let him use the private vehicle, considering that there is only one vehicle in that household. If only one individual in the household participates in the labour market, it is most efficient that that person uses the car because its costs of transport are the greatest.

Time costs also can be used to illustrate that married couples prefer to use private cars rather than public transportation. Marriage usually involves activities that unmarried individuals engage in, such as spending time with their partners at home or the caring of other family members. Such responsibilities take time, and then spending time outside of work for married people is scarcer and valuable. Travelling in a private car becomes relatively cheaper and less time-consuming than traveling by bus, hence the car is the preferred choice. This time cost aspect also can explain the reason why people who experienced an incident during their commute are eager to use private vehicles since it provides the time-cost efficiently.

Finally, time cost also can be used to justify why travel cost does not affect commuter behaviour since the transport mode choice not only depends on the travel cost itself but also considers other costs such as time cost. Research from Herawati (2013) also found that the total value of money while commuting not only influenced by travel costs from trip fare and fuel cost, but also by the time taken and the level of comfort felt by individuals during commuting.

b. Conclusion

Firstly, socio-economic factors such as income, gender, and marital status significantly impacts people decision in choosing travel options, but there is nothing that can be done about that because these factors are embedded in the individual. Furthermore, from this research, it was revealed that mode-specific factors and trip characteristics such as travel time also have a significant impact. This is the factor that has to be improved. People will be persuaded to use public transport more effectively when provided with a better transportation system, allowing for faster and easier ways for people to commute.

Secondly, there is a significant negative correlation between educational background and people's decision to utilize mass transit. This study also revealed that in Greater Jakarta, the tendency to use mass transit is bigger in satellite cities with less population than in the central city. This research challenges the common explanation from previous research that argued that higher education and dense population will accelerate the use of public transport. This research proves that for Indonesian case that common sense has to elaborate more.

The result of this research does not mean that education is not essential, but in fact, there is a complex transmission mechanism for formal education to influence people's behaviour. It is true that education makes people think more logically and systematically which makes people behave more carefully including encouraging green sustainable behaviour, however, one also has

to remember that education also makes people think more effectively as to how to make their work more productive. In Greater Jakarta, the lack of reliability and limited accessibility of mass transit systems make educated people think that even though more costly, the benefit of using a private vehicle overweighs that of the use public transport since it provides the effective way to go to the workplace.

In terms of population, this research reveals that the dense population itself is not sufficient to encourage people to use public transport. If the mass transit system is difficult to access and far enough from their home, they will choose the better, more comfortable, or maybe cheaper option. Therefore, to encourage public transport-use, population density has to be combined with various aspects such as the accessibility and reliability of the whole transport system.

In general, this study discloses several factors as the initial hypotheses that significantly impacts people behaviour to choose the mode of transportation such as education, population, income, gender, and marital status. Whereas age and travel cost factors are not significantly influencing individual's motivation in daily routine transportation choice

For the case in Indonesia, considering that the public transport system is not reliable enough to be more productive the top priority actions are to:

- Improve the quality and reliability of the public transport system, not only to provide safety, convenience, and comfort for passengers but also the transport system that has good availability and fixed-regular schedule.
- Develop an integrated system of mass transit by using a transit-oriented development concept that provides the feeder bus from each residential area, so it makes people much more comfortable to catch the nearest station.
- The government also have to make people shift to utilize public transport by reducing the utility of having

private vehicles by giving disincentive policies like increasing the vehicle tax, imposing fuel tax, establishing electronic road pricing, or set up the higher rate of parking fee.

Finally, this research also suggests further possible improvement for future research. First, this study only covered small number of participants based on commuter survey, as compared to all daily commuters in Greater Jakarta. It could be better to expand the number of participants into views of the general public in future research. Secondly, the obtained dataset in this study used the survey from 2014. Future research could employ updated survey in 2019 Commuter Survey to describe the recent conditions of Greater Jakarta's commuter behaviour. In addition, further research may adopt different methods of data collection such as in-depth interviews or using daily statistics data from transportation authority to provide a better understanding of commuter behaviour. Finally, further research could also improve the analysis by extending the model estimation approach to implement the multilevel conditional probit or two-stage probit that could offer a better estimation model.

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Appendix A

Probit regression

Number of obs = 5,702

LR chi2(11) = 974.46

Prob > chi2 = 0

Log likelihood = -2193.2672

Pseudo R2 = 0.1818

commuter_bhv	Coef.	Std. Err.	z	P>z	[95% Conf. Interval]	
edu_backgr	-0.1105665	0.052823	-2.09	0.036	-0.214098	-0.0070351
population	-0.1283003	0.043977	-2.92	0.004	-0.2144943	-0.0421062
age	0.0081229	0.013437	0.6	0.545	-0.0182126	0.0344584
agesqr	0.00015	0.000163	0.92	0.357	-0.0001693	0.0004692
income	-8.29E-08	1.12E-08	-7.41	0.000	-1.05E-07	-6.10E-08
incomesqr	6.63E-16	1.73E-16	3.84	0.000	3.25E-16	1.00E-15
travel_cost	-1.98E-06	1.36E-06	-1.45	0.146	-4.65E-06	6.88E-07
travel_time	0.0099856	0.000644	15.51	0.000	0.0087238	0.0112474
gender	-0.9970606	0.048041	-20.75	0.000	-1.091218	-0.9029031
tech_prob	-0.2034136	0.044437	-4.58	0.000	-0.2905085	-0.1163188
incident	-0.572707	0.078987	-7.25	0.000	-0.7275182	-0.4178959
marital_stat	-0.2889482	0.059821	-4.83	0.000	-0.4061959	-0.1717004
_cons	-0.3677215	0.242653	-1.52	0.13	-0.8433116	0.1078685

Average marginal effects

Number of obs = 5,702

Model VCE: OIM

Expression: Pr(commuter_bhv), predict()

commuter_bhv	Delta-method		z	P>z	[95% Conf. Interval]	
	dy/dx	Std. Err.				
edu_backgr	-0.02939	0.014023	-2.1	0.036	-0.05687	-0.0019
population	-0.0341	0.011662	-2.92	0.003	-0.05696	-0.01124
age	0.002159	0.003571	0.6	0.545	-0.00484	0.009157
agesqr	3.99E-05	4.33E-05	0.92	0.357	-4.5E-05	0.000125
income	-2.20E-08	2.94E-09	-7.49	0.000	-2.78E-08	-1.63E-08
incomesqr	1.76E-16	4.58E-17	3.85	0.000	8.66E-17	2.66E-16
travel_cost	-5.27E-07	3.62E-07	-1.46	0.145	-1.24E-06	1.82E-07
travel_time	0.002654	0.000159	16.67	0.000	0.002342	0.002966
gender	-0.26499	0.011039	-24	0.000	-0.28663	-0.24335
tech_prob	-0.05406	0.011744	-4.6	0.000	-0.07708	-0.03104
incident	-0.15221	0.020749	-7.34	0.000	-0.19288	-0.11154
marital_stat	-0.07679	0.015798	-4.86	0.000	-0.10776	-0.04583

Appendix BMultinomial Probit Regression
Log likelihood = -2670.2642

Number of obs = 5,702

commuter_bhv	Coef.	Std. Err.	z	P>z	[95% Conf. Interval]	
0 (private transportation)	(base outcome)					
1 (public transportation)						
edu_backgr	-0.14792	0.076706	-1.93	0.054	-0.29826	0.002417
population	-0.21029	0.063806	-3.3	0.001	-0.33534	-0.08523
age	0.021543	0.019404	1.11	0.267	-0.01649	0.059574
agesqr	0.000118	0.000235	0.5	0.616	-0.00034	0.000578
income	-1.30E-07	1.65E-08	-7.87	0.000	-1.62E-07	-9.73E-08
incomesqr	1.07E-15	2.33E-16	4.57	0.000	6.09E-16	1.52E-15
travel_cost	-1.25E-07	1.92E-06	-0.06	0.948	-3.90E-06	3.65E-06
travel_time	0.013741	0.000928	14.81	0.000	0.011922	0.015559
gender	-1.36653	0.069563	-19.64	0.000	-1.50287	-1.23019
tech_prob	-0.22569	0.064562	-3.5	0.000	-0.35223	-0.09915
incident	-0.91046	0.119832	-7.6	0.000	-1.14533	-0.67559
marital_stat	-0.49353	0.086491	-5.71	0.000	-0.66305	-0.32401
_cons	-0.84501	0.351117	-2.41	0.016	-1.53319	-0.15684
2 (para-transit transportation)						
edu_backgr	-2.10E-01	0.117385	-1.79	0.073	-0.44054	0.019598
population	-1.77E-02	0.095384	-0.19	0.853	-0.2046	0.169297
age	-0.03856	0.029036	-1.33	0.184	-0.09547	0.018351
agesqr	0.000621	0.000353	1.76	0.079	-7.1E-05	0.001312
income	3.45E-08	5.59E-08	0.62	0.537	-7.50E-08	1.44E-07
incomesqr	-4.58E-15	3.55E-15	-1.29	0.197	-1.15E-14	2.38E-15
travel_cost	-1.6E-05	3.92E-06	-4.05	0.000	-2.4E-05	-8.20E-06
travel_time	0.012129	0.001353	8.96	0.000	0.009477	0.014781
gender	-1.24442	0.1011	-12.31	0.000	-1.44257	-1.04627
tech_prob	-0.44823	0.097833	-4.58	0.000	-0.63998	-0.25648
incident	-0.30452	0.158536	-1.92	0.055	-0.61524	0.006209
marital_stat	0.037588	0.130068	0.29	0.773	-0.21734	0.292517
_cons	-1.05184	0.510931	-2.06	0.04	-2.05325	-0.05044

Appendix C

Multinomial Probit
Conditional marginal effects
Model VCE: OIM

Number of obs = 5,702

Expression: Pr(commuter_bhv ==1),predict(pr outcome(1)): public transport

commuter_bhv	Delta-method		z	P>z	[95% Conf. Interval]	
	dy/dx	Std. Err.				
edu_backgr	-0.02543	0.01449	-1.76	0.079	-0.05383	0.002966
population	-0.04045	0.012029	-3.36	0.001	-0.06402	-0.01687
age	0.004759	0.003649	1.3	0.192	-0.00239	0.011911
agesqr	1.33E-05	4.42E-05	0.3	0.763	-7.3E-05	0.0001
income	-2.56E-08	3.14E-09	-8.17	0.000	-3.18E-08	-1.95E-08
incomesqr	2.76E-16	6.47E-17	4.27	0.000	1.49E-16	4.03E-16
travel_cost	2.18E-07	3.66E-07	0.6	0.552	-5.00E-07	9.36E-07
travel_time	0.002476	0.000175	14.18	0.000	0.002133	0.002818
gender	-0.24562	0.013309	-18.46	0.000	-0.2717	-0.21953
tech_prob	-0.03687	0.012206	-3.02	0.003	-0.06079	-0.01294
incident	-0.17164	0.022463	-7.64	0.000	-0.21567	-0.12762
marital_stat	-0.09613	0.016308	-5.89	0.000	-0.12809	-0.06417