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TRIGGER VARIABLES OF PRIVATE CAR USERS SWITCHING TO COMMUTER TRAINS: REVEALED PREFERENCE METHOD

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ABSTRACT

Purpose: Only 6% of trips in Jakarta used commuter trains (KRL) out of 27.48 million daily trips in Jakarta before the Covid-19 pandemic. A city to be a reliable transportation if the proportion has reached 44%. This makes Jakarta dominated by private vehicles, especially passenger cars. This study seeks to find trigger variables for private car users who have switched to KRL.

Design/methodology/approach: This study uses a preliminary interview method for respondents who use cars that have switched to KRL. From the results of the preliminary interview, we found that socio-economic characteristics (9 predictor variables) and travel characteristics (9 predictor variables) and willingness to always use KRL (response variable) used in making the questionnaire. The analysis technique used binary logistic regression. The number of samples of respondents to be taken is 387 people.

Findings: Variables of socio-economic characteristics comprising age, gender, education level, profession, marital status, average monthly income, motorcycle ownership, car ownership and driver's license did not significantly affect the response variable of willingness to always use KRL. The travel characteristics of respondents that have a significant effect on the willingness to always use KRL are the variables of travel time (KRL and private car), travel costs (KRL and private car) and the cost of parking a private car when using KRL and when using a private car. The variables of distance to KRL stations, walking time to KRL stations and waiting time at KRL stations have no significant effect on willingness to always use KRL.

Research limitations/implications: From the results of the study, some people who are near the KRL station (less than 400 meters) and walking time of less than 10 minutes still use private vehicles. This makes it very important to develop several other variables in future research.

Practical implications: This is like what has been in Madrid (Spain) where the significant factor for private vehicle users to switch to public transport influenced by timeliness, information, low-income residents, proximity to destination locations, integration between modes, time and cost, savings, and lifestyle.

Originality/value: Several previous studies only explained the variables that could trigger the movement of car users to KRL into 2 characteristics (Socio-economic characteristics and travel characteristics). Meanwhile, the increase in personal vehicle tax, the prohibition of owning a new private vehicle, the increase in the cost of obtaining a driver's license (SIM), and the increase in fuel prices are characteristics of the Pull and Push Transportation Demand Management that we carried out in this study.

Keywords: operational research, engineering management, revealed preference, binary logistic regression.

1. INTRODUCTION

Data on the number of passenger cars in 2016 reached 2,570,433 units, while in 2020 it reached 3,365,447 units (BPS, 2021). This means that there has been an increase in the number of passenger cars by 795,014 units for 4 years. The average increase per year is 198,754 units or 6.25%/year. Data on the length of toll roads, state roads and provincial roads from 2014 to 2019 shows a decrease in road length. In 2014, the length of the road reached 6,955,842 meters, while the road's length in 2019 reached 6,652,679 meters. So there is a decrease in the length of the road as much as 303,163 meters. However, the road area has increased from 43,456,123 m^2 to 46,426,531m2. Although the road area has increased, there is a tendency for the location of the number of roads that are prone to congestion to increase in number. In 2018, it shows that there are 38 locations prone to congestion. 14 congestion-prone points in Central Jakarta, 11 congestion-prone locations in West Jakarta, 8 congestion-prone locations in East Jakarta and 5 locations in North Jakarta. Meanwhile, there are 31 locations prone to congestion in South Jakarta.

Because to the increasing number of roads that are prone to congestion, the main solution is to divert some users of private vehicles, especially private cars, to switch to commuter trains (KRL). This is very important considering that Jakarta has a commuter train (KRL) public transportation, which still has a capital share of 6% (Yudisthira, et al. 2016). This shows the high dependence on private vehicles while public transport modes are neglected. If the quality of Jakarta's public transportation does not improve, people will increasingly depend on private vehicles. People in Jakarta and suburban areas change their mode of transportation from public transportation to private transportation (Yudisthira, et.al, 2016).

The results of research by Ferdiansyah (2009) quite surprise that the willingness of users of private transportation modes in Jakarta to switch to using public transportation is quite large. The switch from private cars to buses is 75%, private cars to KRL are 63%, motorbikes to buses are 80%, and motorbikes to KRL are 72%. However, until 2021, this figure is not accurate because only a few have switched to mass public transportation suchas KRL and Trans Jakarta. This is because only 6% of the 27.48 million movements that use KRL every day.

Tiwari (2006) states that if a city with a population of over 5 million people, ideally the market share of public transportation is 44%, taxis and other public transportation (taxi and non-motorized public transportation) 5%, walking 29%, 4% cars, 10% motorcycles and 7% bicycles. The city of Jakarta has a population of 10,562,088 people in 2020 (BPS 2021). Therefore, the market share of KRL and TransJakarta, which is still at 6% still needs to be increased again to reach 44%.

There are several previous studies related to the variables of the use of transportation modesincluding the following Vaca et al. (2005) stated that an increase in parking rates by 10% impact on decreasing the number of private vehicle trips by 1-3% depending on demographics, geography, travel choices and travel characteristics. If there is a reduction in the cost of using transit public transportation, there will be an increase in the use of public transportation between 3 – 16%. If a parking cash out discount of $1.5 – $2.5 per day apply, there will be an increase in using of public transportation, especially from commuter users by 3 – 30% (ACTC, 2010). Silitonga et.al (2011) stated that the choice of transportation mode based on public transport fares (micro buses), the cost of using private vehicles (cars or motorbikes), travel time for private vehicles, increased vehicle taxes, prohibitions on owning new private vehicles and increases the cost of making and renewing a driving license (SIM). If someone uses a private car and feels the travel time is very long, then he will switch to a motorcycle.If the travel time of public transport felt to be fast and the fare for public transport is perceived to be low, the use of public transport will increase.

Habibian et al. (2013) stated that reducing the travel time of public transport will divert private vehicle users and pedestrians to public transport. Soltanzadeh & Masumi (2014) have four variables that influence the choice of transportation mode: gender, household size, age, and private car ownership. Islam et al. (2015), stated that lower parking rates in cities are factors that influence commuters to choose to use their cars rather than choosing public transportation modes even though there are Park & Ride (P&R) facilities. Meanwhile, if public transport travel times and transfer times are lower, commuters are more likely to choose the P&R mode than driving their vehicles. Zhang (2015) states that the increase in parking and fuel rates for cars causes a shift to buses.If the bus service remains constant, while parking and fuel rates increase, there will be ashift of car commuter users between 15 – 70% to buses. If bus services increase, there will be a shift of car commuter users between 20 and 80% to buses.

Yudhisthira, et al. (2016) stated that people in Jakarta choose transportation modes based on travel time (53.4%) followed by safety (19%) and travel costs (17%). So that it can interpreted that travel time, security and travel, they still cosidered cost for private vehicles more profitable than public transportation. Nazwirman, et. al (2017) stated travellers chose that KRL because it was cheap, fast and safe. Attributes that are suspected to have a relationship include age, last education, intent and purpose of using KRL, length of time as a KRL user, and reasons for using KRL. Muhtadi et.al (2018) stated that there are socio-economic characteristics, namely age, last education level and income/month that influence a person's decision to switch from privatevehicles to KRL. These three variables only predict someone will use regular or temporary KRL by 54.8%. So there are still 33.2% of other variables that can cause private vehicle usersto switch to KRL.

From several previous studies as described above, we can divide the variables that may trigger the movement of car users to KRL can be divided into 2 characteristics:

1) Socio-economic characteristics (gender, household size, age, last education level, income/month and private car ownership

2) Tripl characteristics (KRL fares, private car costs, private car travel time, KRL travel time, car parking rates when using KRL and private cars, waiting time for public transport)

Meanwhile, the increase in personal car tax, the prohibition on owning a new private car, theincrease in the cost of obtaining a driver's license (SIM), the price of fuel, and security are characteristics of Pull and Push Transportation Demand Management which we will conduct research in the future. So that we will make these variables as research instruments using the revealed preference method and the object of the research is private car users who switched to using KRL. This isto find out what variables are the triggers for private car users might switch to KRL.

2. MATERIAL & METHODS

We designed this study of respondents using private car who have switched to KRL in the Jakarta. This research requires 5 stages of research: (1) Determination of the study area ; (2) Revealed preference (RP) questionnaire design ; (3) Collecting and preparing revealed preference data; (4) Data modeling using logistic regression ; (5) Determination of the probability model for private car users who have switched to KRL.

2.1. Determination of the study area

KRL has 6 routes: (1) Bogor/Depok – Manggarai – Jakarta Kota ; (2) Bogor/Depok – Tanah Abang – Pasar Senen – Jatinegara ; (3) Bekasi – Jatinegara – Manggarai – Jakarta Kota; (4) Maja/Parung Panjang/Serpong – Tanah Abang ; (5) Tangerang – Duri and (6) Tanjung Priok

– Jakarta Kota. The following is a map of the KRL route in Jakarta (krl.co.id, 2017). We distributed questionnaires to 14 KRL stations spread out: Bogor, Depok, Manggarai, Jakarta Kota, Tanah Abang, Pasar Senen, Jatinegara, Bekasi, Maja, Parung Panjang, Serpong, Tangerang, Duri and Tanjung Priok.

2.2. Revealed preference (RP) questionnaire design

At this stage, there is some data needed, including:

- KRL data: data on the number of passengers, routes and stations
- Data from the Transportation Agency: the proportion of transportation modes, length of roads, and the number of motorcycles

- Population data: demographic data of the population of Jakarta
- Study literature from reference books, articles or research journals
- Designing a Revealed Preference questionnaire

There are many factors that trigger a private car user to switch to public transportation. Travel time, cost, and quality of service (safety, reliability and security) are trigger factors for switching to public transport (Akriati, et al., 2020). Meanwhile, other research states that travel time, public transport rates, comfort, safety and reliability are the 5 dominant factors in Asia (Muhtadi, et al., 2019). But this can reverse direction, if there is dissatisfaction in using public transportation. If dissatisfaction with public transportation occurs repeatedly, it will reduce the attractiveness of public transportation (Raj & Shetty, 2021). So that people will turn to using private vehicles again.

A small proportion of private car users in Jakarta have switched to KRL. The transition fromprivate car users to KRL influenced by several factors. The factors that support switching toKRL are the preference choices of a private car users. The individual preference of private car is a single choice. If there are several respondents, the single choices can combined and become a collective reference (Lehmann, 2019). So this research will use the RP method to determine the factors that trigger private car users who have switched to KRL in Jakarta. In the RP method, it assumed that there are observers who record the alternatives chosen bythe respondent with certain criteria. The results of interviews with respondents will laterproduce a decision-making model. T he model will checked whether it is consistent with the respondents' answers that have been previously got (Nishimura,2017).

using the RP method was realized as of a questionnaire. There are 2 parts used in this study: (1) predictor variables and (2) response variables. Predictor variables comprise 2 characteristics: (a) socio-economic characteristics, (b) trip characteristics. Each of the socio- economic and travel characteristic associated with a response variable (willingness to use KRL sustainably). In the trip characteristics, there are questions about the geographical distance from the respondent's house to the location of the nearest KRL station and the walking time to the KRL station.

Socio-economic characteristics comprise 9 predictor variables: age, gender, education level, profession, marital status, income/month, number of motorcycles owned, number of cars owned, and ownership of a driving license [Syahlendra, (2020); Saghapour, et.al., (2016) & de Ona. et.el., (2021)]. While the trip characteristics comprise 9 predictor variables: the distance from the house to the destination KRL station, walking time to the KRL station, waiting time at the KRL station, travel time when using the KRL, travel time when using a motorcycle, travel costs when using the KRL, travel costs when using a motorcycle, parking fees/day when using KRL and parking fees/day when using motorcycle [Muhtadi, et al., (2019); Saghapour, et al., (2016); Layton (2017); Diaz, et al., (2011) & de Ona. Et el., (2021)].

2.3. Collection and preparing of Revealed Preference data

For transportation research using a questionnaire, we recommend that 289 respondentsfor public transport users and 271 respondents for private vehicle users (Bolbol, et al., 2012).

However, there are other opinions using the sample size calculation formula to estimate the proportion of the population (Lemeshow, et al., 1990). Here is the calculation formula:

$$n = \frac{z^2_{1-\alpha/2} * p * (1-p)}{d^2}$$

Where: n is the number of samples, $z^2_{1-\alpha/2}$ is the z score at the 1-α /2 level of confidence, p is the estimated proportion and d is the tolerance of error chosen. The most commonly used confidence levels are 95% (1,960) and 90% (1,645). Meanwhile, the value of p * (1-p) will provide a variety of different values for p. The selected sample size will be greatest if p = 0.5.Therefore it is suggested that if the researcher does not know the size of p in the population, choosing p of 0.5 will provide a sufficient amount. For the value of d varies between 0.01 to 0.25. In this study, the d value was taken as 0.05 and the p value was 0.5. The exact number of motorcycle users who have switched to commuter trains is not known. The confidence level used is 95% and an error tolerance of 5%. The results obtained were 383 respondents. For an infinite population, the minimum number of respondents is 384 respondents (Oribhabor & Anyanwu, 2019). In this study, questionnaires will be distributed to 387 respondents spread across 14 KRL stations in Jakarta (Indonesia).

2.4. Data Modeling Using Logistic Regression

Regression is a method used to complete data analysis that explains the relationship between the response variable and one or more predictor or explanatory variables. Meanwhile, logistic regression is a method used to find the relationship between dichotomous or polychaetes response variables and one or more predictor variables (Washington, et.al., 2003).

In statistics, logistic regression (often called logistic model or logic model), is used to predict the likelihood (probability) of an event with logic function data from the logistic curve. Like many forms of regression analysis, using multiple variables can be numeric or categorical. Logistic regression is part of the regression analysis used when the dependent variable (response) is a dichotomous variable. The dichotomous variable usually comprises only two values, which represent the occurrence or absence of an event which is usually assigned the number 0 or 1. Logistic regression will form a predictor / response variable, which linearly combines of the independent variables. We then transformed the value of this predictor variable into probability with the logic function.

Logistic regression is a nonlinear regression, where the specified model will follow a linear curve pattern. For logistic regression, regardless of the size or size of the value of "X", the "Y" value will remain between 0 and 1, so the dichotomous variable used which usually comprises only two values, which represent the appearance or absence of an event which is usually given the number 0 or 1.

In addition, logistic regression also produces odds ratios associated with the value of each predictor. We difine the odds of an event as the probability of an outcome occurring, divided by the probability that an event does not occur. Odds ratios are the set of odds shared by the rest of the odds. The probability-to-predictor ratio defined as the relative amount in which the

probability of an outcome increases (odds ratio> 1) or decreases (odds ratio <1) when the value of the predictor variable increases by 1 unit. In problem identification being studied, by recognizing the determinants of choosing the type of transportation or mode that influence the selection, it is study that the response variables in this study are binary (private vehicles and public transportation), and the predictor variables taken from the group of factors that influence the selection. Logistic regression can determine the relationship between predictor variables and response variables.

Binary data is data with 2 (two) responses, for example private vehicles (1) - public transportation (0), fail-succeed, yes-no, on-off, 0-1 and so on. As in multiple regression analysis, for logistic regression, the predictor variable (X) can also comprise over one variable and can be a continuous or discrete variable. Logistic regression can estimate the probability of the response variable (Y). If the respondent answers yes, then the response variable is Y = 1. Whereas if the respondent answers no, then the response variable is Y = 0. The X variable in this study is a set of predictor variables that can be discrete, continuous or combination (Him, et al., 2020). The response variable in this study is categorical and represents a proportion or opportunity (Tranmer & Elliot, 2015). Since the answer choice for the response variable is 2 (yes / 1 or no / 0), the analysis technique uses binary logistic regression.

Binary logistic regression is a data analysis method used to find the relationship between the binary response variable and the predictor variable that is categorical or continuous (Washington, et al., 2003). The response variable (Y) comprise two categories, namely success and failure, which is denoted by Y = 1 for success and Y = 0 for failure. The variable Y follows the Bernoulli distribution for every single observation. Based on bivariate data (X,Y), where X is a numeric variable or a one-zero variable and Y is a one-zero response variable, it show a logistic regression model with the following general form (Hosmer, et.al., 2013).

$$p = P(Y = 1) = \frac{exp(\beta_0 + \beta_1 X)}{1 + exp(\beta_0 + \beta_1 X)} \quad (2)$$

Where: p = P (Y = 1) expresses the proportion of Y = 1 scores in the population among all possible scores / one-zero scores. Binary logistic regression analysis technique requires a feasibility test of the model. The feasibility test of the model uses a statistical test which aims to study the suitability of the logistic regression model used in the relationship between the predictor variable and the response variable (Wasington, et al., 2003). The null hypothesis is that there is no relationship between the predictor variables and the response variable. Meanwhile, the alternative hypothesis is that there is a relationship between the predictor variable and the response variable (the model is able to represent the relationship between the predictor variable and the response variable).

This statistical test was carried out by dividing the data into groups (g). This group is formed by sorting the existing data based on the level of probability. So the data are sorted from the least likely data (p ~ 0) to the most likely data (p ~ 1).

The basic principle of this statistical test is that the frequency of the prediction results and the frequency of observation of the response variable must have a relatively small difference. The smaller the difference the more feasible the model is. A model that is feasible according to this statistical test will have a large probability value (p-value) that is greater than the 5% confidence level or α = 0.05 (Hosmer, et.al., 2013).

The formula of the feasibility test model is as follows (Washington, et.al., 2003):

$$C^{\wedge} = \sum_{k=1}^{n} \frac{(O_k - E_k)^2}{V_k} \quad (3)$$

Description: $C^{\wedge}$is the Hosmer Lemeshow test (H-L Test); $O_k$is the observed value in the k- group; E_k is the expected value in the k th grip; V_k is the variance correction factor for the k-group. If the probability value > the value of chi^2, it can be said that the statistical test indicates that the model developed is feasible in describing the relationship between the predictor and response variables.

2.5. Determination of the Probability Model of Motorcycle Users Who Have Switched to KRL

The model that was created in step three has passed a series of model feasibility tests. If the results of the feasibility test of the model have met the predetermined requirements, then the model is workable and fit for further research use. From this model, they will be known how much influence the model has on the decision of private car users to switch to KRL. The resulting model comprises several predictor variables. So that in order to increase the number of motorcycle users to switch to KRL in the future, it requires the development of several predictor variables. Therefore, at this last stage, it is suggested that it should develop several predictor variables in the future so that there will be an increase in the number of private car users who switch to KRL.

3. RESULTS & DISCUSSION

This research conducted by distributing questionnaires to 387 respondents. The first part of the questionnaire is about the socioeconomic characteristics of the respondents. 95,06% of respondents are of productive age (between 23 to 55 years), 75,84% of respondentsare male, 73,51% of respondents have a university education level, 70,65% of respondents have a type of work as employees/staff, 76,62% of respondents married, 64,16% of respondents have a monthly income of Rp. 5,000,001, - Rp. 10.000.000,- (US$ 349 – US$ 698), 73,77% of respondents not own motorcycle, 94,06% of respondents have 1 unit of car, and 96,12% of respondents have a driving license. We summarized the socioeconomic characteristics of the respondents in Table 1.

Table 1 The socioeconomic characteristics of the respondents.

Characteristic	Total	%
Age	387	100
Under 23	17	4,42
23 – 55	366	95,06
More than 55	4	1,04
Sex	387	100
Male	292	75,84
Female	95	24,68
Education	387	100
Senior HS	104	27,01
University	283	73,51

Profession	387	100
Entrepreneur	91	23,64
Employee/Staff	272	70,65
Student	24	6,23
Marital Status	387	100
Married	295	76,62
Not Married	92	23,90

Characteristic	Total	%
Average income per month	387	100
Under Rp. 3,6 Million	34	8,83
Rp. 3,6 – 5 Million	91	23,64
Rp. 5,01 – 10 Million	247	64,16
More than Rp. 10 Million	15	3,90
Motorcycle ownership	385	100
Do not have	284	73,77
1 unit	89	23,12
2 units	14	3,64
Car ownership	387	100
1 unit	364	94,06
2 units	23	5,94
Driving license ownership	387	100
Do not have	15	3,88
Have a driving license	372	96,12

The second part of the questionnaire is trip characteristics of the respondents.56,85% of respondents have a distance of 401 – 1000 meters from their house to the nearest KRL station. 53,75% of respondents walked to the KRL station for 5.01 to 10 minutes. 36,43% of respondents waited for the KRL at the station for 5,01 to 10 minutes. 46,77% of respondents have travel time using KRL for 30,01 to 60 minutes. 42,38% of respondents stated that the travel time when using a private car was 60,01 – 90 minutes. The cost of travel for 47,03% of respondents when using KRL is Rp. 3,000,- (US$0.21). 31,78% of respondents stated that the cost of using a private car was Rp. 10.001 until Rp. 15.000,- (US$0,75 – 1,05). 36,95% of respondents pay for private car parking when using KRL to their destination of Rp. 5.000 (US$0,38). 29,46% of respondents spent private car parking fees of Rp. 10.001 – Rp. 15.000,- (US$0,75 – 1,05). We summarized the trip characteristics of the respondents in Table 2.

Table 2 The trip characteristics of the respondents.

Trip Characteristic	Total	%
Distance from home to KRL station	387	100
< 400 meter	118	30,49
401 – 1000 meter	220	56,85
1001 – 1500 meter	20	5,17
More than 1500 meter	29	7,49
Walking time to KRL station	387	100
0 – 5 minutes	14	3,62
5,01 – 10 minutes	49	12,66
10,01 – 15 minutes	116	29,97
More than 15,01 minutes	208	53,75
Waiting time in KRL station	387	100
< 3 minutes	98	25,32
3,01 – 5 minutes	134	34,63
5,01 – 10 minutes	141	36,43
More than 10 minutes	14	3,62
Trave time with KRL	387	100
Trip Characteristic	Total	%
0 – 30 minutes	153	39,53
30,01 – 60 minutes	181	46,77
60,01 – 90 minutes	39	10,08
More than 90 minutes	14	3,62
Travel time with private car	387	100
0 – 30 minutes	68	17.57
30,01 – 60 minutes	73	18,86
60,01 – 90 minutes	164	42,38
More than 90 minutes	82	21,19
Travel cost with KRL	387	100
< Rp. 3..000,-	182	47,03
Rp. 3.001 – Rp. 5.000,-	122	31,52
Rp. 5.001 – Rp. 7.000,-	81	20,93
More than Rp. 7.000,-	2	0,52
Travel cost with private car	387	100
< Rp. 5..000,-	63	16,28
Rp. 5.001 – Rp. 10.000,-	95	24,55
Rp.10.001 – Rp. 15.000,-	123	31,78
More than Rp. 15.000,-	106	27,39
Parking cost if use KRL	387	100
< Rp. 5.000,-	143	36,95
Rp. 5.0001 – Rp. 10.000,-	139	35,92
Rp. 10.001 – Rp. 15.000,-	64	16,54
More than Rp. 15.000,-	41	10,59
Parking cost if use private car	387	100
< Rp. 5.000,-	79	20,41
Rp. 5.0001 – Rp. 10.000,-	96	24,81
Rp. 10.001 – Rp. 15.000,-	114	29,46
More than Rp. 15.000,-	98	25,32

Table 2. shows that the geographical distance between the respondent's house and the nearest KRL station varies. The geographical distance between the respondent's house and the KRL station divided into 4 types: (a) less or equal to 400 meters, (b) 401 to 1000 meters, (c) 1001 to 1500 meters and (d) over 1500 meters. According to Hidayati (2008), the distance from the house to the train station, including the close category, is less than 500 meters. Meanwhile, if the distance to the train station is over 500 meters, they included it in the category of long distance to the train station. The New South Wales Ministry of Transport (2006) states that 90% of households must be within 400 meters of a bus stop or train station. This distance is the straight distance not the distance traveled or walking distance. Similarly, the Greater Vancouver Transportation Authority (2004) uses a straight distance guide of 400 meters. The City of Helsinki (Finland) uses a straight distance reference of 300 meters (HKL, 2008). While the City of Perth (Western Australia) uses a straight distance, reference of 500 meters (Public Transport Authority, 2003).

The distance to the public transportation stop is very important because farther the distance, the fewer people's desire to use public transportation. This is as stated by Ewing & Cervero (2010) that an increase in distance by 10%, there will be a decrease in using of public transportation by 3%.

From the respondents' answers, only 30.49% are within 400

meters of the KRL station. Meanwhile, 69.51% are over 400 meters away from the KRL station. This is an obstacle to increasing the number of KRL passengers in the future. For the variable of walking time to the public transport stop, Yigitcanlar et al. (2007) stated that it takes 10 minutes to cover a distance of 300 meters. Sarker, et al.(2017) stated that it takes walking time between 6 to 14 minutes to reach a public transport stop in Munich (Germany). When walking to the public transportation stops, there are 3 areas, namely the inner city area, residential and commercial area and suburban area.

In this study, the category of walking time dominated to the KRL station between over 15 minutes, 208 respondents (53.75%). The second category, with the highest walking time, is between 10.01 – 15 minutes, which is 116 respondents (29.97%). The third category with the most walking time is between 5.01 – 10 minutes, 49 respondents (12.66%). Walking time of less than 5 minutes stated by only 14 respondents (3.62%). This shows that there are 179 respondents (46.25%) who have a walking time of up to 15 minutes. This is a challenge for KRL in the future to increase the number of passengers because, 208 respondents (53.75%) have a walking timeof over 15 minutes. Where the ideal walking time to the public transport stop is a maximum of 10 minutes (300 meters). We must also remember that the longer the running time, the lower the public's interest in using public transportation.

The third part of the questionnaire is the response variable of private car users who have switched to KRL (commuter train). In this section, we ask respondents questions about their willingness to always use KRL as their daily mode of transportation. The results shownare 133 respondents (34.55%) stated that they do not always use KRL as their daily mode of transportation. Meanwhile, 252 respondents (65.45%) will always use KRL as a mode of transportation every day. For more details, we can see the willingness to always use KRL in Table 3.

Table 3 Willingness to always use KRL (commuter train).

Characteristic	Total	%
Willingness to use KRL	387	100
Not willing to use KRL	157	40,57
Willing to use KRL	230	59,43

The next step is to find the relationship between the 9 predictor variables with the response variable (willingness to use commuter trains). It showed the results in Table 4 below.

Table 4. Results of social economic variables modeling with response variable.

Variables	B	Sig.
Age	,642	,408
Sex	-,365	,187
Education	-,294	,312
Profession	,606	,042
Marital Status	,321	,270
Income /month	,291	,522
MC own	,416	,407
Car own	-,275	,567
Driving License	-1,535	,059
Constant	1,864	,496

From Table 4, we find that the variable profession has a significance value <0.05. There is only 1 predictor variables that have a significance value of <0.05 (profession). There is 1 predictor variable that has a significance value close to 0.05, i.e.: the ownership of a driving license. So the 2 predictor variables may affect the willingness to always use KRL. Therefore,the next step will process modeling with 2 predictor variables with response variables, we can see the results of which in Table 5.

Table 5. Results of modeling 2 predictor variables to response variable.

Variables	B	Sig.
Profession	,331	,108
Driving License	,826	,172
Constant	1,402	,237

From the results of Table 5, we found that all the significance values of the 2 predictor variables were over 0.05. So we stated it for a while that the 2 predictor variables not significant effect on the willingness to always use commuter trains. Therefore, the next step is to process data from the travel characteristics of private car users who switch to KRL (commuter train).

In the trip characteristics of respondents, there are 9 predictor variables: distance of residence to the intended KRL station, walking time to the KRL station, waiting time at the KRL station, travel time when using KRL, travel time when using a private car, travel costs when using KRL, the cost when using private car, private car parking fee/day when using KRL, parking fee/day when using a private car. While the response variable is the willingness to always use KRL on the next trip. We can see the modeling results of the relationship between the trip characteristics and the willingness to always use KRL in Table 6.

Table 6. The results of modeling (1) the travel characteristics variables on the response variables.

Variables	B	Sig.
Distance from home to KRL station	,795	,213
Walking time to KRL station	-,462	,657
Waiting time on KRL station	,114	,884
KRL travel time	-5,840	,000
Private car travel time	5,996	,000
Travel cost if use KRL	-2,940	,020
Travel cost if use private car	1,979	,011
Parking cost if use KRL	-3,712	,002
Parking cost if use private car	7,028	,000
Constant	-13,873	,003

From the results of Table 6, it appears that the predictor variable of the distance from home to KRL station, walking time to KRL station and waiting time on KRL station is not significant (the significance value is more than 0.05). Therefore, the 3 predictor variable at the above was not included in further modeling.

Table 7. The results of modeling (2) the trip characteristics variables on the response variables

Variables	B	Sig.
KRL travel time	-5,832	,000
Private car travel time	5,647	,000
Travel cost if use KRL	-2,477	,027

Travel cost if use private car	1,838	,011
Parking cost if use KRL	-3,367	,003
Parking cost if use private car	6,212	,000
Constant	-11,574	,000

After they did not include 3 predictor variables in the modeling, the significance value of all variables was below 0.05. Then the next step is to test Hosmer and Lemeshow to see whether the empirical data matches or not with the model. Or, we hope that there will be no difference between the empirical data and the model. We will declared the model workable if it has a significance value above 0.05. The following is Table 8, which contains the results of the Hosmer and Lemeshow test.

Table 8. Hosmer and Lemeshow test

Chi Square	df	Sig.
1,455	8	,993

We can see it in Table 8 that the value of the Hosmer and Lemeshow Test is 1,455, with a significance of 0.993 > 0.05. This means that the fit model and the model declared workable and can interpreted. Then the next step is to see the feasibility of the logistic regression model. We can see the feasibility of the logistic regression model from the value of χ^2 in the Omnibus of Model Coefficient Test in Table 9.

Table 9. Omnibus test of model coefficient

Chi Square	df	Sig.
486,941	6	0,000

The number χ^2 on Omnibus of Model Coefficient is 486,941 with a significance level of 0.000. This result means that the model is feasible because the significance value of the model is smaller than the value of the actual level (0.000 < 0.05). The next test is looking for the value of -2 log-likelihood (G) in the summary model output in Table 10.

Table 10. Model summary

-2 Log likelihood	Nagelkerke R Square
35,702	,966

The value of -2 log-likelihood (G) is 35,702. While, the value of χ^2 in the Hosmer and Lemeshow test is 1,455 (Table 8). Then the value of G > χ^2 table (35,702 > 1,455). This means that H_0 rejected and H_1 accepted. So that we decide the logistic regression model workable to be interpreted. The value of Nagelkerke R square is 0.966, it can concluded that the predictor variables: KRL travel time, private car travel time, travel cost with KRL, travel cost with private car, private car parking cost if use KRL, and private car parking cost can explain the possibility of a private car users will switch to KRL by 96,6%.

4. DISCUSSSIONS

Through this research, we found that variables on socio-economic characteristics have no effect on the switch of private car users to KRL in Jakarta (Indonesia). Meanwhile, the factors that trigger the switch of private car users to KRL are: KRL travel time, private car travel time, travel cost if use KRL, travel cost if use private car, private car parking cost if use KRL, and private car parking cost. The models got are:

$ln(\frac{p}{1-p})$ = -11,574 – 5,832 x KRL travel time + 5,647 x private car travel time – 2,477 x KRL travel cost + 1,838 x private car travel cost – 3,367 x private car parking cost if use KRL+ 6,212 x private car parking cost.

From the modeling results, the 6 predictors of these variables influences the interest of private car users to switch to KRL. For further research, it is very possible to use other variables from Transport Demand Management (such as increasing parking rates and implementing ERP). This is because passenger car parking rates are very low in many places in Jakarta (only Rp. 5,000/US$0.35) for onetime parking with no time limit. Meanwhile, to reduce congestion on roads in Jakarta, it is very necessary to develop ERP (Electronic Road Pricing). So that private car users, when passing a road section, will charged ERP tariffs for the development of public transport infrastructure in Jakarta.

As explained by Hidayati (2008), New South Wales Ministry of Transport (2006) and Greater Vancouver Transportation Authority (2004) that the ideal geographical distance for pedestrians is a maximum of 400 meters in a straight line to public transport stops. At a distance of 400 meters can increase the interest of potential users of public transport by up to 90% (New South Wales Ministry of Transport, 2006). HKL (2008) states the closer geographical distance in Helsinki City (Finland) which is a maximum of 300 meters to the public transport stop. So this geographical distance to the KRL stop is very important information to increase public interest in using KRL in the future.

Meanwhile, because of the distance of a KRL station that can reached by private car users on foot, the walking time to the KRL station is also getting longer. This is according to Yigitcanlar et al. (2007), the ideal walking time is about 10 minutes (300 meters) at the longest to take the pedestrian to the public transport stop. Meanwhile, according to Sarker, et al. (2017), the ideal walking time limited to 6 to 14 minutes in the inner city area, residential and commercial area and suburban area. Therefore, walking time that is too long can reduce people's desire to use KRL in the future. The solution that can expected is to collaborate with public transport stakeholders (such as micro buses and online taxis). This will certainly make it easier for people to use public transportation that has integrated as a whole, both coverage area and public transportation fares.

5. CONCLUSIONS

This is like what has been in Madrid (Spain) where the significant factor for private vehicle users to switch to public transport influenced by timeliness, information, low-income residents, proximity to destination locations, integration between modes, time and cost, savings, and lifestyle (de Ona, 2021). To reduce the use of private vehicles, it can be by imposing toll rates on inner-city highways and increasing fuel prices. However, this will be ineffective if travelers can increase their income and have a parking space at work (Wichiensin and Boyce, 2015). However, technical and cost factors will not be enough to trigger private vehicle users to switch to public transportation. Or, the success of public transportation cannot only rely on the operational side. It is likely that the success of public transport also involves strong political support, effective collaboration between relevant agencies, and overall community support (Khan, et al. 2020).

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