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RESEARCH ARTICLE

Analyzing Commuters' Behavior on Egress Trip from Railway Stations in Yogyakarta, Indonesia

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Abstract:

Background:

Prambanan Ekspres Railway is known as one of the commuting modes in Yogyakarta, Indonesia. Sufficient egress modes do not support this railway. Due to lack of urban mass transit facilities, the commuters independently utilize a reliable mode for their mobility, for instance by owning a motorcycle and using overnight parking service facility in their non-home-station.

Objective:

This paper aims to understand the commuters' behavior on their egress trip when they decide to use the train as their main mode.

Methods:

A direct interview survey on the train was conducted during peak hours from Monday to Friday. By implementing stated preference survey, a logit model was used to analyze mode choice decision from the railway station to activity end destination.

Results:

The results indicate that walking distance to the parking area and bus-waiting time have a more significant impact compared to the walking distance to bus stop and in-bus travel time. Furthermore, the high cost of overnight parking also significantly influences the decision of choosing an egress mode. Otherwise, egress trip cost has less significance to encourage commuters' to shift to bus mode.

Keywords: Train passengers, Egress trip, Mode choice, Sensitivity, Captive users, Stated preference.

1. INTRODUCTION

The mass rail system is appeared as a sustainable travel mode for a commuting travel compared to other alternative modes. However, since it does not provide a door to door service, people who use the train as their mode, have to travel through three stages: access, main part, and egress. Access (*i.e.*, a link from the point of origin to boarding station) and egress (*i.e.*, a link from destination station to activity end destination) have paid an attention of researchers in the last few decades. Earlier studies have shown that access and egress stages represent the weakest link in a trip chain by public transit [1], occupy the majority of commuter's entire travel time [2], and reduce the attractiveness of rail system [3].

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Many studies concerning to access and egress trip aim to provide a solution on how to increase the public transport passenger. Most of it has focused on the accessibility of public transport infrastructure [1, 4, 5]. Nonetheless, studies on access and egress trip are mostly concentrating on walking and cycling travel mode. Traveling by train has been considered as the main commuting mode, despite the fact that bus is considered as a connected mode [6]. Since captivity to private vehicle becomes a common phenomenon of urban transport issue in developing countries (see for example [7 - 9]), understanding the selection of travel mode on egress trip for commuters who are using the train as their main mode become interesting. Since there is no availability of commuters, who have their own vehicle at the destination station while public transport services are in limited number to reach their activity end destination.

Subsequently, Yogyakarta has stimulated an increase in commuting demand of people living in its vicinity areas. Therefore, the government provides a commuter train called by *Prambanan Ekspres* Train to support people to travel in commute type. This train has become one of the commuter lines with high passenger and high service frequency compared to other commuter lines that spread across seven big cities in Indonesia (*e.g.*, Jakarta, Bandung, Surabaya, Semarang, Medan, Padang, and Palembang). *Prambanan Ekspres* Train is an ideal mode to commute to/from Yogyakarta because of its efficiency and punctuality compared to other modes [10]. Unfortunately, its high demand is not supported by the connected modes from the railway station to activity end destinations. Most of the passengers prefer to use their own private vehicles, especially motorcycle mode from railway station [11].

Thus, this study aims to understand the selection of travel mode from railway stations in Yogyakarta. Further, the focus of this research is the lack of multimodal public transport system in railway stations in Yogyakarta and how the commuters deal with this situation.

The remainder of this paper is organized as follows. Earlier researches concerning to access/egress mode choices to railway station are discussed in Section 2. Section 3 describes the survey design and data collecting process. Afterwards, the data is analyzed in Chapter 4, followed by a discussion of the modeling results. Finally, some conclusions are drawn, and policy implications are discussed.

2. LITERATURE REVIEW

In the last two decades, researchers concerning to accessibility especially related to multimodal trip have been progressively conducted. The previous studies have shown how the beginning and end of the main mode hold an important role in main mode choice [12 - 14]. This situation is mainly appropriate for travelers using the train as the main mode because they need to travel from/to railway station. For access and egress trip, trip cost and travel time to/from the railway station are essential factors influencing commuters' decision to use train mode [15]. A study conducted by Cervero [16] showed that increasing the service frequency of feeder bus on destination railway station, providing tariff subsidy for train passengers, and restricting the number of parking space near to office area could increase the probability to use the commuter line in California. Meanwhile, Rak and Lep [17] have discovered that 84.5% of suburban railway passengers in Slovenia are walking on their egress mode. The rest, 12.5%, 1.2%, and 0.2% choose public transit, car, and bicycle, respectively.

In a more intricate case, Mollin and Timmermans [6] have analyzed the choice of egress mode in multimodal trips for intercity train passengers. Seven egress modes are explored in this research: public transport, taxi, train taxi, public transport bike, bike in the train, bike at the station, and *Greenwheels* (*i.e.*, rental car based on shared car principle). Several variables used to understand the choice decision consist of trip purpose, distance, trip companions, the amount of luggage, weather, route knowledge and time of day. Concerning low-speed mode as an alternative egress trip mode, the results show that the probability of choosing cycling and walking will increase in the condition of good weather, traveling in daylight, carrying light baggage, the route has been well known, and the availability of trip partner. On the other hand, by increasing the trip distance will lessen the possibility to walk from railway station to activity end destination and shift to use public transport bike. Automobile taxi, train taxi, and *Greenwheels* are used for egress mode when train passengers have specific travel purpose to work, in dry weather, have to bring heavy luggage, a trip with the partner, and unfamiliar with the egress route. Nevertheless, another possibility for being public transport users will increase in case of daylight trip, dry weather, and the egress route is well known.

The previous studies also have put emphasis on the correlation between access mode and boarding station choice. Some discoveries of those studies can be summarized as follows. Keijer and Rietveld have found that the access distance to the station has given a strong impact on mode choice decision [18]. According to Krygsman *et al.* when access distance exceeds a certain threshold, travelers are more reluctant to use public transport [1]. On the other hand, car ownership in a household has no impact on the access trip mode to boarding station [19].

All the above mentioned studies are piloted in the developed countries. Clearly, those public transport facilities in developed countries are sufficient to support the multimodal transport system. In developing countries, it is compulsory to ensure that travelers who choose a commuter line could reach their activity end destination because of the limited service of bus route as alternative egress mode. Regarding public transport in Yogyakarta, there are only eight routes of bus mode with 15-30 minutes of headway. In a worst case of public transport service, the arrival time of para-transit mode is unpredictable. In this paper, there are examinations of travel behavior on egress trip for train passengers in Yogyakarta along with the analysis of some policies in order to escalate the demand for public transport so that the sustainability of transport system can be improved.

3. SURVEY DESIGN AND DATA COLLECTION

The survey was carried out in Yogyakarta, Indonesia. With the intention to understand the condition of the study area, survey design, and data collection, first, the commuter line system, which is connecting Yogyakarta with the surrounding area, is introduced. Second, the connectivity from the train to other modes (egress mode) is expressed. Third, the design of the survey for exploring the egress trip from the train station is presented. Last, the explanation about data collecting is also presented.

3.1. *Prambanan Ekspres* Commuter Line

As previously explained, the role of Yogyakarta as a business and recreational city attracts people living in its surroundings, such as Solo and Kutoarjo. Solo is located on the eastern side of Yogyakarta with the distance of approximately 63 kilometers, while Kutoarjo is located on the western side of Yogyakarta with the distance of nearly 72 kilometers. To support the connectivity among those cities, there is a line of railway system operated since 1994 called as *Prambanan Ekspres*. The frequency of its service is ten times in a day. While the ticket fare is IDR 8000 or approximately 0.62 USD (flat tariff) and it is a single trip ticket only. There are 18 railway stations along Kutoarjo, Yogyakarta, and Solo. Three stations are located in Yogyakarta: Maguwo, Lempuyangan, and Tugu Railway Station.

3.2. Mode Choice for Egress Trip

In Yogyakarta, there are five public transport modes that can be chosen by commuters for their egress trip: bus, para-transit, taxi, motorcycle taxi, and non-motorized taxi (*e.g.*, trishaw and horse carriage). Commuters who choose bus for their egress mode have to walk 15 meters, 352 meters, and 197 meters to reach bus stop in Maguwo, Tugu, and Lempuyangan railway station, respectively. Ticket fare is IDR 3600 (0.28 USD) for bus mode and IDR 4000 (0.31 USD) for para-transit mode (flat tariff).

Nevertheless, some commuters choose to be picked up by their family members or colleague. Also, some of them opt to park their private vehicle (*e.g.*, motorcycle) at the destination railway station. There are three parking area alternatives for car and motorcycle in Lempuyangan railway station. The firstparking area is located in the front of the railway station (on street parking). This parking area has been managed by local people with the permission from the Yogyakarta Transport Agency. Nonetheless, it does not serve overnight parking. This parking area can accommodate approximately 50 units of motorcycles and several cars. The parking fee to use these facilities is IDR 2,000 or 0.15 USD (flat parking fee). The second option is located at people's houses. This parking area is used for motorcycle parking only. There are approximately 12 parking areas along Lempuyangan Street which are located in settlement areas at the opposite of the railway station. The parking service hours are from 05.00 to 22.00. The fee varies and usually depends on the distance from the parking areas to the railway station. However, the fee is IDR 3,000 (0.23 USD) for daily or overnight parking, and approximately IDR 50,000 (3.85 USD) a month for regular customers. These areas can accommodate approximately 50-300 units of motorcycle. The third option is the official parking area within the station. This parking area has been managed by the third party appointed by the railway company. It can accommodate approximately 250 units of motorcycle and 20 cars. Unlike other parking area, passengers that park their vehicles in these areas are imposed with a flat fee of IDR 2,000 (0.15 USD). However, if their parking duration is more than 8 hours, the parking fee will rise to IDR 8,000 (0.62 USD).

There are two parking facilities located at Tugu Railway Station. The first one is located on the east side of the station, and the second one is on the west side. The east parking area is only intended for motorcycle mode. In order to reach the station, precisely at the east entrance of the station, the passengers must walk along 324 meters from the parking area. The fee for using the facility is a progressive tariff, IDR 2,000 (0.15 USD) and IDR 4,000 (0.31 USD) for first two hours for motorcycles and cars, respectively. For the next one hour, the passengers are imposed with fees of IDR 1,000 (0.08 USD) and IDR 2,000 (0.15 USD) for motorcycles and cars, as well as maximally IDR 8,000 (0.62 USD) and IDR 16,000 (1.23 USD) for non-overnight and overnight parking, respectively. Meanwhile, the west parking area can accommodate 450 units of motorcycle and 170 cars. To reach a southern entrance of the station, the passengers must walk for 365 meters. The fees imposed are the same with those imposed in the east area of the station.

The last station is the Maguwo Railway Station. Maguwo railway station is a railway station integrated with the airport. This station does not have the parking areas so the passengers of the train must park their vehicles in the airport parking areas. The parking areas for motorcycles and cars are located approximately 210 meters from the station. To use the facility, the passengers are imposed with a fee of IDR 3,000 (0.23 USD) for daily park and IDR 5,000 (0.38 USD) for overnight parking.

3.3. Survey Design and Research Method

The questionnaire items were divided into five components. The first component is personal characteristics such as gender, age, education level, monthly income, driving license ownership, and occupation. The second component is household characteristics, such as the presence of colleague or family member who can pick up at the station, the availability of private vehicle in a household or workplace. The third is trip characteristics, such as trip purpose and frequency. The fourth component is a detailed information on bus attributes, such as trip chain, distance, travel mode, travel time, waiting time and location of departure and alighting if the respondents using bus for egress trip. The final component is a stated preference related to the desire to use bus mode in their egress trip.

Regarding the stated preference survey, the aim is to understand the passenger preferences for particular attributes of public transport that affect their mode choice decision. Since this paper focuses on increasing the demand for public transport on egress trip, the determined dependent variables only consist of two means: public transport mode (bus and para-transit) and motorcycle mode. The reason why only motorcycle mode involved in stated preference survey is related to our preliminary survey that is showing the very low demand of train passengers who choose the car, walking, and non-motorized transport mode for egress trip. This is also in line with the survey result shown in Fig. (**2**) indicating that there are 85.38% of train passengers who use public transport and motorcycle, and the rest (14.62%) are using the car, walking, car taxi, and non-motorized mode. However, there is also a 'no choice' option if the respondents do not prefer to choose both public transport and motorcycle mode.

For independent variables, six attributes considered influencing mode choice for egress trip consist of walking distance, egress travel time, waiting time, a number of transfer, trip cost, and parking fee at the railway station. The selected attributes refer to the existing literature of mode choice decision on egress trip. For example, Polydoropoulou and Ben-Akiva [20] show that parking fee, walk access time, the number of transfer and transit fare are the dominant factors in selecting travel mode on access and main mode. Meanwhile, by using latent class nested logit model, Wen *et al*. [21] had been analyzing the high-speed rail access mode choice in Taiwan. The result showed that access cost, access time, parking fee, and waiting time have the significant impact on the access mode choice. Kim *et al*. [22] explored several factors that influence the access/egress mode choice to/from light rail stations. Three alternative modes were considered in the model: bus, walk and drop off/picked up. They found that bus availability, park and ride lot, and distance have significant correlation influencing access/egress mode choice decision. Chaucan *et al*. [23] also found that ingress distance to train station has a significant impact on mode shifting to Delhi Metro in India.

We offered eight scenarios to our respondents. Those scenarios were determined by adopting the orthogonal planning method (for detail see [24, 25]). Initially, the number of scenarios were determined by using a full factorial design method based on the number of independent variables and their levels. By using M (*i.e.*, mode choices) of 2, A (*i.e.*, attributes or independent variables) used was 6, and the maximum L (*i.e.*, level) of attributes was 4 (*i.e.* the overnight parking fee), scenario combinations. However, the number of scenario combinations was impossible to accommodate. Therefore, the reduction is necessary to do. The formulation of the alternative hypothesis was carried out by using the concept of orthogonal design so that the number of scenarios became (L–1) x M.A + 1. The minimum number of scenario combinations based on the resultant orthogonal design was (4-1) x (2x6) + 1 = 37 alternative scenario combinations. Conversely, 37 alternative combinations are still too much to offer to respondents. Consequently, eight scenarios were determined to be used by eliminating other scenarios with less good combinations of attributes. The scenarios used are shown in Table **1**.

Table 1. The scenario used in stated preference survey.

No. of Scen.	Walking Distance (meter)		Trip Cost (IDR)		In-Bus Travel Time	Bus Waiting Time (minute)	No. of Transfer	Parking Fee (IDR)
	Parking Area	Bus Stop	Private Vehicle	Bus Ticket				
1	150	500	500 per km	4,000	>2 times longer than private vehicle travel time	10 – 15	≤ 1	3,000
2	150	500	300 per km	5,000	Equal to private vehicle travel time	15 – 20	≤ 1	3,000
3	150	500	500 per km	5,000	>2 times longer than private vehicle travel time	10 – 15	≥ 2	15,000
4	350	250	300 per km	6,000	Equal to private vehicle travel time	15 – 20	≤ 1	20,000
5	350	500	300 per km	4,000	1.5-2 times longer than private vehicle travel time	20 - 25	≥ 2	10,000
6	150	250	500 per km	4,000	1.5-2 times longer than private vehicle travel time	15 – 20	≥ 2	10,000
7	150	250	400 per km	6,000	Equal to private vehicle travel time	10 - 15	≥ 2	20,000
8	350	250	400 per km	5,000	Equal to private vehicle travel time	20 - 25	≤ 1	10,000

The analysis of egress travel mode choice is performed using a discrete choice modeling approach. Since this study focuses on several attributes that can be managed to increase the demand of bus mode on egress trip, a binomial logit model is used to compare between bus mode and motorcycle mode. Due to this state, we neglect other characteristics, such as socio-demographical factors. The data used in our model is obtained from the stated preference survey.

The binomial logit model assumes that a commuter selects a choice having the highest utility value, in which the utility value by using mode *m* for traveler *n* can be expressed as follows.

$$U_{nm} = \beta . X_{nm} + \varepsilon_{nm} \tag{1}$$

Where $\beta.X_{nm}$ is observed as variable and ε_{nm} is the unobservable part. The probability of commuter *n* selects (*m*) motorcycle mode out of bus mode (*b*) can be formulated as [26]:

$$P_{nm} = \frac{1}{1+e^{(U_{nb}-U_{nm})}} \tag{2}$$

The coefficients of β parameters in this model are estimated using the method of maximum likelihood function as shown by:

$$L = \prod_{n=1}^{N} \prod_{m=1}^{M} \left(\Pr_{mn} \right)^{\theta_{mn}} \tag{3}$$

Given the fact that *L* is the product of many terms, it is clearly easier to maximize its logarithm of *L*, rather than *L* itself. This is because the function of *ln* is strictly monotone; therefore, maximizing the logarithm of a function *f(x)* is equivalent to maximizing the function.

$$LL = \sum_{n=1}^{N} \sum_{m=1}^{M} \theta_{mn} \ln\left(\Pr_{mn} \right) \tag{4}$$

in which θ_{mn} is equal to 1 if commuter *n* has chosen mode *m* and 0 if chosen otherwise.

3.4. Data Collecting

A face to face interview was conducted from early August to mid of September 2015. Passengers were requested to fill out a questionnaire, which took approximately 20 minutes to complete. More specifically, the questionnaire survey was distributed from Monday to Friday during peak hours (06.00–10.00 and 16.00–20.00). There are initial restrictions for the respondent. First, passengers must get off at Maguwo, Lempuyangan, and Tugu Railway Station. Second, the frequency of using *Prambanan Ekspres* Train is not less than four times in a month and preferably for the passenger who uses the train for daily travel. Third, the duration of this activity is one-day on destination place (respondents depart and return home on the same day). During the period of the survey, only 154 samples were obtained because surveyors faced the difficulty in identifying the qualified respondents, such as because of the jostle of passengers, while surveyors had to ask the passenger whether or not they satisfy the initial requirements as respondent. Many travelers also disagreed to participate in the study. In the preliminary survey, the questionnaire form was not only distributed in the train but also in the railway station. However, since passengers had a limited time at the transfer point (from destination railway station to their final destination place), they tend to be more reluctant to participate in this survey. Of the 154 collected questionnaires, only 130 data can be analyzed due to incomplete value and have no choices in the stated choice experiment. It should be noted that the average number of *Prambanan Ekspres* passenger in 2014 is 4,630 travelers/day [27]. However, there are only 27% who commute within the same day [11]. For this reason, a number of 130 respondents could express 10.4% of train users with one-day activity duration on destination place.

4. DATA ANALYSIS

4.1. Profile of Respondents

Table **2** illustrates the descriptive statistics on the demographic profile of the commuters using *Prambanan Ekspres* Train. As previously explained, of the 154 respondents surveyed, only 130 respondents (82.28%) were analyzed. Since there are 8 scenarios asked to respondents, a number of 1040 observations (130 respondents x 8 scenarios) are obtained to be analyzed. However, there are only 889 observations modeled in this study due to some missing data.

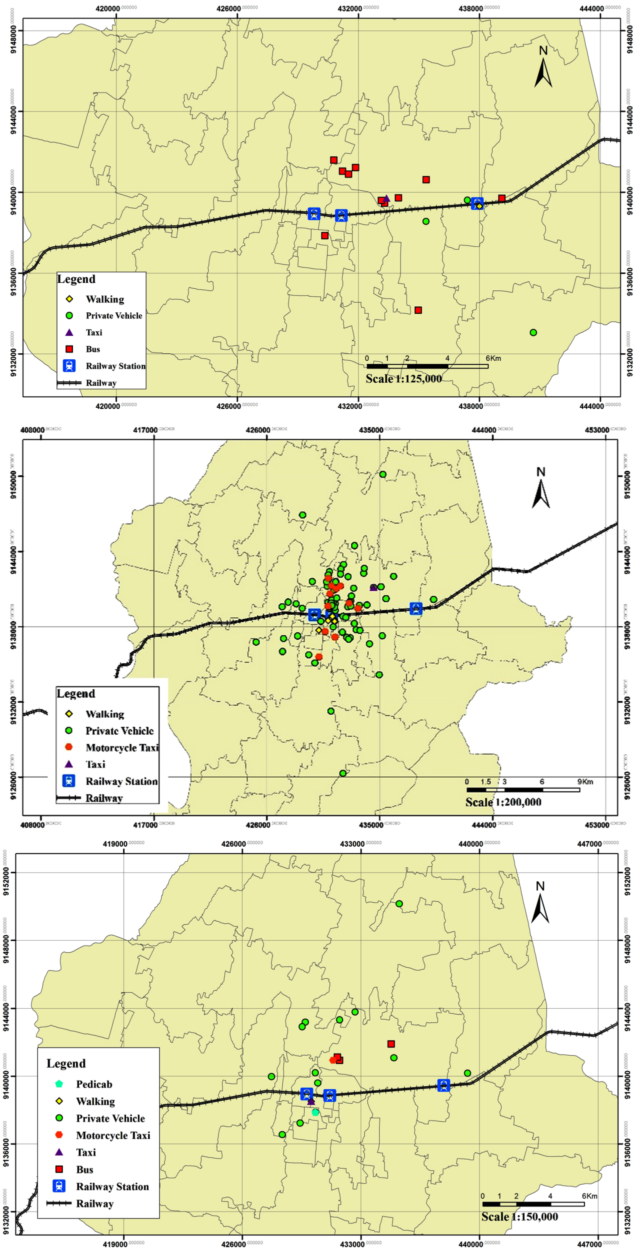
Table 2. Demographic profile of respondents.

Demographic Variable	Category	Frequency	Percentage
Age	Less than 21 years old	15	11.54
	22 - 33 years old	56	43.08
	34 - 45 years old	41	31.54
	46 - 63 years old	18	13.85
Gender	Male	79	60.77
	Female	51	39.23
Education level	High School level	29	22.31
	Graduate level	101	77.69
Monthly income	< IDR 2.600.000 (USD 200)	22	16.96
	IDR 2.600.000 - 6.000.000	77	58.93
	> IDR 6.000.000 (USD 462)	31	24.11
Occupation	Business sector staff	78	60.00
	State sector staff	26	20.00
	University student	18	13.85
	Other	8	6.15

From Table **2**, it can be seen that male was more dominant with 61%. Respondents were also dominated by age group of 22-33 years old (43.08%) and followed by 34-45 years old (31.54%). Looking into income variable, 58.93% of the commuters had a monthly income ranging from IDR 2,600,000 to IDR 6,000,000 (200 USD to 462 USD), while there are 24.11% of respondents with income more than IDR 6,000,000 a month.

4.2. Travel Mode Choice on Egress Route

Fig. (**1**) shows the activity end destination of respondents related to the travel mode chosen. While Fig. (**2**) reports the frequencies for the departure station and egress mode chosen by the commuters. The choice of destination stations in Yogyakarta was closely related to egress trip mode used by the commuters to continue their travel. Approximately, 70% of commuters chose Lempuyangan Railway Station as a destination station in Yogyakarta. Meanwhile, the other two stations (Tugu and Maguwo Railway Station) were chosen by 17% and 13%, respectively, of commuters as a destination station.



(a) Maguwo Railway Station

(b) Lempuyangan Railway Station

(c) Tugu Railway Station

Fig. (1). Respondents' activity end destination and their egress mode in each railway station.

Almost all commuters chose motorcycle as their egress mode alight in Lempuyangan Railway Station. Perhaps, this is due to the overnight parking fee particularly in the parking areas managed by local people, was relatively inexpensive. Travel modes used by commuters alighting in Lempuyangan Railway Station also more varied compared to other stations. There were also walking mode, and riding trishaw selected by commuters indicate that the sites of activity are near to the station. On the contrary, commuters who opt bus mode for their egress trip have only accessed Maguwo and Tugu Railway Station.

Vehicle availability is one of the most important factors that determine the choice of egress mode as it encourages people to use private vehicle compared to public transportation. Fig. (**3**) depicts a relationship between vehicle availability in Yogyakarta as the destination location and the mode used for egress trip. Vehicle availability refers to not only privately owned vehicle but also the official vehicle that can be used by respondents for activity.

The majority of respondents (64%) have private vehicles in Yogyakarta with the ownership of 53%, 7%, and 4% for motorcycles, cars, and both motorcycles and cars, respectively. The motorcycle which owned by respondents tended to use it as the egress mode. However, this does not occur among the owners of cars; the later tends to choose other modes. Probably, the parking areas for cars are more limited, and the overnight parking fee is more expensive than that for a motorcycle. Meanwhile, the commuters with no vehicle in Yogyakarta have a tendency to choose motorcycle also as their egress mode; being met by their relatives or using a private commercial motor service (motorcycle taxi).

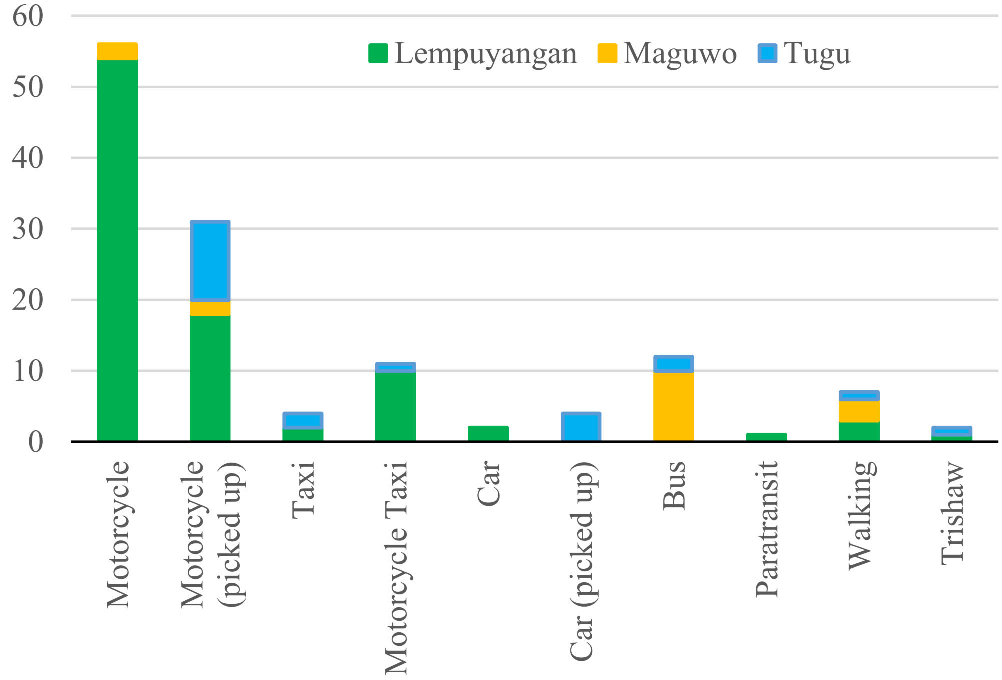


Fig. (2). Egress travel mode choice in each railway station.

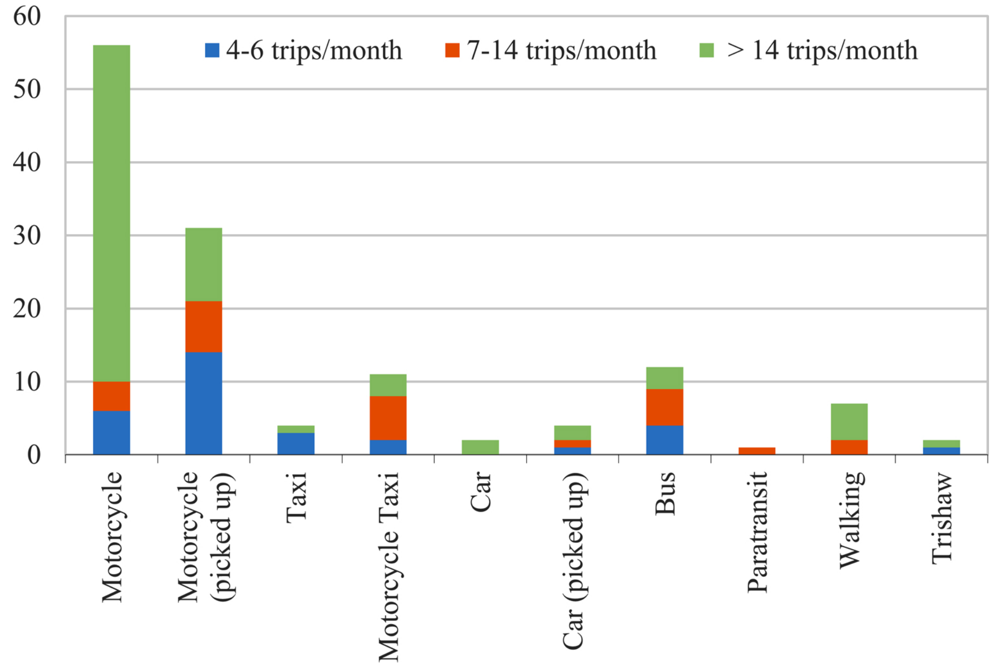


Fig. (3). The effect of private vehicle availability on egress trip mode choice.

Moreover, trip frequency also affects the choice of egress trip mode. As previously discussed, one of the criteria for selecting commuters as respondents is that the commuters who have a commuting trip at a minimum of 4 times a month. However, the selection of samples with a high frequency of making a commuting trip was put first. We expect that this selection could provide more accurate results in identifying the factors affecting the egress mode choice.

As shown in Fig. (**4**), 56% of respondents performed 15-30 trips per month by using the train as their main commuting mode. Most of them tend to opt using private vehicle mode for their egress trip mode either driving alone (by parking their owned vehicle in the destination station) or picked up by their relatives. The similar situation also occurs in 13% of commuters with a high frequency of commuting trip by train (23-30 times a month). Meanwhile, travelers with the lower frequency of commuting trips (less than 15 trips per month), the distribution of egress mode choice tend to be spread evenly in several choices of transport means.

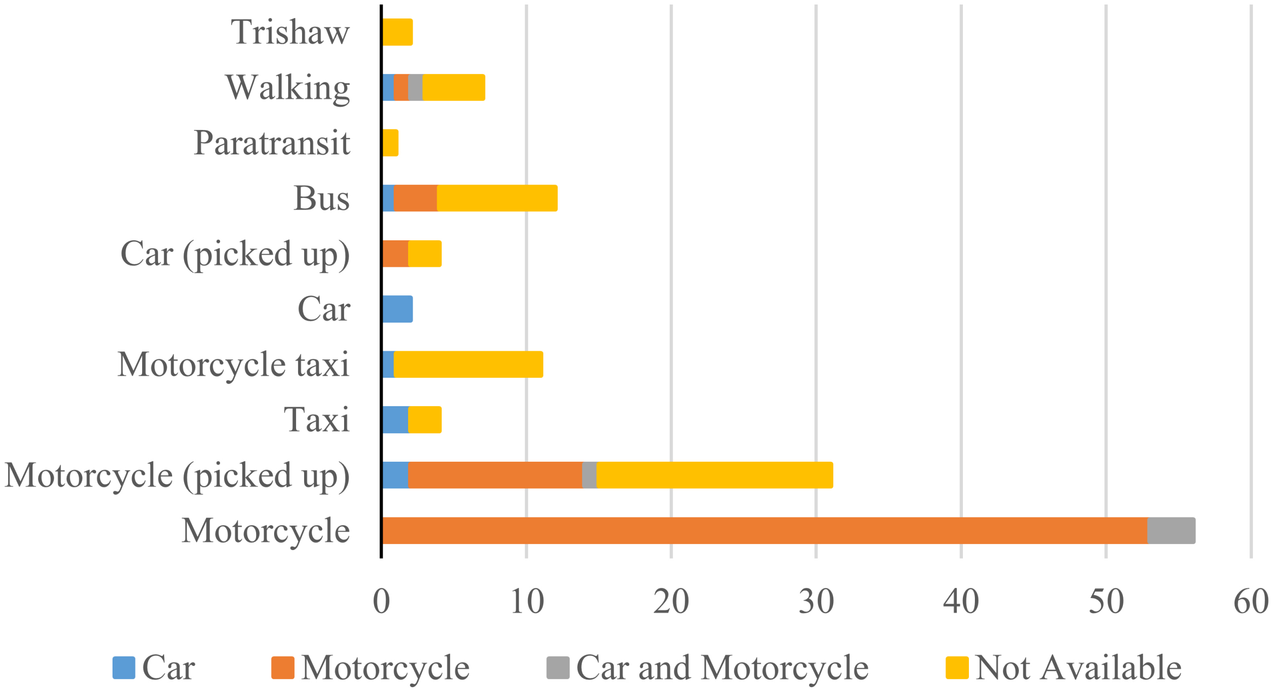


Fig. (4). The effect of commute frequency by train on egress trip mode choice.

5. RESULTS

5.1. Discrete Choice Model

The results of logit model are presented in Table **3**. Except for a number of transfer variables, all the variables considered had significant effects on the egress mode choice with the confidence level is less than 0.95. Moreover, the attributes of public transport waiting time had a significant value 0.99.

Table 3. Coefficients of discrete choice model.

Attributes	Parameter		T Score
Walking distance (in 10^{-2} meter)	-0.243	**	-2.42
In-vehicle travel time (in 10^{-1} minute)	-0.402	**	-2.36
Bus waiting time (in 10^{-1} minute)	-1.430	***	-4.02
Trip cost (in 10^{-3} IDR)	-0.131	**	-2.08
Parking fee (in 10^{-3} IDR)	-0.599	**	-2.26
Number of transfer	0.146		0.70
Constant of private vehicle mode	-1.640	**	-2.11
Observations	889		
Initial log-likelihood	-616.208		
Final log-likelihood	-524.853		
McFadden's Rho-square	0.148		
**** and ** denote significance at the 1% and 5% levels respectively*			

After the coefficient of each affecting attribute was found, the probability of using bus and motorcycle at eight scenarios could be calculated with the results as shown in Fig. (**5**). The results show that Scenario 7 gives the highest probability of using bus mode for egress trip followed by Scenario 4. Conversely, the scenarios with the highest opportunity of using the private vehicle as the egress mode are Scenarios 2 and 5 with the probability values 81% and 79.2%, respectively.

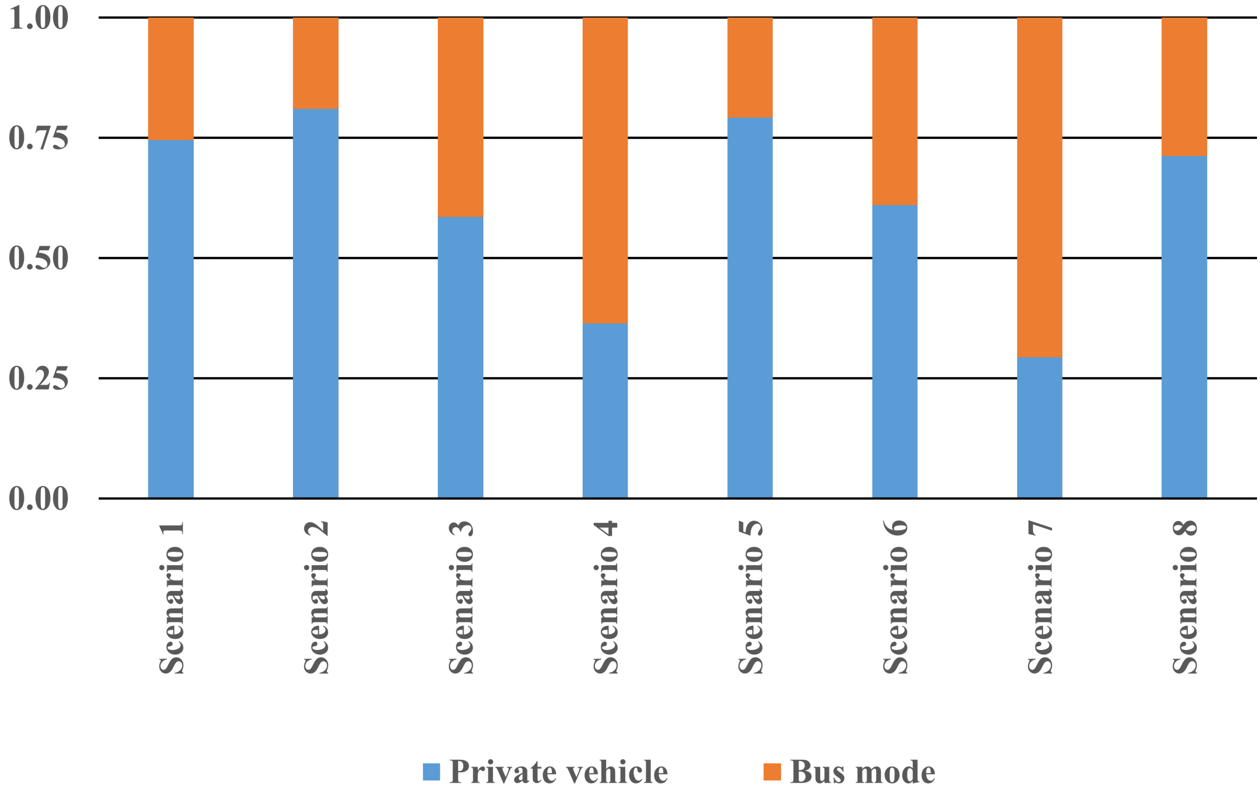


Fig. (5). Probability of egress mode choice in each scenario.

5.2. Simulations

The simulation was carried out by formulating several scenarios of change in attributes, such as parking fee, trip cost, and travel time in a stratified manner, then examining how large changes in values of utility and probability occurred in each trip mode. The basic assumptions used in the simulation are shown in Table **4** and the simulation results are described as follows.

Table 4. Basic assumptions of simulation.

Attribute	Private Vehicle	Bus Mode
Walking distance to parking area/bus stop (meter)	100	500
In vehicle travel time (minute)	15	25
Bus waiting time (minute)	0	15
Egress trip cost (IDR)	1,500	4,000
Parking fee (IDR)	5,000	0
Utility	-2.982	-4.889
Probability	0.871	0.129

5.2.1. Role of Walking Distance

As shown in Fig. (**6**), the scenario was carried out by gradually changing the walking distance with a difference of 100 meters. The result shows that there was no significant shift to use the bus as egress mode by motorcycle users. If the walking distance to the bus stop is similar to the walking distance to the parking area, the probability of using the bus mode was 0.282. If the bus stop is located in the proximity of the railway station exit gate, with the assumption of walking distance is 0 meter, the probability of commuters to use bus mode is 0.334.

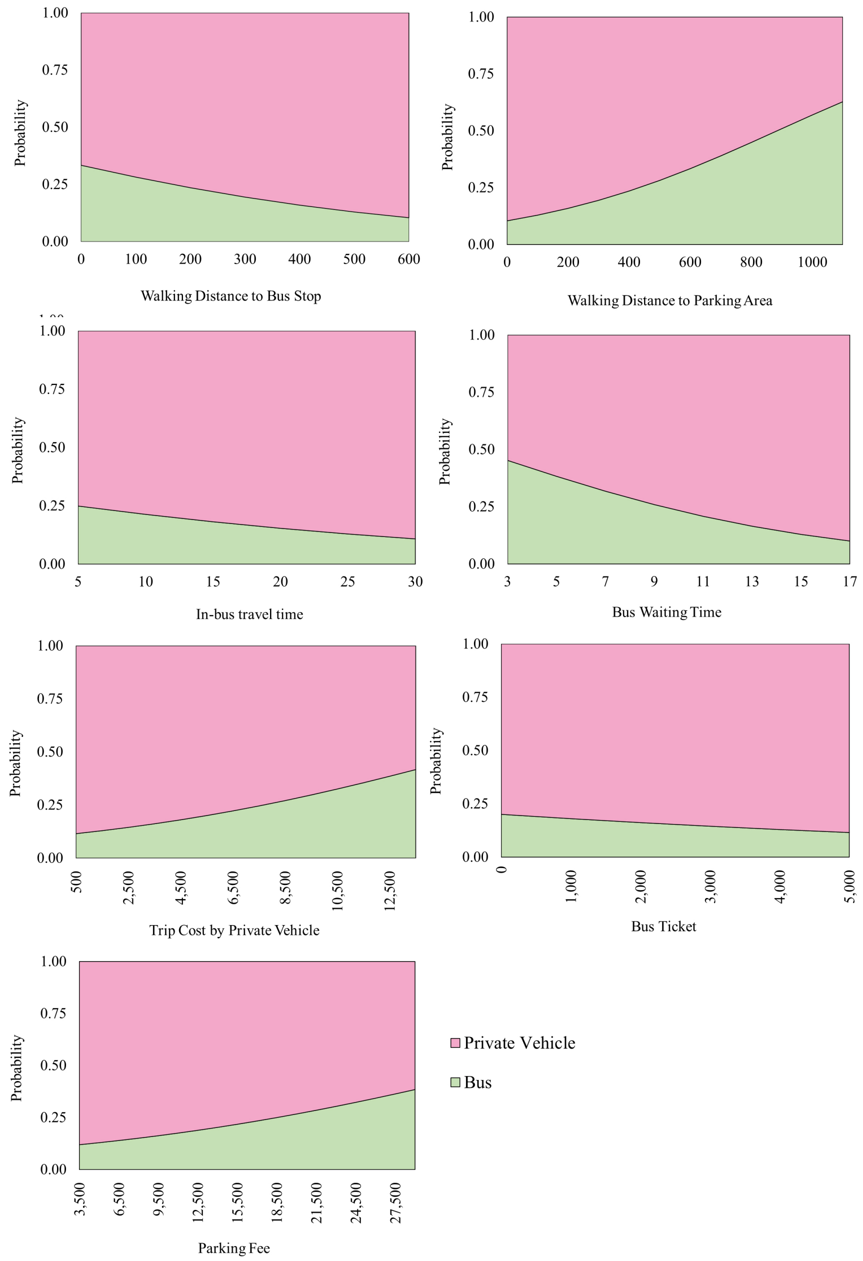


Fig. (6). The role of attributes on egress travel mode choice.

Also, in order to support commuters to use the bus for their egress trip, it is necessary to make a change in the walking distance to the parking area within the station. As shown in Fig. (**6**), if motorcyclists have to walk about 500 meters to reach the parking area, the demand of bus mode will increase from 12.9% to 28.2%. However, when the walking distance is extended and becomes 900 meters, the probability of using bus mode could reach more than 0.5.

5.2.2. Role of Bus Travel Time

In this case, the scenario was carried out by changing the variable of in-bus travel time in a stratified manner with a difference of 5 minutes. First, it should be pointed out that the decrease of travel time may not be more than 100%. Therefore, at this scenario, the decrease of travel time was limited up to 20 minutes from the initial travel time, particularly considered that bus takes more time to board and alight passengers. Based on Fig. (**6**), the decrease of travel time up to 5 minutes was unable to encourage the shifting of commuters from motorcycle to bus in egress trip. The decrease of bus travel time for about 20 minutes from the initial travel time was able to increase the probability of using bus mode from 0.129 to 0.249.

5.2.3. Role of Bus Waiting Time

In this scenario, the decrease of travel time was limited only up to 3 minutes. While bus waiting time varied in a stratified manner for 2 minutes. The result in Fig. (**6**) indicates that 12 minutes decrease of the bus waiting time (from 15 minutes to 3 minutes) will increase the opportunity of using the bus for 249.83% from the existing condition (0.129 to 0.452). With a probability of 0.452, the decrease of waiting time is able to increase the market segment of the bus. Due to this, it can be concluded that bus waiting time has a significant impact on egress mode choice.

5.2.4. Role of Travel Cost

Trip cost by motorcycle mode was designed to increase gradually by IDR 1,000 (0.08 USD). The result shows that when trip cost by using private vehicle is equal to bus fare (IDR 3,500 or 0.27 USD), the probability to use the bus is 0.162 or increase to 25.11% from the existing condition. Then, by looking into the effect of bus fare on egress mode choice in Fig. (**6**), it can be seen that the decreased bus fare of 100% or making the bus free could actually increase the probability of selecting bus as egress mode of 55.07% or with a probability value of 0.201. It can be indicated that the change in fare was less significant in terms of encouraging the shifting from the private vehicle to bus mode.

5.2.5. Role of Private Vehicle Parking Fee

A modification was carried out with the difference of IDR 1,500 (0.16 USD) in a gradual manner. As can be seen in Fig. (**6**), there was relatively no significant increase in the probability of using the bus for egress mode. The results show that the change in the parking fee of 100% did not affect the commuters' preference. They will begin to shift as bus user in their egress mode when the overnight parking fee of a private vehicle is increased to be approximately IDR 37,000 (2.85 USD).

5.3. Sensitivity Value

Table **5** shows the sensitivity values of using the bus. From Table **5**, considering the total travel time, the bus waiting time is more effective to shift to bus mode rather than in-vehicle travel time. Meanwhile, walking distance to the parking area of the private vehicle shows a higher value of sensitivity as compared to the walking distance to bus stop.

Table 5. Sensitivity values of the probability of using bus mode.

Attribute	Sensitivity Value
Walking distance to parking area of private vehicle	0.0004190
Walking distance to bus stop	-0.0003530
In-vehicle travel time for bus mode	0.0066800
Bus waiting time	-0.0256000
Trip cost for private vehicle	0.0000280
Trip cost for bus mode	-0.0000216
Overnight parking fee	0.0000147

CONCLUSION

The aim of this study was to understand the commuter's preferences and behavior using the train as the main mode with respect to egress mode choice decisions. Based on the results of mode choice model, this study formulates several main conclusions. First, by looking into the characteristics of travellers using the train for their commuting trip and their trip pattern. It can be seen that the destination railway station mostly targeted by commuters was Lempuyangan Railway Station, with their private vehicle, especially motorcycle, is the dominant mode used to reach their activity end destination. The short distance on egress trip and the cheap overnight parking fee are the main reasons for commuters to alight in Lempuyangan Railway Station. Commuters who will work tend to alight in Lempuyangan Railway Station and use motorcycle mode for their egress trip, while for commuters with the trip purposes, such as shopping, business or social tends to choose a more varied egress mode. We also found that there is a pattern of relationship between trip distance and mode choice on egress trip. The tendency to use motorcycle mode, both driving alone (by overnight parking) and picked up by colleague or family member, will decrease with the rise of egress trip distance. The second conclusion is concerned with the result of mode choice model. In an existing condition, the probability of railway passengers to use motorcycle mode for their egress trip is 0.838, indicating that the commuter almost absolutely uses motorcycle mode rather than bus mode from railway stations in Yogyakarta. There are several variables that can be considered to influence the railway passengers to shift to bus mode on their egress mode: walking distance to the parking area and bus stop, in-vehicle travel time, egress trip cost, bus waiting time, and parking fee. From the six variables above, by looking into the probability value is higher than 0.5, walking distance to the parking areas at the railway station, waiting time for public transport, and the overnight parking fee of the private vehicle are three main factors that can significantly increase the demand for public transport from railway stations. Meanwhile, given the sensitivity value, bus waiting time, trip cost by motorcycle, and walking distance to parking area have a high sensitivity in terms of a factor of time, cost, and distance, respectively.

Some suggestions that can be applied to increase the use of bus mode for egress trip from railway stations in Yogyakarta are as follows. The first is related to the multimodal trip for railway passengers; government should design a transfer point which can easily connect railway station and bus shelter in order to facilitate commuters to transfer and also to increase the utility of public transport mode. Second, relocating the parking area with more distance than the existing parking area. It is aimed to push the utility obtained by commuters who use motorcycle on their egress trip due to the increased walking distance. Third, the government has to determine the minimum parking rate in the area around of the railway station, so that the tariff gap between the parking area managed by local people and the station's official parking area is not significantly different. In addition, parking fee can also be determined by considering the distance from railway station to parking area (zone based parking rate). Last, for the long term, the government should have started thinking a rail-oriented development, especially in Lempuyangan and Tugu Railway Station with the intention of reducing trip and shortening the egress distance, so that the activity end destination can be reached by walking.

For the further research, egress mode choice model must be developed, especially related to the research method and the influence variables. Development of the research method can be carried out by considering the use of multimodal trip (developing a mode choice model that can simultaneously simulate the decision of main mode choice and egress mode choice) and using the other method, such as nested logit model. Meanwhile, concerning the influence variables, it can be carried out by incorporating socio-economic characteristics and travel patterns of respondents as additional attributes in the utility function.

CONSENT FORPUBLICATION

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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