# PROMOTION OF RAILWAY USE BY IMPROVING ACCESS TO RAILWAY STATIONS IN JAKARTA METROPOLITAN AREA

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## ABSTRACT

Many urban areas in developing countries, especially those considered emerging economies, are facing traffic congestion due to high rate of motorization. Though road-based public transport has been the primary mode for motorized trips, some developing countries possess railway networks in urban areas. Historically, passenger access to railway stations has been rarely considered. However, a railway having the highest passenger capacity can play a key role in alleviating traffic congestion in urban areas. This study aims to pursue appropriate measures to improve access to railway stations in developing countries.

Two pilot projects, a park-and-ride and feeder bus service, were conducted at each railway station in suburban cities of Jakarta. According to the pre- and post-interview survey results on the park-and-ride project, users were generally satisfied with the project. In particular, some car commuters shifted to using railway and were highly satisfied.

On the other hand, the interview survey results on the pilot project for the feeder bus service revealed that residents around the railway stations, especially those from high-income group, are rarely motivated to use the provided free feeder bus service to railway stations.

By comparing the two results, bearing in mind that parking lots around the station and access roads to the station are required, it was found that park-and-ride can be an affordable railway promotion measure. It is also noteworthy that the railway service level is still a key factor affecting modal shift.

**Keywords**: park and ride, feeder bus service, promotion of railway use, developing countries

## 1. INTRODUCTION

Many urban areas in developing countries, especially those considered emerging economies, are facing traffic congestion due to rapid rate of motorization. Although road-based public transport has been the primary mode for motorized trips, some developing countries possess railway networks in urban areas. In some urban areas in developing countries such as Jakarta, Kuala Lumpur, Manila, Yangon and Colombo, the aim is to modernize railway service.

Land acquisition and involuntary resettlement are becoming major obstacles for transportation infrastructure development in many developing countries, such as the case in Bangkok (Wasuntarasook and Hayashi, 2003). Although underground mass rapid transit system requires less land for project implementation, it is one of the most expensive urban transport options. Therefore, modernization of railway lines developed during colonial period is considered as an inexpensive option with less land acquisition for urban transportation.

However, conventional railway services in these countries often have common problems such as institutional issue, low-density land use and access/egress to railway station (Wachi et al., 2011). Historically, these railways were often developed for freight transport of plantation products or natural resources. Thus, passenger access to railway stations was rarely considered when these were built. Urban development has been accelerated along arterial roads rather than railway stations. As a result, population density of railway station catchment area can be lower. Fundamental solution for this disharmony of land use and transportation could be transit-oriented development (TOD). Gilat, M. and Sussman, J. M. (2003) identified prerequisites for transit-oriented development in developing countries: density, extensive transit network, and metropolitan planning organizations; taking Maxico City as an example.

In addition to TOD, a short-term solution to attract passengers is also important to reduce government subsidies and to promote financially viable railway business. The reduction of the number of passengers and swelling government subsidy might lead to the decision of abandoning railway operation itself. As access to railway stations is one of the prominent factors contributing to ridership (Brons, 2009), provision of access and egress transport to a railway station is essential. Brons et al. (2009) also concluded that provision of access services to a railway station can provide improvement and expansion of railway network with less investment.

In terms of railway access and egress transportation, a number of studies have been done in developed countries such as transportation demand forecast (Foote, 2000), route optimization of feeder bus service (Huang and Liu, 2013), methodology of park-and-ride location selection (Holguín-Veras, 2012), and station parking design concept (Martin and Hurrell, 2012). However, studies on travel behaviors and planning issues for railway station access in urban areas in developing countries with practical trials are scarce. This paper aims to identify issues and obstacles of railway access in the context of emerging economies and to pursue solutions for them through the conduct of pilot projects of a park-and-ride and a feeder bus service in Jakarta Metropolitan Area in Indonesia.

## 2. MOTORIZATION AND "MOTORCYCLIZATION" IN JAKARTA METROPOLITAN AREA

The Jakarta Metropolitan Area, called JABODETABEK, is a large-scale metropolitan region with a population of 28 million, and consists of DKI (Special Capital District) Jakarta and eight local municipalities. Its gross regional domestic product (GRDP) is estimated at 1,056,000 billion rupiahs (US$ 102.8 billion) or 19 per cent of the national gross domestic product (GDP) (as of 2010) (Statistics Indonesia, 2010-1 and Statistics Indonesia, 2010-2), showing that the Jakarta Metropolitan Area is strategically the most important region in the country.

The surge in the number of passenger cars and motorcycles is astonishing (Kawaguchi et al., 2010; Yagi et al., 2012; Yagi et al., 2013). The number of registered passenger cars in Jakarta metropolitan area increased by a factor of two, and that for motorcycles increased 4.6 times between 2000 and 2010. As a result, travel speed in major arterial roads in the Central Business District (CBD) decreased roughly by 20% from 2000 to 2007 (estimates from JICA, 2004 and JETRO, 2007). Chronic congestion in the Jakarta Metropolitan Area costs up to 5.5 trillion rupiahs annually (JICA, 2004).

The wholly state-owned company, PT Kereta Api, (PT. KA) is the only organization authorized for the operation and administration of railway services in Indonesia (Wachi et al., 2011). Four radical railway lines and inner city railway lines are operated in the Jakarta Metropolitan Area. Total length of railway lines reaches approximately 166kmThe number of daily boarding passengers at Jakarta Metropolitan Area was 720,000 in 2007. The share of the railway among all motorized transportation modes was 1.3% for commuting trips in the metropolitan area (JICA, 2004). The number of commuter trains during peak hours reached 11.5 per hour per direction for the Bogor Line, a radial railway line to south area. However, the numbers are in the range of 1.5 to 3 trains per hour per direction for low-demand lines. Average train delay time of commuter trains was approximately 10 minutes as of 2010 (JICA, 2013).

The time-series analysis of trip characteristics also depicted notable trend in Jakarta Metropolitan Area. Yagi et al. developed the nested logit models of transportation mode choice in the Area based on the household travel survey in 2002 and 2010 (Yagi et al., 2012). According to the models, the dummy variable of home zone in urban area was significant with a negative sign for public transportation with motorized access. The model of 2010 showed higher t-stat than the one of 2002. This implies that the residents in the urban area have propensity not to use public transportation with motorized access mode, supporting the fact that railway in the Area is losing the share.

## 3. SUMMARY OF PILOT PROJECTS

The Japan International Cooperation Agency (JICA) in conjunction with the Indonesian Coordinating Ministry of Economic Affairs (CMEA) conducted a joint technical cooperation project called JABODETABEK Urban Transportation Policy Integration Project (JUTPI). The project aimed at improving urban transportation systems, easing traffic congestion and developing urban economic activities in the Jakarta Metropolitan Area. The main activities of the project included capacity building on the aspect of coordination in urban transportation policy, and preparation of the urban transportation master plan. As part of the JUTPI project seven pilot projects were implemented to promote coordination among relevant agencies as well as to try the potential of some transportation policies to improve ridership of public transportation (JICA, 2013).

Two of these pilot projects concern the improvement of access to railway stations. It is expected that the pilot projects function as a catalyst to promote railway use. A park-and-ride project in Depok City and a feeder bus service project in Bintaro Jaya area in Tagerang Selatan City are described and analyzed below.

### 3.1 Depok Park-and-Ride Project

Depok City, which is located roughly 20 km (12 miles) south of Jakarta, the capital city of Indonesia, had 806,000 population in 1990; the population has more than doubled to 1,739,000 according to the 2010 population census (Statistics Indonesia, 2010-3) in spite of its limited area of 200.3 square km (77.3 $mi^2$). Population density was roughly 86.8 persons/ha (35.1 persons/acre) as of 2010. Depok City is one of the sub-centers of the Jakarta Metropolitan area with a number of residential complexes, industrial estates and Universities.

Bogor line of PT. KA is penetrating the city's main corridor with 5 stations. During the morning peak hour, trains are operated in 5-minute headway with 8-car train set (JICA, 2013). This line is known as the railway line with the highest number of passengers in Indonesia. It is approximately 40 minutes from Depok City center to Jakarta central business district (CBD).

Pondok Cina station is 180m away from Depok city's main street. There are 8 air-conditioned express trains and 5 air-conditioned economy train bound for Jakarta stops at Pondok Cina station during morning 3 hours peak from 6AM to 9AM. The fare of the air-conditioned express train is 9,000 rupiahs (US$ 87.6 cents) and that of the air-conditioned economy train is 5,500 rupiahs (US$ 53.5 cents). In addition, an economy train without air conditioner stops at the station. While the fare of economy-class train is 1,500 rupiahs (US$ 14.6 cents), service level is low. Since economy trains are not equipped with an air conditioner, passengers open the doors. Some passengers also ride on top of the roof as the train is crowded with passengers.

Two shopping malls are within walking distance from the city's center. The University of Indonesia is also 100m away from the station. Depok Town Square (Detos) shopping mall is located approximately 130m south of Pondok Cina station. Detos and the station are linked with an unpaved street.

Transportation bureau of Depok City initiated the project with assistance from the JICA and the Coordinating Ministry for Economic Affairs (CMEA). The City coordinated with Detos, the Ministry of Transportation (MoT), PT. KA and a subsidiary company of PT. KA for a short-distance commuter railway service in Jakarta Metropolitan Area called PT KAI Commuter JABODETABEK (PT. KCJ). Furthermore, the Transportation Bureau of Depok City and the CMEA negotiated with Detos to provide a parking facility for the park-and-ride pilot project. The project would be beneficial for the management of the shopping mall as it can attract potential customers. The parking utilization ratio of the mall was approximately 25% during daytime of weekday while it is occupied during weekends. The shopping mall finally agreed to provide parking facility for the pilot project, providing also a discount. The daily parking fee of 6,000 rupiahs (US$ 58.3 cents) was reduced to 2,000 rupiahs (US$ 19.5 cents) during the period of the pilot project.

The pilot project aimed to enhance modal shift of car users, especially commuting workers in the morning and evening peaks, to railway by providing an opportunity to try railway. The project components include public relations, provision of park-and-ride facility with discount, construction of 130m walkway from Pondok Cina railway station to Detos shopping mall and interview surveys before and after the project. The public relation activities commenced February 1, 2011 and done for 2 weeks. Ten banners were installed at major streets: the railway station and Detos shopping mall. Moreover, 4,000 leaflets with a railway timetable were distributed for visitors of Detos and the station, and posted for the residents close to the railway station. The construction work of the walkway pavement and canopy was carried out from January 22, 2011 and completed on February 27, 2011. The construction was behind the original schedule of completing construction before the commencement of provision of parking space due to rain and difficulties in coordination with railway station master. The parking fee discount for park-and-ride use and provision of parking space were carried out from February 7 to March 4, 2011. Parking fee for park-and-ride users was 2,000 rupiahs (US$ 19.5 cents) a day from 5 AM to 10 PM, but they have to enter the parking lots during 5 AM to 9AM to be eligible for the discount. Park-and-ride users are also required to register for the project and a special ticket was issued for the participant. During the project period, a total of 51 persons registered for the project. A pre-interview survey on personal attributes, commuting trips and opinions on park-and-ride and railway service was conducted during the registration. After the project, a post-interview survey was also conducted on change in commuting trips and opinions on the park-and-ride and the railway service.

### 3.2 Bintaro Jaya Feeder Bus Project

Tangeran Selatan City is one of the newest municipalities in Indonesia. The city was separated from Tagerang Regency in 2008, considering growing population and urbanization. According to the Population Census in 2010 (JICA 2012), 1,290,000 people resided in the city area of 147.2 square km (56.8 $mi^2$). Population density was 87.6 persons/ha (35.5 persons/ha). Bintaro Jaya in this city is one of the largest housing and commercial developments in Indonesia with around 1,500 ha area (5.79 mi, 3,707 acres). The estimated population of this area is approximately 100,000 (JICA, 2013). The Bintaro Jaya housing complex is catering mainly for higher-income households. Two stations of the Serpong railway line are adjacent to this complex.

Jurangmangu station is located southeast corner of Bintaro Jaya. The Serpong railway line is connecting western part of Jakarta and Jurangmangu station in approximately 25 minutes by railway. Fares are 4,500 rupiahs (US$ 43.8 cents) for an air-conditioned economy train; 8,000 rupiahs (US$ 77.8 cents) for an air-conditioned express train; and 1,500 rupiahs (US$ 14.5 cents) for an economy train from Bintaro Jaya area to CBD of Jakarta. One air-conditioned express train and one air-conditioned economy train stops at Jurangmangu station during morning peak, 3 hours per direction from 6AM to 9AM. Toll road is also in parallel with the railway line.

The pilot project's components include public relations, operation of a feeder bus service from Jurangmangu station to Bintaro Jaya area and installation of bus location information system of the feeder bus. Prior to implementation of the pilot project, series of coordination meetings were held with CMEA, Tangeran Selatan City, bus operators' association of Tangeran Selatan City and management of Bintaro Jaya. The implementation of the project was disseminated through distribution of 4,000 leaflets and displaying 3 banners in roads at Bintaro Jaya residential area. Residents who wished to use the service need to register for the project in advance, which started February 12, 2011. As the number of registered members was limited, the registration was extended until February 27, 2011. A total of 64 residents registered to the feeder bus service that operated on weekdays from February 14 to March 11, 2011. The feeder bus service was providedfree of charge. Air-conditioned minibuses with seat capacity of 25 persons were utilized for the service. The route length was 10.6 km, starting from Jurangmangu railway station and connecting residential area, the area's commercial center and return to the station. The route was one-way circular route. Small bus stops were also prepared. It took approximately 30 minutes for one trip from the station and return to the station. The time schedule of the feeder bus was in accordance with the time schedule of trains bound for Jakarta. Four round trips of buses were operated in the morning peak from 5:45AM to 7:35AM, and 6 round trips of buses for the evening peak from 6PM to 9PM.

Pre- and post-interview surveys were conducted to grasp the impact of the project. Amongst 64 registered feeder bus users, only 45 of them were eligible respondents of the surveys, because the rest were not daily commuters to Jakarta or were students. The pre-survey was conducted during registration procedure, while the post-survey was carried out from February 28 to March 11, 2011. The group discussion was also held to identify main obstacles in using the railway and the feeder bus service. The number of samples of the post-survey was 16.
Apart from the pre- and post-interview surveys for registered users, a stated preference survey on a railway and a feeder bus use was conducted at two shopping centers in the region in order to understand key factors for modal shift. There were 300 respondents interviewed for the stated preference survey in early February.

## 4. RESULTS OF THE PILOT PROJECTS

### 4.1 Depok Park-and-Ride Project

During the project period, daily average of 30 persons among 51 registered utilized the park and ride service. In general, the registered users of the park-and-ride pilot project were satisfied with the project and railway use. The respondents, the registered users, marked their satisfaction level from a variety of aspects in pre- and post-survey. The respondents gave scores in the range of 1, totally unsatisfied, to 5, fully satisfied. The scores on accessibility to railway station and overall railway service significantly improved after implementation of the project, as shown in Table 1. This satisfaction might be due to accessibility improvement measures of the walkway pavement and canopy construction. Furthermore, the scores of the post-survey on egress transportation mode to their final destination, usually their work places, and security in station and train were almost at par with the pre-survey.

Table 1: Average satisfaction scores for the Depok park-and-ride project (all respondents)

| Evaluation Item | Pre-Interview Survey | Post-Interview Survey | Difference |
|---|---|---|---|
| | A | B | B-A |
| Car Access | 3.3 | 3.3 | 0.1 |
| Accessibility to Station in General | 2.7 | 3.4 | 0.7 |
| Train Punctuality | 2.8 | 2.9 | 0.1 |
| Security in Station & Train | 3.3 | 3.3 | 0.0 |
| Cleanliness at Station & Train | 2.6 | 2.7 | 0.2 |
| Seat Availability on Train | 2.0 | 2.3 | 0.3 |
| Announcement & Information at Station | 2.6 | 2.9 | 0.3 |
| Train Fare | 2.4 | 3.2 | 0.8 |
| Overall Railway Service in General | 2.5 | 2.9 | 0.5 |
| Accessibility to office | 3.4 | 3.3 | -0.1 |
| Access & Egress in General | 3.0 | 3.5 | 0.6 |

It is also noteworthy that approximately half of the registered users have no experience of using railway for commuting before the pilot project. These respondents expressed higher satisfaction scores especially on railway use in general and access to railway stations. According to their replies in open-ended questions on impression on the railway service obtained during the post survey, they realized that railway is cheap, fast and convenient mode of transportation. These facts imply that the experience of using railway through the pilot project gave a positive impression on railway use even though the users were previous car commuters. As a whole, 92% of the registered users responded that they would like to continue the service even after the project.

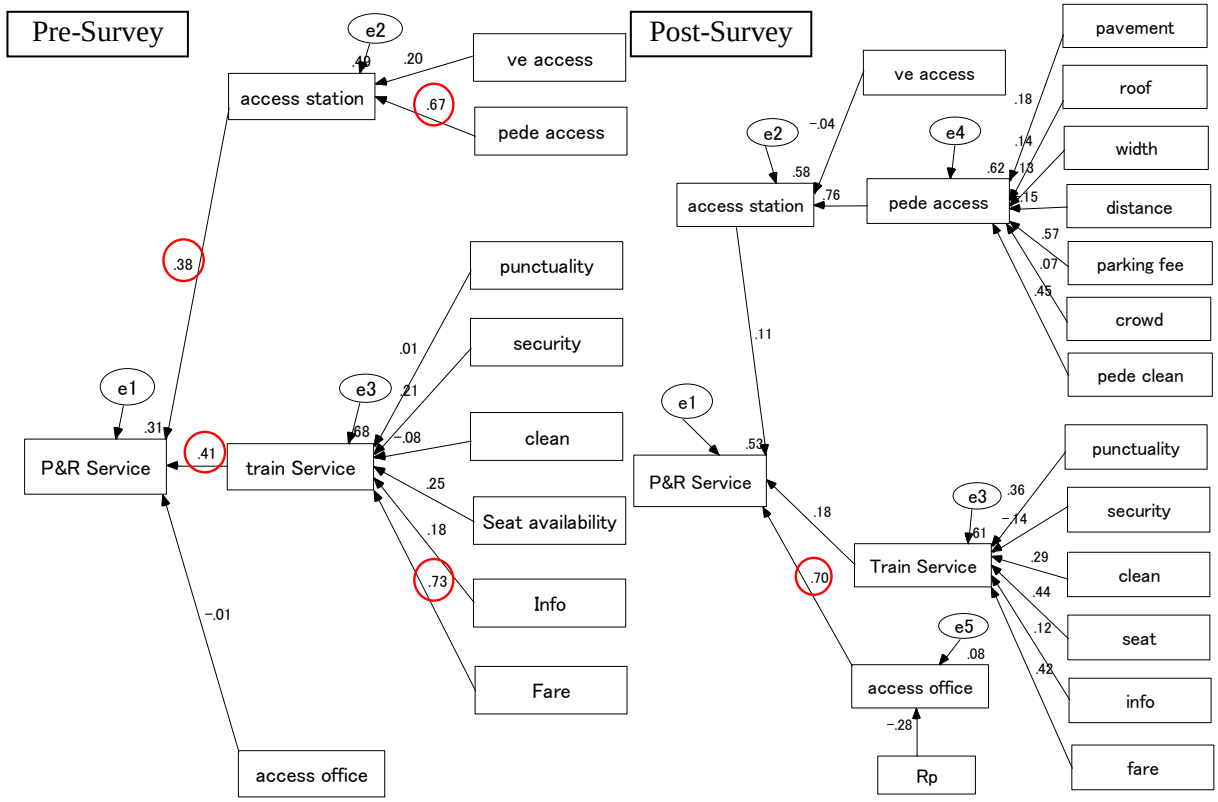
Another question on reasons why they participated the project showed that inexpensive parking fee of 2,000 rupiahs (US$ 19.5 cents) prompted them to participate in the project. While they are considered as relatively from high-income group as they can use a car, nevertheless they are responsive to cost.

Replies to questions on public relations also implied that 54% of the respondents got to know the project through banners on gantries of roads around the station. In case of the park-and-ride project, a banner advertisement on roads became effective measure as there primarily inform car users in a specific area. An implementation body of such project can also choose the most congested road section for a banner advertisement where longer exposure time is expected. These locations are

effective for a park-and-ride project as higher possibility of shift to public transportation could be expected.

In order to identify key factors for promotion of public transport, two structural equation models were developed utilizing pre- and post-survey results. The numbers of samples were 51 for pre-survey and 31 for post survey. Satisfaction scores of each item were utilized as variables.

Overall satisfaction level of railway and park-and-ride services is explained by access to a station, railway service and access to final destination of office in case of a commuting trip. Each variable is also explained by several items as shown in Figure 1. The pre-survey model, which is interpreted as initial perception of the services, showed that the access to a railway station and train service contributed to the overall image of the service. Notably, walking access and railway fare contributed to the overall perception of the service.




| | | | |
|---|---|---|---|
| P&R Service: | Overall satisfaction on park and ride service | parking fee: | Satisfaction on parking fee |
| access station: | Overall satisfaction on access to a station | crowd: | Satisfaction on crowdedness of the walkway |
| train service: | Overall satisfaction on railway service | pede clean: | Satisfaction on cleanliness of the walkway |
| access office: | Overall satisfaction on access to the office | punctuality: | Satisfaction on punctuality of railway service |
| ve access: | Overall satisfaction on accessibility to the station by car | security: | Satisfaction on security of railway service |
| pede access: | Overall satisfaction on accessibility to the station on foot | clean: | Satisfaction on cleanliness of railway service |
| pavement: | Satisfaction on pavement condition | seat: | Satisfaction on seat availability of railway service |
| roof: | Satisfaction on the canopy | info: | Satisfaction on access to information on railway service |
| width: | Satisfaction on width of the walkway | fare: | Satisfaction on fare of railway service |
| distance: | Satisfaction on distance from | Rp: | Total Transportation fare to the office |
| e1 – e4 | Residuals | | |

Note: All the variables in the above figures are on satisfaction scores except for "Rp", total transport fare to office. The numbers over the paths are the standardized path coefficients. The numbers over the endogenous variables are the squared multiple correlations.

Figure 1: Structural equation models of satisfaction level of Depok park-and-ride project.

On the other hand, the post-survey, which is considered to reflect satisfaction with experience, showed that the overall satisfaction of the service is dependent on access to their office from the destination station rather than the access to the Pondok Cina station and the train service. This implies that some respondents might face difficulties reaching their workplace from their destination station and improvement of egress transportation might be a key for them to continue the railway use.

It should be noted that the coefficient of determination of access to the office from destination station was significantly low as only transportation fare was available as an explanatory variable. Other factors such as distance to the final destination, public transportation availability and service level might explain this. This park-and-ride scheme has continued even after the pilot project finished in March 2010, possibly because the parking management realized its relevance, and so stakeholders keep receiving benefits.

### 4.2 Bintaro Jaya Feeder Bus Project

The feeder bus services were operated every weekday for 4 weeks. While a total of 64 persons registered for the pilot project, a total of 14 persons use the feeder bus service at least once during the project period. Not all the registered persons use the system every day. The daily average user of the service was approximately 3 to 6 persons for morning period. Among 64 registered persons, approximately half of them were using car for commuting. However, none of them tried the feeder service. In terms of public relations, the method was almost similar with the Depok Park-and-ride project and the fare of the feeder bus was free of charge. It is assumed that other factors affected the number of users of the service.

Frequency of air-conditioned train during 3 hours morning peak from 6AM to 9AM at the stations for the Depok Park-and-Ride and the Bintaro Jaya Feeder Buses were 13 and 2, respectively. The passengers from Bintaro Jaya have to transfer to buses without air conditioner to reach the CBD of Jakarta, while some trains for Depok Park-and-ride users directly go to the CBD. Alignment of toll roads might be one of the factors also as the toll roads is parallel with railway in case of Bitaro Jaya whist the distance between the Depok Park-and-ride and the nearest interchange is approximately 8 km. It is also noted that the Bintaro Jaya complex is for higher-income households who own cars. While there are several housing complexes mainly for car-owning households around Depok Park-and-ride venue, household income of these residents could be relatively lower.

#### 4.2.1 Pre- and Post-Interview Surveys

The interview surveys before and after the project could give insights on how the perception of the feeder bus and railway service changed after the experience of using it. The comparison of satisfaction levels of pre- and post- surveys are depicted in Table 2. While satisfaction scores of access to a railway station and train punctuality increased after the project, announcement and information dissemination, and overall satisfaction level of railway, feeder bus service, and egress transportation decreased after the project.

Table 2: Average satisfaction scores for the Bintaro Jaya feeder bus project

| Evaluation Item | Pre-Interview Survey | Post-Interview Survey | Difference |
|---|---|---|---|
| | A | B | B-A |
| Feeder Bus Service | - | 4.3 | - |
| Access to Station | 3.3 | 3.8 | 0.4 |
| Train Punctuality | 2.6 | 3.1 | 0.6 |
| Security at Station/Train | 3.2 | 3.3 | 0.1 |
| Cleanliness at Station/Train | 3.1 | 3.1 | 0.1 |
| Seat Availability | 2.6 | 2.4 | -0.2 |
| Announcement & Information | 3.0 | 2.7 | -0.3 |
| Railway Travel Time | 3.5 | 3.4 | -0.1 |
| Railway Service in General | 3.1 | 2.8 | -0.3 |
| Access from Station to Office | 3.4 | 3.4 | -0.1 |
| Access, Railway Service & Egress in General | 4.6 | 3.6 | -1.0 |

Respondents who have experienced using railway for commuting purposes and those who have not, registered for the project. By utilizing the pre-survey results, satisfaction scores of these two groups of respondents were compared to understand perception and attitude toward railway use. The respondents without the experience expressed lower scores for railway service level such as security, cleanliness of train coaches and stations, announce and information and railway travel time. However, general scores of accessibility to office of those without the experience were higher compared with those with the experience. This implies that the main obstacles to use railway for the respondents without the experience were train service level and accessibility to a railway station rather than egress transportation mode. While access to office is key factor to resume the service, improvement of access to station and railway service level might prompt them to use railway.

4.2.2 Telephone Interview Survey to Non Feeder Bus Users

In addition to the post-survey, telephone interview survey was conducted for the registered persons who did not use the feeder bus service at all. 28% of them replied that they might have used the service if the frequency of the feeder service had been high. 18% of them also mentioned that they might have used it if the bus operation had been punctual. This means that improvement of service level, especially frequency, might have attracted potential users. On the other hand, 18% of the respondents answered that they had never used the service while they were registered to the project.

4.2.3 Stated Preference Survey on Commuting Transportation Mode

The stated preference survey on transportation mode choice of commuting trips was conducted at shopping malls in the pilot project area. 260 effective samples were collected. These respondents are not the persons who registered the Bintaro Jaya Feeder Bus pilot project. The contents of the interview survey include personal attributes, daily commuting information, and stated preference on the feeder bus service. In addition to existing transportation modes of car, motorcycle and existing public transportation, railway with the feeder bus service was included in the choice of the survey respondents, identifying the possibility of implementing the feeder bus service. With the interview survey result, multinomial logit models were developed for four groups: all respondents, high-income class with monthly income of more than 6 million rupiahs (US$ 583.8) per month, medium-income class with income of 2 million (US$ 194.6) to 6 million rupiahs per month and low-income class with income of less than 2 million rupiahs per month. The income group is defined based on characteristics

of vehicle ownership. The high income group is generally captive to car use, and, majority of medium income group is using motorcycle. The low income group is dependent on public transport and motorcycles. Four choice set; passenger car, motorcycle, existing public transport and assumed feeder bus service and railway; are considered in the model. Travel time and cost of the respondent's normal commuting trips were interviewed, and they are utilized for model development. For the stated preference section, three options of feeder bus service level were presented to a respondent, and compared with the current mode of transport of the respondent. The feeder bus service level was set based on the orthogonal choice design. It is also assumed that each option of the mode choice model is independent according to the model development in the same region (JICA and CMEA 2012). For the model calibration, possible all independent variables are tested in the initial model, and, independent variables with low t-stat are excluded. Multi-co-linearity is also avoided for the model development. With tens of trials, the model in the Table 3 was estimated.

The adjusted $\rho^2$ value of the model of all income groups was 0.192. t-statistics of motorcycle availability, car availability, frequency of public transport and distance to the feeder bus stops, transportation cost, female dummy variable, and the number of cars in a household were significant. The model for high- income household showed high adjusted $\rho^2$ value of 0.515. However, coefficients of the railway with feeder bus services were not significant, except for the constant specific for it. On the other hand, all vehicle ownership-related variables are significant. This means that mode choice of high-income household is dependent on vehicle ownership. When it comes to low-income households, coefficients of the feeder bus services such as frequency and distance to a bus stop were significant. Therefore, ridership of low-income households is dependent on the service level of the feeder bus service. The adjusted $\rho^2$ value of the mode choice model for the medium-income group was relatively lower. The significant coefficients were similar to all-purpose model. It is assumed that this income group might contain groups similar to high-income group as well as those close to low-income group, and this might make the adjusted $\rho^2$ value low.

Table 3: Transportation Mode Choice Model of Commuting Trips

**All Income Class**

| Alternative/Variable | Coeff. | t-Stat. |
|---|---|---|
| Passenger Car | | |
| Travel Cost in 1,000 rupiahs | $-1.06 \times 10^{-2}$ | -2.47 |
| Number of Car in Household | $5.69 \times 10^{-1}$ | 2.94 |
| Dummy: High Income | $6.63 \times 10^{-1}$ | 1.59 |
| Dummy: Car Availability | 3.83 | 4.80 |
| Dummy: Female | $-5.00 \times 10^{-1}$ | -2.97 |
| Motorcycle | | |
| Travel Cost in 1,000 rupiahs | $-1.06 \times 10^{-3}$ | -2.47 |
| Dummy: Motorcycle Availability | 2.16 | 8.49 |
| Dummy: Middle Income | $7.44 \times 10^{-1}$ | 1.85 |
| Dummy: Low Income | $7.98 \times 10^{-1}$ | 1.90 |
| Dummy: Female | $-5.00 \times 10^{-1}$ | -2.97 |
| Public Transportation | | |
| Travel Cost in 1,000 rupiahs | $-1.06 \times 10^{-3}$ | -2.47 |
| No. of Services per Hour | $2.62 \times 10^{-1}$ | 7.51 |
| Dummy: Middle Income | $7.44 \times 10^{-1}$ | 1.85 |
| Dummy: Low Income | $7.98 \times 10^{-1}$ | 1.90 |
| Feeder Bus & Railway | | |
| Constant | 2.02 | 4.74 |
| Travel Cost in 1,000 rupiahs | $-1.06 \times 10^{-3}$ | -2.47 |
| No. of Services per Hour | $2.62 \times 10^{-1}$ | 7.51 |
| Distance to Feeder Bus Stop (m) | $-5.82 \times 10^{-3}$ | -5.01 |
| Adjusted $\rho^2$ | 0.192 | |

**High Income Class**

| Alternative/Variable | Coeff. | t-Stat. |
|---|---|---|
| Passenger Car | | |
| Travel Cost in 1,000 rupiahs | $-1.88 \times 10^{-3}$ | -1.34 |
| Number of Car in Household | 1.77 | 2.71 |
| Dummy: Current Car User | 5.56 | 2.56 |
| Dummy: Female | -2.19 | -1.96 |
| Motorcycle | | |
| Travel Cost in 1,000 rupiahs | $-1.88 \times 10^{-3}$ | -1.34 |
| Dummy: Motorcycle Availability | 1.47 | 3.04 |
| Dummy: Female | -2.19 | -1.96 |
| Public Transportation | | |
| Travel Cost in 1,000 rupiahs | $-1.88 \times 10^{-3}$ | -1.34 |
| No. of Services per Hour | $2.19 \times 10^{-1}$ | 1.40 |
| Feeder Bus & Railway | | |
| Constant | 1.86 | 1.97 |
| Travel Cost in 1,000 rupiahs | $-1.88 \times 10^{-3}$ | -1.34 |
| No. of Services per Hour | $2.19 \times 10^{-1}$ | 1.40 |
| Distance to Feeder Bus Stop (m) | $-8.29 \times 10^{-3}$ | -1.20 |
| Adjusted $\rho^2$ | 0.515 | |

**Middle Income Class**

| Alternative/Variable | Coeff. | t-Stat. |
|---|---|---|
| Passenger Car | | |
| Travel Cost in 1,000 rupiahs | $-1.83 \times 10^{-3}$ | -3.06 |
| Dummy: Car Availability | 5.16 | 4.53 |
| Dummy: Female | $-6.06 \times 10^{-1}$ | -3.01 |
| Motorcycle | | |
| Travel Cost in 1,000 rupiahs | $-1.83 \times 10^{-3}$ | -3.06 |
| Dummy: Motorcycle Availability | 2.23 | 6.84 |
| Dummy: Female | $-6.06 \times 10^{-1}$ | -3.01 |
| Public Transportation | | |
| Travel Cost in 1,000 rupiahs | $-1.83 \times 10^{-3}$ | -3.06 |
| No. of Services per Hour | $2.44 \times 10^{-1}$ | 5.85 |
| Feeder Bus & Railway | | |
| Constant | 1.14 | 5.26 |
| Travel Cost in 1,000 rupiahs | $-1.83 \times 10^{-3}$ | -3.06 |
| No. of Services per Hour | $2.44 \times 10^{-1}$ | 5.85 |
| Distance to Feeder Bus Stop (m) | $-5.19 \times 10^{-3}$ | -3.88 |
| Adjusted $\rho^2$ | 0.176 | |

**Low Income Class**

| Alternative/Variable | Coeff. | t-Stat. |
|---|---|---|
| Passenger Car | | |
| Travel Cost in 1,000 rupiahs | $-1.80 \times 10^{-3}$ | -2.44 |
| Dummy: Car Availability | 4.43 | 3.10 |
| Motorcycle | | |
| Travel Cost for Motorcycle | $-7.53 \times 10^{-5}$ | -1.93 |
| Dummy: Motorcycle Availability | 4.43 | 2.58 |
| Public Transportation | | |
| Travel Cost in 1,000 rupiahs | $-5.46 \times 10^{-3}$ | -1.20 |
| No. of Services per Hour | $2.06 \times 10^{-1}$ | 2.69 |
| Feeder Bus & Railway | | |
| Constant | 1.29 | 3.18 |
| Travel Cost in 1,000 rupiahs | $-5.46 \times 10^{-3}$ | -1.20 |
| No. of Services per Hour | $2.06 \times 10^{-1}$ | 2.69 |
| Distance to Feeder Bus Stop (m) | $-5.62 \times 10^{-3}$ | -2.06 |
| Adjusted $\rho^2$ | 0.251 | |

4.2.4 Park-and-Ride at Jurangmangu Station

There is a parking space of more than 2,000 square meters (0.5 acres) in front of Jurangmangu railway station. While the parking space was not fully occupied during the pilot project, the number of users increased gradually. As of 2013, the parking space is fully occupied during daytime and the Tangerang Selatan City is planning to expand the park-and-ride space. This could be the affect of the improvement of railway service at Jurangmangu station. The number of air-conditioned trains increased from 2 to 6 trains per 3 hours peak.

## 5. DISCUSSIONS AND CONCLUSIONS

The results of the two pilot projects demonstrated remarkable contrast. The Depok Park-and-ride project with higher railway service level indicated that the experience of using the railway and the park-and-ride service contributed to improve satisfaction level, especially for those who had no experience using railway for commuting purpose. The pre- and post-interview surveys and subsequent analysis on factors affecting the satisfaction level implied that discount might be a key to attract users, while improvement of transportation service level at egress side is essential for them to continue using railways.

In contrast, none of the respondents who had no experience using railway for commuting purpose tried the free Bintaro Jaya feeder bus service although they registered for it. The stated preference survey results depicted that high-income groups are significantly captive to car use, while the low-income group can be attracted with improvement of the service level. Taking into consideration the fact that park-and-ride service at the station adjacent to Bintaro Jaya finally attracted users after the pilot project as the frequency of railway operation increases, it is inferred that park-and-ride service with high frequency of railway service might easily attract potential railway users than the feeder bus service in car-oriented cities in developing countries. Park-and-ride can be a trigger of modal shift to railway.

However, park-and-ride service generally requires huge land within the vicinity of a railway station, a potential space for transit-oriented development. The large-scale park-and-ride facility also can be a cause of traffic congestion around a railway station. On the other hand, capacity of a feeder bus service is significantly higher than that of park-and-ride option. For the purpose of fundamentally solving traffic congestion, intensive public transportation network with trunk route of railway and feeder bus service is essential. In this sense, the results of the pilot project of the feeder bus service give insight on how to attract users for the feeder service, such as strategic marketing that targets non-car-captive groups, improvement of frequency and punctual operation of buses and railways, and shorter travel time.

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Note: Currency rate of 1 U.S. dollar = 10,277 rupiahs as of July 2013 was applied throughout this paper.