VALUING MANGGARAI STATION – SOEKARNO-HATTA INTERNATIONAL AIRPORT RAIL LINK USING STATED PREFERENCE APPROACH

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ABSTRACT

This study attempts to identify the characteristics and preference of the SHIA airport travelers, estimate the subjective value of in-vehicle time and waiting time by providing choice experiments regarding the available modes in combination with the Airport Rail Link (ARL) service as hypothetical situation, analyze how the values vary according to the socio-demographics of respondents and forecasting the mode sharing and the elasticity based on several scenarios. Five hundred respondents as potential demand for the airport access mode from both the online and on-field survey in Jakarta value reliability as the most important factors followed by comfort, journey time, fares and safety, while the most reliable journey according to the respondents is by train.
After various attempts to best analyze the data, statistically significant result is obtained from MNL and Nested models. The values of IVT vary between 632 Rupiah/Minute and 871 Rupiah/Minutes, the values of waiting time vary between 901 Rupiah/Minute and 1,504 Rupiah/Minute. The results of unobserved parameters from the alternative modes are satisfactory negative for bus and positive for ARL alternative.
The segmented models results vary that the value of male is higher than female, the value of high income is higher than low income, the values of taxi user is higher than car user, the value of business traveler is higher than leisure and commuter traveler, the value of self-finance journey is lower than the journey paid by the company. With the standard level of service, the probability result of mode sharing shows that the majority of respondents will use the train service (40.99%), followed by the other modes: bus (30.90%), car (16.52%), and taxi (11.59%).

Keywords: SHIA airport, value of in-vehicle time, value of waiting time, model segmentation, mode sharing.

1 INTRODUCTION

Commercial flight industry in Indonesia is expanding along with the economic growth and the passengers using the airport services are expected to increase each year. From the city center, SHIA Airport can be accessed through Sedyatmo toll road, the access road is experiencing congestion during peak hour whilst also disturbed by flood during the last few years (JICA, 2011). This condition resulted in unreliable travel time from/to the airport.

The government planned to provide rail link service between Soekarno-Hatta International Airport (SHIA) and Manggarai Station by two routes, one through Tangerang and the other through Pluit. The rail link is expected will reduce travel time to the airport and provide more reliable, safer and more convenient travel choice. Given such improvement, the passengers are likely willing to spend extra money or change the mode of transport. No research about the valuation of willingness to pay regarding this new rail link has been found.

This paper develops a stated preference method for the available transport modes in combination with hypothetical Airport Rail Link (ARL) service to achieve several particular objectives:

a) To identify the characteristics and the preference of the SHIA airport travelers.
b) To estimate the subjective value of in vehicle time and waiting time for the SHIA access mode.
c) To analyze how the value of in vehicle time and waiting time vary according to the journey characteristic and socio-demographics of the respondents.
d) To estimate the mode sharing and forecasting the elasticity based on different scenarios.

This object of study focuses on the valuation of in vehicle time and waiting time from access mode between SHIA Airport and Manggarai Station. The data is obtained by defining the journey between SHIA Airport and center of Jakarta by providing hypothetical airport rail link (ARL). It doesn't emphasize the level of service of the ARL service and how it will be implemented in real situation.

2 SHIA AIRPORT ACCESS MODE

An origin and destination (OD) survey conducted by the Indonesian Transport Society MTI (2011) and Directorate General of Land Transportation as cited by Suharti (2010) show the percentage of transport mode users as below.

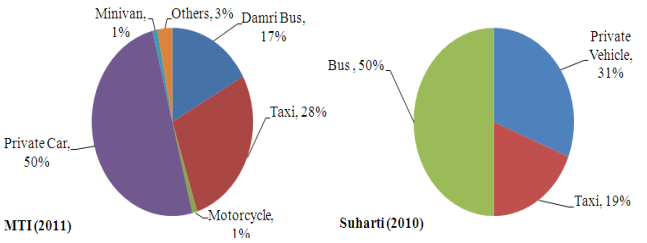

Figure 1. Percentage of mode choice.

Damri Bus is one of widely used airport access mode. For the journey to city center, the travel time requires an average of an hour in vehicle time. The service headway is around 15 and 30 minutes. The ticket fare to the city of Jakarta is 15,000 rupiahs. The weakness of using the bus service in current operation is the access from the city center to the airport is very much depends on the traffic condition.

There are 1790 taxis in operation in the airport, the number is considered sufficient to capture the demand. According MTI (2011) in the morning and afternoon peak hour there is indication of lack of taxi in the terminals, which is not because the lack of the fleet number but most probably because of the difficulty of getting back to the airport after the taxis take the passenger to several destinations due to traffic jam in Jabodetabek area.

To improve the accessibility of SHIA airport from the city centre, the government has assigned PT. Kereta Api Indonesia (KAI) to establish a railway from Manggarai Station in Jakarta to SHIA airport. As commuter line, the railway project will develop 7 km track connecting Tanah Tinggi Station in Tangerang with the Airport. The other route will be a new 33 km long express line between SHIA airport and Manggarai Station via Muara Angke in West Jakarta, Pluit in North Jakarta and continue in parallel with the Toll road to the airport.

3 UTILITIES AND ATTRIBUTES

Stated preference is a part of disaggregate method analysis to observe the travel behavior based on individual decision maker with the assumption that each individual have different travel characteristics and choices.

According to Permeain et al. (1991), stated preference can give good quality information on travel demand and behavior for reasonable cost. The study can also measure people's preferences toward a new transport system that couldn't be measured using conventional method. Where the Airport Rail Link (ARL) is not yet exists; the suitable method to observe the individual response is by using stated preference.

After problem identification and the literature review, the next stage in the methodology is questionnaire design. Design of this experiment is based on utility theory assuming that people want to maximize their utility. Alternative mode is characterized by utility and the attributes which will influence respondent's behavior.

3.1 IDENTIFICATION OF ATTRIBUTE

Three attributes that are hypothetically significant to the choice made by the respondent are travel cost, in vehicle time, and waiting time as on the model:

$$V_i = \delta_i + \beta_{Time} IVTime_i + \beta_{Cost} Cost_i + \beta_{WaitTime} WaitTime_i \quad (1)$$

where V_i is part of the utility which is known by the parameters, δ is Alternative specific constrain (ASC), β_{Time}, $\beta_{Cost,}$ and $\beta_{WaitTime}$ are time, cost, and wait time coefficients to be estimated, $Time_i$, $Cost_i$, and $Wait\ Time_i$ are time, cost, and wait time for alternative i.

The determination of each variables level is based on field survey in combination with reasonable judgment (Table 1). Cost attribute for bus alternative, cost variable based on the current ticket fare with reasonable increase on the bus and KRL ticket. For taxi alternative, the cost levels are based on several route and applying low tariff and high tariff to the cost variables. For train alternatives, the level is based on the finding from news and interview from internet resources.

Table 1. Alternatives and attributes level

Modes	In Vehicle Time (Minutes)			Cost (Rupiah)			Wait Time (Minutes)		
	Lowest	Std	Highest	Lowest	Std	Highest	Lowest	Std	Highest
Bus	45	60	120	26,000	28,000	31,000	25	40	55
Train	30	45	60	50,000	60,000	75,000	15	30	45
Taxi	35	50	100	100,000	130,000	150,000	5	10	15

For in vehicle travel time, the bus and taxi alternative use the distance from Gambir Station to SHIA airport with differences on average speed 20, 40 and 60 kph. For bus alternative, seven minutes travel time by using KRL commuter line is added between Manggarai Station and Gambir Station. The field survey has been conducted to validate the current travel time of each modes. For ARL alternative, the level is based on the finding from news and interviews from internet resources.

The waiting time for available modes is determined by the service headway. For bus alternative the waiting time is the addition of Damri and KRL headway, while for the taxi with assumption that there are queues to get the service

Vehicle operating cost for car depends on speed, type of vehicles, fuel consumption and vehicle maintenance cost correlate with the road alignment, road width and traffic data. A strategy to accommodate car mode is by providing a section on the questionnaire to ask about the perceived travel time and travel cost from the respondent. On the modeling stage, the car alternative availability is given to the model if the respondents usually travel to the SHIA airport by using car.

3.2 DESIGN EXPERIMENT

The choice experiment in this research is designed by using Ngene software to run the efficient design. With three attributes and three levels for each attribute and three alternatives in this design, a full factorial design will give 19,683 choice set. To avoid respondents' fatigue, by following the assumption that the preference across the respondents is homogenous enough that it can be combined, the number of choice in this experiment is reduced to 36 questions separated by four blocks and each block consists of nine choice exercises.

3.3 QUESTIONNAIRE DESIGN

The questionnaires consist of three sections. The first section about the journey characteristics such as journey purpose, journey frequency, responsibility for the ticket/cost, group/Individual travel, the mode people usually use, journey time, journey cost, travel habits, reliability, comfort, safety, luggage. The second section provides choice exercises from the overall 36 choice exercises. Each of the three set of questionnaire consist 9 choice exercises. The third part of the questionnaire ask respondent about the personal information, consist of five questions such as: gender, age, income, occupation, and education.

There are minor corrections for the question after the pilot survey. The main survey is intended to the potential flight passengers, companion of the flight passengers, airport workers and other potential users for airport access mode. It combines both on-field and online survey to get more effective result for this study. On-field method is beneficial to get more representative respondent and online method is beneficial to get more accurate response.

4 RESULTS AND DISCUSSIONS

The data from the survey is being analyzed by using two statistical approaches: descriptive and inferential statistic. There are 300 response from online survey and 200 responses from on-field survey in the Airport, Gambir station, and in the bus to the airport.

4.1 RESPONDENTS CHARACTERISTICS AND PREFERENCE

The respondents perceive that several modes of transport have different quality in term of reliability, comfort, journey time, cheap fare and safety as shown on Table 2 and Figure 2.

Table 2. Mode and journey characteristics

Mode of Transport	Journey Characteristic (%)				
	Comfort	Reliable	Safe	Fast	Cheap
Bus	4.00	0.80	2.60	13.18	25.30
Train	21.20	42.80	24.00	37.69	42.77
Taxi	23.80	7.00	15.20	16.55	0.20
Private Car	41.20	9.40	51.00	20.85	1.81
Motorcycle	9.80	40.00	7.20	21.73	29.92

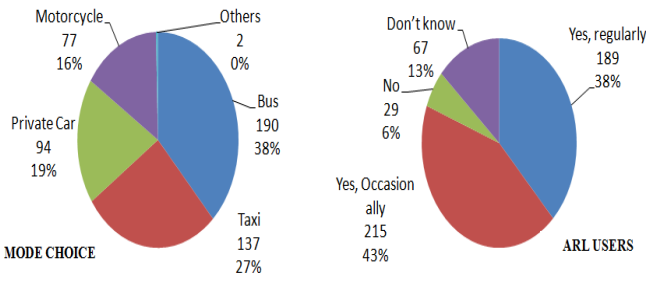

Figure 2. Mode choice and ARL potential users.

The choices by respondent are very much depending on the background and characteristics of the journey from the respondent. By examining the journey characteristics, the rationality behind the behavior of respondent can be observed. While the most respondents travel by bus, after the introduction of ARL service they are willing to use occasionally (43%) and regularly (38%) as shown below.

4.2 VALUE OF IN VEHICLE TIME AND WAITING TIME

The analysis of the choice experiment is using MNL and Nested Logit to examine the base model, model with alternative specific constraint (ASC) and model with ASC for ARL train. The analysis uses Biogeme software for valid data set consist of 3600 choice experiments from 400 respondents after data reduction by eliminating biases. Several statistical measures to examine the validity of the model are maximum log-likelihood, beta estimate of Attribute coefficient, t-statistics of attribute coefficient, Adjusted Rho-squared, and coefficient ratio.

4.2.1 Multinomial Logit (MNL) Model

MNL model work based on probability that the larger the difference in the utility between two alternatives, the more likely the decision maker is to choose the alternative with the higher utility. The probability can be calculated based the equation:

$$P_i = \frac{e^{U_i}}{\sum_j e^{U_j}} \quad (2)$$

where P_i is the probability of a decision maker choosing alternative i and U_i and U_j are the utilities of alternatives $_i$ and $_j$, and $_j$ is the number of alternatives.

The Multinomial Logit (MNL) model results shows statistically significant within 95 percent confidence interval. The value of ASC for bus alternative is negative, following the hypothesis of the reluctant on interchange. The value of ASC for train is positive, appropriate with the hypothesis that people in Indonesia favor the availability of train service. The results are as shown Table 3.

4.2.2 Nested Logit (NL) Model

The widely used MNL model is vulnerable to the problem that arise from a property of the model termed the Independence from Irrelevant Alternatives (IIA). An alternative for the problem is by observing the correlation between alternatives by one of the approaching method termed nested logit. The probability in nested logit is a product of two simple logits, choice probability for alternative i in nest n is $P_i = P_n \, x \, P_{i|n}$

$$P_n = \frac{e^{W_n + \lambda I_n}}{\sum_m e^{W_m + \lambda I_m}} \quad (3)$$

$$P_{i|n} = \frac{e^{Y_i/\lambda}}{\sum_j e^{Y_j/\lambda}} \quad (4)$$

$$I_n = ln \sum_j e^{y_j/\lambda} \quad (5)$$

where P_i is Probability (nest containing i) x Prob (i, given nest containing i), Y_i are variables that are vary over alternatives within the nest, Z_n are variables that vary over the nests but not within alternatives within each nest, and I_n is the inclusive value of nest n, and λ is (μ/μ_1) parameter of I_n. According to Train (2002), the indication of correlation among the alternative in nest k can be measured by $(1 - \lambda_k)$ when λ_k is 1 representing the independence among all alternative in the nest.

Table 3. Biogeme result for MNL model

Model	Model with no ASC		Model with ASC Bus		Model with ASC Train	
	Value	T-Stat	Value	T-Stat	Value	T-Stat
Attributes						
ASC Bus	-	-	-0.49	-8.47	-	-
ASC Train	-	-	-	-	-0.37	9.85
Cost	-2.10E-05	-28.17	-2.59E-05	-26.79	-2.18E-05	-28.56
Wait Time (WT)	-0.03	-18.57	-0.03	-18.32	-0.03	-19.76
In Vehicle Time (IVT)	-0.02	-22.30	-0.02	-18.92	-0.02	-19.02
Statistics						
Observations	3600		3600		3600	
Log likelihood	-3264.39		-3228.65		-3215.51	
Adjusted rho^2	0.204		0.212		0.215	
Coefficient Ratio						
Value of IVT (Rp/min)	1019.05		737.45		871.56	
Value of WT (Rp/min)	1428.57		1139.00		1504.59	
Value of Preference (Rp)	-		19.111.97		16972.48	

The nest is developed to allow the substitution between modes that have similar characteristics, car and taxi are classified as private transport mode while bus and train as classified as public transport mode. After several trials and combination, the best model results for the nested model are shown Table 4.

With mostly t-stats indicating the estimated variables are significant within 95 percent confidence interval, the results show some improvement on the goodness of model fit. There is correlation between bus and train on the public transport nest. As the correlation in a nest increases, split between probabilities in that nest becomes more extreme (differences in utility lead to bigger differences in probabilities), if the bus is not available, more people shift to rail than others.

4.3 VARIATION ACROSS RESPONDENTS CHARACTERISTICS

The result of segmented model with the segmentation by gender, purpose, income, frequency, mode choice and finance characteristics give satisfactory results in accordance with several other researches. The summaries are as in Table 5.

4.4 MODE SHARING AND FORECASTING

In comparison to the mode share before the hypothetical train exists, the result show that some users shifted from using their usual mode to using the train service. With the current (standard) level of service (Table 1) and the estimated coefficient (Table 4), the probability result shows that 18.68% from the bus users, 57.71% from taxi and 12.11% car user will shift to using the ARL service.

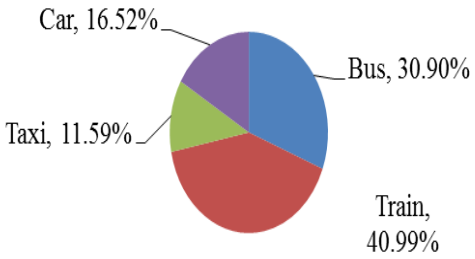

Figure 3. Forecasted of mode sharing.

The likely effect of changes on choice probabilities with regard to the differences on level of service is being conducted as shown at Figure 4.

Table 4. Biogeme result for NL model

Model	Model with no ASC		Model with ASC Bus		Model with ASC Train	
	Value	T-Stat	Value	T-Stat	Value	T-Stat
Attributes						
ASC Bus	-	-	-0.53	-11.05	-	-
ASC Train	-	-	-	-	0.39	13.12
Cost	-2.10E-05	-26.65	-2.53E-05	-28.62	-2.06E-05	-29.69
Wait Time	-0.03	-14.59	-0.03	-12.17	-0.02	-11.35
In Vehicle Time (IVT)	-0.021	-20.21	-0.016	-15.05	-0.015	-13.65
η nest 1 (car, taxi)	1.00	-	1.00	-	1.00	-
η nest 2 (bus, taxi)	1.00	-0.04	1.36	4.00	1.50	4.41
Statistics						
Observations	3600		3600		3600	
Log likelihood	-3264.39		-3218.25		-3201.2	
Adjusted rho^2	0.203		0.214		0.218	
Coefficient Ratio						
Value of IVT (Rp/min)	1019.05		632.41		723.3	
Value of WT (Rp/min)	1428.57		901.19		1116.5	
Value of Preference (Rp)	-		20988.14		19126.21	

Table 5. Segmented model result

Segmentation	Value of IVT (Rp/min)	Value of WT (Rp/min)	Preference (Rp)
Purpose			
Commuter	559	868	20,409
Business	1,050	1,609	20,503
Leisure	605	930	18,246
Mode			
Bus Passenger	707	908	12,785
Taxi Passenger	1,374	2,451	26,758
Car Passenger	604	2,374	31,319
Motorcyclist	648	(276)	12,043
Income			
Low income	494	532	16,609
Medium Income	809	1,239	19,348
High Income	1,268	2,641	30,523
Frequency			
Weekly	615	1,460	31,070
Monthly	944	1,858	10,761
Less Frequent	901	1,372	15,992
Gender			
Male	767	1,070	18,977
Female	617	1,399	19,043
Group			
Group Traveler	736	1,119	18,394
Single Traveler	667	1,017	21,392
Cost			
By Company	867	1,398	17,653
By Self Finance	603	895	20,639

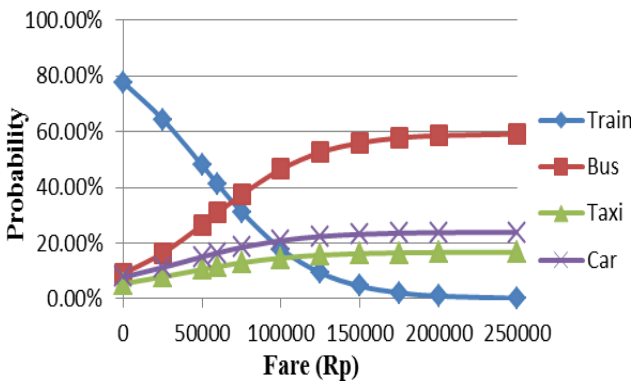

Figure 4. Sensitivity of ARL fare.

The results of sensitivity show that, if the other attributes are being fixed, the ARL Train will dominate the travel behavior until certain level of service. By applying the attributes separately the level of fare is 70,000 rupiah, In Vehicle Time (IVT) is 60 minutes and waiting time is 40 minutes.

5 DISCUSSIONS

The overall results are statistically significant for every model from the hypotheses. The results show significantly higher value of time in comparison to the value of time from previous research in Jakarta. This might relate to the characteristics of the airport access mode traveler because the increase in risk of missing flight which is considerably high. The values of waiting time are higher than the value of in-vehicle time (IVT), in comparison to the value of IVT, the value varies between 1.43 and 1.73 times IVT. The value of time, high value of waiting time, reluctant to use bus and predisposition to the ARL service can be used for project evaluation and determining policy and strategy for public transport operation.

6 CONCLUSIONS

Regarding the journey characteristics of airport access mode, the respondents value reliability (40.00%) as the most important factors following by comfort (23.60%), journey time (21.00%), fares (7.80%) and safety (7.60%) while the most reliable journey according to the respondents is by train (42.80%).

Nested model gives some improvement in the goodness fit by grouping bus and train into one nest. The value of IVT vary between 632 Rupiah/Minute and 871 Rupiah/Minute, the values of waiting time vary between 901 Rupiah/Minute and 1,504 Rupiah/Minute.

ASC for bus service resulted in negative sign for both MNL and Nested model: 20,988 rupiah and 22,764 rupiah respectively. While ASC value for ARL alternative resulted positive sign for both MNL and Nested model: 16,972 rupiah and 19,126 rupiah respectively, which mean people have predisposition to travel using the train service.

The segmentation for the models confirm that the value of male is higher than female, the value of high income is higher than low income, the values of taxi user is higher than car user, the value of business traveler is higher than leisure and commuter traveler, the value of self-finance journey is lower than the journey paid by the company.

With the standard level of service, the probability result of mode share shows that the majority of respondents will use the train service (40.99%), followed by the other modes: bus (30.90%), car (16.52%), and taxi (11.59%).

7 RECOMMENDATIONS

The next research need to take into account the difference between on peak and off peak travel, the reliability, and provide more important factors such as walking time and delay. The next research needs to compare the value of time result with the household income and also to accommodate differences resident and visitor.

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