INTERCITY BUS PASSENGER BEHAVIOR: BOARDING PLACE AND ACCESS MODE CHOICE MODEL - A CASE STUDY OF PROBOLINGGO CITY -

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Abstract: The relocation of bus terminal usually caused more inconvenience to intercity passenger. This study revealed that the intercity bus boarding place and access mode choice model was reasonably successful in providing an understanding of their determinant factors. The policy variables affecting access mode is access travel time, while in the case of boarding place are out of vehicle time (waiting time plus transfer time) and difference in intercity bus time. In addition, it was also found that short distance passenger (travel distance less than 60 km) was found to have higher sensitivity to access travel time and difference in intercity bus time than those long distance passenger. Finally, some policy implications have been identified from model developed in this study.

1. INTRODUCTION

Intercity bus terminals play an important role in serving transfer passengers between intercity and intracity highway-based public transport modes in some developing countries. In Indonesia, for the last decade, there has been a growing tendency for the city's local government to relocate the intercity bus terminal from city center to urban periphery (Dimitriou 1993). For example, in East Java Province, as of 1998 there are 40 intercity bus terminals located in 35 major cities. Among all intercity bus terminals, 22 have been relocated while at least four other cities are planning to relocate their bus terminals. More interestingly to note is that some cities relocate their bus terminals again within 5 to 10 years after the first relocation. Several objectives of intercity bus terminal relocation are to stimulate urban development, to increase capacity of bus terminal, to reduce traffic congestion in streets nearby old bus terminal in city center, and to increase local government revenue.

While billions of *rupiah* have been spent for each of that construction; the evaluation of intercity bus terminal relocation policy has rarely been done. Some researchers (Holik 1990; Soenarman 1995) have done earlier studies on the impact of bus terminal relocation on traffic congestion. The studies show that the relocation have in fact replaced traffic congestion, from the old bus terminal area to the new one. In fact, the most crucial impact of intercity bus terminal relocation that is urgently needed to be solved is decreasing utilization of bus terminal. Instead of using the new bus terminal, passengers are opting to use informal boarding places, which is illegal for the intercity bus to stop. The utilization of bus terminal is considered to be important. First, because local government wants to increase their revenue from terminal fee which is one of a potential new tax for local government (Kristiadi 1987). Second, as the construction for new bus terminal is usually funded by loan from central government, there is a need for its repayment. Moreover, Ministry of Transport has warned that there is a need to evaluate carefully the intercity bus terminal relocation policy (Bisnis Indonesia, September 28, 1995), because travel time and cost of intercity passengers have increased due to longer distance to the new bus terminal.

The purpose of this research is to develop a behavioral model for intercity bus boarding place and access mode choice, to investigate the effect of intercity distance to passenger behavior and to examine some policy implications from the model developed in this study. Such study is limited, as intercity bus passenger in developed countries uses only the formal intercity bus terminal. Although the applied methodology is rather classic, however, this study deals with phenomenon that is new from the perspective of intercity transport system. This phenomenon is the existence of informal boarding place; in which this study found that it have a significant role. This finding has suggested that rather than be eliminated, informal boarding place shall be formalized and accommodated in existing urban and intercity transport system.

2. INTERCITY BUS BOARDING PLACE AND ACCESS MODE CHOICE MODEL

The potential users of a transportation system can be classified according to many different sets of criteria. Ideally, we try to include in each group, travelers who are very similar in their preferences and characteristics, thus they will respond similarly to changes in transportation system. In order to determine variables that are potentially important in explaining boarding place and access mode choice, similar studies on intercity travel should be reviewed. In the case of intercity travel, behavioral modeling has been used for analyzing airport choice. Major influential variables of airport choice that are mostly used by previous researcher are some policy variables, such as: access time, access cost, flight frequency and airfare (Ashford & Benchemam 1987; Harvey 1987; Furuichi & Koppelman 1994; Windle & Dresner 1995; Monteiro & Hansen 1996). Access time and cost will be tested in this research, and the frequency will be replaced by inclusion of waiting time variable. Since intercity bus fare is the same across boarding place, therefore it will not be included as explanatory variables in this study.

In term of market segmentation, most researchers who studied airport choice used market segmentation based on trip purpose (Ashford and Benchemam 1987; Furuichi and Koppelman 1994), while others added status of resident grouping (Harvey 1987; Windle and Dresner 1995). Some other researchers, for example Augustinus and Demakopoulus (1978), Harvey (1987) and Adcock (1997) used market segmentation based on intercity distance. They found that passengers flying for short distance are more sensitive to access time and cost than passengers flying for long distance. Therefore, in this research it is desirable to study the effect of intercity distance to intercity bus passenger behavior.

Research on intercity passenger behavior may involve several levels of choice, however, in relation to the purpose of evaluating intercity bus, the relevant level of analysis is boarding place and access mode choice. The behavioral model employed in this study is based on stochastic choice using the hypothesis of random utility maximization. Little research has been carried out to obtain a better understanding of how intercity bus passengers choose among the services offered by competing boarding places. The fact that travel behavior in transport researches in developing countries has been understudied, supports the use of a nested logit model in order to examine the pattern of intercity bus passenger decision making. Sequential estimation procedure is usually applied because it exploits the ease with which nested logit model partitions into a product of distinct multinomial logit models (Ben-Akiva and Lerman 1985). Previous researchers frequently apply the nested structure by assuming that transfer place choice as an upper level choice and access mode choice as a lower level choice. Hence, in this study, it is also hypothesized that intercity bus passengers have similar choice structure (Figure 1). The utility function for this choice is given as equation (1):

$$U_{bm} = V_b + V_m + V_{bm} + \varepsilon_b + \varepsilon_{bm} \qquad \text{.......................} (1)$$

Where:

V_b = the deterministic component of utility specific to boarding place b.
V_m = the deterministic component of utility specific to access mode m.
V_{bm} = the remaining deterministic component of utility specific to combination (b,m)
ε_b = the random component of the utility specific to boarding place b
ε_{bm} = the random component of the utility specific to the combination (b,m)

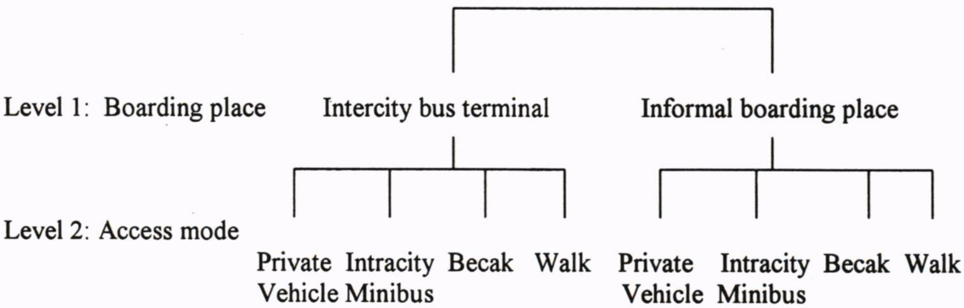

Figure 1. Choice Tree for Intercity Bus Passenger

The formula above implies that the error component exclusively associated with access mode m is negligible, in which all error is associated with access mode-boarding place combination. The probability that individual i choose access mode m conditional on boarding place b can be stated as:

$$Pi\,(m \mid b) = \frac{\exp\,[(V_m + V_{bm}).\mu_m]}{\Sigma_m \exp\,[(V_m + V_{bm}).\mu_m]} \qquad \text{..............................}(2)$$

where μ_m represents a scale parameter associated with the access mode alternatives. The marginal probability that individual i choose boarding place b can be determined as:

$$Pi\,(b) = \frac{\exp\,[\,(V_b + V_{b'}).\ \mu_b\,]}{\Sigma_b \exp\,[(V_b + V_{b'}).\mu_b]} \qquad \text{..........................} (3)$$

where, μ_b is a scale parameter associated with boarding place alternatives, and :

$$V_{b'} = \frac{1}{\mu_m} . \ln \Sigma_m \exp [(V_m + V_{bm}).\mu_m] \quad \text{.............................(4)}$$

The ratio of μ_b / μ_m will have to be estimated along with the unknown parameters of the model, and the following inequality must be satisfied:

$$\mu_b / \mu_m \leq 1 \quad \text{...(5)}$$

If one found that the value of μ_b / μ_m equal to one, equation (3) and (4) reduce to the marginal choice probability of the joint logit model. Finally, the probability that the individual i will choose access mode m and boarding place b can be represented by the product of the conditional and marginal probability (2) and (3) as:

$$Pi\ (m,b) = Pi\ (m \mid b).\ Pi\ (b) \quad \text{................................. (6)}$$

It was believed that if a consumer choice model of this type could be built, it could be useful in forecasting the redistribution of passenger traffic among boarding places. Especially, when new facilities and infrastructure or more services are added to the system. Therefore, this type of model could be helpful in determining the optimum location of new intercity bus terminal. Hence, the independent variables that hypothetically influenced the boarding place choice are access time, access cost, boarding time, waiting time and difference in intercity travel time. Other variables that should be tested are trip characteristics and socioeconomic variables. Among the important trip characteristic variables are trip frequency, the time of trip, number of luggage, and number of accompanying persons. While the socioeconomic variables that may affect the choice of boarding place are age, sex, status of resident, income, and education. Furthermore, in this research it is also desirable to study the effect of intercity distance on intercity bus passenger behavior.

3. DATA COLLECTION

A revealed preference sample survey has been conducted in Probolinggo City (in East Java Province), an intermediate size city with the population of about 180,000, which relocated the intercity bus terminal in 1992. This city was chosen as a study area because it represents the typical bus terminal relocation. The surveys carried out in 1997, assuming that within 5-year period, travelers have already adapted to the situation. In Probolinggo, common public transports mode that can be used as access modes to boarding places are intracity minibus and becak (rickshaw). Other access modes are walk and private vehicles (motorcycle or car). In the study area, there are two types of intercity highway-based public transport modes: intercity bus (capacity = 50 seat + some standing) and intercity minibus (capacity = 9-12 seat). Intercity bus has longer service distance than intercity minibus. Both are operated by private companies.

At present, there are three major intercity bus directions in Probolinggo, namely for Surabaya, Situbondo and Lumajang. In addition to the new bus terminal, there are three major informal boarding places, one for each direction; these are Ketapang Junction for Surabaya direction, Randupangger Junction for Situbondo and Jorongan Junction for Lumajang. Figure 2 shows the sketch of Probolinggo City together with location of bus terminal and other informal boarding places. The informal boarding place usually located in a junction and it has neither waiting facilities nor intercity bus information. Hence, the study area offered a unique opportunity to evaluate the relative importance of intercity bus boarding places.

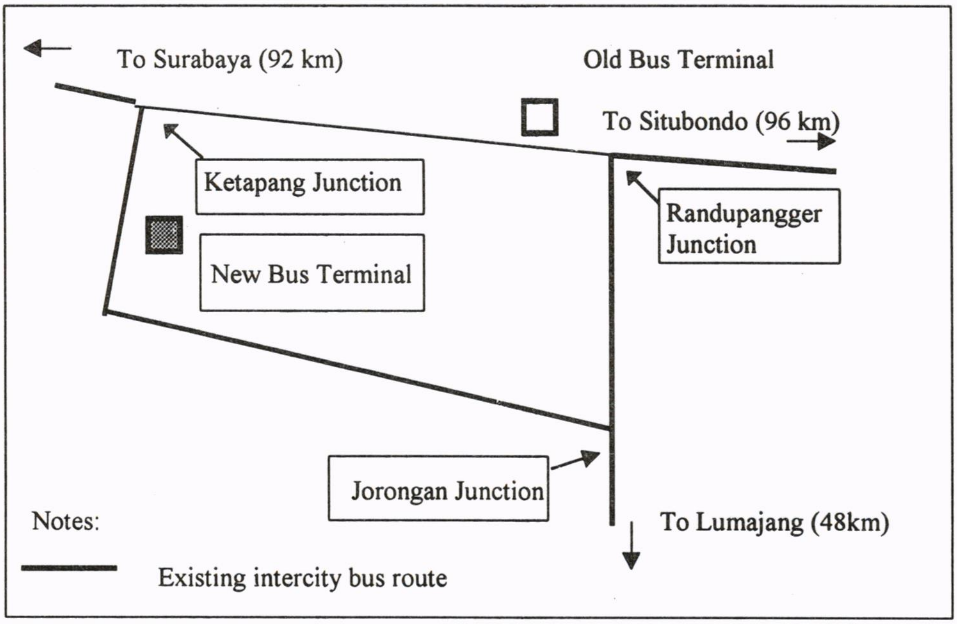

Figure 2. The Sketch of Intercity Network and Informal Boarding Place Location in Probolinggo City

In the study area, there are two types of intercity highway public transport modes: intercity bus and intercity minibus (MPU-*Mobil Penumpang Umum*). Both are operated by private companies. In terms of capacity, the intercity bus is larger than the intercity minibus, and unlike in the intercity minibus, passenger in intercity bus can stand if all seats are fully occupied. Intercity bus has longer service distance than intercity minibus, in which the total travel time of bus on the average is about six hours in one route, while two or three hours for the minibus. Travel fare in intercity bus is fixed and depends on distance, while fare in the intercity minibus can be negotiable depending on distance and traveler's number of luggage. The cruising speed of intercity bus is higher than intercity minibus, this is partly because of its engine capability and that the intercity minibus has more frequent stops than the intercity bus. In terms of user characteristics, intercity minibus users are mostly regular short intercity distance users, such as trader, student, and low-rank officer. It should be noted that there is no difference in fare between passengers utilizing bus terminal and informal boarding place.

Some secondary data from local government have been collected such as: city map, intracity and intercity route, intercity bus schedule, and number of passenger using intercity bus terminal. The average occupancy level of intercity bus is about 70% and minibus is about 60%. In the case of intercity bus, the highest hourly frequency for Surabaya direction is 54 buses (at 15:00 – 16:00), for Situbondo direction is 19 buses (at 13:00-14:00), and for Lumajang direction is 44 (at 16:00-17:00). In the case of intercity minibus, the highest frequency for Surabaya direction is 30 (at 7:00-8:00 and 15:00-16:00), for Situbondo direction is 30 (at 6:00-7:00) and for Lumajang direction is 27 (at 10:00-11:00 and 13:00-14:00).

As there is no previous research on this boarding place choice, it is necessary for the researcher to get some information from intercity bus passengers regarding the reason for using bus terminal. A preliminary interview was conducted with 60 intercity passengers at the bus terminal and junctions. Using scaling analysis to measure the degree of importance (1 for very unrelated reason to 5 for very important reason), the mean and number of respondents for each statement of reason is presented in Table 1.

Table 1. Result of Scaling Analysis for Selecting the Influence Variables

Reason	*Valid N*	*Mean*
To get a seat in intercity bus	59	4.305
It depends on the distance to city destination	52	3.558
To have shorter transfer time	55	3.545
To have shorter in intercity bus time	52	3.519
To have cheaper access cost	56	3.357
It depends on their trip frequency	53	3.340
To have shorter access travel time	57	3.333
To have shorter waiting time	53	3.208
It depends on the number of luggage	53	3.000
It depends on the number of accompanying person	52	2.827

Note: This table includes statements that the mean is more than 2.5

The preliminary interview result suggests the need to test some major policy variables, these are access travel time, access cost, transfer time, waiting time and difference in intercity bus time. Some other important variables are the reason to get a seat in intercity bus (as intercity bus is pooled at bus terminal), distance to city destination, trip frequency, number of luggage and number of accompanying persons. The interview also discovered that the tendency to get a seat is influenced by the number of luggage and number of accompanying persons. Therefore, these variables may represent the need of getting a seat in intercity vehicle.

This study selected revealed preference survey against stated preference survey because most people in this area have a low level of education, so that it would seem to be difficult for them to interpret some hypothetical questions. Revealed preference survey has been conducted by using a choice-based sampling. Choice-based sampling method is one of stratified random sampling methods that stratify the population based on the result of the choice process under consideration. In our case of boarding place choice, the stratification by location of boarding places corresponds to a choice-based sample. The advantage of this method is that the data can be taken at lower cost than other sampling methods. Moreover, choice-based sampling also has the advantage of being easy to be adjusted to represent existing (base) share, as it can be done by utilizing certain procedure (Ben Akiva and Lerman 1985).

Direct interviews with departing passengers were conducted at the bus terminal and three informal boarding places. Respondents were also limited to those who have trip origin inside the area of Probolinggo Municipality. For each passenger, the following data were obtained: origin of trip, possible access modes and chosen access mode to bus terminal and respective informal boarding place, access distance, access time, access cost, transfer time, waiting time and transfer cost. Other trip information was also collected, such as: frequency of using existing bus terminal, trip purpose, intercity distance, number of accompanying person, number of luggage, etc. Socioeconomic data were also collected for the analysis, such as sex, age, education level, occupation, income level, car ownership and status of city resident. Respondents were limited for those who have trip origin inside the area of Probolinggo Municipality. The number of respondent who stated that they had choice in using at least two access modes and both boarding places is 499. These are the samples used for the modeling analysis. Among 499 samples, the number of intercity bus terminal user is 36.1%, while the rest are the informal boarding place user.

4. MODEL ESTIMATION

Using the 499 samples, data relevant to this study such as street origins, access distance, access time, access cost, transfer time, waiting time and transfer cost were checked as to whether the reported value fell within reasonable range. These data were set for chosen and alternative boarding place, as well as for each chosen and alternative access mode. Furthermore, access time for both chosen and alternative access modes were computed based on access distance measured on a map and average speed of the specific access mode. Access cost was taken as out of pocket cost, in which private vehicle user cost was counted as gasoline cost only, while becak user cost was calculated based on average cost per unit distance, and minibus was a flat fare (300 rupiah). Transfer time and waiting time for alternative boarding place were calculated using average reported value for specific boarding place. Difference in intercity bus time was computed through measuring the distance on a map and the average speed of intercity bus.

In the next step, statistical analysis was employed to detect the correlation among variables that would be tested in model development. The test indicated that almost all hypothetical-variables were independent among each other. Several numbers of specifications for the model were tested. Among variables that were tested in this model included access distance, access time, access cost, generalized cost, income, luggage, age, sex and status of resident. For access mode choice model, access cost was found to have a positive sign and low *t* statistic, so it was dropped. Next, the marginal boarding place model was estimated as an ordinary multinomial logit model, treating the inclusive value (logsum) term as an ordinary explanatory variable, that was computed using estimated parameter values from the lower level access choice model. In the case of marginal boarding place choice model, it was decided to treat transfer time and waiting time together as out of vehicle time variable. The variables and their definition for final model development are shown in Table 2. Access mode choice model is given as Model C1 in Table 3, while the boarding place choice model is presented as Model M1 in Table 4.

5. MODEL INTERPRETATION

5.1. Statistical Performance

All of the estimated parameters included in the access mode choice model C1 are significantly different from zero at 95% confidence level, except alternative specific constant for *becak* and access time variable specific to private vehicle and walking.

Table 2. Description of variables in boarding place and access mode choice model

Variable	*Description*	*Unit*
Constant-m	Alternative specific constant; Cm = 1 for alternative access mode m; = 0, otherwise	None
Access travel time	Access travel time to boarding place, treated separately as alternative specific to private vehicle and walk (combined), minibus and *becak*	Minute
Dummy income (private vehicle, minibus & *becak*)	Dummy variable specific to private vehicle, minibus and *becak* choice, =1, if income of passenger's household is more than 300,000 rupiah per month; =0, otherwise	None
Dummy luggage (*becak*)	Dummy variable specific to *becak* choice; = 1, if ratio number of luggage to number of person is more than 1.0; =0, otherwise.	None
Dummy age (*becak*)	Dummy variable specific to *becak* choice; = 1, if age of respondent is less than 25 years old; = 0, otherwise	None
Dummy access distance (private vehicle & minibus)	Dummy variable specific to private vehicle and minibus choice; = 1, if access distance is more than 6 km; = 0, otherwise	None
Dummy resident (minibus)	Dummy variable specific to minibus; = 1, if respondent is resident of Probolinggo City; = 0, otherwise.	None
Bus terminal constant	Alternative specific constant to bus terminal choice; = 1, if using bus terminal; = 0, otherwise.	None
Out of vehicle time	Transfer time plus waiting time in boarding place.	Minute
Difference in intercity bus time	Difference in intercity bus time between using bus terminal and informal boarding place.	Minute
Dummy frequency (bus terminal)	Dummy variable specific to bus terminal choice; = 1, if trip frequency is twice or more in a week; =0, otherwise.	None
Dummy person (bus terminal)	Dummy variable specific to bus terminal choice; = 1, if number of accompanying person is one or more; = 0, otherwise.	None
Dummy luggage (bus terminal)	Dummy variable specific to bus terminal choice; = 1, if ratio number of luggage to number of person is more than 1.0; =0, otherwise.	None
Dummy income (bus terminal)	Dummy variable specific to bus terminal choice; = 1, if income of passenger's household is more than 300,000 rupiah per month; = 0, otherwise.	None

The likelihood ratio that was calculated against L (c) shows that is much larger than the tabulated χ^2 at the 99% confidence level, which implies a good fit. The estimated alternative specific constant of private vehicle and minibus is relatively large, suggesting the lack of explanation variables for those modes in the model.

In boarding place choice model M1, all estimated parameters are significantly different from zero at 95% confidence level, except the dummy for accompanying person. The likelihood ratio is also much greater than the tabulated χ^2 at the 99% confidence level. Estimated constant for bus terminal implies that the informal boarding place appears to have attractiveness that is not represented in the explicit variables of model.

Table 3. Result of Estimation on Access Mode Choice Model

No.	Variables	Model C1 Estimate	Model C1 t-value	Model C2 Estimate	Model C2 t-value
1	Constant (private vehicle)	-3.932	(-8.479)	-3.653	(-7.833)
2	Constant (minibus)	-1.621	(-2.865)	-1.748	(-3.077)
3	Constant (*becak*)	-0.720	(-1.255)	-0.766	(-1.328)
4	Access travel time (private vehicle and walk)	-0.041	(-1.509)	-0.043	(-1.562)
5	Access travel time (minibus)	-0.089	(-6.943)		
	* Access travel time (minibus) – short distance			-0.137	(-7.016)
	* Access travel time (minibus) – long distance			-0.065	(-3.391)
6	Access travel time (*becak*)	-0.156	(-7.928)	-0.152	(-7.905)
7	Dummy income (private vehicle, minibus & *becak*)	2.089	(3.000)	2.123	(3.061)
8	Dummy luggage (*becak*)	1.315	(2.670)	1.338	(2.715)
9	Dummy age (*becak*)	-0.980	(-2.111)	-0.900	(-1.949)
10	Dummy access distance (private vehicle & minibus)	0.685	(3.530)	0.871	(4.048)
11	Dummy resident (minibus)	1.040	(3.052)	0.870	(2.547)
	Initial Log Likelihood, L (0)	-667.250		-667.250	
	Log Likelihood-constant only, L (c)	-550.857		-550.857	
	Final Log Likelihood, L (B)	-461.570		-456.579	
	Likelihood ratio, -2 {L (0) - L (B)}	411.360		421.342	
	Likelihood ratio, -2 {L (c) - L (B)}	178.574		188.556	
	Likelihood index, rho-squared	0.308		0.316	
	Adjusted rho-squared	0.291		0.297	

Table 4. Result of Estimation on Boarding Place Choice Model

No.	Variables	Model M1 Estimate	Model M1 t-value	Model M2 Estimate	Model M2 t-value
1	Constant (bus terminal)	-0.608	(-2.290)	-0.735	(-2.707)
2	Out of vehicle time	-0.104	(-4.322)	-0.106	(-4.379)
3	Difference in intercity bus time	-0.084	(-5.677)		
	* Difference in intercity bus time - short distance			-0.104	(-6.137)
	* Difference in intercity bus time - long distance			-0.029	(-1.402)
4	Dummy frequency (bus terminal)	-1.515	(-5.575)	-1.406	(-5.066)
5	Dummy person (bus terminal)	0.496	(1.848)	0.581	(2.117)
6	Dummy luggage (bus terminal)	1.635	(3.411)	1.682	(3.353)
7	Dummy income (bus terminal)	1.649	(6.499)	1.587	(6.383)
8	Logsum	0.924	(3.985)	1	
	Initial Log Likelihood, L (0)	-345.880		-345.88	
	Log Likelihood-constant only, L (c)	-326.263		-326.263	
	Final Log Likelihood, L (B)	-219.723		-214.795	
	Likelihood ratio, -2 {L (0) - L (B)}	252.314		262.170	
	Likelihood ratio, -2 {L (c) - L (B)}	213.08		222.936	
	Likelihood index, rho-squared	0.365		0.379	
	Adjusted rho-squared	0.342		0.353	
	Combined Model Summary				
	Initial Log Likelihood, L (0)	-1013.130		-1013.130	
	Final Log Likelihood, L (B)	-681.293		-671.336	
	Likelihood index, rho-squared	0.328		0.337	
	Adjusted rho-squared	0.309		0.317	

5.2. Model Structure

The combined model summary indicates that the likelihood index (rho-square) is within reasonable value, supporting the acceptance of model for prediction purpose. However, the logsum variable in marginal probability model shows the closeness with one (the t-test = 0.327). This implies that the appropriate model is a joint logit model, therefore, in the next analysis the model is re-estimated by assuming the logsum to be one. This result indicates that in the study area some passengers may select boarding place first, then choose access mode, however, other passengers may select access mode first and then boarding place. Hence the previous hypothesis that the intercity bus passenger will select access mode after choosing certain boarding place is rejected. Table 5 shows the comparison of model structure for some researches on transfer place and access mode choice.

Table 5. Comparison of Model Structure with Previous Research Result

Researcher	*Case study*	*Model Structure*
Mukundan, 1991	Railway station	nested, upper level: access mode choice; lower level: station choice
Talvitie, 1992	Railway station	joint access mode and station choice
Fan et. al., 1993	Railway station	nested, upper level: access mode choice; lower level: station choice
Bondzio, 1996	Airport choice	nested, upper level: access mode choice; lower level: airport choice
This study	Intercity bus boarding place	joint access mode and boarding place choice

5.3. Policy Variables

Access travel time was found to be the determinant factor of access mode choice. It is interesting to find that passengers put the same weight for access travel time by using private vehicle and walking, probably this is just the reflection of income group in which the rich use private vehicle and the poor are walking. Moreover, passengers felt that access travel time using becak is less desirable than other modes (doubled of access travel time in minibus and triple of access travel time in private vehicle and walking). Unfortunately, estimate of access cost variable was found to be positive, due to lack of variation in access cost caused by the dominance of intracity minibus which applies a flat fare system.

The major determinant factors of intercity bus boarding place choice are out of vehicle time and difference in intercity bus time. Based on comparison of estimated parameters it can be seen that out of vehicle time is relatively weighted more than difference in intercity bus time. It can be concluded that efforts to reduce out of vehicle time and difference in intercity bus time would be desirable to increase the attractiveness of the bus terminal.

5.4. Trip Characteristic and Socioeconomic Variables

The access mode choice model shows that several trip characteristic and socioeconomic variables affect the access mode choice; these are income level, luggage, age, resident and access distance. Passengers with household income of more than 300,000 rupiah have the same preference for using private vehicle, minibus or *becak* as indicated by the model estimation stage where it was found that their separate estimate were not significantly different. Hence, it can be inferred that higher income people are less likely to walk. Due to limited space for luggage provision in minibus, it is statistically proven that if the ratio of luggage per passenger is greater than one, passenger will tend to use *becak*. Life style also affects the choice of access mode; younger people prefer not to use *becak*, because of its image as a traditional transport mode. Moreover, the city resident rather than the nonresident is more likely to choose the minibus as the former is better informed regarding minibus service. Finally, the use of minibus and private vehicle will more likely take place if the access distance is longer than 6 km.

Some trip characteristic and socioeconomic variables that were found to significantly affect the choice of intercity bus boarding place are frequency of intercity trip, number of accompanying persons, number of luggage, and income class of passenger household. Most of the frequent intercity travelers are those who work in other cities and purpose of their trip is for business. Therefore they are more sensitive to time-related variable, and will choose the closest boarding place. The number of persons influence the choice of boarding place because of two reasons: (1) if a grouped traveler is a family group, the need to get a seat on the intercity bus is increased as they bring children, wife or older people, (2) and if a grouped traveler is not a family group, they like to use the bus terminal as a meeting point. Luggage is thought to be a determinant factor for using the bus terminal, because specific provision for storing it is not available on the intercity bus. Hence, the bus terminal user has a higher possibility of getting a seat and putting the luggage near his seat. In terms of income class, it is found that higher income people prefer to use the bus terminal, as they wish to get a comfortable transfer.

6. POLICY IMPLICATIONS

The hypothesis on the difference of short- and long-distance traveler preference was tested by creating two sets of policy variables: one for short intercity distance (less than or equal to 60 km) and another for long intercity distance (more than 60 km). In access mode choice model it was found that the t statistic test for coefficient differences were 0.898, 4.232 and 0.807 respectively for access travel time using private vehicle and walk, minibus and becak. Therefore, only access travel time using minibus was significantly found to have different estimate for short and long intercity distance. The result is shown as Model C2 in Table 3 and Model M2 in Table 4. The low percentage of respondents using private vehicle, becak or who walking may become the cause of insignificant difference here. In addition, similar test for boarding place choice has resulted in t-statistic test values of 0.428 and 3.402 respectively for out of vehicle time and difference in intercity bus time. In conclusion, the effect of access travel time specific for minibus and difference in intercity bus time is smaller for long distance traveler. This is possibly due to decreasing marginal disutility of access travel time and difference in intercity bus time as the intercity distance becomes longer.

The above results have a number of implications for intercity bus terminal development. First, since the short- and long-distance passengers have been identified to have different considerations for boarding place level of service, this finding suggested the need to provide different terminal for the short-distance and long-distance intercity bus service. The old bus terminal that is usually located in city center is highly accessible from all parts of the city, therefore it is better for serving those short-distance travelers who are highly time-sensitive. As long-distance passenger is less time-sensitive, provision of new terminal in urban periphery for them will likely be less problematic. Cities which are considering relocating their bus terminal should take into account the possibility of using the old bus terminal as the terminal for short intercity distance, while the new bus terminal in the periphery will serve the long intercity distance. In fact, this separation of service has actually been applied for different types of vehicle for different service distance: intercity minibus for short distance and intercity bus for long distance services. Hence, the separation of terminal for each vehicle type could be done easily.

Second, given the high time sensitivity of the intercity bus passenger, bus terminal planning should better consider measures to minimize access time and minimize difference in intercity bus time. Improvement in bus terminal access can potentially be an effective tool in shifting intercity passenger to use the bus terminal, and such improvements must be oriented to an entire urban area. When bus terminal has to be relocated, the introduction of intracity minibus which serves all parts of the city should be done to at least maintain the access time to bus terminal. In addition, other measures to minimize the transfer time in bus terminal and keeping the same frequency of intercity bus should also be done. Unfortunately, the effect of access cost and transfer cost were not identified in this study; consequently, the analysis on pricing measure was not possible.

Finally, as the demand for intercity bus grows, more and more urban areas will be forced to rely on multiple transfer places, and efforts will be made to use potential transfer place to the best advantage. The results of this analysis imply that, in the current situation bus terminal services such as restaurant and toilet were not considered important especially for the short-distance intercity bus passenger. All of these suggest the use of potential transfer place as a bus stop, simply by providing a bus bay to reduce the effect on traffic flow and a shelter with few seats.

7. CONCLUSIONS

Model developed in this study is reasonably successful in explaining the important factors influence the use of boarding place, as well as some factors that affect the use of access mode. Hence, the models can be used for the next analysis to evaluate intercity bus terminal development planning. The important factors that affect the use of access mode are access travel time, household income, luggage, age, access distance and status of resident. In terms of boarding place, some important factors are out of vehicle time (transfer time and waiting time), difference in intercity bus time, intercity trip frequency, number of accompanying persons, number of luggage and household income of passenger.

It is observed that compared to the case of the developed country, intercity bus passengers in the study area have a limited choice of access modes, due to low car ownership. In addition, although cost related variables should normally become an important determinant factor of transfer place choice, in this analysis, because of the dominant share of intracity minibus that applies a flat fare system, consequently the access cost does not significantly influence the boarding place choice.

The model shows that there is a significant difference in passenger's weight on access travel time and difference in intercity bus time, between the short-distance and long distance passengers. This finding is in accordance with previous research on airport and railway station choice that has been studied in developed countries. In relation to the case study on intercity bus terminal relocation, this result is important, since it may become the major cause of decreasing utilization of an intercity bus terminal after its relocation.

Hence, the short-distance passenger is not willing to spend longer time to access the new bus terminal; therefore, they prefer to utilize the informal boarding place.

Finally, the estimated model suggest three policy implications:
(1) Since short-distance and long-distance passengers have been identified to have different consideration on boarding place level of service, this finding suggests the provision of different terminal based on intercity distance;
(2) As access time is found to be the most sensitive factor that influence boarding place choice, improvement in bus terminal access can potentially be an effective tool in shifting the intercity bus passenger to use bus terminal, and such improvement must be oriented to an entire urban area;
(3) Existing informal boarding place has some merit from the passenger's point of view; this suggests the use of such a place for bus stop, simply by providing a bus bay and shelter.

With respect to future planning on intercity bus terminal development, behavioral models of intercity bus terminal boarding place and access mode choice provide an important tool for the local government as the decision-maker. Although conceptually this model development is more complicated than some of the simple approaches that are being applied now, however its advantages argue strongly for its adoption. In terms of a somewhat broader conclusion, discrete choice models provide an excellent means of understanding and analyzing the intercity bus boarding place and access mode choice.

The drawback of this study is that the model developed here could not accommodate cost-variable, which is in developing countries may become an important factors. Hence, it is desirable that the future analysis should better include this cost as policy variable. The result of this study could be enhanced in several ways: (1) Estimating similar models on data for other areas and time period (e.g. before relocation); (2) Designing and conducting special studies of intercity bus traveler to develop a better understanding of their overall decision process. Further improvements in knowledge about intercity passenger behavior can help public and private organizations to address specific problems more quickly and efficiently.

REFERENCES:

Adcock, Simon J. (1997) A Passenger Station Choice Model for British Rail Network. **Proceeding of European Transport Conference PTRC, September 1997**, 141-146.

Ashford, N and Benchemam, M.(1987) Passengers' Choice of Airport: An Application of the Multinomial Logit Model, **Transportation Research Record 1147**, 1-5.

Augustinus, JG and Demakopoulus, SA. (1978) Air Passenger Distribution Model for a Multiterminal Airport System, **Transportation Research Record 673**, 176-180.

Ben-Akiva, M and Lerman, SR.: **Discrete Choice Analysis: Theory and Application to Travel Demand**, The MIT Press, Massachusetts, 1985.

Bisnis Indonesia Newspaper (1995) Bus Terminal Relocation Planning in Jabotabek, September 28, 1995 (in Indonesian language).

Bondzio L. (1996) Study of Airport Choice and Airport Access Mode Choice in Southern Germany. **Proceeding of European Transport Conference PTRC 1996.**

Dimitriou, HT.(1993) **A Developmental Approach to Urban Transport Planning: An Indonesian Illustration,** Oxford University Press, Kualalumpur, 1993.

Fan , KS, Eric J Miller and D. Badoe (1993). Modeling Rail Access Mode and Station Choice. **Transportation Research Record 1413,** 49-59.

Furuichi, M and Koppelman, FS. (1994) An Analysis of Air Travelers' Departure Airport and Destination Choice Behavior, **Transportation Research-A, Vol. 28A, No. 3**, 187-195.

Harvey, G. (1987) Airport Choice in a Multiple Airport Region, **Transportation Research-A, Vol. 21A, No. 6**, pp. 439-449,1987.

Holik, A.(1990) Study on Traffic Operation in Arjosari Terminal's Area Nearby in Malang Municipality, Unpublished Thesis, Brawijaya University, Malang, (in Indonesian language).

Kristiadi, J.B. (1987) Financial Aspects in Urban Development, **Prisma No. 1**, 26-36. (in Indonesian language).

Monteiro, ABF and Hansen M.(1996) Improvements to Airport Ground Access and Behavior of Multiple Airport System: BART Extension to San Francisco International Airport, **Transportation Research Record 1562**, 38-47.

Mukundan, S., CY Jeng, GW Schultz and JM Ryan (1991) An Access Mode and Station Choice Model for the Washington DC Metrorail System. **Proceeding of 70th Annual Meeting of the Transportation Research Board,** Washington DC.

Soenarman, J.(1995) Evaluation on Relocation of Grogol Terminal and Kalideres Terminal to Rawabuaya Terminal, Jakarta, Unpublished Thesis, Tarumanegara University, Jakarta (in Indonesian language).

Talvitie, A. (1992) Disaggregate Choice for Rail Riders' Access Mode and Station. **Proceeding of 71th Annual Meeting of the Transportation Research Board,** Washington DC.

Windle, R and Dresner, M. (1995) Airport Choice and Multiple-Airport Regions, **ASCE Journal of Transportation Engineering, Vol. 121, No. 4**, 332-337.