BOARDING PLACE AND ACCESS MODE CHOICE ANALYSIS OF INTERCITY BUS PASSENGER: A CASE STUDY OF PROBOLINGGO CITY, INDONESIA*

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1. Introduction

Intercity bus dominates intercity transport modes in Indonesia; therefore, intercity bus terminals have an important role to serve transfer passengers among intercity and intracity modes. The word "terminal" in this paper means not only "end-terminal" (terminal for start and end of intercity bus) but also "transit-terminal" (terminal for stop or transfer to different modes or routes). Dimitriou[1] pointed out that there has been a growing tendency for city's local government to relocate the intercity bus terminal from city center to urban periphery. 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. Data show that during the last decade, 19 out of 45 bus terminals in East Java Province alone have already been relocated, while six others have been planned to be relocated.

Some researchers [2)-3)] 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. The fact that bus terminal relocation caused more inconvenience to intercity passenger, leading to reduce the use of intercity bus terminal by utilizing informal transfer place, suggested the need to study the intercity bus passenger behavior. 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[4]. 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, [5] 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 implications of scenarios on intercity bus terminal location. Despite the important role of intercity bus terminal in developing countries, no research has been undertaken to overcome complex problems of locating intercity bus terminal in fast growing intermediate city of developing countries. 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. Rather than be eliminated, informal boarding place should be formalized and accommodated in existing urban and intercity transport system.

2. Intercity Bus Boarding Place and Access Mode Choice Model

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[6)-10)]. 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. Most of researchers, who studies airport choice, use market segmentation based on trip purpose[6) 8)]; while others add status of resident grouping [7) 9)]. However, Augustinus and Demakopoulus[11] conclude 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.

It is believed that if behavioral models on intercity bus boarding place choice and access mode choice could be built, it would be useful for determining the optimum location of new bus terminal. The behavioral model employed in this study is based on stochastic choice using the hypothesis of random utility maximization. The fact that travel behavior in transport researches in Indonesian cities 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 applied because it exploits the ease with which nested logit model partitions into a product of distinct multinomial logit models[12]. In this study, researcher applies the nested structure by assuming that boarding place choice as an upper level choice and access mode choice as a lower level choice. The utility function is given as:

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$$U_{bm} = V_b + V_m + V_{bm} + \varepsilon_b + \varepsilon_{bm} \quad \ldots\ldots (1)$$

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)

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:

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

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:

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

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

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

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:

$$\mu_b / \mu_m \leq 1 \quad \ldots\ldots (5)$$

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:

$$Pi(m,b) = Pi(m \mid b).\ Pi(b) \quad \ldots\ldots (6)$$

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 1 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.

Revealed preference survey has been conducted by using a choice-based sampling. 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. Direct interview to departure passenger was conducted in the bus terminal and three informal boarding places. Respondents were also 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 180 (36.1%), while the number of intracity minibus user is 398 (79.8%).

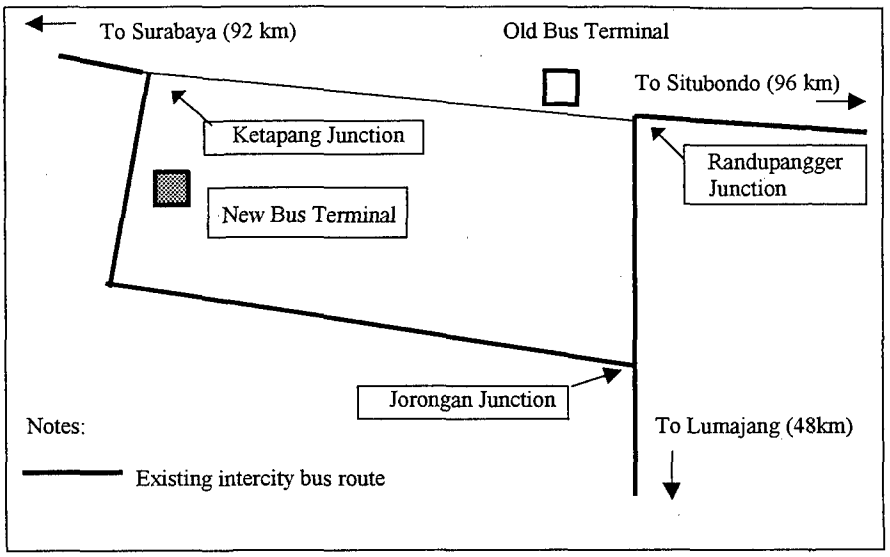

Figure 1. The Sketch of Intercity Network and Informal Boarding Place Location in Probolinggo City

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. An additional survey was conducted to collect specific data such as intracity and intercity minibus headway, passenger share among boarding place, and access mode share to boarding place. Intracity minibus in this city have a flat fare system, therefore intracity minibus was dominantly used (80%).

4. Model Estimation

Using the 499 samples, data relevant to this study such as: street origins, access distance, in-vehicle access time, access cost, transfer time, waiting time and transfer cost were checked whether 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 is taken as out of pocket cost, in which private vehicle user cost is counted as gasoline cost only, while becak user cost is calculated based on average cost per unit distance, and minibus is a flat fare (300 rupiah). Transfer time and waiting time for alternative boarding place were calculated using average reported value for specific boarding place, while difference in intercity bus time was computed through measuring the distance on a map and the 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 all hypothetical variables were independent between each other. Several numbers of specifications for the model have been tested. For conditional access mode choice model, access cost was found to have a positive sign and low t statistic, so it was dropped. 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. When all hypothetical variables were included in the model, it was found that some parameters have a low t statistic, although some of them have a correct sign. These parameters were transfer cost, education level, dummy resident and dummy female. The variables and their definition for final model development is shown in Table 1. The conditional access mode choice model is given as Model C1 in Table 2, while the marginal intercity bus boarding place choice model is presented as Model M1 in Table 3.

5. Discussion of Result

(1) Statistical Performance

All of the estimate parameters included in conditional 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 walk. The likelihood ratio that was calculated against L (c) shows that it 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 in the model that influencing the use of private vehicle and minibus.

In marginal boarding place choice model M1, all estimate parameters are significantly different from zero at 95% confidence level, except 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 informal boarding place appears to have attractiveness that is not represented in the explicit variables of the model.

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 1 (the t-test = 0.327). This implied 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 1. This result indicating that in the study area the intercity passenger may think the two decision level (boarding place choice and access mode choice) simultaneously, instead of sequential as proposed before.

Table 1. Description of variables in access mode choice and intercity bus boarding place 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

Table 2. Result of Estimation on Conditional Access Mode Choice Model

No.	*Variables*	*Model C1*		*Model C2*	
		Estimate	*t-value*	*Estimate*	*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)
	Summary Statistics				
	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 3. Result of Estimation on Marginal Boarding Place Choice

No.	*Variables*	*Model M1*		*Model M2R*	
		Estimate	*t-value*	*Estimate*	*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	
	Summary Statistics				
	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	

(2) Policy Variables

Access travel time was found to be the determinant factors of access mode choice. It is interesting to found that passenger put the same weight for access travel time by using private vehicle and walk, this is because both are consider to be more privacy compared with minibus and becak. Moreover, passenger felt that access travel time using becak is more undesirable than other modes (doubled of access travel time in minibus and triple of access travel time in private vehicle and walk). 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 have flat fare system. The major determinant factors of intercity boarding place choice is out of vehicle time and difference in intercity bus time. Based on comparison of estimate parameter it can be seen that out of vehicle time is relatively weighted more than difference in intercity bus time. It can be concluded that effort to reduce out of vehicle time and difference in intercity bus time would be desirable to increase the attractiveness of intercity bus terminal.

(3) Trip Characteristic and Socioeconomic Variables

The conditional access mode choice shows that several trip characteristic and socioeconomic variables are affecting the access mode choice, these are income level, luggage, age, resident and access distance. Those passenger whose their household income is more than 300,000 rupiah have the same preference in using private vehicle, minibus or becak, as model estimation stage found that their separate estimate was not significantly different. Hence, it can be inferred that higher income people will less likely to walk. Due to limited space for luggage provision in minibus, it is statistically proofed that if the ratio of luggage per passenger is greater than one, he or she will tend to use becak. Life style is also affecting the choice of access mode, in which younger people prefer not to use becak, since becak have an image of conventional modes of transport. Furthermore, the better the knowledge of minibus service have influence the city's resident to choose minibus than the non-resident. Finally, the use of minibus and private vehicle will more likely take place if access distance is greater than 6 km.

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

(4) Effect of Intercity Distance

Importance of access mode and boarding place's level of service is not necessarily to be the same for all travel conditions. In particular, access travel time sensitivity may well vary with the overall length of the journey. This hypothesis 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). The result is shown as Model C2 in Table 2 and Model M2R in Table 3, which is estimated by fixing the logsum to be one. In access mode choice model it was found that the *t* statistic test for coefficient differences[12] were 0.898, 4.232 and 0.807 for access travel time using private vehicle and walk, minibus and becak, respectively. Therefore, only access travel time using minibus was significantly found to have different estimate for short and long intercity distance. The low percentage of respondent using private vehicle, becak or walk may become the cause of insignificant difference here. In addition, similar test for boarding place choice has resulted that the t-statistic test values were 0.428 and 3.402 for out of vehicle time and difference in intercity bus time, respectively. The out of vehicle time was not found to be different, because it is clear that there is no different service for short and long distance intercity passenger, either in bus terminal or informal boarding place. As a conclusion, the effect of access travel time specific for minibus and difference in intercity bus time is smaller for long distance traveler, possibly due to decreasing marginal disutility of access travel time and difference in intercity bus time as the intercity distance become longer.

6. Implications of Scenario on Intercity Bus Terminal Location

The results of behavior modeling have suggested at least three implications for intercity bus terminal development. First, because of 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 bus terminal, and such improvements must be oriented to an entire urban area. Secondly, since the short-distance passenger have been identified to have different consideration on boarding place level of service, this finding suggested the need to provide different terminal for short-distance and long-distance intercity bus. 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 best advantage.

In order to verify the usefulness of model developed in this study, three scenarios of intercity bus terminal location will be illustrated using sample enumeration as an aggregation method. The first scenario is the existing condition (base case), when the intercity bus terminal is located in urban periphery. Second scenario consider when the intercity bus terminal is located in city center, which is assumed to be in the old bus terminal location, while previous informal boarding place is taken as the one usually used before relocation. The third one is accommodating the finding in this study, by splitting the demand into two intercity distance services. It is assumed that the bus terminal located in city center serve those short-distance travelers, while the new urban periphery terminal serve long-distance passenger. In existing situation, there are two types of intercity vehicles: intercity bus and intercity minibus, each has different service depend on intercity distance. Hence, scenario 3 will propose intercity bus terminal and intercity minibus terminal located in urban periphery and city center, respectively. The result of analysis shows the difference in share among access mode and boarding place as can be seen in Table 4 below:

Table 4. Result of Scenario Analysis on Difference of Access Mode and Boarding Place Share

	Scenario 1: Urban periphery bus terminal		*Scenario 2: City center bus terminal*		*Scenario 3: Two bus terminal*	
Access Mode	*Terminal*	*Junction*	*Terminal*	*Junction*	*Terminal*	*Junction*
Private vehicle	1.9	3.5	1.4	1.7	1.8	1.9
Minibus	28.8	51.0	31.1	35.4	34.5	38.3
Becak	3.0	5.4	9.3	10.7	7.1	7.8
Walk	2.3	4.1	4.8	5.5	4.0	4.5
Total	36.0	64.0	46.6	53.3	47.4	52.5

Note: Value is in percentage

By applying model to the samples collected in this study, several points concerning the difference in access mode and boarding place share can be pointed out. Those who own a private vehicle will most likely to use it in scenario 1, since the location of bus terminal and informal boarding place is far from their origin of trip. The same tendency can be inferred from the percentage of minibus user, which is highest in scenario 1. Therefore, in term of motorized traffic, scenario 1 resulted in high utilization. In contrast, the role of non-motorized (becak and walk) is relatively high in scenario 2, but as there is no special lane for becak and proper pedestrian path these may increase the traffic congestion. Moderate share in access mode can be observed in scenario 3. In term of terminal utilization, at least it can be said that scenario 2 and 3 is better than scenario 1, as the percentage of user is about 10% higher. It can be identified that the share of junction as an informal boarding place is relatively still high in all three scenarios. The result support the third implication discussed above, which can be done by formalizing the informal boarding place (building a shelter and providing a bus bay in order not to interrupt the traffic flow). However, it is unreasonable to judge these three scenarios by taken only the passenger's point of view, therefore the local government preference should be taken into account.

As already stated at the beginning of this paper, there are several objectives of intercity bus terminal relocation. These 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. Based on those four objectives, the implication of three scenarios can be analyzed. However, to make it more objective, the construction cost should also be considered. Here, the construction cost will be accommodated in financial aspect, together with local government revenue. As quantitative data is not available, Table 5 shows the most likely implication of the three scenarios on the local government goals.

Table 5. Qualitative Implication Analysis of Three Scenarios on Intercity Bus Terminal Location

No	*Item*	*Scenario 1: Urban periphery bus terminal*	*Scenario 2: City center bus terminal*	*Scenario 3: Two bus terminals*
1	Financial			
	- Construction cost	Low	Moderate	High
	- Local government revenue	Low	Moderate	High
2	City Traffic Congestion	Low	High	Moderate
3	Urban Development	High	Low	High
4	Terminal Capacity	High	Low	Moderate

The discussion on financial aspect is one of the most important factors that affecting the decision of local government to improve the service of intercity bus terminal. Scenario 1 shows that the construction cost of bus terminal is relatively low as land is available and is most likely cheap, but as the model suggest the number of user will be low. As revenue from transfer cost, which is charged to intercity passenger, will depend on the number of passenger, hence the revenue may also become low. In scenario 2, the expansion of existing city center bus terminal may face some difficulties due to limited land availability and expensive land cost. The construction cost of scenario 3 may become the highest, as two terminal should be provided. In term of traffic congestion, some researchers[13)-14)] support the urban peripheral as a location of intercity bus terminal, in order to reduce traffic congestion in city center. However, the total number of vehicle trips may increase as already discussed that the motorized traffic is high in scenario 1. As a result, either scenario 1 or 3 although may reduce the traffic congestion in city center, but it will spread to all over the city, which might be a burdensome when private vehicle ownership is high in the future. Though the effect of existing relocated intercity bus terminal on urban development seems to be low, compared to scenario 2; scenario 1 and 3 could be expected to have higher impact. The terminal capacity is also one of the most cited reason of relocation[3) 15)] , hence it is important to discussed. The terminal land in urban periphery may spacious to accommodate large amount of parking bus. In fact, if Provincial Traffic Bureau (DLLAJ) willing to regulate the interval time between arrival and departure of intercity bus, there is no need to provide large parking space for intercity bus.

The research here is not attempted to propose which one is the best scenario, because it is clear that the best decision is depend on many other factors that may not included in this analysis. However, if local government will relocate intercity bus terminal, at least two factors have to be considered. First, whenever possible improvement of existing bus terminal should be taken as one of the alternative. For longer term, restraining private vehicle in city center while improving public transport service may result in better situation. In financial aspect, it is better to have private sector to operate the bus terminal together with commercial center, which may give higher revenue to local government. Second, if bus terminal have to be relocated, the introduction of intracity minibus which serves all part of the city should be done, at least to maintain the same access time to bus terminal. Moreover, the intercity bus route should be designated so it will pass the road that is far from city center. In addition, it should also minimize the use of the same road with intracity minibus, in order to reduce the possibility of new informal boarding place.

7. Conclusions

This research shows that the model was reasonably successful in providing an understanding of the factors affecting the use of access mode and boarding place. In terms of a somewhat broader conclusion, discrete choice models provide an excellent means of understanding and analyzing the boarding place and access mode choice. The important factors that affecting the use of access mode is access travel time, while in the case of boarding place are: out of vehicle time (transfer time and waiting time) and difference in intercity bus time. It is found that short distance traveler is more sensitive to access travel time and difference in intercity bus time than long distance traveler.

Secondly, the model has been applied to analyze possible implication of three scenarios on intercity bus terminal location. The model can be used as an evaluation tool for decision-maker to select which policy should be adopted to improve the intercity bus terminal service for passenger. Furthermore, this study shows that the share of informal boarding place is relatively high in any scenario. This result is unexpected, as there is no empirical previous study that explaining the important role of informal boarding place. With the high utilization of informal boarding place, it is recommended that local government should formalize informal boarding place by building bus stop to enhance the function of intercity bus terminal.

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.

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都市間バスターミナル利用者の乗車場所選択とアクセス手段選択行動の分析
～インドネシア、Probolinggo Cityをケーススタディとして～

アクマド ウィジャクソノ 室町泰徳 原田昇 太田勝敏

インドネシアの都市の中には、都市間バスターミナルが都心部から郊外部へ移転する例が見られるが、都市間旅行者にとっては利用しにくいものとなっている。本研究は、都市間バスの乗車場所選択と乗車場所へのアクセス手段選択モデルの構築により、それらの選択に影響を与える決定的な要因を明らかにした。乗車場所選択においては乗車外時間と都市間バス乗車時間の差が、アクセス手段選択においてはアクセス移動時間が、それぞれ重要な政策変数であることがわかった。また短距離旅行者は長距離旅行者と比較して、アクセス移動時間と都市間バス乗車時間の差に、より敏感に反応する。このモデルを用いて、ターミナルの配置に関する政策評価を行った。

BOARDING PLACE AND ACCESS MODE CHOICE ANALYSIS OF INTERCITY BUS PASSENGER: A CASE STUDY OF PROBOLINGGO CITY, INDONESIA

By Achmad WICAKSONO, Yasunori MUROMACHI, Noboru HARATA and Katsutoshi OHTA

In Indonesia, the relocation of bus terminal 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 and difference in intercity bus time. Shorter distance passenger was found to have higher sensitivity to access travel time and difference in intercity bus time than their counterpart. Three policy implications have been analyzed to verify the usefulness of model.
