Journal of the Eastern Asia Society for Transportation Studies, Vol. 6, pp. 467 - 479, 2005

IMPACT ON THE EXISTING CORRIDOR DUE TO IMPLEMENTATION OF NEW PUBLIC TRANSPORT CORRIDOR (CASE STUDY: JAKARTA BRT SYSTEMS)

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Abstract: The objective of this research is to analyze the impact of the implementation new public transport corridor to the existing corridor at network level. Jakarta BRT System is taken as a case study. The discussion is focused on the development of public transport network model and the operational plan strategies. The supply model consists of road network with its attributes and other traffic systems, while the demand model combines point-based origin-destination and zone-based origin-destination trip. Several strategies which consider service line, operational aspects, fare system, and integration concept were developed. The predetermined strategies were incorporated into the model, and then simulated. The results, in term of operational bus performance and demand magnitude were analyzed. Simulation to the model yields to different impacts on the existing corridor due to different strategies applied. This result leads to the adjustment of the operational aspects of existing corridor in order to obtain optimum benefit at network level.

Key Words: BRT, network, trunk, feeder, demand.

1. INTRODUCTION

Since last two decades, several transports studies for Jakarta has been carried out either funded by international loans or national or local budget plans. Although, some of those studies were conducted in very comprehensive manner and showed a very good recommendation, yet none of them was officially selected and determined as The Jakarta Transport Master Plan.

In other side, congestion problem in Jakarta is getting worse from year to year. There are several causes of this problem, namely misused of roadway space, capacity deficiency, high private car utilization, and low service of public transport system. So far, the development of transport system in Jakarta has been tended in the highway intensive, which yields to high private car utilization, and in the other hand the public transport system is left far behind. Yet, in the future, the government cannot afford to build more highways due to high land value and space limitation.

In the beginning of year 2004, through its Transport Master Plan, the government of DKI Jakarta initiated a strong commitment to develop and improve its public transport by implementing the first Bus Rapid Transit (BRT) corridor which connects Terminal Blok M to Kota. As in the Master Plan (Dishub DKI, 2004), DKI Jakarta will have 7 BRT Corridors by year 2007 and 15 BRT Corridors by year 2010. This plan seems to be too ambitious, nevertheless this reflects how serious the government in providing good public transport. Starting this year, the Government commences the infrastructure construction of the 2nd and 3rd BRT corridors, connecting Terminal Pulogadung to Terminal Kalideres, so by the end of year 2005 there will be 3 BRT corridors in operation.

The operation of the 1st corridor shows a very promising situation where from day to day the ridership increases gradually. Preliminary evaluation (JICA, 2004) shows that the ridership of Blok M-Kota BRT can reach 60,000 passengers per day. In term of Mass Transport, this figure can be considered low, yet from the existing capacity supplied this number is relatively high especially at evening peak hour. The study also reveals that there is quite significant shifting, around 14%, from private car user to this mode of transport, and this occurs only 4 month after its launching date. A recent study (CTS-UI, 2004) also found that there is an increase of this shifting phenomenon from 14% to 15%.

Referring to the aforementioned situation, the implementation of next two corridors will surely give impacts to the existing corridor. Therefore, this research aims to observe and analyze the impact of the new corridors to the existing one. In the following sections, the BRT network plan in Jakarta, model development, and simulation and analysis of scenarios fed into the model are discussed. The result of the simulation and analysis is concluded in the last section.

2. PUBLIC TRANSPORT AND FUTURE BRT NETWORK IN JAKARTA

Prior to the discussion on BRT network, it is important to know the existing situation of public transport in Jakarta. Until now, bus system is the main or act as the back bone of public transport in Jakarta. They consist of three types of buses, namely large bus, medium bus and small bus. Theoretically, they should form a public transport network system such as trunk and feeder system. But in reality, there is no such system, and those modes operate almost in the same corridors, or in other words they competes each other.

Figure 1 shows the existing bus network in Jakarta. In the context of fare system, there is no integrated fare system, so basically passenger has to pay each time he or she changes the mode. The existing fare system utilizes a flat fare for large and medium bus, and distance based for small bus.

Referring to the Jakarta Transport Master Plan (Dishub-DKI, 2004), in the first stage, there will be 7 corridors by the year of 200. The second stage will be 8 more corridors, consists of several new corridors and the extension of previous corridors, and will be implemented by the year of 2010. Basically, when all corridors are implemented, there will be 9 corridors that form the BRT network in Jakarta. Figure 2 shows the BRT network by the year of 2010. These BRT corridors will occupy almost all major roads in Jakarta. These corridors will be supported by feeder system, which is now being prepared. Therefore, in the future, the public transport network will form the trunk-feeder system and will be integrated in the context of fare system.

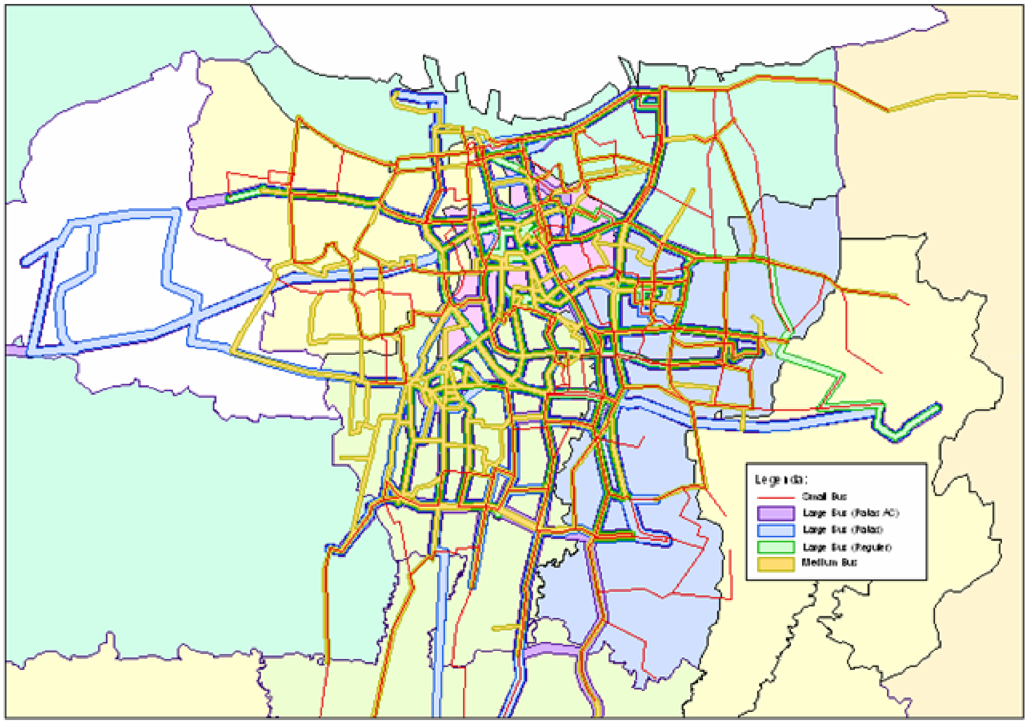

Figure 1. The Existing Public Transport Network

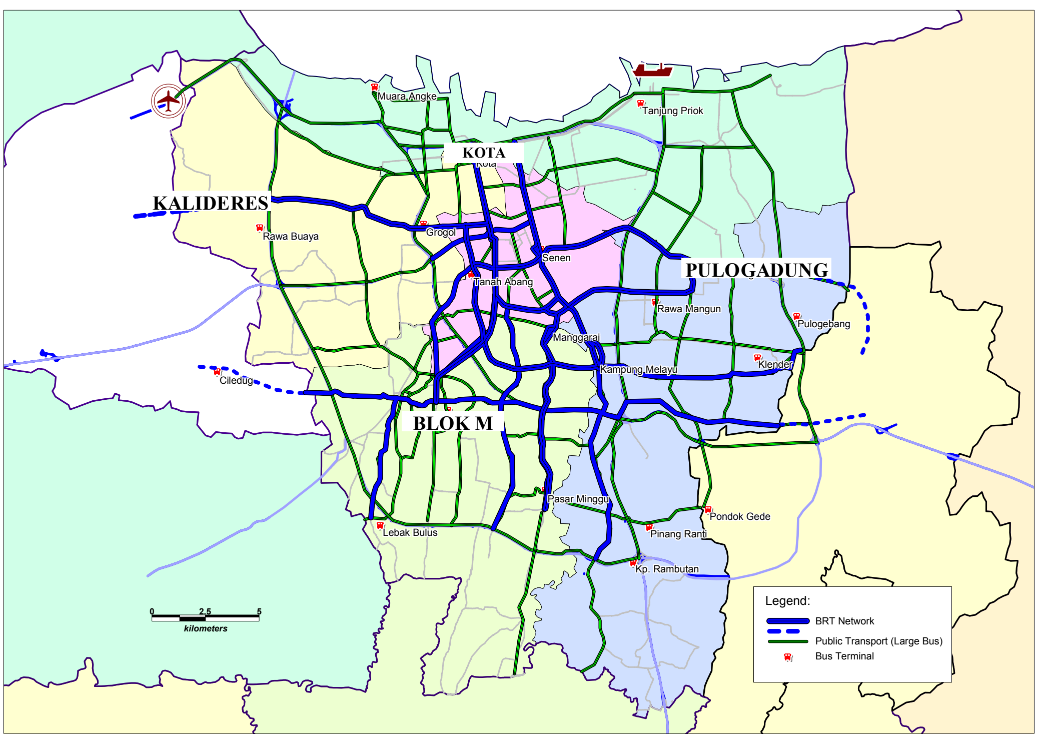

Figure 2. Jakarta BRT Network

The 1st corridor is officially operated in February 2004, the operational characteristics is presented in Table 1. Until this date, the average daily passenger is between 50,000 pax and 60,000 pax in both directions, or around 2,400 pax/hr/direction at peak hour, the actual travel time is around 45 minute per direction, and the average speed is around 20 km/hour. This corridor has two main terminals, in the southern part is Blok M terminal, which is one of the existing terminal for urban bus transport, and in the northern part is Stasiun Kota terminal, which closes to the main railway station. Between these two terminals, there are 18 shelters. This corridor is operated in a closed system, where ticket transaction is done prior to boarding the bus.

Table 1. Operational Characteristics of 1st Corridor (Blok M – Kota)

Number of Fleet	56 unit
Number of shelter	20 unit
Length of corridor	12,9 km
Time operation	05:00 AM – 10:00 PM
Fare	Rp1,500(05:00AM– 07:00AM) Rp2,500(07:00AM – 10:00PM)
Frequency	2 minutes at peak hour 6 minutes at off peak hour
Bus capacity	85 pax

Source: TransJakarta Busway

Figure 3. BRT at 1st Corridor

3. MODEL AND SCENARIO DEVELOPMENT

3.1 Model development

In order to analyze the impact of new corridor to the existing one, a transport supply-demand model has been developed. Basically, the developed model follows the conventional four step model. The supply model is focused only on public transport network which includes existing network and trunk and feeder lines, while the demand model is limited only for the public transport demand (captive demand). In general, as in the four-step planning, the research framework is depicted in Figure 4.

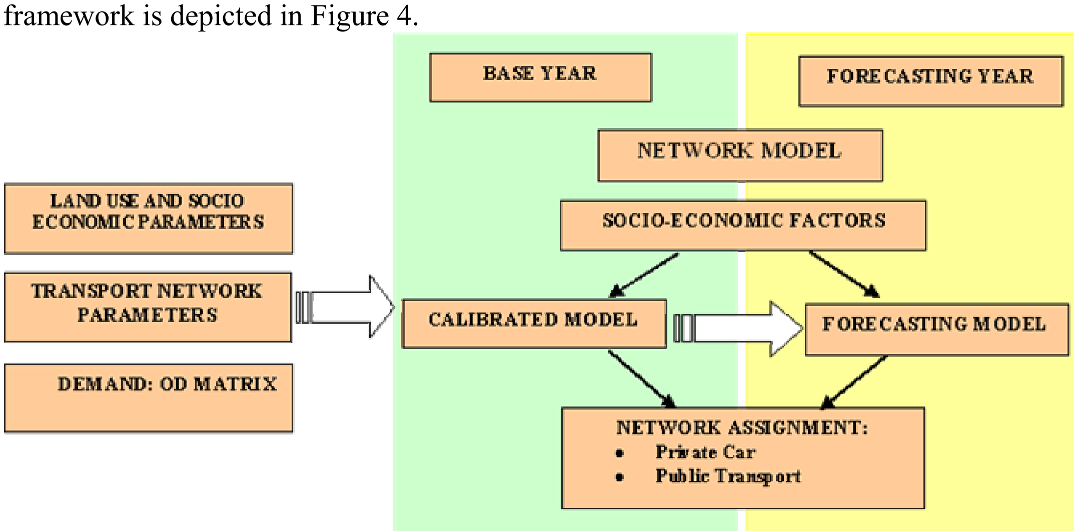

Figure 4. Research Framework

In this research, EMME/2 software version 10 (INRO, 2003) is used to facilitate the development both supply and demand model. The highway network data such geometric data, and links and node capacity is input into the transport network model, while public transport data such as, number of lines, line capacity, line headway, and type of mode is supplied into the public transport model. Figure 5 and 6 represent highway and public transport network model. Since the existing bus system operates in mixed traffic, these two models are necessary to be combined, in order to obtain the real bus performance represented in bus travel speed. While the BRT system operates exclusively on the designed BRT corridors.

Figure 5. Highway Network Model

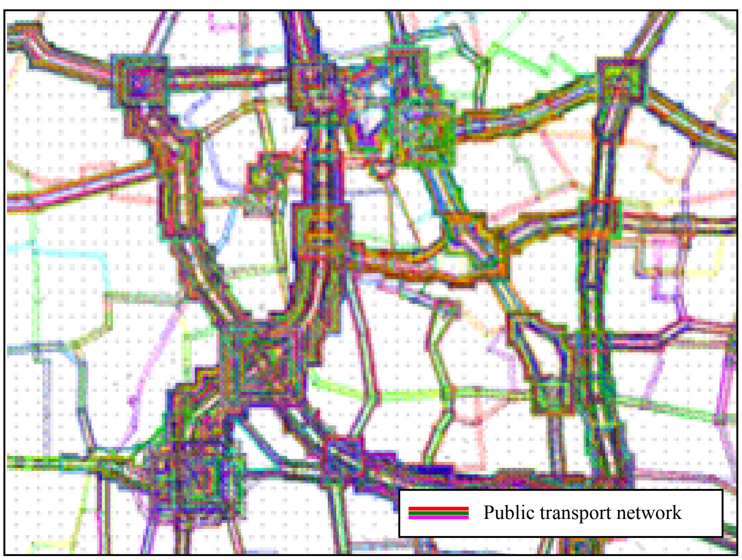

Figure 6. Public Transport Network Model

In the other side, the socio economic, land use, and trip characteristics data, especially for trip made by public transport, obtained from the recent Home Interview Survey (JICA and Bappenas, 2003) is utilized in the demand model. As illustrated in Figure 7, the assumption taken for demand model development are, private car user is in-sensitive to the change of public transport service and demand for the proposed BRT is those trip that shifted from the existing service.

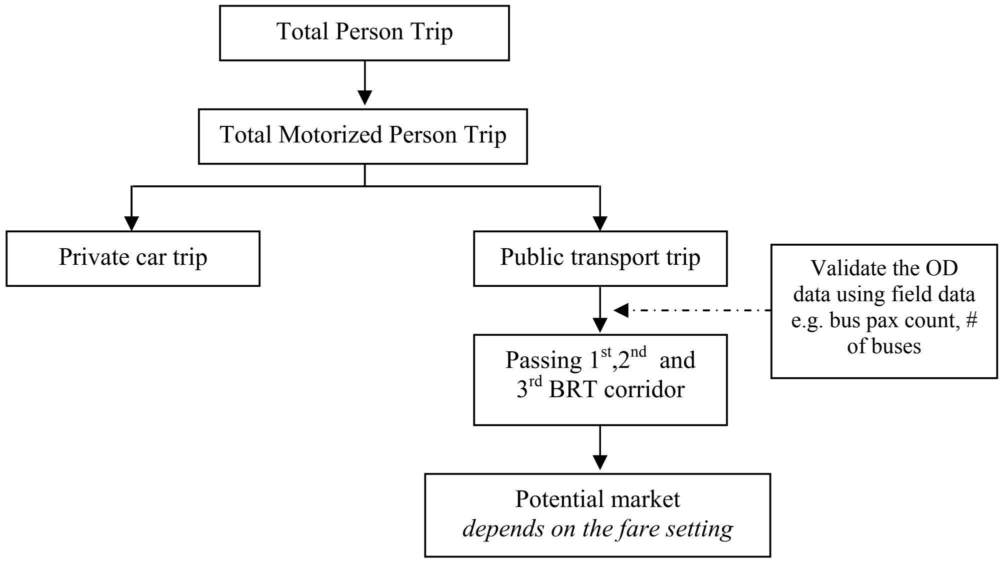

Figure 7. Demand Forecast Flow

Therefore, the O-D matrix used for the model is based on trip made by public transport only, which is obtained from O-D on board survey (Dishub-DKI, 2004) and from JICA Home Interview Survey (JICA and Bappenas, 2004).

Figure 8 and Figure 9 illustrate the desire line between 3rd and 1st corridor and the desire line between 2nd and 1st corridor respectively. These desire lines represent trip pattern or interaction between zones passed by the three corridors.

The standard transit assignment model implemented in EMME/2 is based on the concept of optimal strategies (INRO, 2003). The model denotes a transit network which consists of a set of nodes, and a set of transit lines. The node is defined as a sequence of nodes at which passengers may board and alight, and a set of walk links. The times (or costs) associated with each walk link and each segment of a transit line are constant and known, and the distribution of inter-arrival times of the vehicles at each node, served by a line, is also known. Assuming that the rate of arrival of the passengers at each node is known, the distribution of the waiting time for a vehicle for a given line can be constructed. Hence, the combined expected waiting time for the arrival of the first vehicle and the probability of each line arriving first, among any given set of lines passing at the same node, can be calculated.

The transit line performance function utilized in the model is represented by the generalized costs. This function reflects the applied tariff, dwell- time, headway, delay, and travel speed for each type of service. The average value of time adopted from the SITRAMP study (JICA and Bappenas, 2004), is equivalent to Rp 2710/hour. Thus, the applied tariff for particular transit lines can be converted to 'time', and is weighted combined with total travel time to represent "generalized costs".

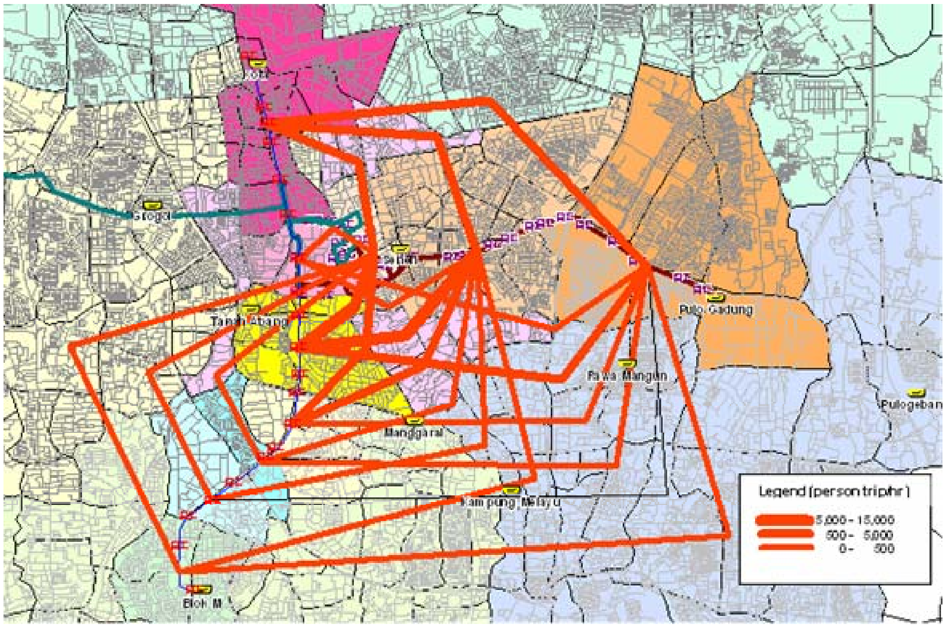

Figure 8. Trip Interaction between 2nd and 1st Corridor (AM Peak, Eastbound)

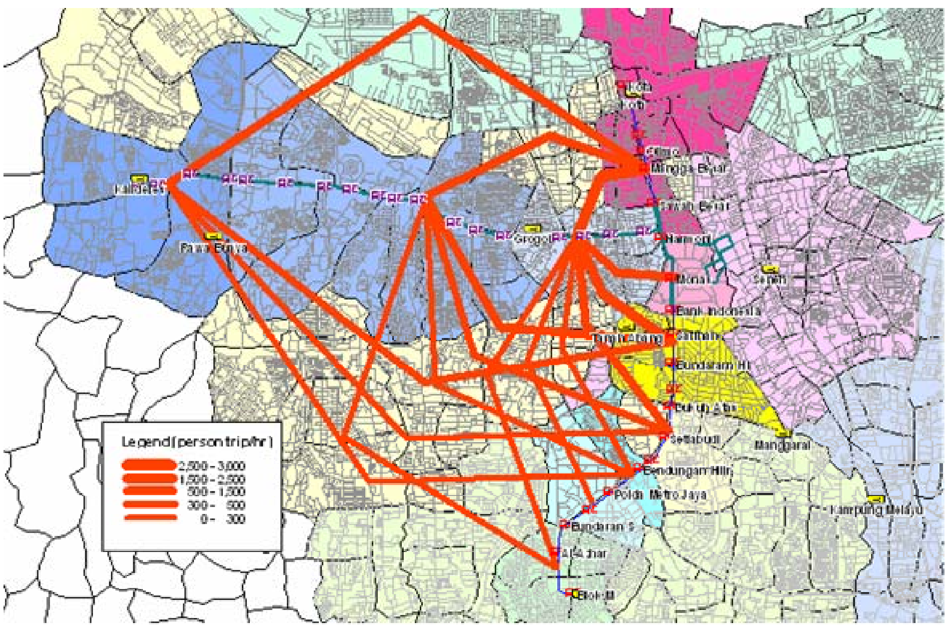

Figure 9. Trip Interaction between 3rd and 1st Corridor (AM Peak, Westbound)

3.2 Model Validation

Figure 10 and Figure 11 represent the initial simulation on the existing bus network and the 1st BRT corridor respectively.

Prior to the forecasting stage, a validation process is carried out. This step is conducted by combining the supply and the demand model at the initial simulation for the existing situation. Both the existing network model and the BRT model for 1st corridor are validated. The parameter used for comparing predicted result and the actual condition is the number of passenger per hour passing at certain selected points. Figure 12 represents the location of validation point for the existing bus.

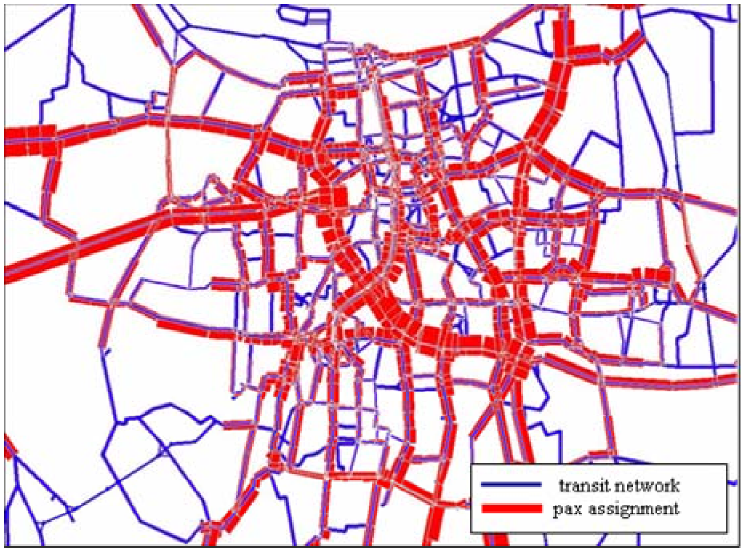

Figure 10. Initial Simulation on Bus Network

Figure 11. Initial Simulation on 1st BRT Corridor

Table 2 shows the result for the BRT system at peak hour. Table 3 presents the comparison of the predicted number and the observed passenger passing on the selected points. From Table 2 and Table 3, it can be concluded that the model is considerably good enough since the difference between model and actual figures is less than 10% in average.

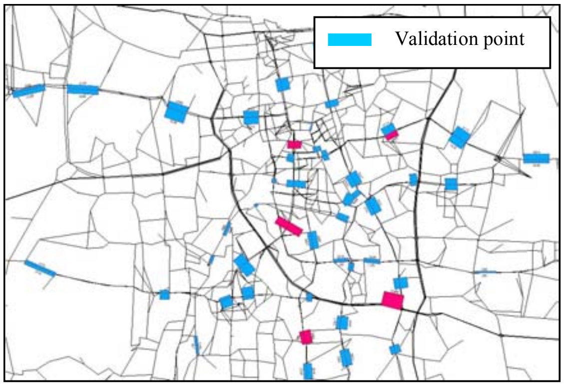

Figure 12. Validation Points

Table 2. Blok M-Kota BRT Passenger at Peak Hour

Lines	**Number of pax (pax/hr)**	
	Observed	**Model**
Blok M - Kota	2243	2310
Kota - Blok M	1417	1397

Table 3. Validation Results (pax/hr) of BRT

POINT CODE	OBSERVED	MODEL	%DIFF	POINT CODE	OBSERVED	MODEL	%DIFF
P46A1	4,301	4,807	12%	P59A1	2,627	2,468	6%
P46A2	2,228	1,984	11%	P59A2	4,475	4,567	2%
P51A1	1,733	1,983	14%	P63A1	2,378	2,589	9%
P51A2	3,367	3,749	11%	P63A2	3,360	3,522	5%
P52A1	1,502	1,725	15%	P64A1	5,293	5,346	1%
P52A2	1,830	2,037	11%	P64A2	3,969	4,055	2%
P53A1	3,995	3,891	3%	P65A1	1,378	1,468	7%
P53A2	3,477	4,145	19%	P65A2	1,156	1,117	3%
P57A1	3,025	3,176	5%	P69A1	1,862	1,999	7%
P57A2	4,136	4,581	11%	P69A2	2,392	2,624	10%
AVERAGE							8%

3.3 Scenario Development

Consideration of several aspects is undertaken in developing the scenarios. The considered aspects are as follow; the alternatives of 2nd and 3rd corridor routes, the existence of feeder lines, the existing bus service, the designated speed, headway, and fare system. Several possible alternative routes have been identified for the new corridors, but there are two most promising routes are selected for the research purpose, as shown in Figure 13 and Figure 14.

At the initial simulation, operational characteristics of BRT system have to be determined first. Table 4 summarizes the designated characteristics of the operational BRT systems for the simulation purpose.

In general there are two main scenarios namely;

- *DO-NOTHING* scenario, where corridor development is focused only in adding new service (e.g BRT corridor), while the existing situation is maintained. There is no fare integration between BRT corridors, hence the BRT route operates only in its corridor. This scenario represent the very basic condition.
- *DO-SOMETHING* scenario, where the corridor development is accompanied by restructuring or eliminating the existing competing transit service, and fare integration between BRT corridors.

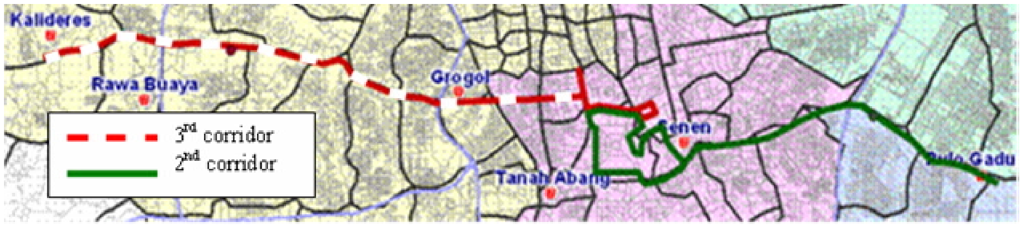

Figure 13. 1st Alternative Route of 2nd and 3rd Corridors

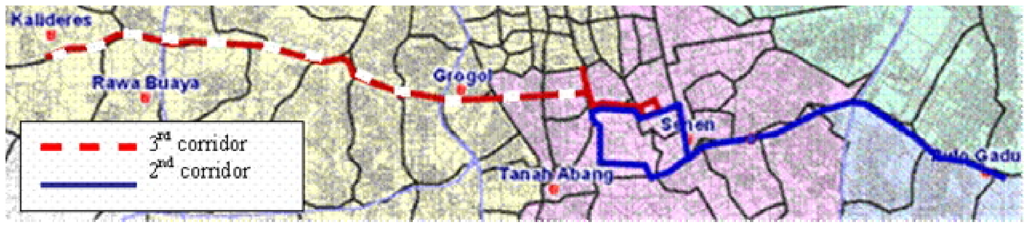

Figure 14. 2nd Alternative Route of 2nd and 3rd Corridors

Table 4. Designated Operational Characteristics of BRT Systems

Parameter	Unit	Value
Average Travel Speed	km/hr	21
Headway in the corridor 1	minute	1.5
Headway in corridor 2 and 3	minute	3
Dwell – time	minute	0.3
Initial Tariff (*flat tariff*)	Rp	2500

More scenarios can be derived from the *DO-SOMETHING* scenario. These scenarios are developed by applying different tariff setting, and introducing integrated feeder service. The scenarios are:

- *DO SOMETHING-1* scenario, where different tariff setting is applied
- *DO SOMETHING-2* scenario, where the feeder service is applied with fixed integrated fare.

Having developed, these scenarios are then able to be simulated through the developed model.

4. SIMULATION AND ANALYSIS

In general, public transport movement resulted from the model shows that most trips around Jakarta vicinity is dominated by small bus, while that of in the center of Jakarta is dominated by large bus.

Simulation on Do-Nothing scenario with the existing tariff for both systems yields to low demand, especially on the 2nd and 3rd corridor (see Table 5). This is due to the inconvenience of the passenger that should pay more when they transfer from one corridor to the other, and furthermore, the existing service still exists, so this service competes with the new one. As consequences of this scenario, there is no significant impact to the 1st corridor in term of passenger per hour boarded due to the introduction of new corridors (see Table 2 and Table 5).

Table 5. Simulation Result of Do-Nothing Scenario
(Fare: Rp 2,500,-)

Alternative routes	Bus Performance				Demand (Low Prediction)				Demand (High Prediction)			
	Bus Headway (min)		# Fleet	Bus km	Pax/peak hr		Average LF		Pax/peak hr		Average LF	
	BM1	BM2			BM1	BM2	BM1	BM2	BM1	BM2	BM1	BM2
1st Alt	1.5	1.5	58	1,513	2,425	1,452	0.35	0.18	2,789	1,641	0.40	0.2
2nd Alt	1.5	1.5	58	1,513	2,358	1,493	0.34	0.18	2,731	1,661	0.42	0.2

Note: BM1 = Blok M-Kota direction
BM2= Kota-Blok M direction

While, simulation carried out on Do-Something scenario, as in Table 6a and 6b, shows that for Do-Something 1 at the existing fare, the demand on 1st corridor is almost doubled from the Do-Nothing scenario. This is considered very realistic situation, due to the integration of fare system between corridors and the partial eliminating of the competing service, so the attractiveness of this service is significantly increased. In this case, passenger who does long trip gains more benefit compared with passenger who does short trip, due to the fixed fare applied. Although demand on 1st corridor is significantly increased, but due to the increase frequency of service (i.e. headway is reduced from 2 minutes to 1.5 minutes), the load factor is still low, and consequently the fleet number is slightly increased compared with the existing.

In order to observe how sensitive the demand to the fare, simulation based on two tariff settings (i.e. Rp 3,000,- and Rp 3,500,-) is conducted, and the result is shown in Table 6a and 6b. In this research, the highest fare for simulation is adopted from the highest fare of the existing system that is Rp 3,500 for Patas AC. It is shown that for both direction, if bus fare is set at Rp 3,000,- demand is significantly declined about 28%, and if bus fare is set at Rp 3,500,- demand is decreased more than 50%. This figures show that the demand is quite sensitive toward the applied fare, so based on this, it is recommended not to increase the tariff more than Rp 3,000,-, unless several care are adopted in order to improve the service. While simulation on Do-Something 2 shows that there is a slight increase of the demand due to the contribution of the integrated feeder service. The fare adopted in the simulation is based on the existing integrated feeder tariff, Rp 2,900,- for the non AC service, and Rp 3,800,- for the AC service.

Table 6a. Passenger Demand of Do-Something Scenario (Low Prediction)

ALT	SCENARIOS	Fare (Rp)	BUS PERFORMANCE		LOW PREDICTION			
			BUS HEADWAY (min)		PAX/PEAK HR		AVERAGE LF	
			BM1	BM2	BM1	BM2	BM1	BM2
1st Alt	DO SOMETHING 1	2,500	1.5	1.5	5,041	3,940	0.73	0.48
		3,000	1.5	1.5	3,651	3,032	0.54	0.38
		3,500	1.5	1.5	1,131	785	0.43	0.30
	DO SOMETTHING 2		1.5	1.5	5,241	4,111	0.77	0.52
2nd Alt	DO SOMETHING 1	2,500	1.5	1.5	4,940	4,385	0.72	0.54
		3,000	1.5	1.5	3,421	3,011	0.55	0.50
		3,500	1.5	1.5	1,138	950	0.44	0.36
	DO SOMETTHING 2		1.5	1.5	5,470	4,628	0.78	0.57

Table 6b. Passenger Demand of Do-Something Scenario (High Prediction)

ALT	SCENARIOS	Fare (Rp)	BUS PERFORMANCE		HIGH PREDICTION			
			BUS HEADWAY		PAX/PEAK HR		AVERAGE LF	
			BM1	BM2	BM1	BM2	BM1	BM2
1st Alt	DO SOMETHING 1	2,500	1.5	1.5	5,797	4,492	0.84	0.55
		3,000	1.5	1.5	3,982	3,415	0.62	0.42
		3,500	1.5	1.5	1,225	912	0.49	0.38
	DO SOMETTHING 2		1.5	1.5	6,394	4,933	0.94	0.62
2nd Alt	DO SOMETHING 1	2,500	1.5	1.5	5,043	5,043	0.62	0.54
		3,000	1.5	1.5	3,228	3,228	0.52	0.50
		3,500	1.5	1.5	1,063	1,063	0.43	0.36
	DO SOMETTHING 2		1.5	1.5	6,783	5,600	0.97	0.69

Note: *BM1 = Blok M-Kota direction*
BM2= Kota-Blok M direction

From Table 6a and 6b, is also shown that the 2nd alternative route of 2nd and 3rd corridors yields to better potential demand increase for the 1st corridor, means that more revenue could be gained by the operator, while maintaining the operational aspects, and consequently the operational costs as well.

By maintaining the bus frequency, the minimum fleet number and bus-km is kept constant, but the impact, due to the increased demand, is on the average load factor. In Do-Nothing scenario, technically, the frequency can be reduced in order to optimize the bus occupancy, while reducing the operational costs. But this action should be carefully taken since it will have an impact to the demand.

5. CONCLUSION

The impact of new corridors to the existing corridor in Jakarta BRT system has been analyzed. If the new corridors are operated and the existing situation is maintained, the impact to the existing corridor is relatively not significant in term of demand. But if special care is taken such as integrating fare and providing feeder service, the demand on the 1st corridor is significantly increased. In order to maintain the performance, bus fleet and frequency on the 1st corridor should be adjusted. From two alternative routes of 2nd and 3rd corridors, the alternative route 2 yields better impact on the existing corridor.

ACKNOWLEDGMENTS

We would like to give our high appreciation to Mr. T. Wachi and JICA-SITRAMP Project which allow us to access and utilized SITRAMP database for the purpose of this research. Without their support and cooperation, this research would not be possible to be finished.

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