1. Preliminary Evaluation of Developing Closed Trunk-and–Feeder Network for Bus Rapid Transit (BRT) in Jakarta, Indonesia

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The effectiveness of Bus Rapid Transit (BRT) system in Jakarta depends on a well-functioning feeder system established by reconfiguring and integrating the existing bus routes which can not be done by incrementally cutting them. Learning from current attempts failure, it requires an optimized closed trunk-and-feeder network model along with regulatory reform model for the entire bus system. In this study, both models are preliminary developed and evaluated. The evaluation is basically to assess whether the existing condition of Jakarta will be adequate enough and/or will require substantial preconditions to make a closed trunk-and-feeder transit system: (i) functioning effectively for transit users and road users, and (ii) prompting minimum impacts to existing operators and bus crews who are considered to be imperative in ensuring the implementation of the network. Based on these evaluation measures, the network room of improvements and implementation preconditions are discussed.

Keywords: bus, public transit, trunk-and-feeder system, regulatory reform, evaluation

Introduction

The effectiveness of the new undergoing Bus Rapid Transit (BRT) system in Jakarta would be unsecured since within the corridors many overlapping bus routes. Some attempts have been made by the authority to reconfigure the routes, particularly those operating on the first corridor of BRT. Unfortunately, they have not functioning well.

Hypotheses

First, the comprehensive plan of concrete feeder network has not been available yet which led to incremental bus routes reconfiguration by cutting and rerouting existing bus routes which were developed without proper route planning. Thus, it is necessary to model the entire network integrated with the BRT network and evaluate its effectiveness for the whole system, transit users and road users in particular.

Second, the failure is mainly because of the lack of institutional arrangement. In the world, particularly developing countries, the establishment of BRT system often becomes a turning point to carry out a regulatory reform for the entire bus system. The process is not occurring in Jakarta's case.

If the network is changed and the institutional arrangement is reformed, there are at least two stakeholders that would be exceptionally affected by the change of the network, the bus operators and crews. Therefore, the impacts for them are also necessary to be examined.

Goal and Objectives

The study is aimed to evaluate the implementation of trunk-and-feeder transit system in order to reconfigure the existing bus routes and integrate them with the current BRT plan in Jakarta, Indonesia.

Based on the research questions, the main objectives of the study are:

1. Develop a set of scenario of trunk-and-feeder transit network to be integrated with the current BRT plan for Jakarta.
2. Asses the appropriate regime for Jakarta and propose an institutional framework.
3. Conduct preliminary evaluation on the network based on transit demand modeling results in terms of effectiveness and equity for transit users, road users, existing operators, and bus crews.
4. Identify network performance improvement points and implementation preconditions.

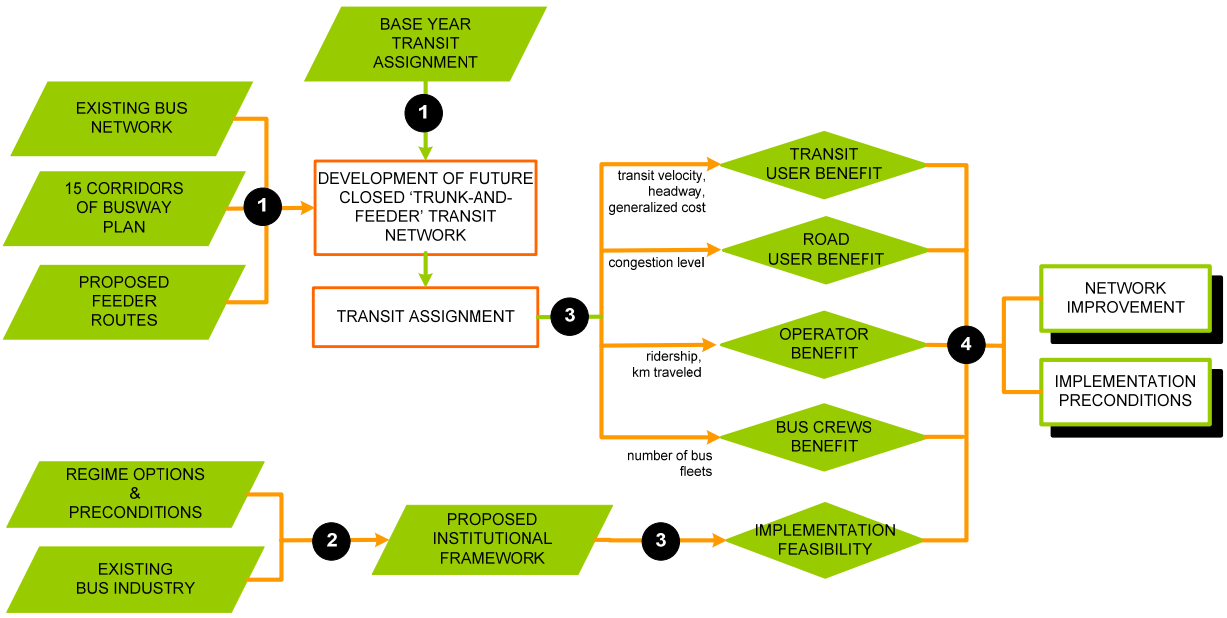

Figure 1 – Study Framework

Methodology

Development Closed Trunk-and-Feeder Transit Network

The study begins with the development of trunk-and-feeder transit network which consists of:

1. ***Trunk lines*** along 15 (fifteen) corridors which are served by BRT system;
2. ***Feeder lines***
   (1) *Main feeder lines* which accommodate trips from the periphery of Jakarta to the main terminals[1] of BRT system. Trips from: (i) north area are connected to Kota, Ancol and Kalideres; (ii) south to Lebak Bulus, Blok M, Warung Jati, Ps. Minggu and Kp. Rambutan; (iii) east to Kalimalang, Pulo Gadung and Pulo Gebang; and (iv) west to Kalideres, Tomang, and Blok M.
   (2) *Intermediate feeder lines*[2] accommodate trips from areas both in the periphery and within Jakarta to BRT system stops.
3. ***Local lines*** accommodate trips with moderate demand in local roads in intercity or nearby suburbs.

To determine the lines, literature review on previous studies and current plan is carried out. The trunk lines are basically determined based on the fifteen planned BRT corridors. For the feeder corridors, the existing bus routes and current plan of feeder routes are also reviewed and partly referred to identify the potential origin and destination. The feeder routes are finally designed by referring the passenger flow resulted from existing transit assignment modeling process.

The principles of the routing are: (i) consider the existing bus routes and demand; (ii) Allow three times transfer at maximum; (iii) Feeder lines must not overlap within the BRT's corridors more than 25%; and (iv) the routings should not compete in the corridor in other parallel roads.

Afterwards, the trunk-and-feeder network developed for 2020 is evaluated through transit assignment modeling process iterative trials to obtain the optimal network which allows almost all zones connected with maximum three times transfer and minimum

[1] The main terminals are the existing bus terminals. So far, the probability to create new terminal location has not been examined.

[2] The transfer points for intermediate and local lines are basically determined by considering the transfer points proposed by Macro Transport Plan of Jakarta but some adjustments are made.

average interzonal generalized cost. Besides modifying the feeder routes, free transfer between the same modes, which means that the base fare is only applied to the first line taken, is also employed as one alternative. As a result, two scenarios of trunk-and-feeder network are compared: i) fifteen (as planned) corridors of BRT and 64 lines of feeder system without free transfer between BRT lines (option A); and (ii) fifteen (as planned) corridors of BRT and 64 lines of feeder system with free transfer between BRT lines (option B).

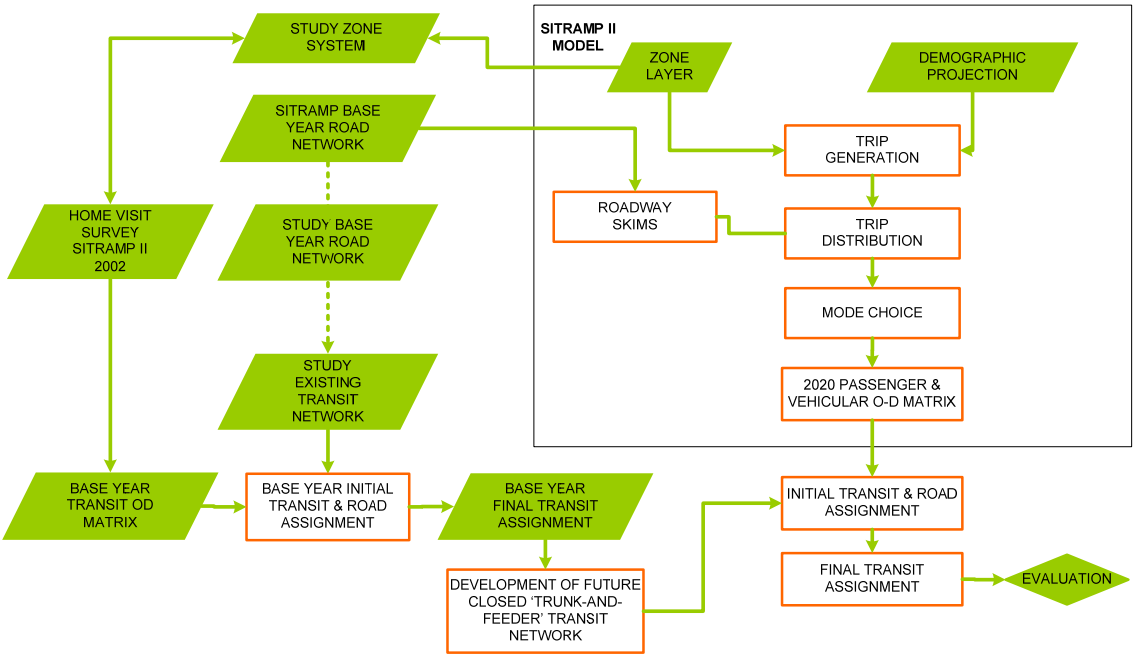

Figure 2 – Closed Trunk-and-Feeder Development Framework

Implementation Scheme

There are many options of regulatory reform experienced by countries in the world ranging from market initiative regime to authority initiative regime. The failure of the former regime and the deficiencies of the latter have led the trend to controlled competition style. The controlled competition is a system of contracting bus provision to private sectors. The system is the one with greatest complexity from the perspective of the authorities, organizational and regulatory framework. Nevertheless, the regime offers merits in answering Jakarta's problem.

There are three main objectives required to be addressed: (i) abolishing the patronage-based revenue sharing system to reduce competition on the road; (ii) augmenting government's capacity in regulating the service quality; and (iii) forcing the market into controllable size of operators.

For the first objective, gross-cost contract payment method should be applied. Here, the operators will be paid based on number of kilometers traveled per day multiplied by the average cost per kilometer. Probability of providing subsidy remains.

The second requires government's arm length in the tactical level to establish the detailed service design. Here, the government of DKI Jakarta represented by the DisHub plays its role as the Transport Authority who has the authority on the establishment of strategic policies. It cooperates with Transport Advisor Board (*Dewan Transportasi Kota*) in formulating and also controlling the implementation of policies.

To encounter the insufficient capacity of the government, three independent public corporations as government's arm's length are being established. They are transport planning company, bus fleet leasing company, and bus revenue collecting company. These companies are formed through negotiated arrangement and being provided with subsidy from the government based on the arrangement.

Transport planning company has the authority to plan and set the system design and conduct competitive tendering to select eligible operator companies to realize the pre-determined design. For Jakarta, BP TransJakarta can be one option that is being upgraded into a Transport Planning Company.

Bus fleet leasing company is a countermeasure for the purpose of abolishing not roadworthy buses operating at present, providing and maintaining the standardized ones as set up by planning company, and leasing them to feeder operators. For BRT the fleets should be procured by the operator company or the consortium. Using this approach, it is aimed to reduce barrier for feeder operators to make an entry to the controlled competition market and provide rooms for operators to deliver high quality service from other aspects of LOS.

The other arm length is revenue collecting company. This company is critical in employing gross-contract to provide the proper instruments to collect revenue and ensure the smoothness of financial flow from operator to government. This company consequently will bridge up different operators and integrate their fare system. The company could also be the mean to ensure transparency throughout the system.

There are some issues to be evaluated further: (i) number ridership and average number of kilometer traveled per day as operator's profit parameter; (ii) number of buses to be banned and compensated; and (iii) number of bus crews that must be redistributed and employed by the new operator composition resulted from the tendering process.

Evaluation Concept

The network proposed is evaluated through a transit assignment process to estimate how the network would likely satisfy the interests of transit users, road users, operators, and bus crews. The evaluation is conducted for three conditions: (i) current condition (existing transit demand and existing road network); (ii) future demand with existing road network; and (iii) future demand with expanded road network.

For transit users, the LOS of transit system is measured, particularly average velocity and headway representing reliability. Other measure that is quite important is the generalized cost, including total travel time, fare, and congestion factor. For road users, the impact of the transit network in improving road congestion is unquestionably one measure that should be evaluated. Finally, the network is evaluated from the implementation feasibility point of view, the three issues mentioned in the implementation scheme.

Results of Evaluation and Discussion

Proposed Network Performance

In the process of developing the network which is iteratively evaluated through transit assignment process, it is verified that the BRT corridors planned should be reassessed because some of them are too short and have insignificant riderships. It becomes disincentive for passengers to use BRT because they have to transfer for more than three times.

In terms of generalized cost, the proposed network is not optimum compared to the existing system. This is because many long trips are not accommodated by three transfers. Therefore, to improve the performance of the proposed network, some room of improvement is available as follows:

- Introducing direct express routes to accommodate long trips or extending BRT system to suburbs.
- Increase the service capacity and headway.

Effectiveness, Equity, and Implementation Feasibility Evaluation

The inputs of the evaluation are the result of transit and road assignment for each

scenario in terms of transit system LOS and road system performance as summarized in Table 1.

From the comparison, it can be concluded that the proposed network offers higher average BRT velocity. Unfortunately, the improvement in transit velocity does not affect the average velocity of mixed traffic since the congestion rate becoming more than twice larger because the rapid increase of car use and higher concentration of transit demands on BRT and feeder corridors which not entirely provide adequate road geometry.

In addition, in fact, to implement BRT system, the corridors should at least have six lanes for smooth operation and avoiding burden on mixed traffic. While for other roads, to accommodate feeders' movement, bus lane should be provided. Thus, the roads should be enhanced into at least standard four lanes.

Using the model, increasing the capacity of the fifteen BRT corridors decreases the congestion rate but the average speed remains. Further, the arterial roads are widened. The average speed increases until 7.8 km/hour. It indicates that highway expansion and a significant shift from car users to public transports are critically needed to improve the traffic.

The current BRT service, with 85 passenger capacity and 3 minute headway, is inadequate to load such ridership level of a closed trunk-and-feeder network as shown by the high level of congestion factor. Increasing capacity of vehicle into articulated buses and applying 1.5 minutes headway will reduce the congestion factor. This should also be applied to feeder buses, at least the same as current BRT fleets.

Nevertheless, it will add a new social cost. About at least 18,000 existing bus crews of 4,500 buses will lose their fleets. Based on the existing number of fleets operating (12,473 buses), at least, 24,946 to 49,892 bus crews must be redistributed and employed by the operator.

The average number of kilometer traveled per day based on the ridership is higher than the current condition, from 486 to 520. It can be positive bargain offered to the incumbents to participate in the reform.

Table 1 - Transit System LOS and Road System Performance Comparison

Network Scenario	Route Length			Avg. Headway		Avg. Speed		Interzonal Generalized Cost		System	
	Avg	Min	Max	Initial	Adj.	Mixed Traffic Bus	BRT	Only Regular Trip	Include Long Trip	Avg. VCR	Avg. Speed
APPROACH C (CURRENT)											
Base Option	11.94	1.4	33.95	7.13	5.76	23.6[1]	17.98[2]	2.18	2.27	0.77	14.8
Option A	9.46	2.08	20.79	4.30	1.51	12.7	29.29	2.15	3.22	0.73	9.1
APPROACH F (FUTURE) – EXSISTING NETWORK											
Option A	9.46	2.08	20.79	4.30	1.45	0.6	25.50	2.19	3.26	1.97	0.3
Option B					1.59			1.87	2.99		
APPROACH F (FUTURE) – NETWORK EXPANDED[3]											
Option A	9.46	2.08	20.79	4.30	1.45	9.2	28.59	2.16	3.23	1.53	7.8
Option B					1.61			1.84	2.96		

Note:
[1]Based on SITRAMP II travel speed survey, the existing mixed traffic bus average speed is 28.1 km/hour
[2]Based on ITDP (2005), the present situation of corridor 1 average speed is 17 km/hour
[3]By widening the road on fifteen corridors into 6 lanes road (94600 pcu/day) and widening the arterial roads into at least 4 lanes road (40400 pcu/day)

Free transfer arrangement obviously merits higher ridership. Without that, existing bus system will be more convenient for not having to do many transfers. To realize it, distance-based and integrated fare and ticketing system are needed. In the future, an integrated fare system between BRT and feeder or zone fare system can be applied.

The system is mainly a matter of institutional arrangement. However, the infrastructure should also be prepared, to facilitate the ticket distribution and payment and also to facilitate the physical transfers. Lack of both issue have failed the current attempt to integrate ticketing system.

Conclusion

Apparently, developing closed trunk-and-feeder transit network requires substantial preconditions that results in considerable costs even though the network is potential to deliver better service quality for transit users. The network itself also requires improvement to be able to provide better impact to the road users.

Furthermore, reconfiguring bus network in Jakarta is quite problematic since many vested interests involved. Two main interests that primarily considered are operators and bus crews who will be directly affected if the system changed, as evaluated previously. If the existing players can not be facilitated in the new system, it is certain that the social cost will be larger. The question is how much larger. This requires further cost-benefit analysis of the improved network which includes these intangible costs within the framework of evaluation.

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