Making TransJakarta a World Class BRT System

Final Recommendations of
The Institute for Transportation and Development Policy

under a grant from the

US Agency for International Development

For the
Livable Communities Initiative

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ITDP
Institute for Transportation & Development Policy

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I. EXECUTIVE SUMMARY

With this report, ITDP completes its technical assistance to DKI Jakarta under the US AID Livable Communities Grant.

TransJakarta has succeeded in building the first full Bus Rapid Transit system in Asia. It is currently moving some 65,000 passengers per day, and attracting some 14% of these passengers from private cars, 6% from motorcycles, and 5% from taxis. Shifting these 16,250 daily trips to bus trips has helped to reduce traffic congestion and air pollution in the TransJakarta corridor, and its has cut travel time for the majority of its passengers by a significant margin. The new sidewalks along Jl. Thamrin and improved pedestrian bridges in the corridor have given the city a cosmopolitan feel and converted a lot of short distance taxi and motor vehicle trips to walking trips, also reducing air pollution and congestion in the corridor. With the additional 27 kilometers of BRT in Corridor II and III, scheduled to open in January of 2006, the demand on the system will increase dramatically, to some 260,000 daily passengers. This will fundamentally improve Jakarta.

However, some urgent changes need to be made to improve the system before Corridor II and III open. The opening of Corridor II and III will bring a lot of additional passengers onto the system, and the current designs and plans will not be able to accommodate this level of demand. We share Jakarta's dream of making TransJakarta a World Class BRT system, and transforming Jakarta into a world class city. What follows is our modest contribution to help make this dream a reality.

I.1.Improving the Capacity of TransJakarta Corridor I.

Currently, Corridor I has a demand of 60,000 to 65,000 passengers per day, and around 2300 – 2500 passengers per direction at the peak hour (pphpd). At this level of demand, TransJakarta is already nearing capacity and passengers are complaining of overcrowding. The capacity of the current busway design in Corridor I is only 2700 pphpd, which is low compared to most other BRT systems. This compares unfavorably with other BRT systems around the world, like Curitiba and Quito, which have capacity of some 12,000 pphpd, and Bogota, with 35,000 pphpd.

In January of 2006, when the Second and Third Corridor of TransJakarta become operational, the maximum load on the critical links of Corridor I will rise to over 3600 pphpd, with daily demand in Corridor I rising to over 100,000 passengers per day. This will cause severe overcrowding and a further deterioration in service quality.

If the current bus routing plan is implemented, the most severe overcrowding will occur at the Harmoni Station, where passenger volumes will range between 5000 and 6000 passengers per hour. The current capacity of the Harmoni Station is only 1000 passengers per hour.

The main reason the capacity on TransJakarta is much lower than on other BRT systems is excessive boarding and alighting times at the stations. This problem cannot be solved by adding additional buses. Adding additional buses will increase capacity but slow bus speeds significantly if other measures are not simultaneously adopted.

This problem is primarily related to the fact that:

- Buses and bus stops have only one door, reducing boarding and alighting speed
- The size of the bus is small for a high volume BRT corridor.
- These problems are further aggravated by the control person, who stands in the doorway, impeding the speed of boarding and alighting

	Average boarding time (seconds)	Capacity (pass/h)	Bus stop time (seconds)	Speed (km/h)	Fleet (buses)
Present Situation	2.5	2700	45	17	60
Stop Interference from Security Person	1.7	3700	35	19	56
Bus with two doors	0.5	6000	22	21	51
With articulated bus	0.3	9600	18	23	26

While the simplest solution is to not have the security person stand in the doorway, this alone will provide only a small increase in the capacity and speed of TransJakarta Corridor I.

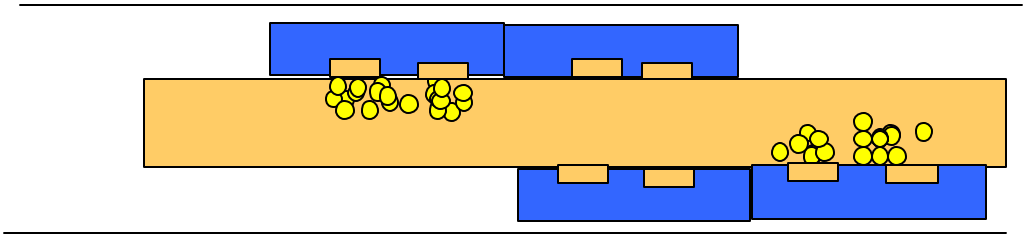
As a ***minimum*** Jakarta needs to make ***one of*** the following two changes in Corridor I if it is to avoid very serious capacity problem when Corridor II and III open.

- Immediately rebuild the stations to have at least two doors, one for entry and one for exit, and convert the existing buses to have two doors, **or**
- Add a second station stop at each stop, and a passing lane at each stop.

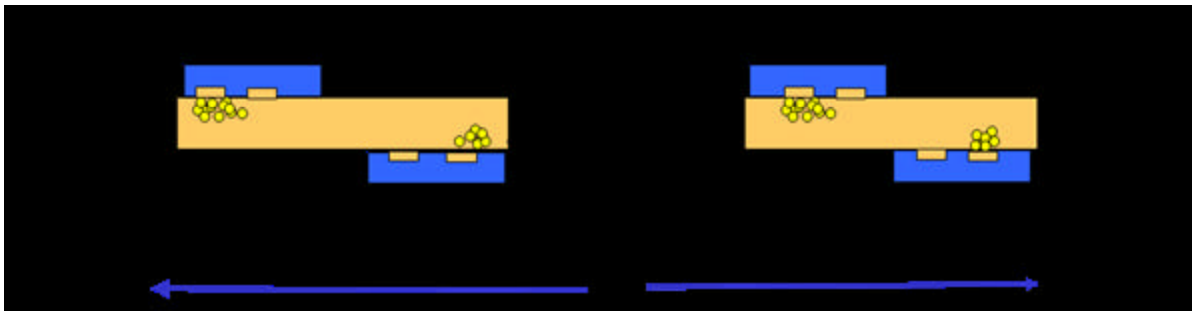
However, one of these two changes alone will only give TransJakarta Corridor I enough capacity to handle the demand of Corridor II and III. It will not be enough to handle the demand when Corridors IV, V, and VI open. While the demand will depend on the routing, ticketing system and design of these additional corridors, DKI Jakarta should consider making all the required changes in Corridor I at once rather than having to reconstruct the corridor again in 2008 or 2009.

For this reason, we suggest that DKI Jakarta change Corridor I in one of two ways:

- Immediately rebuild the stations to handle four-door articulated buses, and require all new bus procurement to be of articulated buses, as below, **or**



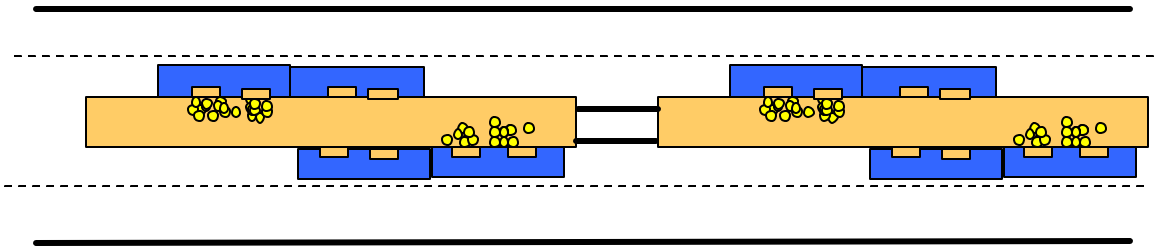
- Rebuild the stations and buses with two doors, add a second station platform at each stop, and add a passing lane at each stop, as below:



The primary advantage of moving to articulated buses with four doors is that you would not need to take an extra lane of roadway at the station stops, and could reach capacities in the 10,000 pphpd range. It should be noted, however, that the optimized routing for Corridors IV, V, and VI would give Corridor I a demand of 13,000 pphpd.

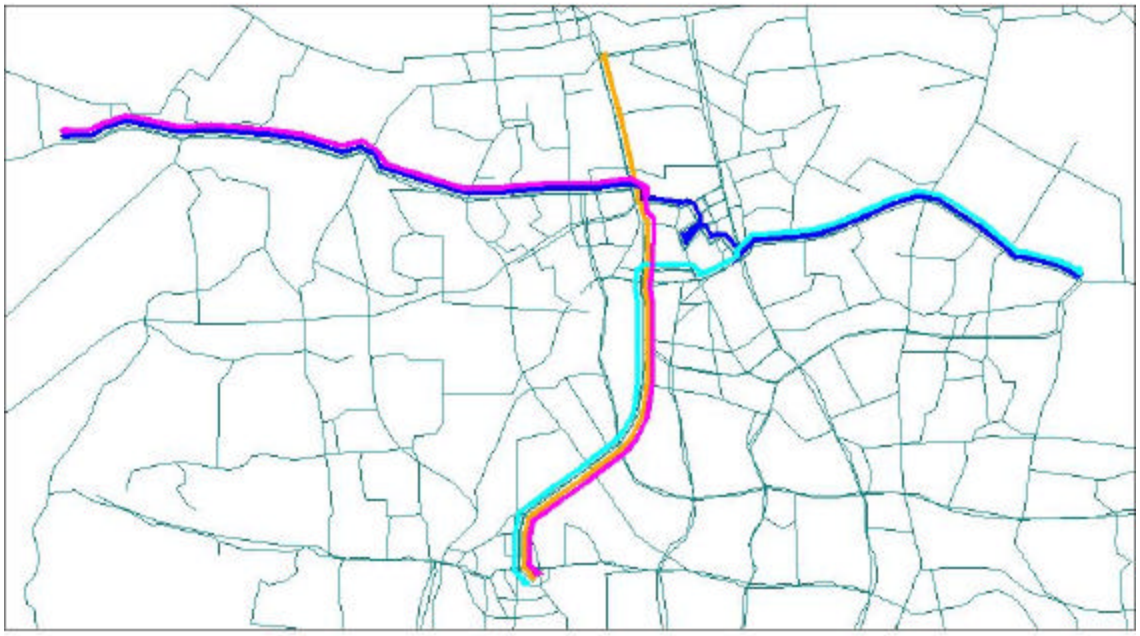
The advantage of using two door buses but adding a section station stop and a passing lane is that TransJakarta already has many buses that can be converted into two door buses for probably about $10,000, the headways between buses would be shorter, and the total capacity of this configuration would be higher than for the articulated bus option. We believe this configuration would be able to handle the demand after Corridor IV, V, and VI opens.

Alternatively, DKI Jakarta could already reconfigure Corridor I to the structure below, combining both the four door articulated buses, the passing lane, and the second station stop. This configuration would yield a capacity well over 20,000 pphpd, which would probably never have to be reconstructed.



The Harmoni Station is a special problem. The main problem is the current plan to have no direct service between Pulo Gadung and Blok M, and between Kalideras and Blok M. If all passengers traveling between Pulo Gadung and Blok M and between Kalideras and Blok M need to transfer at the Harmoni station, there could be as many as 6000 passengers transferring there per hour. The capacity of the Harmoni Station is currently only 1000 passengers per hour.

To avoid real chaos at the Harmoni stop, it is imperative that direct bus services be provided between Pulo Gadung and Blok M, and between Kalideras and Blok M. If these direct services are not provided, the entire BRT system will form gridlock at the Harmoni Station. We suggest the following bus routing options shown below:



Currently, the above bus routes are all possible under the existing physical plans, with the exception of the light blue line. For this route to be possible, an additional exclusive West-bound BRT lane would also need to be built between Senen and Bank Indonesia (light blue above).

This operating structure will reduce the number of transferring passengers at Harmoni to only 1600 per hour. If the other changes in Corridor I recommended above are made, the station should be able to handle this number of transfers.

Some other measures will also improve the capacity of Corridor I, such as tightening the exclusivity of the right of way at the roundabouts with police enforcement, expanding the exclusivity of the right of way between Blok M and Al Ahazar, modifying slightly the internal configuration of the bus, and improving the operation of the buses in the corridor so that the central control system forces them to carefully follow a timetable.

I.2. Improving Traffic Flow in Corridor I

The mixed traffic congestion in Corridor I is much worse than it needs to be, mainly because of four intersections:

- the Sisingamanga Raja/Trunojoyo Intersection
- Pintu/Besar/jem. Batu/Petongkangan (at Kota Station)
- Sissimangi Flyover
- Veteran/Hayam Wuruk/Harmoni/Pranoto

These intersections need to be redesigned and their signal phasing changed to improve their efficiency. Several other minor changes could be made in Corridor I to improve the flow of mixed traffic. Details are contained in the report.

If the bus routing is implemented as suggested above, and a two-directional bus way is constructed between Bank Indonesia and Senen along Medan Merdeka Selatan and Prapatan, the following intersection will also have to be carefully redesigned to accommodate the new bus turning movements:

- Jl. Thamrin/Medan Merdeka Selatan/Medan Merdeka Barat Intersection

I.3. Increasing the Capacity of Corridor II and III

When Corridors II and III open, both will carry over 2700 pphpd. As the designs for Corridor I have been largely replicated in Corridor II and III, and the capacity of Corridor I is only 2700 pphpd, Corridor II and III will be filled to capacity from the day it opens.

As such, it would be cheaper to modify the designs now before the system is actually built, than to wait until after they are constructed and then reconstruct them.

Demand in Corridor II and III will not initially be as high as in Corridor I. Simply adding a second door to each bus and each bus station should be enough to handle the projected

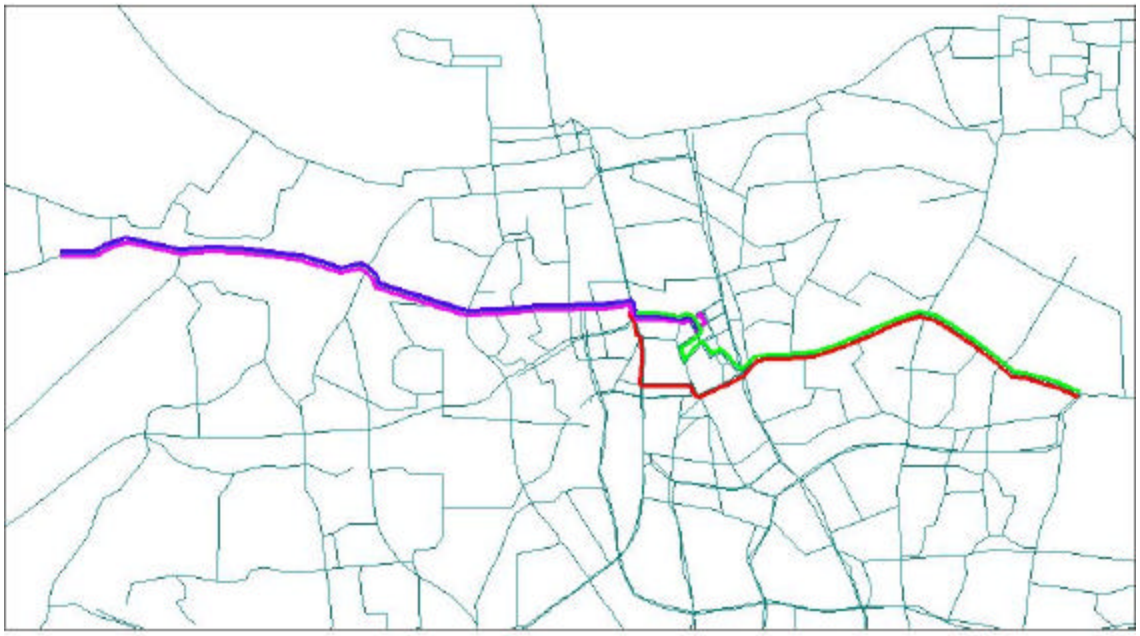
demand. If the single door bus and station stop is to be used, a second station should be added with a passing lane at four stops:

- *Senen, (if a routing near the Senen bus and railway station is selected)*
- *Grogol,*
- *Cempaka Mas,*
- *Roxy.*

If articulated buses are to be procured, the Pulo Gadung – Blok M and Kota to Blok M are the most important routes.

I. 4. Demand Projections for Corridors I, II, and III Under Different Scenarios

The current routing of Corridor II and III are below. The main problem with this routing is that it does not connect with the Senen bus or railway terminals.

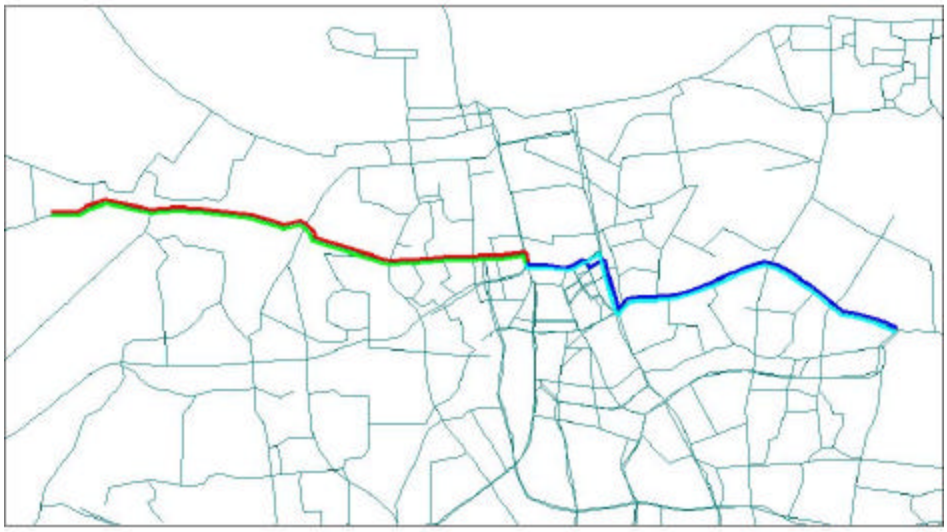


The demand projection for each line under the current scenario is as follows:

Scenario 1 Morning peak hour

Lines	Headway	extension	Travel time	Boarding pax	Max Volume	Pax. paying	# Bus	running km
BM-KT	1.5	13.01	43.58	4412	3644	11523	63	820
KT-BM	1.5	13.02	43.61	2951	2678	63%		
KL-H	2.0	15.24	50.99	3187	2721		54	811
H-KL	2.0	14.78	49.45	1989	1976			
PL-H	1.9	12.66	42.4	2747	2733		46	572
H-PL	1.9	12.19	40.8	2932	2791			
TOTAL		80.9		18218			163	2202

While there are understandable political considerations involved, the decision to bypass the Senen Bus Station – and to a lesser extent the Railway Station – causes a significant loss of passengers.



Were the above itinerary used, demand on Corridor II and III would be much higher:

Scenario 2 Morning peak hour

Lines	Headway	extension	Travel time	Boarding pax	Max Volume	Pax. paying	# Bus	running km
BM-KT	1.4	13.01	43.58	4840	3942	12666	68	885
KT-BM	1.4	13.02	43.61	3913	3582	62%		
KL-H	2.2	12.78	42.74	2528	2451		42	537
H-KL	2.2	12.78	42.74	2150	2150			
PL-H	1.5	11.86	39.72	3930	3557		57	682
H-PL	1.5	12.06	40.39	3183	3023			
TOTAL		75.5		20544			167	2104

The difference in terms of daily ridership on the system is significant:

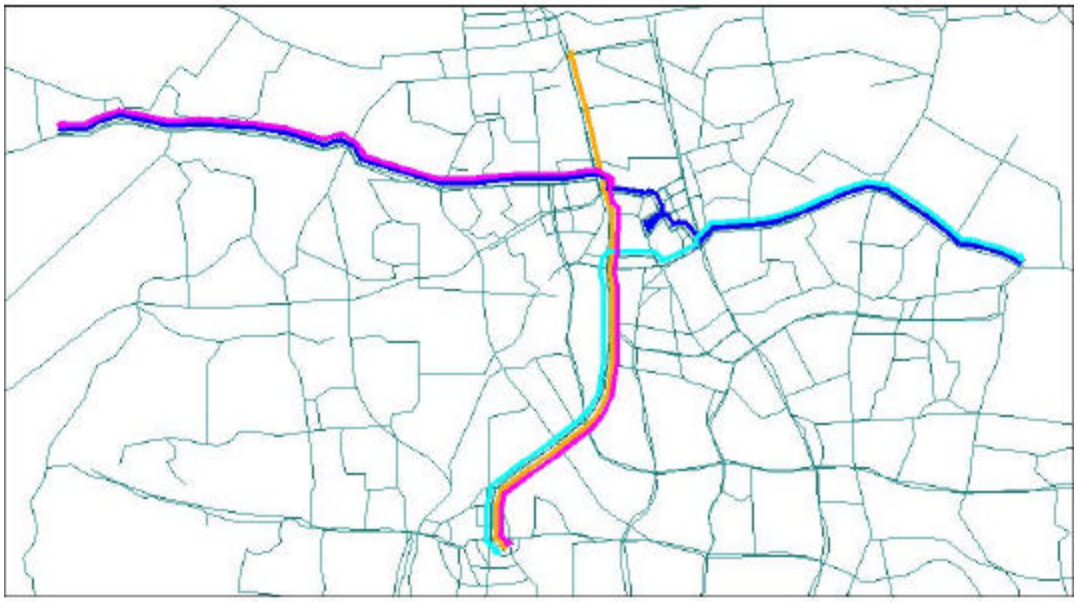
Daily Passengers

Lines	Scenario 1	Scenario 2
BM-KT	63445	69599
KT-BM	42435	56269
KL-H	45829	36353
H-KL	28602	30917
PL-H	39502	56513
H-PL	42162	45772
TOTAL	261975	295423

Because TransJakarta will not connect to the Senen Bus Station, TransJakarta will lose some 33,448 passengers per day. While the specific loss of revenue will depend on the fare structure and operational plan, this is a very significant loss of revenue. These loses should be weighed against the political difficulties of including Senen in the TransJakarta system.

I.5. Optimizing TransJakarta Trunk Line Operational Efficiency

Contracting out of the new TransJakarta bus operations to private operators will happen soon. Because of the coming congestion at Harmoni, it is imperative that TransJakarta and DKI Jakarta determine sooner rather than later what will be the operating routes for contracted lines.



Currently, TransJakarta was planning only to run three separate lines: Blok M – Kota, Kalideras to Harmoni, and Pulo Gadung to Harmoni.

Base scenario

Lines	Headway	extension	Travel time	Boarding pax	Max Volume	Pax. paying	Fleet	running km	operating cost USD	gain USD
BM-KT	1.4	13.01	43.58	4840	3942	12666	64	1140	823	
KT-BM	1.4	13.02	43.61	3913	3582	62%				
KL-H	2.2	12.78	42.74	2528	2451		39	696	503	
H-KL	2.2	12.78	42.74	2150	2150					
PL-H	1.5	11.86	39.72	3930	3557		53	945	683	
H-PL	1.5	12.06	40.39	3183	3023					
TOTAL		75.5		20544			156	2782	2009	1509

Using the traffic model, we tested an alternative scenario which provided the following four services:

- Line I :BlockM-Kota with headway of 2.5 minutes;
- Line II: Pulogadung-Kalideres with headway of 2 minutes;
- Line III: Pulogadung-BlockM with headway of 3 minutes;
- Line IV: Kalideres-BlockM with headway of 6 minutes.

Adding direct services between Pulo Gadung and Blok M and between Kalideras and Blok M will increase demand at the peak hour by 2000 passengers, or some 45,000 passengers per day. This is a significant increase in the revenue of the system.

With direct services

Lines	Headway	extension	Travel time	Boarding pax	Max Volume	Pax. paying	Fleet	running km	operating cost USD	gain USD
BM-KT	2.5	13.01	43.58	2788	2174	14687	36	629	454	
KT-BM	2.5	13.02	43.61	1940	1616	89%				
KL-P	3.0	24.84	83.13	2886	2509		80	1423	1028	
P-KL	3.0	24.64	82.46	2902	2589					
P-BM	3.0	20.98	70.25	2410	2121		56	993	717	
BM-P	3.0	21.17	70.89	2359	2121					
KL-BM	6.0	22.52	75.37	637	543		16	450	325	
BM-KL	6.0	22.51	75.33	528	351					
TOTAL		162.7		16450			188	3496	2525	1555

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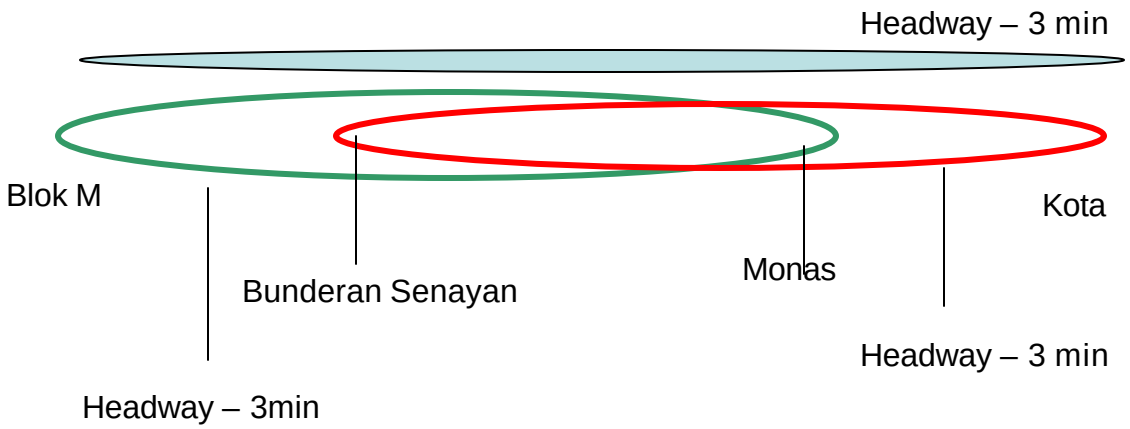
In terms of contracting out bus operations, it would be best if three or four operating companies were hired and paid by the bus kilometer and not specifically linked to a particular bus route. If TransJakarta insists on linking the bus operating contracts with specific bus routes, it would be better to use the bus routes specified in the table above.

The capacity, speed and efficiency of TransJakarta could also be increased by having some buses not make the entire trip between Blok M and Kota, but having some buses go from Kota to Senayan and turn around, and other buses go from Blok M to Monas and turn around.

This operational change would increase bus speeds and would allow fewer buses to handle the same number of passengers, making TransJakarta more profitable.



Because TransJakarta pays by the bus kilometer, this would save 700 bus kilometers per day and make it possible to use 15 less drivers. It would increase headways at the terminals by 1.5 minutes.

When Corridor II opens, TransJakarta would be similarly well advised to make several additional adjustments. For example, some buses in the Pulo Gadung to Blok M corridor might turn around at Senayan.

I. 6. Institutional Issues with TransJakarta

I.6.a. Improve technical decision making

While TransJakarta is working well, physical design decisions significantly reduced the system's capacity. In the future, from an institutional perspective, it is imperative that the Governor empower someone with sufficient technical grounding in Bus Rapid Transit system design to make the final decisions on design and routing in future corridors.

This could be done either by giving a technical person outside of the transportation agency (DisHub) veto-power over DisHub's final designs, by improving the technical understanding of the leadership at DisHub, or by transferring the planning powers to TransJakarta. Any of these actions would still be insufficient to ensure good technical outcomes.

In our opinion, the best scenario to improve operating efficiency at TransJakarta would be to change TransJakarta from a BP to a PT, a publicly-owned company. TransJakarta ideally would have a Board of Directors chaired by the Governor, with representation by the Managing director of TransJakarta, ,the City Planning office, the Office of Landscape Architecture, Transportation (DisHub), and Public Works. If the national government becomes involved in financing future TransJakarta corridors, representatives of the

national government could also be included in the TransJakarta Board. (In Bogota, the national government has just joined the TransMilenio board due to the receipt of a large loan from the World Bank via the national government).

This new PT should completely replace the current BP, which should be abolished. Otherwise, additional administrative confusion will result. This new PT should directly control the farebox revenue but could also receive funds from other government sources.

The power to regulate the bus routes in the TransJakarta corridors should also ideally be transferred from DisHub to PT TransJakarta. PT TransJakarta should also be empowered to directly negotiate all operating contracts for both trunk line and feeder bus line operators, and ticketing system operators, and pay them directly from the proceeds of the farebox revenue. TransJakarta would then need to hire additional competent staff to fulfill these new responsibilities, perhaps some of them coming from DisHub or being seconded from DisHub. The second best scenario would be to leave bus route regulation with DisHub.

I.6.b. Improve Contracting Decisions and Bus Procurement

TransJakarta should competitively bid the trunk line bus operations within all three corridors to the top four operating companies. These operating companies would be promised a minimum number of operating kilometers in exchange for promising to providing the service and meeting minimum service standards. These operating contracts should not be linked to specific corridors.

The competitive bidding requirements should be primarily based on the minimum cost per kilometer that the bus operating companies are willing to provide the service for a period of 8 to 10 years. Each operating company should make this bid based on the assumption that they will have to procure a minimum of 20 articulated buses. The bid should be based on the assumption that the company will take ownership of 22 or 23 of the existing TransJakarta buses. As part of the bid, TransJakarta must insist that the buses procured have the precise dimensions of the final station re-design. The bidder can then decide whether they want to reconstruct these existing buses to fit the new technical standard, or sell them and replace them with other buses meeting the new technical specifications. These contracts should be signed between the operating companies and a newly incorporated PT TransJakarta. The total number of buses needed will depend on:

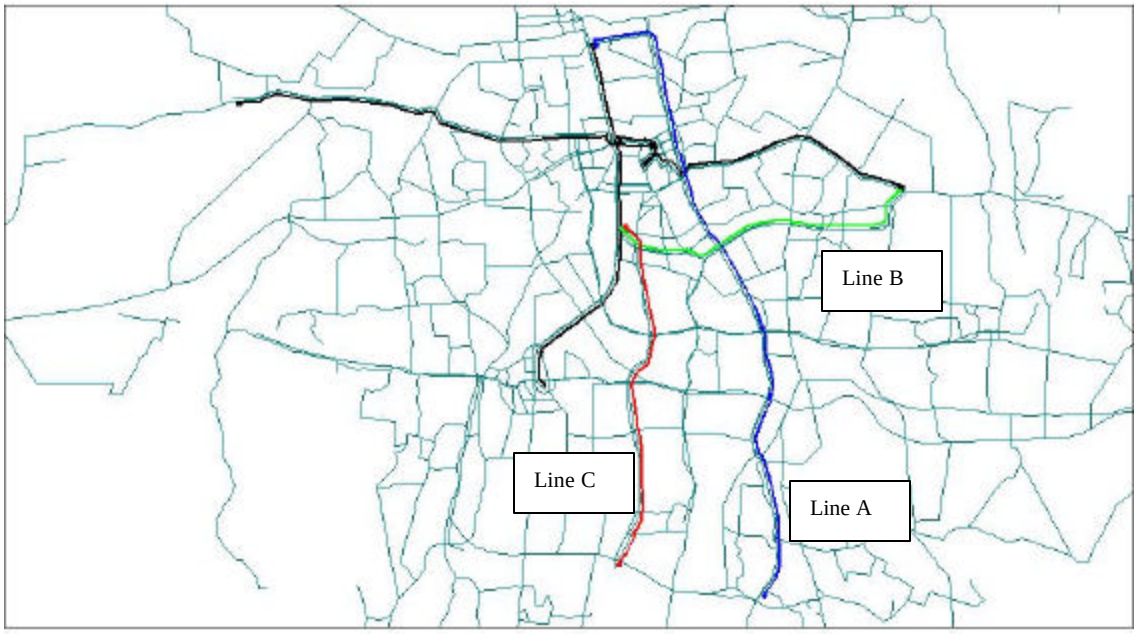
a. the fare structure decided upon
b. the operational system decided upon
c. the final routing of the bus lines and Corridor II

The contracts with bus operating companies should include a system of financial rewards and punishments for good or bad service and maintenance, cleaner vehicles, including small bus owners in the ownership structure, hiring women as bus drivers, and other social objectives.

I.7. Priorities for Next TransJakarta Corridors

The highest priority corridor to do next is actually the Westbound link between Senen and Bank Indonesia to cut travel times and operating costs in the Pulo Gadung – Blok M corridor.

Currently, DisHub has prioritized three additional corridors to extend the Transjakarta BRT system. Corridor I – III are show in black below. In blue, green, and red are shown the next three corridors prioritized by DisHub.

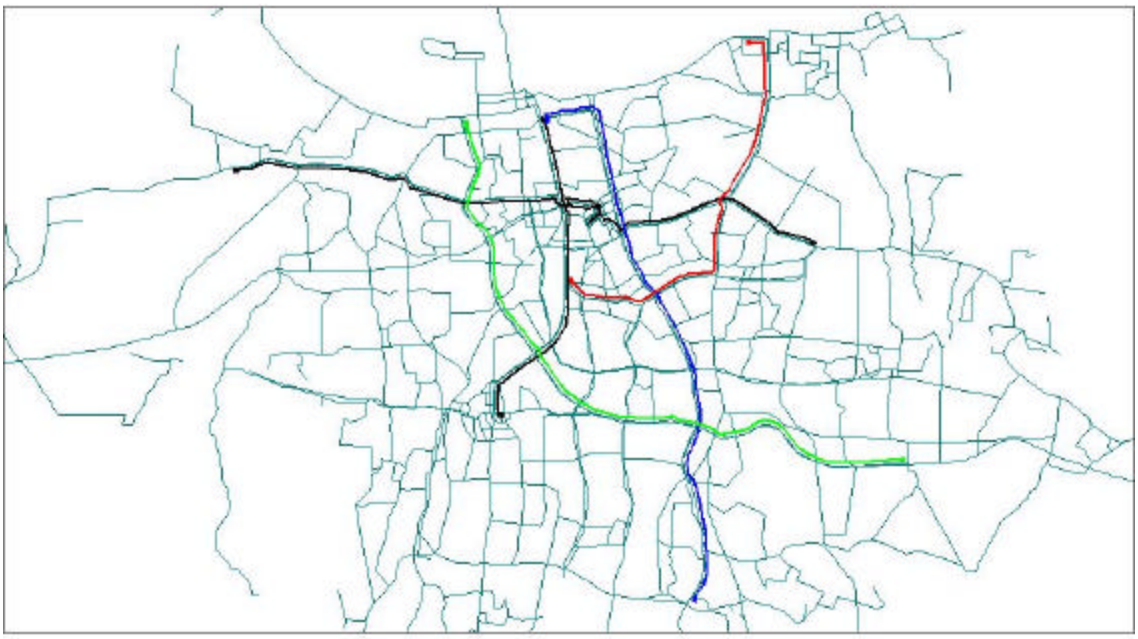


Of these corridors, only Line A has any significant demand. Line B if slightly reconfigured to turn North on Ahmad Yani and Sudarso (under the toll road) would carry significant traffic. Line C pulls demand off Corridor I and does not have heavy demand. Our demand estimates for these corridors indicate that only Line A would be profitable:

Passengers at Morning peak hour

Lines	Headway	extension	Travel time	Boarding pax	Max Volume	Pax. paying
BM-KT	0.7	13.01	43.58	11212	7226	41896
KT-BM	0.7	13.02	43.61	9251	5977	52%
KL-H	0.9	15.24	50.99	7940	6272	
H-KL	0.9	14.78	49.45	5625	5485	
P-H	1.1	12.66	42.41	6457	5073	
H-P	1.1	12.19	40.81	5856	4374	
A	1.0	22	73.97	9747	5543	
A	1.0	22	73.97	6747	3230	
B	0.9	11.07	37.18	7463	6215	
B	0.9	11.32	38.03	5683	4831	
C	2.2	12.24	41.21	1641	1586	
C	2.2	12.24	41.21	2533	2508	
TOTAL		171.8		80155		

Based on demand only, our prioritization of the next corridors would be as follows:



If these corridors were selected as the next priority corridors, the demand on these corridors would be as follows:

Lines	Headway	extension	Travel time	Boarding pax	Max Volume	Pax. paying
BM-KT	0.4	13.01	43.58	20435	13070	85338
KT-BM	0.4	13.02	43.61	16867	10070	51%
KL-H	0.8	15.24	50.99	11121	6651	
H-KL	0.8	14.78	49.45	8450	6265	
P-H	0.8	12.66	42.41	10874	6548	
H-P	0.8	12.19	40.81	8864	5366	
A	0.6	22	73.97	15950	8436	
A	0.6	22	73.97	11034	3227	
D	0.5	25.98	87.34	19885	10405	
D	0.5	25.98	87.34	18089	10322	
E	0.6	16.94	56.88	12020	8331	
E	0.6	16.96	56.94	13897	8880	
TOTAL		210.8		167486		

As this alternative routing would more than double demand on the TransJakarta system, we suggest that this alternative routing be strongly considered. Obviously, we have not had time under the current project to determine the physical feasibility of these corridors for BRT, and the prioritization of the next corridors should be conducted using a multi-criteria analysis.

I.8. Fare Structure and Appropriate Ticketing System

I.8.a. Demand Impact of Different Fare Structures

Before deciding on an appropriate ticketing system, an optimal fare structure needs to be decided upon. The traffic modeling results show several unequivocal results regarding the appropriate fare structure:

- Distance-based fares will significantly improve TransJakarta's Profitability
- Distance-based fares are more important on Corridor I than on Corridors II and III.
- Forcing passengers to pay twice to transfer between Corridor I and Corridors II and III will lead to a 25% drop in passengers on TransJakarta and big loss of revenue.

Morning peak hour

min. fare Rp.	variable fare Rp./km	demand (paying pax)	collected fare USD	average distance	running km	operating cost USD	gain USD	max frequency bus/h
2500	0	11523	3201	13.47	2732	1973	1228	40
1500	70	13653	3283	9.87	2668	1927	1356	46
1000	110	16374	3719	7.94	2844	2054	1666	53
1500	50	18270	4129	10.68	3491	2521	1607	62

The modeling indicates that there are a lot more short distance trips on Corridor I than on Corridors II and III. As such, a fare structure needs to be devised that captures these short trips in Corridor I without losing the longer trips in Corridor II and III.
Also, because of relatively lower incomes at the outer areas of Corridor II and III, more demand is lost for long distance trips to competing bus services than can be justified by revenue increases.

While revenue within TransJakarta would be maximized by a base fare of Rp. 1000 with a Rp.110/ km distance-based charge, ridership would be significantly higher with a Rp.1500 with a Rp.50/km charge, and the loss of revenue is marginal. Because these higher ridership levels are decongesting the mixed traffic lanes and reducing air pollution, the optimal fare structure is Rp.1500 base fare with an additional Rp.50/km charge.

Switching to a distance based fare only in Corridor II and III, retaining a flat fare in Corridor I, and forcing passengers to pay again when transferring between Corridor I and Corridors II and III is absolutely not recommended.

Morning peak hour

min. fare Rp.	variable fare Rp./km	demand (paying pax)	collected fare USD	average distance	running km	operating cost USD	gain USD	max frequency bus/h
2500	0	8506	2363	9.15	1887	1363	1000	25
1500	50	9988	2545	12.87	2139	1545	1000	29
1000	50	13262	2937	11.77	2613	1887	1050	43

This configuration loses 25% of the demand in relation to the scenario with fare integration. The main loss of ridership and revenue results from forcing passengers to pay for transfers between corridors. If this separate fare structure is selected, the adverse impact on revenue can be minimized with a base fare of Rp1000 and Rp50 per kilometer in Corridor II and III.

I.8.b. Institutional Structure for the Fare System

Because shifting to a distance-based fare structure does indeed increase ridership, TransJakarta should change its ticketing system to one that can accommodate distance-based fares. The current system has this capacity but the software, the tickets, and additional out-bound turnstile card readers would all need to be added. The programming on the ticketing system would need to be changed from a 'per-trip' based system to a 'per-rupiah' based system.

While various BOT options are available for procuring the necessary additional ticketing system equipment, it is probably cheaper in the long run to have TransJakarta procure the new ticketing system with public money.

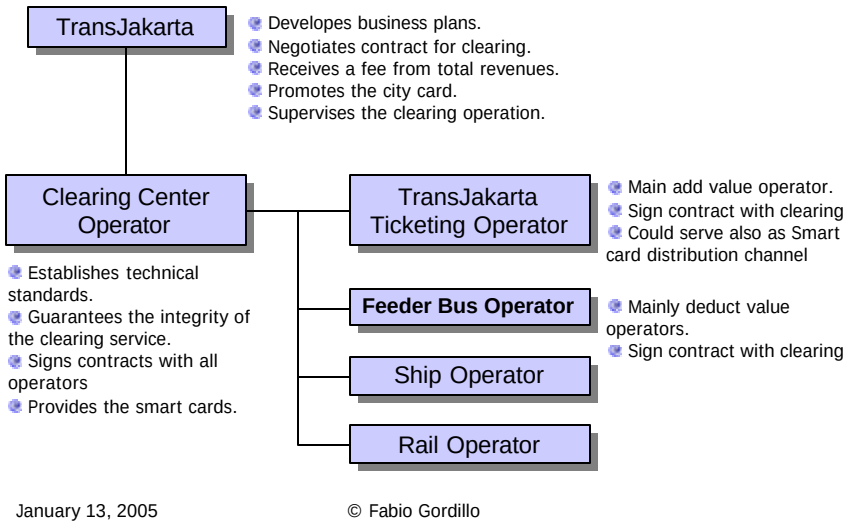
A new PT TransJakarta should be empowered by the Governor to issue a competitive tender for one consortium of companies to manage the Clearing Center Operation of the ticketing system and to procure the necessary ticketing system equipment for operating a cash card or e-purse ticketing system. Ticketing system operations should remain a separate subcontract under TransJakarta.

Having a single contract for a clearing center operator to procure the necessary ticketing system or to reprogram the existing ticketing system (perhaps the existing system supplier could join a bidding consortium) would ensure more transparency than linking the operator with the ticketing equipment procurement.

If a clearing center operator is set up, the TransJakarta tickets could be easily used then by other complimentary service providers, creating the possibility of discounts for commuter rail passengers, ferry boat passengers, and feeder bus operators.

Implementation Plan - Institutions

The following can be the institutional arrangement for the implementation of a multi application card.



After consultation with independent experts and several ticketing equipment and Clearing Center Operator service providers, PT TransJakarta should set a detailed technical specification for the type of ticketing system equipment it wants, and assess what of the old system is usable. Based on this assessment, PT TransJakarta should then develop the terms of reference and supervise the competitive tender for a single Control Center Operator and equipment provider. They should then reissue a competitive tender for the ticketing system operator.

The winning tender for the Control Center Operator and equipment provider should be selected by PT TransJakarta with oversight from an independent technical committee which could be the Public Transit Advisory Council chaired by Prof. Sutanto from the University of Indonesia's Center for Transportation Studies.

When the winning tenders are selected, the contracts must be drawn up in such a way that financial responsibility for an equipment failure is clearly delineated, and penalties for slow repairs incorporated into the contracts in a manner that clearly allocates financial risk with responsibility for the problem.

When TransJakarta takes control of the new system, before turning over revenue collection to the control system operator/equipment provider, it needs to run a series of tests outlined in the report which ensure the integrity of the system. Only once the integrity of the system is ensured should the ticketing equipment provider and control system operator be given control over the revenues. TransJakarta then needs to establish a set of ongoing routines and administrative procedures to prevent possible abuse of the system.

I.9. Adding Feeder Buses

TransJakarta could significantly improve mixed traffic congestion in the BRT corridor and increase the demand and profitability on TransJakarta by adding a system of feeder buses. However, before a successful system of feeder buses can be added, the problems of the limited capacity on the existing Corridors needs to be addressed, and the problems with the ticketing system need to be addressed.

Once a ticketing system is in place that is managed by a Clearing Center Operator able to manage in a transparent manner the fair disbursement of revenues to feeder bus operators, TransJakarta can issue competitive tenders for feeder bus operations that would serve the BRT corridors. The passengers of feeder buses should be allowed free or deeply discounted transfers onto the TransJakarta system without the need for physical integration. These feeder bus operators should be paid using a combination of bus kilometers and passengers brought to the BRT system. They should be selected by competitive bid, and their profitability should be assessed ahead of time using the traffic model. Only feeder buses which increase total system profitability of TransJakarta should be brought under the TransJakarta system.

I.10. Pedestrian Facilities Improvements

The new sidewalks in the TransJakarta corridor look magnificent and change the face of Jakarta. They should be extended along the entirety of Corridor I and on all future TransJakarta corridors.

That being said, pedestrian safety is still an issue along Corridor I due to free left turns, high speed exit and entry ramps, and lack of pedestrian refuge islands at intersections. In some parts of Corridor I, particularly North of Harmoni and South of Senayan roundabout, at-grade pedestrian crossings coupled with improved intersection design should still be considered.

At the Kota railway station, at-grade pedestrian facilities are fine, but the traffic signal at Pintu/Besar/jem. Batu/Petongkangan (at Kota Station) absolutely must be changed to a two-phase signal which gives all pedestrians a full phase to cross in each direction. By simply restricting one turn, the efficiency of the intersection and pedestrian safety can both be greatly improved.

We recommend that the pedestrian facilities on Corridor II and III be looked at carefully from a safety point of view as well as an aesthetic point of view. In Corridor II in particular, many sidewalks are in reasonable condition, but the lack of traffic lights or pedestrian refuge islands, and numerous intersections with almost no break in the traffic, makes these intersections extremely difficult to cross. At station stops like Isquital (in front of Pertamina), Juanda, and Pecenongan, where there is no significant intersection with crossing traffic, pedestrian crossing lights have been installed, but vehicles do not tend to stop. The stop at the Juanda railway station has been constructed in such a location that the current surface pelican cross is not usable and a new one some 50 meters to the west will have to be created. While it is not clear if the current signal phasing is intended to be permanent, the current signal phasing is extremely long, forcing pedestrians to wait extended periods of time. At-grade pedestrian crossing areas are not effective if the waiting time is longer than 2 minutes, and if motor vehicles do not respect the light. As such, the pedestrian crosswalk will need to be accompanied by additional measures, such as:

- additional pedestrian refuge islands either by widening the divider between the busway and the mixed traffic lanes to serve as a median, or creating new medians between main road and service roads, or by creating toll-plaza like stand alone pedestrian refuges.
- overhead lighting for the night time,
- raising the crosswalk surface to create a speed bump.
- Restricting free left turns (where applicable)
- Changing the streets from one-way to two-way and signalizing more of the intersections.

Without these measures, many of the Corridor II BRT stops would be safer with a pedestrian overpass.

I.11. Next Steps

ITDP would like to thank the Governor and Lt. Governor for providing ITDP with a letter requesting further technical assistance for the Global Environmental Facility. Should this effort be successful, ITDP will try to continue our technical assistance in the following areas which were discussed with TransJakarta and DisHub as their priorities.

- DisHub would like input into the selection of the final specific routes for Corridors IV, V, and VI using the traffic model developed in cooperation with UI CTS, and evaluation of the suitability of the corridors.

- TransJakarta would like careful demand estimates for the final operating and routing configurations on Corridor II, III, IV, and V in order to negotiate the best possible terms from private operators.

- DisHub would like ITDP support in optimizing intersection designs in two locations on Corridor I and on the future corridors, to increase the capacity of the busway and the mixed traffic lanes.

- TransJakarta would like support optimizing and rationalizing the bus routes both within the TransJakarta system and for feeder buses in the future corridors to be served by the TransJakarta system.

- TransJakarta would like ITDP's support in establishing a sustainable maintenance regime, which will directly improve bus engine efficiency and reduce CO2 emissions.

- The Regional Planning Board would like help in using the traffic model for testing various traffic demand management scenarios.

- The Department of Planning at DisHub and the Department of Parks and Landscaping would like ITDP's help in designing safe and attractive pedestrian facilities in the TransJakarta corridors and in the historical center, which would increase ridership on TransJakarta.

- Finally, the area around the Kota Railway station to Glodok is of significant historical and cultural interest, and this area is currently blighted and needs to be redeveloped. Improving this area would help to increase demand on TransJakarta. There is an opportunity with a national government fund controlled by the Minister of Economy provided by the World Bank to promote public-private partnerships. There is an abandoned post office and other buildings that could be redeveloped, and the amenities for pedestrians significantly improved. This World Bank fund for public private partnerships has over $1 million, and it is currently under-subscribed. ITDP is ready to assist DKI Jakarta in preparing a proposal for this area that would be eligible for these funds.

II. INSTITUTIONAL RECOMMENDATIONS

Good institutional structures should create incentives for the public sector and private sector to provide an efficient and high quality transit service at as low a price as possible to the public. The nature of contracts between public authorities and private operators and service providers will create different types of incentives that encourage and discourage different behaviors, some of which better serve the public interest than others. Good institutional structures are a necessary but insufficient condition for a world class public transit system.

TransJakarta has initiated what could be a profound transformation of how buses are owned and operated in the city of Jakarta, with tremendous benefits for bus passengers. Prior to TransJakarta, while bus ridership doubled from 1990 to 2000, to nearly 4 million daily bus trips, the modal split for public transport in Jakarta was declining because of poor quality service and the rapid increase in private motor vehicle use. While buses operating in Jakarta increased from about 18,000 in 1990 to 22,000 buses in 2002, during the same period, the number of private cars tripled, from about 500,000 to roughly 1.5 million, and motorcycles increased four –fold, from 800,000 to 3.2 million. As a result, the roads in Jakarta have become increasingly congested, and the air more polluted. Buses find themselves caught in severe congestion, which has increased their operating costs, and cut into their profitability. This in turn led to aging bus fleets which generated less customer satisfaction and more pollution. While the main problem was growing private motor vehicle fleets, the undeveloped and poorly regulated nature of the Jakarta bus sector was also a contributing factor.

Prior to the opening of TransJakarta, there were three types of bus ownership in the first TransJakarta corridor. First, there is a public authority, PPD, which is operated under the national Ministry of Communications and Transport. PPD has a small fleet of about 380 buses, and it continues to receive public subsidies from the national government. The share of transit passengers and lines operated by PPD has been steadily declining over the past 20 years. Secondly, there are three large private bus companies: Steady Safe, Bianglala, and Mayasari Bakti. These big private bus operators own the buses and the route licenses and "lease" their buses to individual operators/drivers on a daily basis. The operator collects all the passenger revenues directly. These bus operators do not follow any particular schedule, but they do have to follow the route assigned to that bus. Finally, there are 'collectives', Metro Mini and Kopaja. These are fleets of buses owned by smaller individual owners who pay a fee to a parent company for the right to operate on one of their routes with their corporate identity. The owners in turn rent the vehicles out to operators. In 2000, the average bus operator was paying some Rp.150,000 to the owner to rent the bus (complete with the route license), and oil and fuel cost Rp.60,000 which is also paid by the driver directly. (Pambagio, Agus. 2000)

The allocation of bus lines in Jakarta is regulated by the Transportation Agency (Dinas Perhubungan, or Dishub), which inherited this role from DLLAJ (Dinas Lalu Lintas dan Angkutan Jalan Raya). The process of awarding the more lucrative routes to specific

companies is not transparent. Other groups such as Organda, (the bus operators union), the police, and sometimes criminal gangs, also extracted informal payments from the bus operators. The bus operators face daily extortions of up to Rp.30,000 just to be allowed to operate a particular bus on a particular corridor. (Pambagio, 2000)

As a result, bus drivers work long hours, have minimal benefits, and are subjected to various formal and informal fees from both public and private agencies. Most bus drivers are therefore ready for a new system.

Customer satisfaction with the old bus system was also low because:

- Buses do not follow a predictable schedule,
- Buses do not stop at bus stops,
- Buses do not stop at all once the bus is full.
- Buses sit waiting to collect more passengers, delaying those already on the bus.
- Buses compete for passengers at curbside in a dangerous way
- The buses are quite deteriorated and polluting
- There is petty criminality on the buses

Within the TransJakarta system, most of these problems have been solved. While buses do not yet follow a predictable schedule, the lead times averaging 2 minutes are sufficiently short to not cause passenger inconvenience. Buses stop at all stops and only at designated stops, they do not wait to collect more passengers, they do not compete for passengers at curbside, the buses are modern, and criminality on the bus has been substantially reduced. These problems were resolved by a combination of the physical design of the system, and because the operators are paid by the bus kilometer and not by the passenger.

However, ***the system could be made into a World Class system with a few modest improvements***. The new system has several problems resulting from unresolved institutional issues. The net result of the problems listed below is that the TransJakarta system is costing the Jakarta taxpayers much more money than it need to, and is congesting the mixed traffic lanes more than necessary.

- Some design decisions on Corridors I, II, and III, were sub-optimal, giving TransJakarta low capacity and low speeds by international standards, and higher infrastructure maintenance costs.
- A routing decision on Corridor II was sub-optimal, reducing TransJakarta demand and revenue.
- Fewer than anticipated parallel bus lines were converted into feeder buses, giving TransJakarta low demand and low revenue, and increasing congestion in the mixed traffic lanes.
- The Department of Transport (DisHub) selected sub-optimal buses, increasing operating costs, and paid more for them than they should have.
- TransJakarta is overpaying the bus operators PT JET
- TransJakarta buses are not being well maintained

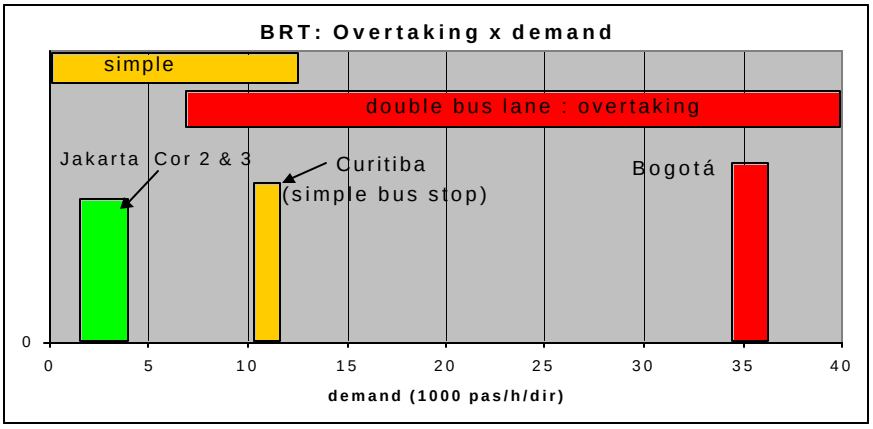
? DisHub procured a sub-optimal ticketing system, undermining the effectiveness, security and transparency of the ticketing system.

For TransJakarta to become a World Class BRT system, all of these problems, and their underlying causes, need to be addressed.

II.1. Decision Making on Planning and Infrastructure Design

Currently, the budget for the planning of TransJakarta, including the prioritization of future corridors, is the responsibility of the Department of Planning of the Department of Transportation (DisHub). The Department of Infrastructure at DisHub is responsible for the physical design and engineering of TransJakarta infrastructure, and for contracting the actual construction. Dishub in turn contracted out the initial planning and design work to PT. Pamintori Cipta, a private consulting firm.

In theory, the planning and the physical design decisions were to be made in a consultative process coordinated by the Busway Coordination Team (Tim Coordinasi) which reported directly to the City Secretary, the senior bureaucrat inside the DKI Jakarta government. ITDP and other experts and advisors had regular access to this coordination team.



While the Tim Coordinasi did provide a forum for discussion, in practice, DisHub made most of the physical design and routing decisions unilaterally, without the full agreement of the Tim Coordinasi. As a result, several fairly serious design mistakes were made which significantly limited the capacity of the TransJakarta busway. Currently, TransJakarta's capacity is only about 2700 passengers per direction at the peak hour (pphpd), while Curitiba and Quito are managing 12,000 pphpd, and Bogoga 36,000 pphpd. These mistakes are again being made on Corridor II and III, currently under construction.

While the routing of the first TransJakarta corridor is quite a reasonable one, Corridor II currently does not pass the nearby Senen Bus Station nor the Senen Railway Station. While it was politically difficult to provide this link, and political decisions must be factored into the decision-making process, the cost to the system of this decision will be some 20,000 passengers per day.

Now that TransJakarta is open, this structure has still not fundamentally changed, although there are discussions underway as to how best to alter this structure.

In the case of TransMilenio, the structure was similar, but with a few critical differences. Before TransMilenio was created, the planning function and the physical works were split. The detailed engineering and construction contracts were awarded and supervised by the Department of Public Works, while the planning contracts, which identified the corridors and established the basic system designs, were awarded to Steer Davies Gleave by the Department of Transportation. Steer Davies Gleave was an internationally accredited and widely respected planning and engineering firm, of a much higher caliber than PT Pamintory Cipta.

Before TransMilenio was created, there was a technical review committee with representatives of the Department of Transportation, Public Works, TransMilenio's Project Unit, and it was chaired by a representative of the Mayor (Ignacio de Guzman) who reported directly to him. This review committee was empowered to take final decisions on all critical issues relating to planning and physical design. In the case of a conflict, it was settled directly by the Mayor directly.

Importantly, after TransMilenio was established, responsibility for detailed design and planning of future corridors was transferred from the Department of Transportation to TransMilenio's Department of Planning, and final decision-making was shifted from this technical committee under the Mayor to the Board of TransMilenio (also controlled by the Mayor).

Furthermore, the power of regulating bus routes in the TransMilenio Corridors was shifted from the Department of Transportation to TransMilenio ***before the system opened***. TransMilenio's Board changes with the Mayor, but at the time that TransMilenio was first created, the Department of Transportation was not on the Board. This decision was taken by Mayor Penalosa mainly because the Department of Transportation resisted the removal of competing bus routes in the TransMilenio corridor, because the Department of Transportation earned money from these routes.

A makpr difference between Jakarta's structure and that of Bogota was that the Tim Coordinasi in Jakarta did not really have decision-making authority. This authority was taken almost entirely by DisHub. This was possible mainly because they had budgetary control over the project, and because the Governor gave them this power. We do not know whether the technical shortcomings of the system were primarily the result of lack of technical capacity, the very tight time frame, because non-technical considerations were driving the decision-making process, or a combination of these factors. With perhaps the exception of the problems with the ticketing system, certainly the main problem was not the lack of sound technical advice. DKI Jakarta had available to them sound expert advice from some of the leading BRT experts in the world, and from the UI CTS, which understood the technical and institutional issues well. Most of the key concerns were raised in the Tim Coordinasi meetings and summarized in a Technical Review issued by ITDP in December of 2003. The Governor and the DisHub leadership

had also visited BRT systems in Brazil, Bogota, and Quito, the three best systems in the world. Despite this, much of this technical advice was not heeded.

These technical problems could have been avoided either by having the Governor give real power to the Tim Coordinasi, by having a leadership at DisHub with a higher level of technical competency and/or concern, and/or perhaps by giving the planning process more time.

To avoid similar technical mistakes in the future corridors, from an institutional perspective, it is imperative that the Governor empower someone with sufficient technical grounding in Bus Rapid Transit system design to make the final decisions on design and routing in future corridors. This could be done either by giving a technical person outside of DisHub veto-power over DisHub's final designs, or by replacing the leadership at DisHub with persons of a higher level of technical understanding, or by transferring the planning powers to TransJakarta. Any of these would be necessary but insufficient to ensure good technical outcomes.

II.2. TransJakarta's Institutional Structure

While TransJakarta was being constructed, DKI Jakarta decided not to rely on DisHub to operate and manage the new TransJakarta system, but to create a new entity. While the original idea was to insulate TransJakarta management and operational decisions from political interference, the way TransJakarta was initially set up severely constrained its influence and left much of the critical decision-making powers in the hands of DisHub. There were three critical differences between TransJakarta and TransMilenio. Unlike TransMilenio,

- TransJakarta does not have the capacity, the budget, or the clear mandate to do the planning for the future TransJakarta corridors.
- TransJakarta does not directly control the revenue from ticket sales
- TransJakarta does not have the power to regulate bus routes in the TransJakarta corridors.

TransJakarta was created on December 31, 2003, when Governor Sutiyoso issued decree No. 110/2003 establishing a busway managing company named Badan Pengelola Transjakarta, or BP TransJakarta. Transjakarta was created as a BP – Badan Pengelola because it can be done directly by the Governor without requiring an act of the regional parliament, DPRD. BP TransJakarta currently has responsibility only to manage and control the 12.9 km busway operating between Blok M and Kota. This includes supervising the operating contract, the ticketing system contract, maintenance of the stations and pedestrian walkways connecting to the pedestrian overpass, and security on TransJakarta buses.

By law, all Badan Pengelola are under the office of the City Secretary. DPRD doesn't allow BPs to manage their own revenues. TransJakarta revenues are categorized as 'own-source revenue' (PAD), and lumped in with other PAD revenues, all of which are under the control of the Revenue Agency. The revenue has to be deposited everyday by the ticketing system operating company into a DKI Government account at Bank DKI. It never passes through TransJakarta's hands.

Officially, the Governor's decree creating BP TransJakarta gives them planning authority. However, because they do not control the revenue from the ticket sales, and they were not given sufficient budget by the regional parliament to do the planning, and because the mandate to do the planning was left with DisHub, in practice planning powers remained with DisHub.

Because TransJakarta does not directly pay the bus operators, its leverage over the bus operating companies is further limited. Payment to operators is using the APBD budget transfer pending approval by the finance office of the Governor. De facto control over the payments continues to rest with DisHub. As such, the accounting regarding the profitability of TransJakarta operations is not that transparent, and there is no clear link between the system's revenues and its costs. Furthermore, because there is no clear link between TransJakarta's performance and their revenue, TransJakarta has limited incentive to improve the system's efficiency.

Finally, unlike TransMilenio, TransJakarta was not given the power to regulate bus routes in the TransJakarta corridor. This power also remained with DisHub. The result of this was that fewer bus lines in the first TransJakarta corridor were cut than was originally planned. As a result of this and the lack of feeder buses, demand on TransJakarta was significantly lower than TransJakarta's potential.

Currently, there are discussions of changing the organizational structures governing urban transportation in Jakarta. One thing being discussed is to create a new entity responsible for route regulation in Jakarta, taking this responsibility away from DisHub. This new entity would be responsible for regulating the monorail and also TransJakarta. TransJakarta would be turned into a publicly-owned company that would directly control the revenues received from ticket sales on the TransJakarta system. They would then continue to contract out bus operations and ticketing operations. Other proposals have suggested that a US-style public transit authority should be created to both own and operate all mass transit services in Jakarta.

In our opinion, a US style mass transit public authority is ill-advised. Even in the US, which has reasonably strong public disclosure and competitive bidding rules, such public authorities are less than fully transparent, and less than efficient. This less than ideal structure evolved in the US largely because of the collapse of privately owned and operated mass transit systems due to declining transit ridership. In Jakarta, however, bus operations in the context of TransJakarta have the potential to be fully self financing and profitable. This is not true of the planned monorail system. ***It would be ill-advised to***

encumber the TransJakarta BRT system with an inefficient structure just because the monorail system can never become operationally self-financing.

In our opinion, the best scenario would be to change TransJakarta from a BP to a PT, a publicly-owned company. TransJakarta ideally would have a Board of Directors chaired by the Governor, with representation by the Managing director of TransJakarta, DisHub, the City Planning office, the Office of Landscape Architecture, DisHub, and Public Works. If the national government becomes involved in financing future TransJakarta corridors, representatives of the national government could also be included in the TransJakarta Board. (In Bogota, the national government has just joined the TransMilenio board due to the receipt of a large loan from the World Bank via the national government).

This new PT should completely replace the current BP, which should be abolished. Otherwise, additional administrative confusion will result. This new PT would directly control the farebox revenue but could also receive funds from other government sources. Responsibility for the planning and design of the future corridors would be transferred from DisHub to TransJakarta, and the power to regulate the bus routes in the TransJakarta corridors would also be transferred from DisHub. It would also directly negotiate all operating contracts for both trunk line and feeder bus line operators, and ticketing system operators, and pay them directly from the proceeds of the farebox revenue. TransJakarta would then need to hire competent staff to fulfill these new responsibilities, perhaps some of them coming from DisHub or being seconded from DisHub.

The second best scenario would be to leave bus route regulation with DisHub, but transfer planning and design to a new PT TransJakarta. Third best option would be to transfer bus route regulation to a new PT TransJakarta but leave planning and design with DisHub, and replace the current leadership of DisHub with more technically advanced personnel.

II.3. TransJakarta and Trunk Line Operations

II.3.a. Corridor I Trunk Line Operations

For the first TransJakarta corridor, BP TransJakarta had only just been created, so an operating contract for Corridor I was basically set up by DisHub with a single private consortium called PT JET (Jakarta Ekspress Trans). PT. JET was created two days before the bus rapid transit system opening out of the largest former bus operators in the first TransJakarta corridor.

PT JET was created out of many of the existing operators in corridor so they would not fully resist implementation but would support the new TransJakarta system.

Like TransMilenio, Curitiba, Quito, and other cities, the trunk line operator is paid by the bus authority on a bus/kilometer basis. Payment by the bus kilometer ends the dangerous competition for the cent and the problem of delays caused by buses waiting for passengers. It also creates an incentive for the private operator to reduce their operating costs to increase their profitability.

PT JET was given the operating contract without a competitive bid. This was partially because the decision to go with private operation rather than direct operation by DisHub or TransJakarta was only decided upon at the last minute, and there was no time to complete a competitive bidding process and open at the promised January 2004 date.

Because this operating contract was awarded without a competitive bid, the Jakarta government has been investigated by KPPU (Komite Pengawas Persaingan Usaha/Anti-Monopoly Commission) for violation of fair business competition laws.
PT JET is a consortium headed by PT Ratax, a radio taxi company also owned by the DKI Jakarta Government. Mayasari-Bhakti, Steady Safe, Bianglala, and PPD are also partners in the consortium, and all own shares in PT JET. These four companies represent the main bus operators in the corridor served by TransJakarta, excluding only Metro Mini and Kopaja.

Creation of PT JET was legally complicated because some of the bus companies did not have transparent corporate legal status. As the owners had never operated a professional bus operation before, they lacked the tools to do careful costing estimates, to establish scheduling, or to determine the number of employees necessary based on this scheduling, and other basic management issues such as establishing maintenance regimes. As a result, when first incorporated, PT. JET did not know how much it would cost to provide the service.

The operating contract is between TransJakarta and PT JET, though it was negotiated by DisHub. The contract with PT JET lasts for 2 years, and it expires in January of 2006. Like in other BRT systems, PT. JET is paid based by TransJakarta on a bus kilometer basis. This has ended the dangerous 'competition for the cent' that used to plague bus behavior in the busway corridor.

Unlike in TransMilenio or in Curitiba or Quito's Ecovia line, PT JET was not required to procure the buses. Rather, the buses were procured directly by DisHub, again without a competitive bid. The ownership of the buses was passed from DisHub to TransJakarta when it was created in January of 2004. Again, partly due to time pressure, the procurement was not subjected to a competitive public bid, and legal questions have been raised. Some 39 vehicles were procured from Hino's local partner, PT New Armada in Magelang, and 17 were procured from Daimler Chrysler's local partner, PT Restu Ibu, in Bogor. Whether this was a violation of the law remains murky, since the laws on administrative procedures allow a certain amount of latitude for the Governor to bypass competitive bidding under certain circumstances.

An additional 34 buses were procured 2004 in roughly the same manner, of which 4 have already been put into operation, and the additional 30 are being held in reserve.

TransJakarta has retained ownership of the buses, and did not pass ownership on to PT JET, the operating company.

There are several problems with having DisHub rather than private bus operators procure the buses. The most obvious point is that the taxpayers needlessly picked up the full cost, rather than private bus operators. Secondly, with public procurement anywhere there is a heightened risk of graft. Thirdly, because DisHub is not a bus operator, they lacked the technical expertise to select an optimal bus. The buses they selected were heavier and more powerful than were necessary for operating TransJakarta routes. As a result, the roadbed deteriorated more rapidly than anticipated, and the buses use more fuel than necessary. Both of these have needlessly increased operating costs. Finally, because PT JET does not own the buses, they do not have as strong an incentive to properly maintain the buses, which is also increasing operating costs.

The lack of a competitive bid, and the speed with which the procurement was done, also increased the risk of graft, and it weakened DKI Jakarta's bargaining position relative to the bus manufacturers . As a result, DKI Jakarta ended up overpaying for the buses.

During negotiations with PT JET, DisHub agreed to pay PT JET Rp.6100/km (roughly $0.75). It was recently renegotiated to Rp.6000/km. The basis of this figure was negotiation.

TransJakarta's payments to PT JET are considerably higher than they would have been had the operating contracts been awarded based on competitive bidding. Calculations done by our experts indicate that at $0.75 per kilometer, bus operators could not only provide the service and make a profit, they could also afford to purchase and maintain the buses, and still make a profit. In Bogota's TransMilenio, for example, which uses much more expensive buses, the operators are paid $0.70 per bus kilometer, and this figure is more than sufficient to cover the cost of the bus procurement. Because PT JET can use TransJakarta's buses free of charge, they are making a very good profit.

Given the Governor's timetable, which was reasonable to impose from a political perspective, and given the financial risks associated with opening the new system, it was perhaps reasonable to award a contract to a single operator at a reasonably high rate in order to insulate the private sector participants from financial risks.

TransJakarta wisely insulated itself against long term financial burdens by making the contract only 2 years in duration. Thus, TransJakarta now has an opportunity in January of 2006 to renegotiate these contractual relationships. Before discussing recommendations, however, plans for Corridor II and III ,which are also scheduled to open in January of 2006, need to be discussed.

II.3.b. Corridor II and III Trunk Line Operations

On Corridor II and III, several institutional changes are being discussed which could represent significant improvements over Corridor I.

First, the current plan is to have private operators procure any new buses needed for operation in Corridor II and III. The plan appears to be to again form a consortium of existing bus operators, one serving Corridor II and one serving Corridor III. Some 50% of the TransJakarta bus trips in each corridor would be given to this existing consortium and the other 50% would be competitively bid. The bid would be based on meeting the service and technical standards at the lowest price per bus kilometer. The winning bid would then set the service payment per bus kilometer for all services in the corridor, including the one operated by the new consortium of existing bus operators.
This new scheme should significantly reduce the price per bus kilometer of providing the service, while ensuring some compensation for the bus operators that are losing bus routes in the corridor. Beyond this, the details have not yet been worked out.

Certainly we support the notion of competitive bidding for the selection of TransJakarta operating companies. Not only will this significantly reduce the amount of money that TransJakarta will need to pay the bus operating companies, and increase the level of private investment into new buses.

TRANSMILENIO POINTS SYSTEM FOR EVALUATION OF COMPETITIVE BIDS FOR TRUNK LINE OPERATORS.

FACTOR	DESCRIPTION	ELEGIBILITY	POINTS	
			MIN*	MAX
Legal Capacity***	Hold the appropriate credentials to submit a proposal	x	-	-
Economic Capacity (1)***	Minimum amount of Net Owner's Equity to submit a proposal	x	-	-
Experience in operation (2) **Maximum Points 450**	Passenger Public Transport Fleet in operation.		30	150
	Specific experience on the corridors (Américas – Calle 13 – NQS – Suba)		50	250
	International experience on mass transport services		-	50
Economic Proposal **Maximum Points 350**	Offered price per kilometer to operate the system		-	350**

Proposal to the City **Maximum Points 100**	Right of exploitation of the concession	x	-	-
	Valuation of the share of TRANSMILENIO S.A. in the revenue of the concessionaire		21	50
	Valuation for the number of buses to be scraped by the concessionaire.		14	50
Composition of the bidder company's structure **Maximum Points 200**	Share of bus company's stock held by former small bus owners.		32	200
Environmental Performance **Maximum Points 200**	Level of emissions, noise and disposal plan for the remainders of the operation		-	200
Fleet offered	Size of the fleet	X	-	-
Maximum Points 50	Manufacture origin of the fleet		-	50
TOTAL		1350 points		

* If the proposal is below the minimum, it will be qualified as NO ELIGIBLE
** If the proposal does not meet the range established in the proposal, it will be qualified as NO ELIGIBLE
*** If the proposal meets all the requirements, it will be qualified as ELIGIBLE

(1) ECONOMIC CAPACITY

The company should prove that, as function of the company's owner's equity, is capable to engage the initial investment based on the maximum number of buses that is offering to the system. (There is a pro forma that needs to be filled out)

The minimum owner's equity is defined by the formula:

$$Pnm = Nmv \times US\$200{,}000 \times 15\%$$

Pnm = Minimum Owner's Equity to be accepted
Nmv = Maximum number of buses offered to the system

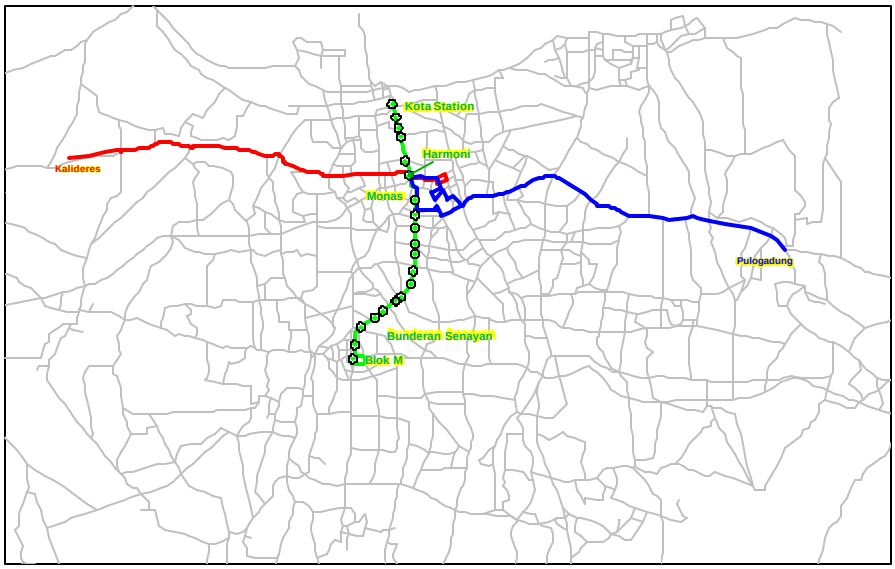
(2) EXPERIENCE IN OPERATION

The bidder should prove to have experience in the operation of public transport of passengers. The experience can be in Bogota, the metropolitan area or in other Colombian cities using vehicle of more than 10 passengers. (There is a pro forma that needs to be filled out)

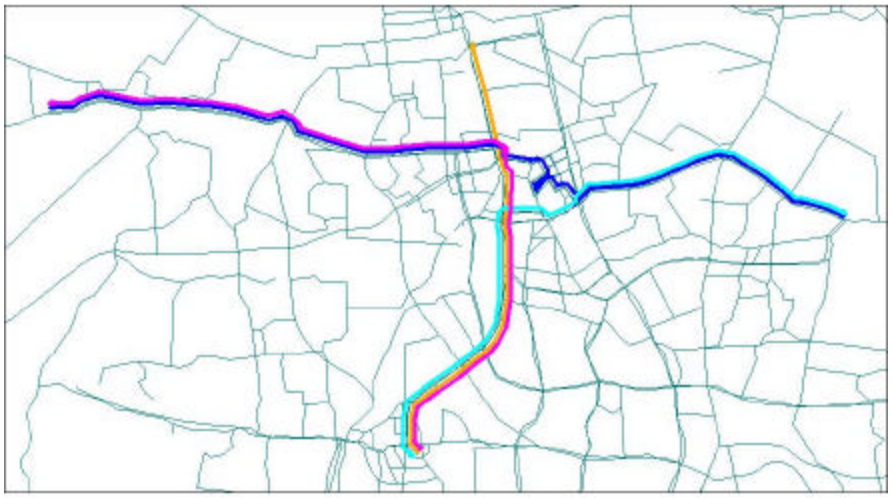
To account the number of vehicles of each owner and certify that the amount is equal or less than two, the following formula will be used:

$$Ownership(j) \leq \sum_{i} \frac{Vehicle(ij)}{N(ij)}$$

The competitive bidding criteria can also be used to help encourage several other socially desirable outcomes. For example, the consortiums can be given extra points in the bidding process for buying cleaner vehicles, for involving more small bus operators in their ownership structure, for hiring women drivers, etc, but certainly the most important factor should be the reputation of the company, and the price at which they are offering the service.



Secondly, there is no operational advantage to breaking up Corridor II and III into two separate corridors. From an operational point of view, it is critical that direct services be offered between Pulo Gadung and Blok M, and between Kalideras and Blok M, and between Pulo Gadung and Kalideras, as pictured below. The contracts made with private operators must either de-link the operating contracts from specific routes, or else the operating contracts should be made for these multiple routes.



TransJakarta has several options in terms of how operating contracts with private operators might relate to these different lines and the different corridors. Traditionally, in cities like Curitiba, Quito, and Sao Paulo, concessions were signed with single monopoly consortiums to operate bus services over the length of the concession, or even for an

indefinite period of time. In these cities, the bus companies always paid for the buses in exchange for exclusive rights to operate buses in particular corridors. Within these corridors, these bus companies also provided feeder bus services. Having a single company provide a monopoly service in the corridor made possible smooth integration of the ticketing system between the trunk lines and the feeder lines.

However, these systems had several problems. The main problem is that with a long term monopoly supplier in a corridor, there was always pressure by the supplier to increase the bus fares. Currently in Curitiba the bus fare is nearly $0.75 (Rp.7000). Secondly, if the bus operator was providing poor quality service, the transit authority URBS had very little recourse short of terminating a 10 year concession contract, and shutting down service until a new company could be hired.

Bogota overcame these problems by de-linking the bus operating contracts from specific corridors. In other words, instead of giving a bus operating company a concession to operate buses in a specific corridor, TransJakarta could negotiate operating contracts with consortiums or individual private bus companies which would be paid a guaranteed minimum number of bus/kilometers over a period of 6 – 10 years in exchange for agreeing to provide a service at an acceptable quality standard at a fixed price per kilometer. The number of bus kilometers would be a function of the number of buses they were willing to invest in. The number of years would be driven by the time required to recoup the investment in the buses.

This contracting model was first developed in Bogota's TransMilenio system, and was one of TransMilenio's most important innovations. Unlike in Curitiba and Quito, where separate corridors are concessioned out to different operators, in TransMilenio contracts were awarded to different private operating companies, Si 99, Ciudad Movil, Express Del Futuro, and Metrobus SA. These contracts obligate the companies to operate a certain fixed number of buses in the corridors, but the routes on which these buses operate are not all concentrated on a single corridor. Rather, they are divided roughly equally between the different bus lines.

Each week, TransMilenio decides how many kilometers need to be operated to meet expected demand, and the private operators decide among themselves who is going to operate them each week. They then inform TransMilenio who is going to operate each route, and TransMilenio gives final approval. At first, TransMilenio directly assigned the buses to meet the daily scheduled service needs. Then according to the number of kilometers needed they divided the kilometers up according to each company's fleet size. The fleets are not all the same size. The bus operators, among themselves, try to organize it in a fair way among themselves so that each bus gets roughly the same number of kilometers.

Even though the bus operators are paid by the passenger kilometer, they ultimately bear some demand risk, because if the demand is lower than projected, TransMilenio has the right to reduce the total number of bus kilometers servicing the system. However, this risk is mitigated by two factors. First, because routes are diversified within the system,

no one company suffers the demand risk for any particular part of the system but they all experience the risk collectively. Secondly, while the operating companies might lose money each year if demand is lower than anticipated by having their kilometers cut, the contract allows for them to extend the period of the concession. The concession contract lasts for 10 years or until the average kilometers per bus reaches 850,000, whichever comes first. However, if after ten years the average is not achieved, the concession is extended until it reaches that average, but no individual bus can have more than 1 million km, nor can bus operators extend the contract by simply buying new buses to bring down the fleet kilometer average. However, the concession cannot be extended more than 15 years. So, the possibility of extending the concession allows the investor to eventually recoup their bus investment in the case of lower than estimated demand, although they would recoup it over a longer period of time. In practice this has not been a problem, as demand has actually been in excess of what was anticipated.

There would be several advantages to TransJakarta of contracting out operations in this manner rather than by giving private operators concessions for specific routes or regions or corridors:

- Competition within each corridor and quality of service contracting
- Diversification of financial risk between more and less lucrative corridors
- Maximum flexibility for TransJakarta to modify bus routes to improve efficiency.

First, allowing bus operators to operate on multiple corridors creates the possibility of competition between bus operators. TransMilenio is contractually allowed to penalize some operators and reward others by increasing or decreasing their scheduled trips, and giving these trips to competing bus operators if one company is not in compliance.

Because TransMilenio pays by the kilometer and each week sets the schedule, the way the fines are imposed on the operators is by cutting back on the number of kilometers that a particular bus company is assigned in the weekly schedule. It is this quality contracting that assures the excellent maintenance of the TransMilenio vehicle fleet, which in turn has dramatically reduced the number of vehicle breakdowns in the system.

Types of Fines:

- Vehicle deficiencies, the fine is a function of the revenue per kilometer
    - 50 kilometers for altering the vehicle in its interior or exterior, non-authorized advertisements, stereos, driver's cellular or walkman use, lights that don't work, unclean bus or seats in a bad shape.
    - 100 kilometers for doors that don't work properly and worn tires.
    - 250 kilometers for altering or damaging the GPS and radio communication system.

- For customer service deficiencies, the fine is equivalent to a 20-day minimum wage. For operations deficiencies, the fine is a function of the revenue per kilometer

- 25 kilometers for stopping the bus at different stations than the assigned ones or for stopping for a longer period or not stopping at an assigned station. For blocking an intersection
- 60 kilometers for parking the bus in an unauthorized place or change the route without authorization. For delaying the operation for no reason or for over passing another bus with the same route
- 175 kilometers for operating in non-authorized hours
- 250 kilometers for picking up or leaving passengers in places different from the stations. For riding the buses on streets different from the trunk lines without TransMilenio's authorization, for drivers abandoning the bus for no reason

- To assess compliance, performance indicators were developed that are a function of the best operator:
  - Difference of < 20% with the best operator, fine = to 0
  - Difference of > 20% < 25%, fine = to 30 kilometers for bus
  - Difference of > 25% < 30%, fine = to 75 kilometers for bus
  - Difference of > 30%, fine = to 120 kilometers for bus

TransMilenio, through its designated inspector, is in charge of the control and revision of the system operation with periodic or random visits.

TransMilenio can also directly fine the drivers for poor driver performance, such as speeding on the roadway or disobeying traffic signals. Speeds are monitored by the global positioning system (GPS) and are constantly monitored from a control center both to capture violators and to detect broken down vehicles for the dispatch of tow trucks.

For administrative and institutional deficiencies, the fine is a function of the revenue per kilometer, as follows:

- 50 kilometers for failing to send the reports required by TransMilenio and for opposing to receive inspectors from TransMilenio, hiding information or providing wrong information
- 100 kilometers for wrong practices in administrative and accounting procedures and abusing of the dominant position

- There are also fines for environmental violations. For this type of violation, the fine is a function of the revenue per kilometer:
  - 25 kilometers for running leaking fuel or oil
  - 50 kilometers for noise and air pollutants above the levels stipulated in the public bid. For mishandling hazardous material and for not following the maintenance, reparation and revision schedules

Below is a list of fines the companies incur if their drivers break the following rules. Drivers face temporary suspension, and operating companies face fines of cutbacks on scheduled kilometers, as the table below indicates.

DRIVER'S ACTION	SUSPENSION	FINE (NO. OF KMS)
No driver's license and bus registration paper	Suspension on the next day	100
No first aid	One day suspension	100
Deny giving information	One day suspension	100
Crash between TransMilenio buses		100
Red light	Immediate suspension	
Putting the bus in reverse in the trunk lines	One day suspension	50
Carry any guns	Immediate suspension	100
Disobey the Police	One day suspension	200
Come to work drunk	Immediate suspension	200
Causing an accident for an irresponsible action	One day suspension	200
Wrong approaching to the platforms	Three in one day gives one day of suspension	50
Speeding	One day suspension	100
Invasion of the pedestrian crossing space		100
Have company in the bus	One day suspension	50
Run out of fuel		100
Mechanical problems that cannot be solved in less than 1 hour		50
Verbal or physical aggression to passengers	Immediate suspension	100
Charge the fare inside the bus	Immediate suspension	200
Disobey the Central Control instructions or traffic authorities	Immediate suspension	100

For security deficiencies, the fine is a function of the revenue per kilometer, 100 kilometers for each day of not complying with contract.

Other Fines for not following the terms of the contract have a fine equivalent to a 50-day minimum wage per month. Fines can also be deducted from the operator's revenue. The revenues from fines becomes TransMilenio's income, and 90% is deposited in a Fines and Benefits Fund.

There is some recourse for private operators if they feel that fines are being imposed arbitrarily or unfairly. At weekly meetings, Transmilenio and the private operators meet to discuss technical issues such as operation and fines. If the operators and TransMilenio, during these discussions, judge that the fines were unfair, Transmilenio sends a message to the Coordinadora's Fund to discount the value of the fines from their payments.

Secondly, having bus operating contracts de-linked from specific corridors will allow TransJakarta to optimize the efficiency of service provision within the system without having to renegotiate contracts with the service providers. This leaves with TransJakarta

the greatest flexibility in terms of changing bus routes and services to maximize the efficiency of the system, and it provides TransJakarta with the greatest flexibility in terms of rewarding and punishing private operators for bad quality of service.

Finally, TransJakarta needs to decide what to do with the 90 buses that they own. Because it should not be the business of TransJakarta to own and operate buses, TransJakarta should transfer these assets to private bus operating companies as part of the competitive bidding process.

Four operating contracts should be enough for Corridors I, II, and III. They would be signed with four different operating companies. According to our preliminary estimates, with the current TransJakarta routing for Corridor II and III, TransJakarta will be able to satisfy the initial demand with 163 buses. As TransJakarta already has 90 buses, they only need 73 additional buses.

In our opinion, all of the 73 new buses to be procured should be articulated buses with a minimum of two doors but preferably with four doors. In our opinion, all of the existing 90 buses need to be reconstructed to have two doors, or sold and replaced with two – door buses.

II.3.c. Recommendations for Contracting out Trunk Line Operations

In our opinion TransJakarta should competitively bid the operations within all three corridors to the top four operating companies. These operating companies would be promised a minimum number of operating kilometers in exchange for promising to providing the service and meeting minimum service standards. The competitive bidding requirements should be primarily based on the minimum cost per kilometer that the bus operating companies are willing to provide the service for a period of 8 years. Each operating company should make this bid based on the assumption that they will have to procure new articulated buses. The bid should also be based on the assumption that each operating company would take ownership of 23 of the existing TransJakarta buses. These existing buses they would either have to reconstruct to have two doors per bus, (we estimate at a cost of roughly $10,000 per bus) or they could sell these buses and buy new two door buses. These contracts should then be signed between the operating companies and a newly incorporated PT TransJakarta.

II.4. TransJakarta Feeder Bus Operations

Currently, TransJakarta is perhaps the only closed-station BRT system in the world operating without a functioning feeder bus system. To be a feeder bus, normally there is either a discount to transfer onto the trunk line, or else the transfer is free.

There is a new system of three express buses that take passengers from some outer suburban areas (Bintaro and two other locations), directly to the TransJakarta corridor non-stop. These buses are privately operated under authorization from DisHub, and are

marked as official TransJakarta feeder buses. They cost Rp. 7500 for a non-stop trip, but they do not provide any free or discounted transfer between TransJakarta and the feeder. Many of the passengers are not taking TransJakarta but are using the new service as simply an express bus service. They are enjoying reasonable patronage at the peak hour and are roughly at 50% capacity.

DisHub made an earlier attempt to create a feeder bus system but it failed. The way the system was supposed to work was as follows. Thirty existing private bus lines with 383 buses, including 142 AC buses, were identified as TransJakarta 'feeder buses' and they were given TransJakarta decals to put on their windshield. Special paper tickets were designed and issued by TransJakarta that were supposed to allow you to transfer at a deep discount between the feeder bus and TransJakarta. The combined TransJakarta-feeder bus ticket, to be sold at TransJakarta stations and on the feeder buses, cost Rp. 3800, for AC feeder bus, and Rp. 2900 for non AC bus. The Jakarta Government agreed to subsidize the feeder ticket for non-AC bus by Rp.1000 per ticket, and for AC bus by Rp. 2000 per ticket, which is about what the customer would have paid had they have paid for two separate tickets. The private bus companies were to simply submit the ticket stubs to TransJakarta and be paid for them at the agreed upon rate.

This system never worked primarily for institutional reasons. TransJakarta first refused to give any tickets to the bus companies, because they realized that the private bus companies could simply tear the tickets and submit them for payment without them ever having been used. Then, the feeder bus operators refused to honor tickets sold at the TransJakarta stations. While the bus companies that owned the feeder buses agreed with the scheme, the bus drivers, who simply lease the buses for a day and then collect the bus fares directly, did not trust that they would ever be compensated by TransJakarta. So they refused to honor passengers with TransJakarta tickets. These lines were actually on perpendicular routes that cross the busway rather than on lines in parallel to the busway, so the problem was less one of competition for passengers than of the institutional agreements between the feeders and TransJakarta.

Problems with establishing feeder bus services are not unique to Jakarta. Every major 'closed' BRT system, including TransMilenio, which now draws more than 60% of its passengers from feeder buses, faced significant problems at first. TransJakarta, like Bogota and Curitiba, are 'closed' systems, where passengers pay when they enter an enclosed bus stop. Once inside the bus stop, passengers can board and alight from the buses very fast, and can transfer to other buses that stop at the same bus stop without paying again. The BRT systems have the potential to have very high capacity and operating speeds.

Because the systems are physically 'closed,' it is easy to change the contracting and regulatory structures inside that system without changing everything about how buses outside the system are regulated and managed. However, because the systems are closed, only a few passengers will be able to walk to and from the BRT trunk line to get where they are going. The other passengers are all going to have to transfer to get on the system. Because transferring usually takes time and costs money, most passengers will

prefer a 'single-seat' trip where they do not have to transfer, even if bus speeds are slower, particularly if it costs less. For this reason, in order to ensure that closed BRT systems have high enough levels of passengers to cover their operating costs, most of them when they were built changed the existing bus route structure so that many of the old bus lines now serve as feeders with a free transfer at the bus terminal.

Because the design capacity of TransJakarta is currently very low, (2700 pphpd), and current demand is nearly at this capacity, it is more important right now to increase the capacity of corridor I than it is to add feeder bus services. However, once the decision is taken to make the necessary improvements in the system's physical design to increase its capacity, feeder bus services should immediately be added. Until the feeder system is in place, profitability of the system will continue to be lower than it could be, and traffic congestion and air pollution in the corridor will continue to be worse than it needs to be.

The contractual relationship between TransJakarta, DisHub, and the feeder bus operators will be critical to its success and failure, and will depend significantly on the contractual structure of the trunk line operators.

Historically, in developing countries, feeder bus contracting has only been successfully been dealt with in two ways. Either the feeder buses serving a given corridor are operated by the same monopoly concessionaire that is operating the trunk line in the same corridor as part of the same operating contract, or the feeder bus operator is contracted out to a separate party directly by the BRT authority (TransMilenio).

Normally this is done by giving a concession contract to a single feeder bus operating company for a particular feeder region. This company may be the same as one of the trunk line operating companies if they win the bid, or it may be a different one.

It has been found that the best way to pay feeder bus operators is by using a combination of both bus kilometers (with the routes somewhat regulated by the authority) and also by the passenger (so that they have an incentive to find good routes and provide a good service that attracts passengers).

With feeder services you run into incentive problems by going with a single payment measure. In Quito, when they had the remuneration based solely on kilometers traveled, some operators found it more convenient not to pick up passengers. After all, the only thing that mattered was their odometer reading and the passengers were a headache. It was the opposite in Leon, where the payment was passenger based, and the feeder operators duly decided not to service non-peak or afternoon peak periods which had fewer passengers.

Other options have not been successful. Using informal paratransit vehicles operating under their own independent authority does not work because the paratransit companies end up competing for passengers for the trunk line service. Even when these vehicles are banned on the main trunk line, they will still try to make the long-haul trip on a parallel

corridor. This was tried initially in TransMilenio and the paratransit companies refused to stop at the TransMilenio stations.
Ultimately, unless the feeders are also paid entirely under contract from TransJakarta, they will never really function as feeders, and their interests of carrying passengers for as long as possible, and TransJakarta's interests of feeding as many passengers as possible onto the busway, will never be resolved.

III. TRANSJAKARTA'S TICKETING SYSTEM

There are several issues relating to the TransJakarta ticketing system that need to be addressed. First, can the current ticketing system be retooled to serve the full range of TransJakarta's ticketing system needs. Second, is the ticketing system sufficiently secure from theft that investors and the public can be confident that the revenues are being used properly. Third, what institutional structure will give TransJakarta the highest quality ticketing service and operation? Fourth, how might a new ticketing system be integrated with other transport service providers?

III.1. Procurement and Contracting of TransJakarta's Fare Collection System

As with bus services, the Department of Transportation (Dinas Perhubungan, or DisHub), was responsible for planning and procurement of the equipment and tickets used in the TransJakarta ticketing system, while operation of the ticketing system was contracted out separately by BP TransJakarta. Money for the procurement by DisHub came from the government budget, and the company was selected without a competitive bid. The contract with the equipment supplier was with DisHub, not with TransJakarta. TransJakarta, which was responsible for operating the system, did not even know what was in the contract between DisHub and the equipment supplier. The equipment supplier, having sold the equipment, had no further stake in the performance of the system.

The equipment purchased included the point of sale computer terminals (POS terminals) that add value onto the tickets, the turnstiles that record the trips used, and the central computer to which all POS terminals and turnstiles send their reports. Currently, DisHub owns this equipment. Ownership was supposed to pass to BP TransJakarta but it never was due to conflicts between DisHub and TransJakarta. TransJakarta currently has no access to either the system hardware or the application software installed at the bus stops or at the central computer, though the maintenance of the hardware installed has been TransJakarta's responsibility starting in February 2005.

The equipment supplier was a consortium between the Colombian firm Medina-Inox and a local partner. The supplier of the ticketing system equipment, Medina-Inox, misrepresented to DisHub its role in Bogotá's BRT system, TransMilenio. It claimed to be the designer and operator of the entire ticketing system, when in fact, it had merely been the supplier of some electro-mechanical equipment such as the turnstiles. Medina-Inox was a sub-contractor to Angelcom SA, another Colombian firm which held the

principal contract. The software to run the ticketing system had been designed by a different sub-contractor to Angelcom SA, a local subsidiary of a French IT company. Medina Inox hired a former staff member from Angelcom SA who brought with him some of the technical knowledge necessary to run the system, but not enough to adapt the system to Jakarta's different ticketing system needs. Medina Inox is now being sued by Angelcom on the basis of theft of intellectual property rights.

DisHub procured the contactless 'smart cards' from MIFARE, another local partner of Medina-Inox, again without a competitive bid.

Upon the creation of BP TransJakarta, BP TransJakarta then contracted out for one year the operation of the ticketing system to a separate company, PT Lestari Abadi after a competitive bid between four pre-determined candidates, which were evaluated with TransJakarta's own evaluation criteria. A full open tender was not held since time was very limited. PT Lestari Abadi operates as ticket sales and revenue collector operator only.

DisHub was supposed to transfer the ticketing system equipment to TransJakarta, but because it never worked well, TransJakarta refused to take ownership of it.

Since the opening of TransJakarta's Bus Rapid Transit system in January of 2004, the ticketing system has not worked well. The following problems were the most serious:

- Customers initially faced long delays waiting to purchase tickets and entering the gate barrier.
- The turnstiles were frequently unable to read the smart cards due to electrical and mechanical failures.
- The smart cards procured were sub-standard and many of them failed.
- The amount of revenue collected was difficult for TransJakarta to track because the data was consolidated by DisHub, and this data was incomplete, and not sent in a secure form to TransJakarta.
- The system was not programmed in a way to handle early morning discounts or discounts from passengers transferring from feeder buses.
- The system was not installed with proper grounding and power stabilization equipment.

While many of the problems were technical, they were at root contractual and institutional problems. Some of the problems encountered could have been avoided had DisHub signed a better contract with the equipment manufacturer. The contract should have required the equipment provider to provide ongoing service, and part of the payment should have been withheld until after the system was operational. The contract should have included stiff penalties for failure. Nor did the contract guarantee the transfer of the secret keys necessary to allow a second party to reprogram the system. As a result, when problems arose, the ticketing equipment supplier tried to get additional resources out of DisHub before agreeing to fix the problem. We do not know the degree to which the

contract with the smart card supplier held the company liable for providing substandard tickets and the loss of revenue to the system.

The operating company, because it had not procured the ticketing system equipment or the tickets, did not have access to the programs and access codes established to set up the system, nor did it have any legal obligation to ensure the ticketing equipment functioned properly. Because they didn't have control over the technology, they couldn't fix the problems even if they had wanted to.

Some of the other problems have basically been fixed. The initial delays at the ticket booths have been significantly reduced by replacement of the POS (point-of-sale) terminals. The basic ticket reading by the turnstiles now usually functions. Deformed or invalid tickets have been collected by TransJakarta and returned to the supplier, and largely replaced with functional ones.

Other problems have not been fixed. The information about the total number of smartcard trips purchased and total number of smartcard trips deducted from cards is supposed to be sent each day after bus system operation hours by batch mode to a central computer using wireless connection. However, the batch data transfer frequently fails, requiring the ticket data in the bus stop computers to be manually uploaded to the central computer. The data network is often down, resulting in doubtful data integrity. The ticket system is barely functioning in regards to integration between the ticket system at the bus stops and the ticket system at the central computer.

The more serious problem is the inflexibility of the way in which the ticketing system was programmed, and the impossibility of fixing this system. Medina-Inox and its local partner in Jakarta were asked to copy the TransMilenio ticketing system, with a few modifications. Medina-Inox put two types of card readers in each bus station; one for a single trip and one for multiple trip tickets. The multiple trip ticket did not work initially, and the single trip ticket reader also did not work well at first but now is generally working.

The problem was that the TransMilenio software was designed for a flat fare system only. TransJakarta has a different fare for different times of day: Rp.1500 from 5:00am-7:00am, Rp.2500 from 7:00am -10:00pm. TransJakarta also wanted to give discounts to passengers using designated feeder buses. They also wanted a ticketing system that could differentiate between the fare for AC and non-AC feeder buses. Unfortunately, Medina-Inox tried to use the same software that was used by Angelcom in Bogotá. Because Bogotá has a single flat fare, the software used does not store a total money value on the smart card, it only stores a total number of trip credits. The turnstile reader only counts the number of trips used, and does not convert this trip into a money value.

Because there is no card reader at the exit terminal, there is no possibility to have distance-based fares. There is also no information being collected on the origins and destinations of TransJakarta riders. As a result, the original software was not usable for TransJakarta's needs and needed to be modified. We do not know if Medina-Inox has the

capability to do it, but they are not volunteering to do it without further payment. The equipment supplier was not made liable for system failures or for fixing and maintaining the system.

III.2. International Experience with Different Ticketing System Institutional Structures

Problems with the ticketing system are not unique to TransJakarta. Institutional arrangements vary widely from system to system, with different benefits and risks. Most systems have the following components:

- The manager of the money (usually a bank or money manager)
- The equipment provider
- The ticket provider
- The ticketing system operator
- The transit authority or its parent agency

How these functions are related institutionally depends upon the technical competence of the transit authority or its parent agency, the level of concern about corruption, the type of system desired, and the need for financing it with private money.

It is fairly standard for the manager of the money, the equipment provider, and the ticket provider to be closely associated, while the ticketing system operator is separate. This allows the equipment provider/financial manager to monitor the ticketing system operator to avoid corruption.

In the case of TransMilenio in Bogota, the ticketing system was done through a unique Build-Operate Transfer model. In this case, there was a competitive tender for a single company to both procure the ticketing system equipment and operate the ticketing system. The company that won this tender, Angelcom SA, both selected and paid for the ticketing equipment, and operates the system. The contract signed was between TransMilenio and Angelcom, not between the Department of Transport or the Department of Public Works and Angelcom. Angelcom in turn receives a fixed percentage of the revenues from TransMilenio. A third company was contracted by TransMilenio to be responsible for managing the revenue once collected. All fare revenue in TransMilenio is placed by the operator into a Trust Fund, and this company managed the TransMilenio Trust Fund on behalf of all the parties with a vested interest in the fair and accurate division of this revenue: TransMilenio, the trunk line operators, the feeder bus operators, and the ticketing system operator.

This Built-Operate-Transfer institutional model for the ticketing system had some advantages and disadvantages. The system was eventually able to attract private investment for the ticketing system equipment in a country where private investment was difficult to secure due to political risk. This reduced the initial capital cost of the TranMilenio BRT system. However, the ticketing system operator receives 10% of TransMilenio's total revenue, whereas their operating costs are probably much lower. As such, it puts an unnecessary financial burden onto system operations. It would have been cheaper if the ticketing system were simply purchased outright by TransMilenio.

This structure did assure that the ticketing system functioned on a basic level. Because Angelcom's profits are determined based on the success of the system, they have a vested interest in system success. Because they were also responsible for operating the system, they had a vested interest in getting equipment that functioned properly. Because they were a ticketing system operating company, they also knew more about the appropriate technology than the government, and were able to negotiate better equipment contracts with subcontractors and get lower prices. By privatizing the procurement contract, they also removed the risk of corruption in the procurement process.

On the other hand, Angelcom bought relatively cheap equipment in an attempt to save money. They complied with their contractual obligations but the quality standards were reasonably poor, the design was inflexible and of poor quality, implementation was slow, and there were a host of technical problems in the first month of operation. These problems could have been solved within the current structure by having harsher penalties for poor performance, and by having TransMilenio specify in the tender a higher technical standard for the ticketing equipment. TransMilenio could even have handled the procurement independently and then 'novated' the contract to the winning ticketing system operator. In this way, the operating system bidder becomes the owner of the new equipment, and can be required to pay for the investment, but the government would retain tighter control over the equipment selection process.

It is fairly common in the transit industry to separate initial equipment procurement from operations. This is usually done when there is a public transit authority that directly collects the farebox revenue, and where there is no expectation that the operating company will provide the investment into the system. Technology providers such as Ascom Monetel, ERG, INDRA or Scheidt and Bachmann, have focused their attention on the technology development and integration tasks, leaving the ticketing system operation to transit agencies. This structure can reduce the ongoing financial burden that a BOT would impose. However, if equipment procurement and operations are separated, contracts will have to be structured carefully to ensure that the equipment providers are responsible to the operating company for system maintenance.

In Hong Kong, the transit agencies created a joint venture company, Creative Star, and assigned it with the responsability to oversee the technological implementation of the smart card project. ERG developed the technology. Years later, Creative Star decided to re-write all the code and keep the exploitation rights to itself. The transit agencies are responsible for the ticketing.

In London, TfL contracted out with a consortium, Transys, the operation (clearing) of the smart card and the technological development. Transys is a joint venture of an operator, EDS and a technology provider, Cubic. In Paris, RATP developed a joint venture with a privately owned technology firm to develop the calypso technological standard. The operation and maintenance is responsibility of RATP.

In Rome, the transit authority contracted out the design of the sytem to ERG, the

operation would be public. In Boston, the transit agency contracted out with Scheidt and Bachmann, the operation would be responsibility of the transit authority.

Some other forms are also being tested in other countries. In Santiago de Chile, a project is under development where four banks will manage the financial resources of a new BRT system and issue the smart cards. The four banks will also contract the technology provider, whose responsibilities are laid out in the contract with the banks. The outcome of this interesting institutional arrangement is uncertain, but looks promising and deserves attention.

III.3. TransJakarta's Revenue Control System

TransJakarta's revenue control system has two types of problems: those inherent in the structure of the system and those caused by equipment failure.

Currently, when the system is working normally, at each TransJakarta station there is a ticket booth with one or more computer (a point-of-sale terminal, or POS terminal). These POS terminals are operated by PT Lestari Abadi staff, but owned by DisHub. These assets are now in the process of being transferred from DisHub to TransJakarta. The POS terminals must be initialized when they are first put into operation. During initialization, software is loaded onto a POS terminal which makes it possible for that terminal to add value onto a smart card. In this process, the terminal is given a specific code / keys given by authorized personnel that make it an authorized POS terminal. Without this code, any person could easily buy a POS terminal, develop the software and start selling tickets.

The smart cards also have to be initialized (programmed and coded) before they can be used in the system. This involves changing the default keys with the key code defined for the system operator. This is done by a special initialization terminal which has an access code, or secret key. Any POS terminal can be an initialization terminal if it has access to the access codes. The access codes also contain instructions about the mapping of the card and other accessibility characteristics.

POS terminals can add value to the card, because they have a key that authorizes them to do so, and the turnstiles can subtract value from the card, because they also have a key that authorizes them to do so. The initialization terminal has the ability to store both of those keys in the smart cards, so that they are recognized both by POS terminals and turnstiles in the system. The access codes established by the equipment provider are required to initialize and/or reprogram the cards. Currently, DisHub claims they do not have these access codes.

Once a POS terminal is initialized, and the smart cards are also initialized, the POS terminals then have to be activated at the beginning and end of each shift. Each cashier has a special smart card that authorizes him or her to open and close the add-value function on the POS terminal. This enables the system operator to track the performance

of their cashiers by obtaining reports on the sales by shift, by POS terminal. This process is currently performed by PT Lestari Abadi in a satisfactory manner.

Once the POS terminal is initialized and activated, value can be added to the smart card. There is currently a moderate risk that someone could gain access to the key code and illegally add value onto cards. This could happen in the following ways:

1. Someone with access to the software in the POS terminals could copy the software.
2. Someone with access to the initialization codes could create new smart cards
3. Someone could hack one of the existing cards and figure out the code through trial and error.
4. Someone with at POS Terminal could disconnect it from the main computer and add value to cards in a way that is not detected by the central mainframe computer.

Unfortunately, we do not have much information about how this process is currently being handled. Our general assessment is that there is not a very strong likelihood of this sort of technological fraud, and it can be controlled by measures suggested below, but some advanced security measures could be considered that would further reduce these risks. These will be listed in the recommendations.

When a customer arrives at a POS terminal, they either buy a new smart card or add credit to an existing smart card. The cash is put in the cash drawer, and the transaction is recorded in the computer at the same time that it adds the credits onto the smart card. This smart card gives them credits for a single trip or for multiple trips at a fixed price of Rp.2500 per trip. When the customer passes through the turnstile, the credit for one trip is then deducted from the smart card.

Currently, the cashiers have to fill out forms where they record the cash at the beginning and end of their shifts. The forms used are signed by both cashier and supervisor of the ticket operator.

TransJakarta should also require the use of pocket less uniforms; in general, booths should be as empty as possible to avoid theft problems and reduce the possibility that the cashier keeps any change.

At the end of each day, each POS terminal in each ticket booth counts the total revenue from ticket sales and sends this information to the central computer. Each turnstile also records each entry and sends this information to a central computer. The central computer currently resides at DisHub, but it will presumably move to TransJakarta at some point. The central computer then generates a consolidated sales report which includes all of the revenue from sales and all of the turnstile entries. TransJakarta currently stations its personnel at the DisHub's site to monitor the ticketing central computer and to receive computer printouts of the sales reports.

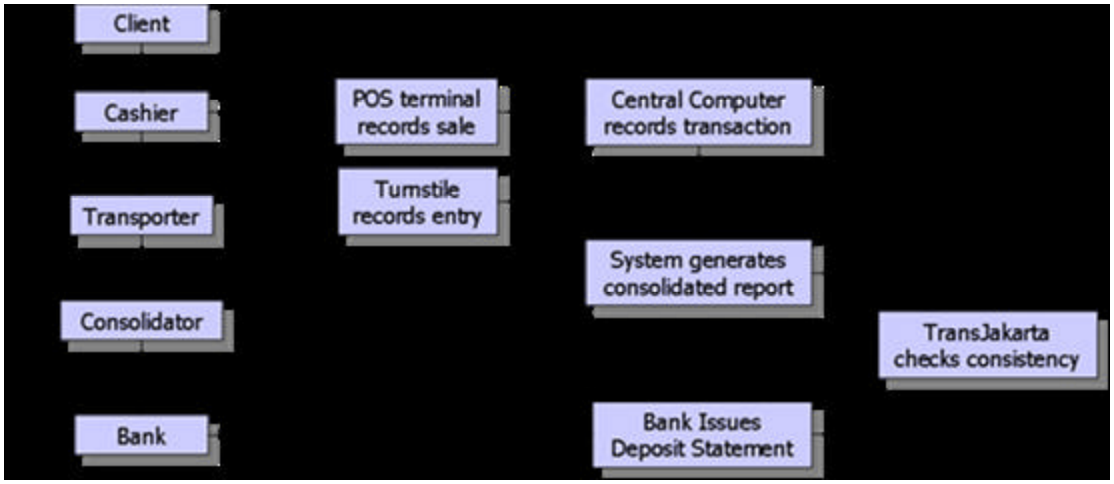
TransJakarta's ticketing department compares its manual counting of sales with computer generated reports. If someone were adding value to cards from an unauthorized POS terminal, this would show up as a big discrepancy between the sales and the system entries. A cursory look at these reports provided no indication that a major discrepancy exists.

At the end of each day, the cash collected by the cashier at the POS terminal is given to a money transporter, also employed by the ticketing system operator PT Lestari Abadi. The transporter brings the money to PT Lestari Abadi. The money is temporarily stored at Lestari Abadi's office vault to be counted, and then deposited to TransJakarta's account at Bank DKI – the city government's bank – after a reconciled sales report is generated with TransJakarta's knowledge and approval. The money stays with PT Lestari Abadi for two or three days while PT Lestari Abadi together with TransJakarta personnel do a verification counting upon total ticket sales each day, based on the ticket sales recorded manually by Lestari's ticketing personnel, ticket sales recorded by the computer display at the bus stop, and the consolidated report generated at the central computer.

This tedious verification effort to decide upon total ticket sales each day is needed since the ticketing system, the computer \ data network between the bus stops and the central computer, and the data gathered at the central computer are not reliable.

The amount of money deposited into the government bank account is decided based on the result of the verification effort. If a discrepancy occurs, then both TransJakarta and PT Lestari Abadi reach an agreement on the sales amount for that particular day. The money agreed upon is then deposited into the government bank account and a deposit slip is generated. TransJakarta receives the deposit slips from the bank.

This is a deviation from typical norms. Normally, all the revenues collected by the ticketing system operator would be deposited directly into the government bank account, without any prior reference to any sales report, or agreement with TransJakarta. Then a public authority like TransJakarta would compare these deposit slips to the sales reports generated by the central computer, and the deposits should be greater than or equal to the sales report.



Ideally, it would happen as above. The ticketing system operator would be responsible for depositing all the cash into the bank, and would be responsible for all the money deposited. The owner of the technology (TransJakarta or DisHub) would generate the consolidated sales report, and compare this to the bank deposits.

The reason that the amount has to be negotiated is that there are several occasions when passengers are purchasing tickets when this transaction is not being recorded by the POS terminal, or they are entering turnstiles when this is not being reported by the turnstile to the central computer. Mechanical and electrical errors intermittently occur at the systems installed in the bus stops.

The reason for this is that circumstances often compel the staff of PT Lestari Abadi to manually override the computing system. Typical examples of this are as follows:

? When there is a power outage,
? When the ticketing equipment or the turnstile is not working properly
? When long cues form at the terminals so that there are big delays at the ticket booth.

During these times, ticketing operators sell uncoded tickets and then just collect them manually at the turnstiles in a box. At these times, neither the ticket sale nor the turnstile entries are recorded. During these times, they control the sales via controlling the stock of cards. Sales are computed by a supervisor taking the difference between the number of cards available for sale at the beginning of the day less the number of cards available for sale at the end of the day.

Certain categories of users may also be admitted to the system without paying the fare, such as TransJakarta staff, who enter by showing a badge. There may be other exemptions but we are not aware of them.

Because there is no electronic paper trail for the sale of tickets that are not entered into the central computer, TransJakarta must rely on the integrity of the ticketing system operator to estimate the number of passengers that are entering the system when the computing system is not being used. This is clearly not a tenable situation.

Furthermore, there is no reliable electronic record of the number of people paying versus the number of people entering the system without having to pay. Were the equipment provider selling tickets illegally from a remote terminal not connected to the central computing system, there would be no reliable way to track this. However, if the numbers were large a long term discrepancy between ticket sales and system entries should be fairly clear from the sales reports.

In addition to these most glaring issues, standard protocols for testing the system's integrity are not fully in place. TransJakarta appointed a group of engineers to assess the quality of the system and attempt to find leaks in it. They have performed some tests, but they have yet to perform a hierarchical test plan that begins with the POS terminal, goes through the integrity of the sales reports, and ends with a transparent balance between the sales report and the bank deposits.

The verification of the tickets sold each day by TransJakarta and Lestari Abadi means there is no discrepancy concerning the total tickets sold each day. However, the reliance on manual reports during this verification (because of an unreliable automated system) means this agreed to amount may or may not be accurate. While ITDP has no evidence of wrongdoing in Jakarta, the experience of other cities – in particular Bogotá's TransMilenio – is that manual reports can be easily altered.

A second, though less likely risk, is that someone could be illegally adding value to tickets in a way which is not being recorded by the central computer, by using a disconnected POS terminal, by copying the software, or by hacking into the access codes on the cards.

III.4. Improving TransJakarta's Ticketing System Flexibility: Integration with Feeder Buses, Future TransJakarta Corridors, and Other modes.

With the opening of Corridor II and III in the TransJakarta, the question of how the ticketing system can be adapted to TransJakarta's needs is again urgent.

Because the current ticketing system records only the number of trips on each card and not a value, the system is unable to provide discounts during non-peak hours or free or discount transfers between systems that are not physically integrated. It also means that the multi-trip cards are unable to provide a discount off peak. The system is also unable to move to a distance based fare, though we are not necessarily recommending a distance based fare. Finally, the existing system cannot provide discount tickets for transfers with commuter rail, planned monorail or boat commuting, nor can the card be used for other commercial transactions.

The MIFARE™ contact less smart card now used in TransJakarta supports the development of a multiple application card. Hardware components installed in the existing system such as turnstiles, station computers, Local Area Networks, UPS, communication hardware and central computers can also be used in the multi application environment.

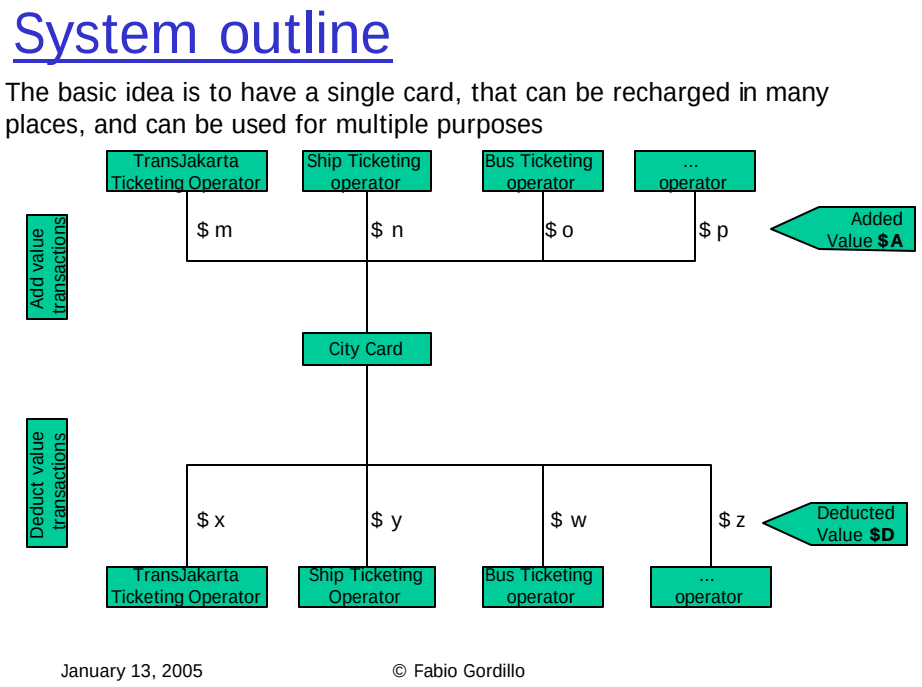
To develop such applications, however, TransJakarta needs to first develop a different institutional arrangement. A Clearing Center Operator needs to be created that will handle the transactions that add value to smart cards, and deducts value from the smart cards. If the clearing center is going to provide a smart card service to multiple system operators, such as for the commuter rail system, the feeder bus operators, the trunk line operators, and ferry boat operators, then value might be added at terminals at each of these locations. These 'add value' transactions would need to be fed into the central computer of the Clearing Center Operator. When a trip is made on TransJakarta or on one or the other systems, this transaction also has to be recorded with the Clearing Center

Operator. By having a Clearing Center Operator separate from TransJakarta, it could handle transactions outside of TransJakarta.

The Clearing Center Operator must

- guarantee that all transactions are received without modification in a clearing center. It must be the only one that knows the secret keys used to add and deduct value and that should reside in both the equipment and the smart cards.
- Develop a safe protocol for the transmission and storage of those secrets keys inside the Operator´s equipment.
- Issue (Initialize) the smart cards with the secret keys.
- Define a communication process to maintain and update a Database with all transactions.
- Define routines to check the integrity (no transactions missing) of the information received.

Whether the Clearing Center Operator is operated directly by TransJakarta or by a consortium of different agencies (commuter rail, ferry, monorail, etc), depends on whether or not a ticketing system is wanted for use both inside and outside of the TransJakarta system.



While the current smart card is okay for multi-application use, it would need to be programmed differently, and this requires an upgrade of the existing software. While the consultant was not given access to the actual program running the fare collection system, our understanding is that it currently works like an electronic token system rather than an 'e-purse' or a cash card. In other words, the 'smart' cards have on them only a number of

trips, not a dollar amount. Each time the card is used another trip is deducted, but this trip is not translated into a dollar value. This is a much simpler program than with an e-purse because currently the system only needs to count transactions, whereas with an e-purse the central database needs to keep track of the value of each transaction. Therefore, to use in a multi-purpose environment or for discount tickets, the 'token' approach needs to be replaced with an 'e-purse' or cash card approach, and the main software and the turnstile software therefore needs to be changed significantly.

Upgrading the software to use the "e-purse" technology available in the existing cards requires having access to the access codes that are currently used to initialize and program the cards. The equipment provider has these codes but thus far has refused to provide them to DisHub or to TransJakarta, and they are not contractually obligated to do so. Some analysis should be done to determine whether it will be more cost effective to simply replace the existing tickets and equipment, to purchase the codes from the equipment supplier, or to hire someone to break the codes.

The fare cards used in Jakarta have 16 separate storage locations with 16 separate passwords. Each of these sectors is programmed separately. If the access codes cannot be received or purchased from the equipment provider, if not all of the 16 sectors on the current 'smart' cards are already programmed, it is possible that the current cards could be reprogrammed using a new access codes. If most or all of the 16 sectors in the current 'smart' card are already programmed, and the access codes cannot be obtained from the equipment provider, then a new technology provider would have to develop the new application in a new set of cards, and all of the existing cards would have to be replaced with these new cards.

III.5 Final Recommendations on the TransJakarta Ticketing System

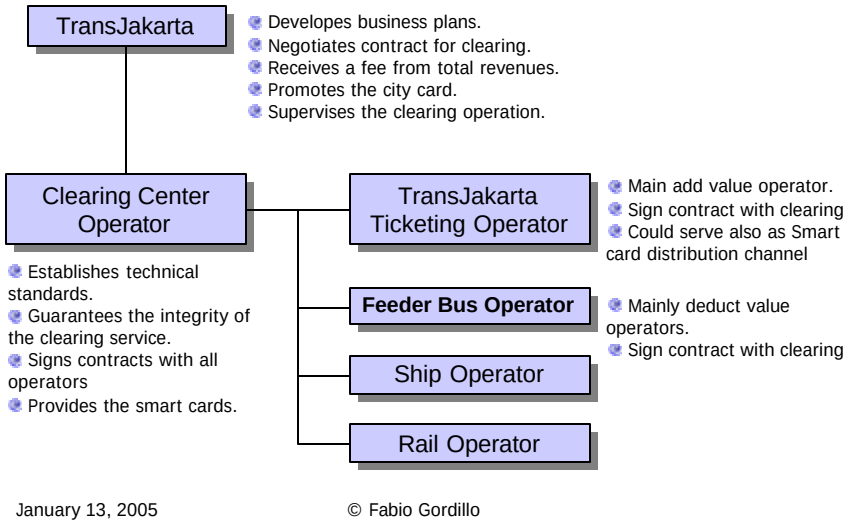
The current ticketing system for TransJakarta provides neither a good service nor security for the revenue stream. We recommend that all of the problems be addressed systematically and all at once to avoid adding further headaches.

No consultant, however, can tell DKI Jakarta what sort of ticketing system it wants. Jakarta must decide for itself what sort of ticketing system it wants. Furthermore, any changes need to be implemented in a manner which minimizes disruption of the existing operations. Based on our preliminary analysis, however, we would recommend the following:

1. TransJakarta should be transformed into PT TransJakarta.
2. PT TransJakarta should be empowered by the Governor to issue a competitive tender for one consortium of companies to manage the Clearing Center Operation of the ticketing system and to procure the necessary ticketing system equipment for operating a cash card or e-purse ticketing system. Ticketing system operations should remain a separate subcontract under TransJakarta.

Implementation Plan - Institutions

The following can be the institutional arrangement for the implementation of a multi application card.



3. After consultation with independent experts and several ticketing equipment and Clearing Center Operator service providers, PT TransJakarta should set a detailed technical specification for the type of ticketing system equipment it wants, and assess what of the old system is usable. Based on this assessment, PT TransJakarta should then develop the terms of reference and supervise the competitive tender for a single Control Center Operator and equipment provider. They should reissue a competitive tender for the ticketing system operator.
4. The winning tender for the Control Center Operator and equipment provider should be selected by PT TransJakarta with oversight from an independent technical committee which could be the Public Transit Advisory Council chaired by Prof. Sutanto from the University of Indonesia's Center for Transportation Studies.
5. When the winning tenders are selected, the contracts must be drawn up in such a way that financial responsibility for an equipment failure is clearly delineated, and penalties for slow repairs incorporated into the contracts in a manner that clearly allocates financial risk with responsibility for the problem.
6. The contract with the equipment provider and the Control Center operator should include the following provisions:

    - They should be required to have sufficient POS terminals and turnstiles to avoid cueing at stations.
    - The POS terminals and all systems should have voltage stabilizers and back-up power systems so that they do not fail in the case of power outages.
    - The access codes (and the encryption algorithm discussed below) used to

add value to cards should be stored inside the POS terminal in a Secure Access Module (SAM), a piece of hardware attached to the inside of the POS terminal. This would make impossible for someone to simply copy the software to obtain the codes.

- Each POS terminal should have a limit to the number and/or value of the transactions that can be performed offline. After this number is reached, the terminal should have to receive an encrypted approval from the mainframe computer. This would make it impossible to add value to cards for long when the computer is off line.
- Instead of using the same access codes to program each smart card, each card could have a unique access code. This can be achieved by combining a system-wide read/write key (mother key) with the unique serial number of each card, using an encryption algorithm such as DES. As a result, each card would have a different read/write key, associated with the mother key in a way that only the technology provider knows. This guarantees that, in the event that a hacker guesses an access code, he won't be able to break the security of the entire system, but just the security of a single card.

7. When TransJakarta takes control of the new system, before turning over revenue collection to the control system operator/equipment provider, it needs to:
   - Systematically test each component in the system for integrity. Those tests should begin with the point-of-sale (POS) terminals and end with an acceptance of the sales reports.
   - Test each component of the system separately to guarantee that each step of the process is working correctly. For example, are the turnstiles properly recording entries? Are they sending the right information to the central computer? Is there a power backup system to keep the information in tact in case of a power outage? Can the information collected by the central computer be tampered with? Are the protocols for controlling this being followed?
   - In particular, to implement the revenue control process, it is necessary to test the POS terminals and be sure that the sales reported in the station level are accurate, and therefore that the manual reports prepared in the stations are reliable.
   - Ensure that all of the money being received by the ticketing system operator is being deposited directly into the bank accounts of the firm selected to be responsible for financial management of the system, without waiting for an agreement between TransJakarta and the operating company on a sales report.
   - The ticketing operator should notify TransJakarta of the entire amount credited for each day, no later than the day right after the collection of the money. The operator should indicate clearly to which day of operation each deposit corresponds.
   - TransJakarta should determine the sales value based on the system report and the contingent reports that could exist for a day of operation and check if the amount credited in the bank is greater than or equal to the consolidated sales

report. In case that there is less money in the bank account, TransJakarta should ask the ticketing operator to deposit the difference.

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Only once the integrity of the system is ensured should the ticketing equipment provider and control system operator be given control over the revenues.

10. TransJakarta needs to establish ongoing routines and administrative procedures to:

- ? check periodically which card serial numbers are active in the system. This would make it possible to identify if there are unauthorized cards in the system.
- ? to prevent doctoring the information generated by the central computer that collates the information on total ticket sales and total trips.
- ? check that at all times the total number of entries are below the total number of sales. This is a very important graph that someone in TransJakarta should maintain and update regularly.

IV. PROJECTED DEMAND ON CORRIDORS I – III UNDER DIFFERENT PRICING AND OPERATIONAL SCENARIOS

Currently, TransJakarta is considering several options for the fare structure in Corridors II and III. This section reviews the impact of these options on the total demand and on the total profitability of TransJakarta.

When Corridor II and III open in January of 2006, the corridor is being designed to allow for transfer between all three corridors at Harmony station, and between Corridor II and III at Pecenongan. There is currently a discussion in Jakarta about how the existing fare system will relate to the new corridors. The following options are being discussed:

- ? DisHub proposes that the existing ticketing system be extended to cover Corridors II and III, the flat fare be retained, and free transfer be provided between Corridors I, II, and III.
- ? TransJakarta proposes that the existing flat fare ticketing system be retained on Corridor I, but that a new system under TransJakarta's control be introduced in Corridor II and III. The new system would require passengers to pay another full fare when transferring between Corridor I, II, and III. TransJakarta would also like to introduce distance-based fares in Corridor II and III, and discounts for transfers from feeder buses.

These and other options will be discussed below.

IV.1. Projected Demand on Current Corridor II and III

Because of flaws with the SITRAMP model developed by JICA (gaps in the network, lack of data on paratransit vehicles or occupancy, and exaggerated expansion factors), ITDP in cooperation with the University of Indonesia Center for Transportation Studies created a new traffic model in EMME/2 for the TransJakarta system to assist with the design of future corridors and contract negotiations with potential operators. Over 60,000 on-board origin destination surveys were conducted with transit passengers. Calibration of the entire network was also done with observed data. The control points for observed volumes of passengers correspond to the 60 bi-directional sections of the OD survey, which were used to expand the OD. In addition, 12 bidirectional points were added to refine the adjustment.

TransJakarta currently counts between 60,000 and 65,000 daily passengers. When modeled using the ITDP/UI CTS traffic model, we get the following simulation results:

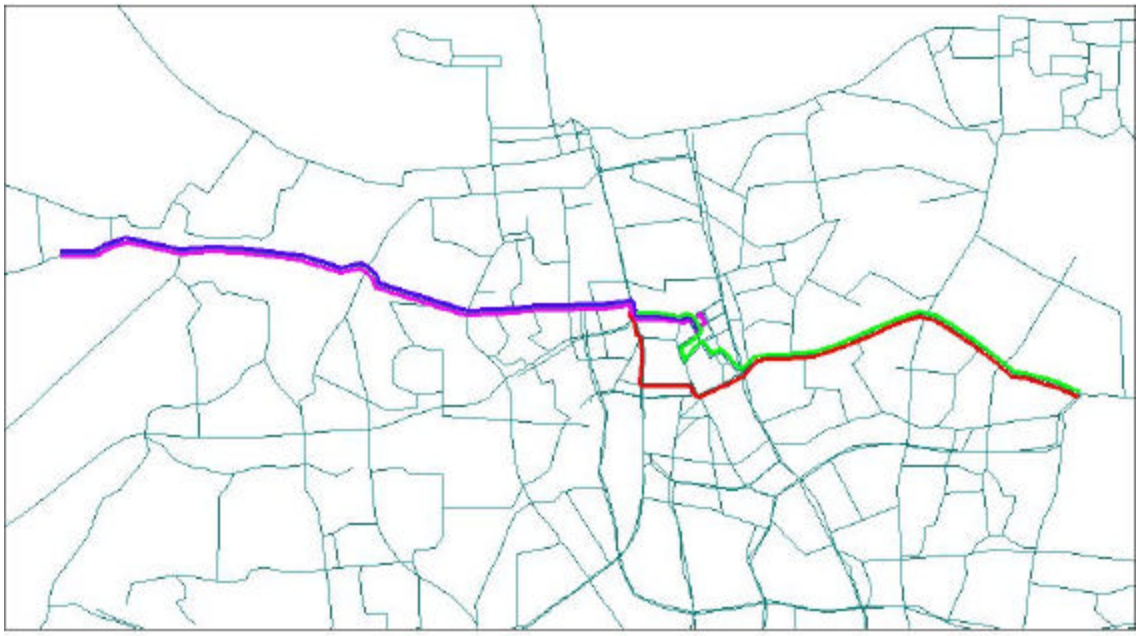
MORNING PEAK
ACTUAL

Lines	Headway	extension	Travel time	Boarding pax	Max Volume
BM-KT	1.5	13.01	43.58	2583	2281
KT-BM	1.5	13.02	43.61	1754	1588
TOTAL		26.03		4337	

DAILY PASSENGERS

Lines	Boarding pax
BM-KT	37144
KT-BM	25223
TOTAL	62366

Based on the request of TransJakarta, ITDP evaluated the projected demand on Corridor II (Pulogadung-Harmoni) and Corridor III (Kalideres-Harmoni) based on the currently planned itinerary, as below:



This proposal considers two free transfer stations, at Harmoni between all the lines and at Pecenongan between corridor 2 and corridor 3.

Modeling results:

Scenario 1 Morning peak hour

Lines	Headway	extension	Travel time	Boarding pax	Max Volume	Pax. paying	# Bus	running km
BM-KT	1.5	13.01	43.58	4412	3644	11523	63	820
KT-BM	1.5	13.02	43.61	2951	2678	63%		
KL-H	2.0	15.24	50.99	3187	2721		54	811
H-KL	2.0	14.78	49.45	1989	1976			
PL-H	1.9	12.66	42.4	2747	2733		46	572
H-PL	1.9	12.19	40.8	2932	2791			
TOTAL		80.9		18218			163	2202

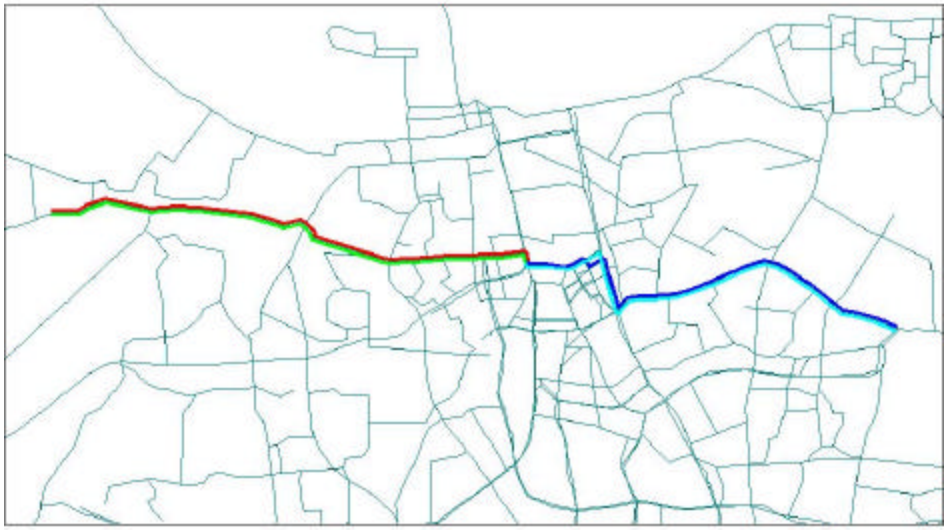
At this level of demand, ***Corridor I of TransJakarta will be significantly in excess of the system's current capacity of around 2700 pphpd***. If the same design used in Corridor I is applied to Corridor II and III, Corridor II and III will be roughly at capacity at soon as it opens. As such, ***Corridor I needs to be reconstructed immediately to accommodate this projected increase of demand prior to the opening of Corridor II and III in January of 2006,*** and Corridor II and III designs should be modified to ensure that the system is not already at capacity the day it opens.

The analysis also shows that if there is no direct bus routing (ie. no bus lines running direct between Pulo Gadung and Blok M, and Kalideras and Blok M, and Pulo Gadung

and Kota, and Kalideras and Kota), then transfers at Harmony will be in excess of 5000 and could be as high as 6000 transfers at the peak hour. The capacity of this station is below 2700, meaning that even with a second station stop and a passing lane, Harmony station will be severely overcrowded. Hence, direct services are required for at least some of these routes to reduce overcrowding at the Harmony station.

The current itinerary of Corridor II bypasses the Senen Bus Station and Senen Railway Station. There may be significant political reasons why this routing was selected. From a demand and operations perspective, however, ITDP has proposed an alternative routing.

Itinerary proposed by ITDP



This itinerary compared with itinerary 1 offers:

- A single line between corridors 2 & 3 with operational returns to adjust the bus frequency with the demand of each corridor
- The route is shorter and does not overlap and hence congest Corridor I as much, reducing delays and operating costs.
- The demand is higher due to proximity to the Senen bus and rail terminals.

Scenario 2 Morning peak hour

Lines	Headway	extension	Travel time	Boarding pax	Max Volume	Pax. paying	# Bus	running km
BM-KT	1.4	13.01	43.58	4840	3942	12666	68	885
KT-BM	1.4	13.02	43.61	3913	3582	62%		
KL-H	2.2	12.78	42.74	2528	2451		42	537
H-KL	2.2	12.78	42.74	2150	2150			
PL-H	1.5	11.86	39.72	3930	3557		57	682
H-PL	1.5	12.06	40.39	3183	3023			
TOTAL		75.5		20544			167	2104

The impact on the TransJakarta BRT system's daily ridership, and hence on its revenue, is listed below:

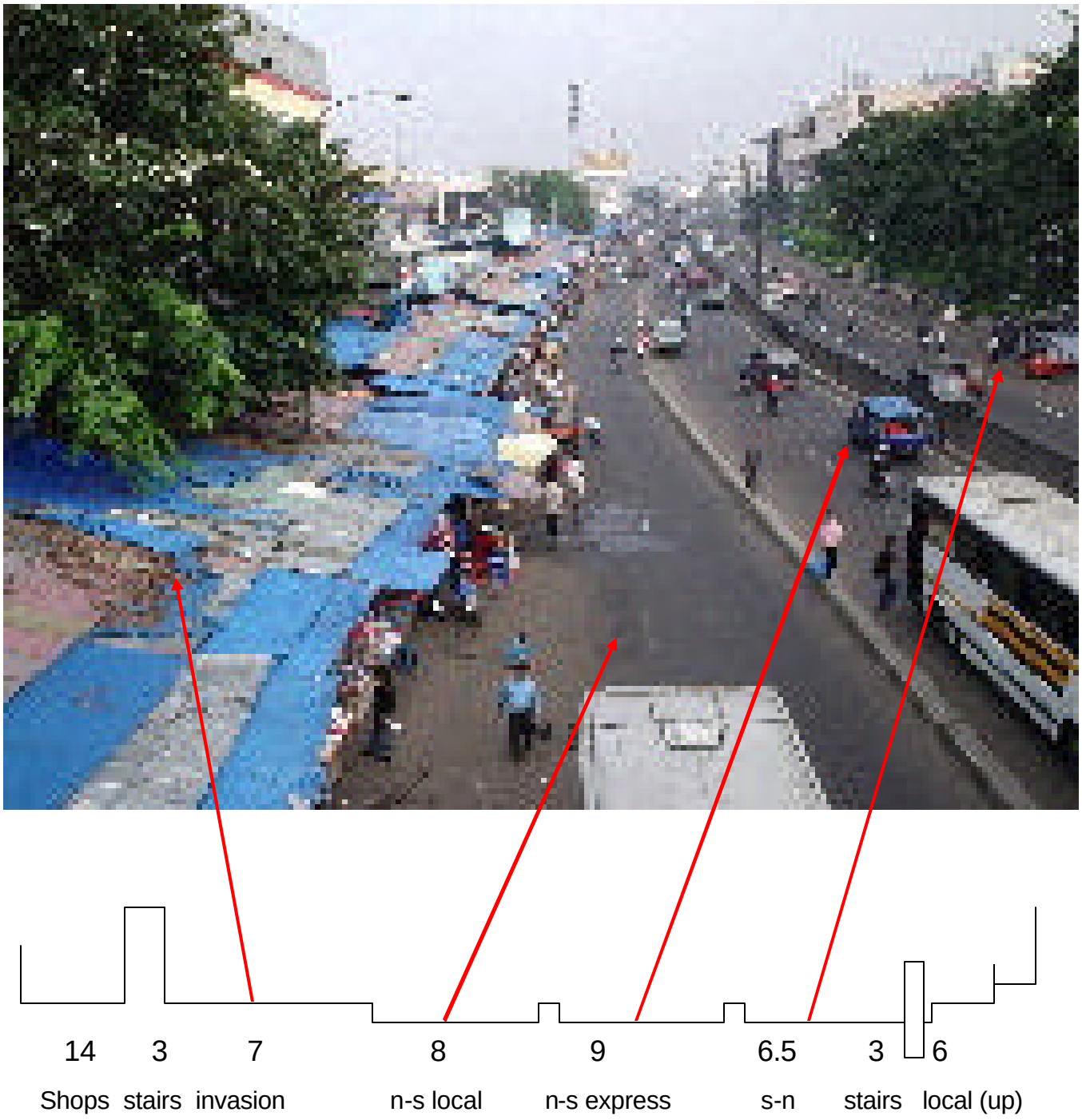
Daily Passengers

Lines	Scenario 1	Scenario 2
BM-KT	63445	69599
KT-BM	42435	56269
KL-H	45829	36353
H-KL	28602	30917
PL-H	39502	56513
H-PL	42162	45772
TOTAL	261975	295423

We evaluated the space available in the corridor, and there is enough space, though removal of the current vendors is necessary and likely to be very contentious.

Photo 15:
Jl. Gunung Sahari, Senen.
(North – South)

The photo shows a view of the Senen bus terminal entrance from a pedestrian bridge located to the south of the terminal (the photo shows the north side of Jl. Gunung Sahari). A BRT bus stop would be very good if built located just on the south side of the road, where there is more space available.



As shown on the photo the local N > S road is almost un-used (after Senen) and there are 7 meters of space lost to invasion. The express road N > S has 9.0 meters and only two lanes are being used. Adding together these wasted areas, there should be enough space for a bus station for the BRT.

The itinerary proposed by ITDP results in a significantly higher demand, a higher revenue, less operating cost and less travel time for passengers. It would also reduce

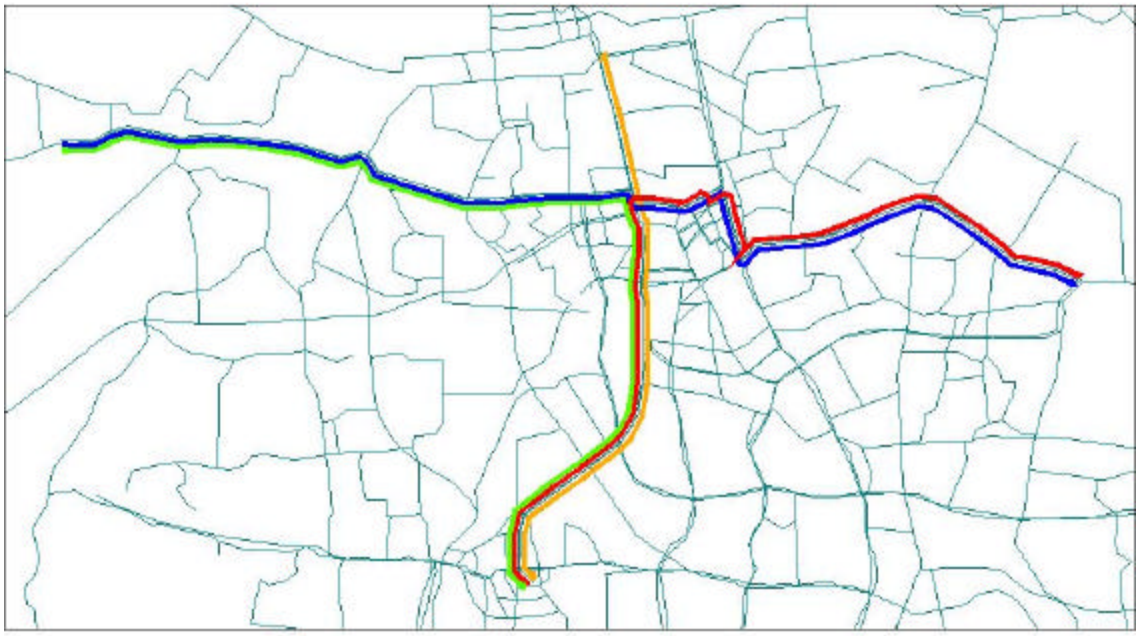
congestion in the mixed traffic lanes. The difference in annual revenue at Rp.2500 per trip is in the range of Rs.25 billion ($2.75 million). If and when this modification in the route is possible, it should be made.

IV. 2. Demand Impact of Different Operational Designs for Corridors I, II, and III

IV.2.a. Impact of Different Operational Designs on Passenger Demand, Revenue and Cost

The configuration of lines in this alternative is composed by the itineraries:

- BlockM-Kota with headway of 2.5 minutes;
- Pulogadung-Kalideres with headway of 2 minutes;
- Pulogadung-BlockM with headway of 3 minutes;
- Kalideres-BlockM with headway of 6 minutes.



In the following tables are shown the comparison between the basic scenario with integration at Harmoni and the scenario with direct services (ITDP itinerary).

Base scenario

Lines	Headway	extension	Travel time	Boarding pax	Max Volume	Pax. paying	Fleet	running km	operating cost USD	gain USD
BM-KT	1.4	13.01	43.58	4840	3942	12666	64	1140	823	
KT-BM	1.4	13.02	43.61	3913	3582	62%				
KL-H	2.2	12.78	42.74	2528	2451		39	696	503	
H-KL	2.2	12.78	42.74	2150	2150					
PL-H	1.5	11.86	39.72	3930	3557		53	945	683	
H-PL	1.5	12.06	40.39	3183	3023					
TOTAL		75.5		20544			156	2782	2009	1509

With direct services

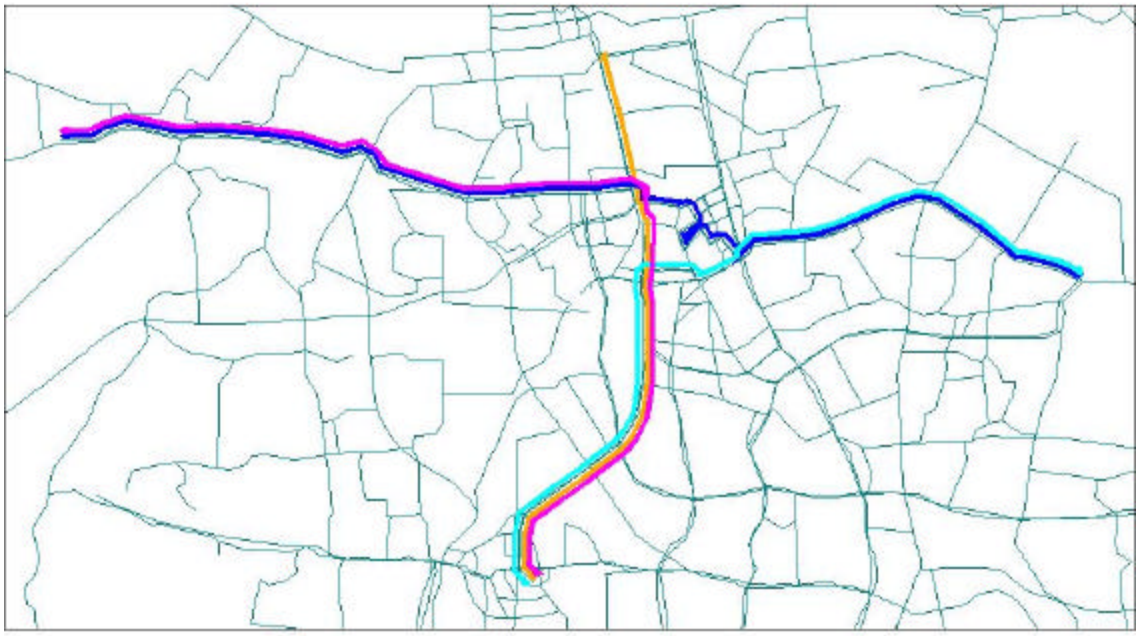
Lines	Headway	extension	Travel time	Boarding pax	Max Volume	Pax. paying	Fleet	running km	operating cost USD	gain USD
BM-KT	2.5	13.01	43.58	2788	2174	14687	36	629	454	
KT-BM	2.5	13.02	43.61	1940	1616	89%				
KL-P	3.0	24.84	83.13	2886	2509		80	1423	1028	
P-KL	3.0	24.64	82.46	2902	2589					
P-BM	3.0	20.98	70.25	2410	2121		56	993	717	
BM-P	3.0	21.17	70.89	2359	2121					
KL-BM	6.0	22.52	75.37	637	543		16	450	325	
BM-KL	6.0	22.51	75.33	528	351					
TOTAL		162.7		16450			188	3496	2525	1555

For almost the same revenue, the configuration with direct services permits to increase the demand (paying passengers) which compensate the higher operating costs.

It reduce the transfers at Harmoni to 1600 passengers/hour, which means that the duplication of the station Harmoni and overpassing lanes are still necessary, but without problem of capacity for a two module station.

There is not a good opportunity to reduce more the transfers offering direct services to Kota, because the volumes are relatively low, and that would induce very high headways for direct services, which is not recommended for BRT.

If itinerary 1 is constructed, it is recommended to develop the same kind of operational design, creating a bidirectional lane south Monas to permit a direct and shorter service from Pulogadung to BlockM, as illustrated as follow



IV.2.b. Impact of Different Operational Designs on Congestion at Transfer Stations

Depending on the configuration, the volume of transfer is excessively high at Harmoni station, from 5000 passengers/hour for ITDP itinerary with a direct line Pulogadung-Kalideres, to 6300 for itinerary 1.

Those volumes are not compatible with the capacity of a one module station, around 1600 transfers per hour, remembering that a transfer station should operate at a lower level of saturation than its capacity, it is then recommended not to operate with more than 1000 transfers/hour per module.

In those conditions, even duplicating the station, and operating with overpassing lane, will not permit to absorb that amount of transfers. The operation with direct services is absolutely necessary.

IV. 3. Demand Impact of Different Fare Structures

ITDP was asked by TransJakarta:

- What would be the optimum flat fare
- What impact would shifting to a distanced based fare on one or more corridors have on revenues and profitability.
- What would be the impact of having distance-based fares on Corridor II and III but flat fares on Corridor I, and forcing passengers to pay again when transferring between lines I, II, and III

IV.3.a. Optimal Flat Fare

ITDP found that the optimum fare given the system's current capacity would be Rs.2100. This would yield both higher revenue and higher profits than the current Rs.2500 fare due to capturing more short distance trips along the corridor.

Morning peak hour

fare Rp	demand (paying passengers)	collected fare USD	running km	operating cost USD	gain USD	max frequency bus/h
2500	11523	3201	2732	1973	1228	40
2200	14634	3577	3248	2346	1231	52
2100	16511	3853	3618	2613	1239	56
2000	18191	4042	3955	2857	1186	63
1800	21640	4328	4516	3262	1066	69
1600	25172	4475	5153	3722	753	77
1400	28759	4474	5671	4096	378	86
1300	30445	4398	5842	4219	178	89

Even if passenger trips is maximized at a fare around Rp1500, the optimal fare is around Rp2100, when factoring in operating cost, which increase proportionally to the demand. If the corridor were designed to handle higher capacity, and the desire was to maximize ridership, a Rp1800 fare would still generate reasonable profits.

IV.3.b. Flat fare .vs. Distance-Based Fare

For Corridor I from Block M to Kota, three different distance based fare systems were tested.

- With a minimum fare of Rp2000 + Rp50 per kilometer
- With a minimum fare of Rp1500 + Rp100 per kilometer
- With a minimum fare of Rp1000 + Rp160 per kilometer

Those values represent three different options for converting the existing fare into a distance-based fare. For example, the current average trip distance on Corridor I is roughly 9.5 kilometers. Rp.2000 + (9.5 x 50) = 2500, Rp. 1500 + (9.5 x 100) = Rp.2450 (rounded to rp.2500), Rp. 1000 + (9.5 x Rp.160 = Rp.2520 (rounded to Rp.2500).

Changing the fare to a distance-based fare will of course change the average trip distance of the passengers captured by the system, so the revenue impacts have to account for this: The following table presents the results compared with actual fare system, for morning peak hour. The operating costs have been calculated with Rp6500 per kilometer.

min. fare Rp.	variable fare Rp./km	demand	collected fare USD	average distance	running km	operating cost USD	gain USD
2500	0	4337	1205	9.53	660	476	728
2000	50	4401	1223	9.29	660	477	746
1500	100	5627	1458	8.51	781	564	894
1000	160	6675	1595	7.69	851	615	980

With a flat fare of Rp.2500 but with some optimization of the bus service in the corridor, some modest increases in profits could be achieved. With a minimum fare at Rp1500 and even more at Rp1000, the total demand increases, respectively 30% and 50%, catching more short trips and less long trips. The trip renovation factor (the number of people getting on and off the buses) on the line is higher, and hence the system is more profitable. The total revenue increase of 20% and 30%, is lower than the increased demand due to the loss of revenue on shorter trips, and the shorter average trip distances.

The bus frequency would need to be adapted to the change in demand structure, so the running kilometer and operating costs also increase, but the gain (collected fare-operating cost) is positive.

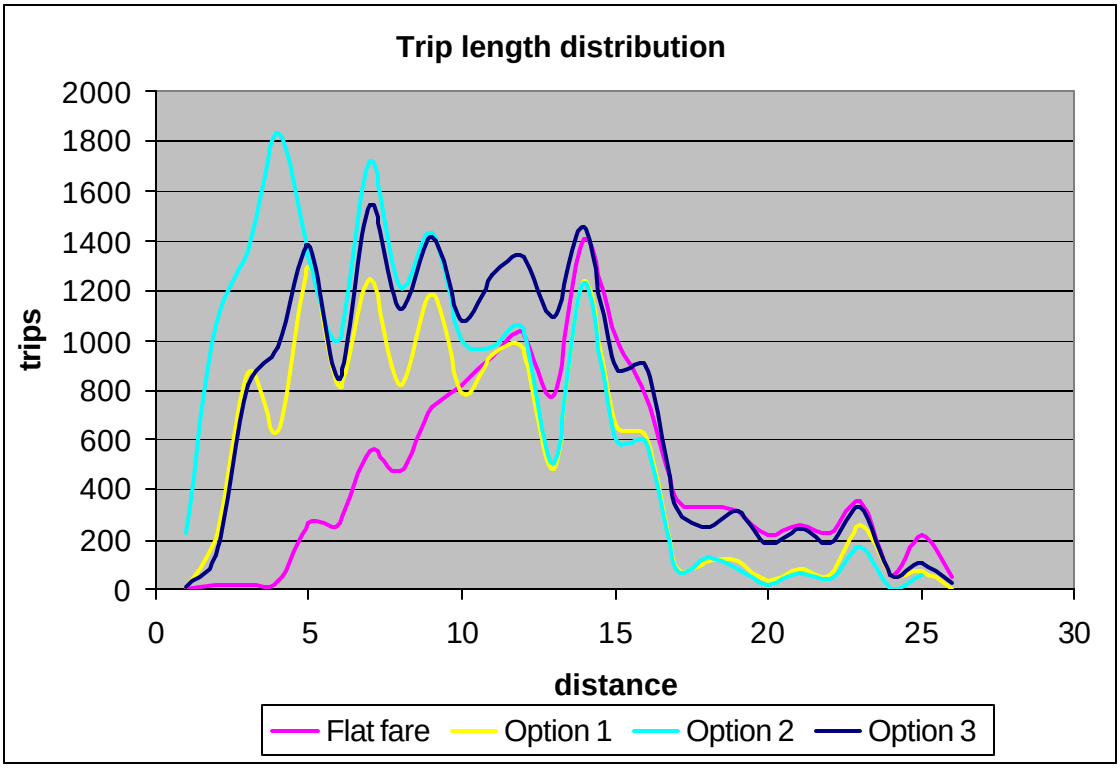
Even in the best scenario, the bus frequency is inferior to 60 bus/hour, it means it is in theory compatible with the actual design of the corridor. But since the operation is not optimized today, some improvement in regularity and boarding time are necessary to absorb the additional demand.

When all the tree corridors are in operation, however, the situation will change, and the distance-based fare considered differently. The first two options (Rp1500+Rp70/km and Rp1000+Rp110/km) are calculated based on the average distance with flat fare. The third one offers a fare discount for long trips in relation with the average flat fare.

Morning peak hour

min. fare Rp.	variable fare Rp./km	demand (paying pax)	collected fare USD	average distance	running km	operating cost USD	gain USD	max frequency bus/h
2500	0	11523	3201	13.47	2732	1973	1228	40
1500	70	13653	3283	9.87	2668	1927	1356	46
1000	110	16374	3719	7.94	2844	2054	1666	53
1500	50	18270	4129	10.68	3491	2521	1607	62

Because of relatively lower incomes at the outer areas of Corridor II and III, more demand is lost for long distance trips to competing bus services than can be justified by revenue increases. The long trips, from Kalideres and Pulogadung to the central area and BlockM principally are penalized. While in compensation short trips equilibrate the passenger balance, there will be disbenefits in the mixed traffic lanes as these longer distance trips are lost to ordinary buses and paratransit routes. Another problem is that in option I and II above, the passengers volumes on corridors 2 & 3 decrease, and increase for corridor 1. Because Corridor I will be facing serious capacity problems unless they are rectified before opening the corridor, while capacity problems will be less of an issue on Corridor II and III, it would be better from the perspective of optimizing the efficiency of the service to push more demand onto Corridors II and III.



Therefore, the optimal fare should flatten out for longer trips, avoiding too much short trips thru a reasonable minimum fare value (Rp1500).

Therefore, ITDP recommends that the whole system shift to a distance based fare with Rs.1500 as the base fare and an additional Rs.50 per kilometer for the whole system.

IV.3.c. Mixed Systems and Transfers Between Corridors

Because of incompatibilities between existing ticketing system in Corridor I and possible future ticketing system in Corridor II and III, Transjakarta proposed to operate the second and third corridors without fare integration with BlockM-Kota corridor, forcing passengers to pay again when transferring onto Corridor I.

With a flat fare, this configuration loses 25% of the demand in relation with scenario with integration. In the following table, it has been considered that corridor 1 stays flat fare, and corridors 2 & 3 operate with distance based fare.

This scenario is absolutely not recommended. The main loss of ridership and revenue results from forcing passengers to pay for transfers between corridors. If this separate fare structure is selected, the adverse impact on revenue is minimized with a minimum fare of Rp1000 with Rp50 per kilometers in Corridor II and III.

Morning peak hour

min. fare Rp.	variable fare Rp./km	demand (paying pax)	collected fare USD	average distance	running km	operating cost USD	gain USD	max frequency bus/h
2500	0	8506	2363	9.15	1887	1363	1000	25
1500	50	9988	2545	12.87	2139	1545	1000	29
1000	50	13262	2937	11.77	2613	1887	1050	43

IV.4. Projected Demand on the Jakarta Monorail and Integration w/ TransJakarta

As part of the Institute for Transportation and Development Policy's (ITDP's) technical assistance to DKI Jakarta for TransJakarta, we developed in cooperation with the University of Indonesia Center for Transportation Studies (UI CTS) a traffic model to predict likely ridership on new TransJakarta lines. The TransJakarta-related outputs of that model will be released by June 30, 2005 in a separate report.

However, the same traffic model is usable to generate projected demand figures for the proposed Jakarta monorail project. We wanted to bring to your attention the results of modeling the current monorail scenario for Jakarta. As the DKI Jakarta Government may be asked to provide ridership guarantees or other forms of guarantees that will be sensitive to projected demand, we thought that these modeling results may be of use to you in your negotiations with the private monorail companies.

Using the most optimistic scenario, at a fare of Rp.5000, demand on the two currently planned Blue and Green monorail lines, the total demand for both lines will be only 31,980 daily passengers. The Blue Line alone would carry only 20,111 daily passengers.

If both the Blue and Green Lines are built, they could raise some Rp.160 million per day in fare revenue and roughly Rp. 48 billion annually. (This is $5.3 million annually.) Raising the fare will not help to increase revenues because ridership falls.

The low ridership levels result from the fact that very few people's trips would be easily served by this particular routing. Most people would have to switch from buses or other modes, and lack of a feeder bus system, the lack of compared to those projected by SITRAMP are mainly due to the false expansion factors used in the SITRAMP model.

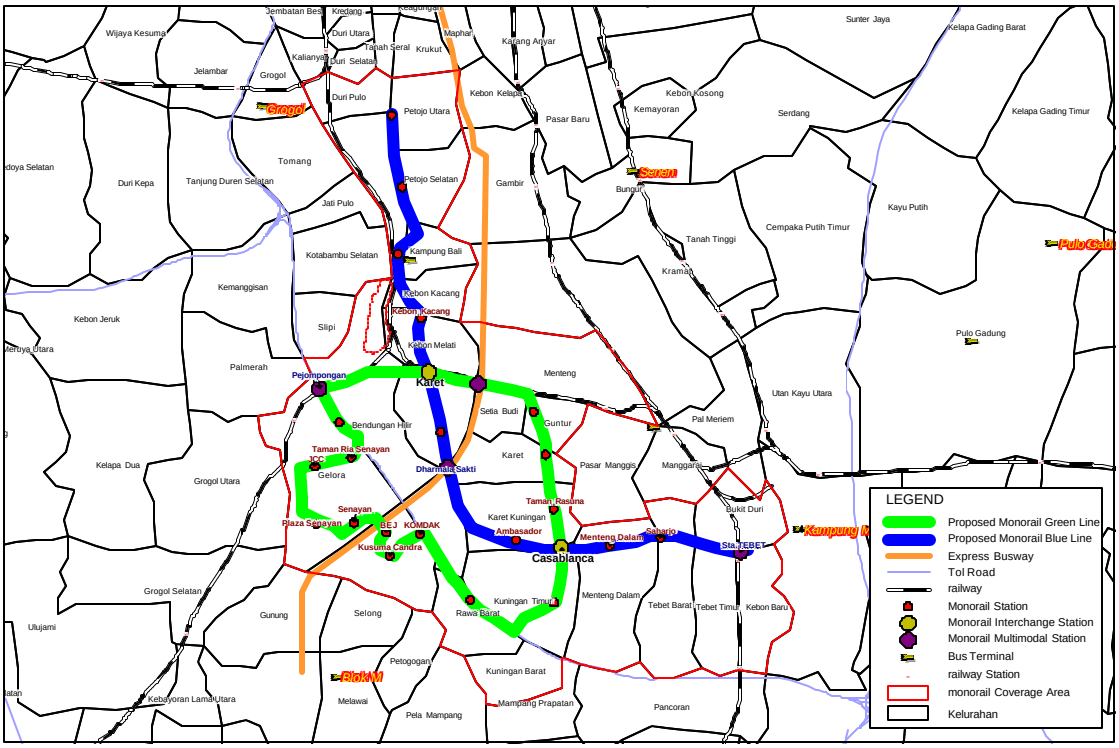
This 25.7km system would cost a minimum $925 million but could cost $1.4 billion or more (the cost of the Kuala Lumpur monorail). Of this, only some $60 - $70 million would be recovered from passenger fares in the first ten years. Therefore, DKI Jakarta needs to be prepared to pay some $1 billion in capital investments, and provide ongoing operating subsidies for this to be viable.

While we have not observed the suitability of the corridors for BRT, if BRT were implemented on the same corridors, we project that it would capture some 75,000 daily passengers. The main difference in demand is due to the lower fare and better connectivity with the rest of the TransJakarta BRT system. The cost would be less than $50 million to construct, and would generate some $6 .25 million in annual revenue, more than enough to cover the operating costs and the cost of bus procurement.

Initial demand estimates for the monorail used SITRAMP, a model developed by JICA. Using SITRAMP, the demand on the proposed monorail would be 98,741 daily riders for both lines. Unfortunately, due to gaps in the network, lack of data on paratransit vehicles, limited and outdated traffic counts at relevant locations, and exaggerated expansion factors, the SITRAMP data was yielding model results that diverge widely from our own observed traffic counts. We therefore had to recreate the traffic model, also using EMME/2 and also in cooperation with UI CTS. Over 60,000 on-board origin destination surveys were conducted with transit passengers. Calibration of the entire network was also done with observed data. The control points for observed volumes of passengers correspond to the 60 bi-directional sections of the OD survey, which were used to expand the OD. In addition, 12 bidirectional points were added to refine the adjustment. The results of this model calibration were to give us predicted values much closer to observed values.

Monorail Project

The existing monorail project proposal includes two lines, the Blue Line from Tebet to Roxi, and a circular Green Line.



Some restructuring of the actual bus system was taken in consideration, by cutting the bus routes with itineraries that overlap the monorail blue line, as illustrated as follow:

The proposed fare was defined at Rp5000. Modal split and adjusted value of time were taken in account to represent the possible attraction of high middle class potential passengers.

The results have to be considered as maximum potential demand, as the considerations that were made correspond to an optimistic scenario. Globally, the results reach only 20% of the demand estimated in the monorail project.

Scenario 1 : With blue line only

Morning peak hour

Lines	Headway	extension	Travel time	Boarding pax	Max Volume	Pax. paying
TEBET-ROXI	5.0	11.07	33.53	1049	772	1547
ROXI-TEBET	5.0	11.07	33.53	498	401	100%
TOTAL		22.1		1547		

Scenario 2: With blue line and green line

Morning peak hour

BLUE LINE + GREEN LINE

Lines	Headway	extension	Travel time	Boarding pax	Max Volume	Pax. paying
TEBET-ROXI	5.0	11.07	33.53	1175	836	1980
ROXI-TEBET	5.0	11.07	33.53	805	591	80%
CLOCKWISE	5.0	14.61	44.02	98	74	
COUNTER CLOCKWISE	5.0	14.61	44.02	382	286	
TOTAL		51.4		2460		

Even if the area around the green line can be of interest for demand, the blue line did not connect it with another interesting area, it did not correspond to some identified major desires lines of trips.

A test with a BRT operating only the blue line, in addition with the projected first three BRT corridors, shows better results, because of the lowest fare (Rp2500) and of the interest of connectivity with the integrated BRT network, offering more choices for origins and destinations.

Morning peak hour

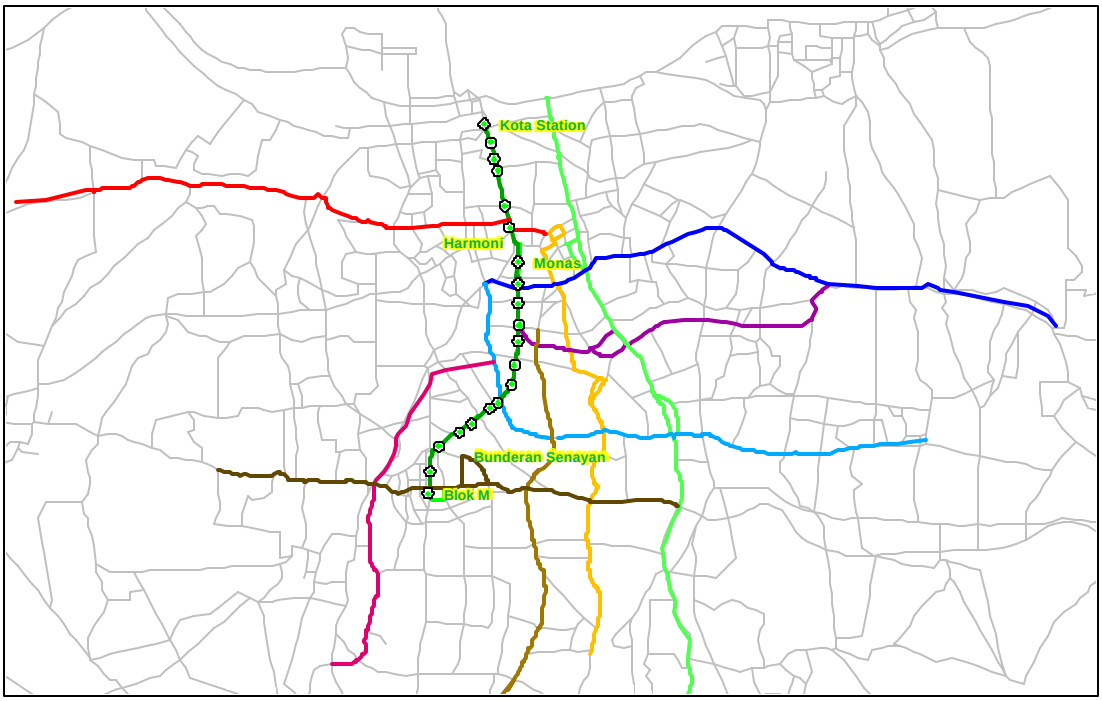
ITINERARY OF BLUE LINE OPERATED BY BRT

Lines	Headway	extension	Travel time	Boarding pax	Max Volume	Pax. paying
TEBET-ROXI	2.9	11.07	37.22	2876	1827	3201
ROXI-TEBET	2.9	11.07	37.22	2941	1834	55%
TOTAL		22.1		5817		

Daily Passengers summary

	Monorail		BRT
	Blue Line	Blue & Green Lines	Blue line
Lines		**Boarding pax**	
TEBET-ROXI	13637	15275	37388
ROXI-TEBET	6474	10465	38233
CLOCKWISE	-	1274	-
COUNTER CLOCKWISE	-	4966	-
TOTAL	20111	31980	75621

IV.5. Next BRT corridors

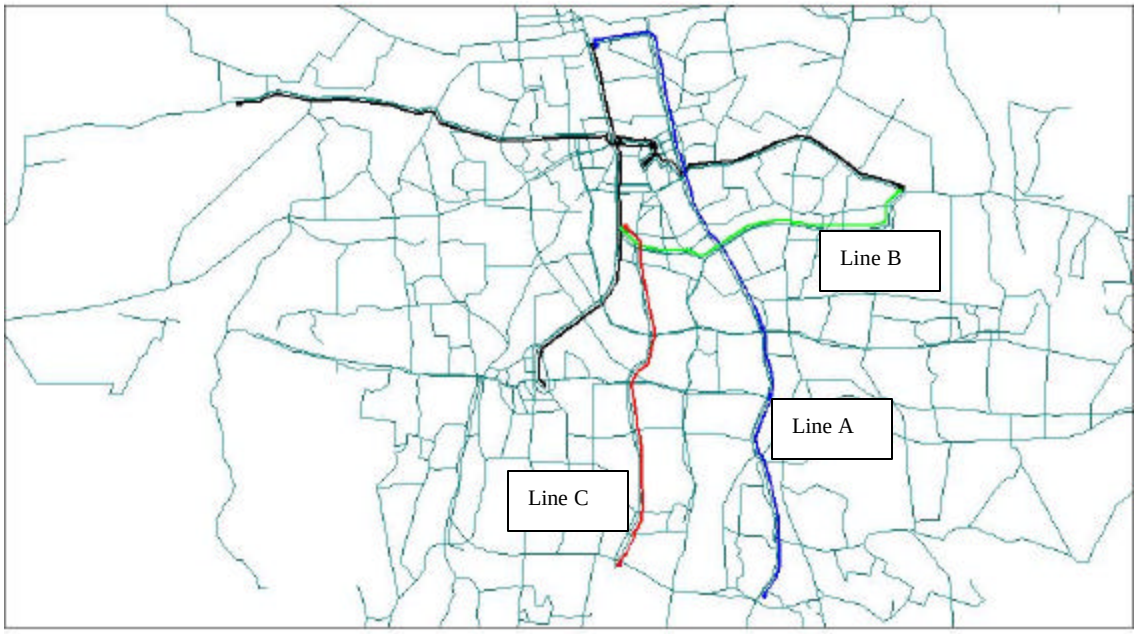


Currently, according to the DKI Jakarta Transportation Master Plan, the corridors shown above are shown to eventually be upgraded to Bus Rapid Transit. ITDP was asked by DisHub which of these corridors should be the highest priority for the next steps, and also was asked to advise on specific routing.

On the following table, the current existing transit demand on all of Jakarta's main corridors is shown. This table is taken from our recently calibrated traffic model:

Jakarta – Desire Lines

The current proposal by DisHub is to expand TransJakarta onto Lines A, B, and C shown below:



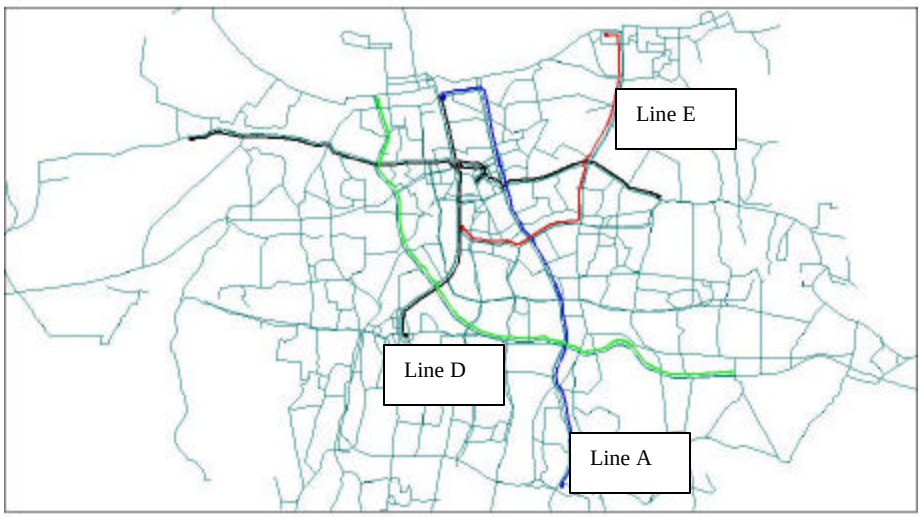
The demand for these corridors is as shown below:

Passengers at Morning peak hour

Lines	Headway	extension	Travel time	Boarding pax	Max Volume	Pax. paying
BM-KT	0.7	13.01	43.58	11212	7226	41896
KT-BM	0.7	13.02	43.61	9251	5977	52%
KL-H	0.9	15.24	50.99	7940	6272	
H-KL	0.9	14.78	49.45	5625	5485	
P-H	1.1	12.66	42.41	6457	5073	
H-P	1.1	12.19	40.81	5856	4374	
A	1.0	22	73.97	9747	5543	
A	1.0	22	73.97	6747	3230	
B	0.9	11.07	37.18	7463	6215	
B	0.9	11.32	38.03	5683	4831	
C	2.2	12.24	41.21	1641	1586	
C	2.2	12.24	41.21	2533	2508	
TOTAL	171.8			80155		

Only the proposed Line A corresponds to a major corridor of demand. Line B is sharing a part of the demand with Corridor II towards Pulogadung. Line C is a corridor of low demand.

Based on demand alone, the following corridors would be optimal for the next phase:
Optimal configuration for demand:



Passengers at Morning peak hour

Lines	Headway	extension	Travel time	Boarding pax	Max Volume	Pax. paying
BM-KT	0.4	13.01	43.58	20435	13070	85338
KT-BM	0.4	13.02	43.61	16867	10070	51%
KL-H	0.8	15.24	50.99	11121	6651	
H-KL	0.8	14.78	49.45	8450	6265	
P-H	0.8	12.66	42.41	10874	6548	
H-P	0.8	12.19	40.81	8864	5366	
A	0.6	22	73.97	15950	8436	
A	0.6	22	73.97	11034	3227	
D	0.5	25.98	87.34	19885	10405	
D	0.5	25.98	87.34	18089	10322	
E	0.6	16.94	56.88	12020	8331	
E	0.6	16.96	56.94	13897	8880	
TOTAL		210.8		167486		

In this configuration, the potential of Line I increases in relation with the proposed extensions, due to a better connectivity of the network. By routing Line E North to Tanjung Priok, it picks up an enormous amount of additional demand. Line D is basically Gen. Subroto and the toll road, which carries very high volumes of transit passengers, though its compatibility with BRT needs to be studied.

With the extension of the network in this way, some interesting combinations of lines can be proposed, like for example a service between Tanjung Priok-BlockM, with a high potential demand. A detailed study is necessary to evaluate the global benefits including all the related costs in a multi-criteria analysis.

V. INCREASING THE BUSWAY'S CAPACITY AND SPEED IN CORRIDOR I

V.1. Bus and Station Design

When Corridors II and III open, demand on Corridor I will rise to some 3644 pphpd. Unfortunately, right now TransJakarta Corridor I can only accommodate some 2700 pphpd, and conditions are already overcrowded at peak hour in some locations:


There are three main causes and several minor causes of very low capacity on TransJakarta:

- ? Buses and bus stops have only one door, reducing boarding and alighting speed
- ? The size of the bus is small for a high volume BRT corridor.
- ? The security person stands in the doorway during boarding and alighting, impeding the speed of boarding and alighting

A rough estimate of the effects of these three easily fixable problems is as follows:

	Average boarding time (seconds)	Capacity (pass/h)	Bus stop time (seconds)	Speed (km/h)	Fleet (buses)
Present Situation	2.5	2700	45	17	60
Improving boarding	1.7	3700	35	19	56
Bus with two doors	0.5	6000	22	21	51
With articulated bus	0.3	9600	18	23	26

Most urgently, TransJakarta should rebuild the stations to have more doors and should use buses with more doors. This would also allow the use of articulated buses on Corridor I. Without changing the doors, the use of articulated buses will do little to improve the current situation because passengers will continue to crowd around the one doorway.

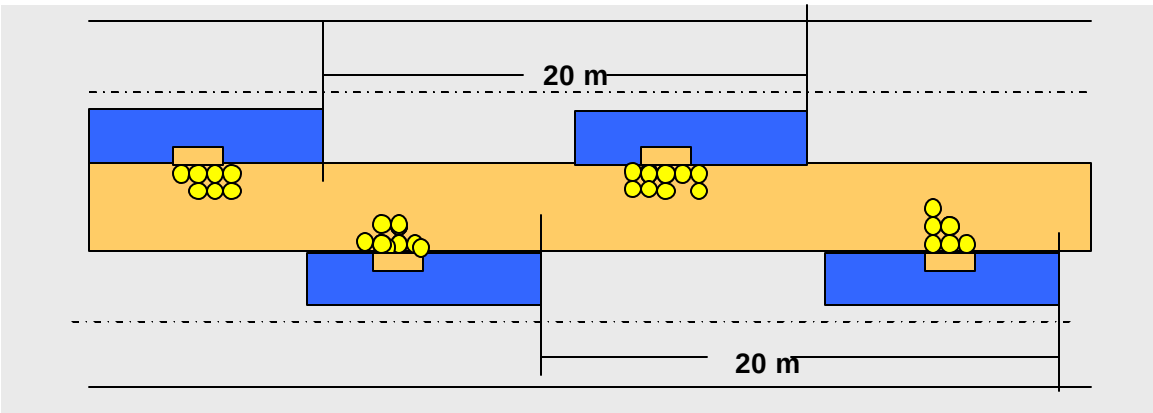
Ideally, the stations in Corridor I should immediately be rebuilt with four doors, two for entry and two for exit. The exit doors do not necessarily have to be inside the enclosed station. Articulated buses should be procured to operate in Corridor I, and the current one door buses should be moved to Corridor II, where demand will initially be much lower These simple measures, which require taking no additional road space, will provide TransJakarta Corridor I with a capacity of 9600 pphpd, more than enough to handle the projected demand upon completion of Corridors II and III.

The current very slow boarding times caused by the single door are aggravated by several smaller issues. Because the gap between the bus floor and the station platform ranges from 25 to 45 centimeters, which is several times wider than standard BRT systems, passengers must take great care entering and existing the bus. This not only slows down boarding, it also creates dangerous conditions. This problem needs to be fixed by minor engineering adjustments in the station design. To ameliorate this problem, TransJakarta's management has placed its security guard directly in the doorway. The location of the security personnel directly in the doorway further reduces the doorway capacity. The security personnel is standing in the doorway also to assist the opening and closing of the doors, which unassisted is quite slow. The current type of folding doors are not only slow, the also occupy a lot of space in the doorway, further reducing door capacity. Switching to metro-style fully retractable doors would ameliorate this problem. Further aggravating this situation, overhead hand bars and straps for passengers to stand have been placed directly in front of the doorway, while there are none in the rear of the bus. This further aggravates a tendency for all standing passengers to cluster around the doorway even when they are not alighting. The hand bar with hand straps directly in front of the door needs to be removed, and additional overhead hand bars placed in the rear of the bus where currently there are none. They should also be at a height easier for people to reach. While all these minor details are not so much in and of themselves, and are easy to fix, taken together they cause a loss of capacity by some 1000 pphpd. While the pros and cons should be weighed, TransJakarta should consider relocating the security person away from the doorway anyway until the other problems are fixed.

V.2. Harmony Interchange Between Corridor I and II

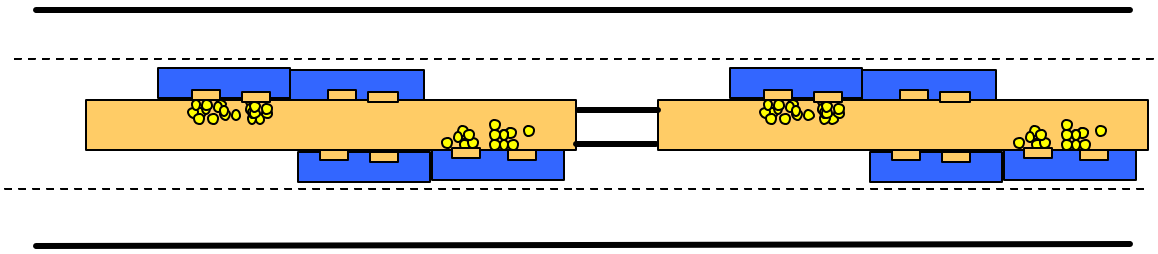
The most urgent reform must take place at the Harmony station, where connections between Corridors I, II, and III, could lead to as many as 6000 passengers transferring per hour, if no direct services from Pulo Gadung to Blok M and between Kalideras and Blok M are added. If they are added, transfers will still be around 1600 at the peak hour at Harmony. This is still greater than Harmony's current capacity, which is only around 1000 passengers at the peak hour. When Corridor II and III are completed, there will also

be a very heavy volume of buses arriving at the Harmony station. With this significant increase in buses and passengers being served by this station, it is important that this station be reconfigured. This configuration adds an overtaking lane at this station, and a second bus stop per direction connected to the first one.



By providing a second bus lane in each direction at the Harmony stop, having a much longer bus stop, and locating the doors in each direction so that they are not immediately across from one another, crowding within the transfer terminal will be reduced and buses cueing at this station stop can be minimized.

Obviously, it would be even better if the buses and bus stations had four doors, as depicted below. This would give the Harmony station sufficient capacity for the next ten years or more, which would prevent having to reconstruct the station in the medium term.

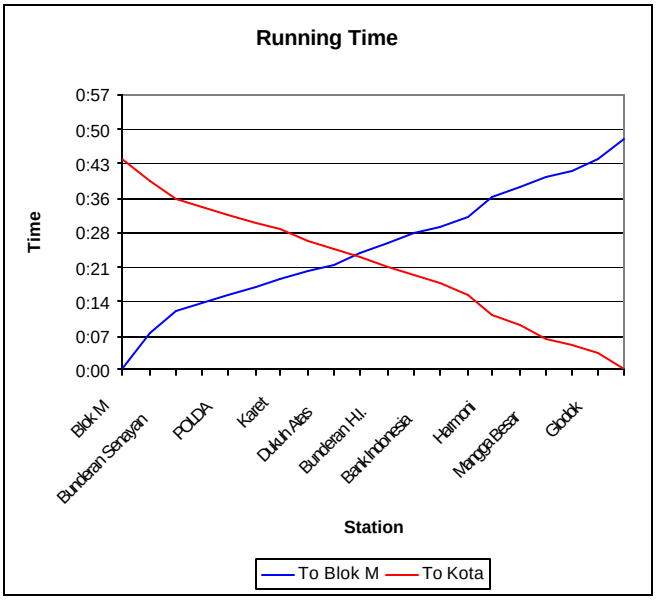


V.3. Improving Capacity and Speed of Busway and Mixed Traffic in Corridor I

Simple changes in the roadway and intersection design in Corridor I could significantly improve the TransJakarta bus speeds and capacity, while also improving the speed and capacity of the mixed traffic. It is also Congestion in this short stretch causes a

significant reduction of efficiency in TransJakarta Corridor I. Most of the delays are caused by just four areas:

- Blok M to the Sisingamanga Raja/Trunojoyo Intersection
- Congestion Along Sudirman/Thamrin
- The Semanggi Flyover
- The Veteran/Hayam Wuruk/Harmony/Pranoto Intersection and Hayam Wuruk/Hasyim Ashari
- Congestion Along Hayam Wuruk
- The Kota Railway Station Intersection (Pintu/Besar/jem. Batu/Petongkangan)



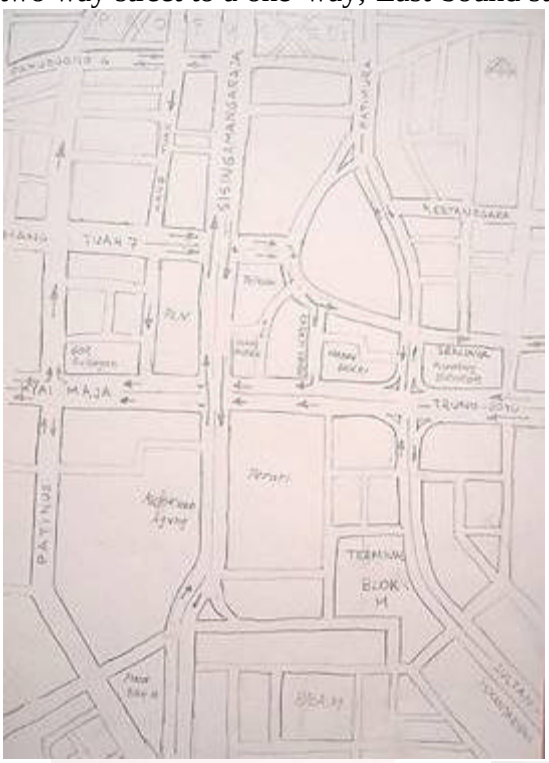
V.3.a.Blok M to the Sisingamanga Raja/Trunojoyo Intersection

There remain boarding delays at Blok M. These are partially the result of the TransJakarta security personnel stopping passengers from boarding the bus when it is only about half full. Security personnel should allow the bus to fill to roughly ¾ capacity before stopping passengers from boarding. Passengers should not be allowed to wait for seats to board.

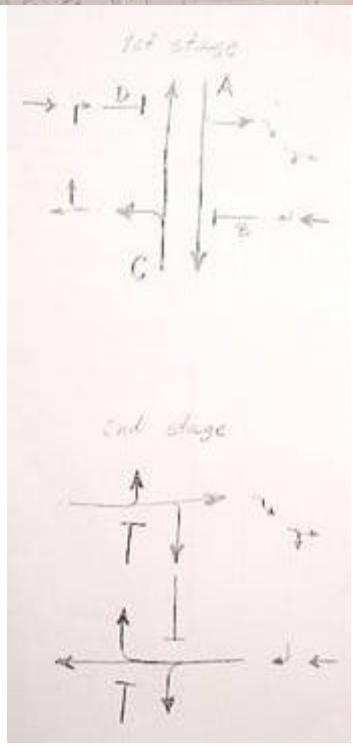
The delays in the first stretch of the TransJakarta busway immediately to the north of Block M are caused by

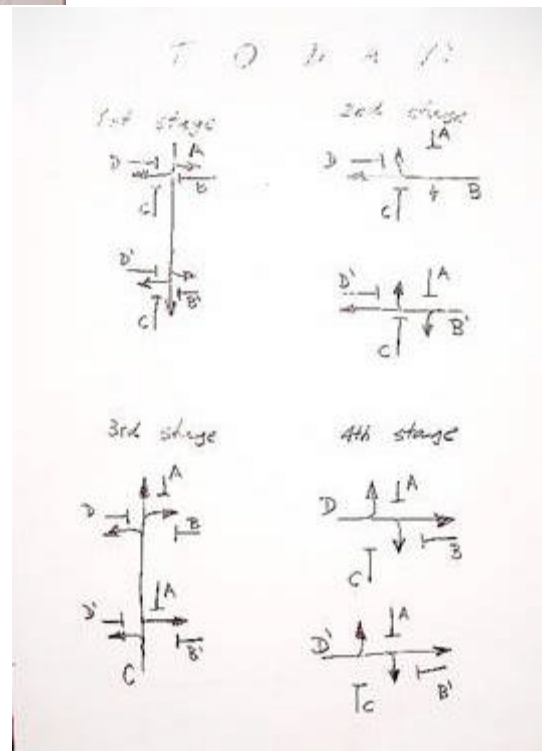
the lack of physical separation of the Busway Corridor and the intersection design at Jl. Trunojoyo/Sisingamanga Raja, causing a significant delay in service.

The best solution for removing this bottleneck is to turn Jl. Trunojoyo from the current two way street to a one-way, East-bound street, and to turn Hang Tuah 7 from the current two way street into a one-way West-bound street.



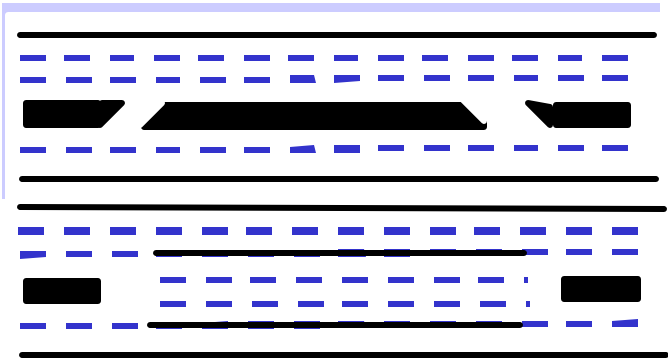
This would then allow for the conversion of the traffic signal at Jl.Trunojoyo/ Sisingamangaraja from four phases to two phases.
This transition in turn will require the opening and signalization of the intersection at Patimura and Senjaya.





V.3.b. Mitigating Congestion Along Sudirman/Thamrin

Some fairly simple measures could be taken to reduce the level of congestion in the mixed traffic lanes along Jl. Sudirman and Jl. Thamrin. The current busway in this section is 4 meters wide, and the mixed traffic lanes are each 4 meters wide also. This is much wider than is generally necessary. By narrowing the bus lane to 3.5 meters and the mixed traffic lanes to between 2.86 meters and 3 meters, the Jl. Sudirman/Thamrin stretch could be expanded to three mixed traffic lanes in each direction instead of only two in the central part of the carriageway.

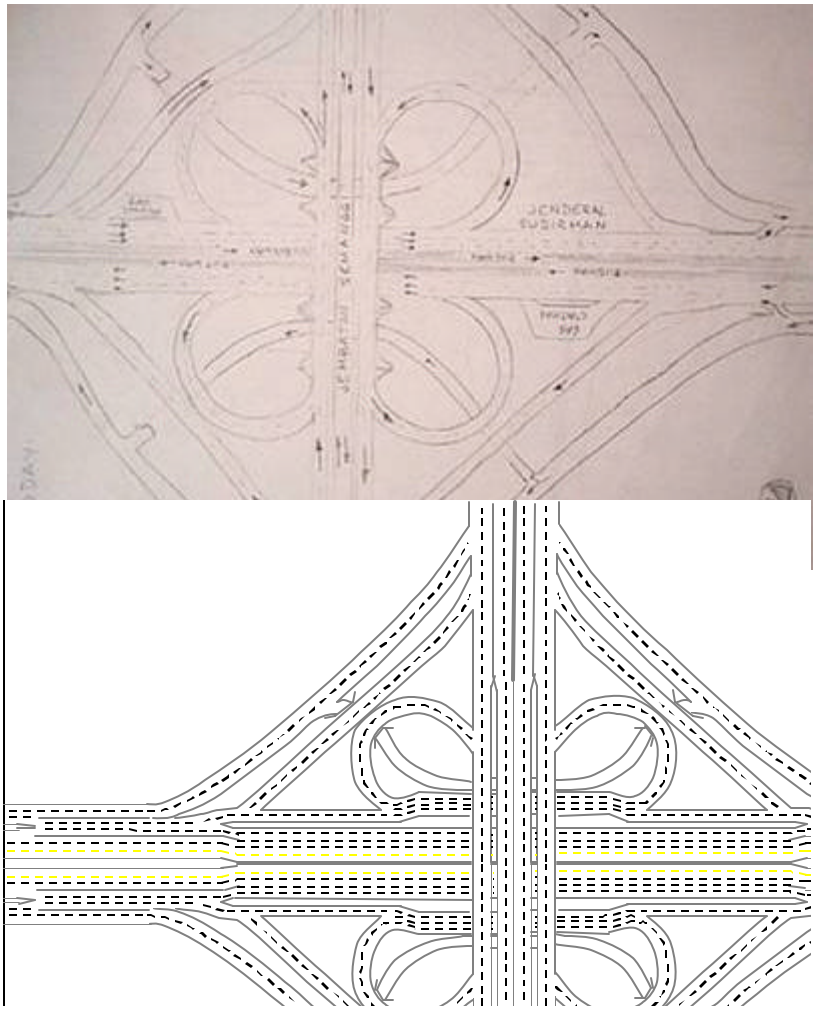


There are also bottlenecks at the points along the road where transition lanes exist between the higher speed central lanes and the slower speed local lanes.

This problem could be easily resolved by simply taking out part of the median and allowing for a longer transition area, as below.

V.3.c. The Semanggi Flyover

The current congestion at the Jl. Sudirman/Semanggi Flyover could be resolved by widening Jl. Sudirman on land available under the flyover.



Under the flyover, we propose creating a new local route just for traffic interconnecting with Genderal Gatot Subroto. These local roads (one on each direction) shall be constructed under lateral clearance available on the bridge. This solution will improve capacity under the bridge from 3 to 8 lanes, 4 just for straight flow, and 4 for turns (2 for direct movements ahead and left and 2 for right turns).

This configuration would allow the use of a merge way between local and express ways in order to not overload the expressway.

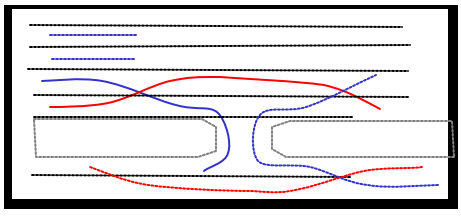
V.3.d.The Veteran/Hayam Wuruk/Harmony/Pranoto Intersection and the and Hayam Wuruk/Hasyim Ashari Intersection

These two intersections are already major bottlenecks and will become even more serious bottlenecks when Corridor II and III are completed. ITDP developed a concept for improving its function with a single North-South TransJakarta line. However, with the addition of Corridor II and Corridor III, we were unable to develop a design until we knew the routing for Corridor II and III, and the bus routes on it. Dishub engineers should consult leading traffic experts like Pedro Szasz or others from reputable firms for reconfiguring these intersections before Corridor II and III are opened to avoid a major bottleneck.

V.3.e. Congestion Along Hayam Wuruk

There are several problems which are pervasive throughout the corridor but which are more pronounced in the northern section of the corridor which are aggravating mixed traffic congestion and slowing down bus speeds. First, buses that have continued to operate in the mixed traffic lanes do not stop at designated bus stops, nor do they stop only in the curb lane. They frequently consume two full lanes of traffic. The congestion impact of this is further exacerbated as they sometimes idle in these locations waiting for passengers. The removal of more of the bus lines with the opening of Corridor II and III should help this problem somewhat. Tighter police enforcement of illegal stopping of buses would also help.

There are also problems of illegally parked vehicles along the northern part of the corridor, as well as considerable illegal vending activity and various forms of paratransit occupying the roadway waiting for passengers. Much of the northern section of the corridor needs to be revitalized, and part of an urban revitalization effort in the Glodok area should include working out a more rational parking plan, rationalization of vending activity, and integration of paratransit idling into the design or tighter regulation of this activity. We estimate that two out of four lanes are lost due to these activities.

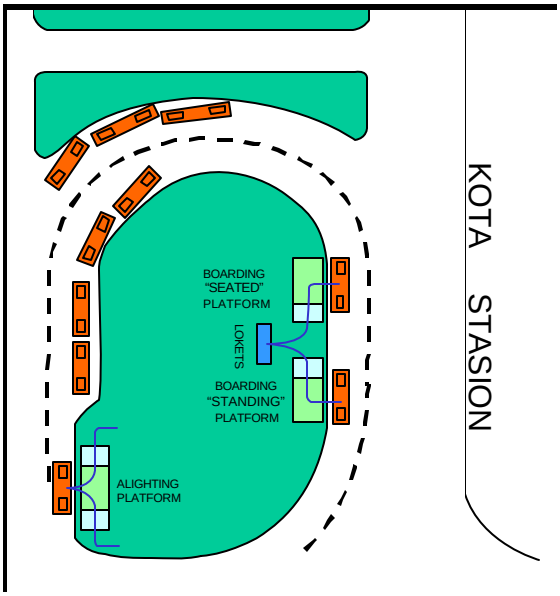


There are also several U turns in the corridor, particularly in the northern section. The current configuration is acceptable for locations where the number of u-turning private vehicles is less than 1200 vehicles per hour. For between 1200 vehicles per hour and 2000 vehicles per hour, a traffic light separating the u-turning traffic and the busway should be used. For volumes over 2000, an additional U-turn should be added in another location to split the turning volumes at each U-turn. The U – turn just north of the Harmony intersection will have to be addressed as a special case as it will have to accommodate turning buses as well.

V.3.f. The Kota Railway Station Terminal and Pintu/Besar/Jem. Batu/Petongkangan Intersection

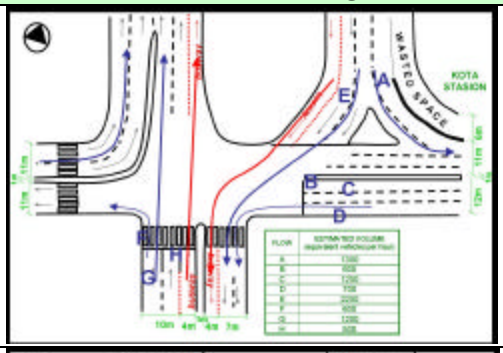
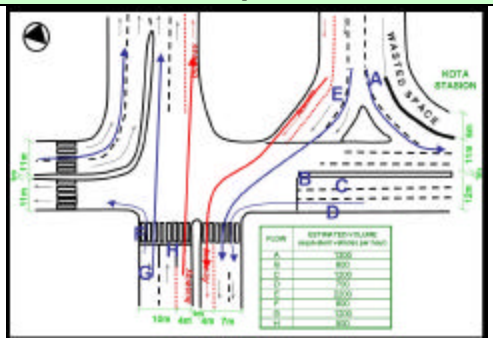
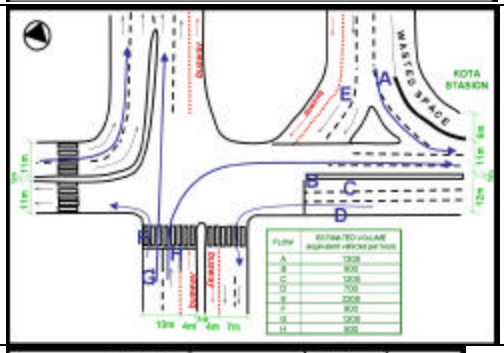
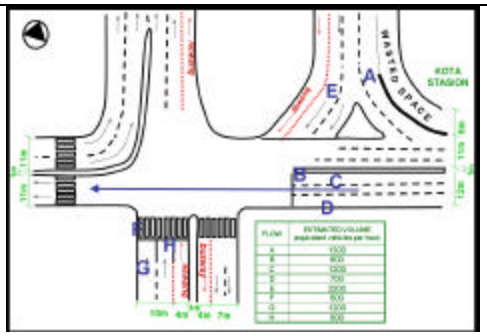
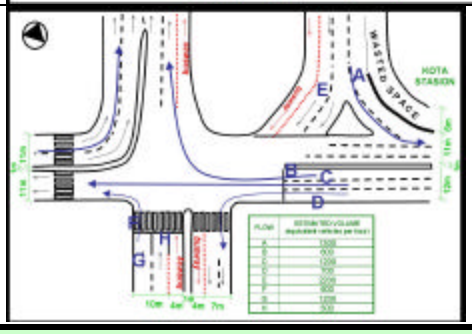
Widening the existing roundabout at the Kota Terminal would create an area for buses to queue after dropping passengers and before picking up. The current system results in passengers waiting a long time to alight when additional buses are added.

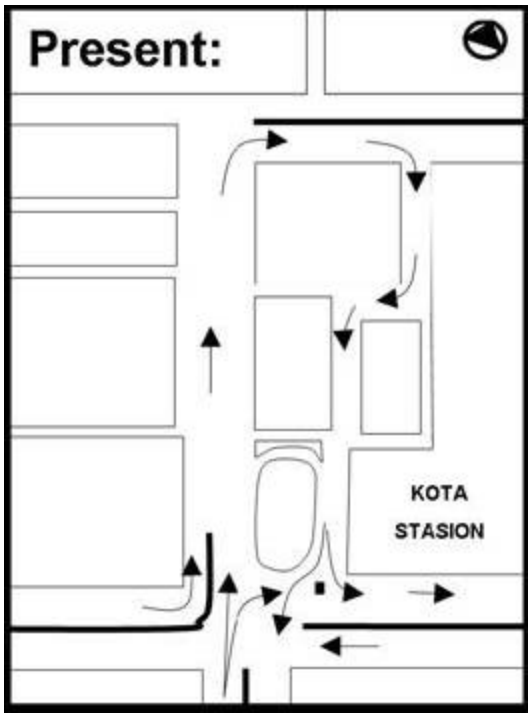
As at the Blok M terminal, there is a problem of the buses departing less than full. Creating a separate boarding platform for passengers willing to stand from those wishing to sit would allow those willing to stand to board faster, and increase the load factor of each bus, increasing system efficiency.

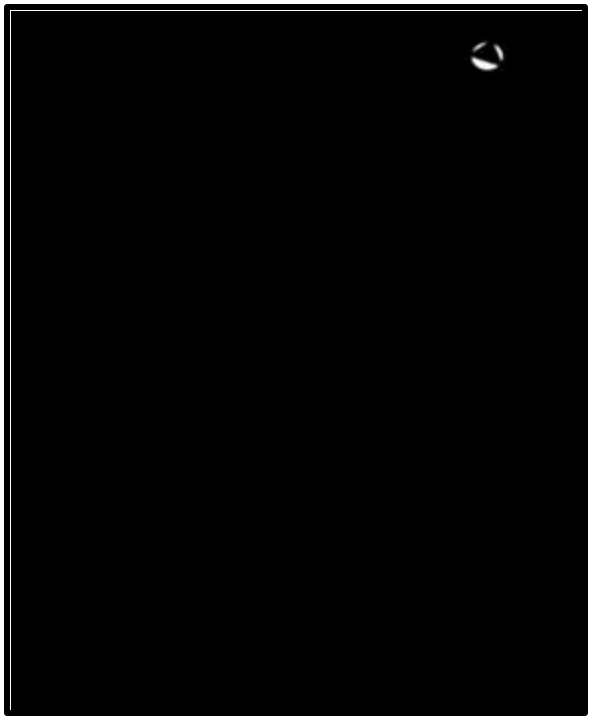


As in other areas, illegally idling paratransit vehicles consume a full traffic lane.

Another major bottleneck is created at the Pintu/Besar/Jem.Batu/Petongkangan Intersection, with some 500 to 1500 meters of congestion much of the day. This bottleneck could be improved significantly by reducing the signal phasing from three phases to two in the manner below. This would require also rerouting some right turning northbound traffic in manner shown below:

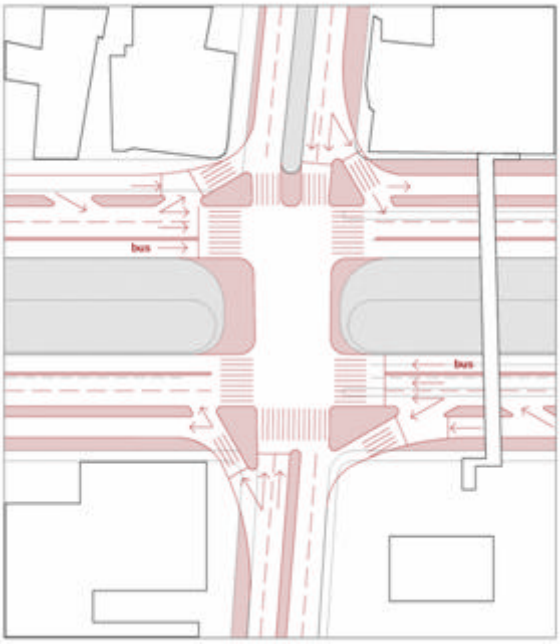
	Existing	Proposed
1st STAGE		
2nd STAGE		
3rd STAGE		





V.4. Pedestrian Facilities in Corridor I

The new sidewalks along Jl. Thamrin, soon to be extended throughout the length of the corridor, coupled with the improvements in the pedestrian overpasses, have brought about a fundamental transformation of this major commercial corridor. It has opened up short distance trips between shops to pedestrian travel, and dramatically increased street life in the corridor. The pedestrian overpasses, where they have been reconstructed, are heavily utilized and appreciated.



That being said, even after reconstruction, where the new pedestrian facilities have been rebuilt, the lateral streets are still difficult to cross in some locations. For example, at Sarinah's, crossing K.H.Wahid Hasyim remains difficult and unsafe. Free left turns at the traffic signal are the biggest problem. This could be tolerated if the turning ratios were tighter, but as they are currently designed, vehicles turn at very high speeds. At such high turning speeds, there is virtually no safe period to cross.

In many locations pedestrian refuge islands could be constructed (as illustrated right) without any adverse impact on mixed traffic flow.

The on and off ramps at the flyovers are also places of considerable danger for crossing pedestrians. The turning ratios on the access ramps could be sharpened and the crossing itself could be elevated to slow these turning vehicles.

At-grade pedestrian access to the BRT system should still be considered in the Northern and Southern most sections of the BRT Corridor. The basic principles for determining whether or not pedestrian overpasses are necessary are the following:

- The number of lanes that have to be crossed before reaching a pedestrian refuge (2 is safe at reasonably high speeds, 3 less so)
- The presence or absence of a traffic signal, and how this signal is phased, (free left turns make it hard to cross even if there is a signal)
- The average vehicle speeds and vehicle flow in the corridor (lots of vehicles with few gaps obviously makes it harder to cross)

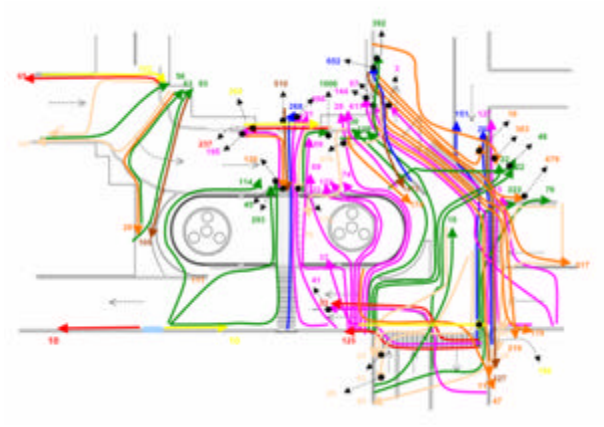
The pedestrian bridges used on Corridor I increase the passenger's total travel time by 6 minutes (around 12 minutes in equivalent time for each passenger when the discomfort factor for walking is included). They are particularly inconvenient for the elderly, children, or anyone carrying packages.

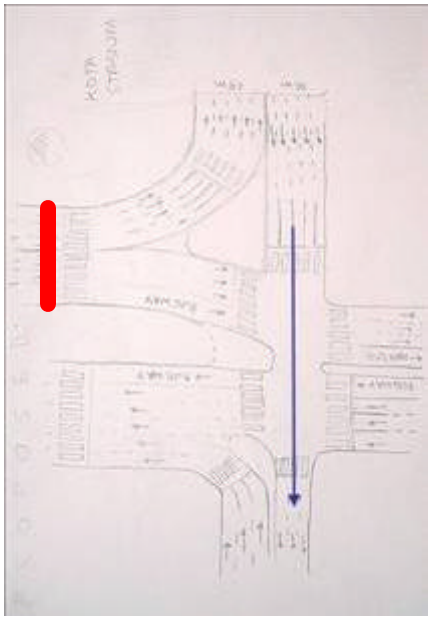
Therefore, there should be a very compelling reason why the surface crossing cannot be made reasonably safe through changes in the intersection's physical design and changes in the signal phasing. While on Jl. Sudirman the travel speeds are sufficiently high, the road sufficiently wide, and the intersections sufficiently few that pedestrian overpasses are no doubt necessary. However, from Sarinah's North, and from the Senayan roundabout South, with some modest intersection design changes and changes in the signal phasing (restricting free left turns, adding in some cases lead pedestrian intervals,

etc) many of these intersections could be made safe enough for surface crossing. As part of the expansion of the modern pedestrian facilities this should certainly be considered.

With the dramatic increase in pedestrian movements at the Kota Railway Station and around Blok M, it is even more important that the pedestrian facilities be systematically redesigned.

At Kota, simplifying the signal phasing as suggested above resolves most of the pedestrian conflicts as the pedestrians can simply cross with the light. This requires that the left turning traffic in front of Kota station be given a red phase to allow pedestrian crossing in the area indicated below. This approach will have about 1800 pcu per hour, with four lanes to accommodate it, so saturation level will only be 1800/(2000*4)=.225. Therefore, there is no difficult to have 50% pedestrian time without saturating this part of the intersection. The cycle on this approach could be around 60 or 70 seconds green time and 60 or 70 seconds red time, which is an optimal balance of pedestrian and vehicle delays given the high pedestrian volumes. **No tunnel is therefore necessary**.





As the Kota Railway Station is an area of great historical importance, the pedestrian facilities in the entire area should be upgraded.

The Blok M area pedestrian facilities also need to be significantly upgraded, and again a detailed design needs to be developed when the traffic pattern for this area is settled.

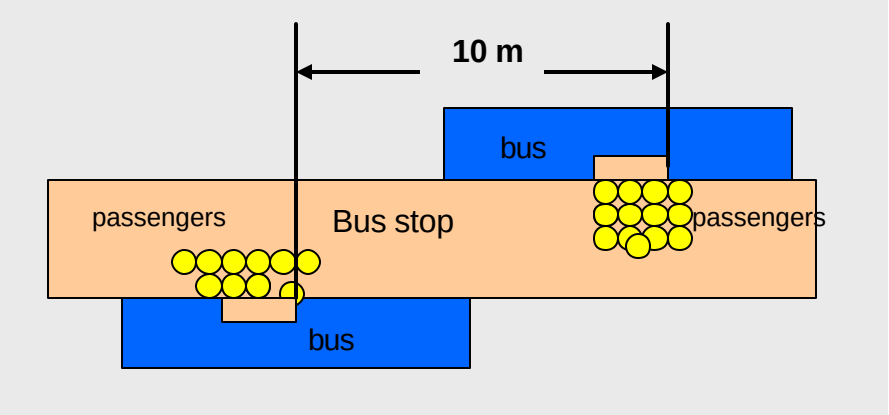
VI. PHYSICAL DESIGN ISSUES ON CORRIDOR II AND III

VI.1. General Comments to Improve Busway Operations

For the busway's speed and capacity, the main bottleneck is the bus stop, and the time it takes for passengers to board and alight. All the measures suggested below are based on the effort to reduce the boarding time per passenger as much as possible.

VI.1.a. Overtaking Lanes, Larger Buses and More Doors

The initial demand in Corridors II and III is going to be just over 2700 pphpd. This is the capacity of Corridor I. The bottlenecks in the system will be concentrated at four or five major stations. As such, in the short term, if the Corridor I configuration has already been designed for Corridor II and III, at all stations it would at least help if the station platforms were wider (minimum width of 4 meters), and if a distance (10m) between the two opposite boarding points were included to avoid excessive people concentration.

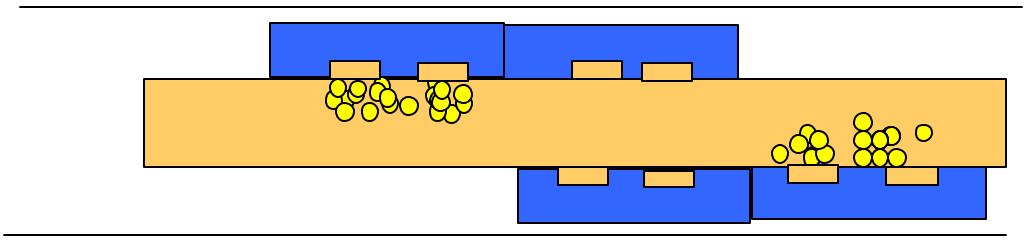


However, there are several stations in Corridor II and III where the volume of passengers is high enough that significant delays in service will result if changes to the Corridor I design are not made. These stations, (including Harmony in Corridor I which is shared with Corridor III, and was already discussed) are as follows:

- *Senen, (if a routing near the Senen bus and railway station is selected)*
- *Grogol,*
- *Cempaka Mas,*
- *Roxy.*

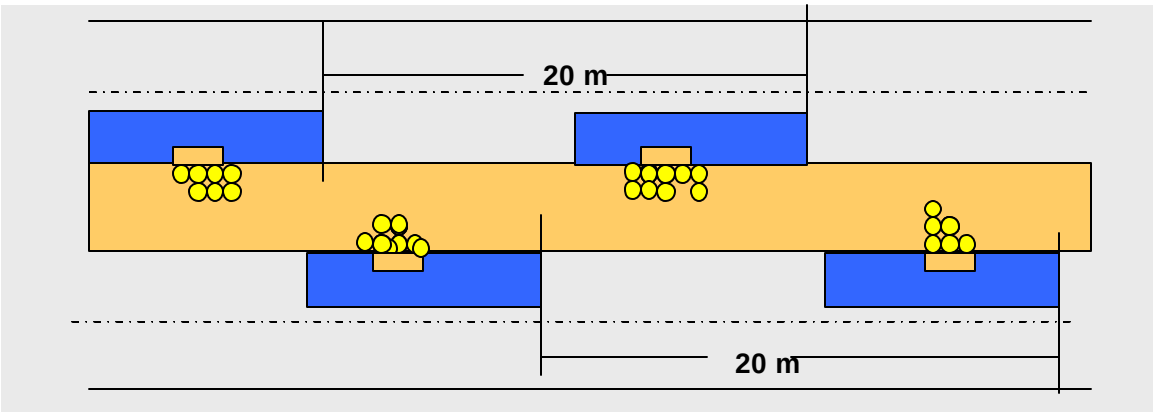
Given that the medium term passenger demand in Corridor II and III is not that high, there is more than one option for addressing this capacity problem:

- Option I: Keep the basic right of way geometry but give all stations in Corridor II and III two or even four doors, and gradually introduce larger, articulated buses with two and even four doors.



- Option II: Keep the existing buses with one door but add a passing lane at the four stations listed above, and add a second boarding platform at these station stops.

In these locations, stations should be 5 to 7 meters wide, and an overtaking lane needs to be added, to provide space for two buses in each direction.



Both options will give Corridor II and III enough capacity for the medium term. In the long term, the measures in both Option I and Option II should be implemented.

VI.1.b. Distances Between Stops

While we do not know how the specific location of the proposed bus stops in Corridor II and III compares to volumes of trip origins and destinations in those locations, the currently projected average of 700 meters between stations is generally considered to be a bit long. Normally, as station stops grow beyond 500 meters apart, the speed advantages for the buses are outweighed by the disadvantages of increased walking times.

VI.1.c. Bus station width

Four (4) meters should be the minimum width requirement for any station. If the central island is 5 to 10 meters wide it is better to construct one big station for two sides than two small ones.

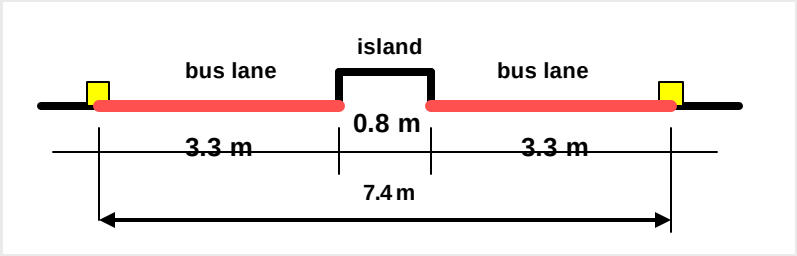
For some high demand stations (such as Harmoni or Monas, Senen, Grogol, Cempaka Mas and Roxy) we recommend a minimum of 5 meters width, and if possible 6 or 7 meters.

VI.1.d. Buslane Width

Currently, the bus lane widths in Corridor I are wider than they need to be. As such, sidewalks are narrower than they could be, and space for mixed traffic is also constrained. Generally, 3.3 meters width is enough for any typical section of the busway lane. 3-meters width is sufficient for bus stops because buses need to be brought close to bus station and are travelling at low speed.

BRT requirements:

A. Typical or stretch (not at bus stop):



B. Bus stop:

1.4.2 General traffic

VI.2. Design Measures to Improve Conditions for Mixed Traffic

For mixed traffic, the intersections are the main bottlenecks, and each intersection requires special design and all available width. Some general recommendations would apply to all intersections. Whenever possible:

- Locate bus stop far (>150m) from intersections to allow more space for general traffic and more space for bus station,
- Locate bus stops near but not directly in front of major trip attractors like shopping malls and office buildings.

- Allow safer pedestrian at-grade crossings (when on level is recommended).
- Reduce the number of phases to improve capacity. Usually capacity can be increased by 50% just by not allowing direct right turns for all movements.
- Control parking in the corridor.

VI.2.a. Station location at intersection

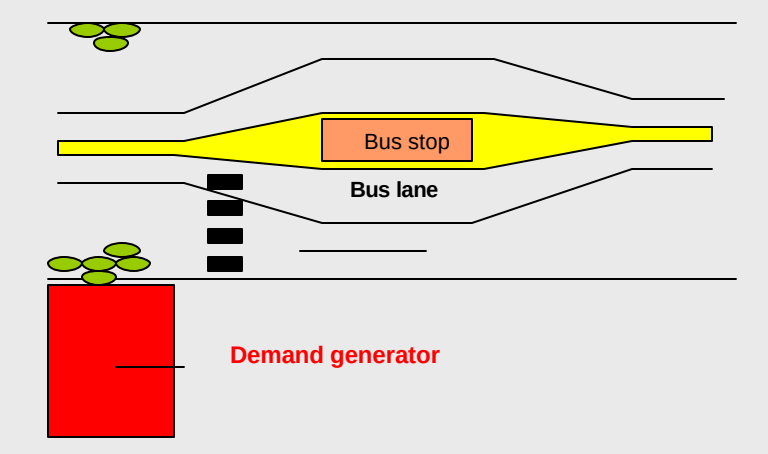
Typically we consider that bus stations should be more than 150 meters away from the intersection, to provide additional capacity for turning vehicles and to increase the number of mixed traffic vehicles able to clear the light in a single signal phase.

In fact, the distance is a function of the green time at the signal, where the distance L > 2.5*TG, where TG is green time. For most of the corridor, the green time is around 50 seconds, so, so 2.5*60 = 150m.

As intersections are infrequent, occurring only every 2 km on average, except in the central area, there is little difficulty in keeping bus station stops away from intersections.

VI.2.b. Location of bus stations at non-intersections

For bus stops not at intersections, the bus station should be located near the attracting point but not directly in front of it. Directly in front, there will tend to be a lot of non-BRT buses, taxis and paratransit vehicles and pedestrians congregating. To reduce congestion, so we split the BRT bus stop and the remainder lines bus stop.



VI.2.c. Width of the Mixed Traffic Right of Way

Mixed traffic lanes need to be wide enough to accommodate a reasonable growth of the general traffic in the corridor less the bus lines cut from the corridor. This width should be proportional to peak hour directional pcu volume. The following table shows the correspondent width needed for some typical sections:

Corridor 2-3 Examples of minimum width values					
	present		future		
section	volume (pcu/h)	width (m)	increase	volume (pcu/h)	width (m)
Mediros	2400	5.7	30%	3120	7.4
Pulomas	3400	8.1	20%	4080	9.7
Cempaka Mas	4000	9.5	15%	4600	11.0
Roxi	2400	5.7	30%	3120	7.4
R S S Waras	4500	10.7	15%	5175	12.3

The last column with future increase is adopted for cross sections requirements. An increase is estimated by taking into account existing bottlenecks on the corridor and nearest points, and improvements under construction.

The general methodology adopted is:

X = saturation = Volume/capacity < 60%

This means that considering volume as an independent variable, a higher capacity should be provided in order to obtain a saturation level below 60%.

60% is for spare capacity, and interruptions of operation (such as eventual parking, remaining bus stops, etc.)

S = Capacity (pcu/h) = 700* L

pcu = means passenger car unit, where all classes of vehicles are weighted to its equivalent on standard cars.
L = width in meters

So, capacity is proportional to width.

From 1 and 2 we obtain:

L > Volume/(700*60%) = Volume/420

So, instead of the maximum of 700 pcu/m.h of maximum capacity we calculate the width with 420 pcu/h.m (operational capacity).

Another condition is that:

L > 5 m is needed to avoid one broken vehicle blocking the road.

This condition is applicable not just for the total width but in case of separated express and local lanes to each of them.

VI.3. Pedestrian Access

ITDP did not have time to evaluate in any great depth the pedestrian access issues in Corridor II and III. However, some cursory observations indicate that surface crossing should be viable in many parts of Corridor III with proper design. In Corridor II, in some locations where the bus stop corresponds to a major intersection (like at Senen) at-grade crossing should be possible, but in other locations at grade crossing will require more improvements than the simple addition of a pedestrian crossing light and a zebra crossing. Without further modifications, these at-grade crossings could be quite dangerous.

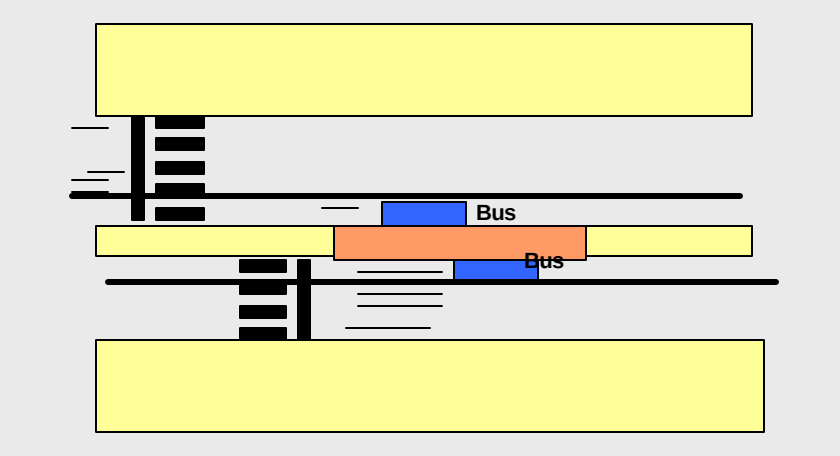
Walking around the city center, along the route of Corridor II, many sidewalks are in reasonable condition, but the lack of traffic lights or pedestrian refuge islands and numerous intersections with almost no break in the traffic makes these intersections extremely difficult to cross. At station stops like Isquital (in front of Pertamina), Juanda, and Pecenongan, where there is no significant intersection with crossing traffic, pedestrian crossing lights have been installed, but vehicles do not tend to stop. The stop at the Juanda railway station has been constructed in such a location that the current surface pelican cross is not usable and a new one some 50 meters to the west will have to be created. While it is not clear if the current signal phasing is intended to be permanent, the current signal phasing is extremely long, forcing pedestrians to wait extended periods of time. At-grade pedestrian crossing areas are not effective if the waiting time is longer than 2 minutes, and if motor vehicles do not respect the light. As such, the pedestrian crosswalk will need to be accompanied by additional measures, such as:

- additional pedestrian refuge islands either by widening the divider between the busway and the mixed traffic lanes to serve as a median, or creating new medians between main road and service roads, or by creating toll-plaza like stand alone pedestrian refuges.
- overhead lighting for the night time,
- elevating the crosswalk.
- Restricting free left turns (where applicable)
- Changing the streets from one way to two way and signalizing more of the intersections.

Without these measures, many of the Corridor II BRT stops would be safer with a pedestrian overpass.

For these exclusive pedestrian signals, we recommend:

If the total cross exceeds 25 meters the crossing should be divided in two steps, with separate and shorter green times and cycles, and an offset between them:



The offset of the pedestrian crossing is to alert pedestrians that green times are not the same at each side.

VI.4 Specific Recommendations for Segments in Corridor II.

At the time when this evaluation was done, the routing for the TransJakarta Corridor I was completed from Pulo Gadung through Senen, but the routing was not clear from Senen to Harmony. Now that this routing is clear, there are several additional intersections which are not further discussed which require further analysis to avoid significant bottlenecks for both mixed traffic and the TransJakarta system. These locations include the following intersections:

- Senen Raya and Kwini 1

Currently, a lot of left turning traffic is going to obstruct the busway unless the current gap is closed prohibiting this left turn.

- Left turn onto Kwini 2.

The busway crosses two lanes of traffic and there is no signal. It may need to be signalized.

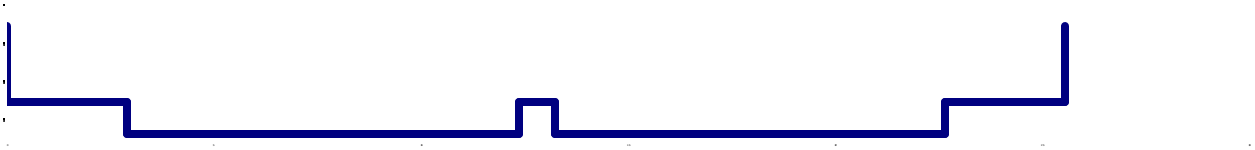
- Right turn off of Pejambon onto Medan Merdeka Timur.

They will probably have to signalize this, and there is already a long cue. There are four lanes with a median between two and two, and the busway is turning right from the left-most lane across a very congested lane of traffic. This is really a bottleneck and it may be possible to move the busway to the other side of the median earlier in the route since there aren't any stops.

Planning for Corridor II was also more advanced than on corridor 3, so our evaluation is more detailed for Corridor II.

VI.4.a. Segment Pulo Gadung – Flamboyan (1.2 km)

VI.4.a.i. Typical Existing Cross Section:



Corridor 2 typical section: Pulugadung – Flamboyan (Mediros Hospital)					
Type	sidewalk (north)	traffic w>e	Island	traffic e>w	sidewalk (south)
Width	2.9	9.45	0.85	9.42	2.9
Sum	2.9	12.35	13.2	22.62	25.52

This first stretch has a narrow section, with only three lanes per direction. Width of sidewalk is less than three meters available. On practical terms, the first curb lane is rarely used for a real flow traffic lane, but it is being used for parking, pedestrian, street vendors, etc.

Photo 1:
Pulogadung – Flamboyan (Mediros Hospital)

Photo 2:
Pulogadung – Flamboyan
(Mediros Hospital)

Therefore, the traffic uses mostly two lanes. The BRT lanes can be implemented while maintaining the actual capacity for mixed traffic if:

- The sidewalks are reconstructed and preserved only as a walk way.
- Parking and other uses on the first lane are forbidden and controlled (this means permanent policeman allocated to patrol this section)

If the above cannot be implemented, it is recommended not to implement BRT exclusive lanes on this 1.2 km section, just use the left lane as a normal lane, shared by BRT and general traffic.

Directional traffic goes up to 2400 pcu/hour. According to the standard of 400 pcu/meter, the general traffic would need only 2400/420 = 5.6 meters.

In the near future, volume could increase by 30% and therefore the general traffic would need 7.4 meters.

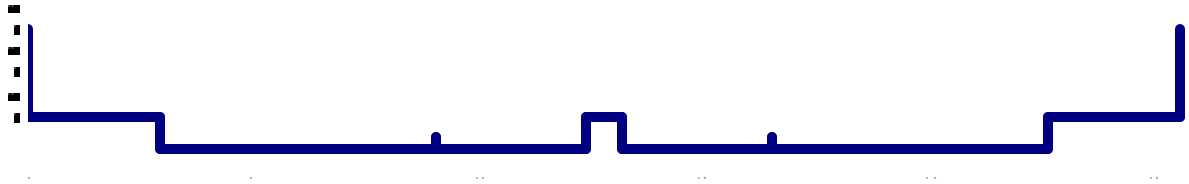
However, there is not enough space to provide 7.4 meters for the general traffic. The existing space of 5.6 meter is only enough for the present volume, so we suggest Jakarta government to acquire land to obtain a wider section.

VI.4.a.ii. DisHub and ITDP Proposed Typical TransJakarta Cross Sections

Presently, for the first 100 meters from Pulo Gadung terminal, there is a signalized right turn conversion from west to enter south to the terminal, and boarding and alighting on buses and associated street vendors on this section is very intensive. If the BRT were implemented, saturation degree would be above 100% and considerable congestion will occur on peak periods. While bus lane for this segment would certainly give a big travel

time advantage to the busway, the mixed traffic lanes will very badly congest, which may not be ideal for the rest of the traffic.

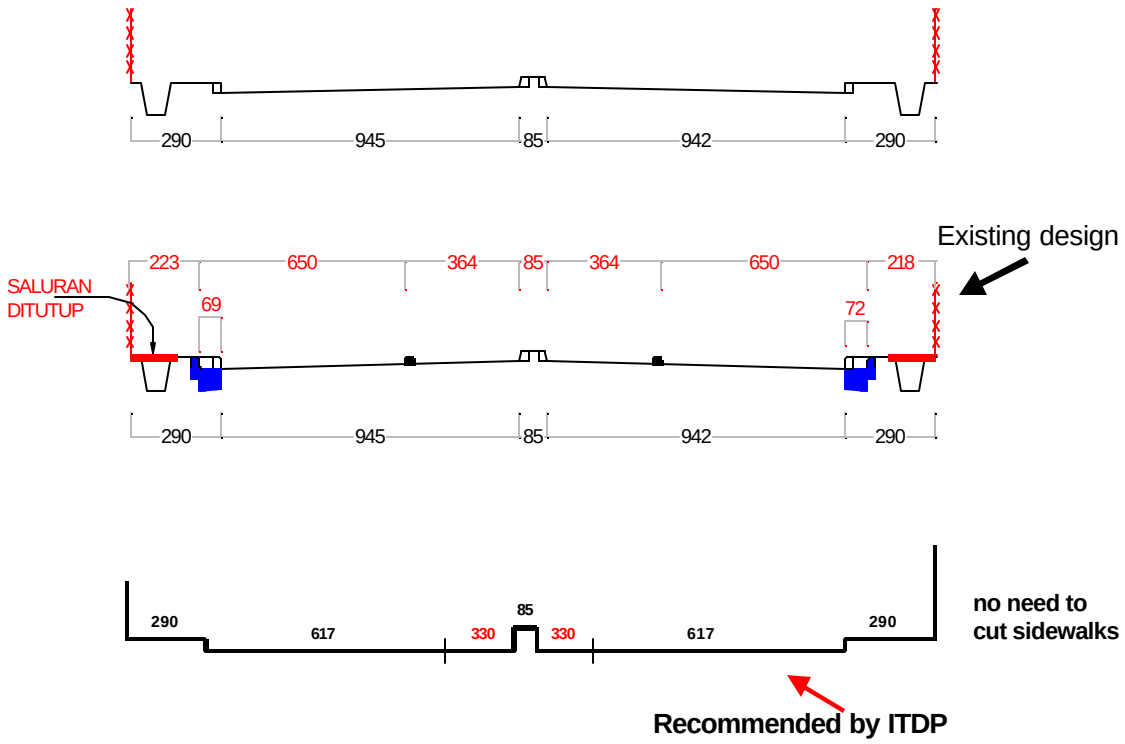
Typical DisHub proposed cross section (not at bus station):



Corridor 2 typical section: Pulugadung - Flamboyan (Mediros Hospital)							
Type	Sidewalk (north)	Traffic w>e	BRT	Island	BRT	traffic e>w	sidewalk (south)
Width	2.9	6.15	3.3	0.85	3.3	6.12	2.9
Sum	2.9	9.05	12.35	13.2	16.5	22.62	25.52

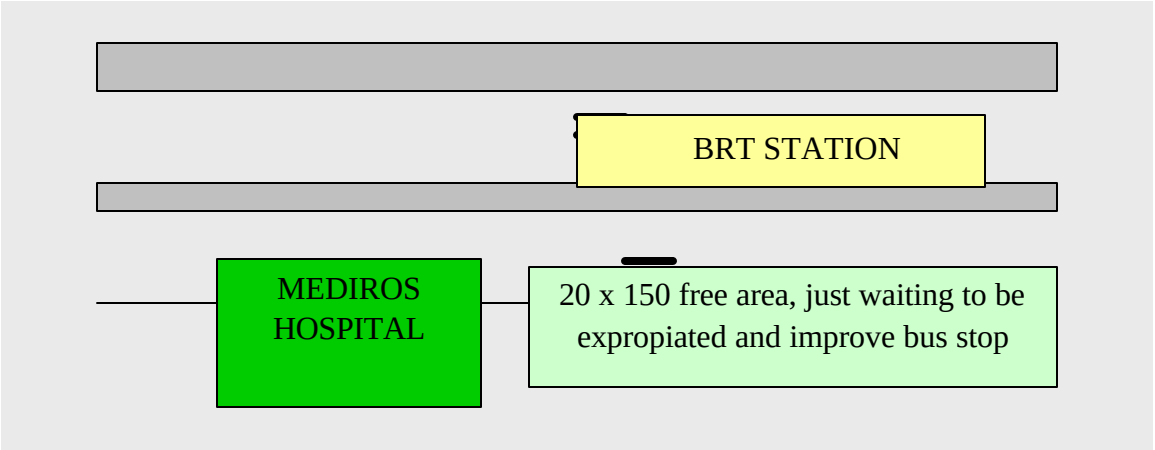
The following figure shows comparison between ITDP and the current project proposals: In either case, he curb lane and sidewalk must be reconstructed on most of the section, to define which is which. The ITDP alternative avoids cutting sidewalks and leaves only 0.43m less width for the general traffic.

Segment : Pulogadung – Bermis (typical)



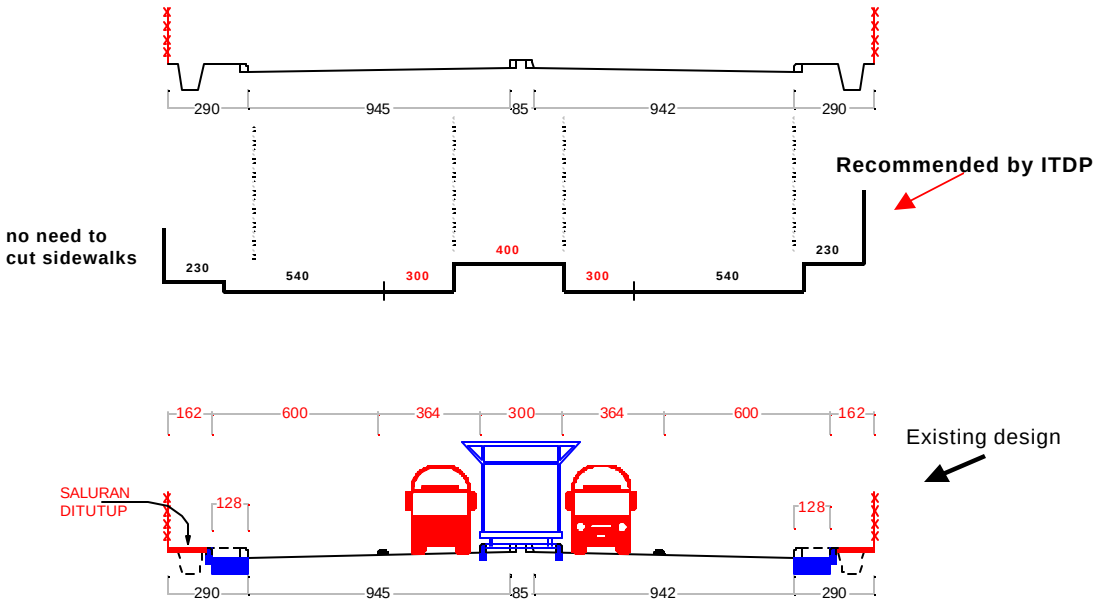
VI.4.a.iii. ITDP and DisHub Suggested Cross Section at TransJakarta Bus Stops

There is only one bus station being proposed for this section located in front of Mediros Hospital. At bus stops, we recommend some adjustments to the DisHub treatment. The ITDP alternative has 1.0meter more for the bus station, an additional 0.70 meters for the sidewalk and 0.60 meter less for general traffic. We also recommend that the bus station not be built directly in front of the hospital, but just to the East, allowing the remaining buses and taxis to stop in front of Mediros Hospital and split the problem.



Proposed layout for Mediros Hospital bus station

Segment : Pulogadung – Bermis (bus stop)



While this solution is preferable, it is not ideal. Ideally, DKI Jakarta should acquire some land particularly at the bus stations. At the location of the proposed bus station there is an empty land that seems to be prepared for these use (immediate East to Mediros Hospital), as shown on previous scheme.

Photo 3:
Land that could be acquired for busway (East of Mediros Hospital)

With this additional 20 meters (12 would be enough) a good bus stop could be provided.

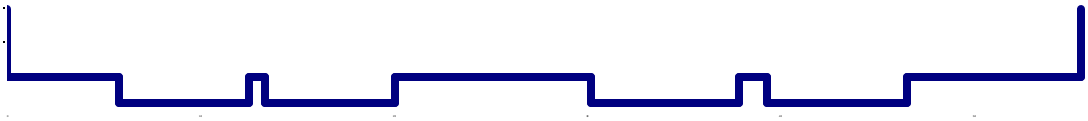
ITDP proposal (without land acquisition)							
Type	Sidewalk (north)	Traffic w>e	BRT	Island	BRT	traffic e>w	sidewalk (south)
width	2.3	5.4	3	4	3	5.4	2.3
sum	2.3	7.7	10.7	14.7	17.7	23.1	25.4

ITDP proposal (with land acquisition of 12 x 130 m)							
width	4.2	9	3	5	3	9	4.2
sum	4.2	13.2	16.2	21.2	24.2	33.2	37.4

VI.4.b. Segment Flamboyan - Toll road at Cempaka Mas (3.0km)

This stretch is much wider than the previous segment (Pulogadung – Flamboyan), and it has local and express lanes, wide sidewalks and island:

VI.4.b.i. Existing Typical Cross Section



Corridor 2- Flamboyan toll road typical section (Gading, Pulomas, Asmi, Pedongkelan)

Type	sidewalk (south)	Traffic e>w local	Separator	Traffic e>w express	Island	traffic w>e express	Separator	traffic w>e local	sidewalk (north)
width	5.8	6.7	0.85	6.7	10.17	7.6	1.5	7.25	9
sum	5.8	12.5	13.4	20.05	30.22	37.82	39	46.52	55.52

This 3.0 km stretch is basically express, and there are only two signalized intersections located at:

- ? Kelapa Gading: 500 meters west to beginning.
- ? Under the toll road (Wiyoto Wiyono) at the west extremity of the section.

These two points are already quite congested and need improvement to avoid increase of congestion after the BRT corridor is implemented. This topic will be discussed separately.

VI.4.b.ii. DisHub and ITDP Proposed Typical TransJakarta Cross Sections

According our previous calculation, 9.7 meters width would be enough for general traffic, therefore on the E > W side (narrower than W > E) if from the (6.7 + 6.7) = 13.4 meter is taken 3.3meters for BRT lane, the remaining 13.4 - 3.3 = 10.1 meters of the existing road would be enough for general traffic (without cutting the central island). But with the present division, this would mean only (6.7 - 3.3) = 3.4 meters for the express road, and we do not recommend it (need at least two lanes). The alternative would be to remove the separator and operate with only three lanes without express and local. However, field verification showed that at some places there is a considerable difference of level between the local and express roads, up to 30 cm, and costs of levelling both lanes might be too high. Therefore, we consider cutting the central island and separators to maintain two express lanes for general traffic is acceptable.

VI.4.b.iii. Dishub and ITDP Proposed Cross Section at TransJakarta Station Stops

DisHub is recommending passing lanes at the bus station stops along this part of the corridor. However, our analysis indicates that boarding and alighting volumes are low,

thus, a passing lane at the station is not needed. This will help reduce the need to widen the right of way at bus stops and mitigate congestion impacts for mixed traffic.

In summary, while four lanes are needed for general traffic to avoid an adverse congestion impact, there is no need to provide overtaking lane at bus stops in this section.

VI.4.c. Segment Toll Road (Cempaka Mas) - Galur Flyover (2.5 km)

This section is 2.5 km long, with no intersections, and 5 bus stops for the busway are being planned.

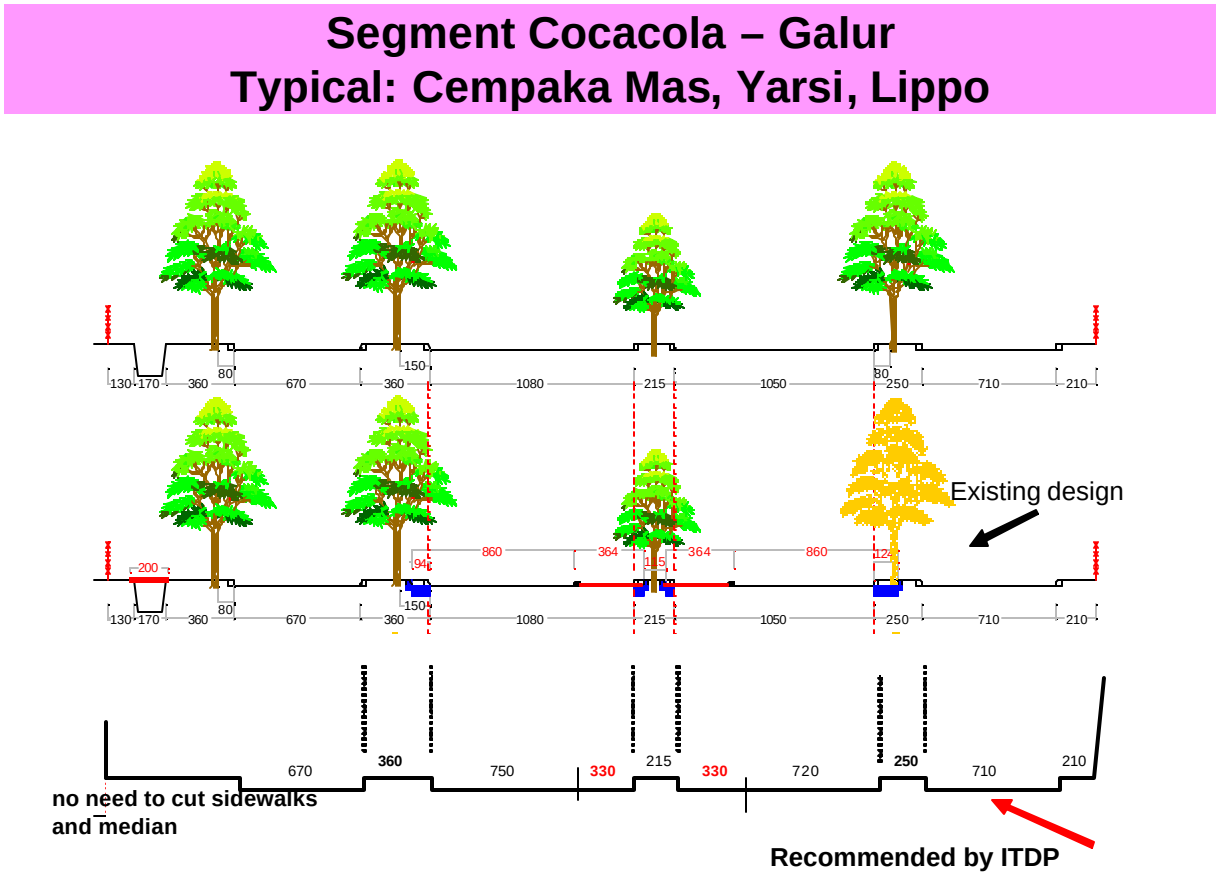
VI.4.c.i. Typical existing cross section

Here the cross sections is wide (about 64 meters), and about 35 meters is for traffic with 5 lanes per direction. Traffic volume analysis shows that 11.0 meters is enough for general traffic needs, so it is possible to use the existing paved section to implement the BRT.

VI.4.c.ii. DisHub and ITDP Proposed Typical Cross Section for TransJakarta

The existing project proposal is to cut the central island and separators to maintain the present 5 lanes for general traffic.

The following figure compares ITDP and project proposals:

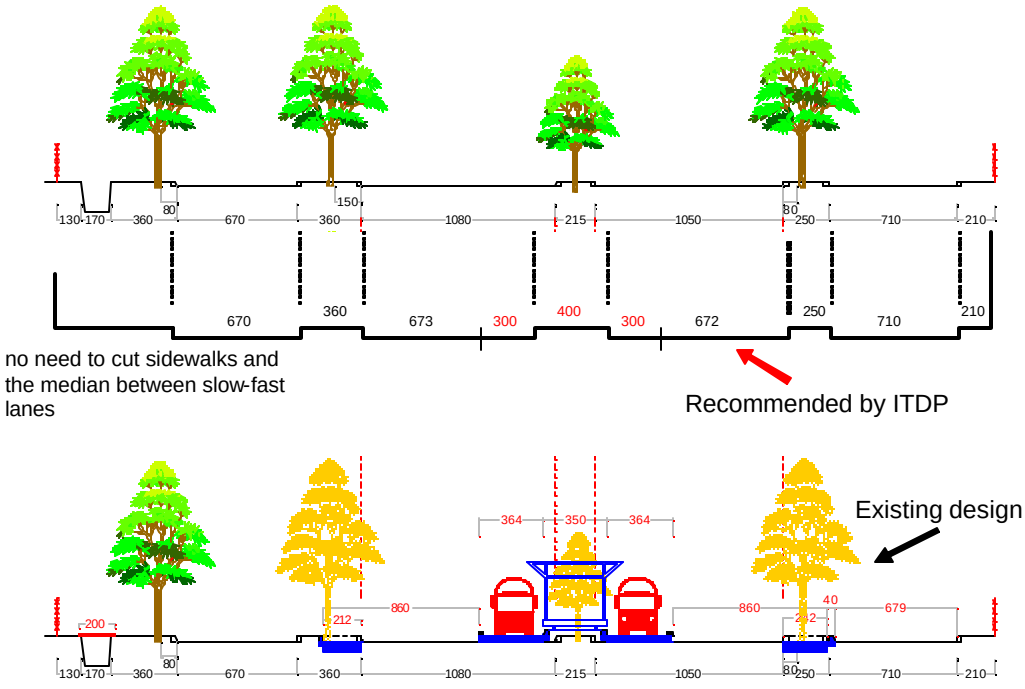


The typical cross section corresponds to 80% of section. ITDP proposal avoids four small cuts on island to give (8.6 - 7.2) = 1.6 meters for the general traffic.

VI.4.c.iii. DisHub and ITDP Proposed Cross Sections at Transjakarta Bus Stops

ITDP proposal only uses four lanes for general traffic which consists of two express and two local lanes.

Segment Cocacola – Galur
Bus stop: Cempaka Mas, Yarsi, Lippo



The following photos show that presently a minimum of one lane is wasted on parking and in some cases only two lanes are available for general traffic. All photos were taken on afternoon peak on W > E direction.

Photo 4:
Cocacola - Galur

The above photo shows buses and vans parking on local and express way occupying the left lanes and leaves only three lanes available for traffic.

Photo 5:
U-turn near Cempaka Mas

At the U-turn W- E near Cempaka Mas, there are only 2 lanes available for direct traffic.

U- turns should deserve a special analysis and design. An example of possible solution is discussed later for corridor 3.

Photo 6:
Buses parking on express and local lanes (near Galur flyover)

The above photo shows that buses eventually make a stop for some minutes waiting to fill the bus. For example we see buses parking on express and local lanes blocking two lanes.

Photo 7:
Local lane is being used for parking

The above photo shows that on local lane the left lane is being used for parking. Even though the density of the area is not high, but the parking is enough to make the local lane under-utilized.

Parking is almost inversely proportional to land use intensity. Big shops and point of attractions have off–road parking facilities, but small shops such as car repairing do not have off-road parking facilities.

Photo 8:
After Galur flyover (W > E)
The local lane being used for parking and stopping buses.

Just after Galur flyover on W > E direction only one lane is available for circulation on local road. This is an almost congested point because the local lane is the only entrance from Galur intersection conversion flow (under the fly over). The rest of the lanes are being used for parking and for stopping buses.

Photo 9:
Galur flyover (W > E)

On the same place (Galur flyover, W > E) on express road straight from the flyover, stopping bus occupies the left lane of the express lane, leaving only one lane for other

traffic. This practice should not be allowed. Buses should stop 30 meters ahead where a third lane is available

So at this place only two lanes are available on the corridor. This is practically the same traffic that uses the 5 lanes theoretically available from this point to Cempaka Mas.

As calculated before, the traffic volume, by considering future increase, will require a width of 11.0 meters. Field analysis indicates that the present volume passes normally in 3 lanes and sometimes just in two lanes.

In our meetings with the busway team, the team's justification presented for 5 lanes is based on an effort to preserve the local lanes for local traffic, that in practice means preserving the local lanes for parking and stopping vehicles. This means Jakarta would be cutting trees to preserve existing parking practices on the corridor.

VI.4.d. Segment Galur Flyover to Senen

For this segment the busway project will have two bus stops:

Galur: located 100 meters after (to the west) Galur flyover. The existing plan proposed by the busway team seems appropriate.

Senen: Located between Senen flyover intersection and the approach of the Senen tunnel which is under construction. ITDP has not seen the design of this bus stop, so there is no comment on it.

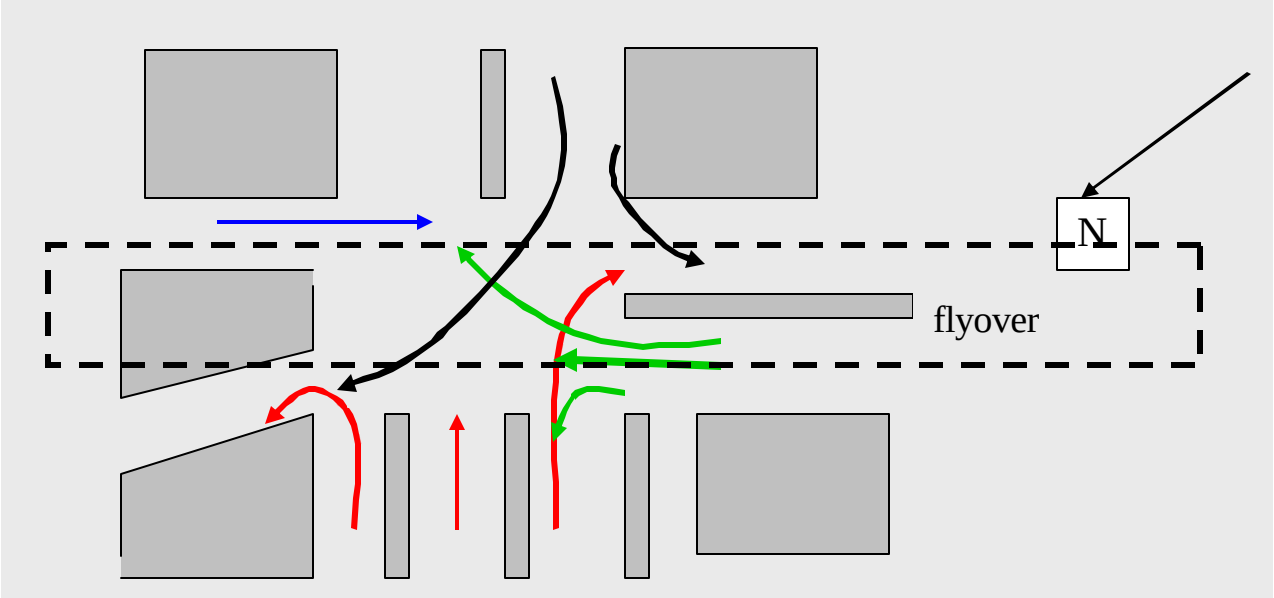
VI. 5. Specific Recommendations for Intersections in Corridor II

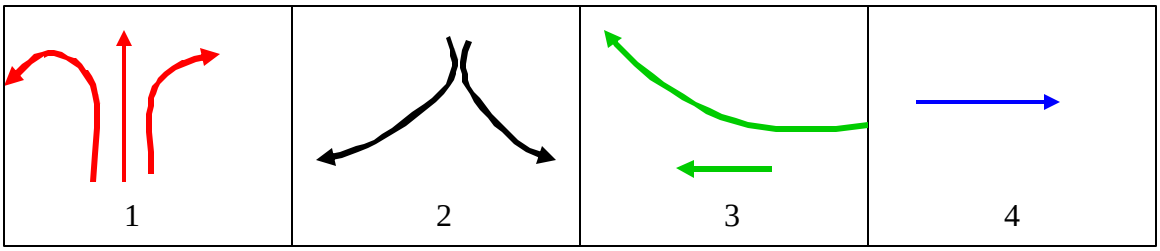
VI.5.a. Senen intersection

Presently there is a four-phase signalized intersection.

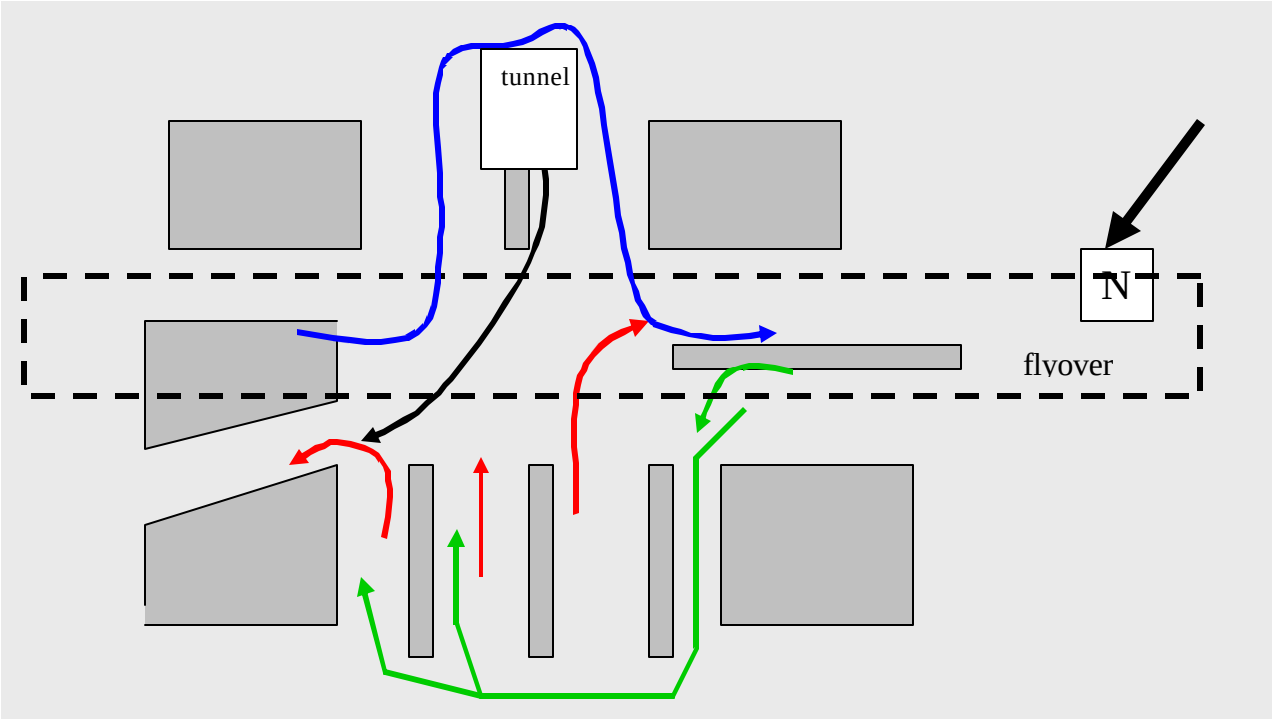
Future design of this intersection depends on the BRT itinerary from Senen to the West which is not yet decided by the government.

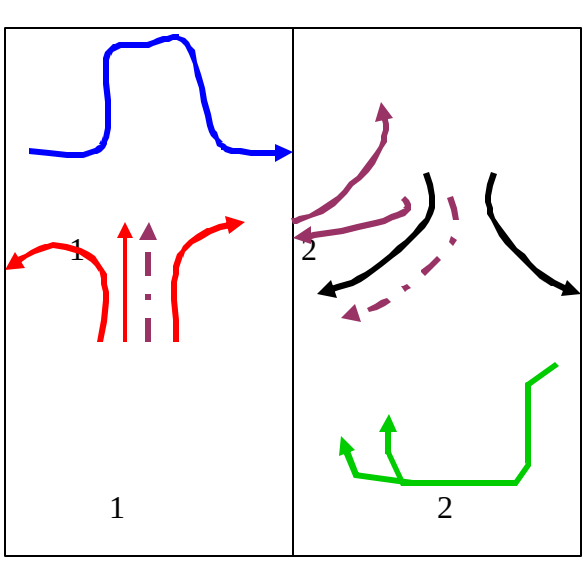
The present scheme (simplified): 4 phases

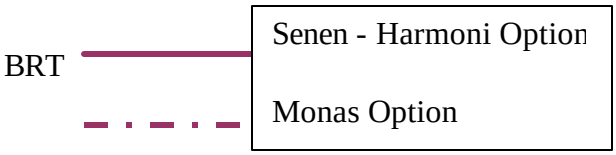




ITDP recommendation (after the BRT and Senen tunnel is constructed):



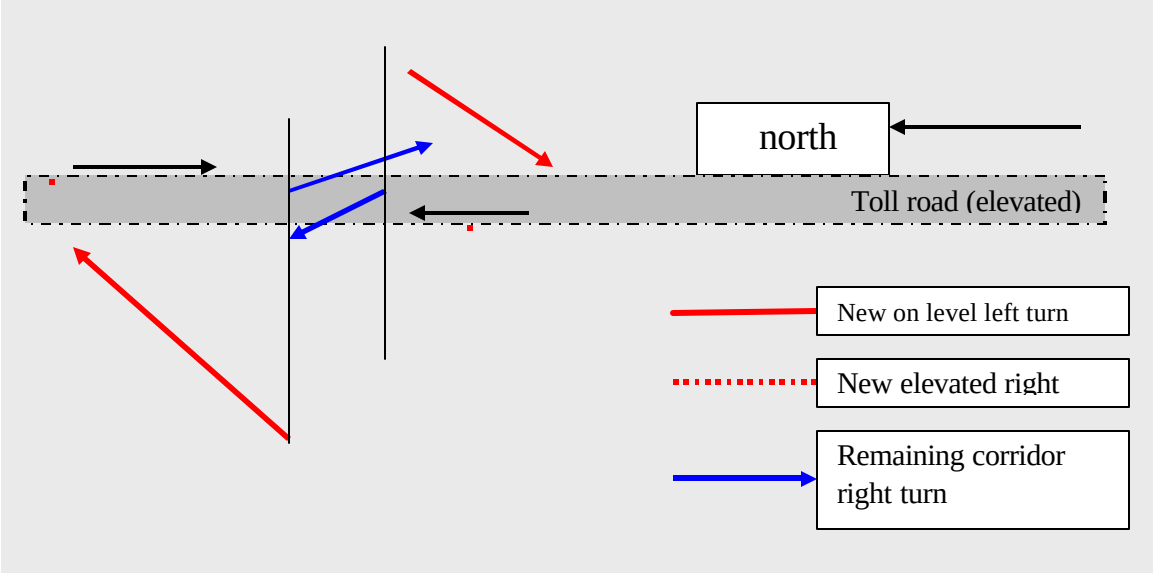




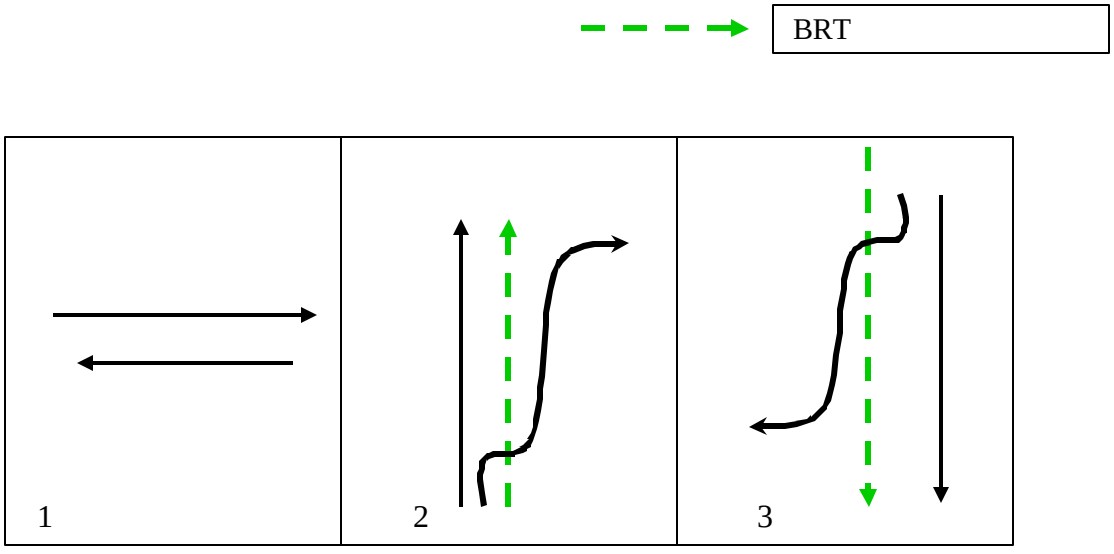
Our recommended solution takes advantage of the future tunnel to provide an off-level crossing North - South. The South > North crossing should have an additional signal 150 meters away to the West of the intersection to leave only two phases on the main intersection. The BRT lanes would run on the same phase of corresponding general traffic either from/to Harmoni or Monas. This scheme will increase intersection capacity by around 50%.

VI.5.b. Toll road intersection (CocaCola)

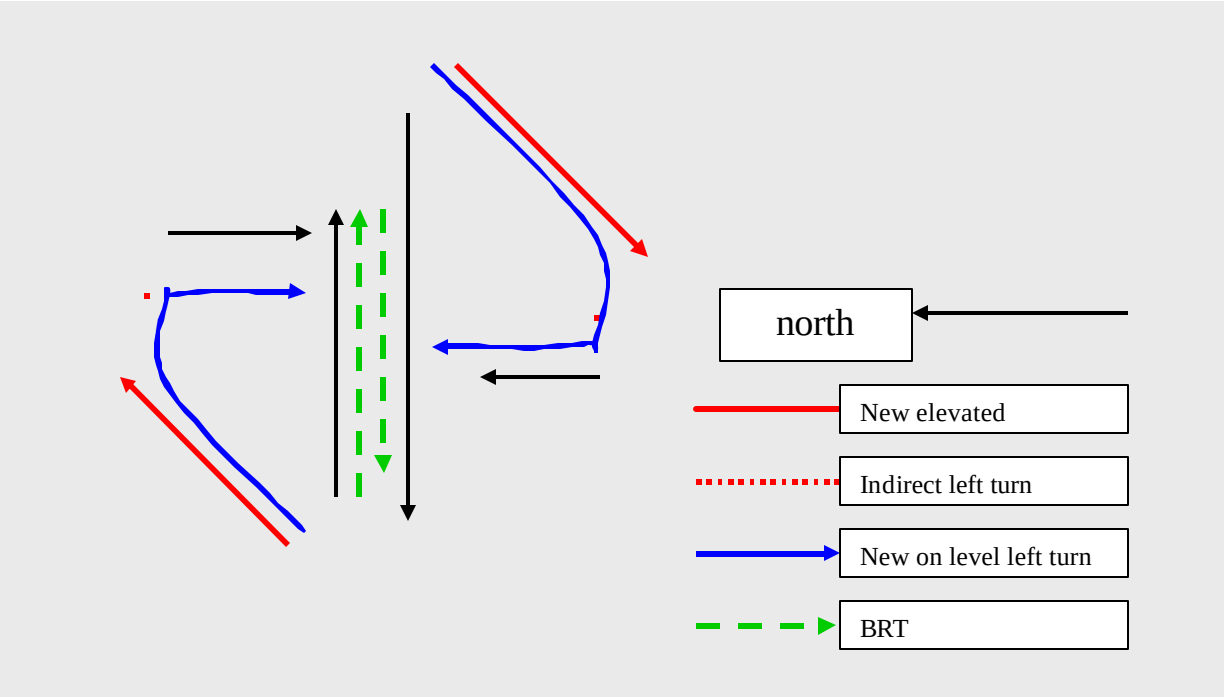
The present traffic light scheme operates with four phases with all movements allowed. The intersections is being reconstructed with two additional directional bridges for right turn from crossing road (that is N > W and S > E).

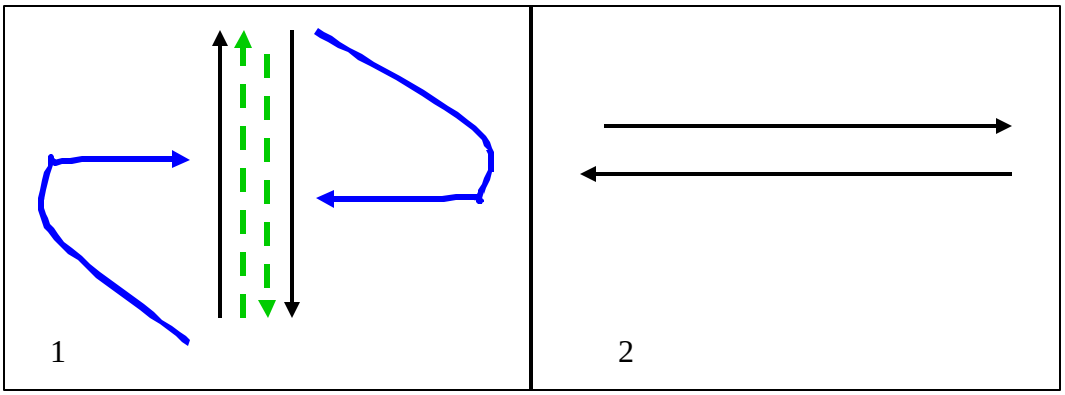


Probably, the new design would use a standard 3-phase scheme. This will means some additional delay and complicated design of BRT, with some additional conflict with BRT:



Our proposal would be a simpler 2-phase scheme, using existing left turn facilities on the corridor to cross on two additional signals under the toll road and eliminate straight right turns, as follow:

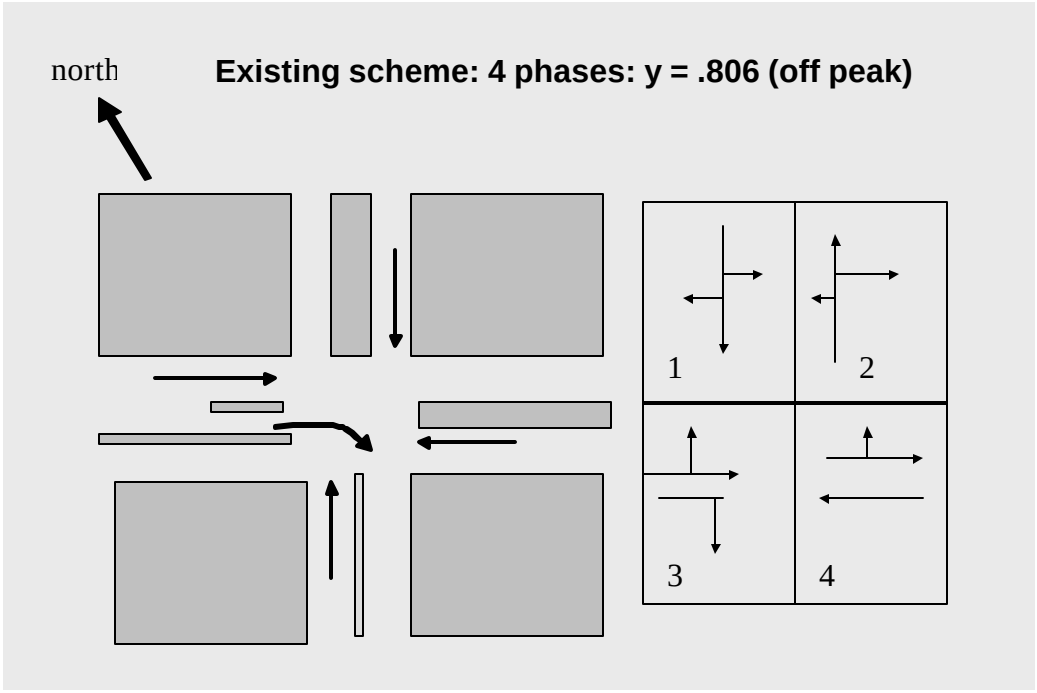


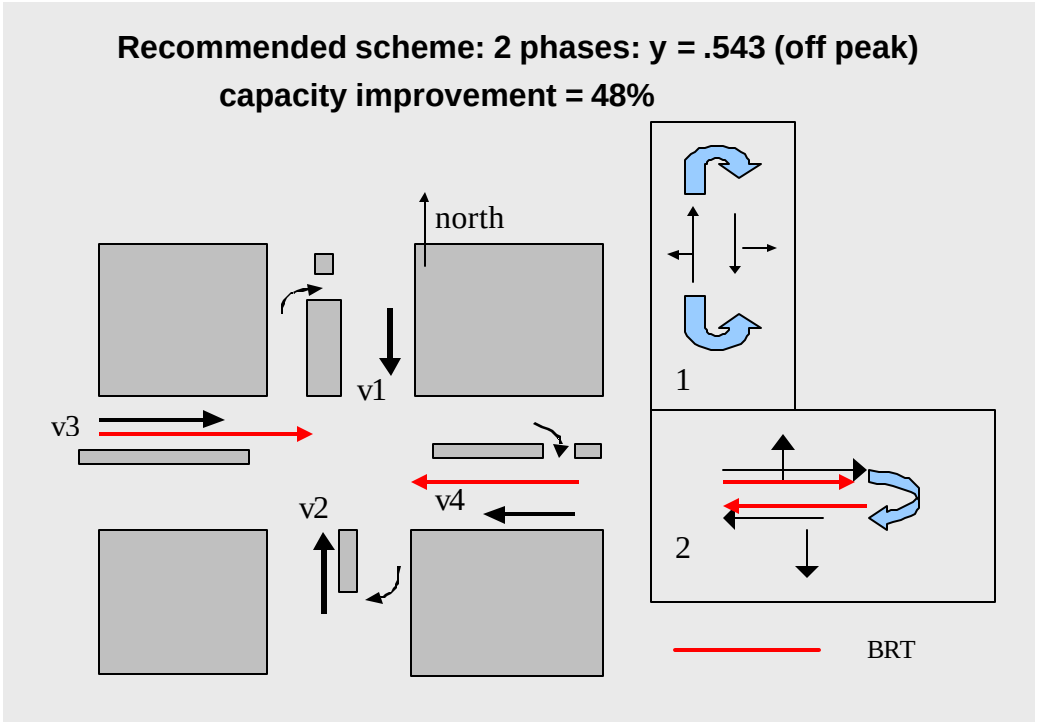


As usual, a 2-phase scheme will result on more capacity, smaller cycle and less delay for general traffic and BRT.

VI.5.c. Perintis Kemerdekaan x Kelapa Gading intersection

This is the only traffic intersection from the toll road to Pulogadung. The traffic light at the intersection operates with 4 phases. This can easily be reduced to a 2-phase scheme in order to increase intersection capacity.


north
Existing scheme: 4 phases: y = .806 (off peak)
1
2
3
4

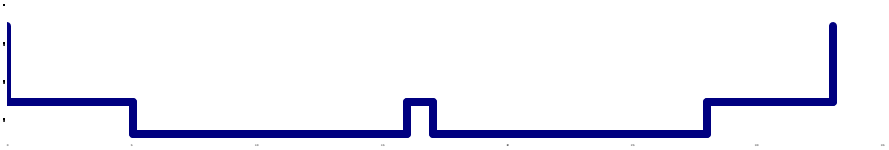

Recommended scheme: 2 phases: y = .543 (off peak)
capacity improvement = 48%
north
v1
v2
v3
v4
1
2
BRT

VI.6. Notes on Corridor III

The following suggestions are limited to the stretch Harmoni - Grogol (excluded Grogol intersection), and one intersection at Rawa Buaya.

VI.6.a. Segment Harmoni – Railway (K. H. Hasyim Ashari) (2km)

VI.6.a.i. Typical section



Type	sidewalk (north)	Traffic w>e	Island	Traffic e>w	sidewalk (south)
width	5	11	1	11	5
summary	5	16	17	28	33

The sidewalk here has many uses, with no available space for pedestrian on some locations:

Photo 10:
Sidewalk - corridor 3

Traffic volume prediction for the near future is 3200 pcu (passenger car equivalent) per direction. The existing 11 meters road width available for general traffic, even with irregular parking, is enough for obtaining a low saturation level except at some bottle necks discussed in the next page.

VI.6.a.ii. Bottlenecks (actual and future)

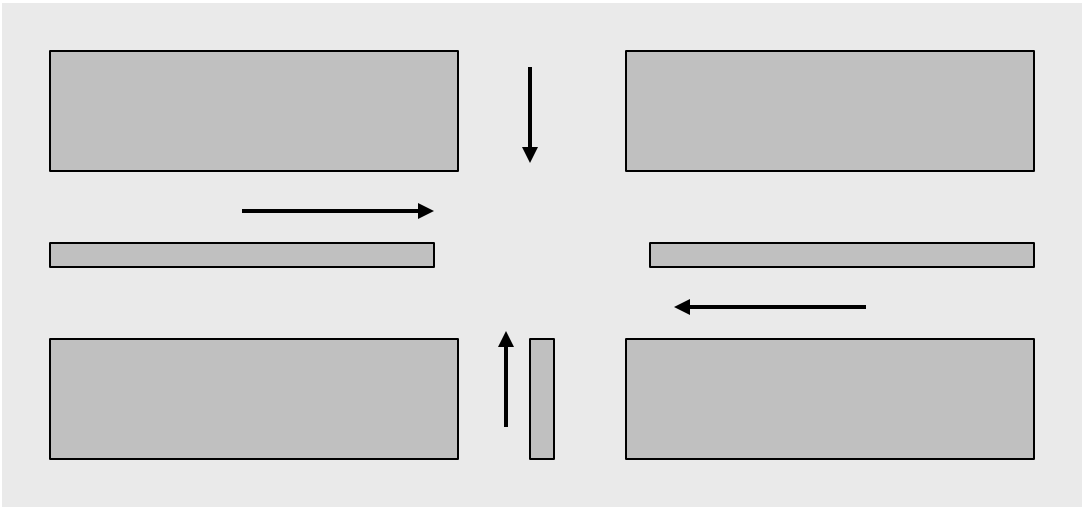
In all figures north is up, like normal geographical maps. We comment on present operation and suggest improvements needed to maintain or reduce v/c (volume/capacity) ratio and increase general flow quality after the BRT is implemented.

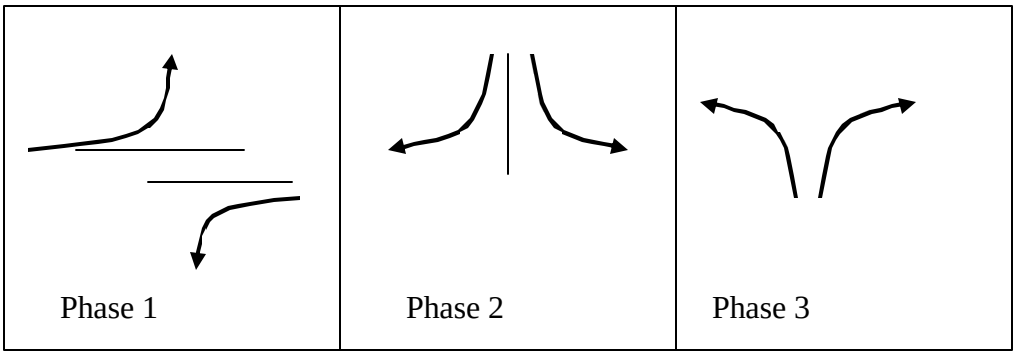
The first stretch (east side) with 700 meters is with low commercial use, no traffic signals and operates at low v/c ratio, and high velocity.The second stretch from Jl. A.M Sangaji to Jl. K.H Mas Mansyur has three signalized intersection, as follows:

Jl. A.M Sangaji

Cycle = 96 second

Consists of 1 phase, right turns not allowed on corridor, north approach is one way, and south approach is two ways, as follow:





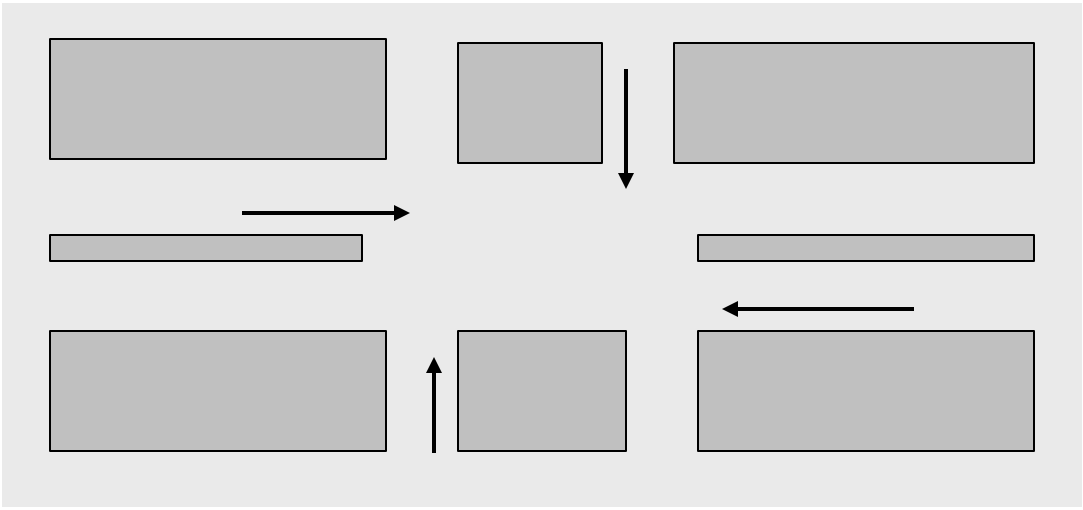
Volumes on transversal are quite low and the 3-phase scheme is operating well.

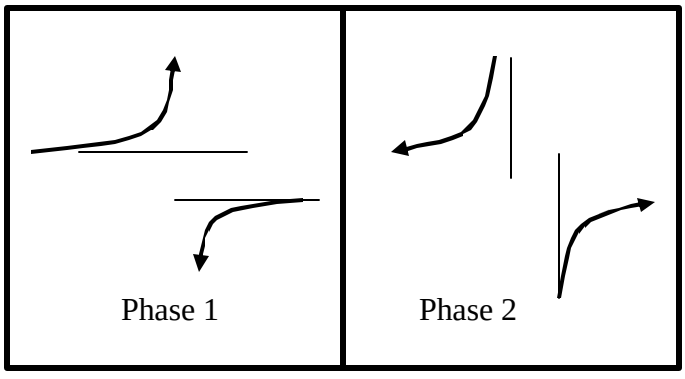
No suggestions, as right turns on corridor are forbidden, therefore the BRT can be implemented without changes on phases.

Jl. Cideng Barat / Jl. Cideng Timur

This is the most important crossing on this stretch, about 350 meters to west of Jl. A.M Sangaji.

Right conversions are already forbidden on four approaches, and the signal operates only on two phases. Cycle is 128 seconds and a common cycle and coordination with Jl. A.M Sangaji intersection will improve average speed (this is only a suggestion, not a critical issue). No other suggestions.



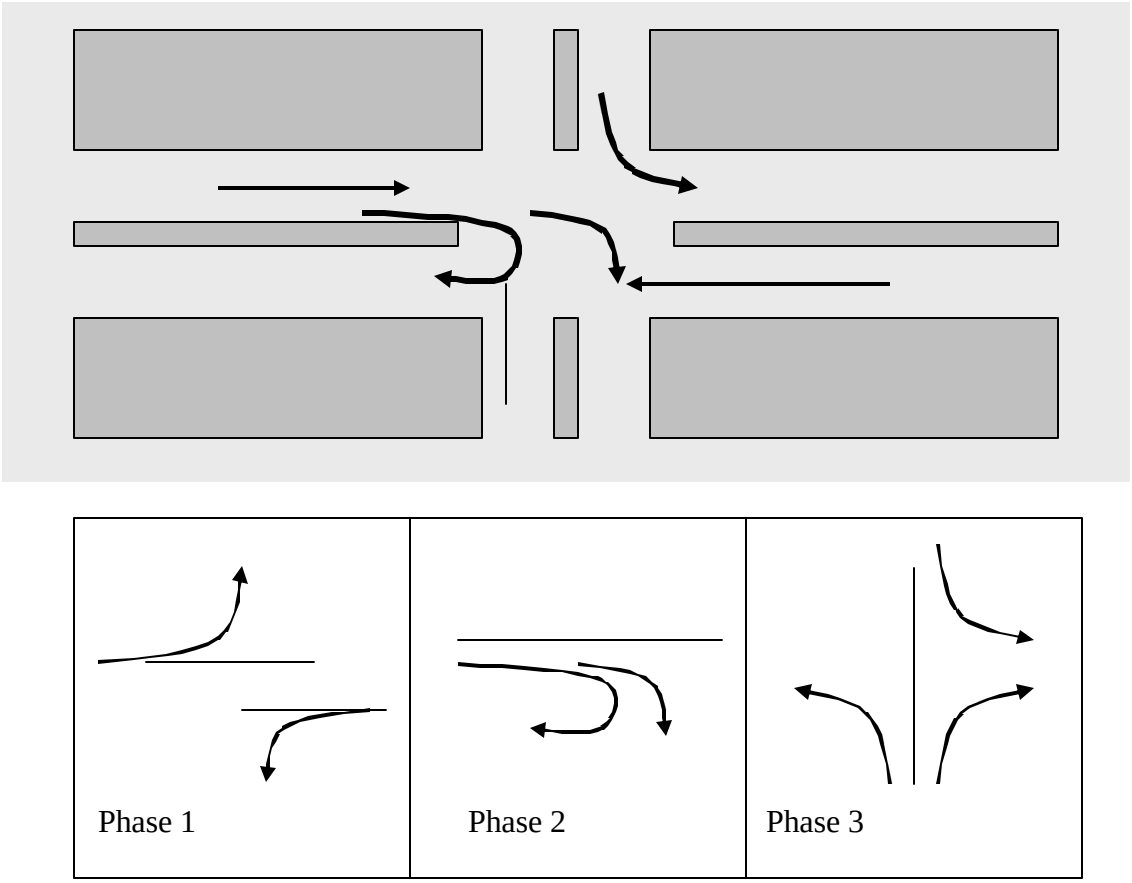


Jl. K. H. Mas Mansyur / Jl. Biak

This transversal should have usually low movement and operates without problems. However, it is the main access from west bound (Grogol) to Roxy Mas trade centre. Cars and buses coming from the west make a U-turn to go to Roxy Mas trade center straight

by the corridor, or make a right-turn to enter Roxy Mas trade center by a secondary access by Jl. Biak/Jl. Ternate. On Saturdays, right turn volume is around 1000 pcu/hour.

The intersection has three phases: the first is for the corridor, the second is for the left and U–turn, and the third is for the transversal, where the north-bound approach has only the left option, to avoid the conflict with south approach.



Roxy Mas trade center

The shopping mall can attract up to 10 thousands people per hour, and this volume represents more than 1000 cars. One to three lanes are occupied only by buses mainly waiting for their potential passengers. And this is the main cause of congestion on the corridor.

Photo 11:
Roxy Mas trade center

Railroad crossing

Actually, this is the main bottleneck of corridor 2 on E > W direction. There are three main causes of the bottlenecks at this point, as described below in increasing order of magnitude:

The train itself is a minor problem. Usually at peak hour there are around four trains per hour, each train interrupts flow about 1 minute, so capacity is reduced by 1/15 (or 7%).

Photo 12:
Train crossing at Senen/Galur

There are a lot of small vehicles such as motor cycles, mini buses, bicycles crossing and making irregular U-turns at this point causing about 15% of capacity is lost.

The following table shows the final liquid capacity obtained:

Railroad crossing overall reduction		
width	**pcu/hour/m**	**pcu/hour**
11	700	7700
factor	reduction	capacity
Train crossing	7%	7161
Irregular crossing	20%	5729

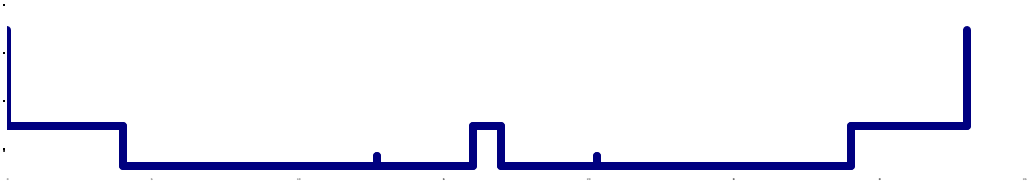
IV.6.a.iii. Recommendations

-----Cross sections

The present demand per direction is about 2400. By removing the existing bottlenecks could increase demand up to 3140. As suggested before, a width to avoid saturation should be around V/400, or:

L = 3400/400 = 8.5 meters

a. Typical: (not at bus stop)



Corridor 3 (Harmoni to Railroad): typical section recommended by ITDP

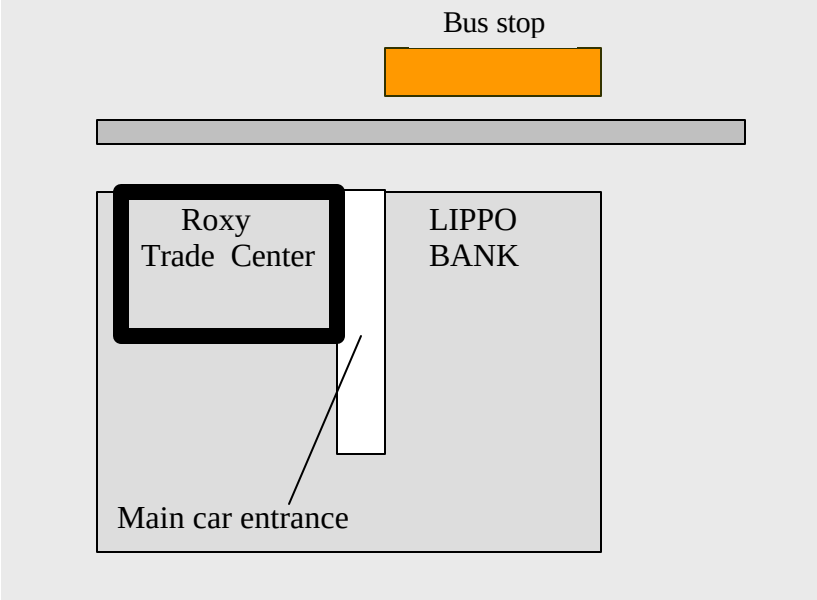
Type	sidewalk (north)	Trafic w>e	Bus w>e	Island	Bus e>w	Traffic e>w	sidewalk (south)
width	4	8.7	3.3	1	3.3	8.7	4
sum	4	12.7	16	17	20.3	29	33

We propose to cut only one meter on each side of the "existing side walk" and it will be more appropriate to say: to construct a side walk where today there is only an undefined area.

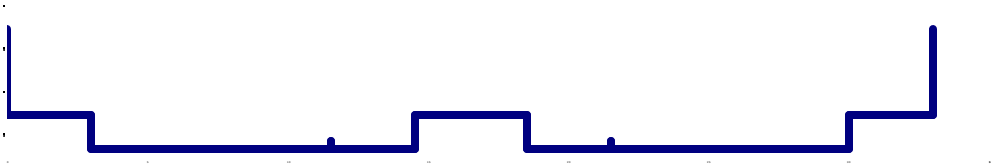
-----Bus stations

At Roxy Mas

Bus station should be constructed not in front on Roxy Mas trade center in order to avoid concentration of bus stopping on the same place. We suggest to build a bus station located 130 meters to the east of the main pedestrian Roxy Mas entrance (where today is already a formal bus stop - in front of Lippo Bank).



The station should be 4 meters wide.



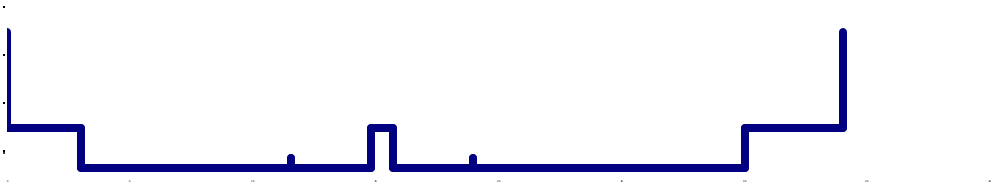
Corridor 3 (Harmoni – Railroad) : ITDP recommendation for bus station secti

Type	sidewalk (north)	Trafic w>e	Bus w>e	Island	Bus e>w	Traffic e>w	Sidewalk (south)
Width	3	8.5	3	4	3	8.5	3
Sum	3	11.5	14.5	18.5	21.5	30	33

VI.6.b. Roxy to Jl. Biak

Roxy to Jl. Biak should have the same lay out.

In front of Roxy Mas (south side) need additional space for remaining bus stop, therefore an extra space should be provided, as follows:



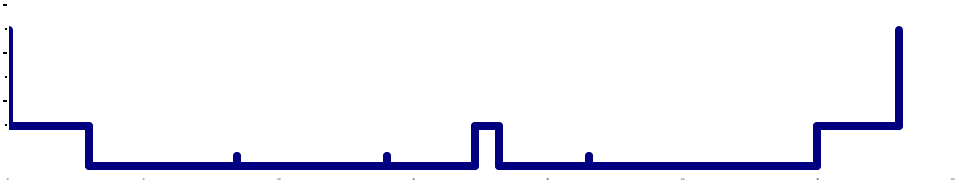
Corridor 3 (Harmony – Railroad): proposed typical section in front of Roxy Mas

Type	Sidewalk (north)	Trafic w>e	Bus w>e	Island	Bus e>w	Traffic e>w remaining buses stop	sidewalk (south)
width	3	8.5	3.3	0.9	3.3	11	4
sum	3	11.5	14.8	15.7	19	30	34

Note: Actual existing side walk in front of Roxy Mas has 6.5 meters width, allowing extra lane width of 34.0 meters, instead of 33.0 meters.

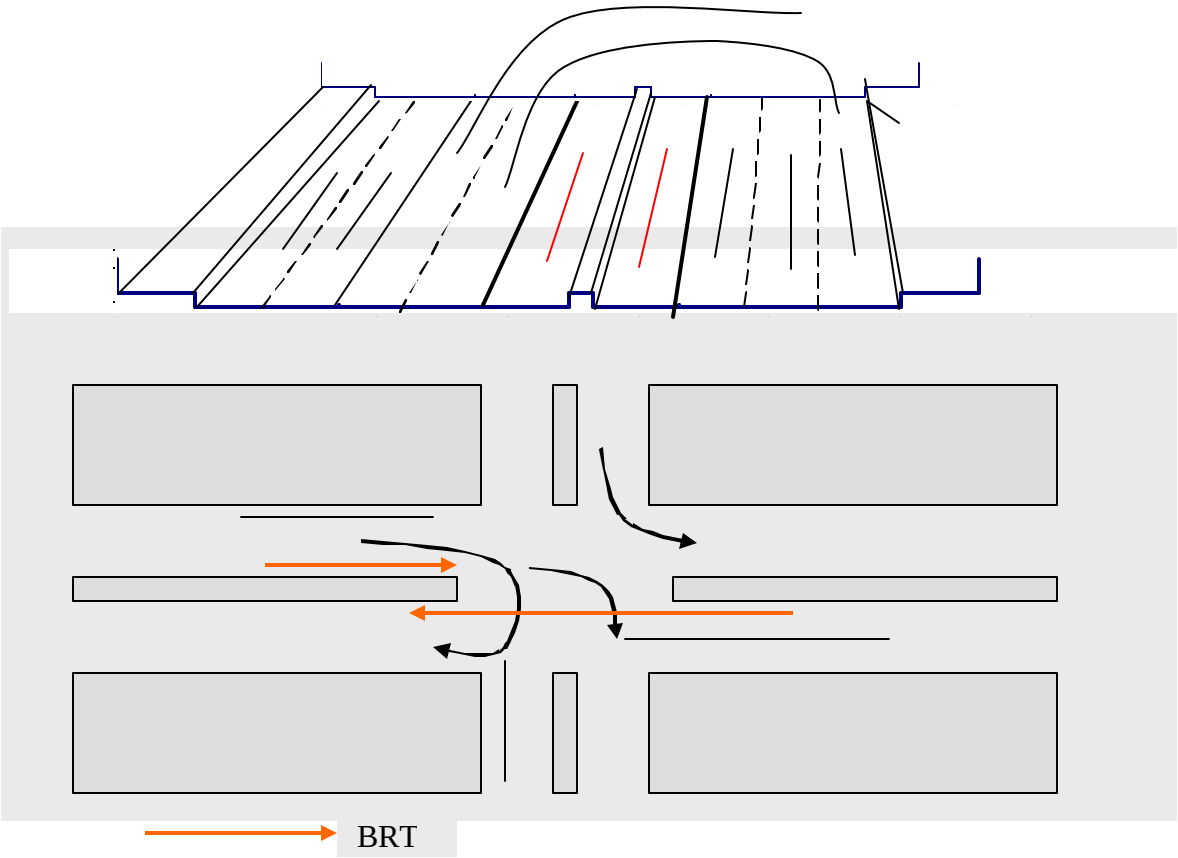
Signalized intersections

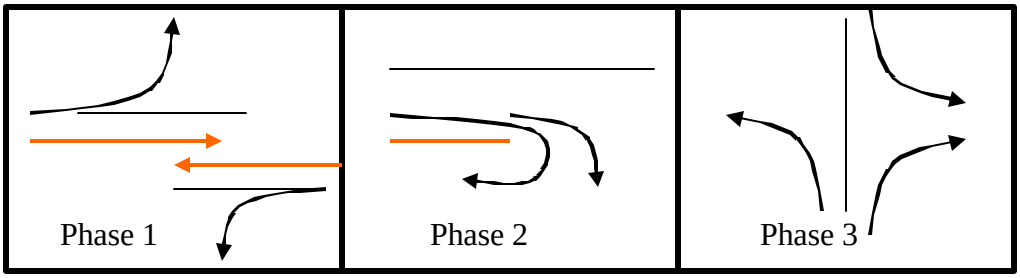
As discussed before, only the Jl. Biak/corridor 3 intersection needs changing. After analyzing different alternatives, we suggest just to use the actual scheme by considering the BRT bus lanes as if they were part of a central island.



Corridor 3 (Harmoni – Railroad): proposed typical section

Type	Sidewalk (north)	Trafic w>e	Right conversion w>s	Bus w>e	Island	Bus e>w	Traffic e>w	Sidewalk (south)
width	3	5.5	5.5	3.3	0.9	3.3	8.5	3
sum	3	8.5	14	17.3	18.2	21.5	30	33





The BRT buses would stop to allow right conversion (similar to corridor 1 conversion from south to east - Jl. Majapahit to Jl. Juanda)

After the BRT is implemented, assuming that the pavement on the railroad crossing is improved and maintained, the general traffic would run at higher velocities than it does today.

Of course if the remaining buses continue to stop in the mixed traffic lanes, as is the current habit of the bus drivers which stop and wait to fill passengers, this will cause congestion if not controlled (police control).

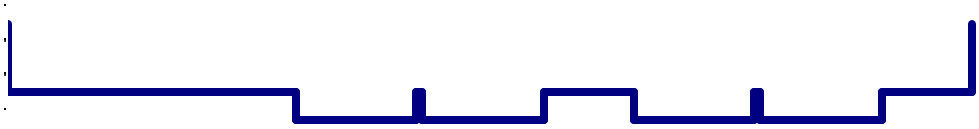
Railroad crossing

As mentioned before, road maintenance even only at the rail crossing is very essential. We also recommend: **interrupt bus lane in both directions, about 20.0 meters before the crossing and start again 30.0 meters after.**

Rail road (Grogol): Kyai Tapa

This stretch is strictly express and problems can be found only on the extremities (Grogol intersection and the U- turn west>west near railroad crossing) that will be discussed separately.

The Length is 1.5 km with local and express lanes on each direction, two pedestrian bridges that correspond to the two proposed busway bus stops. Middle island is wide with a lot of trees. Side walks are also very wide especially on the north side, where there is also a secondary local street parallel to the corridor:



Corridor 3 (Harmony – Railroad): Proposed typical section

Type	Sidewalk (north)	trafic w>e local	Sep	Traffic w>e express	Island	traffic e>w express	Sep	Traffic e>w local	Sidewalk (south)
width	19	8	0.4	8	6	8	0.4	8	6
sum	19	27	27	35.4	41.4	49.4	49.8	57.8	63.8

From the table it can be seen that the corridor on this segment is very wide, and there is enough space for everything. The only important project option for now is if we can implement the busway by only using the present road space or shall we widen it.

Directional peak hour future volume is estimated around 5200 pcu, and if adopting the same value of 420 pcu/m for a very adequate V/C ratio, about 5200/420 = 12.3 meters for the general traffic will be needed.

Each direction has 8+8+0.4 = 16.4 m (including separator, and if we subtract 3.3 for the bus lane then the remaining space will be 13.1 m or only a little more than the 12.3 needed.

Therefore, our recommendation is just remove the separator and let the 13.1 meters only for a 4 lanes road per direction (3.27 meters each lane) and that is the same present number of lanes, as described below:

Type	Sidewalk (north)	Traffic w>e	BRT	Island	BRT	Traffic e>w	Sidewalk (south)
width	19	13.1	3.3	6	3.3	13.1	6
sum	19	32.1	35.4	41.4	44.7	57.8	63.8

This solution avoids cutting the central island, sidewalks and trees. If necessary, the separator between the local and express lanes can be rebuilt: with 0.3 meters we can obtain local and express lanes each one with (13.1 - 0.3)/2 = 6.4 m = two lanes of 3.2 meters per lane.

Critical points

U-turn near railroad crossing

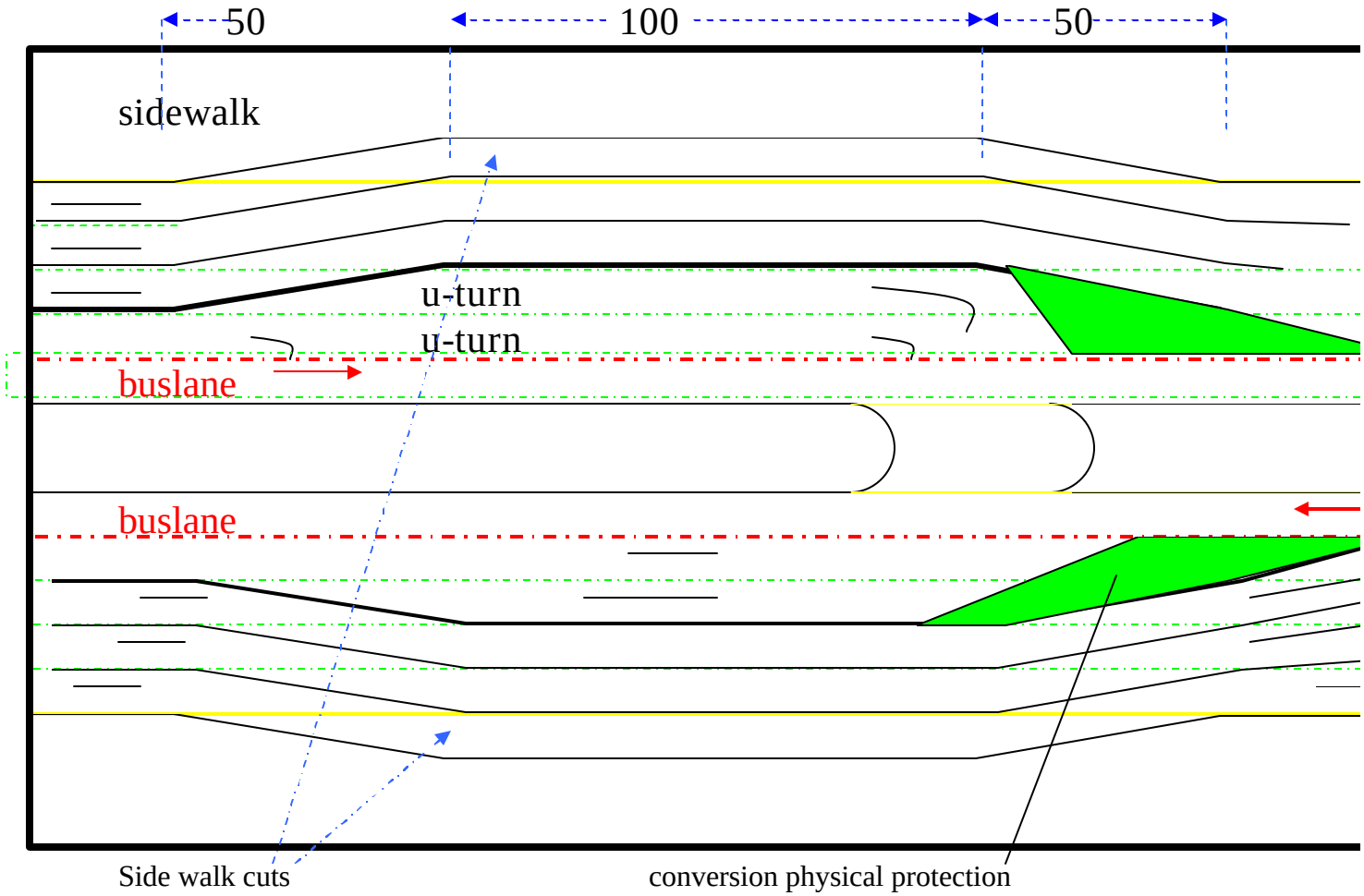
Actual volume of U-turn is considerably high (1500 pcu/hour), and the specific location of the conversion is inconvenient, just where the road is not widened and the U-turn ratio is not adequate.

Our proposal is:

Move the actual U-turn 100 meters away to the west side where there is more space. Introduce a second U-turn on the middle of the stretch to reduce the volume of present U-turns and reduce the additional vehicle km generated (present km is estimated as 30,000 vehicles km/day). The best location of the second U-turn can be better estimated from an O-D survey of U-turn vehicles.

A number of different U-turn alternatives are available, but all of them could perform better if more space is available, so we suggest cutting the lateral sidewalks to provide an extra lane on each direction, as shown on figure 2:

A lot of u turn different alternatives are available, but all of then could perform better if

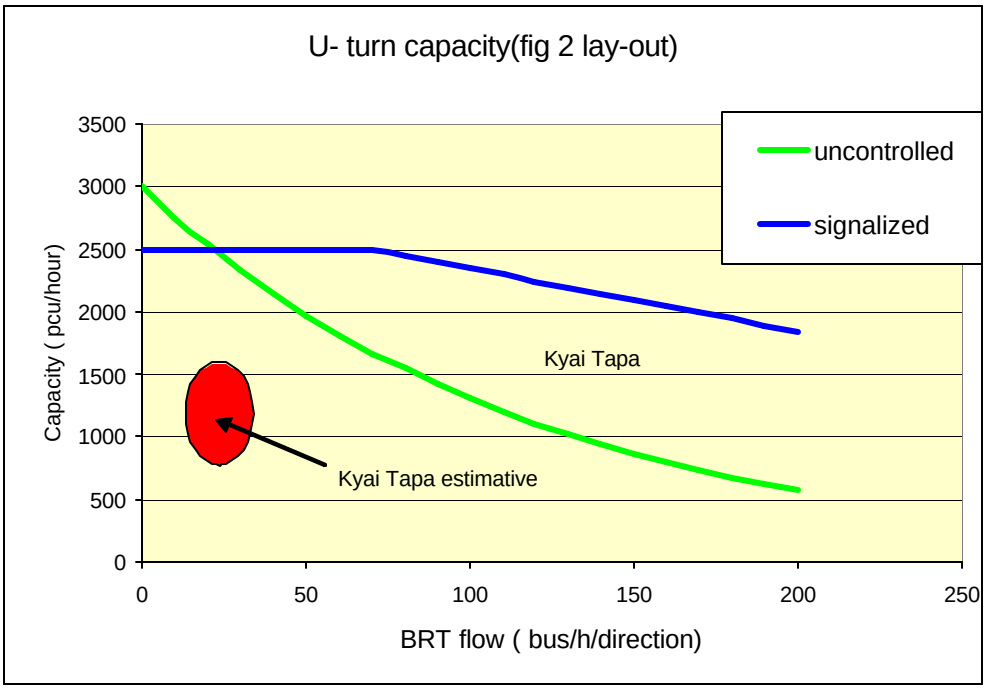


The general concept is to use the same approach already implemented on corridor 1. The main advantage is avoiding the traffic signals that would introduce a considerable delay for BRT buses and the general traffic.

On the other hand, at present the U-turns are unprotected from opposite general traffic and this eventually introduces delays and queues that block the BRT lanes.

To avoid this problem and improve the situation, we suggest a physical protection is provided, so the U-turn only has conflicts with BRT buses, that at an expected volume of 20 to 30 buses per hour/direction is quite a small conflict compared with the 5000 vehicles (not pcu, just the vehicles) on opposite side.

The sidewalk cuts are to provide an extra second U-turn lane, which can double the capacity. The U-turn capacity of this solution is estimated by the following graph:



The green line is the suggested proposal, and the red ellipse is the estimated volumes (conversion of 1500 vehicles if divided on two points should be around 500 to 1000 on each one, and the BRT flow as a maximum of 30/hour/direction (2700 passengers/hour).

The traffic signal (blue line) that introduces delays to the BRT buses and general traffic would be recommended at much higher volumes.

Grogol intersection – (not evaluated)

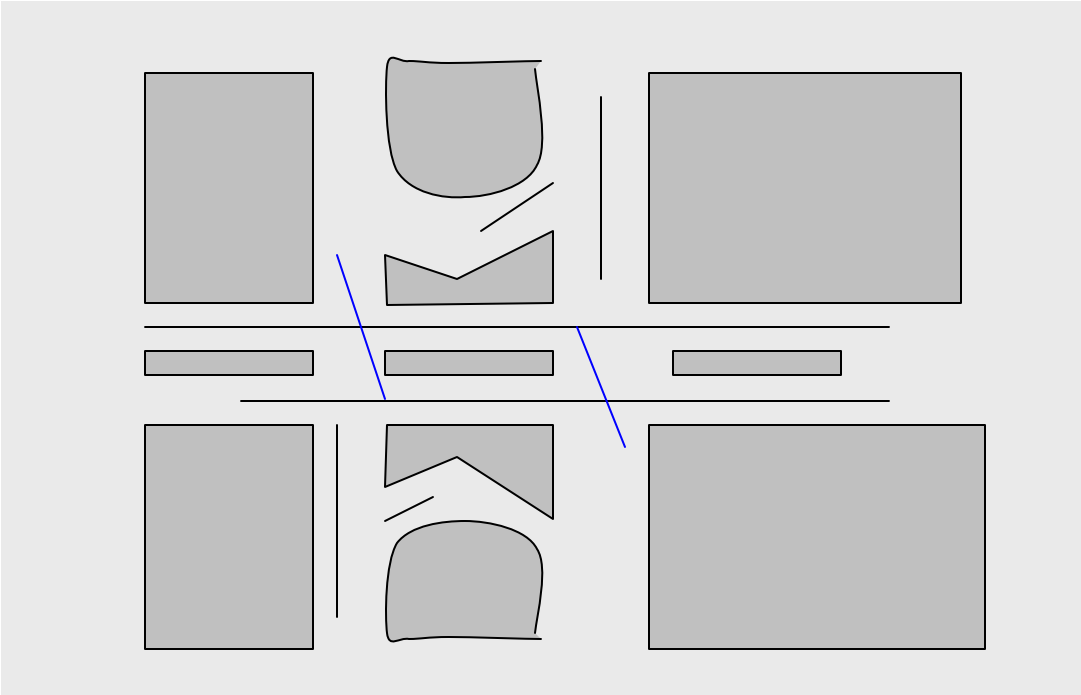
a. Kalideres- Grogol

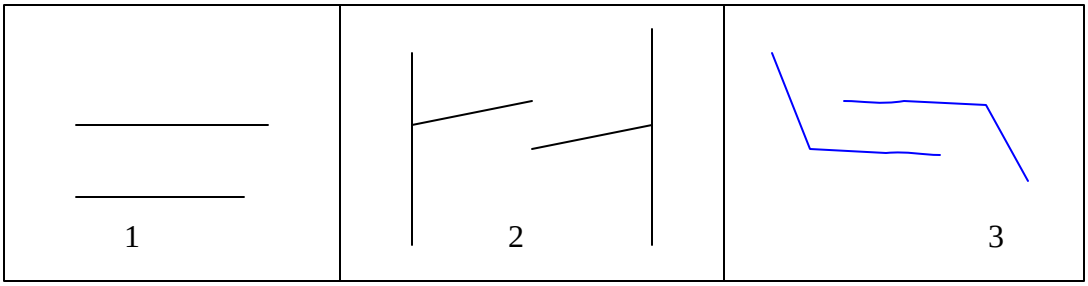
Not evaluated due to insufficient time to observe the stretch on all periods. It seems that the project is like corridor 2, giving for general traffic more space than they really need, especially on the Kalideres – Pesing fly over (under construction) west stretch. This seems more of a rural highway than an urban road, and the volume/capacity ratio seems very low.

b. Rawa Buaya intersection

The location is reserved for future highway crossing and space between the two crossings opposite the traffic is around 120 meter.

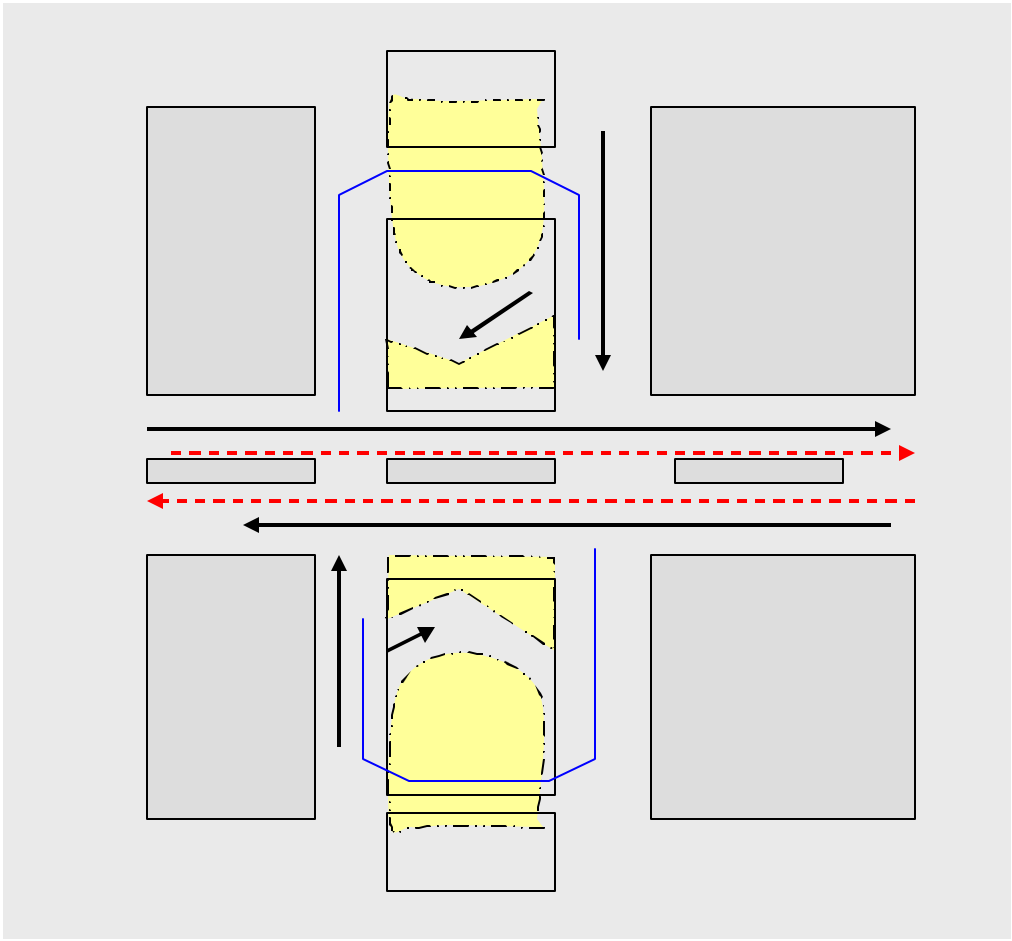
Today the critical point is the right turns which is allowed on the corridor resulting from practically two signals with three phases each one.

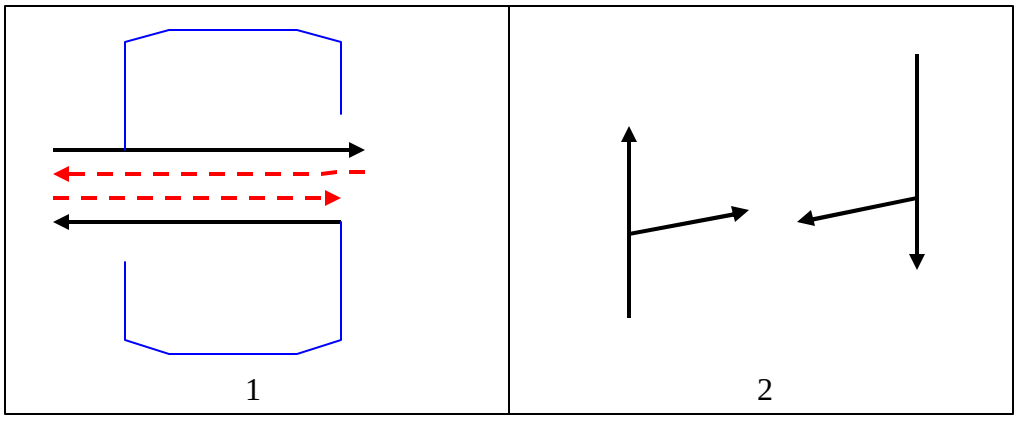




c. Recommended solution

Use available space to construct an auxiliary roundabout to the corridor right-turns and reduce intersection to a very simple and effective two-phase scheme, as follow:





Off course the present U-turns available on transversal which are being used as informal terminals should be relocated, but there is a lot of space available.

Off course the present U-turns available on transversal which are being used as informal terminals should be relocated, but there is a lot of space available.

ANNEX I

Because of flaws with the SITRAMP model developed by JICA (gaps in the network, lack of data on paratransit vehicles or occupancy, and exaggerated expansion factors), ITDP in cooperation with the University of Indonesia Center for Transportation Studies created a new traffic model in EMME/2 for the TransJakarta system to assist with the design of future corridors and contract negotiations with potential operators. Over 60,000 on-board origin destination surveys were conducted with transit passengers. Calibration of the entire network was also done with observed data. The control points for observed volumes of passengers correspond to the 60 bi-directional sections of the OD survey, which were used to expand the OD. In addition, 12 bidirectional points were added to refine the adjustment

A.I. Estimation of Origin Destination matrix based on onboard survey

The origin destination onboard survey has been applied in 60 strategic selected sections, with a simultaneous frequency occupation survey to permit the expansion of the data collected.

Location of the surveyed sections

The data has been collected for all the day, though it is possible to extract matrices for different periods of time. In the present study, a morning peak hour matrix was extracted. Considering only the origin destinations pairs that appear during one hour will result in a matrix with a poor distribution, meaning that only a part of the ODs can be observed in this

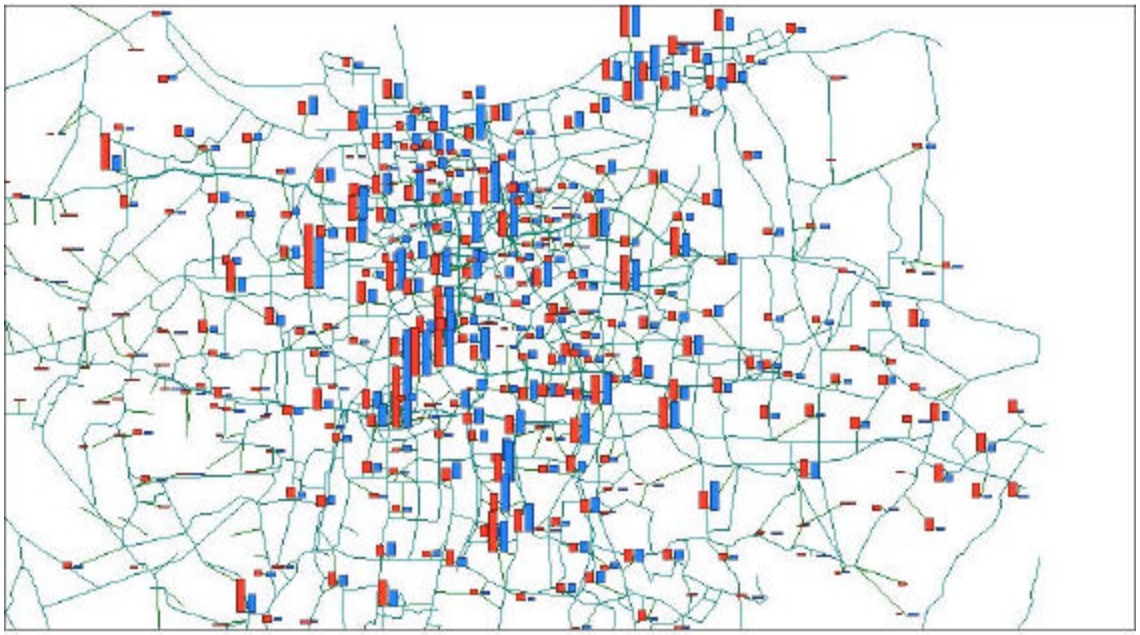
period, and the expansion of the data will conduce to concentrate the trips on few ODs, with many empty cells in the matrix.

To correct this problem, at first a morning peak period from 7h00 to 9h00 was considered to increase the distribution; and the trips occurring during others periods of the day were included also in the distribution, but weighted by the time they occur in relation with the morning peak, it means that those ODs exist in the morning peak but in a lower proportion, depending on the time of the day they have been observed.

Each OD section has been expanded individually with the total number of passengers observed in the morning peak hour. Originally, it was planned to expand the data for each transit line at each section, which would result in a more accurate expansion factor, but the data available did not permit to execute this process.

After expansion of each section, the double counting were automatically identified, that means how many ODs of each section are passing thru other sections, and the total volumes of each OD has been adjusted to match the passengers counts at each section it pass thru.
Total by Origins and Destinations

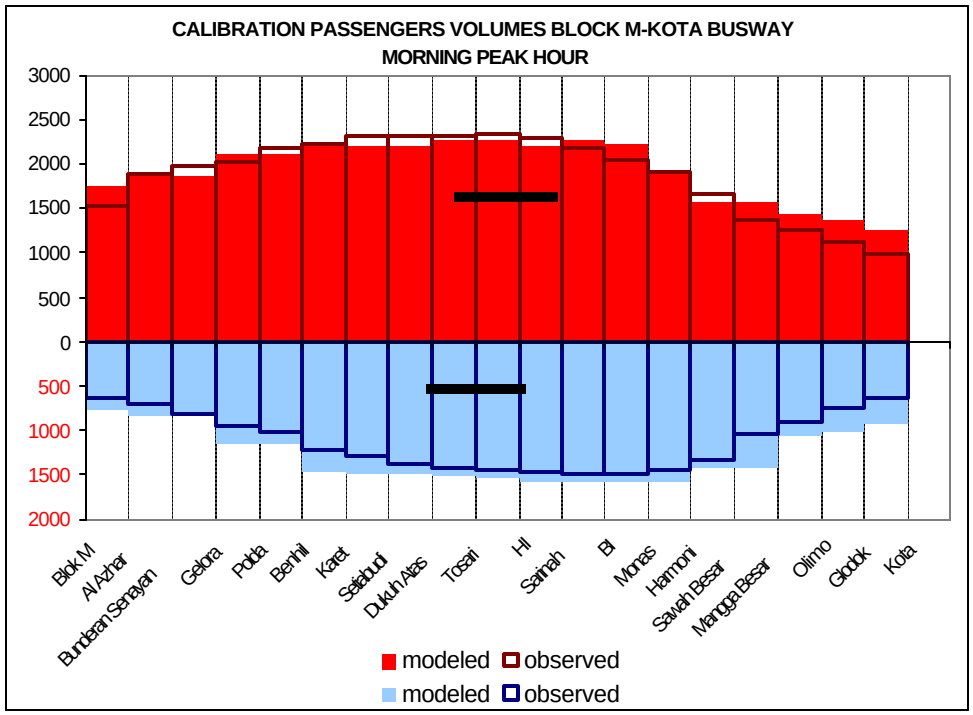
Productions (red) and attractions (blue) at morning peak hour

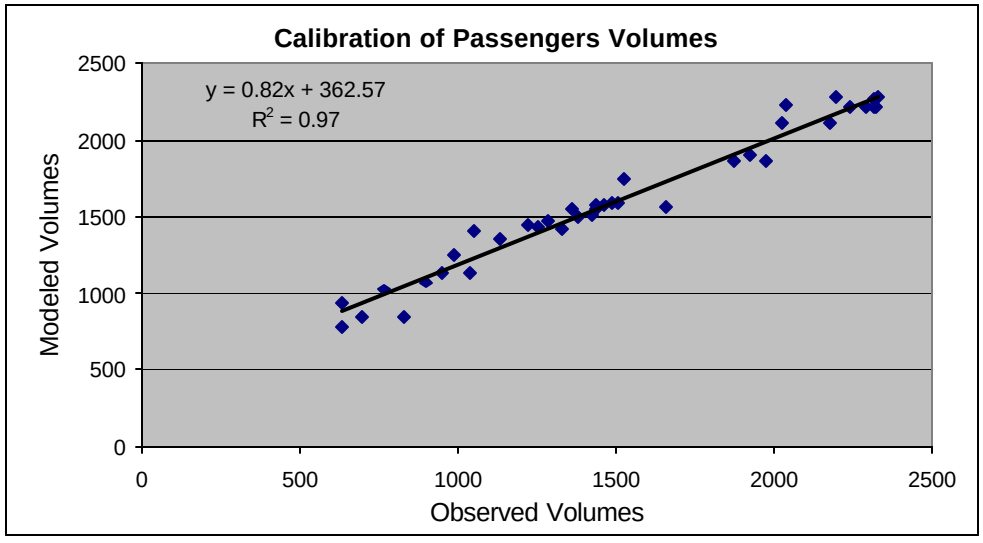


A. 2. Model Calibration

A.2. a. TransJakarta Calibration

The volumes of passengers have been calibrated with observed data from TransJakarta at morning peak hour.





Globally, the calibration is very satisfactory. The angular coefficient 0.82 is a little bit low, it reflects the fact that, for the small volumes (between 600 and 1200), the modeled volumes are lightly overestimate.

Simulation results:

MORNING PEAK
ACTUAL

Lines	Headway	extension	Travel time	Boarding pax	Max Volume
BM-KT	1.5	13.01	43.58	2583	2281
KT-BM	1.5	13.02	43.61	1754	1588
TOTAL		26.03		4337	

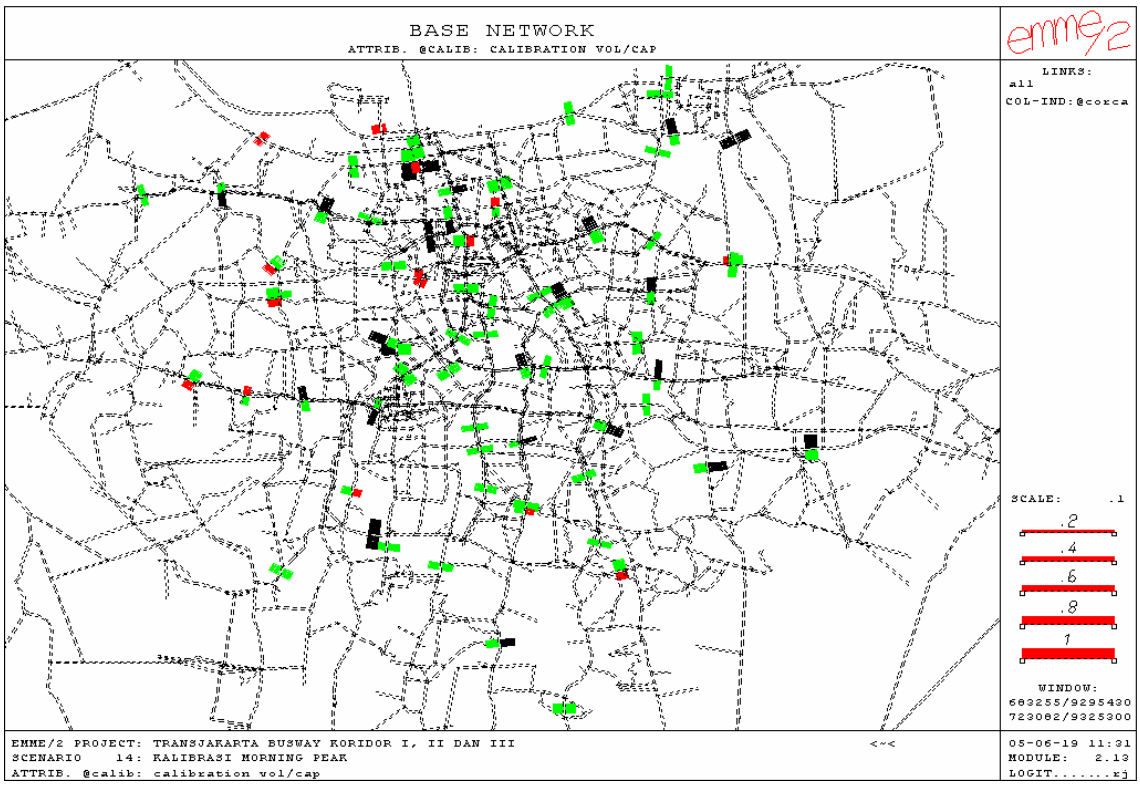
DAILY PASSENGERS

Lines	Boarding pax
BM-KT	37144
KT-BM	25223
TOTAL	62366

A**. 2. b. Total network calibration**

The control points for observed volumes of passengers correspond to the 60 bidirectional sections of the OD survey, which were used to expand the OD. In addition, 12 bidirectional points were added to refine the adjustment.

The next figure represents the location of the points. The coloration indicates the calibration level, green where assigned volumes/observed volumes are included in an interval of 20%, black over 20%, red under 20%.



The regression between observed and modeled volumes validate the calibration.