According to the present plan of track elevation on the Central Line, beginning point of track elevation in Jakarta station yard is nearer than the JICA Study Report (Feasibility Study on Track Elevation of Central Line, 1982) and arrived tracks of the Central Line at Jakarta station are only two tracks (No. 11 and 12) which are assigned for commuter train exclusively. (Refer to 5-3-1 (3) 7) c))

Consequently, the long-distance train and some of middle-distance train on the Central Line should be transferred to the Eastern Line or terminate at Manggarai station.

Also, for loop operation, it will be necessary to standardize the systems, thus old mechanical signalling of the Eastern and Western Lines will have to be replaced with automatic signalling, and it will be necessary to electrify and install automatic signalling on the Bekasi Line.

To achieve headways of 6 minutes on the Central Line and 10 minutes on the Extended Loop Line, projects at least up to the option "b" are required. However, in consideration of the financial condition of Indonesia, both committed projects and "on-going" projects will be taken in option "a," and the economic priorities of the options "a" and "b" will be compared with each other.

5-2-1 Transportation Plan

(1) Option "a" transportation plan

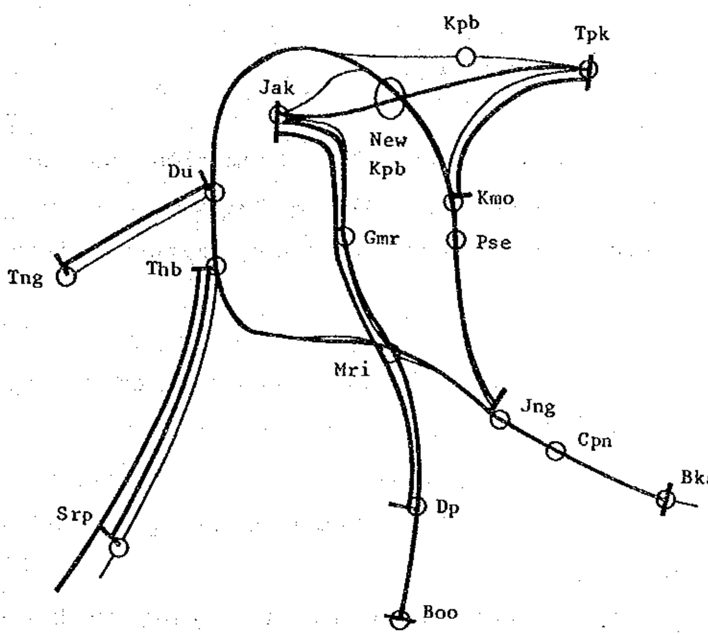
1) Train operation routes

Fig. 5.2.1.1 shows the planned train operation routes for options "a" and "b."

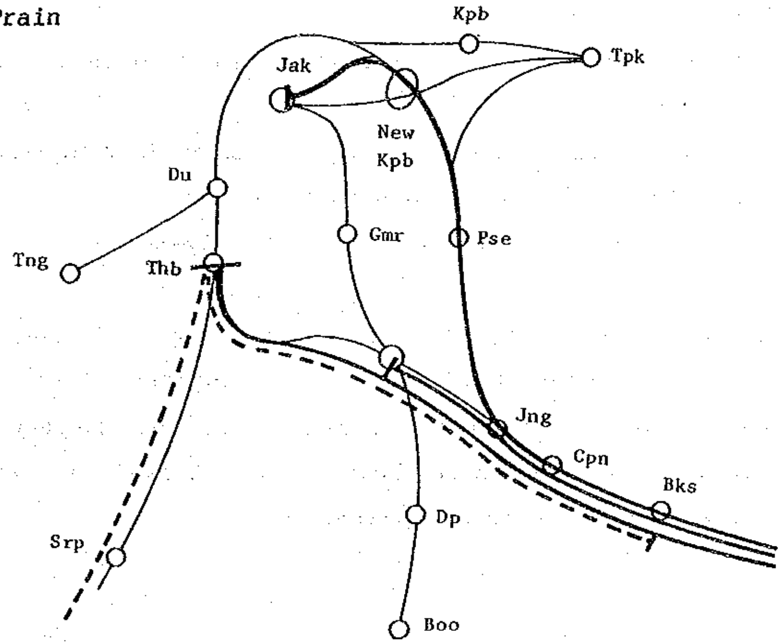
They are the same as present operation routes, except for the following.

a) At present, the some of the trains on the Serpong and Tangerang Lines are operated to Jakarta, but in the future the trains will be limited to Tanahabang and Duri. This is to increase the number of trains on the Western Line and to avoid switchback at New Kampungbandan.

b) To connect the Western and Eastern Lines to Jakarta, electric cars will be operated between Jakarta and Tanjungpriok. Electric cars will also be operated between Tanjungpriok and Kemayoran.



(1) JABOTABEK Train



(2) Middle and long Distance Passenger Trains, Coal Freight Trains

Fig. 5.2.1.1 Train Operation Route (a Option, b Option)

c) When the Central Line is elevated, the long-distance trains will be operated on the Eastern Line, the middle-distance trains will be operated to Manggarai.

d) Coal freight trains will continue to operate from on the Serpong Line to Bekasi. However, as demand increases, the number of trains will be reduced but the length of the trains will be increased.

2) Restrictions in facilities

Option "a" was planned with the assumption that the following facility improvements (concerning train operation) will be completed in 1992, and that except for these, no other improvements will be made before 2005.

- o Track elevation and Automatic signalling on C/L (Kota-Mri)
- o Automatic signalling on E/L
- o Automatic signalling on W/L
- o Electrification and Automatic signalling on Serpong Line (including Srp. Sub-depot)
- o Electrification and Automatic signalling on Bekasi Line (including Bks. Sub-depot)
- o Double tracking, Electrification and Automatic signalling on C/L (Mri-Dp)
- o Automatic signalling for single track on C/L (Dp-Boo)
- o Improvement of Kampungbandan Station
- o Establishment of the Train Operating System

Under Option "a", all lines in the JABOTABEK Area will have automatic signalling, except the Tangerang Line, Tanjungpriok Line and Tanjungpriok-Kemayoran branch of the Eastern Line, which will result in reductions in headway, and travel time and improvements in the safety of train operation.

Furthermore, when all of the lines except the Tangerang Line are electrified and the Serpong and Bekasi Sub-depots are completed, it will be possible to commonly operate electric cars thus efficiency will be enhanced by the rational use and operation of electric cars.

The track elevation of the Central Line (Kota-Mri) will be effective in the elimination of railway crossing accidents and in ensuring punctual operation.

Also, completion of the Train Operation System will be very effective in restoring normal operation a short time after an emergency and in ensuring punctual operation.

This is an indispensable system for minimizing the effect which the delay of middle and long distance trains would cause to the punctual operation of JABOTABEK trains.

Compared with Option "b," Option "a" will be subject to the following facility restrictions with respect to train operation.

- o The number of electric cars will be limited to 164 in both 1992 and 2005.
- o Central and Western Lines will not have grade separations in Manggarai Station.
- o Tangerang Line will not have automatic signalling.
- o Improvements (2nd step) in the Manggarai Workshop will not made.
- o Depok Depot will not be constructed.

a) Restriction in number of electric cars

Under option "a", new electric car construction will be limited to 44. Thus, including the 120 cars now in use, the total number of electric cars will be limited to 164. This is the severest restriction for traffic demand.

b) Level crossings in Manggarai Station

In Manggarai Station, the Central Line trains and Western Line trains are crossing each other.

Option "b" allows for grade separation while option "a" does not.

If level crossings remain, on the Central Line and the Western Line, train operation will not be possible with headway below 8 minutes on both lines. But in the case of a option, train headway of the Central Line and the Western Line are more than 8 minutes, because the number of electric cars is limited to 164.

c) Tangerang Line remaining under the present blocking system

If automatic signalling were introduced on the Tangerang Line, the minimum single track headway would be reduced to 15 minutes. Under the present blocking system, 29 minutes, is the minimum headway.

d) Manggarai Workshop

The second step for improvement of the Manggarai Workshop is excluded, thus the inspection and repair capacity is low, and larger higher number of spare electric cars are necessary.
Under Option "a", 16% of used cars are kept in reserve to replace those in inspection and repair. In Ry-1, -2 or -3, Option "b," the reserve rate is 13%.

e) Depok Depot

According to Option "a", sub-depots of electric cars should be installed at Serpong and Bekasi, to improve and the use efficiency of electric cars.

Because, Depok Depot can not be used, monthly checks must be made at Bukitduri Depot. Then, the car use efficiency decreases accordingly.

3) Demand forecasts and transportation capacity

With the reserve rate set at 16%, as described above, the usable number of cars among the 164 total is 140. Table 5.2.1.1 shows the number of cars on each line and the resulting capacity of each line relative to total demand.

The electric car trains are composed of 4 car units, and the proportion of transportation capacity relative to demand varies from line to line, but it is generally about 50%.

Table 5.2.1.1 Option "a" Transportation Capacity (1992)

Lines	Sections	Number of Electric Cars Used	Number of Cars per Train	Transporation Capacity/Demand (%)
Central Line	Jak - Dp	72	8	48.6
	Dp - Boo		8	55.3
Eastern, Western, Bekasi Line	Du-New Kpb-Pse-Jng	52	8 and 4	45.2
	Du-Mri-Jng -BKs			60.1
Serpong Line	Thb - Srp	12	4	55.5
Tanjungpriok, Eastern Branch Line	Jak - TpK	4	4	36.7
	TpK - Kmo		4	27.3

4) Comparison of the service levels of Options "a" and "b"

Table 5.2.1.2 compares the headways of Option "a" in 1992 and 2005 with those of Option "b". The urban railway, requires a maximum headway of 30 minutes in order to meet the minimum service level. Under Option "b" headways are barely within this limit, and under Option "a" in some sections this limit is exceeded.

The loop operation's travel time will be greatly reduced because the present switchback operation at Kampungbandan and Jakarta Stations will be resolved with the construction of the New Kampungbandan Station.

Reduction of travel time on the Central Line results from double tracking and automatic signalling between Manggarai and Depok. Although, track elevation between Jakarta and Manggarai will not provide large reductions in travel time, stopping or slowing at crossings will no longer be necessary, and crossing accidents will be eliminated.

Table 5.2.1.2 Headways of Options "a" and "b"

(Unit: Minute, Second)

Lines	Operating Sections	Car Types	1992		2005	
			a	b	a	b
Central Line	Jak - Dp	EC	16'40"	8'30"	16'40"	4'30"
	Dp - Boo	EC	65'20"	30'	65'20"	25'
Western and Eastern Line	Du - New Kpb - Pse - Jng	EC	32'20"	12'	32'20"	10'
	Du - Mri - Jng - Bks	EC	16'20"	10'	16'20"	5'
Serpong Line	Thb - Srp	EC	28'40"	18'	28'40"	16'
Tangerang Line	Du - Tng	DC	29'	24'	29'	20'
Tanjungpriok Line	Jak - Tpk	EC	124'	30'	124'	25'
Eastern Line	Tpk - Kmo	EC	124'	30'	124'	20'

Note: (1) Under Option "a," the number of electric cars would be limited to 164 in both 1992 and 2005.
Under Option "b," the number of electric cars would be commensurate with demand.

(2) The headway between Jak-Dp on the Central Line is representative of the average headway for trains running between Jak-Dp and Jak-Boo. The headway of Du-Mri-Jng-Bks is representative of all trains operating between Du-Bks and on the Loop Line.

(2) Option "b" transportation Plan

1) Train operation routes

The train operation routes of option b are identical to those of option as is shown in Fig. 5.2.1.1.

2) Restrictions in facilities

Table 5.2.1.3 shows the facility improvements which are closely connected with train operation, for each alternative. Option b calls for the following improvements in 1992, in addition to those option a: (No facility improvements are planned for the period between 1992 and 2005.)

- Grade separation at Manggarai Station
- Automatic signalling on Tangerang Line (including Tng Sub-Depot)
- Construction of Depok Depot

The grade separation at Manggarai Station is essential for coping with the future increases in transportation demand.

Installation of automatic signalling on the Tangerang Line along with construction of new stations will shorten the minimum train headway under the net shaped diagram from 29 minutes under the current block system to 15 minutes. Since a sub-depot is to be constructed at Tangerang, under this project, the efficiency of car operations can be raised by inspecting and repairing cars at the sub-depot.

Depok Depot is an essential facility for inspecting the trains and repairing them in good condition. On the other hand, option b has the following facility limitations.

- The Serpong Line is single track
- The Tangerang Line is single track and is not electrified.

a) The Serpong Line is single-tracked

If the single-tracked Serpong Line is electrified and an automatic signalling system is installed, the minimum train headway under the

Table 5.2.1.3 Facility Improvements Classified by Alternatives (Related to train operation)

Improvement item	Year 1992, 2005		Year 2005		
	a	b	Ry1	Ry2	Ry3
Automatic signalling on E/L Automatic signalling on W/L	○	○	○	○	○
Electrification and Automatic signalling on Serpong Line (including Srp Sub-Depot)	○	○	○	○	○
Electrification and Automatic signalling on Bekasi Line (including Bks Sub-Depot)	○	○	○	○	○
Double tracking, Electrification, and Automatic signalling on C/L (Mri-Dp)	○	○	○	○	○
Automatic signalling for single track on C/L (Mri-Boo)	○	○	○	○	○
Improvement of Kampungbandan Station	○	○	○	○	○
Establishment of Train Operating System	○	○	○	○	○
Grade separation at Manggarai Station		○	○	○	○
Automatic signalling on Tangerang Line (including Tng Sub-Depot)		○	○	○	○
Construction of Depok Depot		○	○	○	○
Double tracking, Electrification and Automatic signalling on C/L (Dp-Boo)			○	○	○
Relocation of Kota-Station				○	○
Construction of Car-depot in relation to Kota-Station				○	○
Electrification on Tangerang Line				○	○
Double tracking of Serpong Line				○	○
Construction of Cibinong Line					○

net shaped diagram will be 15 minutes as stated above.

Table 5.2.1.4 shows the headway and the number of cars per train on the Serpong Line during peak hours which were determined from the results of the demand forecast. It is assumed that the load factor will be about 200%.

Table 5.2.1.4 Train Headway on the Serpong Line during Peak Hours

Alternative \ Section, Car Type		Thb-Srp (EC) Headway (minute)	Thb-Srp (EC) Number of cars per train	Thb-Rk (DC) Headway (minute)	Thb-Rk (DC) Number of cars per train	Combind headway of (EC)+(DC) (minute)
1992	a	28.7	4	60	2	19.4
	b	18	4	60	2	13.9
2005	a	28.7	4	60	2	19.4
	b	16	8	60	2	12.6

According to the transportation plan, on the Serpong Line EC trains will be operated between Thb and Srp and DC trains between Thb and Rk. Since the demand for DC trains is small, 2-car trains operating with a 60 minute headway will be sufficient.

As Table 5.2.1.4 shows, however, the combined headway of EC and DC trains will be shorter than 15 minutes under Option b in 1992 and in 2005. Under Option b in 1992, the combined headway will become 22.5 minutes if the number of EC cars is increased to 8 and the EC car headway is increased to 36 minutes. Therefore, the operation of both EC and DC trains can be extended to Tanahabang. However, the headway of EC trains should not exceed 30 minutes from a commercial standpoint. Therefore, it will be necessary to stop trains, with low ridership, from operating beyond Serpong, which will compel passengers to transfer to EC trains and cause rider dissatisfaction.

Under option a, the combined headway of EC and DC trains will be 19.4 minutes in both 1992 and 2005.
This is because the number of electric railcars is limited to 164.

b) The Tangerang Line is single track and is not electrified

Installation of automatic signalling on the Tangerang Line will shorten the minimum headway under the net shaped diagram to 15 minutes. This does not present a problem because when transportation demand will be the greatest, the headway will be 20 minutes and DC trains will consist of 8 cars under option b in 2005. However, this will be the only section that uses DC in JABOTABEK. Therefore, it cannot share cars with the other sections, which is a negative factor.

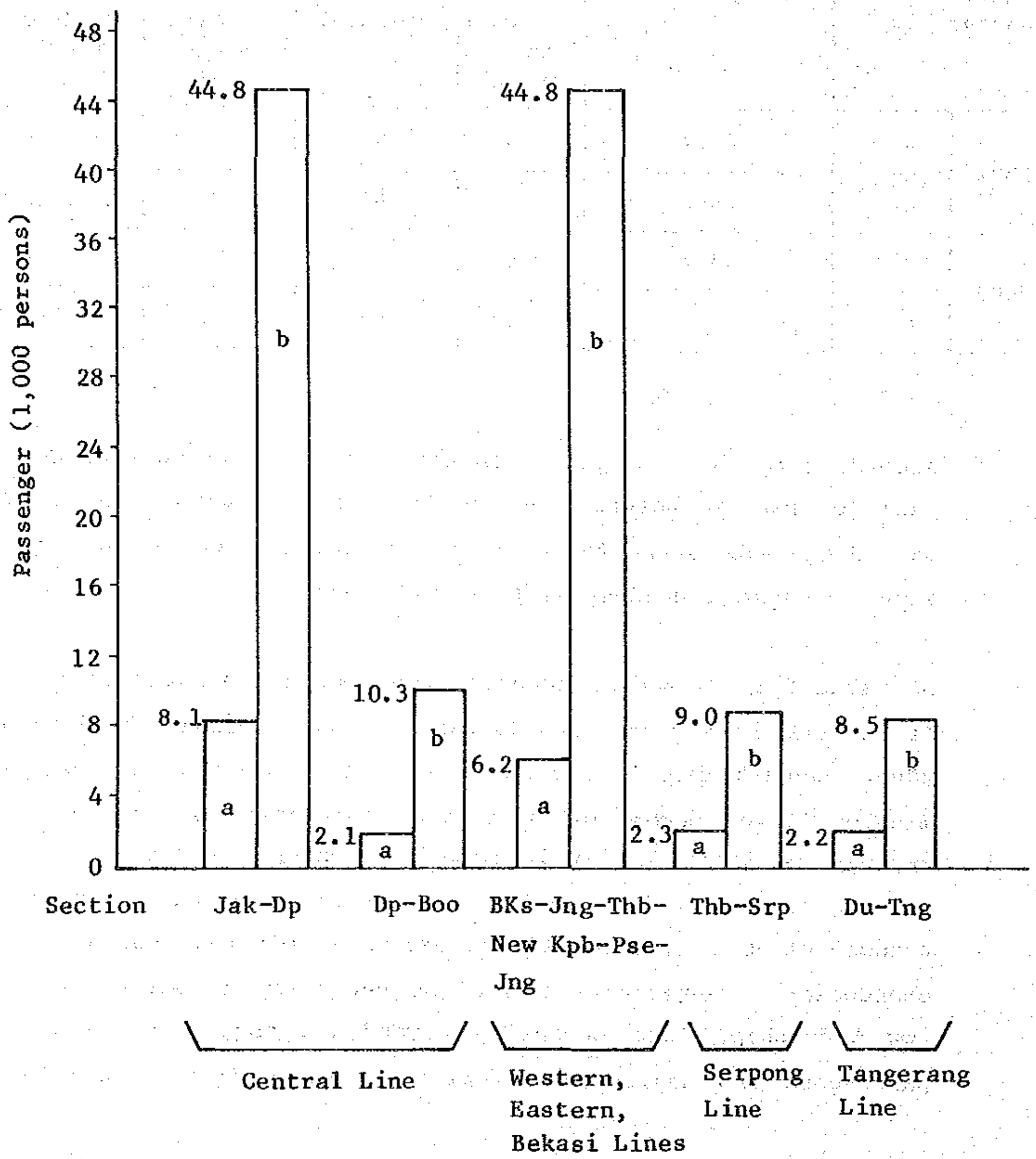


Fig. 5.2.1.2 Maximum Transportation Capacity of "a" and "b" Option (Peak one hour, one way, 1,000 persons)

3) Demand Forecast and Transportation Capacity

Fig. 5.2.1.2 shows the maximum transportation capacities of options a and b as determined by the facility limitations. The maximum transportation capacity in one hour and one way is given in units of 1,000 passengers.

4) Service Level of Option "b"

As Table 5.2.1.2 shows, the train headway of the Central Line (Jak - Dp) during a morning peak hour will be 8 minutes and 30 seconds in 1992 and 4 minutes and 30 seconds in 2005. The headway of Du - Mri - Bks on the Loop Line will be 10 minutes in 1992 and 5 minutes in 2005. The travel times under option "b" are almost the same as under option "a" as is shown in Fig. 5.2.1.3.

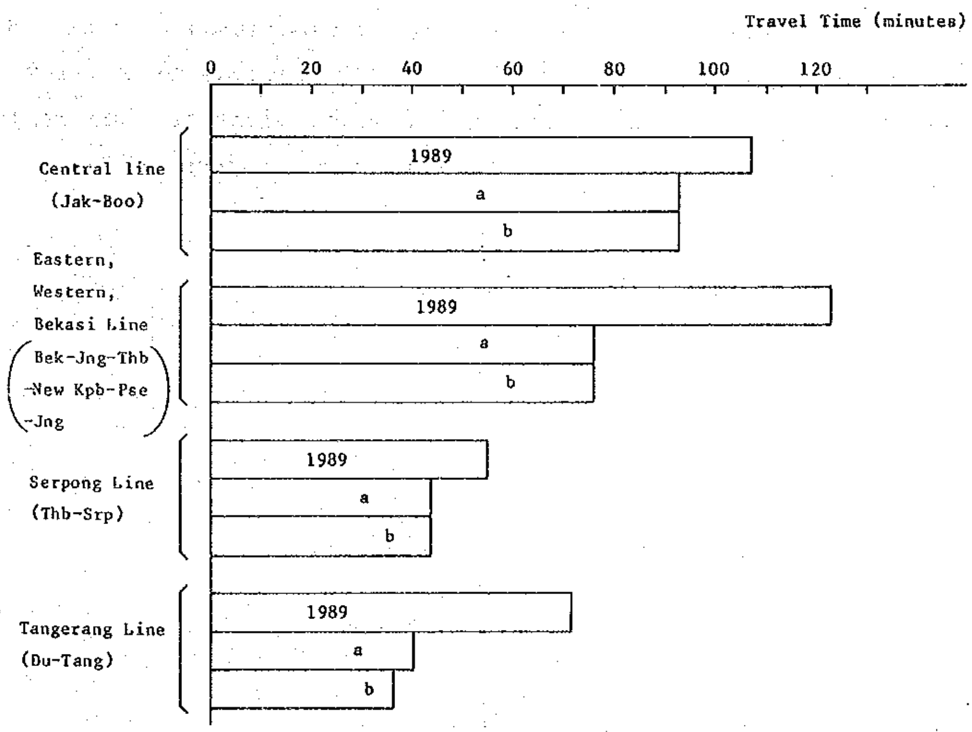


Fig. 5.2.1.3 Travel Time of the Present, a Option and b Option

5-2-2 Feeder Service

There are two alternative railway improvement projects for enhancing urban transportation service, one of which will be completed by 1992. The two projects options "a" and "b" which aim to improve passenger service facilities are listed below.

Option "a"

- Track elevation and automatic signalling of C/L (Kota-Mri)
- Electrification and automatic signalling on the Bekasi line
- Double tracking, electrification and automatic signalling of C/L (Mri-Boo)

Option "b"

- Grade separation at Maggarai Station

The above-mentioned will include the construction of a car park and space for pedestrians though the utilization of the remaineder of PJKA's right of way. However, the scheme for integration of railway and bus transportation was not addressed in these projects with the exception of the Gambir Station Track Elevation Project and the Manggarai Grade Separation Project. This is because the design team was only concerned with increasing railway transportation capacity. A comparison of the reduction of transfer time resulting from the implementation of option "a" or "b" is shown in Appendix 4-2.

5-2-3 Facility Plan

(1) Option "a"

The objectives and the particulars of the projects included in the option "a" are shown in the following Table 5.2.3.1.

Table 5.2.3.1 Project Items for Option "a"

Project Item	Objectives	Particulars
1. Track elevation and Automatic Signalling of C/L (Kota - Mri)	1) Increase in the number of trains 2) Increased speed 3) Increment in punctuality 4) Improving operational safety 5) Personnel reduction 6) Easing road traffic congestion 7) Eliminating crossing accidents 8) Effective use of space under elevated track	1) Track elevation 2) Automatic signalling 3) Improvement of station facilities and station plaza 4) Related projects
2. Automatic Signalling on E/L 3. Automatic Signalling on W/L	1) Loop operation 2) Train increase 3) Speed-up 4) Improving operational safety 5) Reduction of block sections 6) Reduction of signal handling time	1) Automatic signalling
4. Electrification and Automatic Signalling on Serpong Line (including Srp.Sub-Depot)	1) Train increase 2) Speed-up 3) Improving operational safety 4) Personnel reduction 5) Improving efficiency of car operation 6) Reducing car maintenance costs 7) Improving energy efficiency	1) Electrification of Tanahabang-Serpong 2) Installation of automatic signalling on the Tanahabang-Serpong section 3) Improvement of platforms and station buildings 4) Installation of sub-depots

Project Item	Objectives	Particulars
5. Electrification and Automatic Signalling on Bekasi Line (including BKS.Sub-Depot)	1) Extended loop operation; and Same objectives as in Item "4"	1) Electrification of Jatinegara-Bekasi 2) Installation of automatic signalling on the Jatinegara-Bekasi section 3) Improvement of platforms and station buildings 4) Installation of sub-depots
6. Double tracking, Electrification and Automatic Signalling on C/L. (Mri - Dp)	1) Large increase in the number of trains; and Same objectives as in Item "4"	1) Double tracking of Manggarai-Depok 2) Installation of automatic signalling on the Manggarai-Depok section 3) Improvement of platforms and station buildings
7. Automatic Signalling for Single track on C/L (Mri - Dp)	1) Increase in number of trains 2) Speed-up 3) Improving operational safety 4) Reduction of block sections 5) Reduction of signal handling time	1) Automatic signalling 2) Improvement of platforms and track facilities
8. Improvement of Kampungbandan Station	1) Eliminating shuttle operation 2) Realization of loop operation 3) Improvement of passenger services	1) Western Line train operation extended to Tanjungpriok with turnback at Kampungbandan Station discontinued 2) To connect Western and Eastern Lines with each other, a shorter connecting line will be constructed near Kampungbandan

Project Item	Objectives	Particulars
		3) Kampungbandan Station will be improved to accomodate Western Line trains. Eastern Line trains will stop at the new station and operate to the Jakarta Kota Station 4) In addition to the above station improvements, other related passenger facilities will be improved such as transfer facilities.
9. Improvement of feeder service (station plaza included in No.1, No.5, No.6)	1) Construction of Station Plaza	1) Station plaza will be created through the effective use present railway land for improvement in feeder services for passengers
10. Establishment of Train Operating System	1) Quick recovery from emergencies 2) Improvement in punctuality	1) Construction of a Train Operating Center 2) Establishment of telecommunication network
11. Rolling Stock	1) Answering to increasing demand	

(2) Option "b"

The objects and particulars of the projects included in Option "b" are as shown in the following Table 5.2.3.2.

Table 5.2.3.2 Project Items for Option "b"

Project Item	Objectives	Particulars
12. Grade separation at Manggarai Station	1) Train increase through resolution of level crossing of tracks 2) Speed-up 3) Improving operational safety 4) Improving passenger services	1) Grade separation of Western and Central Lines 2) Improvement of station buildings and passenger facilities 3) Installation of free passage
13. Automatic Signalling on Tangerang Line (including Tng.Sub-Depot)	1) Train increase 2) Speed-up 3) Improving operational safety 4) Reduction of block sections 5) Reduction of signal handling time	1) Automatic signalling of Duri-Tangerang 2) Installation of sub-depot
14. Improvement of Passenger handling facilities, (Jng, Pse, Thb)	1) Train increase Reduction of on/off time and resolution of level crossing 2) Improving passenger services	1) Increasing height and width of plat-forms 2) Installation of overbridges 3) Change of track layout
15. Investment of Manggarai Workshop (2nd Step)	1) Answering to increas-ing cars 2) Reducing the number of days required for inspection and the prolongation of inspection cycles	1) Expansion and modernization of facilities
16. Construction of Depok Depot	1) Answering to increasing cars Bikitduri and Jakarta Kota Depots in shortage in accommodating capacity	1) Installation of car depot
17. Rolling Stock	1) Answering to increasing demand	

5-2-4 Selection of a, b Option

(1) Economic analysis of option b

1) Objective

The objective of an economic analysis is to evaluate a viability of the said project from an economic view point. The methodology adopted in this study is the "with-without" analysis. It evaluates the viability of the project comparing with the "without" situation. In this case "with" case is "b" and "without" case is "a".

The projects included in Option b railway investment plan are as follows;

- Grade separation at Manggarai station
- Automatic signaling on Tangerang Line
- Improvement of passenger handling facilities
- Investment of Manggarai workshop (2nd step)
- Construction of Depok depot
- Increase of necessary number of rolling stocks

2) Evaluation criteria

The evaluation criteria adopted in this study is "Economic Internal Rate of Return (EIRR)" which is considered to be the most preferable criteria in project evaluation. The EIRR is a discount rate which makes total amount of net benefit in present value, which are generated through the execution of the project, to be zero. The EIRR satisfies the following equation, in other words.

$$\sum_{i=1}^{n} \frac{\text{(Amount of Net Benefit in i-th year)}}{(1+\text{EIRR})^{i}} = 0$$

3) Preconditions of the analysis

a) Project life

Twenty years from the completion of option "b"

b) Pricing date

Prices of April 1989

c) Foreign exchange rate

1 US dollar = 1758 Indonesian Rupiahs

4) Economic cost of option "b"

a) Construction cost

The economic cost of option "b" is derived from the construction cost (in terms of financial cost) shown in Table 5.2.4.1 through a procedure described below.

Table 5.2.4.1 Total Financial Cost of Option b (Rp. 000.000)

		1987/8	1988/9	1989/90	1990/1	1991/2	1992/3	Total
Civil Engineering		301	1234	2206	14293	27967	22818	68819
Foreign Portion		228	951	1715	7933	17863	14404	43094
Local Portion	Labour Cost	73	283	491	1940	3058	2558	8403
Local Portion	Others	0	0	0	4420	7046	5856	17322
Station Building		304	1250	221	972	11931	15229	29907
Foreign Portion		255	1059	188	0	7370	11042	19914
Local Portion	Labour Cost	49	191	33	299	1196	1496	3264
Local Portion	Others	0	0	0	673	3365	2691	6729
Track		156	613	10822	17104	24975	22418	76088
Foreign Portion		147	576	6954	9273	16134	19845	52929
Local Portion	Labour Cost	9	37	1470	2508	2820	721	7565
Local Portion	Others	0	0	2398	5323	6021	1852	15594
Signals		126	514	5812	11909	17087	8349	43796
Foreign Portion		121	496	4771	9796	14580	7732	37495
Local Portion	Labour Cost	5	18	347	689	810	189	2058
Local Portion	Others	0	0	694	1424	1697	428	4243
Telecommunucations		42	167	56	103	1326	1887	3580
Foreign Portion		40	161	54	94	1287	1836	3471
Local Portion	Labour Cost	2	6	2	3	10	13	36
Local Portion	Others	0	0	0	6	29	38	73
Workshop		0	0	1361	6888	13766	13766	35780
Foreign Portion		0	0	1072	5092	10171	10171	26505
Local Portion	Labour Cost	0	0	289	548	1096	1096	3029
Local Portion	Others	0	0	0	1248	2499	2499	6246
Electric Power Facilities		0	0	166	584	1522	1683	3956
Foreign Portion		0	0	161	549	1420	1568	3699
Local Portion	Labour Cost	0	0	5	11	32	36	84
Local Portion	Others	0	0	0	24	70	79	173
Catenary		248	991	1677	2690	12066	16936	34607
Foreign Portion		228	911	1567	2439	10064	13963	29171
Local Portion	Labour Cost	20	80	110	67	605	893	1775
Local Portion	Others	0	0	0	184	1397	2080	3661
Machinary		0	0	1621	8193	16400	16400	42615
Foreign Portion		0	0	1595	8040	16093	16093	41822
Local Portion	Labour Cost	0	0	26	47	93	93	259
Local Portion	Others	0	0	0	106	214	214	534
Rolling Stocks		0	0	0	103560	105149	105149	313858
Foreign Portion		0	0	0	102510	104078	104078	310666
Local Portion	Labour Cost	0	0	0	1050	1071	1071	3192
Local Portion	Others	0	0	0	0	0	0	0
Land Aquisition and Compensation		0	0	0	6200	0	0	6200
Foreign Portion		0	0	0	0	0	0	0
Local Portion	Labour Cost	0	0	0	0	0	0	0
Local Portion	Others	0	0	0	6200	0	0	6200
Total		1177	4769	23942	172496	232187	224634	659205
Foreign Portion		1019	4154	18077	145726	199058	200731	568765
Local Portion	Labour Cost	158	615	2773	7162	10791	8166	29665
Local Portion	Others	0	0	3092	19608	22338	15737	60775

- Foreign Portion

  The Indonesian tax regulations exempt import taxes on railway equipment and railway construction materials. The foreign exchange rate is determined through the floating exchange rate system. Then the economic cost on foreign portion of railway construction is considered to be equal to financial cost.

- Local Portion

  - Labour Cost

  The income level of workers for the construction is considered to be below the minimum taxation level of income tax. Then, the economic cost of labour is considered to be same as financial cost.

  - Other Cost

  The tax portion of the value added tax (10%) is removed from the financial cost.

Table 5.2.4.2 shows the construction program and the construction costs of option "b" in terms of economic price.

b) Additional investment

The number of required rolling stocks increases to cope with the increase of demand. The additional investment on the rolling stocks are summarized in Table 5.2.4.3.

Table 5.2.4.2 Economic Cost of Railway Investment (Option b)

(Rp.000000)

	1987/8	1988/9	1989/90	1990/1	1991/2	1992/3	Total
Civil Engineering	351	1333	2206	13891	27326	22286	67393
Station Building	355	1350	221	911	11625	14984	29446
Track	182	662	10604	16620	24427	22249	74745
Signals	147	555	5749	11779	16932	8310	43472
Telecommunucations	49	180	56	102	1323	1883	3594
Workshop	0	0	1361	6775	13538	13538	35212
Electric Power Facilities	0	0	166	582	1516	1676	3940
Catenary	289	1070	1677	2673	11939	16747	34395
Machinery	0	0	1621	8183	16381	16381	42566
Rolling Stocks	0	0	0	103560	105149	105149	313858
Land Acquisition/Compensation	0	0	0	6200	0	0	6200
Total	1373	5151	23661	171277	230156	223203	654821

Table 5.2.4.3 Additional Investment of Rolling Stocks

(Rp.000000)

Year	Number	Amount
1993	20	37370
1994	20	37370
1995	20	37370
1996	20	37370
1997	20	37370
1998	20	37370
1999	20	37370
2000	24	44840
2001	24	44840
2002	24	44840
2003	24	44840
2004	24	44840
2005	20	37370
2006	24	44840
2007	20	37370
2008	24	44840
2009	20	37370
2010	24	44840
2011	20	37370
Total	412	769790

c) Reinvestment

The reinvestment cost should be calculated when the useful life of the asset expires within the project life. The project life of the study is 20 years as defined before and the minimum useful life of railway asset is not less than 20 years.
Then, no reinvestment is appropriated.

d) Residual value

The twenty year period of project life is defined only for the project evaluation. The option "b" facilities last even after the period. Therefore, the remaining value of the assets is appropriated as the residual value at the last year of the project life. The following table shows the useful life and the residual value of railway assets.

Table 5.2.4.4 Useful Life and Residual Value

(Years,Rp.000000)

	Useful Life	Residual Value
Civil Engineering	50	40436
Station Building	45	16359
Track	-	37372
Signals	20	0
Telecommunications	-	1797
Workshop	45	19562
Electric Power Facilities	30	1313
Catenary	-	17198
Machinery	20	0
Rolling Stocks	25	499233
Land Acquisition/Compensation	-	5237
Total	-	638507

The railway assets such as track, telecommunications and catenary are considered as replaceable assets while the others as depreciable assets except land. The residual value for the former are appropriated as a half of initial investment amount, since they are replaced year by year.

As for the land acquisition and compensation, only the cost of land acquisition is appropriated. The value on rolling stocks includes the amount of the additional investment.

5) Economic benefits

a) Maintenance and operation cost difference

(i) Railway

- Maintenance Cost

The maintenance and replacement costs of option "b" were estimated using the method adopted in Japan. The costs were calculated according to the maintenance rate and the cumulative amount of investment cost by railway assets (refer to Table 5.2.4.5). The costs were derived by multiplying the rate by the costs.

Table 5.2.4.5 Maintenance Rate by Railway Assets

	Maintenance Rate
Civil Engineering	0.0017
Station Building	0.0067
Track	0.1500
Signals	0.0210
Telecommunications	0.1200
Workshop	0.0057
Electric Power Facilities	0.0130
Catenary	0.0130
Machinery	0.0500
Rolling Stocks	0.0137

- Operation Costs

The operation costs of the option "b" comprise personnel costs, electricity costs and fuel costs.

Table 5.2.4.6 shows the summary of the operation costs of option "a" and "b".

Table 5.2.4.6 Operation Costs of Option "a" and "b"

(Rp. 000000)

	1993		2005	
	a	b	a	b
Personnel				
Driver	1013	912	1013	1352
Conductor	733	659	733	979
Station	2212	2922	2212	3136
Workshop	437	625	437	1087
Depot	328	469	328	815
Electricity	6010	13318	6010	18945
Fuel	327	323	424	470
Total	11060	19228	11157	26784

The personnel cost was estimated according to the information submitted by PJKA (refer to Table 5.2.4.7).

Table 5.2.4.7 Average Personnel Cost

(Rp./year)

Driver	1312467
Conductor	1414491
Station	1923896
Workshop & Depot	1331941

Source:PJKA

(ii) Road Vehicle

The estimation of road vehicle operating costs were carried out based on the Phase 1 report of 'The Consulting Engineering Services for Jakarta Outer Ring Road Project' issued in October 1988.

The vehicle operating costs depends largely on the type of vehicle. The costs for the categorized vehicles, which were set at the traffic assignment procedure in the demand forecast, were estimated by composition rates of the vehicles.

The financial and economic unit prices of the major operating cost components are shown in Table 5.2.4.8.

The cost components comprise of vehicles, tires, fuels, engine oils, wages, interests, insurance and overhead. Using these cost components and the composition rates mentioned above, the weighted averages of the categorized vehicle operating costs by arterial road and tollway, by speed and by each planning year were estimated. Table 5.2.4.9 shows the results.

b) Time saving benefit

The time saving benefits caused by the execution of the option b were calculated from the difference of the passenger hours between "with" and "without" cases. The time savings by mode are shown in Table 5.2.4.10.

Table 5.2.4.8 Unit Prices of Vehicle Operation Cost Component

(Rp.)

Price of Vehicle			Financial Price	Economic Price
Passenger Car	:	Honda Civic NB 1500	43,000,000	20,640,000
Van	:	Toyota Kijang Minibus	17,625,000	14,629,000
Pick-up	:	Toyota Kijang Pick-up	10,775,000	8,943,000
Taxi	:	Toyota Corolla 1300	34,300,000	16,464,000
Medium Bus	:	Benz 0508 I	70,785,000	58,752,000
Large Bus	:	Benz OH 306 S	121,660,000	100,978,000
Small Truck	:	Mitsubishi Colt FE 104	20,515,000	17,027,000
Large Truck	:	Mitsubishi Fuso FM 516H	51,370,000	42,637,000

Depreciable value of vehicle : 90% of vehicle price

Price of one set of tire/tube			Financial Price	Economic Price
Van/Pick-Up	:	550 x 13	40,000	28,476
Passenger Car	:	185 x 14	82,000	68,677
Medium Bus	:	750 x 16	100,000	83,752
Large Bus	:	900 x 20	224,000	187,605
Small Truck	:	750 x 15	98,000	82,077
Large Truck	:	900 x 20	224,000	187,605

Fuel and engine oil price (per liter)	Financial Price	Economic Price
Gasoline	385	366
Diesel oil	200	198
Engine oil for passenger car	2,100	1,909
Engine oil for mini bus and petrol truck	1,975	1,795
Engine oil for bus and diesel truck	2,225	2,023

Wages (per hour)	Financial Price	Economic Price
Maintenance	1,031	1,031
Driver (Bus)	1,435	1,435
Driver (Truck)	1,435	1,435
Conductor (Bus)	539	539
Assistant (Truck)	576	576

Source: "The Consulting Engineering Services for Jakarta Outer Ring Road Project Phase 1 Report" October 1988

Table 5.2.4.9 Economic Operating Cost of Road Vehicles

(Rp./km)

SPEED (km/H)	Arterial Road 1992 Sedan	Truck	Mcycle	Bus	Arterial Road 2005 Sedan	Truck	Mcycle	Bus
7.5 ∿ 12.5	420	736	93	1273	420	887	93	1436
12.5 ∿ 17.5	327	566	73	1051	327	667	73	1160
17.5 ∿ 22.5	277	477	61	938	277	553	61	1019
22.5 ∿ 27.5	242	418	54	869	242	479	54	936
27.5 ∿ 32.5	218	378	48	826	218	430	48	882
32.5 ∿ 37.5	199	351	44	799	199	395	44	847
37.5 ∿ 42.5	185	327	41	782	185	366	41	824
42.5 ∿ 47.5	174	313	39	774	174	346	39	814
47.5 ∿ 52.5	164	302	36	771	164	334	36	806
52.5 ∿ 57.5	158	293	35	775	158	322	35	807
57.5 ∿ 62.5	154	290	34	782	154	316	34	811
62.5 ∿ 67.5	151	287	34	793	151	312	34	818
67.5 ∿ 72.5	149	288	33	807	149	311	33	833
72.5 ∿ 77.5	149	292	33	827	149	315	33	850
77.5 ∿ 82.5	150	299	33	846	150	319	33	870
82.5 ∿ 87.5	152	308	34	870	152	327	34	891
87.5 ∿ 92.5	156	317	35	897	156	337	35	917
92.5 ∿ 97.5	162	331	36	927	162	347	36	947
97.5 ∿ 102.5	168	345	37	956	168	362	37	975
102.5 ∿ 107.5	174	364	39	986	174	377	39	1003

SPEED (km/H)	Tollway 1992 Sedan	Truck	Mcycle	Bus	Tollway 2005 Sedan	Truck	Mcycle	Bus
7.5 ∿ 12.5	396	683	88	1157	396	834	88	1320
12.5 ∿ 17.5	306	516	68	940	306	618	68	1048
17.5 ∿ 22.5	256	428	57	828	256	504	57	908
22.5 ∿ 27.5	222	374	49	762	222	434	49	829
27.5 ∿ 32.5	200	335	44	717	200	387	44	773
32.5 ∿ 37.5	181	310	40	689	181	354	40	737
37.5 ∿ 42.5	167	288	37	672	167	327	37	714
42.5 ∿ 47.5	155	275	34	659	155	310	34	699
47.5 ∿ 52.5	146	264	32	652	146	296	32	688
52.5 ∿ 57.5	139	256	31	653	139	284	31	686
57.5 ∿ 62.5	133	250	30	657	133	276	30	685
62.5 ∿ 67.5	131	248	29	662	131	272	29	688
67.5 ∿ 72.5	128	246	28	670	128	269	28	696
72.5 ∿ 77.5	126	247	28	682	126	268	28	706
77.5 ∿ 82.5	127	249	28	695	127	269	28	719
82.5 ∿ 87.5	126	253	28	710	126	273	28	731
87.5 ∿ 92.5	128	258	28	730	128	277	28	749
92.5 ∿ 97.5	131	267	29	749	131	283	29	769
97.5 ∿ 102.5	136	274	30	771	136	291	30	790
102.5 ∿ 107.5	141	282	31	794	141	299	31	811

Table 5.2.4.10 Time Savings by Mode

(000 hours per year)

Mode	1993	2005
Railway	-201228	-328042
Bus	247549	473540
Motorcycle	428	638
Sedan	1013	1044

The time saving benefits were calculated according to estimated users time value by mode. The time value estimates for private mode users were derived from the Outer Ring Road study. The time value for public mode users was estimated through the time value mode split model analysis in the demand forecast. These estimates were assumed to increase in proportion to the growth of per capita GDP in DKI Jakarta. Table 5.2.4.11 summarizes the time value estimates.

Table 5.2.4.11 Time Value Estimates by Mode

(Rp. per hour and per person)

Mode	1993	2005
Railway User	454.7	921.3
Bus User	454.7	921.3
Sedan User	5443.5	10847.6
M-cycle User	2681.6	5343.9

Note: The time value estimates for motorcycle users were assumed to be a half of sedan users.

In addition to the time saving benefits of travelers, time savings of freight transportation within the study area by trucks were appropriated. The time savings generate from the faster running speed of trucks caused by the reduced bus trips.

The "Technical Paper No. 1 Economic Evaluation Methodology" of Jakarta Urban Transportation Project issued in 1986 considers the value of freight of trucks as Rp.1 million per one ton.
The time value were estimated as Rp. 85.6 per vehicle-hour at 1985 constant price by using a standard test discount rate (15%).

In this study, the values were updated to Rp. 71.74 per vehicle hour in 1989 constant price assuming the load factor as 0.625. The difference of these values comes out from the load factor assumption. The value was assumed to increase the same as the time value of passengers.

6) Result of the analysis

Table 5.2.4.12 shows the result of the economic analysis. The EIRR of this project reached to more than 22%. A sensitivity analysis was conducted to confirm the viability of option b project. The result is shown in Table 5.2.4.13. It indicates that the viability is preferable in terms of the EIRR.

Table 5.2.4.13 Result of Sensitivity Analysis

- EIRR - (%)

Cost/Benefit	Base	- 10%
Base	22.8	21.0
+ 10%	21.2	19.5

Table 5.2.4.12 Economic Analysis of Option b Railway Investment Project

EIRR (%) 22.84627
(Million Rupiah) Benefit: 1.00 Cost : 1.00

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Cost	1373	5151	23661	171277	230156	223203	37370	37370	37370	37370	37370	37370	37370	44840	44840	44840
Initial Investment	1373	5151	23661	171277	230156	223203										
Additional Investment							37370	37370	37370	37370	37370	37370	37370	44840	44840	44840
Residual Value																
Benefit	0	0	0	0	0	0	138601	160603	182606	204609	226611	248614	270617	292505	314392	336280
Time Saving							27665	37759	47853	57947	68041	78135	88228	98322	108416	118510
Public Mode User							21062	30477	39893	49308	58724	68139	77555	86970	96386	105801
Private Mode User							6603	7281	7960	8638	9317	9995	10674	11352	12031	12709
Cost Saving							110936	122845	134753	146662	158571	170479	182388	194182	205976	217770
Railway							-28676	-29804	-30933	-32061	-33189	-34318	-35446	-36689	-37932	-39175
Maintenance							-20507	-21019	-21531	-22043	-22555	-23067	-23579	-24193	-24807	-25422
Operation							-8169	-8785	-9402	-10018	-10634	-11251	-11867	-12496	-13125	-13753
Road Vehicle							139612	152649	165686	178723	191760	204797	217834	230871	243908	256945
Net Benefit	-1373	-5151	-23661	-171277	-230156	-223203	101231	123233	145236	167239	189241	211244	233247	247665	269552	291440

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
Cost	44840	44840	37370	44840	37370	44840	37370	44840	37370	-638507	786104
Initial Investment											654821
Additional Investment	44840	44840	37370	44840	37370	44840	37370	44840	37370		769790
Residual Value										-638507	-638507
Benefit	358168	380056	402059	423947	445949	467837	489840	511728	533731	556307	6945061
Time Saving	128604	138698	148792	158886	168980	179074	189168	199262	209356	219450	2471144
Public Mode User	115217	124632	134047	143463	152878	162294	171709	181125	190540	199956	2210175
Private Mode User	13388	14066	14745	15423	16102	16780	17459	18137	18816	19494	260969
Cost Saving	229564	241358	253267	265061	276970	288764	300672	312466	324375	336858	4473917
Railway	-40418	-41661	-42789	-44032	-45160	-46403	-47532	-48775	-49903	-50457	-795353
Maintenance	-26036	-26650	-27162	-27777	-28289	-28903	-29415	-30029	-30541	-30541	-514065
Operation	-14382	-15011	-15627	-16255	-16872	-17501	-18117	-18746	-19362	-19916	-281288
Road Vehicle	269982	283019	296056	309093	322130	335167	348204	361241	374278	387315	5269270
Net Benefit	313328	335216	364689	379107	408579	422997	452470	466888	496361	1194814	6158957

Note: Time saving of freight by truck transportation were included in "Time saving of Private Mode User" of the above table.

(2) Financial analysis of option "b"

1) Purpose and method of analysis

In order to judge the profitability of option "b", the financial internal rate of return (FIRR) is to be obtained.

FIRR is calculated like EIRR in the economic analysis in that it obtains the discount rate at which the present values of the cost and the income become 0.

It is obtained by the following equation:

$$0 = \sum_{t=1}^{n} \text{cash flow}\cdot t/(1+FIRR)^{t-1}$$

in which

n : Project life

cashflow•t : Operating income of each year (Business income-Business expenditure [Note 1])-Amount of investment.

[Note 1]

The business expenditures usually include depreciation expenses. However, they are carried back in the calculation of FIRR because they simply are account processing costs and do not cause any actual cash outflow. Depreciation expenses are excluded from the beginning in the present assessment.

No interest on a loan is subtracted from the cash flow to calculate FIRR as it is apparent from the above equation. Therefore, FIRR indicates the high limit of a loan which a project can bear if the required fund is completely obtained from the loan.

2) Assumptions

The project life, pricing date and the foreign exchange rate are assumed to be the same in the economic assessment.

3) Amount of investment

The investment process is assumed to be the same as in the economic assessment. However all the prices are financial expenses to which taxes etc., are carried back.

The yearly amount of the initial investment of the financial expense base is given in Table 5.2.4.1.

The additional investment, reinvestment and residual value are assumed to be the same as in the economic analysis (the prices are based on financial expenses).

The residual value of assets by type is as shown in Table 5.2.4.14.

Table 5.2.4.14 Residual Value (Million Rp)

Civil Engineering	41291
Station Building	16615
Track	38044
Signals	0
Telecommunications	1791
Workshop	19878
Electric Power Facilities	1318
Catenary	17304
Machinery	0
Rolling Stocks	499233
Land Acquisition/Compensation	5237
Total	640711

4) Business income

The passenger fare income is appropriated. The passenger fare income is calculated by multiplying the number of railway passengers obtained by the traffic demand forecast by a fare rate. The fare rate is assumed to be Rp 13.4/passenger km. This was calculated from the passenger fare income and the number of passengers (passenger.kms) in the *JABOTABEK Area in 1987/88 in consideration of the percentage of* the fare payments. (it was estimated to be 58% from PJKA materials and ARSDS'S survey materials).

In other words, it is calculated that this fare per passenger km. is Rp 7.7 (4,531 Mil Rp/585 Mil passenger kms.) from the actual passenger fare income in the JABOTABEK Area in 1987/88. On the other hand, it is a fact that only 58% of all passengers actually paid fares.

It was assumed that fares will be collected from all the passengers in consideration of the elevation and the improvements of the station (especially, the improvements of the ticket inspector's gates and ticket handling windows) by the execution of option "b" and PJKA's policy to increase ticket examinations on the trains. Therefore, the fare rate was assumed to be Rp 13.4/passenger km (4,531 Mil Rp/585 Mil passenger kms /0.58) in the present assessment.
Note that the fare rate was assumed to be unchanged during the project life.

5) Business expenditure

a) Maintenance expenses

The maintenance expenses are obtained by multiplying the cumulative amount of investments (financial expenses base = market price base after carrying back taxes etc.) by maintenance rates.
(As for the maintenance rates classified by work categories, refer to Table 5.2.4.5)

b) Operating expenses

The operating expenses consist of personnel expense and power expense (electricity and fuel). They are the same as the operation costs in the economic analysis.

6) Results of analysis

FIRR of option "b", which was calculated on the basis of the cash flow obtained from the above assumption is 5.07% (refer to Table 5.2.4.16 for the details of the results).

7) Sensitivity analysis

A sensitivity analysis of the investment and revenue (fare income) was attempted. The results are shown in Table 5.2.4.15. (Refer to Table 5.2.4.17 through Table 5.2.4.19 for the details of the results).

Table 5.2.4.15 Sensitivity Analysis

(FIRR %)

1) Base Case	5.07
2) Investment 10% up	4.30
3) Revenue 10% down	3.81
4) 2) +3)	3.11

Table 5.2.4.16 Financial Analysis of B-Option (Base Case)

FINANCIAL ANALYSIS OF B-OPTION (Base Case)

(Mil. RP)	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
OPERATING PROFIT	0	0	0	0	0	0	30082	35878	41673	47469	53265	59060	64856
OPERATING REVENUE	0	0	0	0	0	0	58443	65286	72129	78972	85814	92657	99500
OPERATING EXPENSE	0	0	0	0	0	0	28361	29408	30455	31503	32550	33597	34644
WORKING COST	0	0	0	0	0	0	28361	29408	30455	31503	32550	33597	34644
MAINTENANCE COST	0	0	0	0	0	0	20728	21240	21752	22264	22776	23288	23800
PERSONNEL COST	0	0	0	0	0	0	329	391	453	516	578	640	702
ELECTRICITY COST	0	0	0	0	0	0	7308	7777	8246	8715	9184	9653	10121
FUEL COST	0	0	0	0	0	0	-4	0	4	9	13	17	21
DEPRECIATION	0	0	0	0	0	0	0	0	0	0	0	0	0
INVESTMENT	1177	4769	23942	172496	232189	224635	37370	37370	37370	37370	37370	37370	37370

(Mil. RP)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
OPERATING PROFIT	70549	76243	81936	87629	93323	99118	104812	110607	116301	122096	127790	133586	146352
OPERATING REVENUE	106343	113186	120029	126872	133715	140558	147400	154243	161086	167929	174772	181615	188458
OPERATING EXPENSE	35794	36943	38093	39242	40392	41439	42589	43636	44785	45833	46982	48029	42106
WORKING COST	35794	36943	38093	39242	40392	41439	42589	43636	44785	45833	46982	48029	42106
MAINTENANCE COST	24414	25028	25643	26257	26871	27383	27997	28509	29124	29636	30250	30762	24304
PERSONNEL COST	764	826	889	951	1013	1075	1137	1199	1261	1324	1386	1448	1510
ELECTRICITY COST	10590	11059	11528	11997	12466	12935	13404	13873	14342	14811	15280	15749	16217
FUEL COST	25	29	34	38	42	46	50	54	58	63	67	71	75
DEPRECIATION	0	0	0	0	0	0	0	0	0	0	0	0	0
INVESTMENT	44840	44840	44840	44840	44840	37370	44840	37370	44840	37370	44840	37370	-640711

OPERATING REV. UP/DOWN 100%
INVESTMENT UP/DOWN 100%

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
OPERATING REVENUE	0	0	0	0	0	0	58443	65286	72129	78972	85814	92657	99500
OPERATING EXPENSE	0	0	0	0	0	0	28361	29408	30455	31503	32550	33597	34644
INVESTMENT	1177	4769	23942	172496	232189	224635	37370	37370	37370	37370	37370	37370	37370
CASH IN	0	0	0	0	0	0	58443	65286	72129	78972	85814	92657	99500
CASH OUT	1177	4769	23942	172496	232189	224635	65731	66778	67825	68873	69920	70967	72014
NET CASH	-1177	-4769	-23942	-172496	-232189	-224635	-7288	-1492	4303	10099	15895	21690	27486
ACC. NET CASH	-1177	-5946	-29888	-202384	-434573	-659208	-666496	-667989	-663685	-653586	-637692	-616001	-588515

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
OPERATING REVENUE	106343	113186	120029	126872	133715	140558	147400	154243	161086	167929	174772	181615	188458
OPERATING EXPENSE	35794	36943	38093	39242	40392	41439	42589	43636	44785	45833	46982	48029	42106
INVESTMENT	44840	44840	44840	44840	44840	37370	44840	37370	44840	37370	44840	37370	-640711
CASH IN	106343	113186	120029	126872	133715	140558	147400	154243	161086	167929	174772	181615	188458
CASH OUT	80634	81783	82933	84082	85232	78809	87429	81006	89625	83203	91822	85399	-598605
NET CASH	25709	31403	37096	42789	48483	61748	59972	73237	71461	84726	82950	96216	787063
ACC. NET CASH	-562806	-531403	-494307	-451518	-403035	-341287	-281315	-208078	-136617	-51890	31059	127275	914337

FIRR % 5.07%

Table 5.2.4.17 Financial Analysis of B-Option (Investment 10% Up)

FINANCIAL ANALYSIS OF B-OPTION (Investment 10% up)

(Mil. RP)	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
OPERATING PROFIT	0	0	0	0	0	0	30082	35878	41673	47469	53265	59060	64856
OPERATING REVENUE	0	0	0	0	0	0	58443	65286	72129	78972	85814	92657	99500
OPERATING EXPENSE	0	0	0	0	0	0	28361	29408	30455	31503	32550	33597	34644
WORKING COST	0	0	0	0	0	0	28361	29408	30455	31503	32550	33597	34644
MAINTENANCE COST	0	0	0	0	0	0	20728	21240	21752	22264	22776	23288	23800
PERSONNEL COST	0	0	0	0	0	0	329	391	453	516	578	640	702
ELECTRICITY COST	0	0	0	0	0	0	7308	7777	8246	8715	9184	9653	10121
FUEL COST	0	0	0	0	0	0	-4	0	4	9	13	17	21
DEPRECIATION	0	0	0	0	0	0	0	0	0	0	0	0	0
INVESTMENT	1177	4769	23942	172496	232189	224635	37370	37370	37370	37370	37370	37370	37370
OPERATING REV. UP/DOWN	100%												
INVESTMENT UP/DOWN	110%												
OPERATING REVENUE	0	0	0	0	0	0	58443	65286	72129	78972	85814	92657	99500
OPERATING EXPENSE	0	0	0	0	0	0	28361	29408	30455	31503	32550	33597	34644
INVESTMENT	1295	5246	26336	189746	255408	247099	41107	41107	41107	41107	41107	41107	41107
CASH IN	0	0	0	0	0	0	58443	65286	72129	78972	85814	92657	99500
CASH OUT	1295	5246	26336	189746	255408	247099	69468	70515	71562	72610	73657	74704	75751
NET CASH	-1295	-5246	-26336	-189746	-255408	-247099	-11025	-5229	566	6362	12158	17953	23749
ACC. NET CASH	-1295	-6541	-32877	-222622	-478030	-725129	-736154	-741383	-740817	-734455	-722298	-704344	-680595
FIRR %	4.30%												

(Mil. RP)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
OPERATING PROFIT	70549	76243	81936	87629	93323	99118	104812	110607	116301	122096	127790	133586	146352
OPERATING REVENUE	106343	113186	120029	126872	133715	140558	147400	154243	161086	167929	174772	181615	188458
OPERATING EXPENSE	35794	36943	38093	39242	40392	41439	42589	43636	44785	45833	46982	48029	42106
WORKING COST	35794	36943	38093	39242	40392	41439	42589	43636	44785	45833	46982	48029	42106
MAINTENANCE COST	24414	25028	25643	26257	26871	27383	27997	28509	29124	29636	30250	30762	24304
PERSONNEL COST	764	826	889	951	1013	1075	1137	1199	1261	1324	1386	1448	1510
ELECTRICITY COST	10590	11059	11528	11997	12466	12935	13404	13873	14342	14811	15280	15749	16217
FUEL COST	25	29	34	38	42	46	50	54	58	63	67	71	75
DEPRECIATION	0	0	0	0	0	0	0	0	0	0	0	0	0
INVESTMENT	44840	44840	44840	44840	44840	37370	44240	37370	44840	37370	44840	37370	-640711
OPERATING REVENUE	106343	113186	120029	126872	133715	140558	147400	154243	161086	167929	174772	181615	188458
OPERATING EXPENSE	35794	36943	38093	39242	40392	41439	42589	43636	44785	45833	46982	48029	42106
INVESTMENT	49324	49324	49324	49324	49324	41107	49324	41107	49324	41107	49324	41107	-704782
CASH IN	106343	113186	120029	126872	133715	140558	147400	154243	161086	167929	174772	181615	188458
CASH OUT	85118	86267	87417	88566	89716	82546	91913	84743	94109	86940	96306	89136	-662676
NET CASH	21225	26919	32612	38305	43999	58011	55488	69500	66977	80989	78466	92479	851134
ACC. NET CASH	-659370	-632451	-599839	-561534	-517535	-459524	-404036	-334535	-267559	-186569	-108103	-15625	835509

Table 5.2.4.18 Financial Analysis of B-Option (Revenue 10% Down)

FINANCIAL ANALYSIS OF B-OPTION (Revenue 10% down))

(Mil. RP)	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
OPERATING PROFIT	0	0	0	0	0	0	30082	35878	41673	47469	53265	59060	64856
OPERATING REVENUE	0	0	0	0	0	0	58443	65286	72129	78972	85814	92657	99500
OPERATING EXPENSE	0	0	0	0	0	0	28361	29408	30455	31503	32550	33597	34644
WORKING COST	0	0	0	0	0	0	28361	29408	30455	31503	32550	33597	34644
MAINTENANCE COST	0	0	0	0	0	0	20728	21240	21752	22264	22776	23288	23800
PERSONNEL COST	0	0	0	0	0	0	329	391	453	515	578	640	702
ELECTRICITY COST	0	0	0	0	0	0	7308	7777	8246	8715	9184	9653	10121
FUEL COST	0	0	0	0	0	0	-4	0	4	9	13	17	21
DEPRECIATION	0	0	0	0	0	0	0	0	0	0	0	0	0
INVESTMENT	1177	4769	23942	172496	232189	224635	37370	37370	37370	37370	37370	37370	37370

(Mil. RP)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
OPERATING PROFIT	70549	76243	81936	87629	93323	99118	104812	110607	116301	122096	127790	133586	146352
OPERATING REVENUE	106343	113186	120029	126872	133715	140558	147400	154243	161086	167929	174772	181615	188458
OPERATING EXPENSE	35794	36943	38093	39242	40392	41439	42589	43636	44785	45833	46982	48029	42106
WORKING COST	35794	36943	38093	39242	40392	41439	42589	43636	44785	45833	46982	48029	42106
MAINTENANCE COST	24414	25028	25643	26257	26871	27383	27997	28509	29124	29636	30250	30762	24304
PERSONNEL COST	764	826	889	951	1013	1075	1137	1199	1261	1324	1386	1448	1510
ELECTRICITY COST	10590	11059	11528	11997	12466	12935	13404	13873	14342	14811	15280	15749	16217
FUEL COST	25	29	34	38	42	46	50	54	58	63	67	71	75
DEPRECIATION	0	0	0	0	0	0	0	0	0	0	0	0	0
INVESTMENT	44840	44840	44840	44840	44840	37370	44840	37370	44840	37370	44840	37370	-640711

OPERATING REV. UP/DOWN 90%
INVESTMENT UP/DOWN 100%

(Mil. RP)	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
OPERATING REVENUE	0	0	0	0	0	0	52599	58757	64916	71074	77233	83392	89550
OPERATING EXPENSE	0	0	0	0	0	0	28361	29408	30455	31503	32550	33597	34644
INVESTMENT	1177	4769	23942	172496	232189	224635	37370	37370	37370	37370	37370	37370	37370
CASH IN	0	0	0	0	0	0	52599	58757	64916	71074	77233	83392	69550
CASH OUT	1177	4769	23942	172496	232189	224635	65731	66778	67825	68873	69920	70967	72014
NET CASH	-1177	-4769	-23942	-172496	-232189	-224635	-13132	-8021	-2910	2202	7313	12425	17536
ACC. NET CASH	-1177	-5946	-29888	-202384	-434573	-659208	-672340	-680361	-683271	-681069	-673756	-661332	-643796

(Mil. RP)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
OPERATING REVENUE	95709	101867	108026	114185	120343	126502	132660	138819	144978	151136	157295	163453	169612
OPERATING EXPENSE	35794	36943	38093	39242	40392	41439	42589	43636	44785	45833	46982	48029	42106
INVESTMENT	44840	44840	44840	44840	44840	37370	44840	37370	44840	37370	44840	37370	-640711
CASH IN	95709	101867	106026	114185	120343	126502	132660	138619	144978	151136	157295	163453	169612
CASH OUT	80634	81783	82933	84082	85232	78809	87429	81006	89625	83203	91822	85399	-598605
NET CASH	15075	20084	25093	30102	35111	47693	45232	57813	55352	67934	65473	78054	768217
ACC. NET CASH	-628721	-608636	-583543	-553441	-518339	-470637	-425405	-367592	-312240	-244307	-178834	-100780	667437

FIRR % 3.81%

Table 5.2.4.19 Financial Analysis of B-Option
(Investment 10% Up/Revenue 10% Down)

FINANCIAL ANALYSIS OF B-OPTION (Investment 10% up/Revenue 10% down)

(Mil. RP)	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
OPERATING PROFIT	0	0	0	0	0	0	30082	35878	41673	47469	53265	59060	64856
OPERATING REVENUE	0	0	0	0	0	0	58443	65286	72129	78972	85814	92657	99500
OPERATING EXPENSE	0	0	0	0	0	0	28361	29408	30455	31503	32550	33597	34644
WORKING COST	0	0	0	0	0	0	28361	29408	30455	31503	32550	33597	34644
MAINTENANCE COST	0	0	0	0	0	0	20728	21240	21752	22264	22776	23288	23800
PERSONNEL COST	0	0	0	0	0	0	329	391	453	516	578	640	702
ELECTRICITY COST	0	0	0	0	0	0	7308	7777	8246	8715	9184	9653	10121
FUEL COST	0	0	0	0	0	0	-4	0	4	9	13	17	21
DEPRECIATION	0	0	0	0	0	0	0	0	0	0	0	0	0
INVESTMENT	1177	4769	23942	172496	232189	224635	37370	37370	37370	37370	37370	37370	37370
OPERATING REV. UP/DOWN	90%												
INVESTMENT UP/DOWN	110%												
OPERATING REVENUE	0	0	0	0	0	0	52599	58757	64916	71074	77233	83392	89550
OPERATING EXPENSE	0	0	0	0	0	0	28361	29408	30455	31503	32550	33597	34644
INVESTMENT	1295	5246	26336	189746	255408	247099	41107	41107	41107	41107	41107	41107	41107
CASH IN	0	0	0	0	0	0	52599	58757	64916	71074	77233	83392	89550
CASH OUT	1295	5246	26336	189746	255408	247099	69468	70515	71562	72610	73657	74704	75751
NET CASH	-1295	-5246	-26336	-189746	-255408	-247099	-16869	-11758	-6647	-1535	3576	8688	13799
ACC. NET CASH	-1295	-6541	-32877	-222622	-478030	-725129	-741998	-753756	-760403	-761938	-758362	-749674	-735875
FIRR %	3.11%												

(Mil. RP)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
OPERATING PROFIT	70549	76243	81936	87629	93323	99118	104812	110607	116301	122096	127790	133586	146352
OPERATING REVENUE	106343	113186	120029	126872	133715	140558	147400	154243	161086	167929	174772	181615	188458
OPERATING EXPENSE	35794	36943	38093	39242	40392	41439	42589	43636	44785	45833	46982	48029	42106
WORKING COST	35794	36943	38093	39242	40392	41439	42589	43636	44785	45833	46982	48029	42106
MAINTENANCE COST	24414	25028	25643	26257	26871	27383	27997	28509	29124	29636	30250	30762	24304
PERSONNEL COST	764	826	889	951	1013	1075	1137	1199	1261	1324	1386	1448	1510
ELECTRICITY COST	10590	11059	11528	11997	12466	12935	13404	13873	14342	14811	15280	15749	16217
FUEL COST	25	29	34	38	42	46	50	54	58	63	67	71	75
DEPRECIATION	0	0	0	0	0	0	0	0	0	0	0	0	0
INVESTMENT	44840	44840	44840	44840	44840	37370	44840	37370	44840	37370	44840	37370	-640711
OPERATING REV. UP/DOWN													
INVESTMENT UP/DOWN													
OPERATING REVENUE	95709	101867	108026	114185	120343	126502	132660	138819	144978	151136	157295	163453	169612
OPERATING EXPENSE	35794	36943	38093	39242	40392	41439	42589	43636	44785	45833	46982	48029	42106
INVESTMENT	49324	49324	49324	49324	49324	41107	49324	41107	49324	41107	49324	41107	-704782
CASH IN	95709	101867	108026	114185	120343	126502	132660	138819	144978	151136	157295	163453	169612
CASH OUT	85118	86267	87417	88566	89716	82546	91913	84743	94109	86940	96306	89136	-662676
NET CASH	10591	15600	20609	25618	30627	43956	40748	54076	50868	64197	60989	74317	832288
ACC. NET CASH	-725284	-709684	-689075	-663457	-632830	-588874	-548126	-494050	-443182	-378985	-317997	-243680	588608

(3) Result

Using Option "a" the "without case" and Option "b" the "with case" as described in the foregoing two sections, EIRR and FIRR were calculated. For the base case, EIRR was 22.8%, and FIRR was 5.07%.

With the cost taken as +10% and the benefit as -10% for the sake of a sensitive analysis, EIRR is given as 19.5%, and with the cost taken as +10% and the income as -10%, FIRR is given as 3.11%. This shows that Option "b" would have a significant impact on the national economy.

In Indonesia, the opportunity cost for capital is generally about 15%, and thus it can be said that Option "b" is fully feasible from a national economic point of view.

Furthermore, due to transfer of passengers to the railway, benefits such as reduction of air pollution and economization of oil resources are expectable.

In making a financial evaluation, the fare rate was not changed during the project life. However, the fare could be raised depending on social conditions as it has been in the past, and a public government fund or a low interest (2-3%) inter-governmental assistance fund could be used to cover the costs. Therefore Option "b" is considered to be financially feasible.

5-3 Alternative Patterns for Railway Case (Ry1, Ry2, Ry3)

5-3-1 Transportation Plan

(1) Transportation plan of alternative Ry1

1) Train operation routes

The train operation routes for Ry1 are identical to those of option "b" as is shown in Fig. 5.3.1.1

2) Restrictions in facilities

The only facility improvement planned in Ry1 is the double tracking of the Depok-Bogor section of the Central Line.

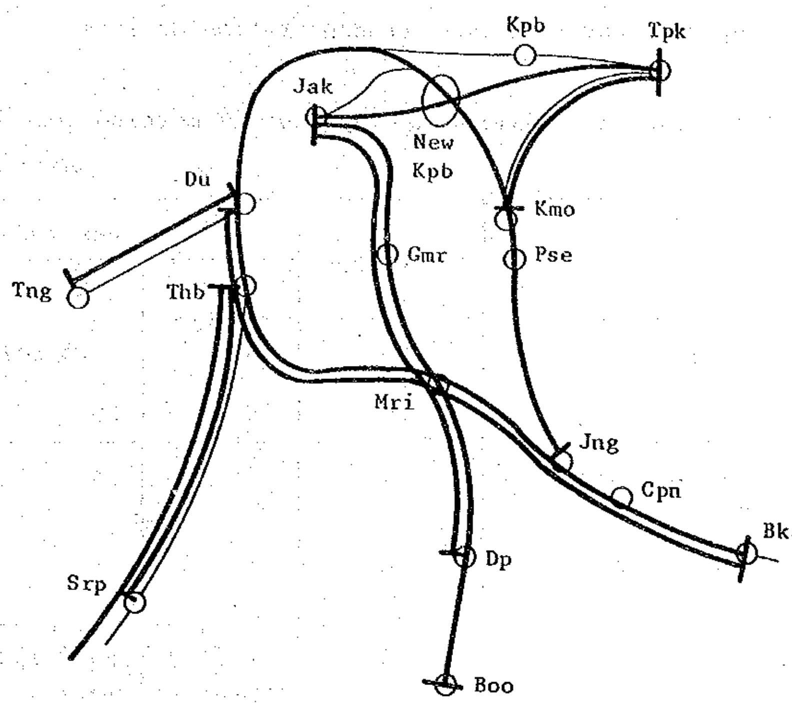
If the single-tracked Depok - Bogor section is single electrified and an automatic signalling system is introduced, the maximum time for travel between stations will be 5.5 minutes. Therefore, the minimum train headway according to the net shaped diagram will be 14 minutes. If this section was double tracked, the minimum headway could be decreased to as low as 3 minutes depending on the number of signals installed.

Ry1 has the following problems concerning transportation

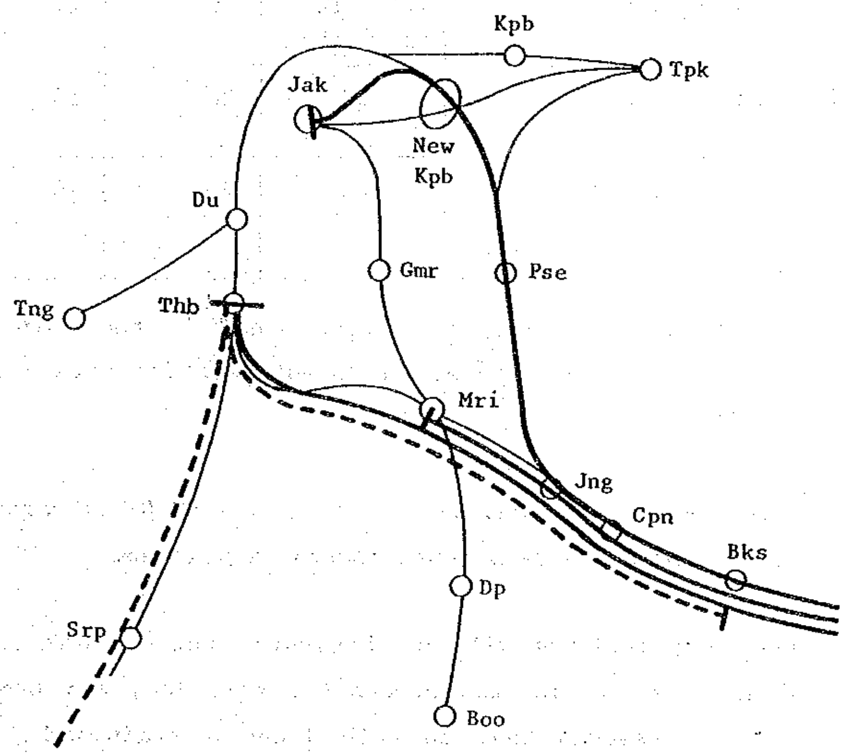
- Trains on the Central Line and the loop line (Eastern Line, Western Line), which are the most important lines in the JABOTABEK Area, use separate tracks in Ry1, as in options a and b (See Fig. 5.3.1.1.).

  To connect the two lines, operation of electric railcars is planned between Tanjungpriok and Jakarta. In this case, however, passengers must change trains twice, once at Jakarta and once at New Kampungbandan.

- It was stated in "Restrictions in Facilities" of option "b" that the Tangerang Line is not electrified and that the Serpong Line is single-tracked. Ry1 will have the same limitations.



(1) JABOTABEK Train



(2) Middle-and long-distance passenger trains, coal freight trains

Fig. 5.3.1.1 Train Operation Route (Ryl)

3) Forecasted Demand and Transportation Capacity

Table 5.3.1.1 shows the train headway of alternative Rys necessary during morning peak hours to meet transportation demands.

Table 5.3.1.1 Train Head for Alternative Ry (during morning peak hour)

Unit: minute

Line	Section	Train Type	Year 2005		
			Ry1	Ry2	Ry3
Central Line	Jak - Dp	EC	4	3.5 (4)	3.5
	Dp - Boo	EC	20	20	20
Western, Eastern, Bekasi Line	Du-(New Jak)-New Kpb - Pse - Jng	EC	8	8	8
	Du-Mri-Jng-Bks	EC	4	4	4
Serpong Line	Thb - Srp	EC	16 (17) Single track	25 (27) Double track	25 (26) Double track
Tangerang Line	Du - Tng	Ry1 DC Ry2,3 EC	20	17	17
Tanjungpriok Line	Jak - Tpk	EC	20	15	12
Eastern Branch Line	Tpk - Kmo	EC	20	20	20

Note (1) The figures indicate the travel head in the combination of Ry and BC-01. The figures in parentheses indicate that of Ry and BC-02.

(2) The head of the combination of Ry and BC-01 is equal to that of Ry and BC-02 where no parentheses is written.

The necessary headways will be 4 minutes between Jak and Dp on the Central Line and 4 minutes between Du, Mri, Jng, and Bks on the Loop Line. It is assumed that on both lines a train will consist of 8 cars. Table 5.3.1.2 shows the maximum transportation capacities (one morning peak hour, one-way) for alternative Ry's and by section.

It is assumed that the minimum headway is 3 minutes on the double track sections and that each train consists of 8 cars. However, the transportation capacity will actually be increased in steps by increasing signalling facilities and in accordance with transportation demand.

All of the alternatives have the same maximum transportation capacity between Jak and Dp and on the loop line (Bks - Thb - Jak - New Kpb - Pse - Jng). Dp - Boo is double-tracked in Ry1, Thb - Srp of Serpong Line is double-tracked in Ry2 and Du-Tng of Tangerang Line is electrified in Ry2.

Table 5.3.1.2 Maximum Transportation Capacity by Alternative (Peak one hour, one-way, train set 8 cars, 1,000 persons)

Line	Section	Maximum Transportation Capacity				Improvement of Facility
		Option "b"	Ry1	Ry2	Ry3	
Central Line	Jak-Dp	44.8	44.8	44.8	44.8	
	Dp-Boo	10.3	44.8	44.8	44.8	Double tracking (Ry1,2,3)
Bekasi , Western, Eastern Line	Bks-Jng-Thb-New Kpb-Pse-Jng	44.8	44.8	44.8	44.8	
Serpong Line	Thb-Srp	9.0	9.0	44.8	44.8	Double tracking (Ry2,3)
Tangerang Line	Du-Tng	8.5	8.5	10.3	10.3	Electrification (Ry2,3)

4) Service level

Table 5.3.1.3 shows the travel times of Ry1, Ry2 and Ry3 against those under Option "b."

As the Central Line has the double tracking completed between Depok and Bogor under Ry1, the waiting time of the meeting trains in the case of the single track is reduced. The travel times of the other lines (Loop Line, Serpong Line and Tangerang Line) under Ry1 are the same with those of Option "b."

Table 5.3.1.4 shows, in percentage, the numbers of trains in the time zones of evening peak, daytime peak-off, early morning and nighttime with the number of trains in the morning peak hours taken as 100%.

Two cases are shown, but the percentage is subject to change with the characteristic of the respective lines, operation of the cars and form of assignment of the personnel.

Table 5.3.1.3 Travel Time by Alternative

Line	Section	Travel Time (minutes)				Improvement of Facility
		Option "b"	Ry1	Ry2	Ry3	
Central Line	Jak-Dp	93	83	83	83	Double tracking (Dp-Boo, Ry1,2,3)
Bekasi , Western, Eastern Line	Bks-Jng-Thb-New Kpb-Pse-Jng	76	76	76	76	
Serpong Line	Thb-Srp	38	38	33	33	Double tracking (Ry2,3)
Tangerang Line	Du-Tng	42	42	38	38	Electrification (Ry2,3)

Table 5.3.1.4 Numbers of Trains by Time Zone

Case	Morning Peak Hours (07:00-09:00)	Evening Peak Hours (16:00-18:00)	Daytime (09:00-16:00)	Early Morning (04:00-07:00)	Nighttime (18:00-23:00)
1	100	75	35	40	30
2	100	90	80	70	65

Source: PMS Report

(2) Ry2 Case

1) Train operation routes

Train operation routes are shown in Fig. 5.3.1.2.

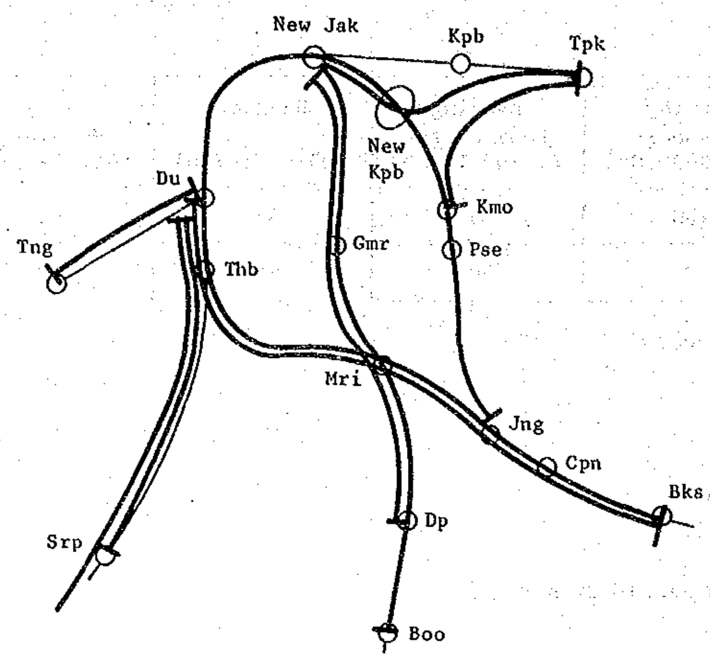
As the New Jakarta station is completed under Ry2, electric cars on the Central Line and the middle and long distance passenger trains are operated to the New Jakarta station. The other trains are of the same operation routes with those under Ry1.

2) Restrictions in facilities

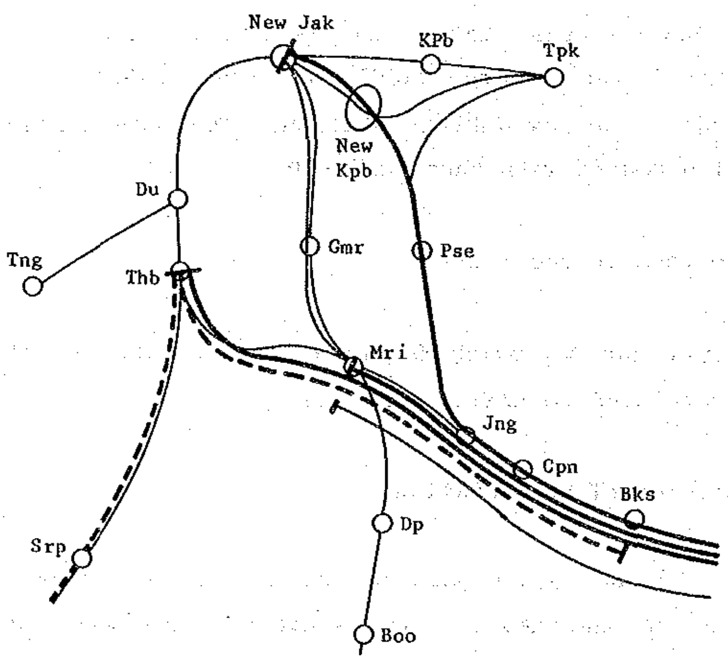
Under Ry2, the following facility improvements are planned as projects greatly related to train operation.

a) Relocation of Kota Station

When the New Kampungbandan Station is completed under Option a, trains on the Eastern and Western Lines will no longer use the present Jakarta Station, as shown in Fig. 5.2.1.1.



(1) JABOTABEK train



(2) Middle and long distance
Passenger Trains, Coal Freight Trains

Fig. 5.3.1.2 Train Operation Route (Ry2)

As described in "2) Restrictions in facilities (1) Ryl Case," separation of the Central Line from the Eastern and Western Line is not convenient for passengers. This problem can be resolved through the relocation of Kota Stations.

b) Construction of car depot relative to relocation of Kota Station

With relocation of Kota Station, a new depot will be required instead of the present Jakarta Depot. This new depot should preferably be placed in the direction of the airport, so that the trains arriving at and departing from New Kota Station will not have to turn back. However, depending on the availability of land, it could also be located on the Tanjungpriok side.

c) Track elevation of E/L (Kota-Gangsentiong)

With the railway grade separated from road traffic, crossing accidents, and road traffic congestion due to crossing interruption, will be eliminated.

d) Construction of new stations

Construction of new stations is an effective way of increasing the demand and reducing the headway of trains operating on single track sections. However, taking into account the time lost in stopping at the new stations, including the time for deceleration and acceleration, travel time will increase.

e) Electrification of the Tangerang Line

When the unelectrified section of line in JABOTABEK is electrified, electric cars in JABOTABEK will be able to effectively operate through the Depok Depot and the Serpong, Bekasi and Tangerang Sub-depots.

f) Double tracking of the Serpong Line

If Serpong Line remain single-tracked, but is electrified and is installed automatic signalling, it will be possible to operate a minimum headway of 15 minutes. However, passengers on DC trains from Rankasbitung will have to change to electric cars at Serpong in the peak morning hours. If the line were double tracked, this problem would be resolved.

When the major facility improvements are completed under Ry2, the JABOTABEK train transportation problems will generally be resolved. There are only three major remaining problems, all of which concern the relationship between JABOTABEK trains and middle-and long-distance trains. The first problem is how to operate the middle-and long-distance trains among the sharply increasing number of JABOTABEK trains. The second is how to secure the on-time operation of JABOTABEK trains against delayed middle-and long-distance trains coming into the JABOTABEK Area. The third is the handling of coal trains from Cigading along the Merak Line. These will be discussed in the section on Ry3.

3) Demand forecast results and transportation capacity

As shown in Table 5.3.1.1, "Headways of Alternative Ry (morning peak hours)," the headway between Jak-Dp on the Central Line is reduced to 3.5 minutes, which is smaller than that of Ry1. On the Serpong Line, the Ry2 headway is 25 minutes, longer than that of Ry1 at 16 minutes. This is because the number of cars per train composition is increased from 4 in Ry1 to 8 in Ry2 and because the headway of the net diagram on single track is a minimum of 15 minutes. The headways of the other lines are the same as those of Ry1.

As shown in Table 5.3.1.2, the maximum transportation capacity of Ry2 on the Serpong and Tangerang Lines will become larger than that of Ry1, reflecting the effects of the double tracking of the Serpong Line and electrification of the Tangerang Line.

4) Service level

As shown in Table 5.3.1.3, the travel times of Ry2 on the Serpong and Tangerang Lines are reduced through the foregoing facility improvement.

(3) Ry3 case

1) Train operation routes

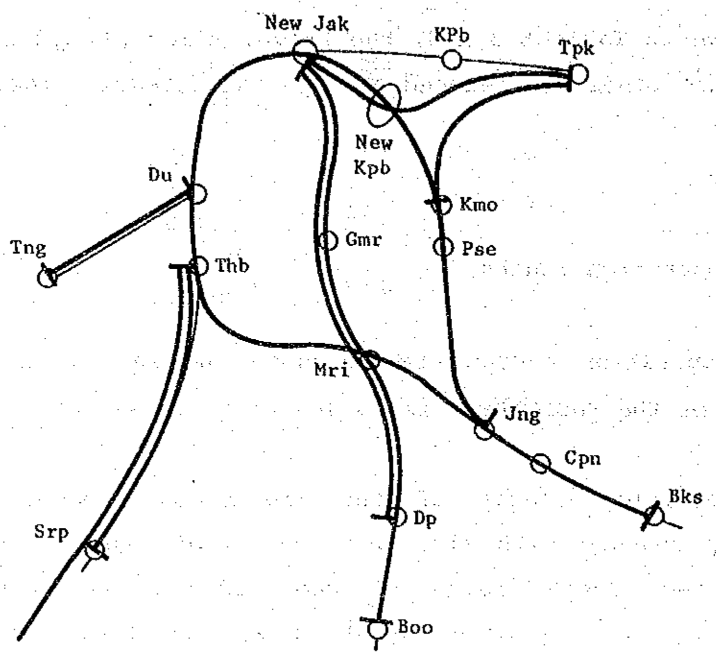
Train operation routes are as shown in Fig. 5.3.1.3. The operation routes of the JABOTABEK trains are the same as those of Ry2.

The operation routes of the middle-and long-distance trains are greatly changed with the construction of the Cibinong Line. Except for a few, these trains are operated via the Cibinong Line to New Jakarta. On the other hand, the coal trains from Cigading are operated from Serpong via the Cibinong Line to Cibinong and Tanjungpriok.

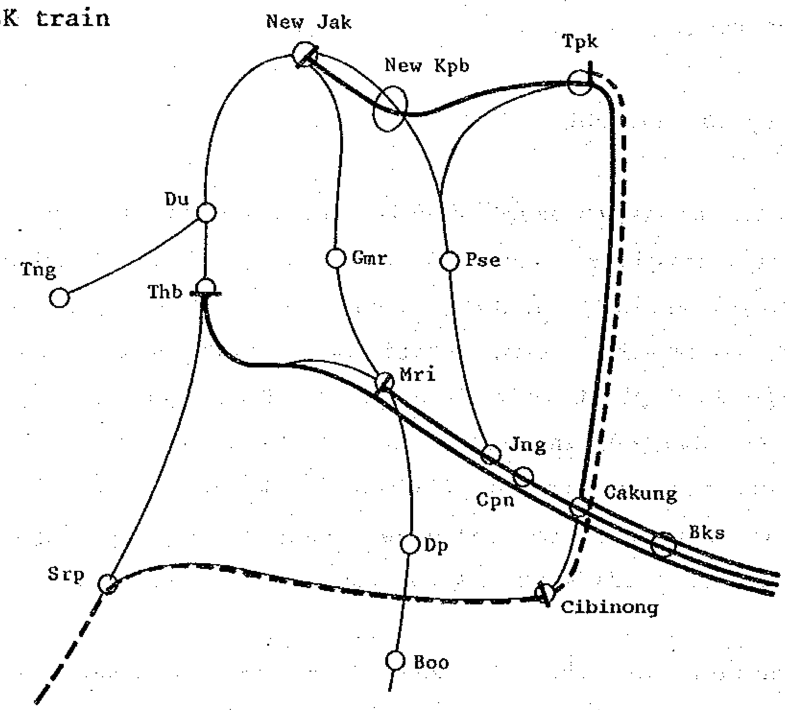
2) Facility improvement

The facility improvement deeply associated with the train operation under Ry3 involves only the construction of the Cibinong Line. Coal from Cigading is presently transported by railway from Tanahabang to Bekasi and by truck from Bekasi to a plant in Cibinong, while cement from the said plant is transported to Tanjungpriok by truck. However, the Tanahabang-Jatinegara-Bekasi section has the greatest railway transportation demand in JABOTABEK. Moreover, transportation of the coal is expected to increase greatly in the future, making it difficult to operate trains for the coal on the Western Line.

Construction of the Cibinong Line is intended to separate the operation route of coal trains from the Western Line and, at the same time, substitute the truck transportation of cement, etc., between Cibinong and Tanjungpriok, and truck transportation of coal between Bekasi and Cibinong with railway transportation.



(1) JABOTABEK train



(2) Middle and long distance trains,
Coal Freight Trains

Fig. 5.3.1.3 Train Operation Route (Ry3)

3) Demand forecast results and transportation capacity

As shown in Table 5.3.1.1, the headways in the morning peak hours of Ry3 are the same as those of Ry2. The maximum transportation capacity of Ry3 (Table 5.3.1.2) is the same as of Ry2.

4) Service level

The travel time by section for Ry3 is the same as that for Ry2 (see Table 5.3.1.3.)

5) Scheduled speeds

The scheduled speeds at present and those by section for the respective alternatives are as shown in Table 5.3.1.5. The scheduled speed is calculated by including stop time in the operation time (travel time).

In each of the Ry alternatives, the scheduled speed exceeds 30 km/h on any of the lines. The Central Line is the highest at 36.9 km/h, followed by the Serpong Line at 36.3 km/h and the Loop Line at 34.2 km/h. This is higher than the scheduled speed of 33 km/h on the Yamanote Line in Tokyo. Because average distance between station and station of the JABOTABEK Line is longer than the Yamanote Line.

6) Number of electric and diesel cars

The required number of electric cars and diesel cars by alternative are as shown in Table 5.3.1.6.

Table 5.3.1.5 Schedule Speed by Alternative

(km/h)

Line	Central Line	Bekasi, Eastern, Western Line	Serpong Line	Tangerang Line
Section	Jak-Boo	Bks-Jng-Mri-Du-N.Jak-N.Kpb-Pse-Jng	Thb-Srp	Du-Tng
Year 1988 at present	30.7	21.2	25.4	16.1
a Option (1992)	34.9	34.2	31.7	28.6
b Option (1992)	34.9	34.2	31.7	31.7
a Option (2005)	34.9	34.2	31.7	28.6
b Option (2005)	34.9	34.2	31.7	31.7
Ry1 BC-01 (2005)	36.9	34.2	31.7	31.7
Ry2 BC-01 (2005)	36.9	34.2	36.3	33.3
Ry3 BC-01 (2005)	36.9	34.2	36.3	33.3
Ry1 BC-02 (2005)	36.9	34.2	31.7	31.7
Ry2 BC-02 (2005)	36.9	34.2	36.3	33.3
Ry3 BC-02 (2005)	36.9	34.2	36.3	33.3

Table 5.3.1.6 Number of Electric Cars and Diesel Cars by Alternative

Alternative	Electric Cars	Diesel Cars	Total
1992 a	164	66	230
1992 b	332	58	390
2005 a	164	96	260
2005 b	592	96	688
Ry1 BC-01	660	94	754
Ry2 BC-01	708	52	760
Ry3 BC-01	756	52	808
Ry1 BC-02	656	94	750
Ry2 BC-02	704	52	756
Ry3 BC-02	756	52	808

7) Operation of middle-and long-distance trains

a) Number of trains

Judging from the results of the demand forecast, the increase in the number of passengers on middle-and long-distance trains, if 1988 is taken as 100%, will be 171-178% in 2005, although this will vary more or less by alternative.

The present number of trains in one day for both ways, according to the train diagram of September 5, 1987, is as follows:

Central L.	Eastern L.	Western L.	Total
41	29	4	74

This does not include the diesel car trains connecting Cikampek and Purwakarta to JABOTABEK, as they are designated as JABOTABEK trains.

Therefore, the number of middle-and long-distance trains in 2005 is estimated to be 128-134 in one day for both ways.

b) Headways of middle-and long-distance trains

The present operation by time zone of the middle-and long-distance trains is as shown in Table 5.3.1.7.

Table 5.3.1.7 Operation Frequency by Time Zone of the Middle-and Long-Distance Trains

Lines	Operating Direction	Early Morning (03:00-06:00)	Morning Peak Hours (06:00-09:00)	Daytime (09:00-14:00)	Evening Peak Hours (14:00-17:00)	Nighttime (17:00-23:00)
Central Line (Gambir)	To Jakarta	19%	33	24	10	14
	To Cikampek	5	5	30	30	30
Eastern Line (Pasar-senen)	To Jakarta	31	25	6	13	25
	To Cikampek	0	38	8	16	38

Note: (1) Based on the revised train diagram of September 5, 1987.

(2) The number of trains was counted at Gambir for the Central Line and Pasarsenen for the Eastern Line.

From the above table, it can be seen that Central Line trains going to Jakarta account for 10% of all the trains operated per hour in the morning peak time zone and those going to Cikampek 10% of all the trains operated per hour in the evening peak time zone.

On the other hand, the Eastern Line is slightly different from the Central Line and accounts for 10% of the trains going to Jakarta per hour in the early morning and morning peak hours, respectively and 13% of the trains going to Cikampek per hour in the morning peak hours.

As just indicated, these are a large number of trains in service during the morning and evening peak hours. In the future, due to large increases in the number of JABOTABEK trains and the elevation of the Central Line, middle-and long-distance trains will no longer be able to be operated on the Central Line (reasons to be stated later), and it will become difficult to intensity train operation in the morning and evening peak hours.

As shown in Table 5.3.1.1, the headway of electric cars on the Eastern Line is 8 minutes, and that on Bekasi Line 4 minutes for 2005. This will result in operation on the Eastern Line becoming practicable and that on the Bekasi Line difficult.

If Kota Station is relocated under Ry2, middle-and long-distance trains can be operated on the Central Line, meaning they can be operated as at present, partly on the Central Line and partly on the Eastern Line. Nevertheless, operation between Jatinegara and Bekasi will remain difficult.

Therefore, the operation of middle-and long-distance trains in the morning and evening peak hours in the future should be avoided.

Even if the train operating system is completed, it would be difficult to punctually operate the JABOTABEK trains together with the middle-and long-distance trains in the peak hours.

c) Operation of middle-and long-distance trains on the Central Line

Track elevation of the Central Line is now in progress, and when it is completed, the middle- and long-distance trains can no longer be operated to Jakarta station via the Central Line.

The reasons are as follows:

- Beginning point of track elevation is nearer to Jakarta station on the present plan than one of the JICA Study Report (Feasibility Study on Track Elevation of Central Line) and there is a sharp curve around above mentioned point in this report.

- Then it is impossible to install track turnout for making routes to other tracks from the Central line in Jakarta station.

- Trains on the Central Line can use only two tracks (track No. 11 and 12) in Jakarta station, but those two tracks are exclusive for electric railcar trains, therefore middle- and long-distance trains cannot reach to Jakarta station.

- Middle- and long-distance train that is longer than electric railcar train cannot be operated to the Jakarta depot, because middle- and long-distance train stops on the track turnout connected up and down tracks on the Central Line. Furthermore, another locomotive cannot be coupled to middle- and long-distance train, then train is not able to shuttle back to Manggarai station.

Furthermore, even if middle- and long-distance trains are required to terminate or originate at Gambir station, shunting of locomotive to change the position causes hazards to main line since two main tracks, two supplementary tracks and two platforms are provided at Gambir station.

To resolve above problem, a locomotive may be additionally coupled at the rear end of each train at Jatinegara station. By this method, shunting of locomotive at Gambir station can be eliminated but causes number of locomotive required for operation at the same time, all train should be stop at Jatinegara station for coupling or uncoupling of locomotive.

d) Use of Cibinong Line

The Cibinong Line is intended for freight trains. But, it may be used for operation of the middle and long distance trains. By this, the foregoing problems will be resolved, but this causes inconvenience to the passengers going to Manggarai, Gambir and Pasarsenen.

8) Coal transportation

a) Transportation items and transportation sections

The transportation items as related to the Cibinong cement plant is as shown in Table 5.3.1.8.

Table 5.3.1.8 Transportation on the Cibinong Line

Direction	Transportation Sections	Items	Present transportation method
To Cibinong plant	Cigading → Cibinong	Coal	Railway (Cigading-Bekasi) Truck (Bekasi-Cibinong)
	Tanjungpriok → Cibinong	Plaster	Truck
From Cibinong plant	Cibinong → Tanjungpriok	Cement	Truck
	Cibinong → Tanjungpriok	Clinker	Truck
	Cibinong → Cigading	Clinker	Truck

Construction of the Cibinong Line is a project under Ry3, and so under Ry1 and Ry2 of 1992 and 2005 respectively, the railway transportation is made as is presently.

b) Number of trains

The present coal train has a composition of 18 freight cars (coal 540t) hauled by a diesel locomotive.

Based on the demand forecast, the number of trains in future will be obtained in unit of the present train as below.

Table 5.3.1.9 Number of Trains on the Cibinong Line

Year	Transportation Sections	Number of Trains
1992	Cigading → Cibinong	8 (Loaded)
	Cibinong → Cigading	8 (Loaded 3 + Empty 5)
2005	Cigading → Cibinong	16 (Loaded)
	Cibinong → Cigading	16 (Loaded 3 + Empty 5)
2005 (via Cibinong Line) 2005	Cibinong → Tpk	16 (Loaded)
	Tpk → Cibinong	16 (Loaded 4 + Empty 12)

Note: Loaded - Loaded train; Empty - Empty train

Thus, under Ry1 and Ry2, a total of 32 coal trains in one day and both ways are to be operated between Thb-Mri-Jng-Bks where the electric car trains are most frequent in JABOTABEK. Then, it should be considered to increase the train unit and decrease the number of the coal trains. While there may be problems such as, for example, stretching the storage track, it is desirable to haul 36 freight cars (loaded) with 2 diesel locomotives.

c) Required number of cars

The required number of cars for coal transportation is as shown below.

Table 5.3.1.10 Required Number of Cars by Year

Year	Train Operation Route	Number of Diesel Locomotives	Number of Freight Cars
1992	Cigading - Thb - Mri - Bks	7	114
2005	Cigading - Thb - Mri - Bks	13	223
2005	Cigading - Srp Cibinong - Tpk	16	248

5-3-2 Feeder Service

The following are clarifications to the development program for integrated transportation:

(1) Area service

1) Railway station and proximate bus terminal

- Jakarta Kota
  Relocation of the Kota Bus Terminal into the redevelopment area when the New Jakarta Kota Station is completed.

- Pasar Minggu
  Provisions for a pedestrian bridge between the railway station and the new bus terminal for smooth passenger transfer.

- Depok Baru
  Introduction of a bus terminal into the station's front plaza.

- Kebonpedes
  Reopening of Kebonpedes Station at roughly the same time as the opening of the new bus-terminal in Bogor DJJAJR.

- Pasar Senen
  Transfer of some portion of Pasar Senen Terminal's function to the station's front plaza.

- Rawabuaya
  Connection with new/station facilities and the new Kalideres Bus Terminal for smooth passenger transfer.

2) Shuttle service between the railway station and the intercity bus terminal

- Cakung (New Cakung)
- Tanjung Barat (Pasar Rebo)
- Binto (Cilandak)
- Bekasi (existing Bekasi intercity bus terminal)

3) Direct feeder service between the railway station and the area served by the station. (The detailed feeder service route will continue to be examined in the feasibility study stage.)

- Radial service
- Zonal service
- Rudder service

The function of proposed feeder service based on current information by main station is indicated in Fig. 5.3.2.1.

(2) Program for the improvement of intermodal facilities

It is proposed that transfer resistance factors in intermodal transportation be reduced by making the following improvements to facilities.

1) Improvement of traffic flow

- Widening of access road to station
- *Provision of station front plaza or bus pool*

2) Provision of traffic safety facilities

- Signalling
- Pedestrian bridge
- Stairs design

The result of studies for transfer time reduction are summarized in Appendix 4-2.

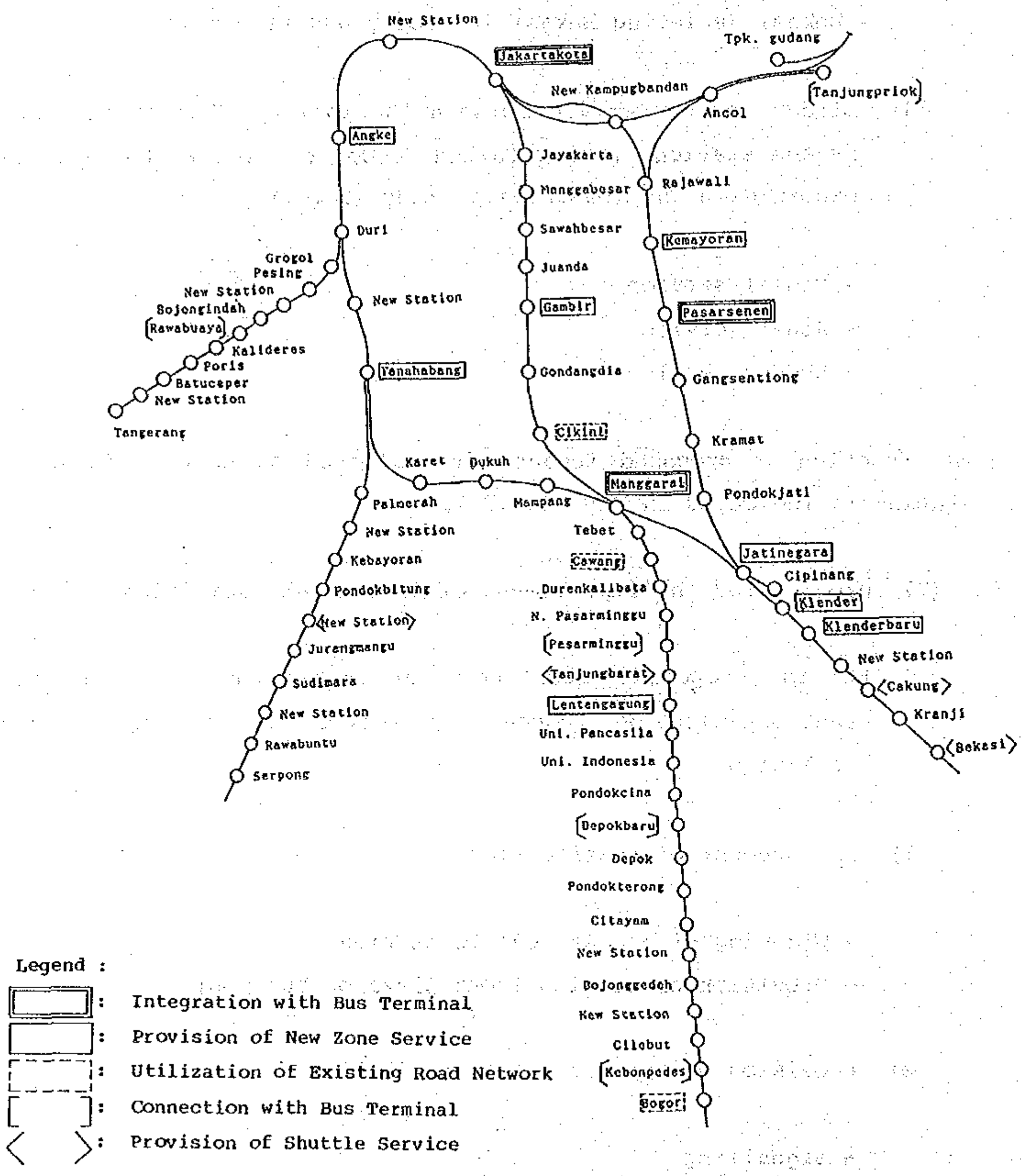


Fig. 5.3.2.1 Function of Proposed Feeder Service

5-4 Alternative Patterns for Road Cases (BC-00, BC-01, BC-02)

The contents and schedule of various projects and plans, were described in Section 3-3-2, but this section summarizes them again to specify which category of projects have been considered as the base cases (mainly road based transportation systems) against heavy railway improvements that are the main concerns of this study.

Three base cases explained here are called BC-00, BC-01 and BC-02. The BC-00 includes 1992 projects and plans and BC-01 and BC-02 both include the projects and plans to be implemented up to the year 2005. Two alternative cases for 2005 will be combined to the three railway improvement cases Ry-01, Ry-02 and By-03 that have been explained in the previous section (Section 5-3).

5-4-1 Base Case for Year 1992 (BC-00)

BC-00 includes the following three categories of projects:

(1) Completion of the traffic management program and parking restraint project.

(2) Completion of on-going and committed road construction project within JABOTABEK Region (JUTP, JUDP-1 and Toll roads - see Table 3.3.2.1)

(3) Construction of three bus priority lanes along the routes shown in Fig. 3.3.2.1.

5-4-2 Base case for Year 2005 (BC-01)

BC-01 includes the following system improvements

(1) Completion of the secondary arterial roads shown in Table 3.3.2.2.

(2) Completion of the urban toll road network, i.e. the Inner Ring Road, Outer Ring Road and Harbor Road.

(3) Introduction of further traffic management measures within the Outer Ring Road, including the extension of area licensing scheme.

(4) Introduction of additional seven bus priority lanes, and shuttle bus routes between the new bus terminals and railway stations listed shown below:

- East Terminal	- Cakung Station;
- South Terminal	- Tanjung Barat Station;
- South West Terminal	- Bintaro Station; and
- West Terminal	- Rawabuaya Station.

(5) Construction of East/West mass Transit Corridor from Kebon Jeruk, via Tanah Abang, Gambir, Pasar Senen and Pulo Gadung to new interchange with railway between Klender Baru and Cakung.

(6) Construction of Blok M-Sudirman-Thamrin-Kota and from Blok M to Pasar Minggu Mass Transit Corridor.

(7) Development of street system within the East/West Jakarta and within the Tangerang/Bekasi Core-Cities.

5-4-3 Base Case for Year 2005 (BC-02)

BC-02 is the addition of the following improvements on BC-01.

(1) Extension of Mass Transit Corridor from Kebon-Jeruk to North Serpong from new station near Cakung to Pondok Gede.

(2) Provision of the road/street system within the southeast/southwest suburbs.

5-4-4 Mass transit corridor network

Mass transit systems and corridors have been proposed by past studies. The mass transit corridors considered in this study run along North-south corridor and West-east corridor. The former route passes Blok M-Sudirman-Thamrin-Kota, where persistent peak-hour traffic jams are present. The latter route should play an important role under the JABOTABEK development policy that direct the urban development along the east-west corridor with the constraints on south.

(1) North-South Route

The construction of mass transit system along Blok M-Sudirman-Thamrin-Kota would alleviate the worsening condition of traffic congestion.

An assumed development scenario is as follows:

By 1992: Between Blok M-Sudirman-Thamrin-Kota a bus priority lane will be constructed to characterize this corridor as a mass transit corridor.

By 2005: Kota-Thamrin-Sudirman-Blok M corridor will be upgraded into another higher capacity mode, which will be extended to the Blok M-Pasar Minggu section.

Total length will be about 23 km. This corridor is to be integrated with Pasar Minggu railway station to provide a feeder services to the existing heavy rail systems and distribute the railway passengers to the southern part of the central area.

(2) West-East Route

Future development in JABOTABEK area will mainly be in the western and eastern areas. Population increases are expected in both areas.

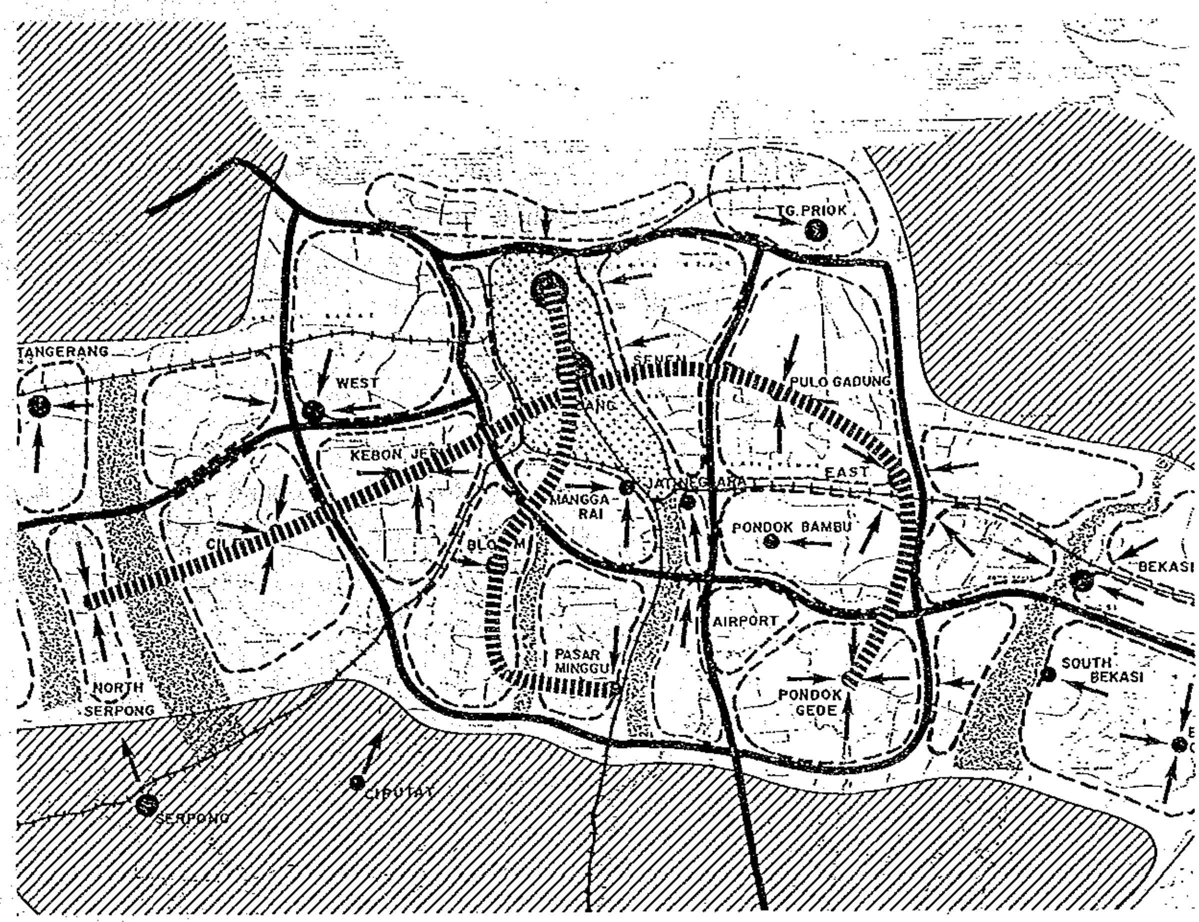
The West-east route originates in North Serpong, which will be developed as a sub-centre. North Serpong is located in an area having no transportation services between the Tangerang and Serpong Lines. This West-east route goes through Ciledug-Kebon Jeruk-Tanah Abang-Gambir-Pasar Senen-Pulo Gadung-East Metropolitan Center-New Railway Station (between Klender Baru and Cakung) and Pondok Gede. Total length will be approximately 49 km.

The development scenario by the year 2005 of this corridor is as follows:

Stage 1: Construct the system along Kebon Jeruk-Tanah Abang-Gambir-Pasar Senen-Pulo Gadung-New Railway Station.

Stage 2: Extend the system from Kebon Jeruk to North Serpong, and from the new railway station near Cakung to Pondok Gede.

The layout of the above mentioned routes are shown in Fig. 5.4.4.1



LEGEND

- Metropolitan Center
- Sub Center
- Secondary Center
- Green Preservation/ Recreation Zone
- Central Area
- Traffic Regulation Zone
- Limited Development Zone
- Freeway
- Railway
- Mass Transit Corridor

(A) Kota - Thamrin - Dukuh - Sudirman - Block M - Passar Minggu.

(B) North Serpong - Ciledug - Kebon Jeruk - Tanah Abang - Passar Senen - Pulo Gadung - East Metropolitan Center - New Railway Station - Pondok Gede.

Fig. 5.4.4.1 Routes of Mass Transit Corridor

5-4-5 Selection of Appropriate MRT System for Main Corridors

(1) Introduction

For the Main Corridors (North-South and East-West) for which an MRT system is to be planned as established between the JICA study team and the counterpart team for BC01 and BC02, an appropriate system will be chosen in consideration of the demand forecast.

(2) Procedures for selection of the system

Selection of the appropriate system for the demand will be made according to the procedures shown in Fig. 5.4.5.1, and in the selection, the prospected socioeconomic and urban traffic developments will be comprehensively taken into account.

(3) Selection of the system

1) Demand forecast

The demand forecasts, or more specifically the whole day both direction maximum sectional traffic volumes and morning peak one way hourly maximum sectional traffic volumes of the North-South Corridor (referred to as "N-S Line" below) and East-West Corridor (referred to as "E-W Line" below) for the patterns of the combinations of Ry1, Ry2, Ry3 and BC01, BC02, are shown in Table 5.4.5.1.

As seen from Table 5.4.5.1, the maximum sectional traffic volumes at peak hours of N-S and E-W Lines are different only for about 10% between the patterns, and so there will be not much difference produced with whatever pattern taken for examination for selection of the system. Thus, the system examination will be made of the pattern of BC01-Ry1. In this case, the peak hour one way sectional traffic volume as related to the railway network is shown in Fig. 5.4.5.2.

The peak hour one way hourly maximum sectional traffic volume in and after 2005 is estimated as shown in Fig. 5.4.5.3.

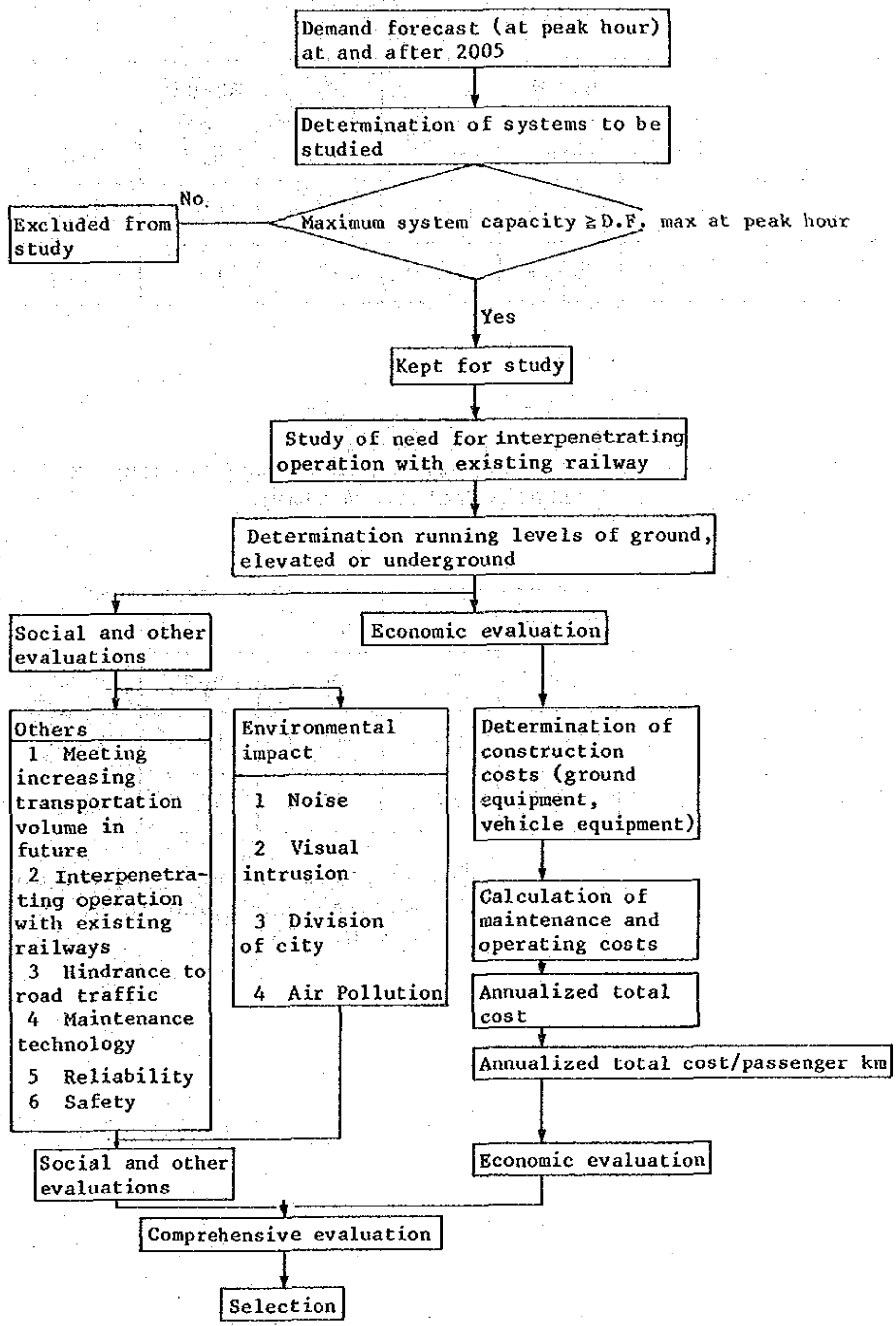


Fig. 5.4.5.1 Flow of System Selection

Table 5.4.5.1 Demand Forecast of Mass Transit

A. Maximum Transportation Volume in Both Directions in One Day (Thousand persons/day) (Sectional Traffic Volume)

Case	BC-01			BC-02		
	Ry1	Ry2	Ry3	Ry1	Ry2	Ry3
N-S Line	442.1	425.5	424.3	419.5	409.6	408.3
E-W Line	411.8	383.9	373.0	433.7	412.0	410.7

B. Maximum Transportation Volume in One Direction During Morning Peak Hours (Thousand persons/hour) (Sectional Traffic Volume)

Case	BC-01			BC-02		
	Ry1	Ry2	Ry3	Ry1	Ry2	Ry3
N-S Line	21.0	20.2	20.2	19.9	19.5	18.4
E-W Line	19.6	18.2	17.7	20.6	19.6	19.5

The averages during 3 peak hours in the morning are given in B.
(A x 0.0475)

BC01, RY-1 2005

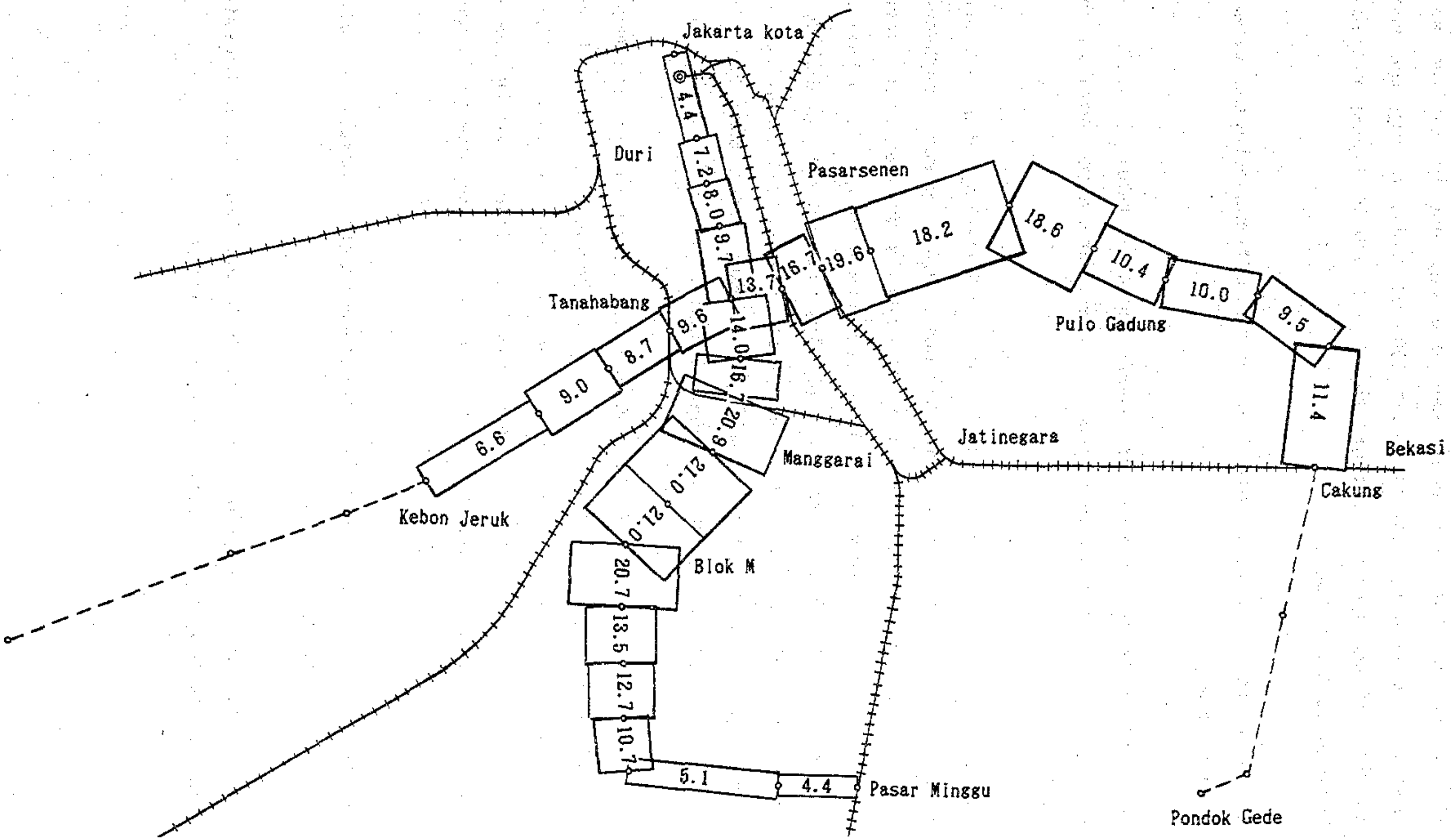


Fig. 5.4.5.2 The Peak Hour One Way Hourly Maximum Sectional Traffic Volume (2005)

It is assumed that the peak hour one way hourly maximum sectional traffic volume will grow up after 2005 at 6.4%, namely the same rate to that of the annual mean growth of all public transportation means between 1992 and 2005.

2) Types of the systems examined and maximum transportation capacity of each system

The systems to be examined are those shown in Table 5.4.5.2. Maximum transportation capacities of these systems are also shown in the same table.

In some reports, it is reported that the buses by means of exclusive lane allow transportation of maximum 30,000 passengers/h/one way. But, the transportation capacity of buses is substantially determined by the ability of processing the passengers getting off and on the bus at each bus stop and, more particularly, the processing ability at the bus terminal in the midtown area where the traffic demands concentrate. Thus, it is considered in many cases that the realistic limit of buses is 20,000 passengers/h/one way.

The demands forecasts of the N-S and E-W Lines in the JABOTABEK Area in 2005 are respectively about 20,000 passengers in terms of one way, one hour in peak hours, as shown in Fig. 5.4.5.2. Then, the passengers will eventually exceed 30,000 in about 5 to 10 years after 2005, and so the buses are considered to be not always adequate in capacity for N-S and E-W Lines.

3) Examination of the need of interpenetrating operation with the existing railway

MRT in the Main corridor has its N-S and E-W Lines crossing the existing railway at the latter's main stations.

Table 5.4.5.2 Maximum Transportation Capacity of Each System

	Bus (Exclusive Lane)	Monorail (straddled type)	Linear motor car	Automated guided transportation system	L R T	Conventional railway
Minimum interval	30-20" (14.4")*	1.5'	1.5'	1.5'	2'	1.5'
Number of passengers per car ($0.14\ m^2$/man)	120	184	142	70	370 (1 unit)	280
Number of cars per train	1	2 - 6	2 - 6	4 - 12	1 - 3	2 - 10
Maximum transportation capacity per hour (1 direction)	14400 - 21600 (30000)*	14720 - 44160	11360 - 34080	11200 - 33600	11100 - 33300	16800 -84000
Commercial speed (km/h)	15 - 30	30	30	30	30	30 - 35

* World Bank's Technical Paper No. 52 reports that the buses allow one way, 1 hour, 30,000 passengers. For this case, the bus headway is 14.4".

Then, if the interpenetrating operation of MRT and existing railway is practicable, the servicing efficiency of the network, cars and ground facilities is enhanced. In particular, in the section between the Cakung Station at which E-W Line and Bekasi Line cross each other and the Jatinegara Station, medium and long distance trains and commutation trains are concurrently present, and in 2005, the track capacity will be close the limited. Then, with increasing demand thereafter, if it is possible to have some of the commutation trains directing from Bekasi to the midtown area run directly onto the MRT line from the Cakung Station, it will be much more convenient for the commutators.

4) Establishment of running level (ground level, elevated or underground)

The following two cases were examined.

a) Case 1

In consideration of the highly developed land use in the cities inside of Inner Ring Road, the underground structure is taken, while an elevated structure will be examined for the section between Inner Ring Road and Outer Ring Road, and a ground level structure considered outside the Outer Ring Road.

b) Case 2

An elevated structure is considered throughout inside the Inner and Outer Ring Roads, and outside the Outer Ring Road, a ground level structure is taken.
The relationship among Running level, Inner Ring Road and Outer Ring Toll Roads are shown in Fig. 5.4.5.4.
Buses are examined in Case 2 only.

5) Economic assessment

Table 5.4.5.3 and Table 5.4.5.4 shows the construction costs of the systems according to the running levels of Cases 1 and 2.

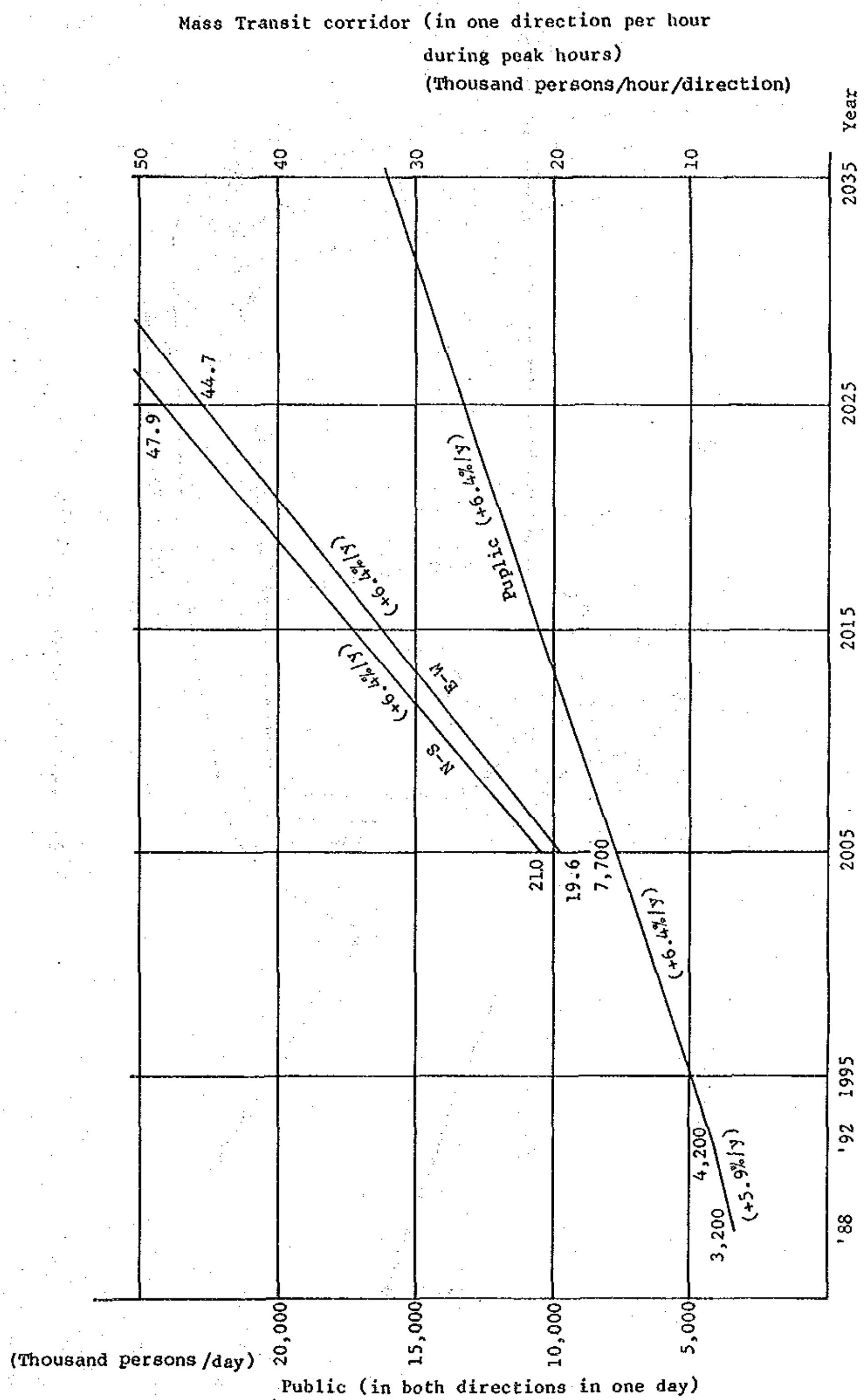


Fig. 5.4.5.3 Increase of Demand

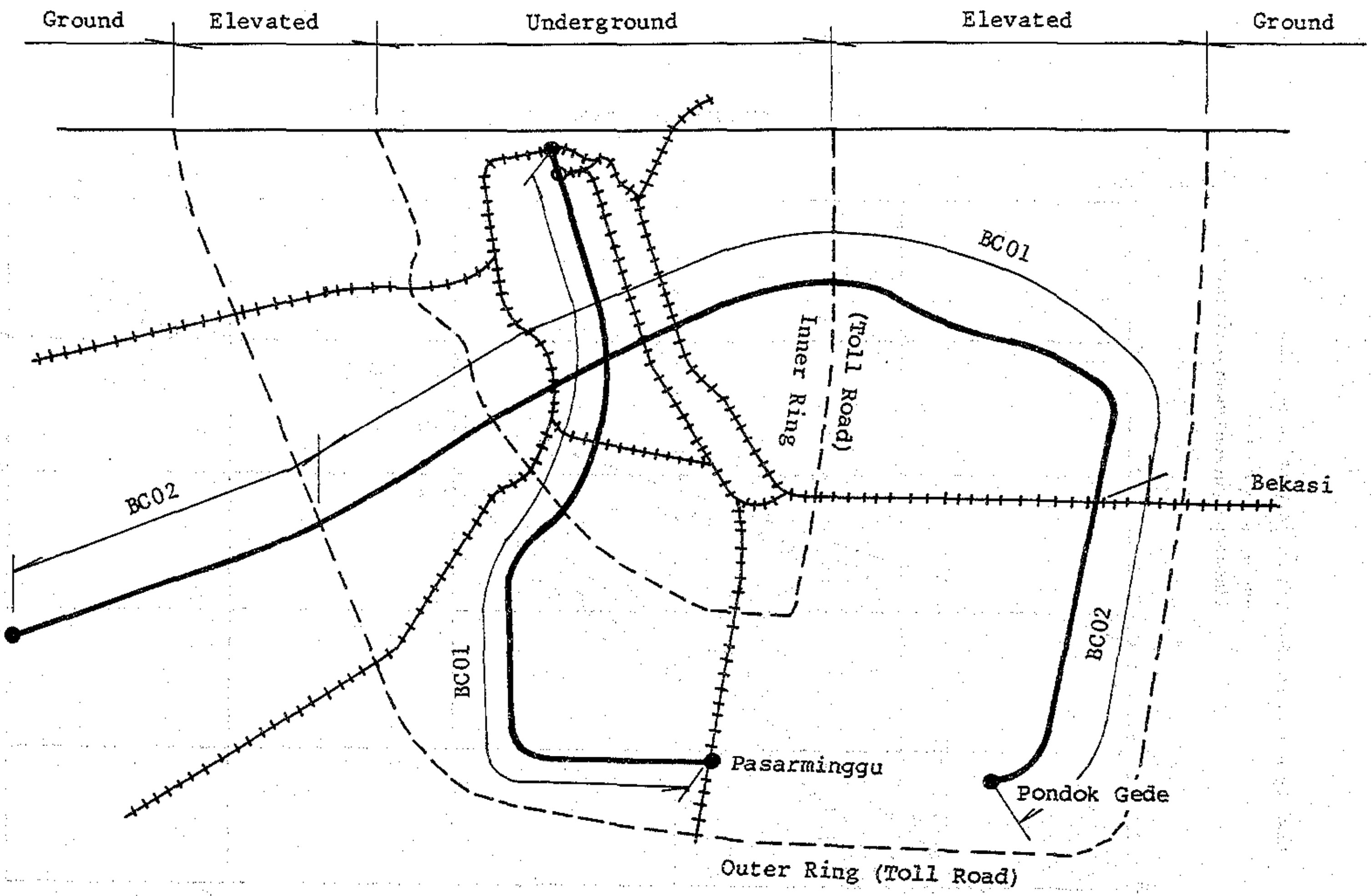


Fig. 5.4.5.4 Running Levels

For each system and each running level of Cases 1 and 2, the construction cost per km was determined in reference to the cases in Japan, then it was modified in consideration of the difference in the construction cost between Indonesia and Japan to suit to the condition in Indonesia, and assuming the service life for each component of the system and the annual interest rate of 6%, the annualized cost per km and then the annualized total cost was calculated for each system and per Case 1 and Case 2.

For the maintenance and operation cost, the cost per car-km in Japan was obtained for each system, then it was divided into the personnel and materials costs which were then corrected with the cost difference between Indonesia and Japan taken into account. The maintenance and operation costs thus obtained for the systems and the running levels of Cases 1 and 2 are shown in Tables 5.4.5.3 and 5.4.5.4.

For the cars of the respective systems, the annualized cost was calculated with the import price to Indonesia taken into consideration and the service life and annual interest rate assumed to be 25 years and 6% respectively.

Detailed examination of running levels for each system will be left to the F/S on the construction of MRT, and in the present study, the iron wheel systems (ordinary railway, linear motor and LRT) will be considered under Case 1, and the bus and rubber wheel systems (monorail and automatic guided transportation system) will be considered under Case 2 in consideration of:

a) Present condition of advancement of land utilization inside Inner Ring Road; and
b) Actual experiences up to the present of the running levels of the respective systems.

The costs of the systems are shown in Table 5.4.5.5.

Table 5.4.5.3 Costs of Systems Under Case 1 Running Levels

Items \ Systems	Bus		Monorail		Linear Motor		L R T		Automated guided transportaiton		Ordinary Railway	
	Elevated	Under-ground	Elevated	Underg-round	Elevated	Under-ground	Elevated	Under-ground	Elevated	Under-ground	Elevated	Under-ground
Route Extension (Double Tracks) (km)												
E - W			17.2	9.8	17.2	9.8	17.2	9.8	17.2	9.8	17.2	9.8
N - S			11.5	10.9	11.5	10.9	11.5	10.9	11.5	10.9	11.5	10.9
Total			28.7	20.7	28.7	20.7	28.7	20.7	28.7	20.7	28.7	20.7
Capital Cost (10^9Rp) (Excluding Vehicle)												
Constructive Cost/km			57.9	159.2	43.4	101.3	50.7	108.5	57.9	119.0	65.1	114.7
Capital Cost			4960		3710		4120		3340		4870	
Annualized Cost (*1)			317		238		264		214		312	
Vehicle Cost (10^9Rp)												
Number of Vehicles			509		652		254		1334		328	
Unit Vehicle Cost			2.00		1.68		2.92		1.00		1.85	
Vehicle Cost			1018		1100		742		1334		606	
Annualized Vehicle Cost (*2)			80		86		58		104		47	
Operation Cost (10^9Rp)												
Annualized Car-km (10^6Rp)				44.8		57.8		22.4		119.1		29.2
Operating Cost/Car-km			1950	2890	1310	1950	1880	2790	2060	3080	1310	1950
			2343		1578		2261		2487		1578	
Annual operating cost			105		91		91		296		46	
Annual total cost (10^9Rp)			502		415		372		614		405	
Annual passenger km (10^6 passenger-km)			4296		4296		4296		4296		4296	
Total Cost per passenger-km (Rp)			117		97		87		143		94	

(*1) Average service life: Elevated structure, 40 years; Underground structure, 50 years; Annual interest rate, 6%.

(*2) Car service life: Bus, 12 years; other vehicles, 25 years; Annual interest rate, 6%.

Table 5.4.5.4 Costs of Systems Under Case 2 Running Levels

Systems / Items	Bus	Monorail	Linear Motor	L R T	Automated guided transportation	Ordinary Railway
Route Extension (Double Tracks) (km)						
E - W	27	27	27	27	27	27
N - S	22.4	22.4	22.4	22.4	22.4	22.4
Total	49.4	49.4	49.4	49.4	49.4	49.4
Capital Cost (10^9 Rp) (Excluding Vehicle)						
Constructive Cost/km	14.5	57.9	50.7	57.9	43.4	65.1
Capital Cost	715.1	2860	2510	2860	2140	3220
Annualized Cost (*1)	47.2	189	166	189	141	212
Vehicle Cost (10^9 Rp)						
Number of Vehicles	890	509	652	254	1334	328
Unit Vehicle Cost (10^9Rp)	0.185	2.00	1.69	2.92	1.00	1.85
Vehicle Cost (10^9 Rp)	164.6	1018	1100	742	1334	606
Annualized Vehicle Cost (*2) (10^9 Rp)	19.6	80	86	58	104	47
Operation Cost (10^9 Rp)						
Annual Car-km (10^6 Rp)	68.2	44.8	57.8	22.4	119.1	29.2
Operating Cost/Car-km (10^9km)	854	1950	1310	1880	2060	1310
Annual operating cost	58.1	87	76	42	246	38
Annual total cost (10^9 Rp)	125	356	328	289	492	297
Annual passenger km (10^6 passenger-km)	4296	4296	4296	4296	4296	4296
Total Cost per passenger-km (Rp)	29	83	76	67	115	69

(*1) Average service life: elevated structure 40 years underground structure 50 years, annual interest 6%.

(*2) Service life of vehicle: Bus, 12 years, Other Vehicle, 25 years, annual interest 6%.

Table 5.4.5.5 System Cost

Systems / Items	Bus	Monorail	Linear Motor	L R T	Automated guided transportaiton	Ordinary Railway
Annualized Capital Cost (10^9 Rp)	47.2	189	238	264	141	312
Annualized Vehicle Cost (10^9 Rp)	19.6	80	86	58	104	47
Annual operating cost (10^9 Rp)	58	87	91	50	246	46
Annual total cost (10^9 Rp)	125	356	415	372	491	405
Total Cost passenger-km (Rp)	29	83	97	87	115	94

6) Social and other assessments

Social and other assessments will be made of (a) noise, (b) visual intrusion, (c) division of city and (d) air pollution, as representing the environmental aspect, as shown in Fig. 5.4.5.1. The running levels are different between the inside and the outside of the Inner Ring Road, and so the assessment will be made separately for the inside and the outside of the Inner Ring Road.

Assessment will also be made for the following.

(a) Possibility of meeting the increasing traffic volume in future.
(b) Possibility of interpenetrating operation with the existing railways.
(c) Extent of hazards to the road transportation.
(d) Any experience of maintenance in Indonesia.
(e) Reliability.
(f) Safety.

7) Comparison of the system characteristics

The criteria for the foregoing economic assessment and social and other assessments and the characteristics of the systems as compared with one another are as shown in Table 5.4.5.6 and 5.4.5.7.
For the demand in the order of 2005, the bus system is considered to be economically distinguished but is inferior to the other guided transportation systems in the environmental aspect, adaptability to the increasing demand in future, reliability and safety, and so the guided transportation systems are recommended for MRT of the Main Corridor in JABOTABEK Area.

8) Conclusion

From the forecasted demand in 2005, it is urgently required to construct some guided type MRT for the N-S and E-W Lines.

Table 5.4.5.6 Criteria for Assessment

Economic evaluation Cost/Passenger-km (Rp)	80 >	80 to 90	90 to 100	100 <
	◎	○	△	×
Social and other evaluation				
Noise	none ◎	very few ○	some △	heavy ×
Visual Intrusion	none ◎	very few ○	some △	to great extent ×
Division of City	none ◎	to a little extent ○	to some extent △	to great extent ×
Air Pollution	none ◎	a little ○	some △	heavy ×
Transport Capacity Passengers/hour/ one direction	>40,000 ◎	40,000 ≧ to 30,000 ○	30,000 ≧ >25,000 △	25,000 ≧ ×
Interpenetration with existing railways	possible ◎	almost possible ○	possible with some investment △	impossible ×
Extent of obstruction to road traffic	none ◎	a little ○	some △	heavy ×
Experience of maintenance technology in Indonesia	abundant ◎	some ○	very little △	none ×
Reliability	very good ◎	good ○	average △	poor ×
Safety	very good ◎	good ○	average △	poor ×

Table 5.4.5.7 Characteristics of the Systems

Item \ System	Bus	Monorail	Linear motor car	L R T	Automated guided transportation	Ordinary railway
Economic evaluation	◎	○	△	○	×	△
Social and other evaluations						
Noise						
Within innerring road	△	△	◎	◎	△	◎
Outside innerring road	○	○	△	△	○	△
Visual instrusion						
Within innerring road	△	△	◎	◎	△	◎
Outside innerring road	○	○	○	○	○	○
Division of city						
Within innerring road	△	△	◎	◎	△	◎
Outside innerring road	○	○	○	○	○	○
Air Pollution	△	◎	◎	◎	◎	◎
Transport Capacity	×	◎	○	○	○	◎
Interpenetration with existing railways	×	×	△	◎	×	◎
Hazards to Road Traffic						
Within innerring road	△	△	◎	◎	△	◎
Outside innerring road	○	○	○	○	○	○
Experience of Maintenance in Indonesia	◎	×	×	◎	×	◎
Reliability	△	◎	◎	◎	◎	◎
Safety	△	◎	◎	◎	◎	◎

For the sake of calculation of the annualized generalized cost for choice of the optimum pattern for Master Plan, any guided type system may be employed for the N-S and E-W Lines without much effect on the choice of optimum pattern. Thus, for the calculation of generalized cost LRT will be adopted which is considered to be excellent from the comprehensive view points as shown in Table 5.4.5.7.

A more detailed study concerning the choice of the system, including examination of the running levels, should be made in the stage of F/S.

5-5 Cost Estimation

Estimation of Construction Cost

Estimation of the construction cost was made according to the following.

(1) The engineering work cost was estimated as of 1989, and the subsequent rise of prices was not taken into account.

(2) The engineering work cost was estimated upon the existing investigation data and the data furnished by Indonesia.

(3) The imported machines and materials were assumed to be free from tax.

(4) The engineering work cost was classified into the foreign and local currencies.

(5) The engineering work cost includes the investigation, design and work management cost and reserve expense.

(6) The exchange rate was assumed to be Rp13.4=¥1 (April 1989).

Result of Estimation of Construction Cost

The construction cost is as shown in Table 5.5.1.1.

Table 5.5.1.1 Cost Estimation for Each Case

(1) Railway Case (Rp.Million)

IMPROVEMENT CASE	FOREIGN	LOCAL	Total
a b	823,800 1,393,100	256,700 340,300	1,080,500 1,740,400
R y - 1 R y - 2 R y - 3	2,093,450 2,940,660 3,840,130	389,900 817,400 933,200	2,483,350 3,758,060 4,773,330

(2) Base Case (Rp.Million)

IMPROVEMENT CASE		FOREIGN	LOCAL	Total
BC00	Road	438,800	421,600	860,400
	Total	438,800	421,600	860,400
BC01	Road	1,496,200	1,437,400	2,933,600
	Mass Transit	3,003,400	1,803,800	4,807,200
	Total	4,499,600	3,241,200	7,740,800
BC02	Road	1,496,200	1,437,400	2,933,600
	Mass Transit	3,748,600	2,165,200	5,913,800
	Total	5,244,800	3,602,600	8,847,400

CHAPTER 6 TRANSPORTATION DEMAND FORECAST

Chapter 6 Transportation Demand Forecast

6-1 General

6-1-1 Objective

The objectives of transportation demand forecast in this study is to estimate future transportation demand within the JABOTABEK Area regarding effects caused by the various transportation improvement options. They are the option b of railway improvement by 1992, road development projects, the mass transit system developments, road traffic constraint policies and the railway improvement packages.

Transportation demand forecast models were developed to cope with the needs of this study. The results of the forecast are the bases of the subsequent works such as facility planning and economic/financial analysis.

6-1-2 General Procedure

Future transportation demand in JABOTABEK Area was estimated sequentially based on the steps shown in Fig. 6.1.2.1.

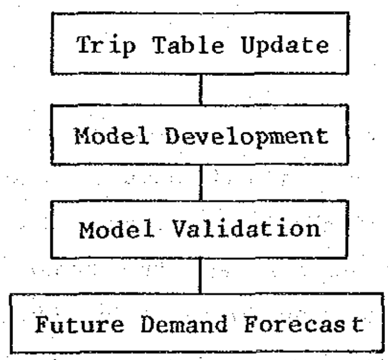


Fig. 6.1.2.1 Procedure of Demand Forecast

The first step is to update person trip tables developed by ARSDS study by JICA. It has been more than three years since the tables were made. This step aimed to develop 1988 trip tables in order to establish reliable demand forecast models for this study.

Supplementary screen line surveys were conducted to obtain the information of the existing demand.

The second step is to develop demand forecast models for this study. They were developed through analyses of the estimated 1988 OD tables, zonal socio-economic characteristics and transportation networks within the area.

The third step is a model validation. The models developed in the second step were tested by comparing the estimated and observed traffic volume by mode. In this procedure, the estimated trip tables for public modes were modified. The revised models were developed based on these modified trip tables. The demand forecast system comprising the above developed models was finalized through this model validation step.

The forth step is to forecast future transportation demand. Future socio-economic framework and future transportation networks including alternative improvement options were prepared for the projection.

6-2 Model Development

6-2-1 Preconditions

(1) Trips analyzed and forecasted

Trips analyzed and forecasted in this study are the trips within DKI Jakarta, the trips between DKI Jakarta and Botabek and the trips between DKI Jakarta and the other areas. So, the trips within Botabek and the trips between Botabek and the other areas were excluded from this study. Those excluded trips were considered to have a smaller importance compared with the trips dealt with in this study.

(2) Data base

The ARSDS (Arterial Road System Development Study in Jakarta Metropolitan Area by JICA) was adopted as a data base of this study. The ARSDS developed various person trip and vehicle trip tables through field surveys including a person trip survey within JABOTABEK Area.

(3) Modes

Modes considered in this study are railway, buses, mass transit system, motorcycles and sedans. The former three modes were treated as a public mode, while the others as a private mode. Trucks were also considered as a freight transportation mode other than the above modes.

(4) Trip purposes

Only all purpose trips were analyzed and forecasted. Trip purpose, such as work, business, shopping and so on, was ignored. Effects by an increase of a particular trips could not be analyzed. These were grasped as a whole.

(5) Peak period demand

Only all day trips were analyzed and forecasted. It means that traffic congestion at peak period could not be analyzed. But, a mode split model developed in this study was integrated with a traffic assignment procedure as described later. The effects of road congestion during the peak periods were considered to reflect the mode split between railway and bus through the procedure.

(6) Traffic zones

The JABOTABEK Area were divided into 113 traffic zones, while the other area were divided into 17. The traffic zone system is the same as ARSDS. Fig. 6.2.1.1 and 6.2.1.2 show the traffic zones of DKI Jakarta and Botabek respectively.

(7) Trips by private and public modes

Trips by private modes were not analyzed and forecasted in this study. The Outer Ring Road Study projected future vehicle trip tables based on its revised traffic count surveys conducted in 1988. Its socio-economic framework was considered to be the same as this study.

The study team made use of the results of the above study, and concentrated to forecast the trips by public modes.

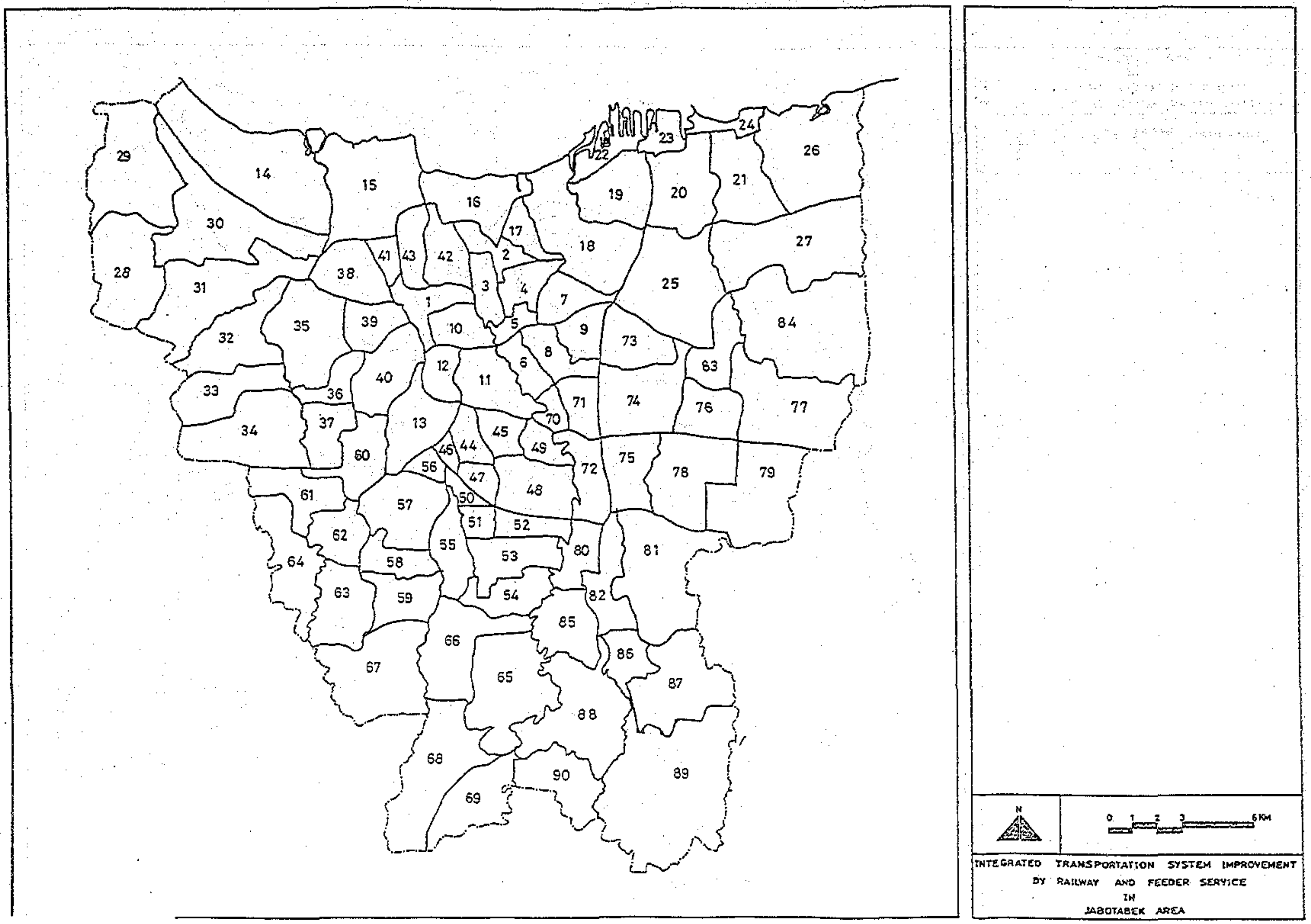


Fig. 6.2.1.1 Traffic Zones for DKI Jakarta

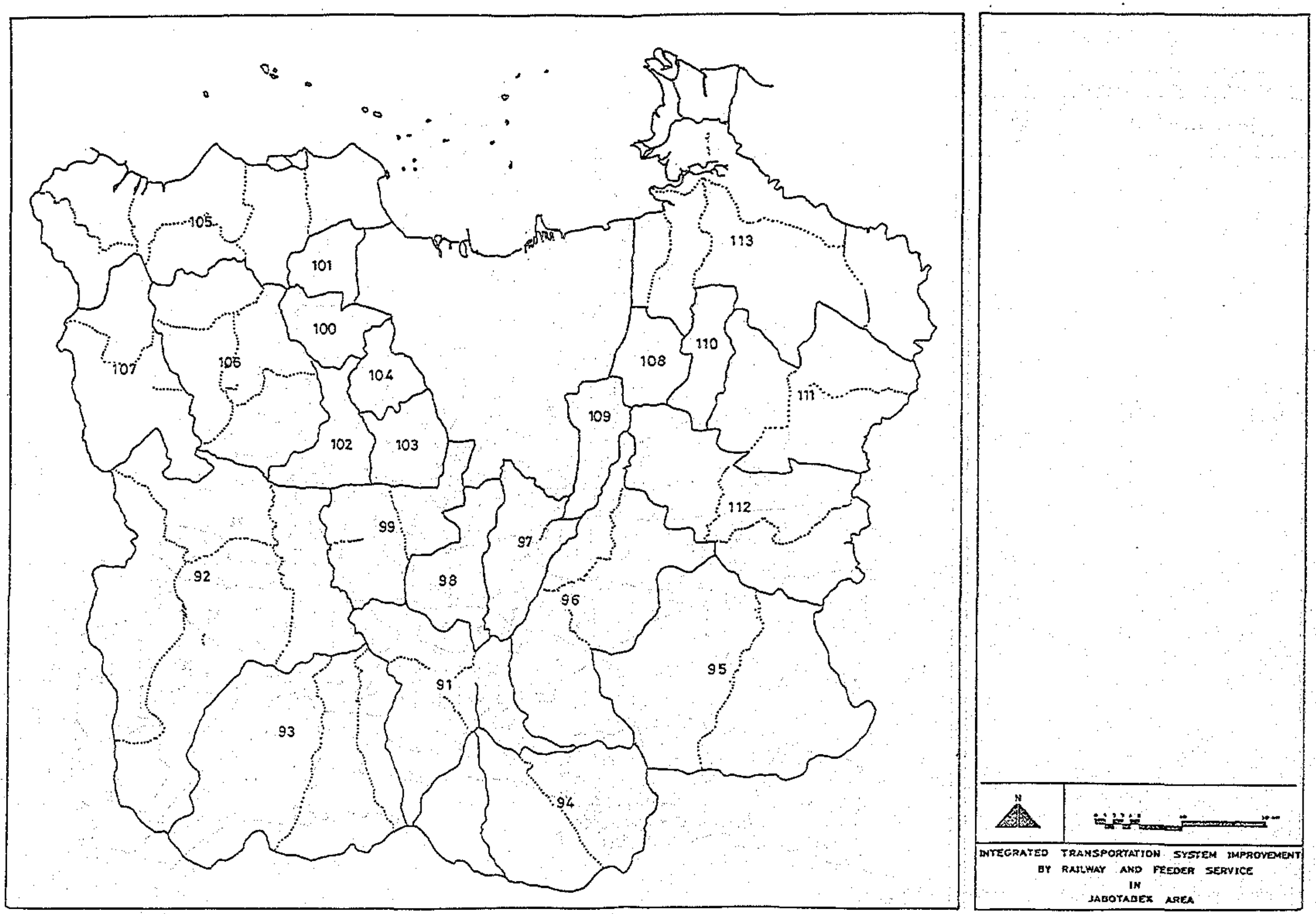


Fig. 6.2.1.2 Traffic Zones for Botabek

6-2-2 Forecasting System

(1) General

Fig. 6.2.2.1 shows a general procedure of the forecasting system development adopted in this study.

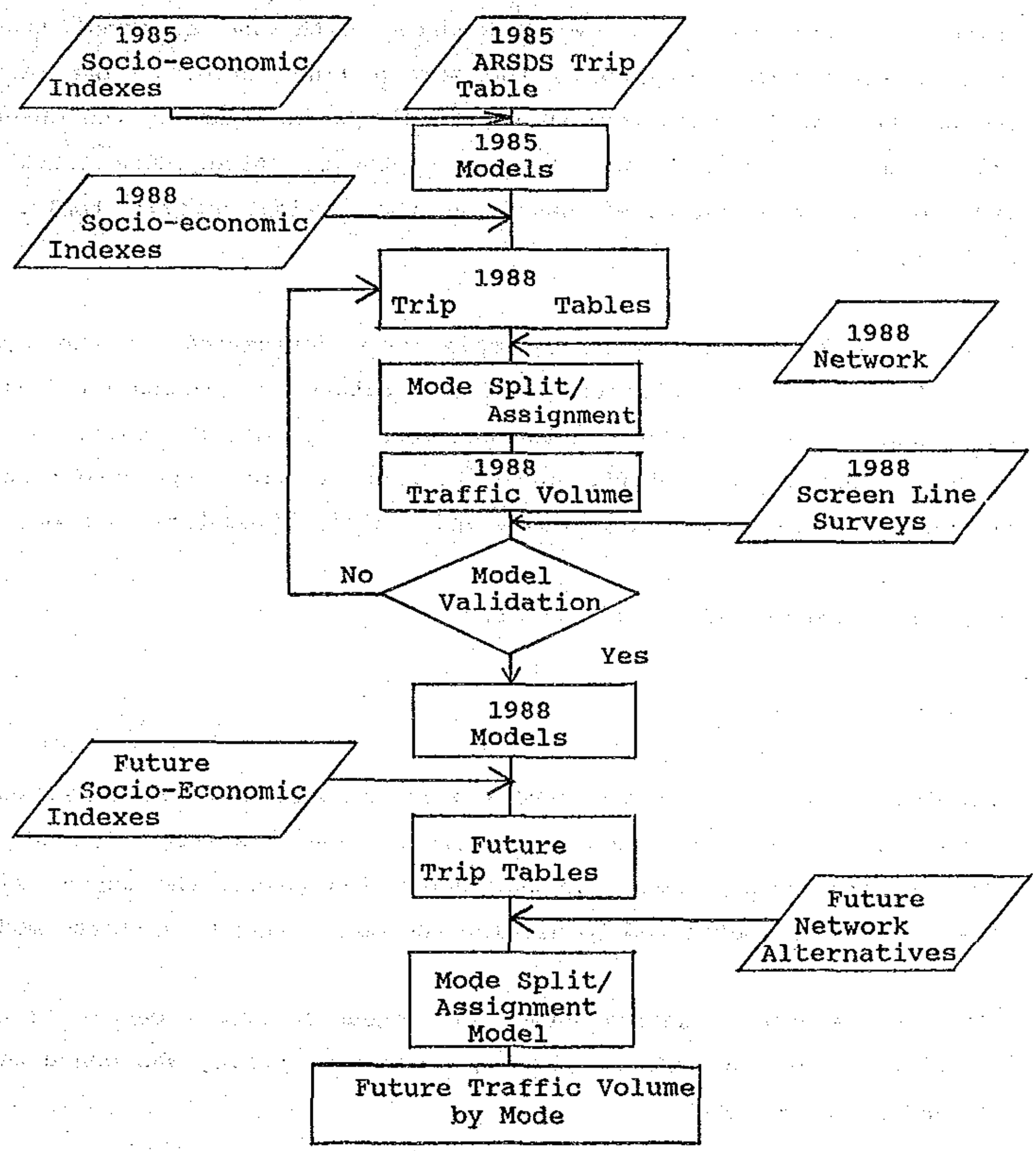


Fig. 6.2.2.1 General Flow Chart of Forecasting System Development

The development work was commenced by model buildings based on 1985 ARSDS trip tables and socio-economic indexes in 1985. By using these models and socio-economic indexes in 1988, 1988 trip tables were estimated tentatively. The feedback routine shows that these tables were revised by an iterative procedure. The trips of the estimated 1988 trip tables were divided by a mode split model into railway and bus according to the levels of service of these two modes. Then, the trips were assigned to each network by mode. The assigned traffic volumes at selected links were compared with the observed traffic volumes which were obtained by the screen line surveys. The railway and bus trip tables were revised repeatedly to be equal to the observed values until the differences became acceptable. After this iteration, 1988 models were estimated based on the validated trip tables and networks.

Future transportation demand by mode were forecasted by the system consisting of these validated models. Future socio-economic indexes and future transportation networks were the major inputs of the system. The major outputs were traffic volumes, passenger-hours, passenger-kilometers, vehicle-hours and vehicle-kilometers by mode.

(2) Trip table update and model validation

1) Supplementary surveys

Supplementary screen line surveys were conducted at selected points regarding railway and bus passengers. These surveys intended to clarify the actual number of passengers who passed the screen lines. The results were utilized to develop the models and to validate models.

The bus passenger counting survey was conducted from December 13 to 15 in 1988, while the railway passenger counting survey was conducted on 20 and 21 of December.

The number of bus passengers on board was counted by surveyers at each survey points. The number of buses by vehicle type was counted at the same time as well.

Table 6.2.2.1 Bus Passenger Counting Survey Results

(Both direction per day)

Survey Point	Large Bus		Medium Bus		Small Bus		Total	
	passenger	vehicle	passenger	vehicle	passenger	vehicle	passenger	vehicle
1. Jl. Daan Mogot	(19,536) 29.041	(499) 688	4.789	195	36.013	4.375	69.843	5.258
2. Jl. Gajah Mada	132.028	2.674	257	14	30.250	4.020	162.535	6.708
3. Jl. Gunung Sahari	46.172	1.121	42.908	2.812	34.166	6.514	123.246	10.447
4. Jl. Sudirman	202.647	3.691	18.397	1.191	-	-	221.044	4.882
5. Jl. Srengseng	14.217	338	49.253	2.984	9.228	1.020	72.698	4.342
6. Jl. Raya Bogor	(9.907) 24.873	(237) 612	48.220	1.994	33.486	6.326	106.579	8.932
7. Jl. Tol Jagorawi	(7.310) 34.849	(177) 662	3.948	137	1.307	175	40.104	974
8. Jl. Tol Pondok Gede	23.960	577	56	3	32	3	24.048	583
9. Jl. Kalimalang	460	16	420	31	31.170	3.838	32.050	3.885

Note: Figures in parentheses indicate the number of passengers and vehicles of long distance bus services.
Source: DLLAJR Long Distance Bus Survey
: Bus Passenger Counting Survey by the study team

The survey was conducted only on city bus passengers such as PPD, Patas, Metro Mini, Kopaja, Microlet and etc., since it was very difficult to count long distance bus passengers through darkened bus windows. The number of the passengers were incorporated according to the DLLAJR's long distance bus survey conducted in 1987. The number of bus vehicles surveyed was compared with the other surveys and it was considered acceptable. The survey results are summarized in Table 6.2.2.1.

The number of railway passengers was counted at selected survey stations by train. The surveyors counted the number at the stations just before the train departed. The survey days were, however, stormy with severe rain and flood all over the area. The results of survey showed less number of railway passengers than anticipated. The surveyors reported information from PJKA station officials that the number was very small compared with an average weekday. The study team abandoned to utilize the railway survey results, after careful examinations of collected data. Instead of the survey, the study team decided to use the ARSDS railway passenger counting survey results by extrapolating the number with a growth rate of passengers derived from PJKA's ticket selling reports within JABOTABEK Area. The estimated number of railway passengers is shown in Table 6.2.2.2 together with the results of ARSDS survey.

Table 6.2.2.2 Estimated Railway Passenger Number at the Selected Section (All day, both directions)

Section	Line	1985 ARSDS	1988 Estimates
Kalideres	Tangerang	2305 (6969)	2484 (7510)
Sudimara	Serpong	12949	13953
Lenteng Agung	Bogor	36087 (23709)	38886 (25548)
Cakung	Bekasi	11528	12422

Note: Figures in parentheses are medium and long distance train passengers.

2) Network development

Three kinds of transportation network were developed to represent level of services in 1988 by mode. They are road, bus and railway network. These networks were prepared to assign trips for the validation as well.

The road network was developed to represent a basic transportation network. It includes major arterial roads, secondary roads and tollways in a form of "link" and "node" to be processed by computer. It also includes QV parameters to calculate vehicle operating speed which corresponds to the traffic volume on each road link.

The bus network was generated by computer based on information on bus routes and the above road network. The bus routes, consisting of more than 300 routes, were tied up into 186 representative routes for the analysis with a careful attention. Information on service levels of bus transportation, such as bus routes, waiting time, transfer time and bus fare were prepared for the analysis. The operating speed of bus was derived from a relationship between bus and other vehicle speed. The speed of the other vehicles were calculated through a capacity restraint assignment procedure by each road link. The relationship, which was quoted from "Traffic Restraint and Parking Policy Studies" in 1987 by Pamintori, Buchanan and others, was shown as a following equation.

$$VB = 1.201 \times V^{0.831}$$

where,

VB : operating speed of buses

V : other vehicles speed from the QV curves

The network also includes corresponding road link information to obtain a total link traffic volume on each road.

The travel cost by bus was calculated by using the following fare rates per one ride except long distance buses. These figures were weighted average fares by bus type derived from information of DLLAJR.

Large Bus	Rp.239
Medium Bus	Rp.200
Small Bus	Rp.183
Long Distance Bus	Rp.10.4 per km

The railway network consists of railway link, station node, platform node, transfer link, terminal node and line information. The network includes the bus net work described above. Railway passengers can use the bus network as an access and egress transportation mode.

The travel time by railway consists of a line haul time, waiting time, transfer time and terminal time for intermodal transfer. The line haul time was calculated according to the operating speed of trains. The waiting time was calculated according to the number of trains in service in a day. The transfer time was assumed to 10 minutes for one transfer. The terminal time for intermodal transfer is estimated according to the results of the field surveys on station facilities and feeder services conducted in this study.

The travel cost by railway was calculated according to the following equations which were derived from fare tables of PJKA.

JABOTABEK Trains: Rp.200 + Rp. 6.67 x distance (km)
Medium and Long
Distance Trains: Rp. 11.137 x distance (km)

These three networks were integrated into one network owning road network nodes jointly. Railway passengers can transfer to bus network and bus passengers can also transfer to railway. Typical network diagrams are shown from Fig. 6.2.2.2 to 6.2.2.4.

3) Methodology

As described before, the methodology to update trip tables have a close relation to model building and model validation. Fig. 6.2.2.5 shows a detailed procedure of trip table update, model building and model validation.

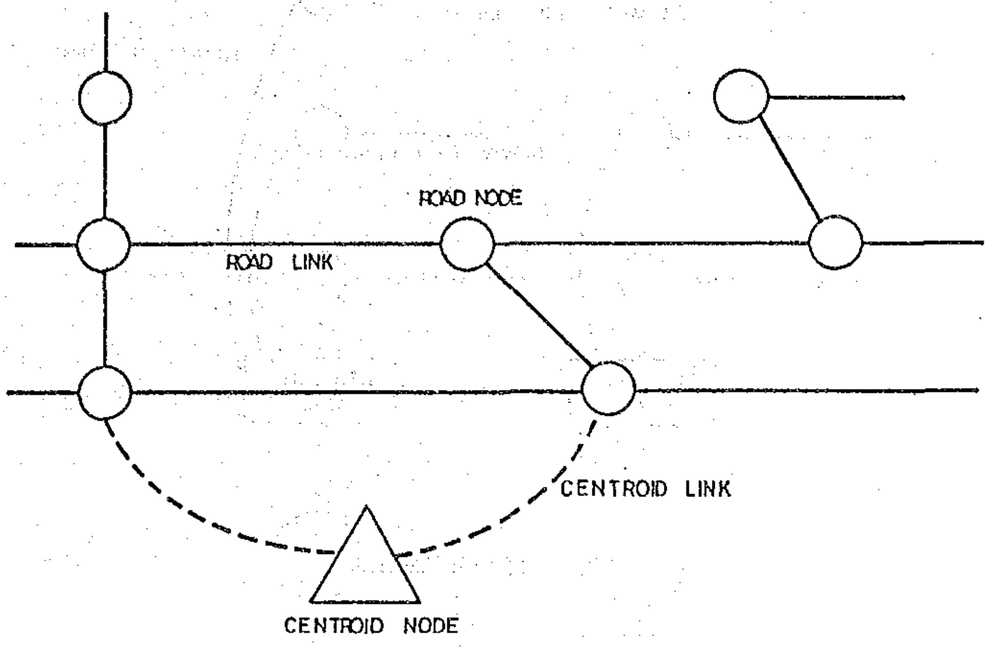


Fig. 6.2.2.2 Conceptual Diagram of Road Network

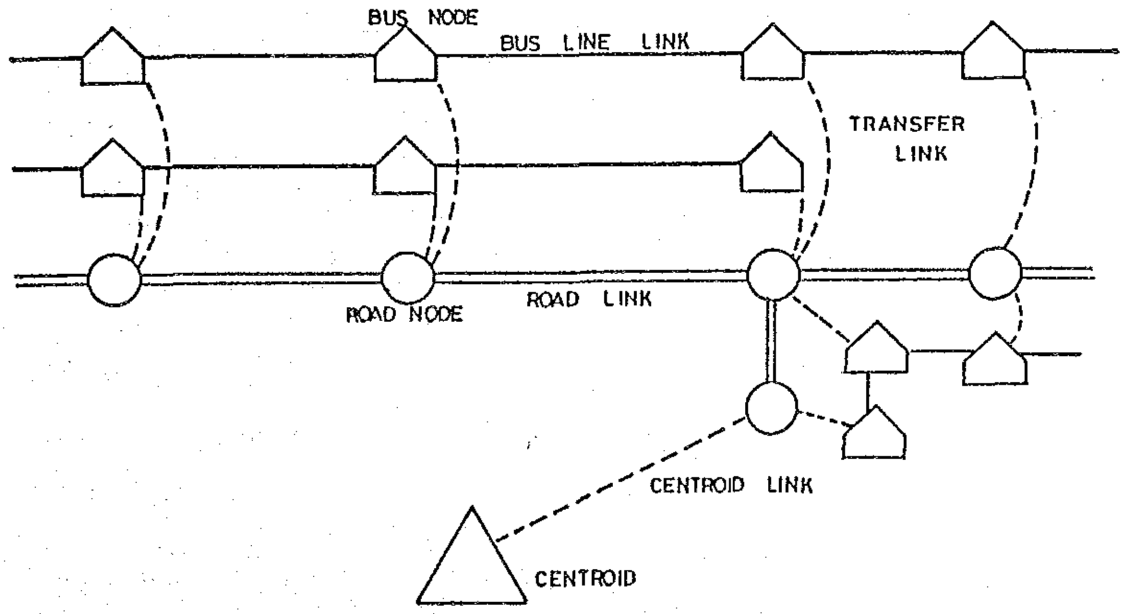


Fig. 6.2.2.3 Conceptual Diagram of Bus Network

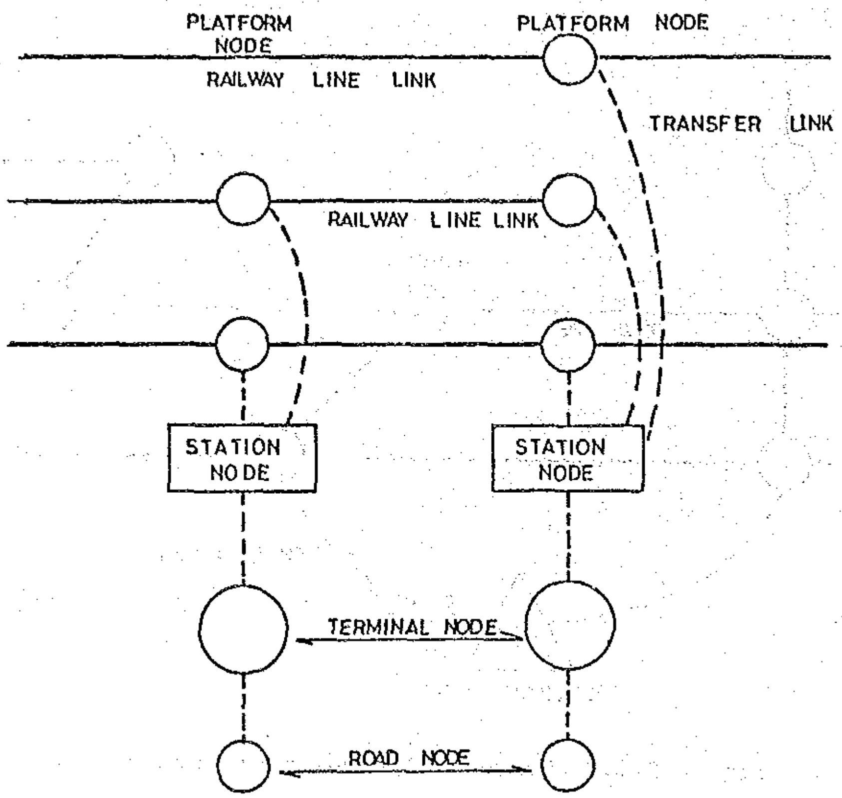


Fig. 6.2.2.4 Conceptual Diagram of Railway Network

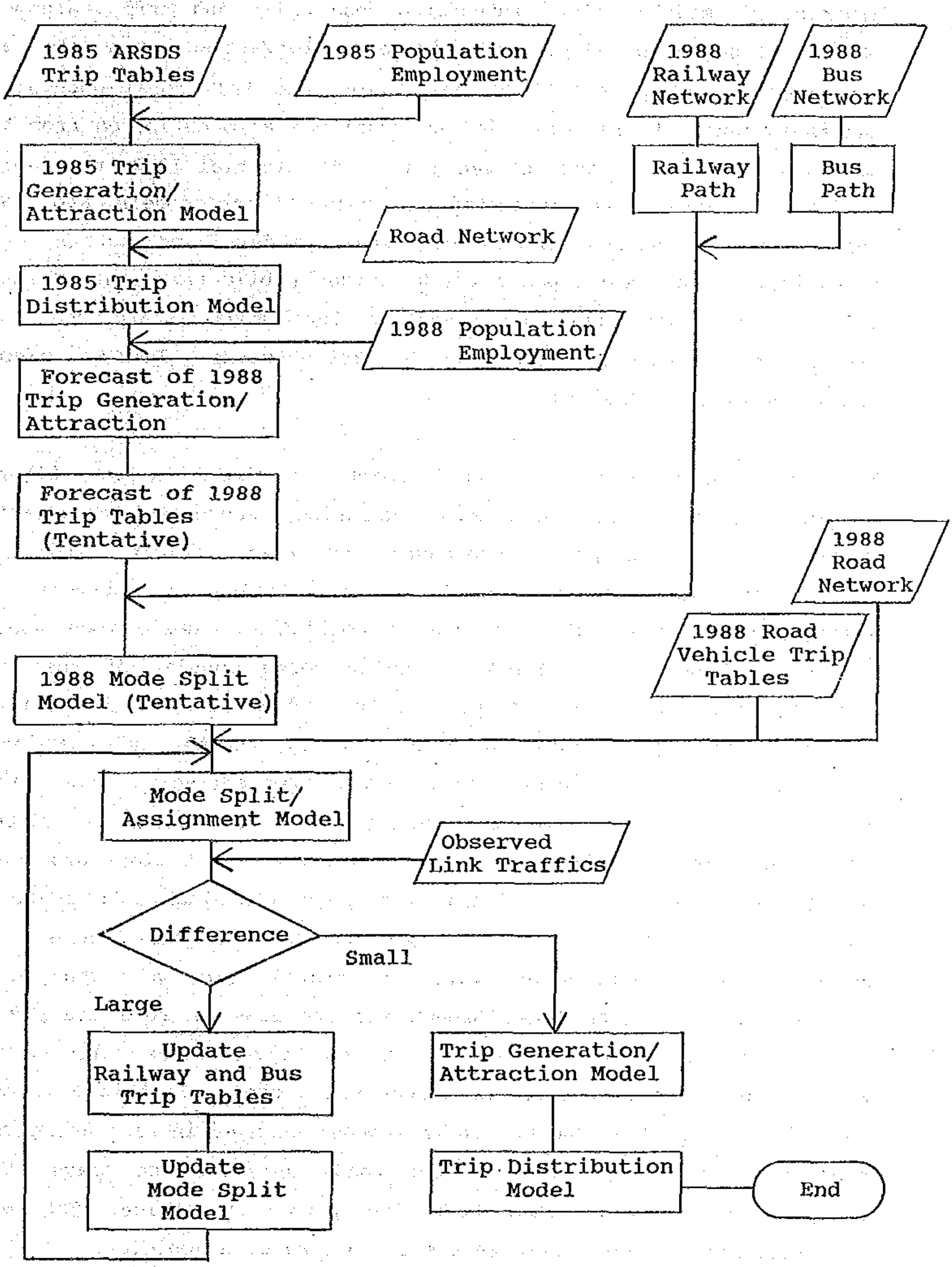


Fig. 6.2.2.5 Model Validation and Update of Trip Tables

The models were developed based on a conventional four step procedure in this study. They are trip generation/attraction models, trip distribution models and an integrated mode split and trip assignment model. As shown in the figure, trip generation/attraction models were estimated by using 1985 ARSDS trip tables and 1985 zonal population and employment. A trip distribution model was also estimated from the tables and road distances between zones. The initial 1988 trip tables for public mode were estimated by using these models and 1988 socio-economic indexes of zones. These models and tables were tentative. A mode split model which divides public trips into railway and bus mode was estimated based on 1985 modal share and 1988 explanatory variables derived from the 1988 networks. This was also a tentative mode split model.

The mode split/assignment model, which is shown in the figure, consists of the mode split model described above and a capacity restraint trip assignment procedure for road vehicles including buses. The input of the model is trip tables and networks by transportation mode. The trip tables consist of public mode users, motorcycles, sedans and trucks. The networks consist of the road network including the QV information, the bus network and the railway network. The trip tables were divided by three, and they were assigned to the networks three times respectively. In every assignment step, the mode split model splits the public mode trip table into bus and railway trips according to travel times and costs of both modes which were calculated through a minimum path route of each network. The routes were not changed in these three time assignment for public modes, while the travel times were changed by the QV curves of each link through the increase of road traffic in each assignment step. The change of the travel times affected the mode split at the successive next mode split step. In this way, mode split between railway and bus in this model changes in each assignment step mentioned above. As for the road vehicles, the travel time change on each link affected the minimum path route choice. The route were searched in every assignment step for the road vehicles.

The mode split/assignment model assigns traffic volume on each transportation link. The results were compared with the results of the screen line surveys. If the difference between the results of the model and the observed traffic volume is sufficiently small, it can be said that the models were validated and that the trip tables were updated. If the difference is not small, the railway and bus trip tables are modified in a manner described below.

Suppose Ak is an observed railway traffic on k-th link, EK is an assigned railway traffic on the k-th link and Mu is an updating coefficient for railway trip table, the Mu is calculated as follows:

$$Mu = \left(\sum_{k=1}^{n} Ak \times Ek\right) / \sum_{k=1}^{n} (Ek)^2$$

The Mus were calculated for the railway and bus trip tables respectively. The trip tables were updated by the Mus. The mode split model was also updated since the share between railway and bus has changed through the trip tables update.

In this manner, the model validation and the trip table update procedures were carried out repeatedly until the difference between the assigned and observed the traffic volumes became sufficiently small. Table 6.2.2.3 shows the final results of the model validation. The trip generation/attraction models and the trip distribution model were developed by using these updated trip tables finally.

(3) Models

1) Trip generation/attraction model

Trip generation of i-th zone is defined as total trips originating from the i-th zone. The trip generation of the i-th zone is a total of trips in i-th row of a trip table. Trip attraction of j-th zone is defined as total trips terminating at the j-th zone. The trip attraction of the j-th zone is a total of j-th column of a trip table.

Table 6.2.2.3 Observed and Estimated Traffic on Selected Links

Link	Mode	Observed	Estimated	Est./Obs.
Univ. Indonesia - Depok	Railway	38886	45984	1.182533
Cakun - Bekasi	Railway	37970	41874	1.102818
Bintaro - Sudimara	Railway	21463	10624	0.494991
Pesing - Rawabuaya	Railway	2484	12213	4.916666
Daan Mogot	Bus	69843	28802	0.412382
Gajah Mada	Bus	162535	167883	1.032903
Gunun Sahari	Bus	123246	141730	1.149976
Sudirman	Bus	221044	163623	0.740228
Serengseng, Raya Bogor, Tol Jagorawi	Bus	219381	250347	1.141151
Tol Pondok Gede, Kalimaran	Bus	56098	182260	3.248957
Daan Mogot, Tol JKT Merak	Road	102983	77427	0.751842
Raya Bogor, Tol Jagorawi	Road	113224	89959	0.794522
Parman	Road	145862	86185	0.590866
Sudirman	Road	187576	197738	1.054175
Tol. JKT Bekasi, I.S.JKT Timur	Road	50895	83490	1.640436
Martadinata	Road	71213	53839	0.756027
Gajahmada	Road	98319	159999	1.627345
Kramat Raya	Road	138011	97153	0.703951
Sudarso	Road	76805	114325	1.488509

Note: Estimated and observed traffic volumes of road vehicles are shown in PCU.

Trip generation and attraction models were developed through analyses of relationships between the zonal trip generation/attraction and zonal socio-economic indexes. Fig. 6.2.2.6 and 7 show these relationships with zonal employment and population regarding DKI Jakarta zones respectively. Fig. 6.2.2.8 and 9 show the relationship with zonal population regarding Botabek zones and other area zones.

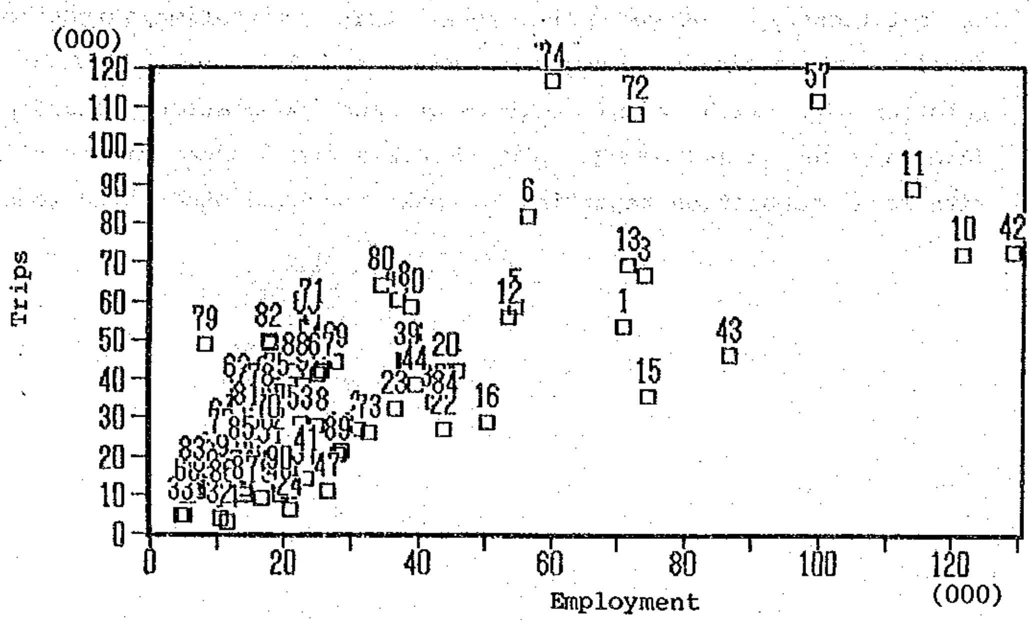


Fig. 6.2.2.6 Relationships Between Trip Generation/Attraction and Employment (DKI Jakarta)

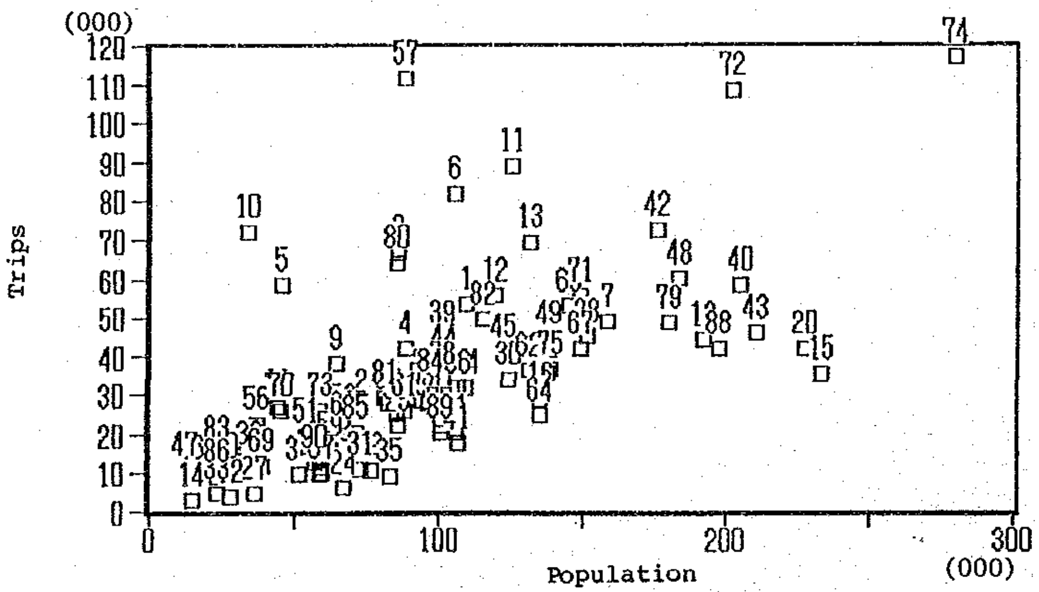


Fig. 6.2.2.7 Relationships Between Trip Generation/Attraction and Population (DKI Jakarta)

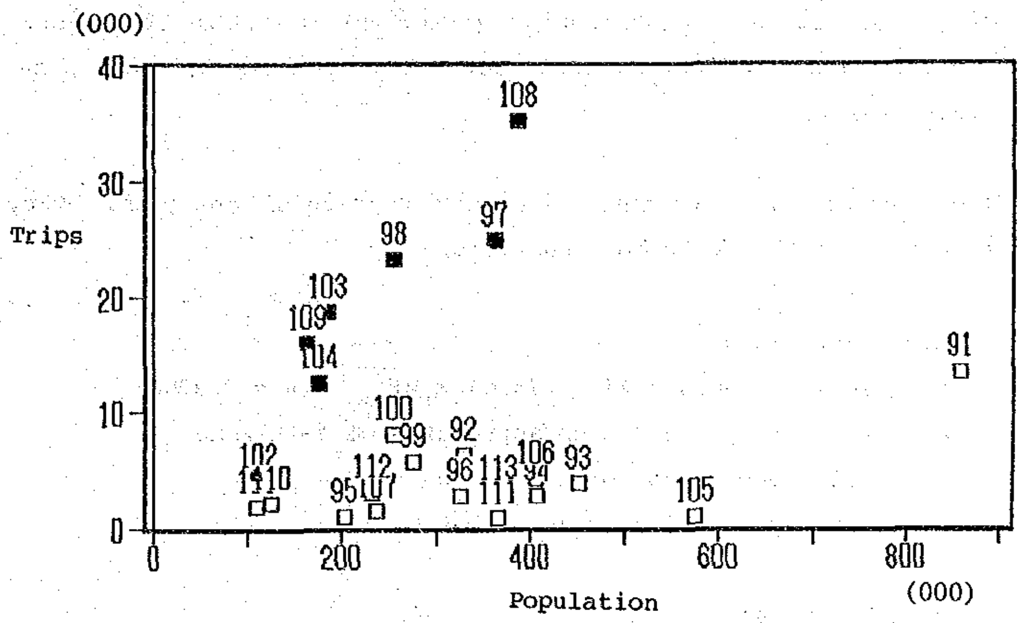


Fig. 6.2.2.8 Relationships Between Trip Generation/Attraction and Population (Botabek)

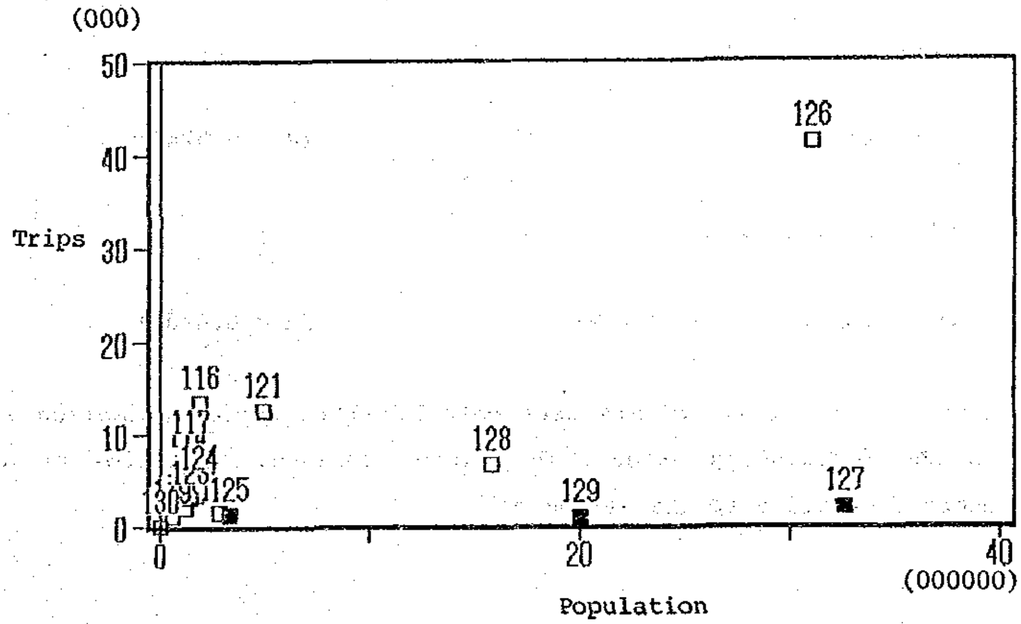


Fig. 6.2.2.9 Relationships Between Trip Generation/Attraction and Population (other area)

Five trip generation/attraction models were developed considering the difference of the relationships (refer to the above figures). They are the models for DKI Jakarta, Botabek 1, Botabek 2, other area 1 and other area 2.

These models were estimated through regression analyses. They were expressed as the following equations.

- DKI Jakarta Model

$$Gi = 820.75 + 558.6 \times Ei + 175.66 \times Pi \qquad (R = 0.8288)$$

where, Gi : trip generation/attraction of i-th zone

Ei : employment of i-th zone

Pi : population of i-th zone

- Botabek 1 Model

$$Gi = -512.76 + 82.60 \times Pi \qquad (R = 0.9103)$$

- Botabek 2 Model

$$Gi = 895.35 + 7.23 \times Pi \qquad (R = 0.5053)$$

- Other area 1 Model

$$Gi = 1985.75 + 0.7651 \times Pi \qquad (R = 0.8244)$$

- Other area 2 Model

$$Gi = 755.70 + 0.0080 \times Pi \qquad (R = 0.4453)$$

Zone specific coefficients were calculated to avoid estimation errors in the forecasting stage. They were expressed as ratios of actual numbers of trips to the estimates.