Chapter 4

DEMAND FORECAST

Chapter 4 DEMAND FORECAST

This chapter deals with the ridership projection. The transport planning, facilities planning and economic/financial analysis are conducted based on the results of this projection. Various studies have been conducted regarding the urban transport of the Klang Valley area. Each of them includes traffic demand forecast. Among them, JICA M/P 87 is considered as the latest and most comprehensive. The present study followed it in general methodology, but the socio-economic framework and land-use plans have been reviewed and the latest information were taken into the calculation. The modal split was reassessed considering the new DMU and feeder-bus service. And the traffic was reassigned to the new transport network (including LRT, Monorail) planned in the present RBCS study. Traffic flow between Klang Valley and Seremban areas was newly estimated by applying the reviewed population and employment data to the model developed in JICA M/P 87. Fig. 4-1-1 shows the relationship between the present study and JICA M/P 87.

4-1 Forecasting Steps

4-1-1 Forecasting Procedure

Forecasting was made by the following process;

① Estimate the new category-wise trip production in Klang Valley area applying the new population/employment data. (The categories are set up according to car-ownership, employment status and to trip purposes. Each of them is given a certain ratio, based on survey in JICA M/P 87. The same ratio was used in the said estimation). Refer to 4-2-1.

② Adjust the ratio of public/private mode. The adjustment is made according to the trips classified by traffic mode. Refer to 4-4-1. The classified trips by traffic mode were forecasted in JICA F/S 89.

③ Calculate the interzonal-trip ratio against the total trip production, excluding the intrazonal-trips from the OD matrix. Each control total is calculated with the public/private mode. Refer to 4-3-2.

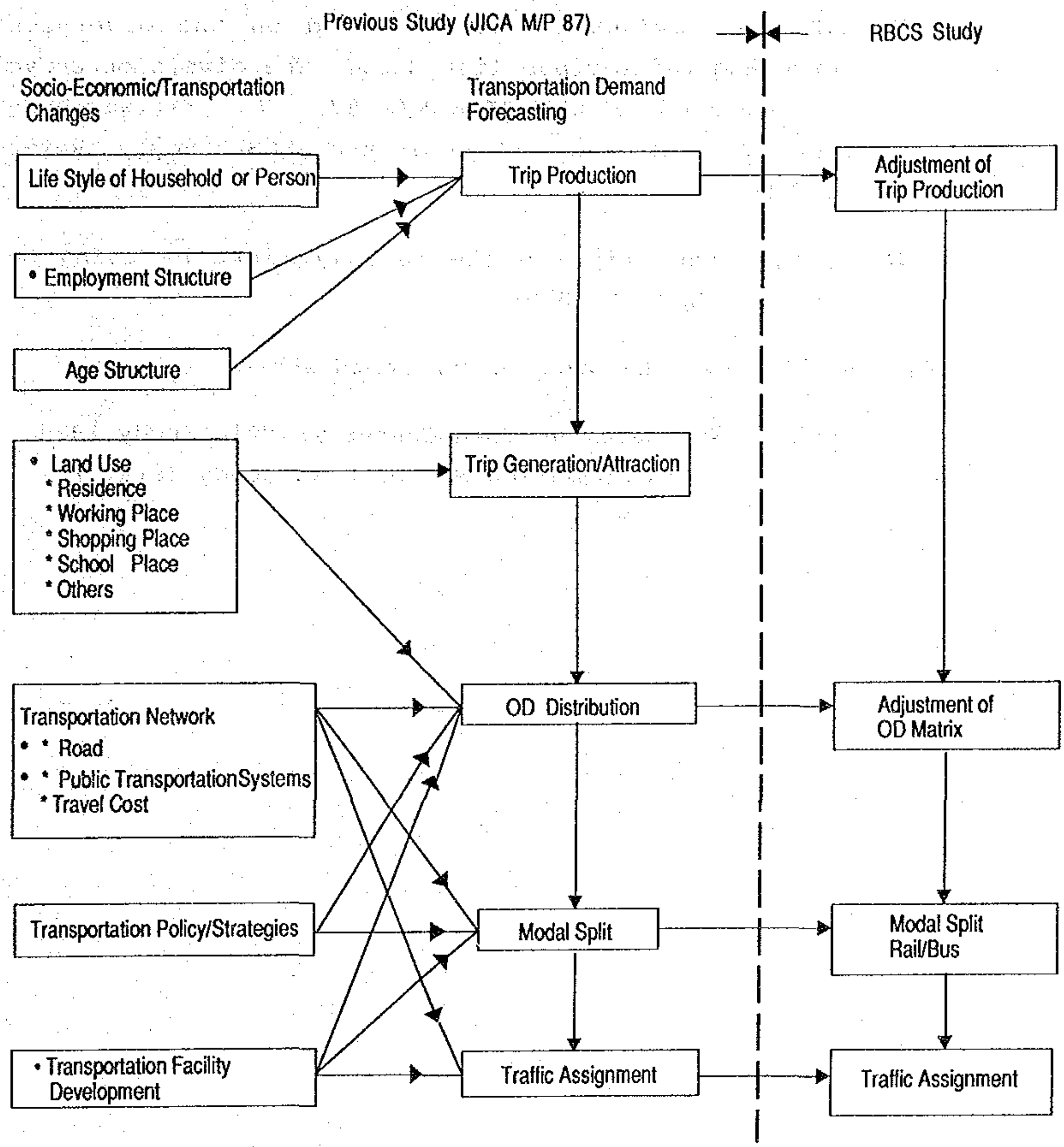
④ Consolidate the 166 zones of JICA M/P 87 into 54 zones of the RBCS Study, formulate a new OD matrix and classify it into public/private OD matrixes. Refer to 4-1-3(2).

⑤ Calculate the parameters of each gravity model for the private/public OD matrix to estimate the trip distribution to/from Negeri Sembilan. Refer to 4-4.

⑥ Calculate the trip production in Negeri Sembilan area. The trip distribution is estimated based on the foregoing transportation studies*. The trips to/from K.L. are assessed by use of the traffic volume on Cordon line. Refer to 4-4.

⑦ Calculate trip distribution to/from KL with the gravity model. Refer to 4-4.

⑧ Prepare the RBCS OD matrix from the Klang Valley and Negeri Sembilan OD matrixes. Refer to 4-4.



Note: Items marked with·were updated by RBCS study

Fig.4-1-1 Basic Approach of RBCS Traffic Demand Forecast

⑨ Make railway/bus OD matrix based on the diversion curve and railway bus-link data. The diversion curve was prepared in the JICA M/P 87. The railway-bus-link data are newly set up in the RBCS Study. Refer to 4-5-1.

⑩ Assign the trips to the railway links by using OD matrix. Refer to 4-5-2.

Fig. 4-1-2 shows the process mentioned above.

* Note to ⑥ - Seremban Town Center Traffic Study 1985
- N. Sembilan Master Plan Study (Draft)

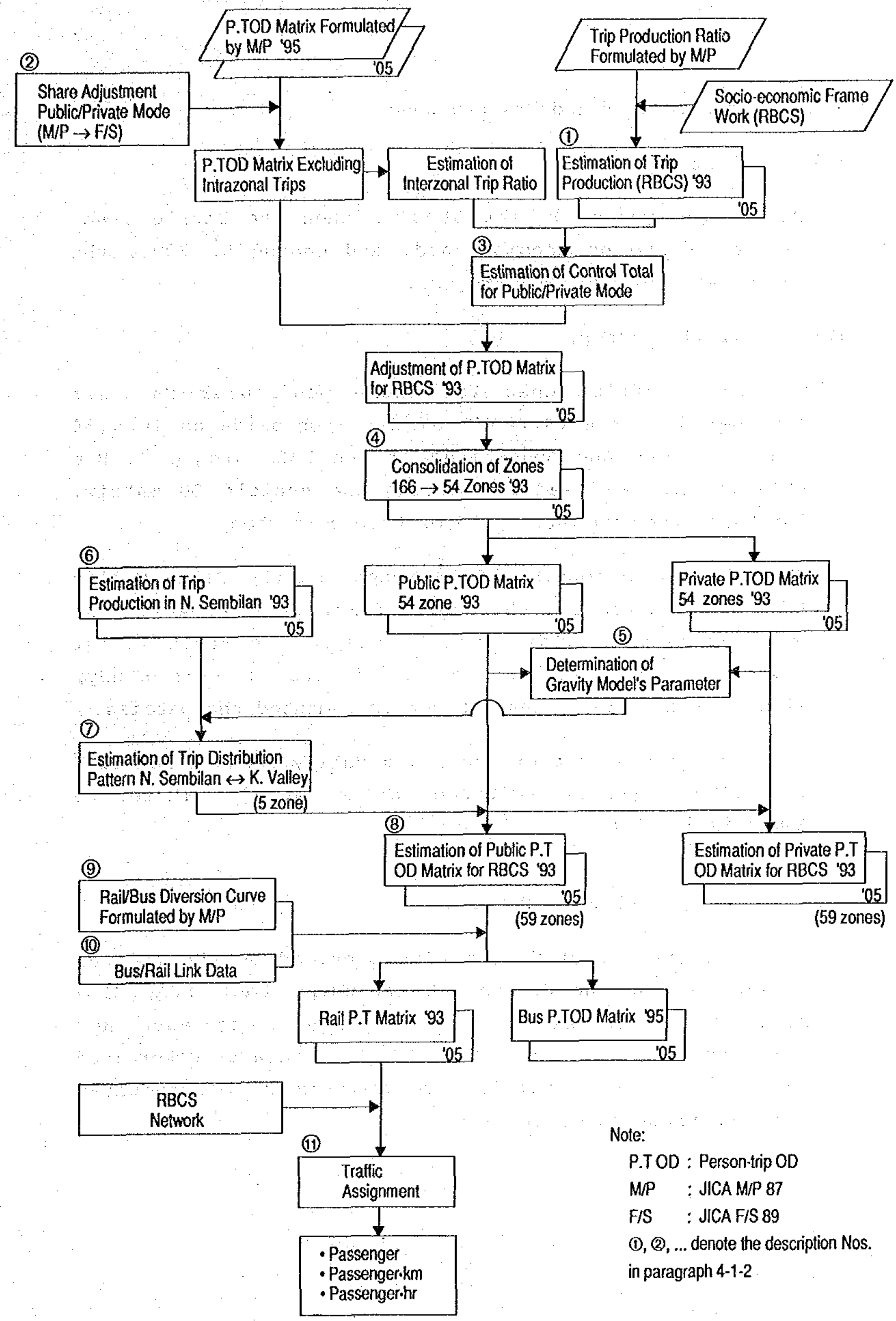


Fig 4-1-2 Work Procedure for Demand Forecasting

4-1-2 Target Year and Traffic Zone

(1) Target years;

The target years are set at 1993 when the Double Track Project is to be accomplished, and ending at 2005, the target year of the RBCS Project.

(2) Traffic Zones;

The 174 traffic zones for whole peninsular Malaysia considered in the JICA M/P 87 were consolidated into 64 zones to meet the objectives of the RBCS project. But this zoning was used for making the vehicle OD matrix. For the person OD matrix, 59 of them were used.

These 59 zones consist of 54 zones for the Klang Valley Area and 5 zones for the Negeri Sembilan Area, while the outer area was divided into 5 zones. The Bukit Tinggi development project was not considered in this study, since the government has not yet implemented the details.

The traffic zone map of the Klang Valley, Negeri Sembilan and other areas is indicated in Fig. 4-1-3. (Refer to Appendix 4-1-1.)

4-1-3 Integrated RBCS* Network

Based on the latest information provided by the related authorities of the Government including KVPS, MRA, City Hall, the networks and service levels of each new transport mode related to the RBCS have been predetermined as given below. Traffic demand forecast is conducted based on these preconditions.

(1) MRA network for commuter service;

1) Network in 1993;

Since the DTP is scheduled to be accomplished by 1993, the railway commuter network in 1993 was presumed as shown in Fig. 4-1-4.

2) Network in 2005;

The railway commuter network in 2005 was presumed as shown in Fig. 4-1-5.

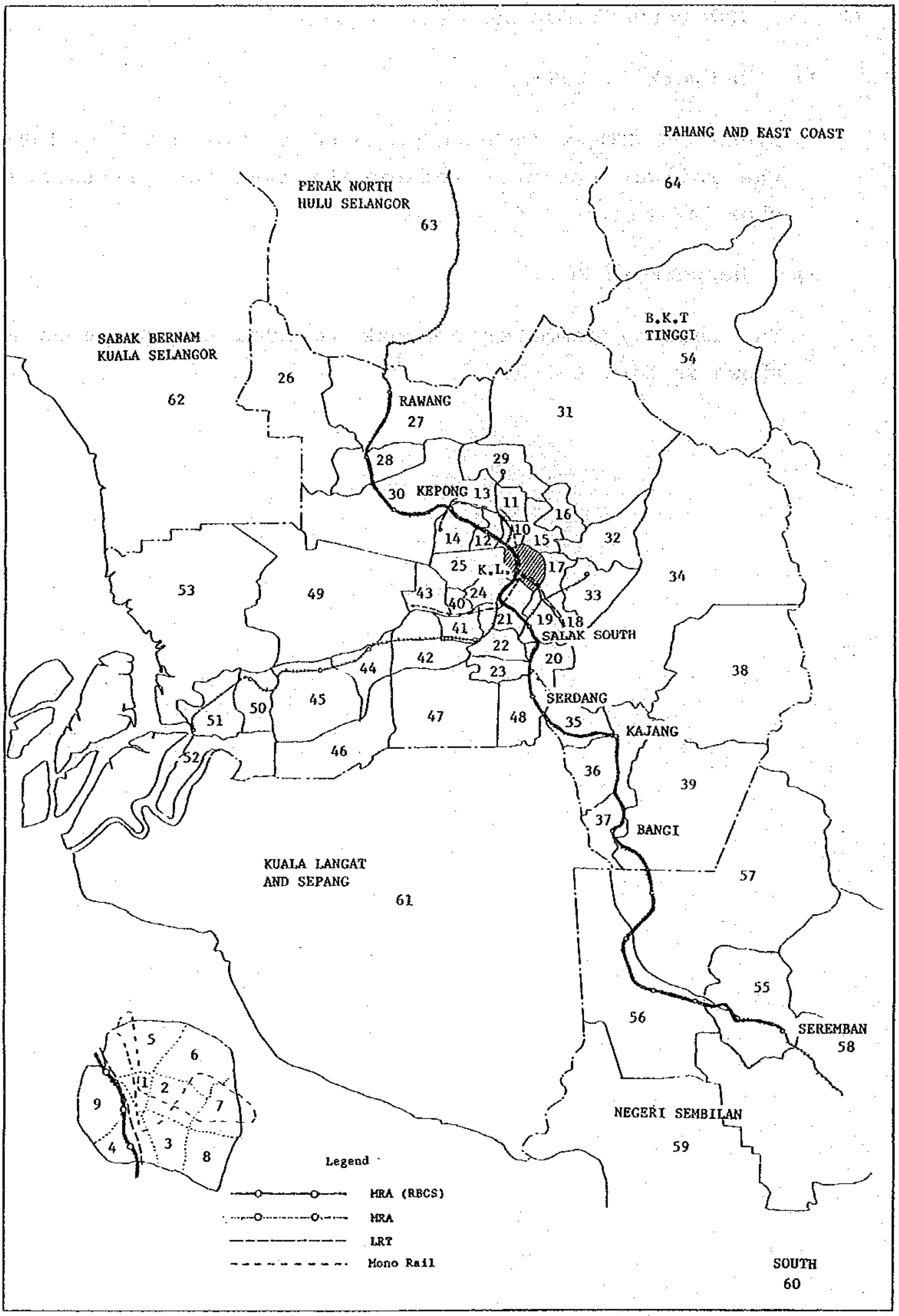


Fig. 4-1-3 Traffic Zone Map

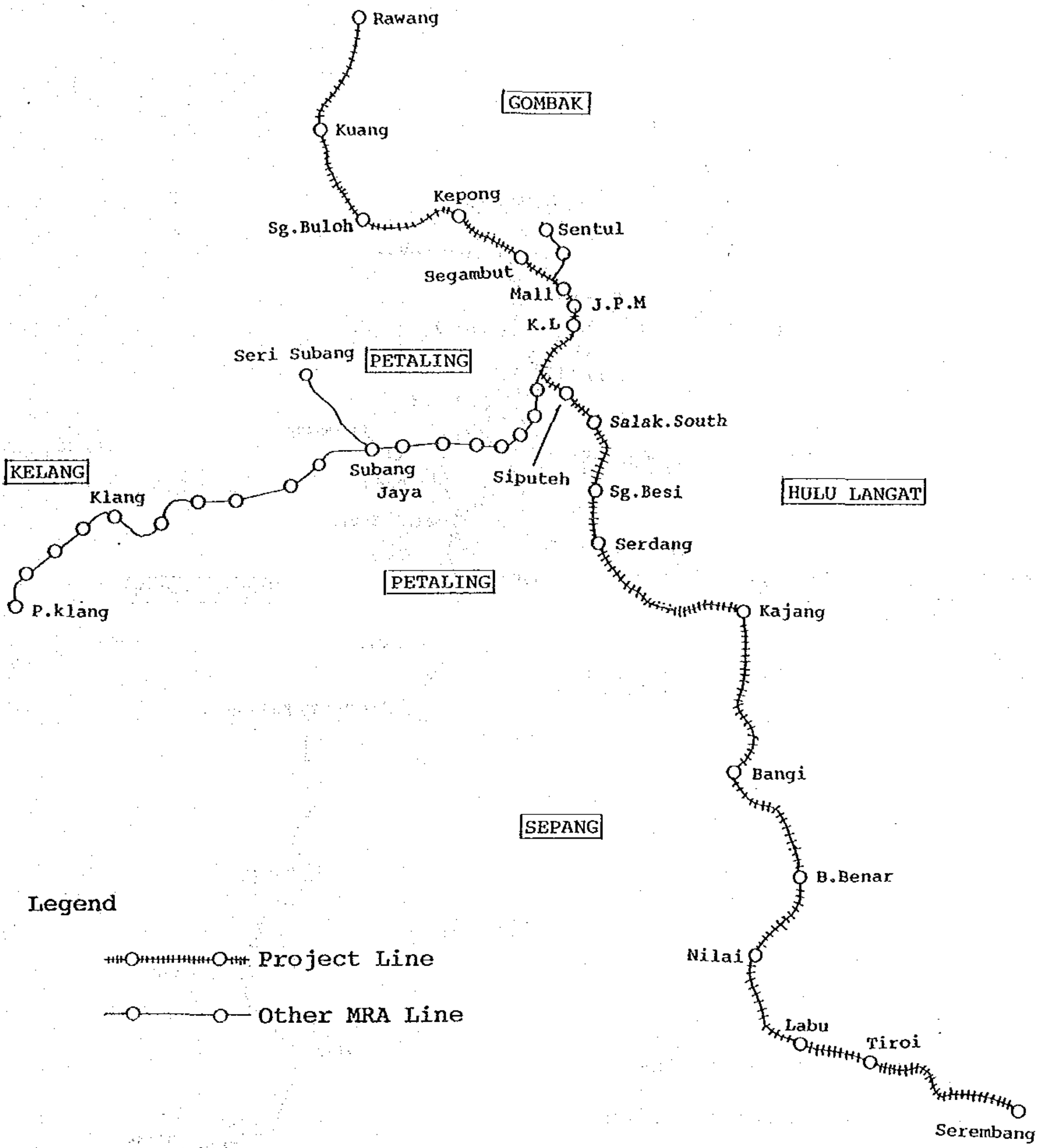


Fig. 4-1-4 MRA Network for Commuter Service (in 1993)

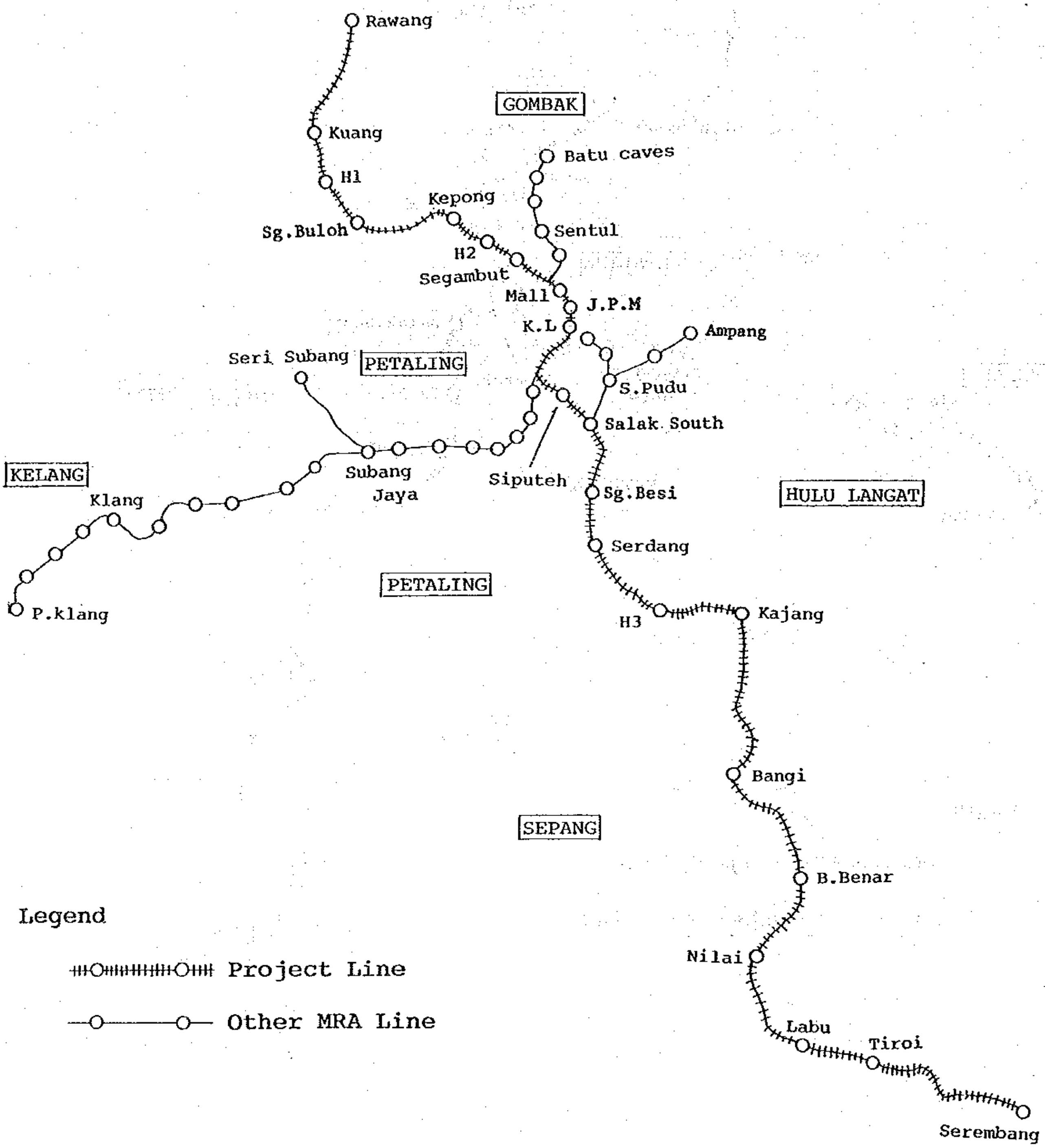


Fig. 4-1-5 MRA Network for Commuter Service (in 2005)

(2) LRT/Monorail Network;

According to the City Hall, the first stage of the Monorail service will be started in 1993. Other part of the Monorail network is assumed to be accomplished by 2005. LRT will be completed by 2005.

Networks of Monorail and LRT are shown in Fig. 2-4-1 and 2-4-2 respectively.

* Note: The "Integrated RBCS" is a conceptual service provided by all the MRA, LRT, Monorail, feeder-bus networks covering the whole Klang Valley and Seremban areas. While the RBCS under the present study is limited to the MRA's Rawang-Seremban service and the feeder bus services to be newly created along the section.

(3) Road Network;

1) Road network in 1993;

A road network plan was prepared in the JICA F/S 89. This network was designed for 1995 and 2005. It is incorporated into the network in 1993 for use in this Study. The actual progress of the two Express Ways (North-South and Shah Alam) and the Ampang Highway is reflected.

2) Road network in 2005;

Road network in 2005 of JICA F/S 89 is adopted as shown in Fig. 4-1-6.

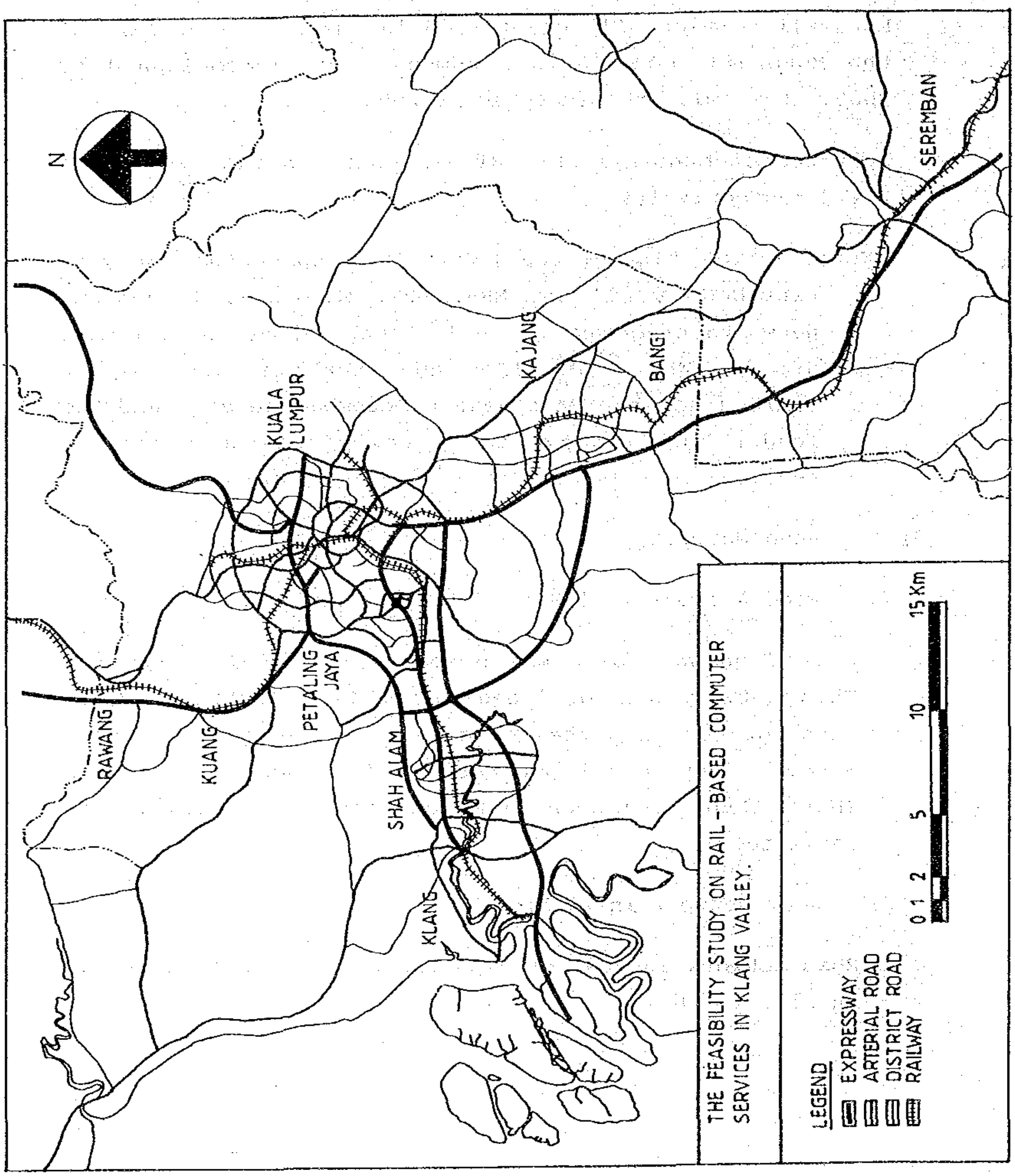


Fig. 4-1-6 Road Network in Klang Valley and Seremban in year 2005

4-2 Estimation of Trip Production

4-2-1 Estimation of Trip Production in Klang Valley Area

Trip production is the total amount of car trips or person trips in an objective district. Small trips around one's own house and/or office within the survey time were excluded from the total amount.

The trip production model in the Klang Valley Area was set up in the JICA M/P 87. The present study employed the same model, which is given below:

$$T^{\rho} = \sum_{\kappa l} A^{\rho}_{\kappa l} \times N_{\kappa l}$$

where:

T^{ρ} : Trip production by trip purpose (ρ)

$A^{\rho}_{\kappa l}$: Trip production rate by trip purpose (ρ), vehicle ownership (κ) and employment status (l)

$N_{\kappa l}$: Population by vehicle ownership (κ) and employment status (l)

The unit factors composing the above ($A^{\rho}_{\kappa l}$) are given in Table 4-2-1.

The new vehicle ownership (κ) and employment status (l) estimated by the field survey during this study is shown in Table 4-2-2.

Table 4-2-3 shows the forecast result (T^{ρ}) of trip production in the Klang Valley Area. The procedure for the estimation of trip production is shown in Appendices 4-2-1 ~ 2.

Table 4-2-1 Trip production Rate by Vehicle Ownership by Employment Status and Trip Purpose in Klang Valley (study results of JICA M/P 87)

Vehicle Ownership Category (κ)		Employment Status Category (ι)	$A^{\rho}_{\kappa\iota}$ = Trip Production Rate by Trip Purpose						
			To Work	To School	HB Business	NHB Business	HB Private	NHB Private	To Home *
		Employed	0.989	0.000	0.040	0.221	0.312	0.380	1.405
Non Car	1	Student	0.000	0.994	0.005	0.003	0.226	0.083	1.079
		Others	0.000	0.000	0.029	0.024	0.800	0.073	0.621
		(Housewife)	0.000	0.000	0.022	0.005	0.888	0.057	0.661
		(Jobless)	0.000	0.000	0.036	0.042	0.712	0.088	0.581
		Employed	1.049	0.000	0.045	0.257	0.369	0.437	1.549
Motor Cycle	2	Student	0.000	1.025	0.006	0.004	0.245	0.085	1.121
		Others	0.000	0.000	0.050	0.023	0.890	0.084	0.699
		(Housewife)	0.000	0.000	0.023	0.006	0.902	0.053	0.669
		(Jobless)	0.000	0.000	0.077	0.039	0.878	0.115	0.729
		Employed	0.999	0.000	0.073	0.388	0.486	0.646	1.793
One Car	3	Student	0.000	0.984	0.006	0.004	0.307	0.112	1.147
		Others	0.000	0.000	0.061	0.046	1.077	0.120	0.865
		(Housewife)	0.000	0.000	0.025	0.017	1.180	0.113	0.907
		(Jobless)	0.000	0.000	0.096	0.075	0.973	0.126	0.823
		Employed	0.978	0.000	0.110	0.566	0.525	0.644	1.883
Multi Car	4	Student	0.000	1.002	0.012	0.013	0.353	0.123	1.207
		Others	0.000	0.000	0.056	0.060	1.303	0.209	1.085
		(Housewife)	0.000	0.000	0.028	0.022	1.508	0.199	1.195
		(Jobless)	0.000	0.000	0.084	0.097	1.097	0.218	0.975

* Estimated by Team

[To Home] = [To Work] x 0.805 + [To School] x 0.895 + [Business] x 0.383 + [Private] x 0.682

(based on JICA M/P 87)

Table 4-2-2 Vehicle Ownership and Employment Status

% of Vehicle Ownership			Employment status category	Persons by vehicle	
	1993	2005		1993	2005
(κ)	%	%	(ι)	x 1000	x 1000
[Non Car]	22.6	18.8	Employed	353	476
			Student	233	309
			Others	113	143
			Total	690	928
[Motor Cycle]	26.4	23.7	Employed	413	600
			Student	261	390
			Others	133	180
			Total	806	1169
[One Car]	37.5	40.1	Employed	586	1015
			Student	371	660
			Others	188	304
			Total	1145	1979
[Multi Car]	13.5	17.4	Employed	211	440
			Student	133	286
			Others	68	132
			Total	412	859
[Total]	100.0	100.0	Employed	1563	2531
			Student	988	1645
			Others	502	758
			Total	3053	4934

Table 4-2-3 Person trip Production, Klang Valley 1993 - 2005

Trip Purpose	1993	2005	Average Annual Growth Rate (%) 1993 - 2005
To Work	1,418,300 (15.4%)	2,544,500 (15.8%)	4.9
To School	987,500 (10.7%)	1,642,900 (10.2%)	4.3
Business	655,400 (7.1%)	1,159,200 (7.2%)	4.9
Private	2,271,400 (24.7%)	3,975,500 (24.8%)	4.8
To Home	3,860,200 (42.0%)	6,738,800 (42.0%)	4.7
Total	9,192,700 (100.0%)	16,060,800 (100.0%)	4.7

4-3 Estimation of Trip Distribution in Klang Valley Area

4-3-1 Share Adjustment between Public and Private Modes

The latest study results on the share between public and private modes in JICA F/S 89 was adopted in this study. OD matrix by JICA M/P 87 was adjusted using conversion factors. (Appendix 4-3-1).

4-3-2 Estimation of Control Total in Klang Valley Area

(1) Exemption of the intra-zonal trips;

Intra-zonal trips mostly consist of trips by walk/bicycle modes. Since they are not considered as railway commuting trips, the intra-zonal trip was excluded from the OD matrix.

(2) Estimation of control total;

The trip control total by public and private modes was estimated based on the forecasted results of JICA F/S 89 by exemption of intra-zonal trips. Table 4-3-1 shows the result.

Table 4-3-1 Control Total for Public/Private Modes

		1993	2005	Average Annual Growth Rate (%)
Trip Production		9,192,700	16,060,800	4.7
Public	(%) *-1	27.54	28.11	
Private	(%) *-1	72.46	71.89	
Inter-zonal ratio				
Public	*-2	0.673	0.689	
Private	*-2	0.480	0.477	
Control total				
Public		1,703,900	3,110,900	5.1
Private		3,197,200	5,507,300	4.6

Note: *-1 JICA F/S 89
*-2 JICA M/P 87

4-3-3 Adjustment of Trip Distribution;

The trip generation and attraction is usually calculated using several parameters including the traffic characteristic in the zone, socioeconomic framework, land use, condition of employment. Among these parameters, JICA M/P 87 adopted the population framework. The RBCS Study estimated a new population framework.

Accordingly the trip generation and attraction by zone is calculated based on estimation model which was developed by JICA M/P 87 (Appendices 4-3-2 ~ 3).

The trip distribution for RBCS was estimated by Present Pattern Method, because the OD matrix in 1993 and 2005 is already estimated. The trip generation and attraction are subject to the control total as mentioned 4-3-2.

4-4 Estimation of Trip Distribution in Negeri Sembilan

4-4-1 Work Procedure

The trip distribution between Klang Valley and Negeri Sembilan was estimated by the following process.

- Estimation of trip production in this area
- Estimation of interzonal trips in connection with Klang Valley area
- Estimation of trip distribution by use of the gravity model parameters which were built by Klang Valley OD matrix.

The work procedure for the estimation is shown in Fig. 4-4-1.

4-4-2 Estimation of Trip Production and Trip Distribution

(1) Trip production and inter/intra trips;

In order to estimate the railway demand of this area to/from the Klang Valley Area,

a. Estimate trip production in Negeri Sembilan area in 1993/2005 in reference with the trip production rate per population in Klang Valley in 1993/2005 by the result of this study.

b. Estimate the number of inter zonal trips of each zone in Negeri Sembilan area based on the data from:

- Seremban Town Centre Traffic Study 1985
- N. Sembilan Master Plan Study

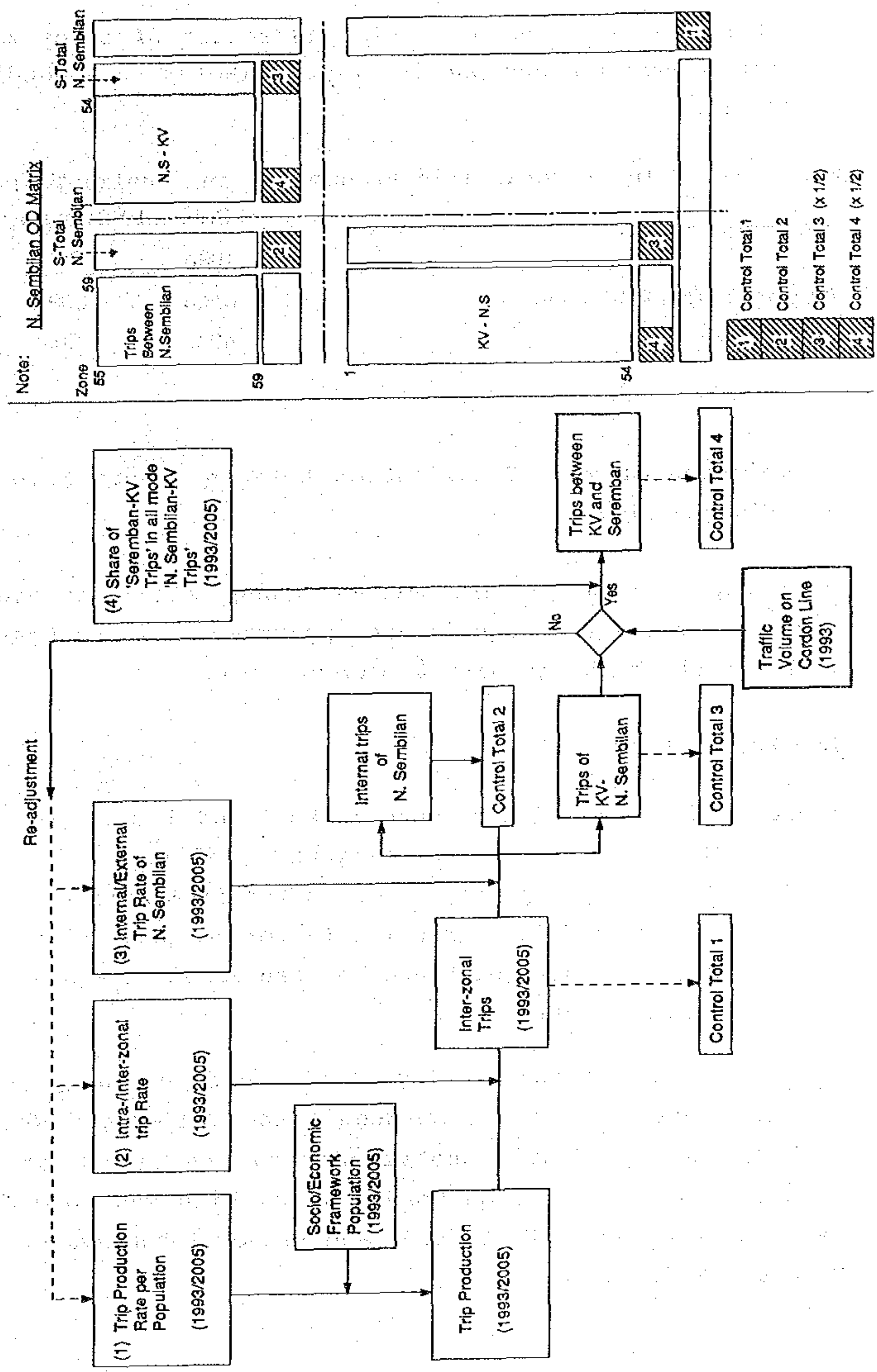


Fig. 4-4-1 Basic Approach for Person Trips (All Mode) between Seremban-Klong Valley

Tables 4-4-1 shows the estimated result of inter-zonal trip production and public trips. (Refer to Appendices 4-4-1~2)

Table 4-4-1 Inter-zonal Trip Production and Public Trips

Unit: x 10^3 Trips/day

	1993	2005
Inter-zonal Trip Production	184.5	369.1
Public Trips	49.2	98.4

(2) Formulation of Trip Distribution between Negeri Sembilan and Klang Valley;

Trip distribution pattern between Klang valley and Negeri Sembilan is calculated using the parameters of the gravity model of which the formula is given below:

$$Tij = G \times Pi^a \times Pj^b / Dij^c$$

Where Tij = Trips between zones i and j
G = Gravity coefficient
Pi = Trip generation factor from zone i
Pj = Trip attraction factor to zone j
Dij = Road distance between zones i and j
a,b,c = Parameters

The parameters of the gravity model are shown in Appendix 4-4-3. Inter-city trips between Klang Valley and Negeri Sembilan were adjusted and trended by the result of the traffic count survey on Cordon line which was conducted by Highway Planning Unit (HPU) and Projek Lebuhraya Utara-Selatan BHD(PLUS).

4-5 Traffic Assignment to RBCS

4-5-1 Travel Time

(1) Estimation of travel time;

The travel time is considered as the time required to travel between the centroids of the origin zone and the destination zone. The time consists of walking time, waiting time and riding time. The walking time was estimated by Team's field survey. The riding time (i.e. time on board the feeder-bus and train or stage-bus) was estimated by the planned train schedules or bus speed and route length. The waiting time for train was assumed from the planned headway of RBCS trains. The maximum waiting time was assumed as 10 minutes. The waiting time for bus was assumed from the current bus headway during rush hours.

A conceptual link map of bus and rail trip is shown in Fig. 4-5-1.

(2) Assumptions for service level;

The above-mentioned time factors were quantified under the following assumptions on the service levels of the rail and bus modes. As for passenger fare, it was assumed that the RBCS fare and bus fare are equivalent. "RBCS fare" here means the total of the fares of feeder-bus and train. The "bus-fare" here means the total of the fares of feeder-bus and stage-bus.

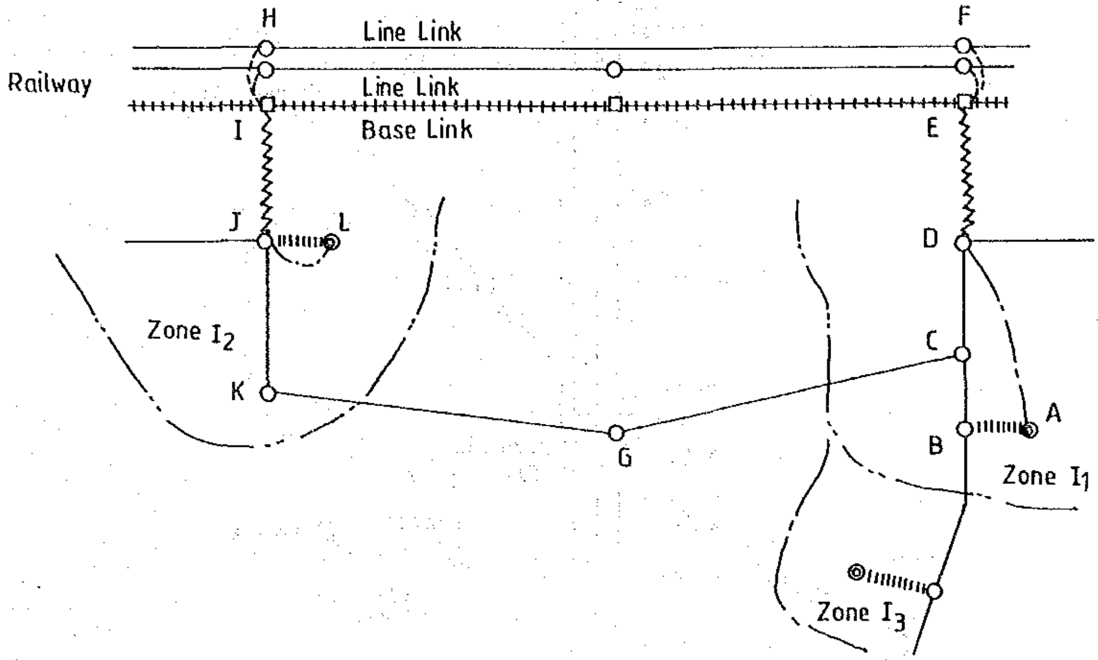
1) RBCS

- Line haul time (Refer to Chapter 5 Railway Commuter Transport
- DMU operation plan (Fig. 4-5-2)
- Train waiting time (Table 4-5-1)
- Access time from Station front plaza to the station (Refer to Appendix 4-5-1).
- Service levels of LRT/Monorail (Refer to Table 4-5-2)

- Travel time of feeder bus (Refer to Appendix 4-5-1)

2) Bus

- Bus travel time was estimated based on bus operating speed and operating routes, taking consideration of the existing bus operation.
- Access time to bus stop was estimated from the collected data by interview survey. (Refer to Appendix 4-5-1)



A, L : Centroid Node
B, C, G, K : Road Node
D, J : Access Node
E, I : Station Node
F, H : Platform Node
A-B, J-L : Centroid Link (CL)
A-D, J-L : Feeder Link (FL)
F-H : Line Link (LL)
D-E, I-J : Access Link (AL)
E-F, H-I : Station Link (SL)

Estimation of Tavel Time between Zone I_1 - I_2

(1) Buse User A - B - C - G - K - J - L
Walk + Bus + Walk

(2) RBCS User A - D - E - F H I - J - L
Bus or/and walk + Walk + Rail-way + Bus or/and walk

Fig. 4-5-1 Conceptual Link Map for Model Split

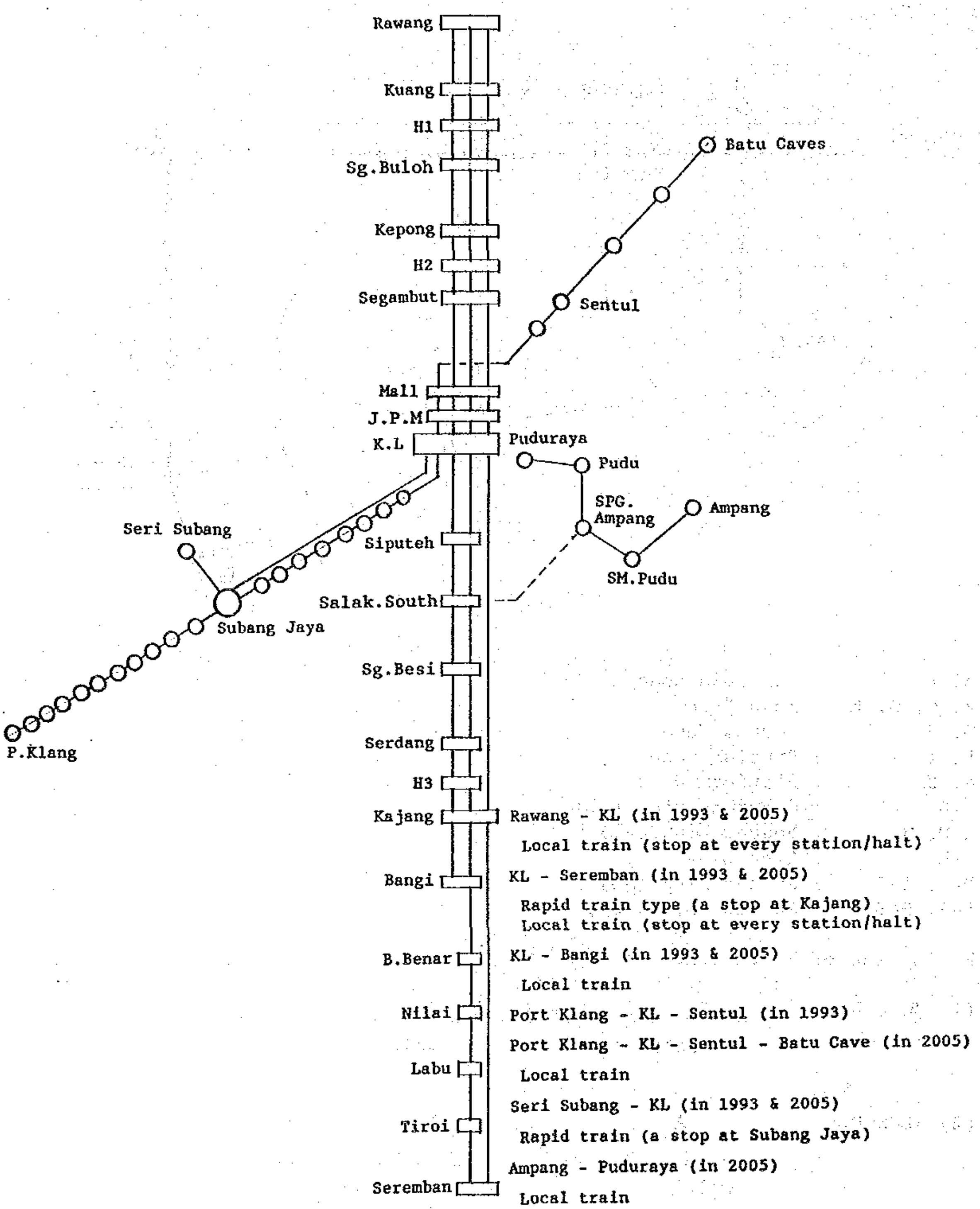


Fig. 4-5-2 DMU Operation Plan

Table 4-5-1 Number of Trains and Waiting Time

Line No.	Type	Operating Section	Type of Train	1993 (without)		2005 (with)		2005 (without)	
				Numbe of Train (Peak 1 hour)	Waiting Time (min)	Number of Train (Peak 1 hour)	Waiting Time (min)	Number of Train (Peak 1 hour)	Waiting Time (min)
Line 1	MRA	Rawang-Bangi	Local	0	10	2	5	0	10
Line 2	MRA	Rawang-Seremban	Local	2		3		2	
Line 3	MRA	Rawang-Seremban	Rapid	1		1		1	
Line 4	MRA	P.Klang-Sentul (P.Kiang-Batu Caves in 2005)	Local	3	10	4	7.5	4	7.5
Line 5	MRA	Air Port-K. L	Rapid	2	15	2	15	2	15
Line 6	MRA	Puduraya-Ampang	Local	-	-	6	5	6	5
Line 7	Mono-rail	Puduraya-Puduraya	Local	20	1.5	20	1.5	20	1.5
Line 8	LRT	Puduraya-Conraught	Local	-	-	12	2.5	12	2.5
Line 9	LRT	Peoples Park-Manjalara	Local	-	-	12	2.5	12	2.5

Table 4-5-2 Operating Conditions of LRT/Monorail

Transport Mode	Networks	Route Length (Km)		Number of Stations		Commercial Speed (km/h)	
		1993	2005	1993	2005	1993	2005
Monorail	Phase-1 (1993)	8.10	8.10	16	16	22	22
	Phase-2 (2005)	-	6.5	-	8	-	24
LRT	Sentul - KL - People's Park (2005)	-	18	-	18	-	40
	KL - Kepong - Manjalara KL - Cheras (2005)	-	16	-	16	-	40

Note: Data based on the information from City Hall

(3) Modal split between rail and bus;

The share between rail users and bus users was estimated based on a theoretical diversion curve which shows correlation between the modal share (%) and the travel time from origin to destination. The diversion curve used in this study is the one developed in JICA M/P 87 which is shown in Fig. 4-5-3.

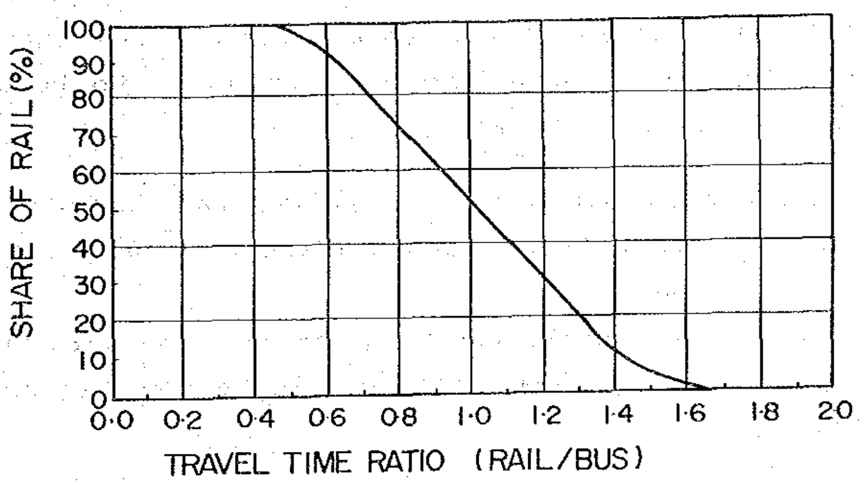


Fig. 4-5-3 Theoretical Diversion Curve for Rail and Bus Riders

4-5-2 Result of Traffic Demand Assignment

(1) Share of RBCS and Stage-bus;

The share of public mode users between integrated RBCS and the stage-bus is shown in Table 4-5-3. (Refer to Appendices 4-5-2 ~ 3)

Table 4-5-3 Demand for Public Transport Modes

(x 1000 Trips/day)

Year	Integrated RBCS	Bus	Total
1993*-1	201	1,551	1,752
1997*-2	538	1,701	2,239
2005*-3	862	2,348	3,210

Note: *-1 Public transport demand after completion of DTP
*-2 Public transport demand on initiation of RBCS Project
*-3 Public transport demand after completion of RBCS Project

(2) Railway Link Traffic Demand (Sectional Traffic Demand)

Fig. 4-5-4 shows the sectional traffic demand estimated, as the result of the calculation of link assignment, to pass through each station of the Rawang-Seremban Corridor.

The Figure indicates that the Northern-Suburban and Northern-Intermediate Sections of the Corridor (Refer to Chapter 13) will have a traffic demand of approximately 30,000 commuters in 2005, 7 to 8 times as large as that of 1993. This means that the area is going to become the suburbs of the K.L. area.

The Southern-Intermediate and the Central Sections (Refer to Chapter 13) will see approximately 90,000 commuters, 2.4 to 2.7 times.
The traffic demand in the rest of the Southern-Suburban (Refer to Chapter 13) will be distinctly higher, over 30,000 commters.

The items that are noteworthy: First, the largest traffic demand, approximately 110,000, will appear in the Salak South - Sg. Besi section. This will mark the required capacity of the infra-structure, as far as commuter traffic is concerned.
Secondly, the Mall - K.L. section will be conspicuous in smaller traffic compared with the adjacent sections. This indicates the effect of the multi-modal development of the transportation infra structures (Monorail and LRT) in this particular city center area. Table 4-5-4 shows the section of heavy link traffic demand.

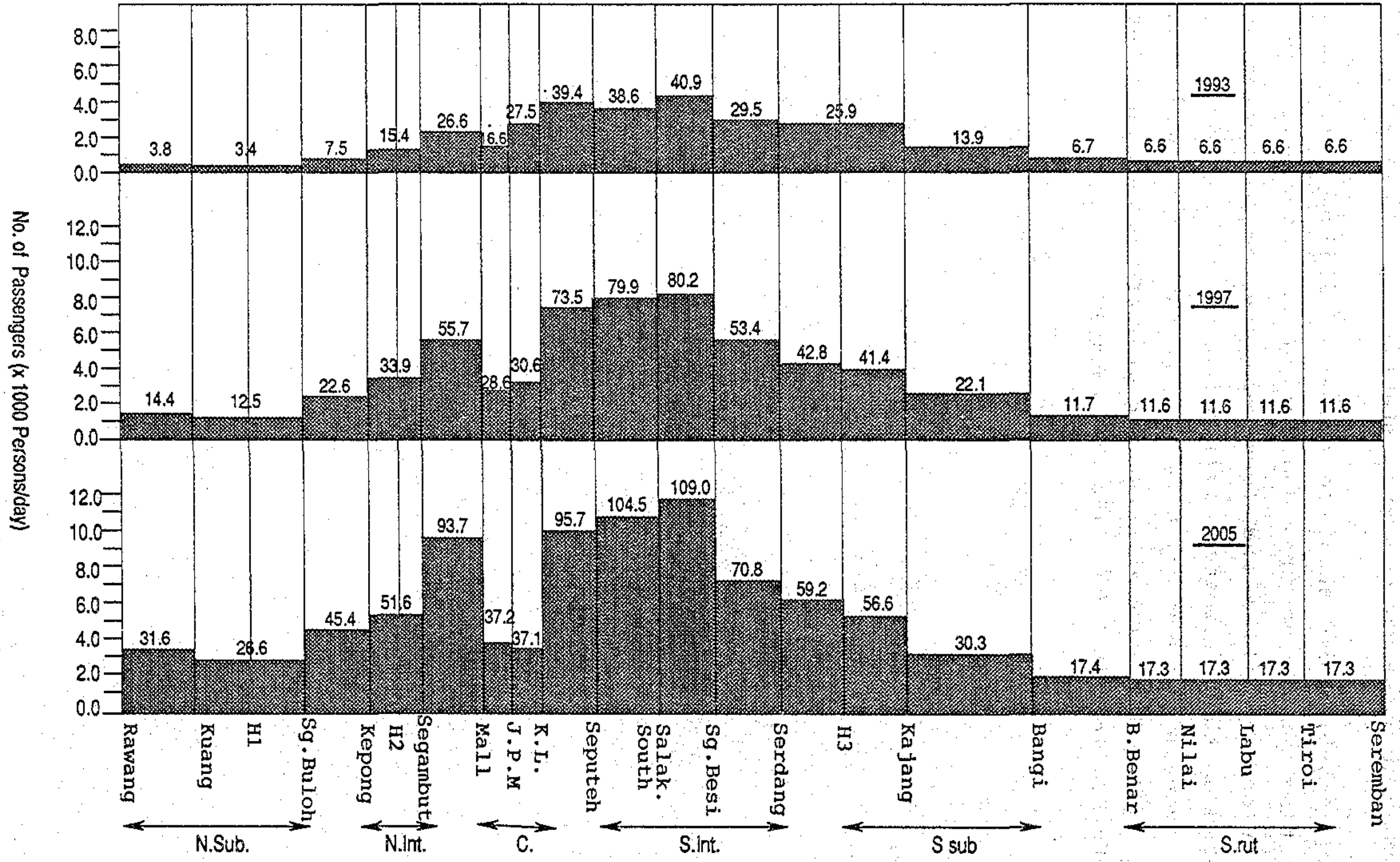
Table 4-5-4 Heavy Link Traffic Demand

(x 1000 persons/day)

Year	Seputeh - Salak South	S. South - Sg. Besi
1993	38.6	40.9
1997	79.9	80.2
2005	104.5	109.0

(3) Number of passenger demand by station;

Fig. 4-5-5, 4-5-6 show the number of railway passengers getting on/off at the stations of the Corridor. The station facilities and feeder-bus system were planned based on this estimate. Considerable traffic demand will be seen in the section between Segambut and S. Besi even in 1997. The area will further grow and change into the suburban area in 2005. (Refer to Appendix 4-5-4)



Note: Passenger in 1997 is estimated by interpolation

Fig. 4-5-4 Link traffic Demand

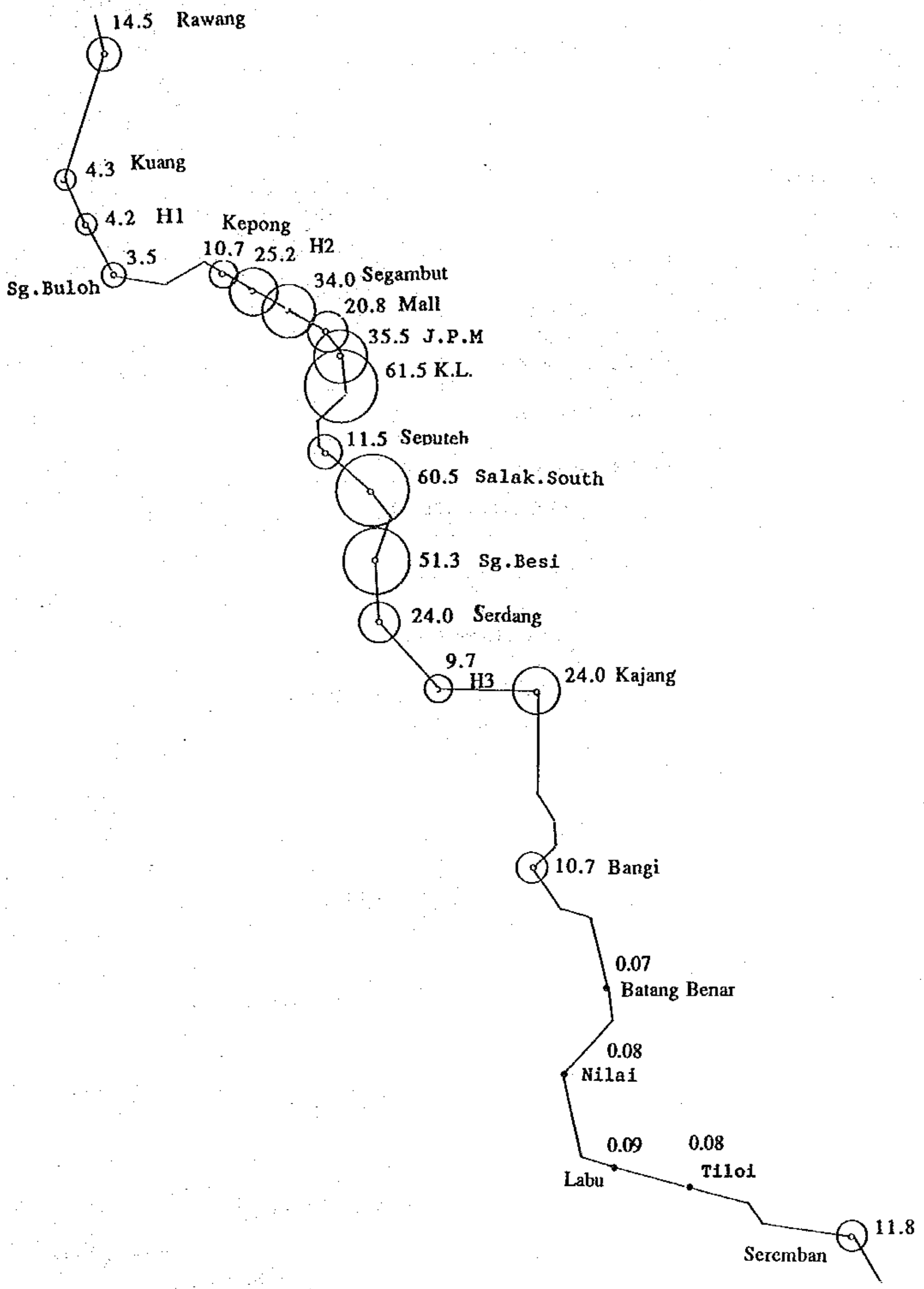


Fig. 4-5-5 Number of Passenger Demand by Station (in 1997)
(Units: x 1000 Passengers per day)

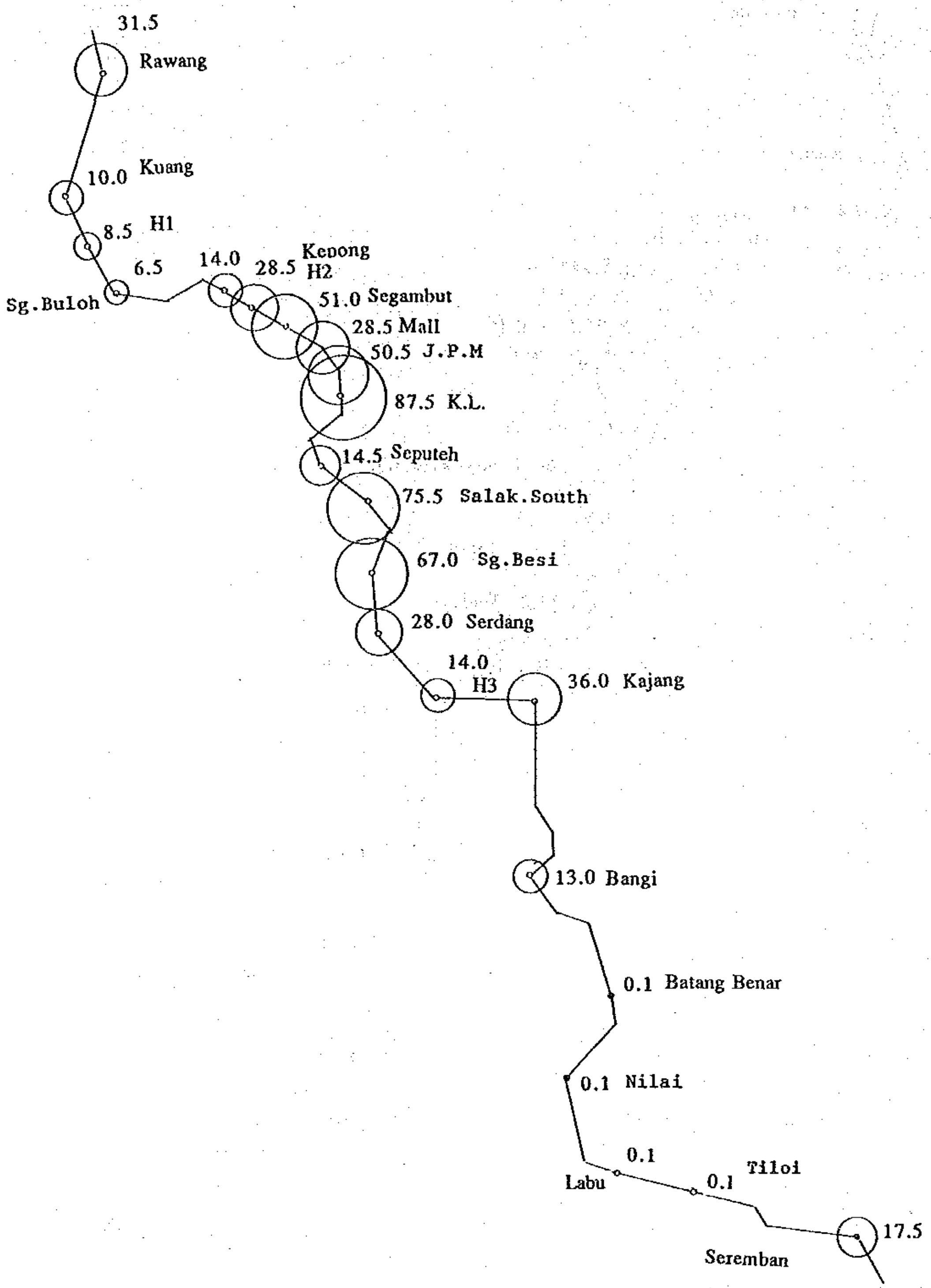


Fig. 4-5-6 Number of Passenger Demand by Station (in 2005)
(Units: x 1000 Passengers per day)

4-5-3 Road traffic

For use of the economic analysis, the traffic assigned to the road mode was also calculated. The data such as the link lengths, road widths, Q/V values etc. were provided by JICA F/S 89.

4-6 Projection of Case-with-the-Project and Case-without-the Project

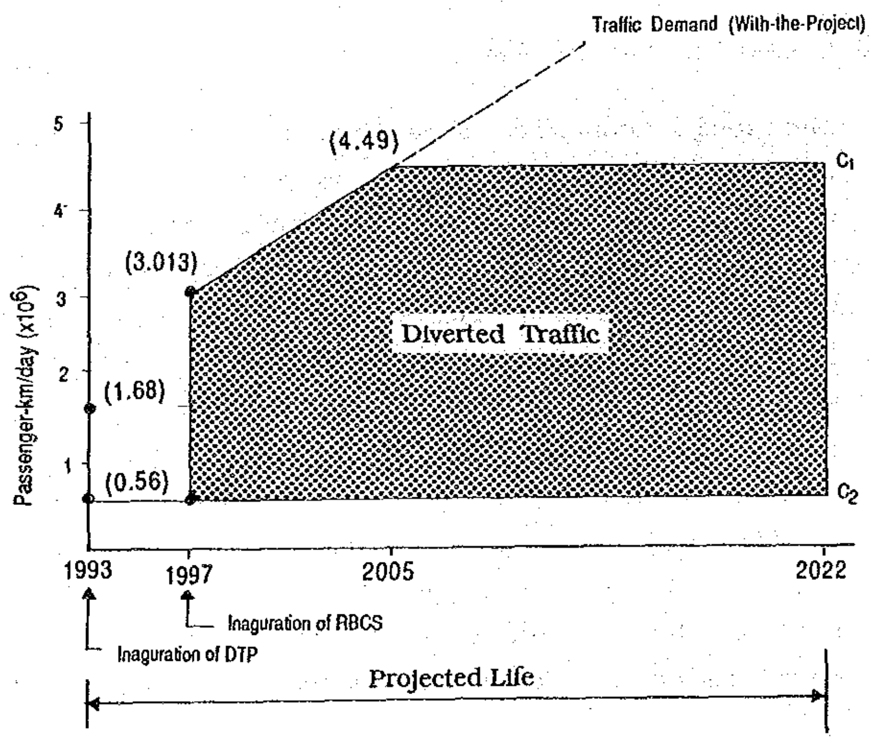
The present demand forecast was conducted covering the period 1993 - 2005 (The same period with the socio-economic frame-work). While, in the financial/economic analyses, the calculation must be done covering the whole project life of 30 years (1993 -2022)and comparison must be done between the Case-with-the-Project and Case-without-the-Project.

① Case-with-the-Project;

The socio-economic frame will expand continuously after 2005 and the traffic demand will grow to exceed the transport method prepared by this study. There may be ways RBCS carries could manage to develop the trend of traffic conversion from stage Bus to RBCS. There may be loss of the customers who would be dissatisfied with the maybe worsening RBCS service level. But in conducting the financial/economic analyses of this study, team considers it will be appropreate to assume the converted traffic will be kept at the same level in volume as in 2005, in With-the-Project Case. Because it will be no better than a guess work to quantify how much the carriers could do and how much the users would be lost.

② Case-without-the-Project;

With the same expansion of the socio-economic framework expected during 1993-2005, the traffic demand will grow to exceed the transport capacity prepared by the DTP, Monorail, LRT etc. There may be ways rail carriers could manage to make the both ends meet for some years coping with the growing demand. There may be loss of customers who have once switched to rail mode, might go back to road modes. But in conducting the financial/economic analyses of this study, Team considers it will be appropreate to assume that the RBCS will be kept at the same level in volume as of DTP in 1993, in Without-the-Project Case, provided with the 33 DMUs assigned to the Rawang - Seremban corridor as planned by MRA (Capacity-wise 561,000 passenger-km according to MRA as of completion of DTP) and at the same level volume as in subsequent years. Fig. 4-6-1 indicates concept of diverted traffic volume. (Refer to appendix 4-6-1.)



Note: C1 Transport Capacity of RBCS
C2 Transport Capacity for DTP

Fig. 4-6-1 Concept of Diverted Traffic Volume

Chapter 5

RAILWAY COMMUTER TRANSPORT

Chapter 5 RAILWAY COMMUTER TRANSPORT

5-1 Objective

This chapter deals with the commuter train transport plan on the Rawang-K.L.-Seremban section. The objective of the study is to work out a plan for efficient DMU operation satisfying the traffic demand forecasted in the preceding chapter, on the one hand and on the other, a plan for the improvement of the ground facilities supporting the said train operation. More concretely, the objectives of the study are to clarify the following issues:

(1) The number of DMU trains and DMUs per train to be operated during commuting hours of the day in 1997 and 2005;

(2) The sections and routes where DMUs are operated in 1997 and 2005; and

(3) The use of arrival and departure lines for DMU trains at Kuala Lumpur station during commuting hours.

5-2 Framework of Transport Plan

(1) Traffic volume

The targeted passenger transport volume of the DMU train is set at the traffic demand estimated and given as sectional traffic between each station in Chapter 4.

(2) Ground facilities

The train operation plan presupposes that the improvement of the ground facilities will be achieved by 1993 as planned in DTP. Thereafter up to 2005, their improvements will be planned in line with the increase of traffic, in a manner to minimize the headway of DMU train operation and to maximize the line capacity during the commuting hours.

(3) DMUs

The number of DMUs per train is determined according to the traffic demand on the most congested section during morning peak hours, and according to carrying capacity of a DMU.

In a section of a very small traffic, however, train consist is reduced to save the number of DMUs.

5-3 Basic Assumptions for the Planning

5-3-1 Railway network

RBCS's railway network is shown in Fig.5-3-1.

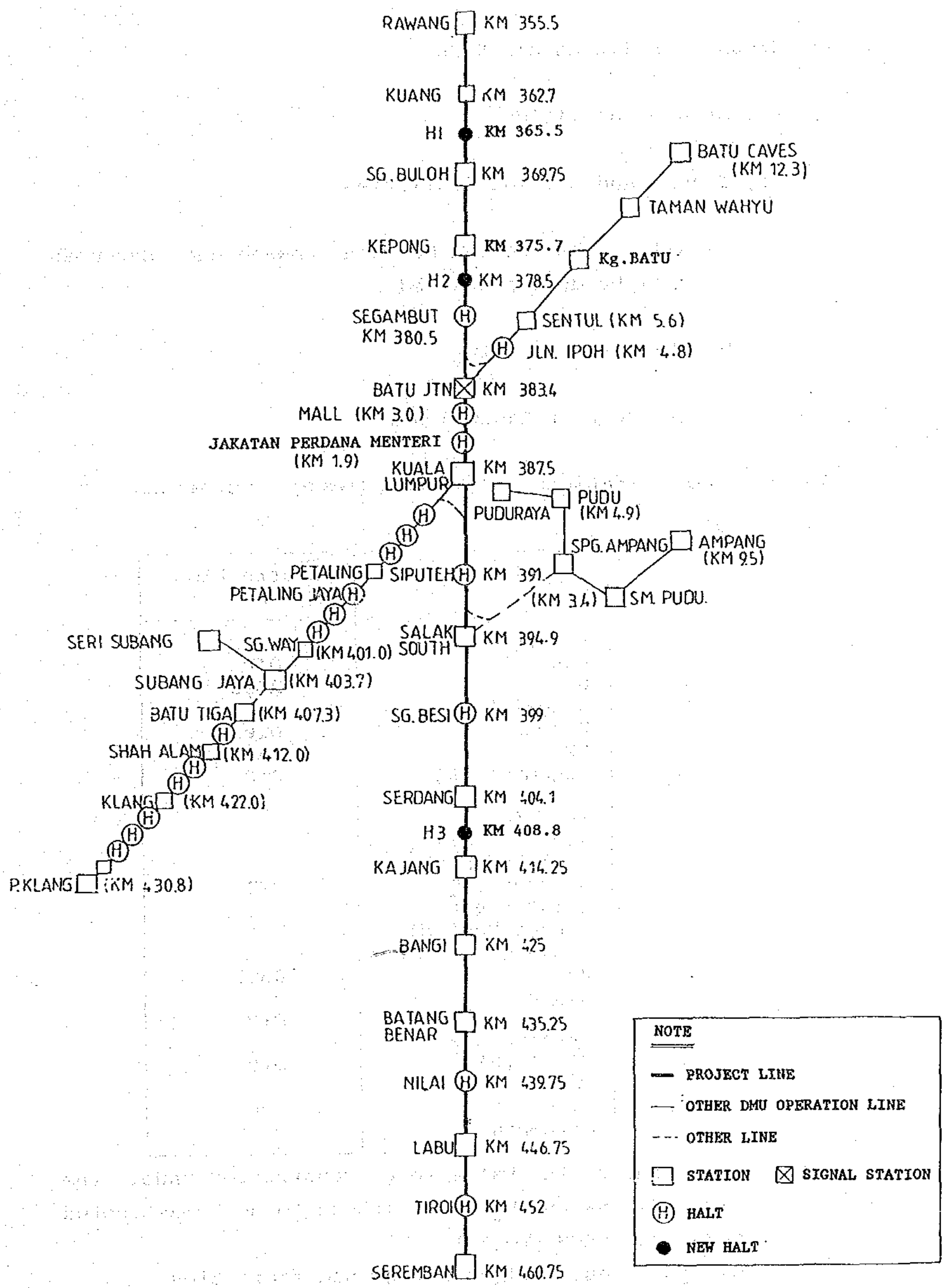


Fig.5-3-1. RBCS's Railway Network (in 2005)

5-3-2 Ground Facilities and DMUs

(1) Ground facilities

1) Tracks and station facilities

a) All of the section between Rawang and Seremban will be double tracked

b) Stations and halts

As shown in Table 5-3-1.

Table 5-3-1 Stations and Halts (Rawang - Seremban)

Station/Halt	Construction by
Rawang	
Kuang	DTP
H1	RBCS
Sungai Buloh	
Kepong	DTP
H2	RBCS
Segambut (H)	DTP
Mall (H)	
J.P. Menteri (H)	
Kuala Lumpur	
Siputeh (H)	DTP
Salak South	
Sungai Besi(H)	DTP
Serdang	
H3	RBCS
Kajang	
Bangi	DTP
Batang Benar	
Nilai (H)	DTP
Labu	
Tiroi (H)	DTP
Seremban	

Note: (H) denotes the halts to be constructed under the DTP. H_1, H_2 and H_3 denote those to be constructed under the RBCS project.

c) Speed restrictions for ground facilities

Speed restrictions at curves, turnouts, and downward slopes are regulated as follows.
(Refer to Appendix 7-1-1, Table 1)

Table 5-3-2 Curve

Curve radius (m)	Speed limit (km/h)
1000 or more	100
800 or more	95
700 or more	90
600 or more	85
500 or more	80
450 or more	75
400 or more	70
350 or more	65
300 or more	60
250 or more	55
225 or more	50

Table 5-3-3 Turnout (Simple Type)

Turnout No.	Speed limit (km/h)
6	19
9	28
12	38
15	48

Table 5-3-4 Downward Slopes

Downward gradient (0/00)	Speed limit (km/h)
Less than 5/1000	120
Less than 10/1000	115

2) Signaling system

a) Signal aspect

3-aspect. (G, Y, R_1 & R_0)

G: Green
Y: Yellow
R(R_1 & R_0): Red

For high-speed operation, it is desirable to introduce 4-aspect system by addition of a retardation aspect signal between a proved aspect signal and a caution aspect signal throughout the section. (Refer to Appendix 5-1) However, securing the necessary braking distance for a high speed train is achievable by use of a varied 3-aspect system — G-Y-Y-R_1-R_0 indication system. Considering that DTP has adopted a 3-aspect system; and the section that will allow 120 km/h operation after RBCS is limited to the 11 km-long section between the 442 km and 453 km, the 3-aspect system (G-Y-R_1-R_0) will be adopted, in principal, and the varied 3-aspect system (G-Y-Y-R_1-R_0) in the above-mentioned 120 km/h - operation section.

b) Block system

Automatic block system (minimum block length 500 m)

(2) DMU

1) Maximum speed: 120 km/h

2) Acceleration

To be capable of reaching 100 km/h in 165 seconds after starting on a straight and flat track.

3) Deceleration

2.6 km/h/sec

(Note: The train operation diagram is prepared assuming 2.0 km/h/sec)

4) Car length

21.5 m (between couplings)

5) Average carrying capacity

140 passengers (72 seated, plus 68 standing)

6) Maximum number of DMUs per train

10 cars

5-3-3 Operating and Stopping Time

(1) Operating time between stations

Based on the basic conditions of ground facilities and DMUs as above-mentioned, a train diagram was drawn up. Then operating time between each station was calculated as shown in Tables 5-3-5 and 5-3-6. The following conditions were observed; (Refer

Appendix 5-2-1)

1) The planned operating speed shall be lower than the restricted speed by 2 km/h.

2) The operating time is indicated using time unit of 30 seconds.

3) The total planned operating time between Rawang and Kuala Lumpur and between Kuala Lumpur and Seremban shall not be below the estimated operating time.

Note: (1) Trains from Seremban to Rawang's direction (North-bound) is designated as "up trains", and those in the opposite direction (South-bound) as "down trains".

(2) It is presumed that the existing speed restriction of 15 km/h at the section between 401.3 km and 402.1 km will be raised by the year 1997 through improving the track bed condition.

Table 5-3-5 Planned Operating Time of DMU Trains between Stations on Rawang - Kuala Lumpur Section

(1) Local

DOWN TRAIN ↓					Section		↑ UP TRAIN				
Track No.	RBCS Plan	RBCS Cal	D.T.P. Plan	D.T.P. Cal	Station	Distance (km)	D.T.P. Cal	D.T.P. Plan	RBCS Cal	RBCS Plan	Track No.
					Rawang						
	7.30	7.22	7.30	7.22		7.20	7.20	7.30	7.20	7.30	
					Kuang						
	3.30	3.15	6.30	6.24		2.60	5.50	6.00	3.18	3.30	
					H 1						
	4.30	4.12				4.45			3.38	4.00	
					Sungai Buloh						
	6.30	6.24	6.30	6.24		7.20	6.56	7.00	6.56	7.00	
					Kepong						
	2.30	2.27	4.00	3.50		2.15	4.08	4.00	2.17	2.30	
					H 2						
	2.30	2.24				1.40			2.44	3.00	
					Segambut (H)						
	4.00	3.43	4.00	3.43		2.80	3.48	4.00	3.48	4.00	
					Batu Junction (S)						
						1.20					
					Mall (H)						
	2.00	1.41	2.00	1.41		1.10	1.41	2.00	1.41	2.00	
					J.P. Menteri (H)						
3 #		2.38		2.38		1.90	2.20	2.30	2.20	2.30	1,2 #
4 #	3.00	2.56	3.00	2.56			3.30	3.30	3.30	3.30	3,4 #
1,2 #		3.30	3.30	3.32							
					Kuala Lumpur						
4 #	36.00	34.24	33.30	32.12	Total	32.00	32.04	33.00	34.02	36.00	1 #

(2) Rapid

DOWN TRAIN ↓					Section		↑ UP TRAIN				
Track No.	Rapid (B) Plan	Rapid (B) Cal	Rapid (A) Plan	Rapid (A) Cal	Station	Distance (km)	Rapid (A) Cal	Rapid (A) Plan	Rapid (B) Cal	Rapid (B) Plan	Track No.
					Rawang						
	7.00	7.00	7.00	7.00		7.20	6.30	6.30	6.30	6.30	
					Kuang						
	2.00	2.06	2.00	2.06		2.60	2.05	2.00	2.05	2.00	
					H 1						
	3.30	3.08	3.00	3.08		4.45	3.04	3.00	3.04	3.00	
					Sungai Buloh						
	6.00	5.54	5.30	5.22		7.20	5.38	6.00	6.18	6.30	
					Kepong						
	2.00	2.06	1.30	1.30		2.15	1.26	1.30	1.49	2.00	
					H 2						
	1.30	1.20	1.30	1.20		1.40	1.34	1.30	1.34	1.30	
					Segambut (H)						
	3.30	3.12	3.00	2.56		2.80	3.10	3.30	3.26	3.30	
					Batu Junction (S)						
						1.20					
					Mall (H)						
	2.00	1.41	1.00	1.00		1.10	1.04	1.00	1.41	2.00	
					J.P. Menteri (H)						
3 #				2.12		1.90	2.03	2.30	2.20	2.30	1,2 #
4 #	3.00	2.56	2.30	2.30			3.13				3,4 #
1,2 #				3.06							
					Kuala Lumpur						
	Kepong.Mall								Kepong.Mall		
	Parda.stop		All pass				All pass		Parda.stop		
4 #	30.30	29.23	27.30	26.52	Total	32.00	26.34	27.30	28.47	29.30	1 #

(Note) 1. DTP : Ground facilities are assumed to be completed by the DTP.

2. RBCS : Assuming construction of additional halts by the RBCS Project.

3. Rapid (A): Rapid train passing all stations between Rawang and Kuala Lumpur.

4. Rapid (B): Rapid train stopping at Kepong, Mall, and Pardana Menteri only.

5. H and (H): Halts

6. (S) : Signal station

7. Cal : Calculated operating time

8. Plan : Planned operating time

9. 7.20 : 7 minutes 20 seconds

10. Track No.: Arrival/departure track for DMU trains

Table 5-3-6 Planned Operating Time of DMU Trains between Stations on the Kuala Lumpur - Seremban Section

(1) Local

DOWN TRAIN ↓					Section		↑ UP TRAIN				
Track No.	RACS		O.T.P.		Station	Distance (km)	O.T.P.		RACS		Track No.
	Plan	Cal	Plan	Cal			Cal	Plan	Cal	Plan	
1,2 #			4.30	4.10			3.55	4.00			3,4 #
3 #			3.30	3.21	Kuala Lumpur		3.40	4.00			2 #
4 #	4.00	3.30	4.00	3.30		3.50	4.15	4.30	4.15	4.30	1 #
					Brickfierd Yard						
					P.Klang Line J. (S)						
					Siputeh (H)						
	4.00	4.06	4.00	4.06		3.90	3.54	4.00	3.54	4.00	
					Salak South						
	5.00	4.50	5.00	4.50		4.10	5.12	5.30	5.12	5.30	
					Sungai Besi (H)						
	5.00	5.02	9.00	8.48		5.10	9.10	9.30	5.10	5.30	
					Serdang						
	5.00	4.46	9.00	9.00		4.90	8.34	8.30	4.55	5.00	
					H 3						
	5.30	5.33				5.25			5.08	5.30	
					Kajang						
	10.00	9.38	10.00	9.38		10.75	10.08	10.00	10.08	10.00	
					Bangi						
	8.30	8.34	8.30	8.34		10.25	8.00	8.00	8.00	8.00	
					Batang Benar						
	4.30	4.18	4.30	4.18		4.50	4.30	4.30	4.30	4.30	
					Nilai (H)						
	5.30	5.34	5.30	5.34		7.00	5.37	5.30	5.37	5.30	
					Labu						
	5.00	4.50	5.00	4.50		5.25	4.39	5.00	4.39	5.00	
					Tiroi (H)						
	9.00	9.00	9.00	9.00		8.75	8.14	8.30	8.14	8.30	
					Seremban						
4 #	71.00	69.41	73.30	72.08	Total	73.25	72.13	73.30	69.42	71.30	1 #

(2) Rapid

DOWN TRAIN ↓					Section		↑ UP TRAIN				
Track No.	Rapid (B)		Rapid (A)		Station	Distance (km)	Rapid (A)		Rapid (B)		Track No.
	Plan	Cal	Plan	Cal			Cal	Plan	Cal	Plan	
1,2 #							3.23	3.30			3,4 #
3 #			3.30	3.00	Kuala Lumpur		3.08	3.30			2 #
4 #	4.00	3.09	4.00	3.09		3.50	3.43	4.00	3.43	4.00	1 #
					Brickfierd Yard						
					P.Klang Line J. (S)						
					Siputeh (H)						
	2.30	2.24	2.30	2.24		3.90	2.30	2.30	2.30	2.30	
					Salak South						
	4.00	3.40	4.00	3.40		4.10	3.46	4.00	3.46	4.00	
					Sungai Besi (H)						
	4.00	3.40	4.00	3.40		5.10	3.34	3.30	3.34	3.30	
					Serdang						
	8.30	8.14	7.30	7.35		4.90	7.21	7.30	7.50	8.00	
					H 3						
						5.25					
					Kajang						
	9.00	9.02	8.30	8.20		10.75	8.46	9.00	9.38	10.00	
					Bangi						
	7.00	7.08	7.00	7.08		10.25	7.00	7.00	7.00	7.00	
					Batang Benar						
	3.30	3.27	3.30	3.27		4.50	3.36	3.30	3.36	3.30	
					Nilai (H)						
	4.30	4.16	4.30	4.16		7.00	3.56	4.00	3.56	4.00	
					Labu						
	2.30	2.37	2.30	2.37		5.25	2.40	3.00	2.40	3.00	
					Tiroi (H)						
	8.00	7.48	8.00	7.48		8.75	7.08	7.30	7.28	7.30	
					Seremban						
	Kajang Stop								Kajang Stop		
4 #	57.30	55.25	56.00	54.04	Total	73.25	54.00	55.30	55.41	57.00	1 #

(Note) 1. Rapid (A): Trains which pass all stations between Kuala Lumpur and Seremban.

2. Rapid (B): Trains which stop at Kajang only.

(2) Stopping time

2 minutes or more at Kuala Lumpur station, and 1 minute or more at other stations.

(3) Standard travelling time between stations

The standard travelling time between major stations is shown in Table 5-3-7.

Table 5-3-7 Standard Travelling Time Between Major Stations by Train Type

Section	Train type		Travelling time (minute/second)			Schedule time (km/h)	Remarks
			Running	Stop	Total		
Rawang - K.L.	DTP		33.00	(6) 6	39.00	49	
	RBCS	Rapid(A)	27.30	(0) 0	27.30	69	
		Rapid(B)	29.30	(3) 3	32.30	59	Stopping at Kepong, Mall, and Pardana Menteri
		Local	36.00	(8) 8	44.00	43	
K.L. - Seremban	DTP		73.30	(10) 10	83.30	52	
	RBCS	Rapid(A)	55.30	(0) 0	55.30	79	
		Rapid(B)	57.00	(1) 1	58.00	75	
		Local(A)	71.30	(11) 11	82.30	53	
K.L. - Kajang	RBCS	Rapid(B)	22.00	(0) 0	22.00	73	
K.L. - Bangi	RBCS	Local(A)	40.00	(6) 6	46.00	49	
		Local(B)	40.00	(6) 11	51.00	44	Number of refuge: 1

(Note) 1. The figures given in the horizontal columns indicated "DTP" denote the estimated value.
2. Operating time: for up trains
3. Stopping time: 1 minute per station. Figures in parentheses denote the number of stopping stations.

5-3-4 Improvement in DMU Handling Capacity at Kuala Lumpur Station

During commuting hours, platforms of Kuala Lumpur Station are mostly occupied by long-distance passenger trains and freight trains. (See Appendices 5-3-1 and 5-5-1)

In order to enable operating a large number of DMU trains, during these hours, the following measures have to be taken.

(1) Suspension of handling long-distance passenger trains and freight trains during commuting hours.

1) DMUs

To be operated between 6 a.m. and 12 p.m., with commuting hours defined as between 6 a.m. and 8:30 a.m. and between 4 p.m. and 7 p.m.

2) Long-distance passenger trains

To be operated in principle between 5:30 and 6:30 a.m., 8:30 a.m. and 4 p.m., and 7 p.m. and 12 p.m.

3) Freight trains

To be operated between 3 a.m. and 6 a.m., 8:30 a.m. and 4 p.m., and 7 p.m. and 12 p.m.
(Note: Track maintenance is carried out utilizing the fixed time zone from 12 p.m. and 3 a.m.)

(2) Restricted platform use during commuting hours

To minimize decrease in train handling capacity due to level crossings among up and down trains during commuting hours, DMU trains are assigned to platforms as follows:

1) Up train .... Track No. 1 and 2

2) Down train .... Track No. 3 and 4

For passenger's convenience, each platform is assigned for a specific direction, as follows:

Track No.1 ... for Sentul - bound trains
Track No.2 ... for Rawang "
Track No.3 ... for Seremban "
Track No.4 ... for P. Klang "

(3) Removal of parcel handling works

The main tracks of the Kuala Lumpur Station are occupied for a considerable period of a day to handle parcels carried by long-distance passenger trains. To make available the maximum use of these tracks by DMU trains, the parcel handling work is to be shifted to the Brickfield Yard. (See Appendix 5-5-1)

(4) Shifting of shunting operation of long-distance passenger trains from K.L. to Brickfield

Among 20 long-distance passenger trains arriving at K.L., only 2 trains pass through the Kuala Lumpur Station and the rest are either originated or terminated there.

Coaches of the originating/terminating trains are shunted by shunting locomotives between Kuala Lumpur station and the coach shed. This shunting operation interferes train movement on the main tracks and causes decrease in the train handling capacities of main tracks.

In order to improve this situation, the trainset is moved from the station to the Brickfield yard tracted by the main-line locomotive immediately after discharging passengers, and shunting works are carried out in the yard.

In this connection, related tracks in the coach shed have to be upgraded, with introduction of radio equipment for communication between a main-line locomotive driver and a shunter in the yard.

(5) Minimum headway

Train headway, upon completion of the DTP, is expected to be approximately 9.5 minutes between Rawang and Kuang, 10 minutes. between Batu Caves Line Junction (Jct.) and Kuala Lumpur, and 13 minutes. between Batang Benar and Labu.

On the section between Batu Caves Jct. and P.Klang Line Jct., where DMU trains for the Rawang - Seremban line and those for the Batu Caves - P.Klang line are jointly operated on the same tracks, the train headway for each line becomes 20 minutes. This is because approximately the same number of trains for both lines are jointly operated on the section where the minimum headway is limited to 10 minutes.

By introducing automatic block system, it is estimated that the minimum headway of the Batu Caves Jct. and the P.Klang Jct. will be improved up to approximately 5 minutes as shown in the preliminary train diagram. (See Appendix 5-6-1)

(6) Level crossing

Even after the double tracking is completed by the DTP, the level crossings at Batu Caves Jct. and P.Klang Jct. will remain.

By reducing the train headway between Batu Caves Jct. and P.Klang Jct. by introducing the automatic block system, the number of trains will grow in future. Then, even a slight delay of a single train crossing these junctions will adversely affect the subsequent train traffic for a long period of time. Thus, it is recommended to grade-separate these junctions as early as possible. (See Appendix 5-7-1)

5-4 Transport and Operation Plan

5-4-1 Framework of Plan

The RBCS system is planned to have a transport capacity equivalent to the traffic demand as of 2005.

Hence, the transport and operation plan for RBCS as of 2005 is, first, drawn up in view of the traffic demand in 2005. Then a plan as of 1997, where the RBCS is to be inaugurated, is planned taking account of coordination with the plan for 2005.

(1) Traffic volume between stations

Traffic volume between stations is determined by procedures as shown in Fig. 5-4-1 and Fig. 5-4-2.

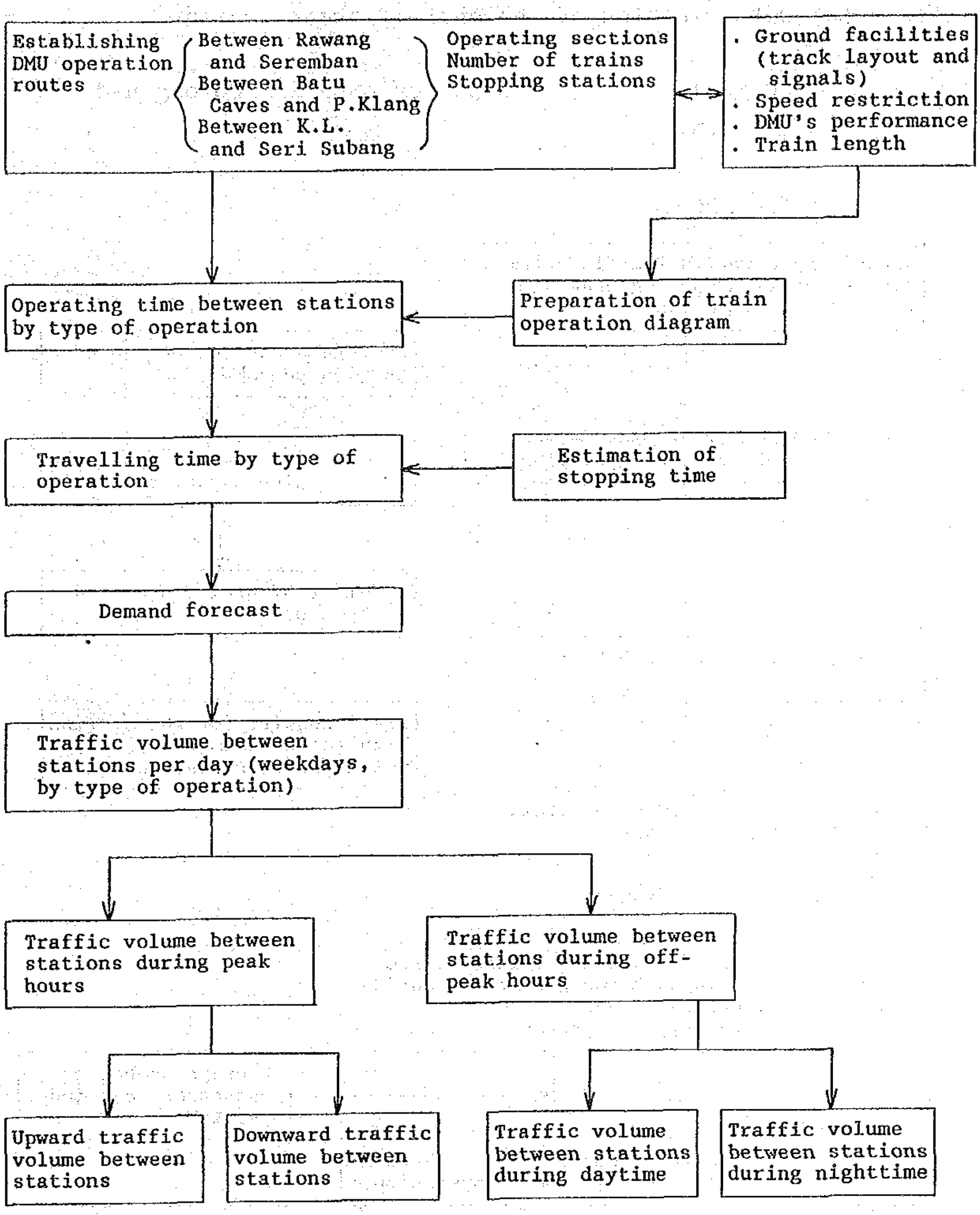
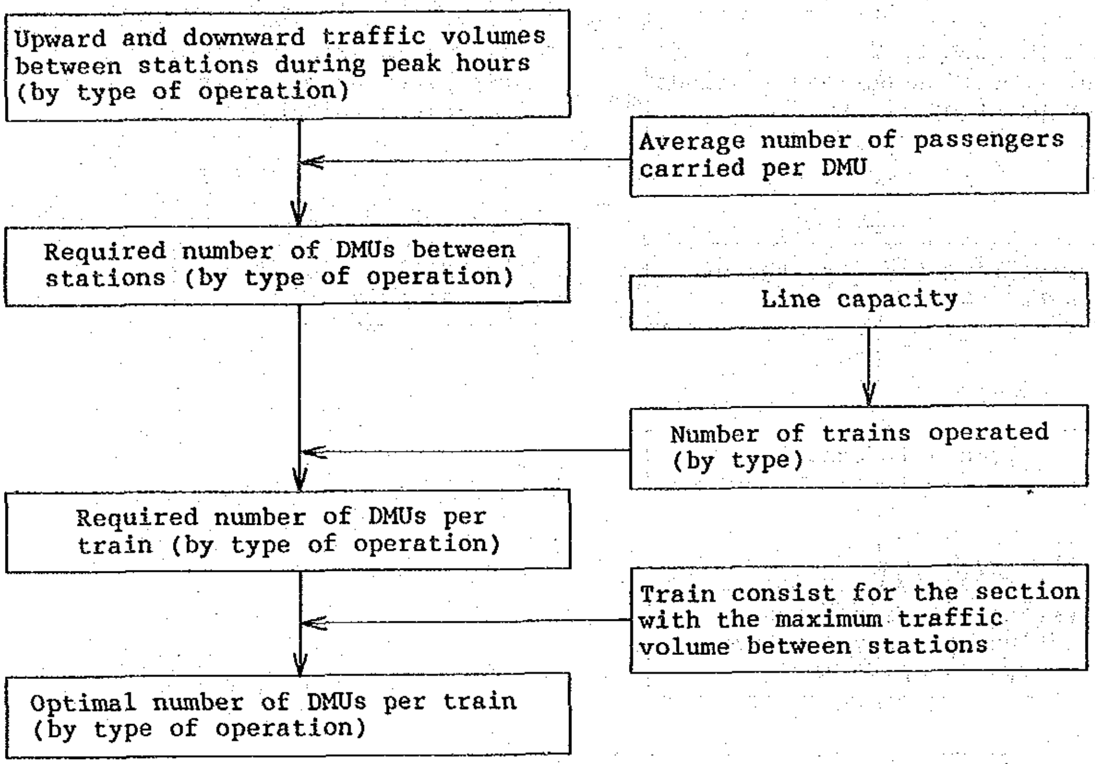


Fig. 5-4-1 Procedures to Determine Traffic Volume Between Stations

(2) Determination of the optimal train consist

Optimal train consist for DMUs is determined as follows.

1) Peak hours



2) Off-peak hours

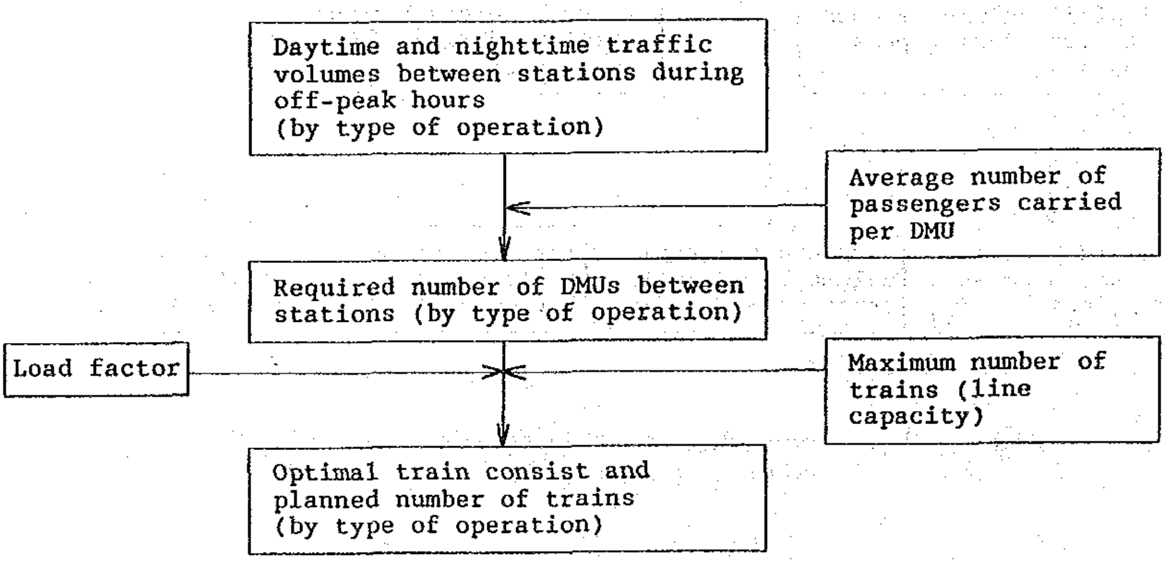


Fig. 5-4-2 Procedures to Determine the Optimal Train Consist

5-4-2 Types of DMU Operation and Number of Passengers

(1) Types of DMU operation

Incidentally, the types of DMU operation provisionally employed as the preconditions of the demand forecast (Chapter 4) are as shown in Fig. 5-4-3. They had been put to consultation wiht MRA.

Fig. 5-4-3 Types of DMU Operation

Rawang - K.L. - Seremban section

Station	L1	L3	L2	L2'
Rawang	●	●	●	●
Kuang	●	●	●	●
H1	●	●	●	●
Sg. Buloh	●	●	●	●
Kepong	●	●	●	●
H2	●	●	●	●
Segambut(H)	●	●	●	●
Mall(H)	●	●	●	●
J.P.Menteri(H)	●	●	●	●
K.L.	●	●	●	●
Siputeh(H)	●	●	|	|
Salak South	●	●	|	|
Sg.Besi(H)	●	●	|	|
Serdang	●	●	|	|
H3	●	●	|	|
Kajang	●	●	●	|
Bangi	●	●	|	|
Batang Benar		●	|	|
Nilai(H)		●	|	|
Labu		●	|	|
Tiroi(H)		●	|	|
Seremban		●	●	●

Batu Caves - K.L. - P.Klang section (related section)

Station	L6	L6'	L6''	L7
Batu Caves	●		●	
Taman Wahyu	●		●	
Kg.Batu	●		●	
Sentul	●		●	
JLN. Ipoh	●		●	
Mall	●		●	
J.P.Menteri	●		●	
K.L.	●		●	●
TMN.Ghazali	●		●	|
Angkasapuri	●		●	|
Pantai Dalam	●		●	|
Petaling	●		●	|
Petaling Jaya	●		●	|
KG.Datuk Harun	●		●	|
Seri Setia	●		●	|
SG.Way	●		●	|
Subung Jaya	●		●	●
Seri Subung				●
Batu Tiga	●		●	
SG.Renggam	●		●	
Shah Alam	●	●	●	
PDG.Jawa	●	●		
STN.Janakusa	●	●		
Klang	●	●		
Teluk Pulai	●	●		
Teluk Gadong	●	●		
KG.Raja Uda	●	●		
P.Klang Pusat	●	●		
P.Klang	●	●		

(Note) 1. L1, L3 : Local
2. L2, L2' : Rapid (K.L. - Seremban section)
3. —●— : Stopping station

(2) DMU's carrying capacity

1) DTP

According to the tender specifications, in the DTP, MRA intends to have DMUs with following carrying capacity.

Minimum number of DMUs per train: 3
Seating capacity: 210 passengers/train
Standing space: 90 passengers/train
Total: 300 passengers/train

This means that the carrying capacity per DMU-car is 100 passengers.

On the other hand, the capacity in the 1993 transportation plan is determined at 110 passengers per DMU, according to the material of MRA's Passenger Bureau.

2) RBCS train plan

DMU trains for the RBCS require a large carrying capacity with reasonable riding comfort, while from financial viewpoint the total number of DMUs has to be minimized. To attain these contradicting requirements, seat arrangement, location and number of doors, and flexible train consist during off-peak hours have to be scrutinized taking account of the following standard service levels; (Refer to Chapter 6 "DMU Plan")

a) Peak hours

- To ensure seats for passengers on board for longer than 30 minutes.

- To limit the maximum number of passengers per car to 245.

b) Off-peak hours

The train consist and the number of trains are planned with the average load factor of 80% on the most congested section.

5-4-3 Transport and Operation Plan in 2005

(1) Traffic volume between stations

The traffic volume for each type of DMU train operation, as determined by the demand forecast, is assigned to peak and off-peak hours by using the following method.

1) Peak hours

Based on the data furnished by MRA's Passenger Bureau (Refer to Table 5-4-1), the ratio of traffic volume between stations during peak hours to the total daily traffic volume of the day is estimated to range between 57% and 63%. From this it was calculated to be 12% - 15% per hour of the total traffic of the day. This ratio is verified by the Cordon line survey data of buses and passengers at 10km from Kuala Lumpur.
(Refer to Appendix 5-8-1)

Table 5-4-1 Passenger Trips/Day During Peak and Off-peak Hours (1993)

Section	Number of Passenger Trips/day					
	Peak		Off Peak		Total	
		%		%		%
K.L. - Rawang	15,300	60	10,200	40	25,500	100
K.L. - Seremban	20,400	63	11,900	37	32,300	100
K.L. - P.Klang	10,000	57	7,500	43	17,500	100
K.L. - Subang	-		-		-	

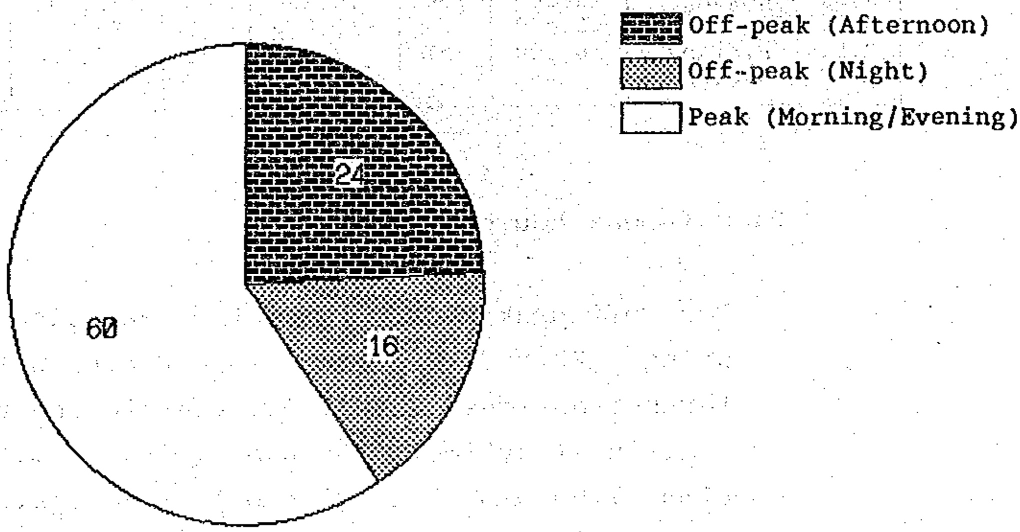
2) Off-peak hours

For off-peak hours, the ratio was also estimated using MRA's data. The off-peak hour's traffic is further assigned to daytime traffic and night time traffic (daytime: 8:30 a.m. - 4:00 p.m. and night time: 7:00 p.m. - 12:00 p.m.) This assignment was made using the ratio studied in the periodical transport survey (1985) conducted by Japanese National Railway (JNR); i.e. 60% for the daytime hours, and 40% for the nighttime hours.
(Refer to Appendix 5-8-1)

3) Traffic assignment

Distribution of traffic volume as calculated from 1) and 2) above is illustrated below.

a) Rawang - Kuala Lumpur



b) Kuala Lumpur - Seremban

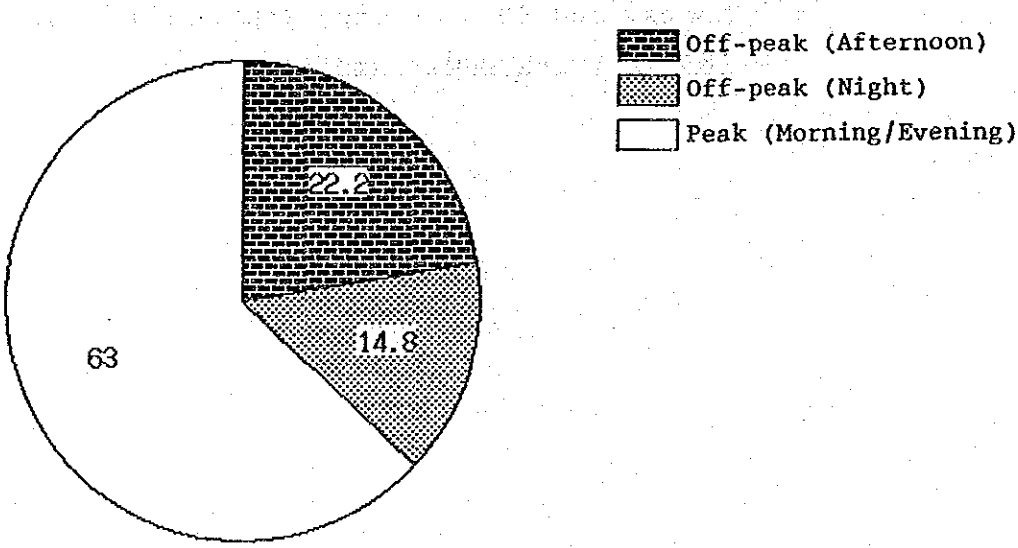


Fig.5-4-4 Assignment of Traffic Volume by Time Zone

c) Traffic volume between stations in 2005

Traffic volume between stations in 2005 was estimated as shown in Fig.5-4-5. The section with the largest traffic volume is Segambut - Mall and Salak South - Sg.Besi, ranging between 93,000 and 109,000 per day, while the section with the smallest traffic volume is between Bangi and Seremban, at 17,000 passengers per day.

Traffic volume in the Mall - Kuala Lumpur section is relatively small, with 37,000 passengers per day.

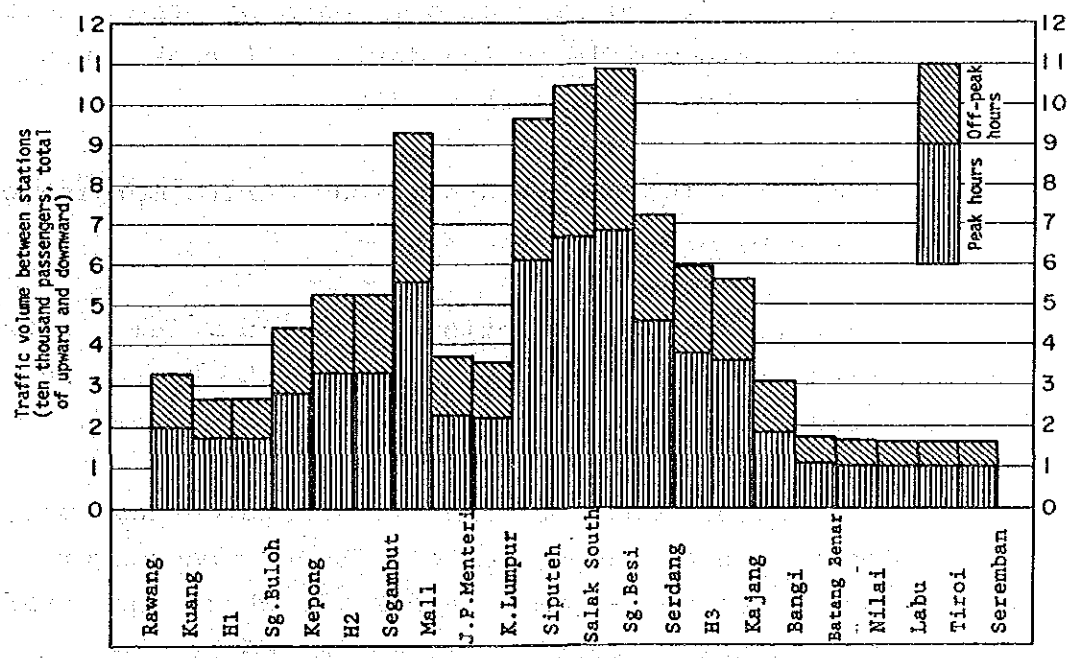


Fig.5-4-5 Traffic Volume Between Stations
(2005, weekdays, excluding P.Klang line)

(Refer to Appendix 5-9-1)

(2) Traffic volume between stations by direction

Traffic volume between stations during peak and off-peak hours were further divided into in-bound traffic (toward K.L.) and out-bound traffic toward Rawang or Seremban.

1) Peak hours

The in-bound traffic volume ratio in the morning peak hours accounts for 65%, according to JICA M/P 87. This value was adopted.

2) Off-peak hours

The traffic volume ratio in each of the in-bound and out-bound direction during off-peak hours was assumed by the Team to be 50%.

3) Traffic volume between stations during morning peak hours by directions in 2005

From the above assumptions, traffic volume between stations by direction during peak hours in the morning was estimated as shown in Fig.5-4-6.

The largest downward traffic volume during morning peak hours, approximately 18,000 passengers, is seen between Segambut and Mall, while the traffic on adjacent sections is estimated to be in the range between 7,000 and 10,000 passengers, showing a conspicuous difference.

On the other hand, the largest upward traffic volume, approximately 22,000 passengers, is seen between Sg.Besi and Salak South.

Traffic volume from Kuala Lumpur to Mall is approximately 3,900 passengers, with a large number of passengers getting off at Kuala Lumpur.

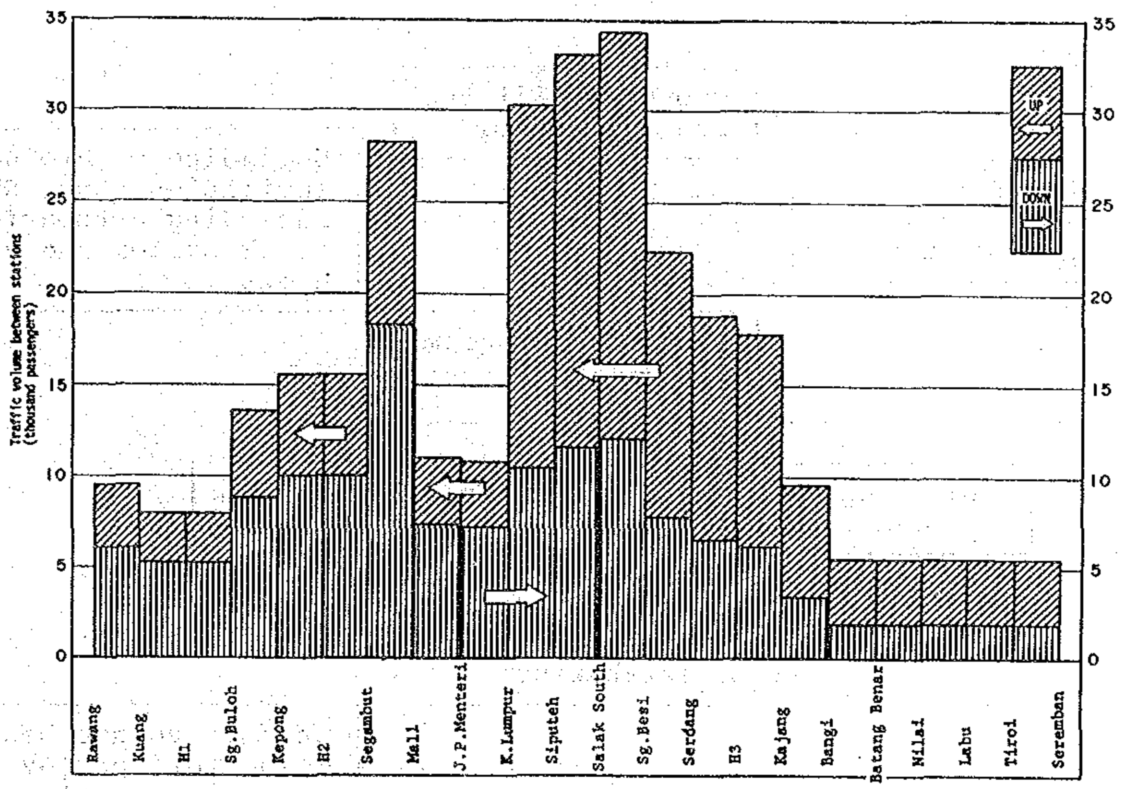


Fig.5-4-6 Traffic Volume Between Stations during Morning Peak Hours by Direction (2005, Weekdays) (Refer to Appendix 5-9-1)

(3) The maximum number of DMU trains

1) During peak hours

The maximum number of DMU trains was determined in accordance with the following procedure.

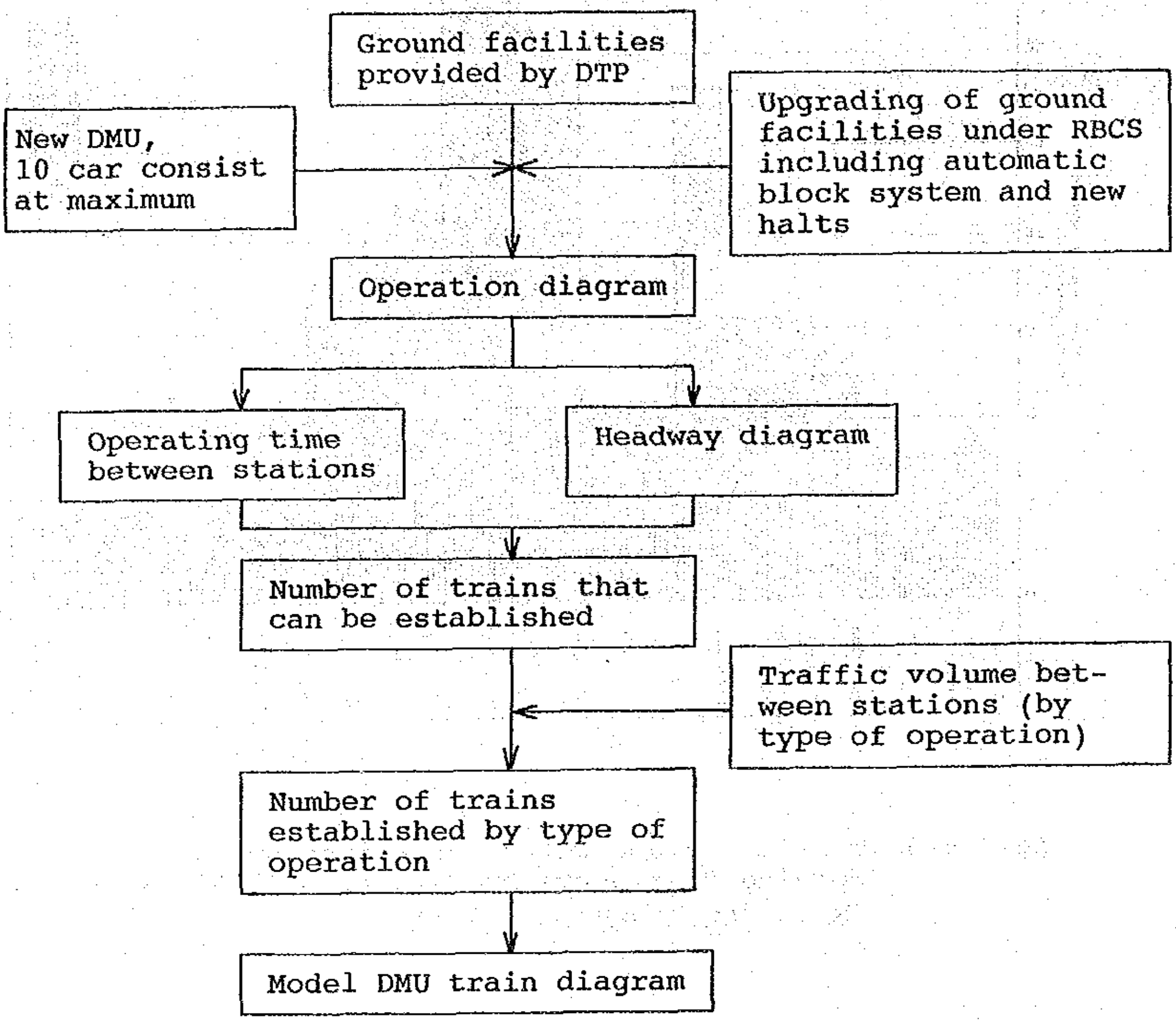


Fig. 5-4-7 Procedures to Prepare Train Diagram

First, from the headway diagram of a section around Kuala Lumpur (Refer to Appendix 5-6-1), the number of trains that can be operated between Batu Caves Line Jct., Kuala Lumpur, and P.Klang Line Jct. is determined.

Then, the number of trains for each type of operation is determined in consideration of corresponding traffic volume between stations (Refer to Fig. 5-4-8 and Appendix 5-9-1 and a model DMU train diagram is prepared.

In this case, the ratio of DMU trains on the Rawang - Seremban section to those on Batu Caves - P.Klang section is set at 1:1 because the largest sectional traffic of the two sections are comparable.

Table 5-4-2 The Largest Traffic Volume Between Stations (2005)

Section	Stations	Traffic volume (passengers/day, up and down total)
Rawang - K.L. K.L.- Seremban	Segambut - Mall Salak South - Sg.Besi	93,714 109,005
Batu Caves - K.L. K.L.- P.Klang	Batu Caves - Taman Wahyu Batu Tiga - Shar Alam	89,173 70,109

On the other hand, the ratio of rapid trains to local trains between Kuala Lumpur and Seremban is set at 1:2 in consideration of traffic volume between Salak South and Sg.Besi. (Refer to Fig.5-4-8)

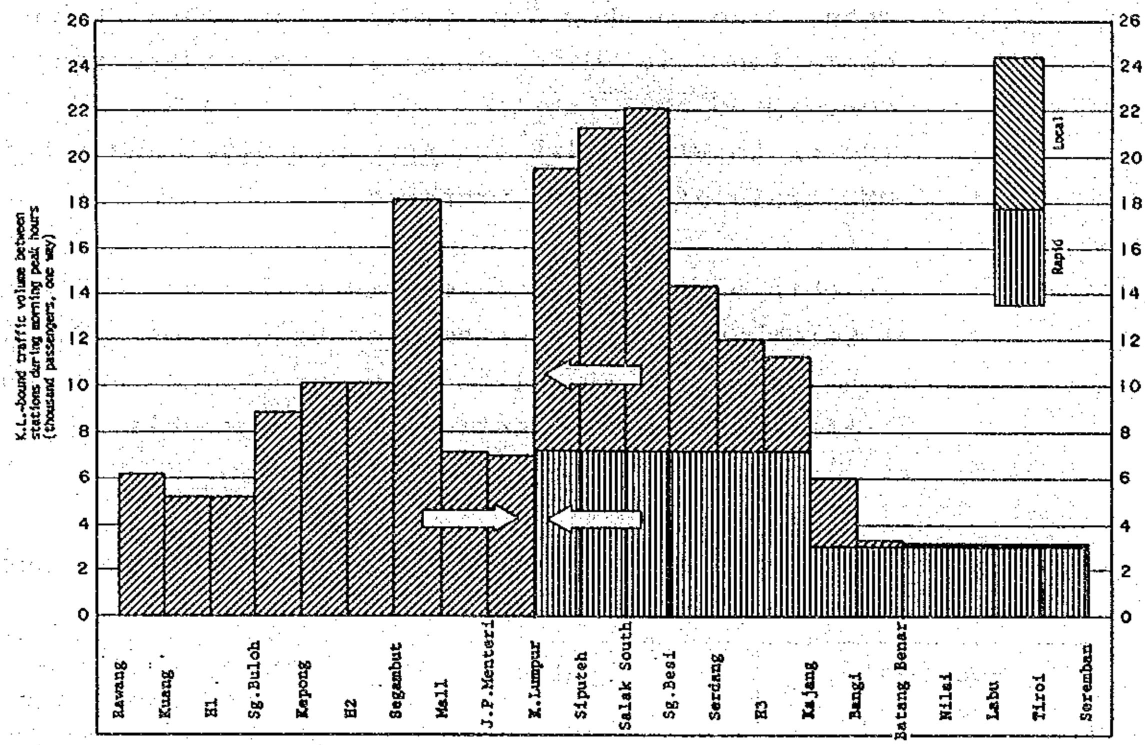


Fig.5-4-8 In-bound Traffic Volumes between Stations During Morning Peak Hours by Type of Operation (2005, Weekdays)

The maximum number of DMU trains (DMU train operation capacity) that can be operated during morning peak hours is shown in Table 5-4-3. Note that, between 6:00 a.m. and 6:30 a.m., considerations are given to the operation of two in-bound long-distance passenger trains terminating at the K.L. station, and deadhead operation of these trains to the coach shed. The number of trains operated in the evening peak hours is considered to be the same as that in the morning peak hours.

Table 5-4-3 The Maximum Number of DMU Trains During Morning Peak Hours (One way) (6:00 - 8:30)

Type of operation	Number of DMU trains		
	Rapid	Local	Total
Rawang - Seremban	5	9	14
Batu Caves - P.Klang	-	-	12
Total	(5)	(9)	26

(Note) Rapid and local trains operated between Batu Caves and P.Klang is not included.

2) During off-peak hours

a) The maximum number of DMU trains during daytime hours (8:30 a.m. - 4:00 p.m.)

The maximum number of DMU trains was determined in consideration of line capacity, number of long-distance passenger/freight trains as shown in Table 5-4-4. (As for the number of long-distance passenger/freight trains, refer to Appendix 5-10-1)

Table 5-4-4 The Maximum Number of DMU Trains During Off-peak Daytime Hours (One way) (8:30 - 16:00)

Item	The maximum number of DMU trains	
	Up	Down
Long Distance Passenger Train ⓐ	7	4
Freight Train ⓑ	6	9
Total ⓐ + ⓑ = ⓒ	13	13
The maximum number of trains with track utilization rate set at 60% $\left(\frac{450 \text{ min.} \times 0.6}{5 \text{ min.}}\right)$ ⓓ	54	54
The maximum number of DMU trains ⓓ - ⓒ = Ⓔ	41	41

Thus, assuming that the ratio of DMU trains on the Rawang - Seremban line to that on the Batu Caves - P.Klang line is 1:1, 20 trains/one way can be operated on each line.

b) The maximum number of DMU trains during night time hours (7:00 p.m. - 12:00 p.m.)

The maximum number of DMU trains during night time hours is determined in the same manner as that during daytime hours, as shown in Table 5-4-5.

Table 5-4-5 The Maximum Number of DMU Trains During Off-peak Night Time Hours (One way) (19:00 - 24:00)

Item	The maximum number of DMU trains	
	Up	Down
Long Distance Passenger Train ⓐ	4	4
Freight Train ⓑ	8	7
Total ⓐ + ⓑ = ⓒ	12	11
The maximum number of trains with track utilization rate set at 60% $\left(\frac{300 \text{ min.} \times 0.6}{5 \text{ min.}}\right)$ ⓓ	36	36
The maximum number of DMU trains ⓓ - ⓒ = Ⓔ	24	25

Thus, assuming that the ratio of DMU trains on the Rawang - Seremban line to that on the Batu Caves - P.Klang line is 1:1, 12 trains/one way can be operated on each line.

3) The maximum number of DMU trains per day

The maximum number of DMU trains by time zone in 2005 was estimated from 1) and 2) above, as shown Table 5-4-6.

Table 5-4-6 The Maximum Number of DMU Trains by Time Zone (One way)

(up)

Time zone		Peak	Off-peak	Peak	Off-peak	
Item		6:00 - 8:30	8:30 - 16:00	16:00 - 19:00	19:00 - 24:00	Total
Long Distance Passenger Train		1	7	0	4	12
Freight Train		0	6	0	8	14
DMU	Batu Caves - P.Klang	12	21	18	12	63
	Rawang - Seremban	14	20	18	12	64
Total		27	54	36	36	153

(4) DMU train operation plan

1) Peak hours

a) Number of DMUs per train

The number of DMUs required per train was determined in accordance with the following procedure.

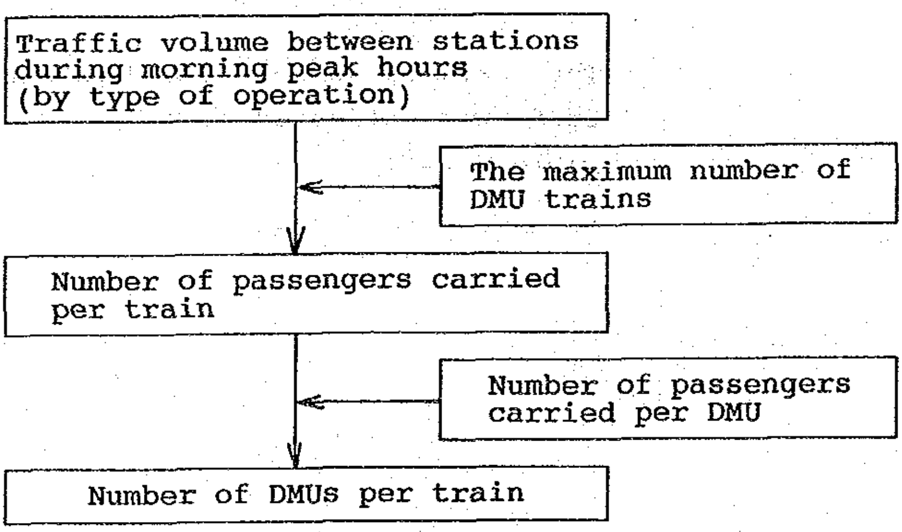


Fig. 5-4-9 Procedures to Determine DMU Train Circuit

b) Number of passengers carried per DMU

The number of passengers carried per DMU is determined by DMU's design and load factor.

Railcars used for commuting are required to have the following characteristics:

i) To be capable of carrying as many passengers as possible during peak hours;

ii) To allow quick boarding and detraining within a short period of time; and

iii) To assure a certain number/quality of seats for long-ride passengers.

Carrying capacity of DMU for RBCS (hereinafter referred to as RBCS car) is increased to 140 passengers/car from 107 passengers/car for DTP car. Load factor for RBCS car, on the other hand, is set at 175%, in consideration of 177% set for DTP car.

Consequently, the maximum carrying capacity of RBCS car becomes 245 (140 x 175) passengers/car. (Refer to Table 5-4-7)

c) The number of DMUs per train

Relationship between the number of passengers per DMU and the number of DMUs required per train, on the sections with the largest traffic volume, is shown in Table 5-4-7.

Table 5-4-7 The Number of DMUs per Train
(One Way, During Morning Peak Hours in 2005)

Section	Train type	Max. sectional traffic demand	Number of trains during (one way)	Number of DMUs per train
Rawang - K.L.	Local	18,274	12 (14)	6.2 → 7 (5.3)
K.L. - Kajang	Rapid	7,295	5 (4)	6.0 → 7 (7.4)
K.L. - Bangi	Local	15,023	9 (10)	6.8 → 7 (6.1)

Where, Carrying capacity : 140 passengers/DMU
Max. number of
passengers per DMU : 245 passengers/DMU
Max. load factor : 175%
(Refer to Appendix 5-11-1)

In Table 5-4-7, train consist of rapid DMU is calculated to be 6.0 DMU/train, while that for local DMU (K.L. - Bangi) as 6.8 DMU/train.

In consideration of unified train consist among rapid and local trains and riding comfort of rapid DMUs passengers, rapid train consist was determined as 7 DMUs/train. Similarly, train consist of local train (Rawang - K.L.) is determined as 7 DMUs/train.

2) Off-peak hours

In general, the load factor for off-peak hours is assumed to be 70% to 80%. In this study, the required number of trains and the required number of DMUs per train were calculated with the load factor of 80%.

Traffic volume between stations during off-peak hours is shown in Fig.5-4-10. (Refer to Appendix 5-9-1)

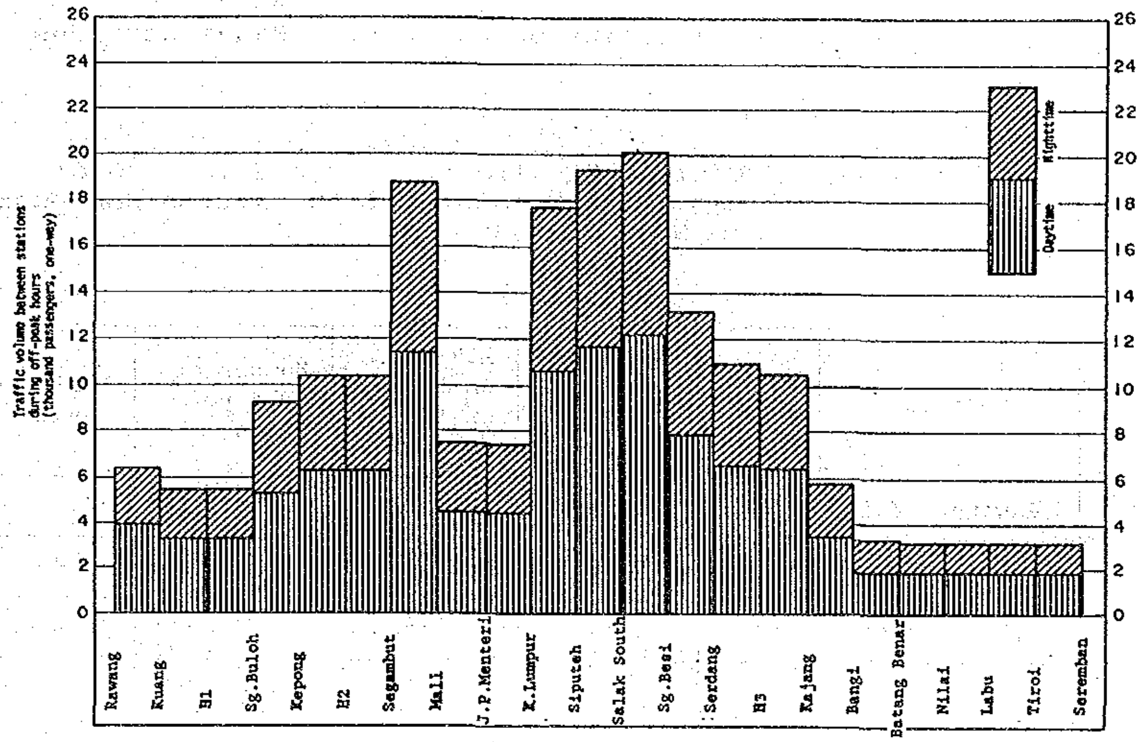


Fig.5-4-10 Traffic Volume between Stations during Off-peak Hours (2005, Weekdays)

a) Daytime hours

By dividing the maximum sectional traffic demand between stations during daytime hours by the maximum number of DMU trains, the number of DMUs per train becomes 5 ~ 6 as shown in Table 5-4-8.

This implies that it is more practical to operate somewhat reduced number of trains of 7-car consist than to operate 5 or 6 car-consist trains with the minimum headway.

In case of 7-car train operation with average load of 112 passengers/DMU, required number of trains were calculated as shown in Table 5-4-8; 15 local trains on the Rawang - K.L. section, 5 rapid trains on the K.L. - Kajang section, and 11 local trains on the K.L. - Bangi sections.

Table 5-4-8 Number of DMU Trains Required in Case of 7-car Train-Consist During Daytime Non-peak Hours (One Way, in 2005)

Section	Train type	Max. sectional traffic demand	Max. number of trains (one way)	Number of DMUs per train	Number of trains
Rawang - K.L.	Local	11,246	20	5.0	14.3 -> 15
K.L. - Kajang	Rapid	3,955	6	5.8	5.1 -> 5
K.L. - Bangi	Local	8,145	14	5.2	10.4 -> 11

Note: Carrying capacity
--- 112 (=140 x 0.80) passengers/DMU

b) Night time hours

With the same way taken in a) above, the required number of 7-car trains during night-time non-peak hours were calculated as shown in Table 5-4-9.

Table 5-4-9 Number of DMU Trains Required in Case of 7-car Train-Consist During Night Time Non-peak Hours (One Way, in 2005)

Section	Train type	Max. sectional traffic demand	Max. number of trains (one way)	Number of DMUs per train	Number of trains
Rawang - K.L.	Local	7,497	12	5.6	9.5 → 10
K.L.- Kajang	Rapid	2,637	4	5.9	3.4 → 4
K.L.- Bangi	Local	5,430	8	6.1	6.9 → 7

Note: Carrying capacity --- 112 (=140 x 0.80) passenger/DMU

(5) Types of DMU train operation

The traffic demand between stations suggests that the following factors should be considered in determining the types of DMU train operation.

1) Local trains between Bangi and Seremban

As the traffic demand is small compared with other sections, the train consist and number of trains determined as above should be reduced.

During peak hours in the morning and evening, some rapid trains are to be put into service linking Kuala Lumpur and Seremban.

As to the local trains, they are operated between Bangi and Seremban in the form of shuttle operation by small consist (1 car).

2) Rapid trains between Kuala Lumpur and Seremban

Traffic demand between Kajang and Seremban is also relatively small.

Hence, adjustment of the train consist or turning-back of some rapid trains at Kajang was considered.

i) Adjusting the train consist

To adjust the train consist, DMU trains could be divided or integrated at Kajang Station. However, this will brings about increase in stopping time of rapid trains, increasing travelling time. Also, additional capital investment and manpower assignment for the adjusting work is required. Thus, this solution is not adopted.

ii) Adjusting the number of trains

Instead, it is considered appropriate to take the following method:
Rapid trains from K.L. stop at Kajang Station. During peak hours, the trains continue to run up to Seremban, carrying passengers equivalent to their seating capacities, while during off-peak hours, a few trains turn back to K.L. at Kajang.

(6) DMU operation plan in 2005

The DMU operation plan in 2005 was drawn up as follows.

1) Between Rawang and Bangi (Between Rawang and Kajang for rapid trains)

Trains consist of 7 DMUs are operated with the following schedule.

Table 5-4-10 Number of DMU Trains in 2005
(Weekdays, One Way) (Rawang - Bangi)

Section	Train type		6:00 - 8:30	8:30 - 16:00	16:00 - 19:00	19:00 - 24:00		Total
Rawang - K.L.	Local		12	15	12	10		49
K.L. - Kajang	Local		9	11	9	7		36
	Rapid		5	5	5	4		19
	Total		14	16	14	11		55
Kajang - Bangi	Local		9	11	9	7		36
	Rapid		5	4	5	3		17
	Total		14	15	14	10		53

Note: Relation between time zone and number train as of the K.L. Station

2) Between Bangi (Kajang for rapid trains) and Seremban

Considering the small traffic demand of the section, DMU trains are operated as follows.

a) Peak hours

i) Rapid trains

7 trains are operated, each consisting of 7 DMUs, carrying passengers equivalent to seating capacity.

Traffic volume between stations:
3,492 passengers/one way (upward)
Seating capacity:
504 (= 72 passengers x 7 cars)

Number of trains: 7 (= 3,492 ÷ 504)

ii) Local trains

3 trains are operated, each consisting of 1 DMU, shuttling between Bangi and Seremban at an interval of 60 minutes.

Traffic volume between stations:
62/one way (upward)

Service level and number of passengers carried

- With headway of 60 minutes
  Number of train: 3 trains
  (= 2.5 hours x 60 minutes ÷ 60 minutes)
  Number of passengers carried per train:
  21 passengers
  (= 62 passengers ÷ 3 trains)

Note:
With headway of 30 minutes
Number of trains: 5 trains
(= 2.5 hours x 60 minutes ÷ 30 minutes)
Number of passengers carried per train:
13 passengers
(= 62 passengers ÷ 5 trains)

b) Off-peak hours

i) Daytime hours

- Rapid trains

4 trains are operated, each consisting of 7 DMUs, carrying passengers equivalent to their seating capacity.

Traffic volume between stations:
1,893 passengers/one way

Seating capacity: 504 passengers
(= 72 passengers x 7 DMUs)
Number of trains: 4 trains
(= 1,893 passengers ÷ 504 passengers)

- Local trains

3 trains are operated, each consisting of 1 DMU, at an interval of two hour.

Traffic volume between stations:
34 passengers/one way
Number of passengers carried per train:
12 passengers
(= 34 passengers ÷ 3 trains)

ii) Night time hours

- Rapid trains

3 train, consisting of 7 DMUs, is operated.

Traffic volume between stations:
1,262 passengers
Seating capacity: 504 passengers

- Local trains

2 trains are operated, each consisting of 1 DMU, at an interval of two hour.

Traffic volume between stations:
22 passengers/one way
Number of passengers carried per train:
11 passengers
(= 22 passengers ÷ 2 trains)

The number of DMU trains between Bangi and Seremban in 2005 is shown in Table 5-4-11.

Table 5-4-11 Number of DMU Trains in 2005 (Weekdays, One Way)
(Bangi (Kajang for rapid) - Seremban)

Time zone / Train type		6:00 – 8:30	8:30 – 16:00	16:00 – 19:00	19:00 – 24:00		Total	Remarks
Local		3	3	3	2		11	1-car consist
Rapid		7	4	7	3		21	7-car consist
Total		10	7	10	5		32	

3) Model DMU train diagram during morning peak hours in 2005

A model diagram is shown in Fig.5-4-11.

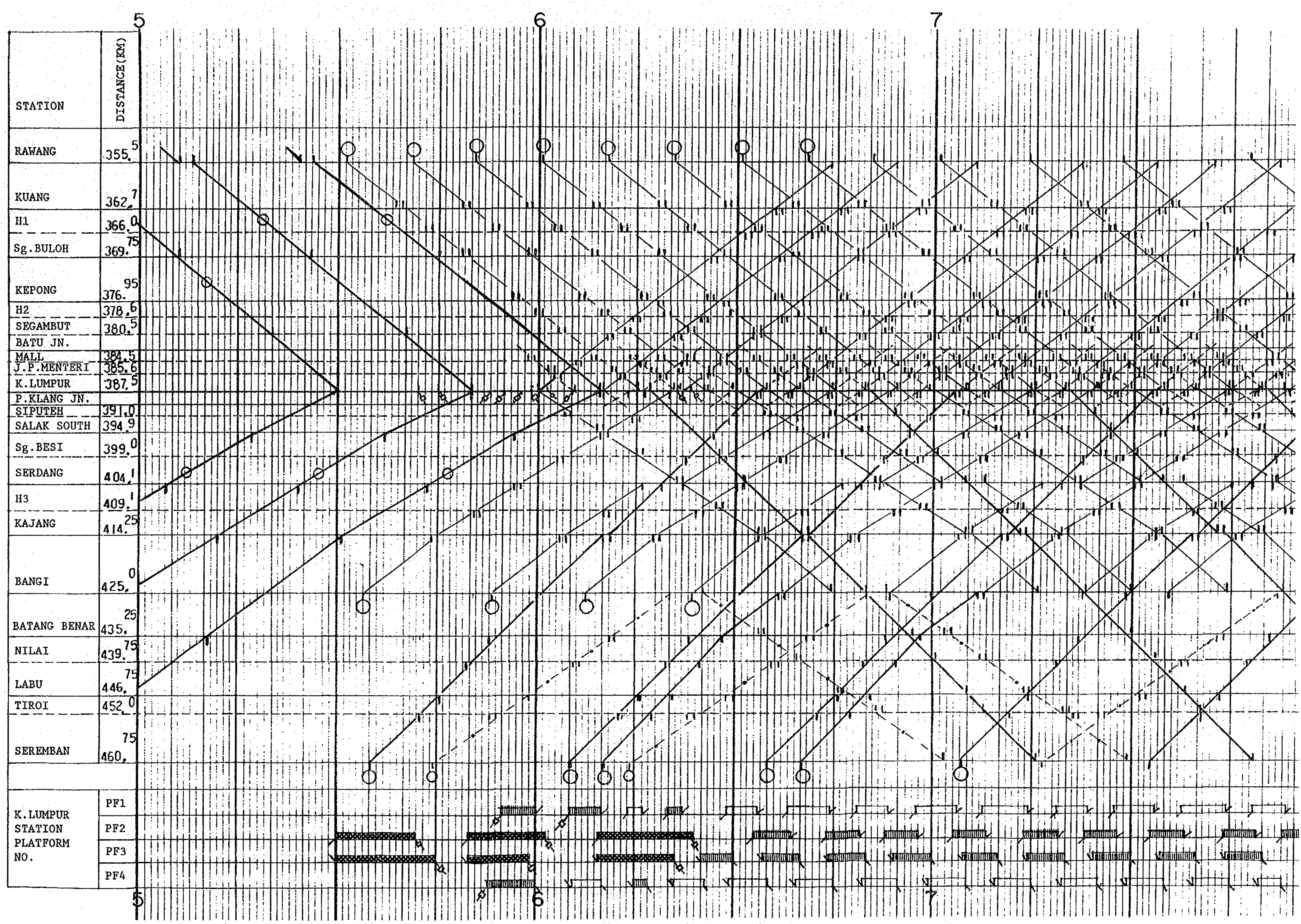
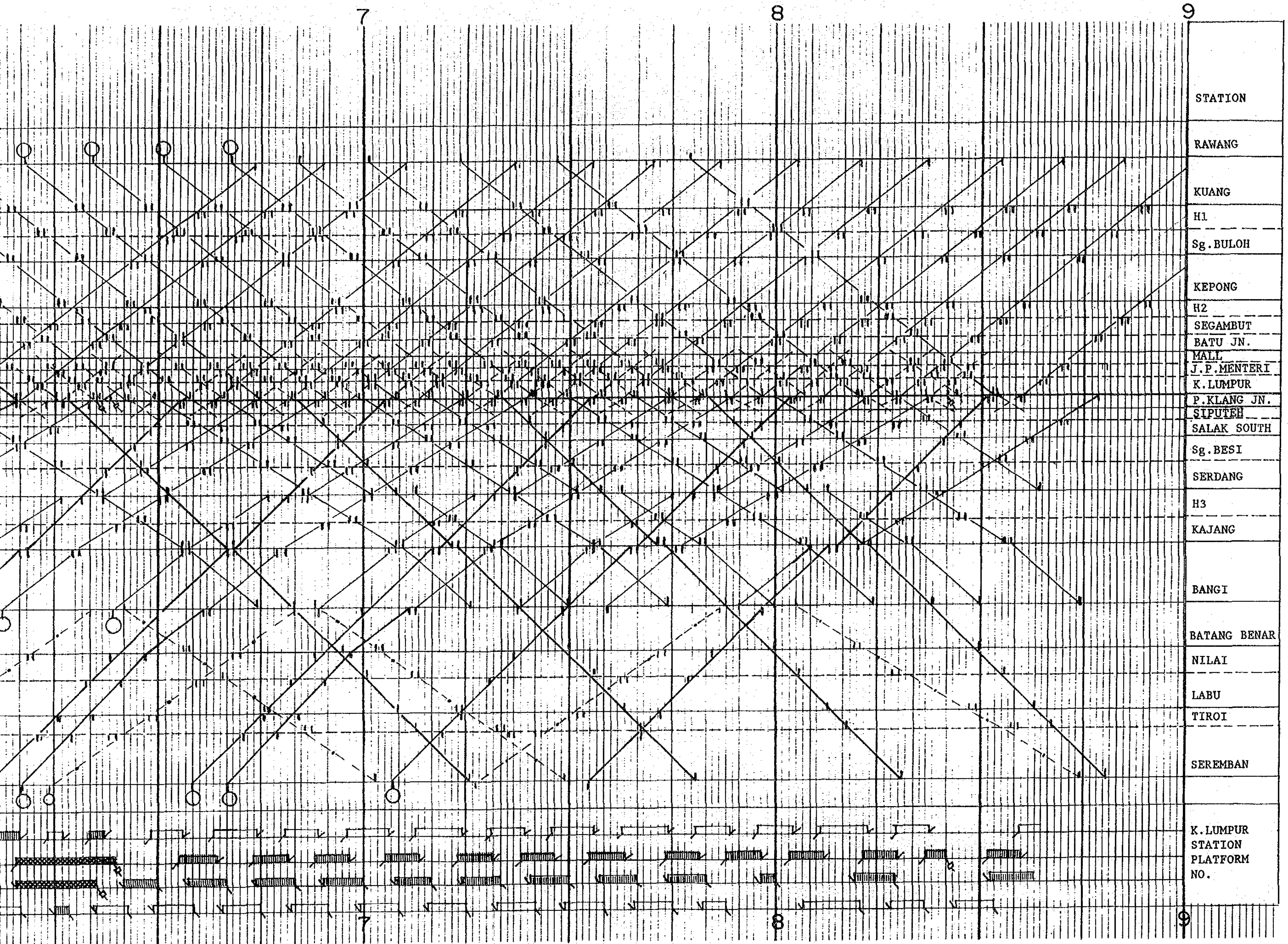


Fig. 5-4-11 Model DMU Train Diagram During Morning Peak Hours



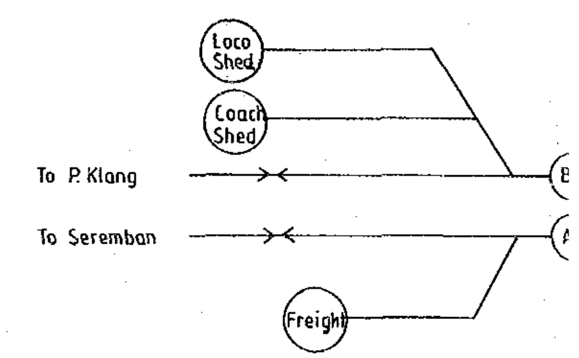
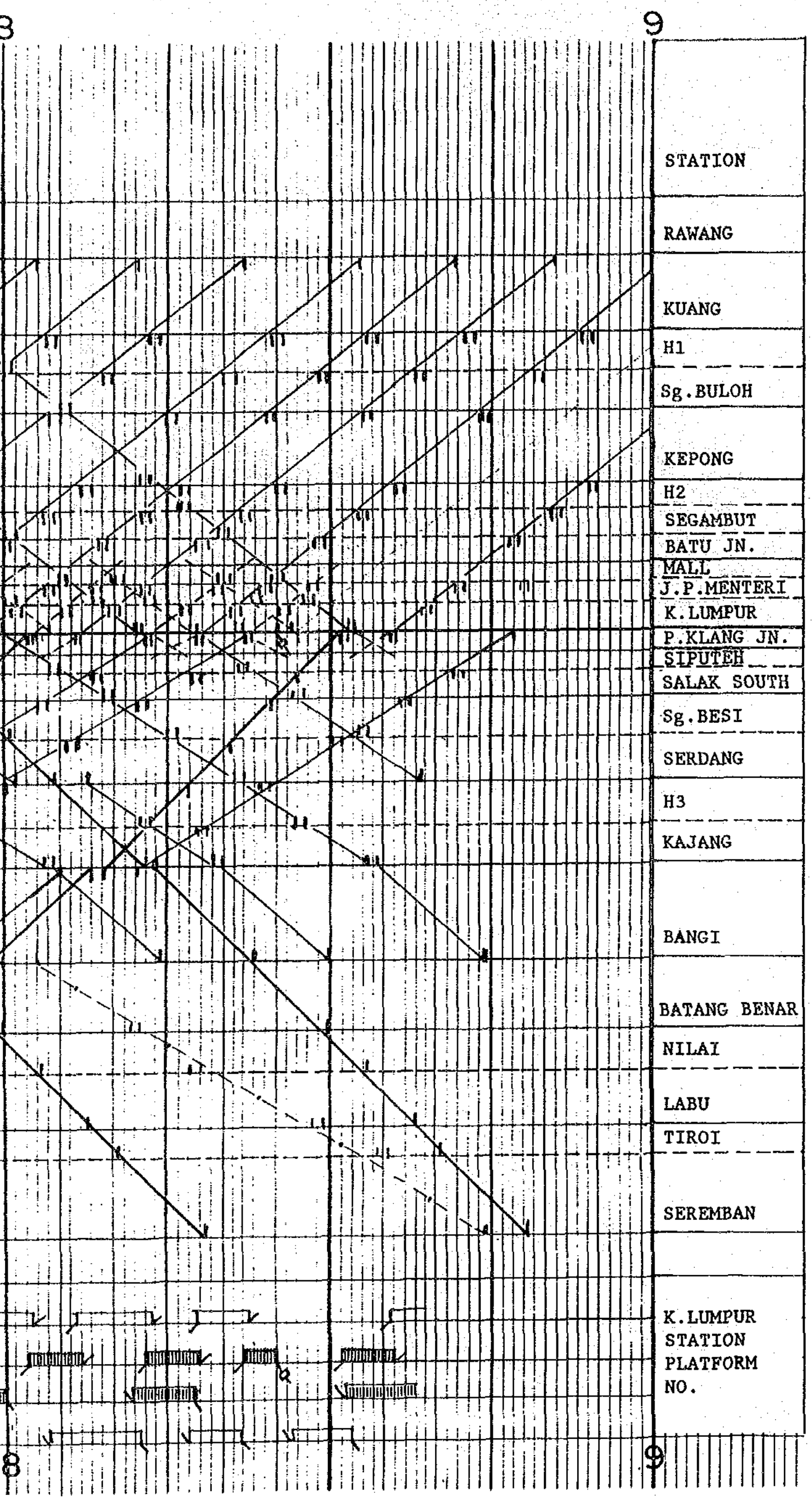
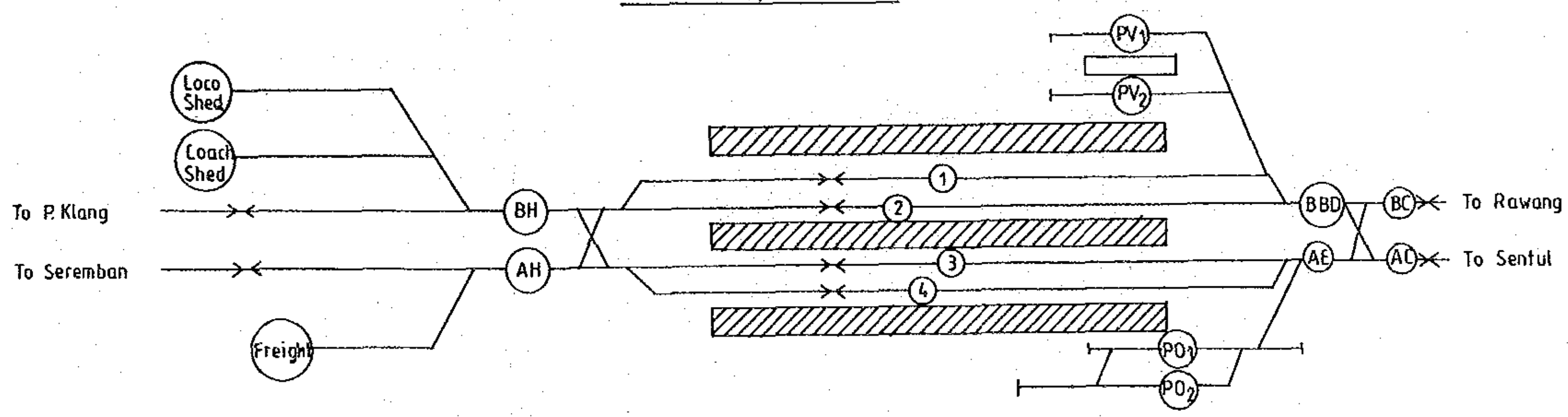


Fig. 5-4-11 Model DMU Train Diagram During Morning Peak Hours in 2005



	DMU (Rapid)
	DMU (Local)
	DMU (P.Klang Line)
	DMU (Shuttle Service)
	Long Distance Passenger
	Deadhead

Kuala Lumpur Station



5-4-4 Transport and Operation Plan in 1997

(1) Traffic volume between stations

Traffic volume between stations by peaks/off-peaks time zones as well as by each direction was estimated by the similar way as for 2005. (Refer to Appendix 5-9-1)

(2) The maximum number of DMU trains

1) During peaks hours

The same number of DMU trains as for 2005 (Refer to Table 5-4-3)

2) During off-peak hours

The same number of DMU trains as for 2005 (Refer to Table 5-4-4 and Table 5-4-5)

(3) DMU train operation plan

1) Peak hours

In Table 5-4-12, train consist required in the K.L. - Bangi (Local) section turns out to be 5.2 DMUs/train, however, since this train consist is required for a short section of 8 km between Sg.Besi and Siputeh, the train consist as of 1997 was determined as 5 DMUs/train.

Table 5-4-12 Number of DMU Trains Required in Case of 5-car Train Consist During Morning Peak Hours (One Way, in 1997)

Section	Train type	Max. sectional traffic demand	Max. No. of trains (one way)	Number of DMUs per train	Number of trains
Rawang - K.L.	Local	10,853	12	3.7	8.9 → 10
K.L. - Kajang	Rapid	5,020	5	4.1	4.1 → 5
K.L. - Bangi	Local	11,402	9	5.2	9.3 → 9

Note: Carrying capacity : 140 passengers/DMU
Max. number of passengers per DMU : 245 passengers/DMU
Max. load factor : 175 %

As shown in Table 5-4-12, required number of trains during morning peak hours on the Rawang - K.L. section (one way) becomes 8.9 with average headway of 17 minutes. In view of achieving 15 minutes headway, however, it was planned to operate 10 trains with average 217 passengers carried per DMU.

On the K.L. - Kajang section and the K.L. - Bangi sections, 5 rapid trains and 9 local trains are operated respectively.

2) Off-peak hours

a) Day-time hours

Table 5-4-13 Number of DMU Trains Required in Case of 5-car Train-Consist During Daytime Off-peak Hours (One Way, in 1997)

Section	Train type	Max. sectional traffic demand	Max. No. of trains (one way)	Number of DMUs per train	Number of trains
Rawang - K.L.	Local	6,679	20	3.0	11.9 -> 12
K.L. - Kajang	Rapid	2,722	6	4.1	4.9 -> 5
K.L. - Bangi	Local	6,181	14	4.0	11.1 -> 11

Note: Carrying capacity
--- 112 (= 140 x 0.80) passengers/DMU

As shown in Table 5-4-13, 12 local, 5 rapid and 11 local trains are operated on the Rawang - K.L., K.L. - Kajang and K.L. - Bangi sections respectively.

b) Night-time hours

Table 5-4-14 Number of DMU Trains Required in Case of 5-car Train-Consist During Night-time Off-peak Hours (One Way, in 1997)

Section	Train type	Max. sectional traffic demand	Max. No. of trains (one way)	Number of DMUs per train	Number of trains
Rawang - K.L.	Local	4,453	12	3.3	8.0 -> 8
K.L. - Kajang	Rapid	1,815	4	4.1	3.3 -> 3
K.L. - Bangi	Local	4,121	8	4.6	7.4 -> 7

Note: Carrying capacity --- 112 (= 140 x 0.80) passengers/DMU

As shown in Table 5-4-14, 8 local, 3 rapid and 7 local trains are operated on the Rawang - K.L., K.L. - Kajang and K.L. - Bangi sections respectively.

3) Bangi - Seremban (for Rapid Train, Kajang - Seremban)

Since the traffic demand in this section is scarce, DMU train operation was planned as follows;

a) Peak hours

i) Rapid train

7 trains of 5-car consist are operated carrying around 360 passengers per DMU (= equivalent to the seat number). Among them, 2 dead-head trains between Seremban and Bangi are operated as rapid trains on the said section and as local trains on the Bangi - K.L. section.

. sectional traffic : 2,335 passengers/up-direction
. seat number : 360 (= 72 x 5 DMU)
. train number required : 6.5 (= 2,335/360) → 7

ii) Local train

3 trains of one-car consist are operated shuttling between Bangi and Seremban. Since traffic demand is small, train headway was at 60 minutes.

. sectional traffic : 62 passengers/up-direction
. number of passengers
per train (DMU) : 21 passengers/train (DMU)

b) Off-peak hours

i) Daytime hours

a. Rapid train

4 trains of 5-car consist are operated carrying around 360 passengers per DMU (equivalent to the seat number).

. sectional traffic : 1,266 passengers/one-way
. seat number : 360 (= 72 x 5 DMU)
. train number required : 3.5 (=1,266/360) → 4

b. Local train

3 trains of one-car consist are operated with 2 hours-headway.

. sectional traffic : 33 passengers/one-way
. number of passengers
per train (DMU) : 11 passengers/train (DMU)

ii) Night-time hours

a. Rapid train

3 trains of 5-car consist are operated carrying around 360 passengers per DMU (equivalent to the seat number).

. sectional traffic : 844 passengers/oneway
. seat number : 360
. number of trains required : 2.3 (=844/360)
→ 3

b. Local train

2 trains of one-car consist are operated with two hour-headway.

. sectional traffic : 22 passengers
. number of passengers per train : 11 passengers/train (DMU)

4) DMU train operation plan in 1997

From calculation results of 1) - 3), the number of DMU trains are summarized as shown in Table 5-4-15.

Table 5-4-15 Number of DMU Trains in 1997
(Weekdays, One Way)

Section	Train	6:00–8:30	8:30–16:00	16:00–19:00	19:00–24:00	Total
Rawang - K.L.	Local	10	12	10	8	40
K.L. - Kajang	Local	9	11	9	7	36
	Rapid	5	5	5	3	18
Kajang - Bangi	Local	9	11	9	7	36
	Rapid	5	4	5	3	17
Bangi - Seremban	Local	3	3	3	2	11
	Rapid	7	4	7	3	21

5-5 Train Operation Management

To safely operate heavily dense commuter trains, a quick and appropriate traffic control is the prerequisite. The followings are the recommendations relating to the RBCS train operation management;

(1) Use of train diagram and operation diagram by dispatchers

At present, dispatchers collect actual operating data from stations by telephone and record them on blank diagrams (forms printed with lines representing stations and time). With the train traffic increase, however, a train dispatcher will be pressed with this data collecting work. This will adversely affect the proper job of a dispatcher, that is, controlling train traffic in accordance with the operation schedule.

Furthermore, suspension of train operation and change in operating time due to track maintenance work, etc. must be appropriately controlled by a dispatcher. In order to facilitate it, it is most advisable to use a daily train diagram and an operation diagram (both printed), to fill in any change in train schedules beforehand, and with the progress of the train operation, record the actual operation facts and data. Introduction of the automatic recorder will also be effective for this purpose.

(2) Accident prevention measures

With the increase in the number of trains as well as the number of passengers, accidents may have larger impacts on the total train schedules, increasing the scale of damages.

In particular, commuter railway service should be armed with various backup systems to make up for the human errors; For examples;

1) Prevention of overrun

To prevent a train from running over a stopping position due to failure of a driver, a system to stop the train automatically should be introduced.

2) Prevention of entering wrong line

If a train enters a wrong line at a turnout due to wrong route setting and careless train operation, the total schedules for trains and car utilization will be severely affected.

Precaution should be paid in setting those points, especially at junctions between P.Klang Line and Batu Caves Junctions.

As a countermeasure, it is recommended to introduce a system to prevent any mishandling of signals.

3) Prevention of erroneous passing of stations

Two types of DMU trains - rapid service and ordinary local trains - are operated. It might happen that a driver makes an erroneous passing of stations. hence appropriate measures should be taken to prevent this error. For example, it is effective to let every driver post his train diagram in his cabin for constant checking upon departure from a station.

4) Indication of signal identification points for train drivers

As train speed increases, a train driver is expected to identify a signal aspect more accurately and quickly. For this purpose, a visible sign should be provided at a signal identification point, together with training for drivers to apply brakes if the sign is not visible due to bad weather, etc.