CHAPTER 7

PRELIMINARY ENGINEERING STUDY AND COST ESTIMATION

FEDERAL ROUTE NO 76 BETWEEN
PENGKALAN HULU AND GERIK

CHAPTER 7: PRELIMINARY ENGINEERING STUDY AND COST ESTIMATION

7.1 General

In this chapter, the basic design for the highway network alternative plans proposed for the Peninsular will be prepared. Similarly, for Sabah and Sarawak, the proposed highway network will also be examined through the preparation of the basic design.

After the designs are completed, the cost estimation for all routes in each proposed network will be calculated according to the functional classification of each route. Then, the cost-benefit analysis of each alternative and proposed network will be analyzed in the following chapter.

In preparing the design of each route, all major control parameters such as the topographical, geological, hydrological, and the natural reserve are considered to determine the engineering and economic feasibility.

In addition, the procedure towards implementing the task has been formulated based on the locally available references as much as possible to ensure the adoption of the future highway network with the forecasted traffic scenario.

7.2 Design Criteria and Its Application

(1) General

The following are the basic design criteria exercised in the design of the alternative routes:

a. Minimizing environmental impacts by conserving natural environments such as national parks, forest reserves and water catchment areas. All national parks will be avoided while forest reserves and water catchment reserves will also be preserved.

b. Minimizing the effect of flooding and landslides by aligning the newly proposed road in suitable locations and also taking preventive measures such as close turfing and drainage of critical slopes.

c. Minimizing construction cost by utilizing the existing roads and minimizing river crossing.

d. Reducing critical intersections such as between two different transportation infrastructure facilities by over-passing all the principal highway and minor highway systems from the existing railway lines.

e. Minimizing disruption of community cohesion due to formation of indirect barricade resulting from construction in built up areas.

(2) Application of Design Criteria

The application of design criteria are divided into the following four sections:

- Geometric
- Interchanges and At-Grade Intersections
- Service Facilities
- Establishment of Number of Lanes

a. Geometric Design Criteria

Currently, there are two standards that are applicable for road design namely "A Guide on Geometric Design of Road, JKR 8/86" and "Interurban Toll Expressway System of Malaysia Design Standards, MHA 11/86."

The first standard covers the design of inter urban expressway, highway, primary road, secondary road and minor road in rural areas, and urban expressway, arterial, collector, and local street in urban areas. These roads are classified in descending order of hierarchy into seven groups known as JKR Standard R6 to R1 for rural areas and U6 to U1 for urban areas.

The second standard covers only the design of interurban expressway and its facilities such as ramps, toll gates and service/rest areas. Since the existing expressway and those under construction are designed mainly according to this standard, the design standard for the proposed expressway and its facilities will adopt this standard while other roads will be designed according to the JKR standard.

Table 7.1, shows the proposed design standard with respect to the functional classification of the roads. The principal highway system is stratified into two design types namely the expressway and the major highway.

The expressway is designed with the highest design standard for high travel speed and comfort. To accomplish this target, level of service B is adopted for almost all stretches of the expressway except at difficult sections such as in mountainous terrain. The level of service for such section can be designed a step lower to level of service C since the level of service is constraint by the design speed. Actually, the level of service is controlled by the operating speed that is approximately ninety percent of the design speed.

The major highway that also forms the backbone of the proposed highway network is designed with standard R5. Even though level of service B is desirable for this type of highway, the lack of full access control is constraining the operating speed making level of service B ineffective. To minimize the cost, level of service C is adopted for this type of highway.

The minor highway system that consists of a network with similar service characteristics as the principal highway system is provided with level of service C. Basically this type of highway is designed to standard R5 but for cost minimization purposes, some portions with comparatively low traffic demand may be designed to standard R4.

The primary road system that serves intermediate trip lengths and medium travelling speed is sufficient to be designed to standard R4 with level of service C.

Table 7.1: Functional Classification and Design Standard

Road Category		Design Standard			Level of Service
		R6	R5	R4	
Principal Highway System	Expressway	●			B or C
	Major Highway		●		C
Minor Highway System			●	o	C
Primary Road System				●	C

● Desirable o Minimum

b. Interchanges and At-Grade Intersection Design Criteria

The standards used for the design of interchanges and at-grade intersections are "Inter-urban Toll Expressway System of Malaysia, MHA", "A Guide to the Design of At-Grade Intersection, JKR", and "Planning and Design of Interchanges, Japan".

Basically, all these standards cover the planning and design of interchangesand at-grade intersections. However, for the specific item such as the interval of the planned interchanges, the local references do not state clearly the standard of the interval of the interchanges. So, viewing from the existing expressways configuration and the practical planning of such interchanges in Japan and USA, the following standard is proposed:

Table 7.2: Standard of Interchange's Intervals

Site Location /Conditions	Interval (km)
Urban and major industrial areas	5-10
Flat area with dotted small towns	15-25
Rural and Mountainous areas	25-30

Source: Planning and Design of Interchanges, Japan

For the type of intersection to be constructed, the study team is proposing that this selection to be based on the road classification and the number of lanes. The recommended types of intersection, either the elevated intersections (interchanges) or the at-grade intersections (signalized intersections) are shown below.

Table 7.3: Interchanges and At-Grade Intersections Design Criteria

Road Category by Design Standard And No. of Lane			No. of Lane	Expressway		Major Highway			Minor Highway			Primary Road	
				R6		R5			R5 or R4			R4	
				6	4	6	4	2	6	4	2	4	2
Principal Highway System	Expressway	R6	6	IC	IC	IC	IC	IC+SI	IC	IC	IC+SI	IC	IC+SI
			4		IC	IC	IC	IC+SI	IC	IC	IC+SI	IC	IC+SI
	Major Highway	R5	6			IC	IC	IC+SI	IC	IC	IC+SI	IC	IC+SI
			4				IC	IC+SI	IC	IC	SI	IC	SI
			2					SI	IC+SI	SI	SI	SI	SI
Minor Highway System		R4	6						IC	IC	SI	IC	SI
			4							SI	SI	SI	SI
			2								SI	SI	SI
Primary Road System		R4	4									SI	SI
			2										SI

Source: 1. Inter-urban Toll Expressway System of Malaysia, MHA
2. A Guide to the Design of At-Grade Intersection, JKR
Notes: IC = Interchange, SI = Signalized Intersection

c. Service Facilities Design Criteria

Depending upon their functional characteristics, the service facilities can be grouped as either rest areas and/or service areas.

Since the Expressway is designed with full access control, the service facilities shall be provided only for the Expressway, therefore, the MHA design standard specified earlier is adopted. This standard covers the planning and design of service facilities located at the following intervals:

Table 7.4: Service Facilities Interval

Service Facilities	Minimum Intervals	Maximum Intervals
Rest area (AADT < 40,000 veh)	10 km	20 km
Rest area (AADT > 40,000 veh)	5 km	10 km
Service area	30 km	50 km

Sources : Inter-urban Toll Expressway System of Malaysia, MHA
Note ; veh : vehicle

d. Establishment of Number of Lane

The establishment of the number of lanes is related to the highway capacity specified in vehicle per day and the traffic demand forecast in the year 2010 such that if the traffic demand forecast is more than the calculated highway capacity, multi-lane construction is recommended.

The highway capacity was examined based on "A Guide on Geometric Design of Roads (JKR 8/86)" and the "Highway Capacity Manual (Special Report 209, Transportation Research)".

However, the adjustment factor of lateral clearance and peak hour factor could only be referred to the Highway Capacity Manual since there is no specification on the adjustment factor in the former standard. Consequently, as to ensure the uniqueness of the solution, all other necessary adjustment factors were also applied according to the specification of this standard.

The computed highway capacities in vehicle per day by each geometric design conditions are shown in Table 7.5.

Table 7.5: Designed Roads and Highways Capacity

(Unit: veh/day)

Road Standard	Lane No.	Level of Service	Capacity According to Design Speed (km/h)		
			120	100	80
R6	6	C(B)	(65,787)	(61,068)	45,357
	4		(43,858)	(40,724)	30,238
R5	6	C	64,398	60,373	43,991
	4		42,932	40,250	29,328
	2		13,054	12,140	8,377
R4	4	C	41,487	38,895	28,515
	2		11,791	10,966	7,566

Source: 1. A Guide on Geometric Design of Roads (JKR 8/86)
2. Highway Capacity Manual (Special Report 209,Transportation Research)

Note : 1. Values in bracket are for level of Service B
2. Design Hourly Volume Ratio (K); 15%
3. Composition Ratio of Heavy vehicles; 15%
4. Directional Distribution Ratio (D); 55%

7.3 Geology and Topography Conditions

This section presents the summary of considerations to be adopted by referring to the natural conditions (Geology and Climatic features) in this country.

The probable route of a road and its design are considerably influenced by the topography,physical features and land use of the area traversed. Geometric design elements such as alignment, gradient, sight distance and cross-section are directly affected by topography and must be selected so that the designed roads will reasonably fit into those natural and man-made features. Besides that, it is an economic approach in term of minimizing construction and maintenance cost.

The profile of a road can generally be divided into three groups, namely, flat, rolling and mountainous. Consideration to adopted for the purpose of constructing, improvement and rehabilitation of roads are based on the following points:

1. Flat Terrain

   Alluvial deposit is found predominantly on the coastal plain. This deposit is commonly characterized by soft ground and merits special consideration for road construction.

   In the Beruas Formation areas that are located in Sabah and Sarawak, there are only a few existing Federal roads running on this thick soft ground especially on the coastal plain.

2. Rolling and Mountainous Terrain

   Rolling and Mountainous Terrain consists of thick weathered zone of Granite, Palaeozoic and mesozoic sedimentary rocks. These zones are easily eroded by surface water and heavy rainfall, and as a result will cause slope failure and landslide.Together with geological consideration, the fundamental conditions of topographical classification are shown in Table 7.6.

   It should also be noted that based on the geological analysis, some grounds in the flat terrain are found to require soft ground treatment before the proposed roads can be overlaid. Besides, for rolling and mountainous terrain, the heavily weathered zone should be designed at a minimum of 1:1.0 cut slope gradient in consideration of the slope failure prevention measures.

Table 7.6 : Terrain Conditions and Natural Ground Cross Slopes

Type of Terrain	Condition	Cross Slopes
Flat	Flat terrain adheres to areas of alluvial deposits where it is extensively distributed in the coastal plain,along the river and part of the final eroded plain in cycle of erosion distributed in the inland.	< 3% (< 1.7^0)
Rolling	Rolling terrain adheres to area which consists of eroded plain and plain of an old age in the cycle of erosion with an elevation approximately below 150 meter high.	3% - 25% (17^0 -14^0)
Mountainous	Mountainous terrain is adheres to areas which consists of mountainous region of old age in the cycle of erosion with an elevation approximately above 150 meters high.	> 25% (> 14^0)

7.4 Unit Cost Analyses

The unit prices of construction works were determined based on the current bid prices (1992) by JKR and MHA as shown in Table 7.7. These unit prices consist of labour, material and equipment costs plus overhead and profit. The overhead and profit were estimated as 15% of the summation of labour, material and equipment costs.

Table 7.7: Summary of Construction Unit Price (1992)

(UNIT: RM)

NO.	DESCRIPTION	UNIT	PENINSULAR	SABAH	SARAWAK
1	GENERAL	L.S.	–	–	–
2	SITE CLEARING		–	–	–
	Clearing and Grubbing	m2	0.6	0.5	0.4
	Borrow Material	m3	21.0	5.5	5.2
	Weak Soil Treatment	m2	44.0	44.0	44.0
4	BRIDGE		–	–	–
	L < = 20m	m2	1,700.0	1,700.0	1,700.0
	20m < L < = 30m	m2	2,200.0	2,200.0	2,200.0
	30m > L	m2	2,600.0	2,600.0	2,600.0
	Continuous Box Girder	m2	3,900.0	3,900.0	3,900.0
5	DRAINAGE		–	–	–
	Side Ditch	m	110.7	110.7	110.7
	R.C. Pipe Culvert	m	256.3	628.0	638.9
	R.C. Box Culvert	m	9,000.0	9,000.0	7,361.1
6	PAVEMENT		–	–	–
	Subgrade Preparation	m2	0.6	3.5	1.7
	Granular Subbase	m3	24.2	28.0	59.2
	Macadam Road Base Course	m3	31.9	58.6	62.8
	Prime/Tack Coat	m2	1.2	1.3	1.3
	Asphaltic Wet Mix Crushed Rock Base	ton	51.2	51.2	51.2
	Asphaltic Concrete Base Course	ton	78.2	122.2	122.2
	Asphaltic Concrete Wearing Course	ton	94.0	153.0	133.9
7	MISCELLANEOUS		–	–	–
	Turfing (Common Soil)	m2	3.6	3.5	2.0
	Turfing (Soft Rock)	m2	10.1	4.0	6.4
	Guardrail	m	49.7	55.0	50.3
	Delinator	no.	25.0	25.0	51.2
	Road Marking	m2	24.2	30.0	26.3
	Guide Signs	no.	1,910.4	1,655.6	1,655.6
	Regulatory & Warning Signs	no.	32.4	32.4	32.4
	ROW Fence	m	114.0	5.6	5.6
	Emergency Telephone	km	59,940.0	59,940.0	59,940.0
	ROW Pegs	no.	17.8	5.4	5.4
	Kilometer Post	no.	70.0	165.6	165.6
8	TUNNEL		–	–	–
	Tunnel	m	27,800.0	27,800.0	27,800.0
9	INTERCHANGE		–	–	–
	Interchange	no.	9,688,000.0	9,688,000.0	9,688,000.0
	Grade Separation	no.	5,382,000.0	5,382,000.0	5,382,000.0
10	SERVICE FACILITIES		–	–	–
	Service Area	no.	1,100,000.0	1,100,000.0	1,100,000.0
	Rest Area	no.	700,000.0	700,000.0	700,000.0

Note : The above figures are indicative unit price

To simplify the project cost calculation, the construction cost per kilometer is summarized in Table 7.8.

Table 7.8: Summary of Unit Cost Calculation For Peninsular (1992)

Route Type	No.of Lane	Terrain	Unit Cost (million RM/km)		
			New	Multi-lane	Improvement
EXPRESSWAY (R6)	6	FLAT	4.793	3.012	-
		ROLLING	4.882	4.162	-
		MOUNTAINOUS	14.141	9.366	-
	4	FLAT	4.125	2.482	-
		ROLLING	4.242	3.469	-
		MOUNTAINOUS	12.464	7.245	-
MAJOR HIGHWAY AND MINOR HIGHWAY (R5)	6	FLAT	4.091	2.574	-
		ROLLING	4.340	3.557	-
		MOUNTAINOUS	13.311	8.005	-
	4	FLAT	3.431	2.121	-
		ROLLING	3.750	2.965	-
		MOUNTAINOUS	11.392	6.192	-
	2	FLAT	1.919	-	1.393
		ROLLING	2.580	-	2.136
		MOUNTAINOUS	8.610	-	4.594
PRIMARY ROAD (R4)	4	FLAT	2.839	1.584	-
		ROLLING	3.245	2.484	-
		MOUNTAINOUS	10.260	5.471	-
	2	FLAT	1.673	-	1.118
		ROLLING	2.244	-	1.841
		MOUNTAINOUS	7.930	-	3.769

Notes:
1. New - New links/routes, by passes, realignment, reformation, etc
2. Multi-lane - Additional number of lane to the existing lane number. For this following conditions are considered:
   R6: 4-Lane to 6-Lane
   R6: 2-Lane to 4-Lane
   R5: 2-Lane to 6-Lane
   R5: 2-Lane to 4-Lane
   R4: 2-Lane to 4-Lane
3. Improvement - Widening of Carriageway/lane width to suit the proposed design standard
   R5: 3.50m/lane
   R4: 3.25m/lane

7.5 Summary of Alternative Network Plans

Based on the proposed Alternative Highway Network Plans outlined in the previous chapter, for Peninsular Malaysia, three alternatives are formulated by applying the design criteria and the capacity constraint. For Sabah and Sarawak, no alternative is considered since the proposed networks are simple and the capacity constraint is insignificant.

In principal, there are three types of proposed road construction. The first type is the new road construction of the proposed new links and realigned segments of the national highway network conceptual plan. The second type is the multi-lane road construction that resulted from the analysis of traffic demand on the proposed network configuration. Finally, the third type is the improvement construction in the form of widening of the sub-standard sections of the existing 2-lane roads and highways.

In Alternative 1, the network is designed to its maximum possible number of links as outlined by the proposed highway plans. This network can simultaneously accommodate the traffic capacity of the forecasted year 2010 and provides the highest level of service in term of availability of roads.

However, in Alternative 3, the number of links is reduced to its minimum. Hence, as to sustain the forecasted traffic capacity, multi-lane road construction is maximized.

Alternative 2 falls in between the two extremes. This alternative is designed to balance the provision of the number of links and multi-lane construction from the maximum case (Alternative 1) and the minimum case (Alternative 3).

All the alternatives for Peninsular, Sabah and Sarawak highway network plans design summary are presented in Table 7.9.

7.6 Estimation of Construction Cost

The following four cost components are used to estimate the project cost of the identified routes.

1. Direct construction,
2. Land acquisition and compensation,
3. Engineering, and
4. Physical contingency.

The basic premises in the project cost are as follows:

1. The unit price of each cost component was determined based on the economic conditions of the current year (1992).

2. For construction works, it is assumed that the normal 5% Malaysian taxes and duties on import equipment and materials (tax percentage depending on type/kind of equipment and materials) will be imposed.

3. Engineering cost of feasibility study, detailed design and construction supervision was assumed to be 15% of the construction cost.

4. Physical contingency was estimated to be 10% of the summation of the construction cost, land acquisition and compensation cost, and engineering cost.

The project cost was estimated on the basis of financial cost estimate. The economic project cost can also be analyzed by deducting the transferable items such as taxes and duties from the financial cost.

Land acquisition and compensation cost was estimated based on the area of required land acquisition (in hectares) estimated in the basic design. In this way, the effect of land acquisition and compensation cost could be analyzed for the proper reservation of right of way of the potential routes. The unit price for this segment is based on information from JKR Headquarters, MHA, and Sabah and Sarawak JKR. This unit price is adjusted on the assumption that sixty percent (60%) of the country are non built up and the other forty percent (40%) are built up areas.

In summary, the estimated project cost for all alternatives and regions is presented in Table 7.10.

Table 7.9 : Summary of Length of Preliminary Design of Highway Network Plans

(Unit:km)

Road Category By Construction Type And No. of Lane			Alternatives/Regions														
			Peninsular									Sabah			Sarawak		
			Alternative I			Alternative II			Alternative III								
			C	W	I	C	W	I	C	W	I	C	W	I	C	W	I
Principal Highway System	Expressway	6-Lane	127	412	0	127	412	0	127	412	0	0	0	0	0	0	0
		4-Lane	739	0	0	464	0	0	148	0	0	0	0	0	0	0	0
		Total	866	412	0	591	412	0	275	412	0	0	0	0	0	0	0
	Major Highway	6-Lane	0	170	20	0	170	20	0	278	20	0	0	0	0	0	0
		4-Lane	110	2064	20	181	2196	20	198	2421	20	0	359	0	0	346	0
		2-lane	309	0	820	238	0	688	221	0	355	133	0	400	333	0	293
		Total	419	2234	860	419	2366	728	419	2699	395	133	359	400	333	346	293
Minor Highway System		6-Lane	15	0	0	15	0	0	15	0	0	0	0	0	0	0	0
		4-Lane	134	246	0	134	246	0	134	247	0	0	193	0	0	0	0
		2-Lane	646	0	930	501	0	930	224	0	882	0	0	0	0	0	35
		Total	795	246	930	650	246	930	373	247	882	0	193	0	0	0	35
Primary Road System		4-Lane	209	355	5	209	355	0	209	355	0	41	604	0	32	18	0
		2-Lane	909	0	1045	571	0	1028	571	0	1028	414	0	449	960	0	426
		Total	1118	355	1050	780	355	1028	780	355	1028	414	604	449	992	18	426
Total Length by Type of Construction		6-Lane	142	582	20	142	582	20	142	690	20	0	0	0	0	0	0
		4-Lane	1192	2665	25	988	2797	20	689	3023	20	41	963	0	32	364	0
		2-Lane	1864	0	3005	1310	0	2646	1016	0	2265	547	0	849	1293	0	754
		Total	3202	3247	2840	2440	3379	2686	1847	3713	2305	547	616	858	1325	364	754
Total			9322			8505			7869			1975			2443		

Note: (1) C:New, W : Widening, I: Improvement
(2) Committed project of 6th Malaysia Plan are excluded

Table 7.10 : Summary of Preliminary Design Estimated Project Cost By Alternatives and Region

(Unit: Million M$)

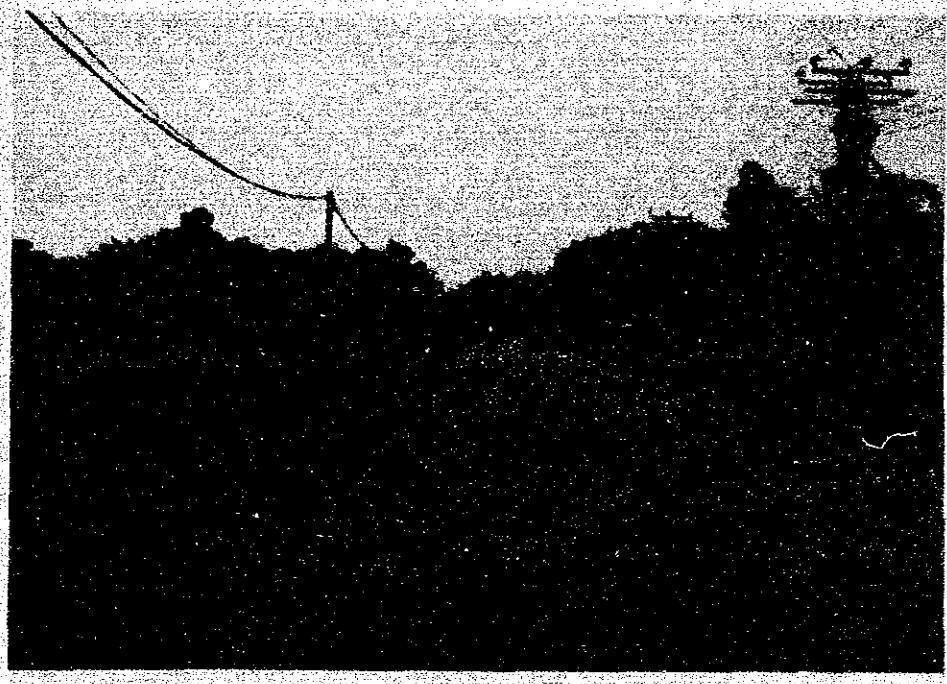
Road Category		Alternative (I)		Alternative (II)		Alternative (III)	
		Length (km)	Project Cost	Length (km)	Project Cost	Length (km)	Project Cost
Principal Highway System	Expressway	1278	19680.380	1003	8134.096	687	5410.623
	Major Highway	3513	13811.946	3513	14030.544	3513	15366.268
Minor Highway System		1971	8234.288	1826	6981.165	1501	5885.118
Johor Primary Road		723	2454.09	568	2012.882	568	2012.882
Melaka Primary Road		60	273.939	60	273.939	60	273.939
N.Sembilan Primary Road		192	695.301	192	695.301	192	629.301
Selangor Primary Road		105	391.712	105	391.712	105	391.712
Perak Primary Road		151	450.923	151	450.928	151	450.928
P.Pinang Primary Road		54	254.748	54	254.748	54	254.748
Kedah & Perlis Primary Road		388	1025.690	273	598.316	273	598.316
Pahang Primary Road		255	802.257	200	633.657	200	633.657
Terengganu Primary Road		193	542.604	186	542.604	186	542.604
Kelantan Primary Road		439	1492.975	374	1010.637	374	1010.637
Total Primary Road System		2560	8384.244	2163	6864.724	2163	6864.724
Total Peninsular		9322	40110.858	8505	36010.529	7869	33526.733

Road Category	Sabah		Sarawak	
	Length (km)	Project Cost	Length (km)	Project Cost
Major Highway System	892	4213.183	972	3724.194
Minor Highway	0	0	35	118.635
Primary Road System	1083	3879.127	1436	4967.199
Total	1975	8092.311	2443	8810.028

Note : Committed projects of 6th Malaysia Plan are excluded

CHAPTER 8

EVALUATION OF ALTERNATIVE PLANS



FEDERAL TRUNK ROAD A-5
SANDAKAN, SABAH

CHAPTER 8: EVALUATION OF ALTERNATIVE PLANS

8.1 Evaluation Procedure

The alternative road network plans prepared in the preceding Chapter are evaluated in this Chapter to identify which is superior. The evaluation will be made from the following viewpoints

(1) Functional Suitability of the Network
(2) Economic Evaluation
(3) Likely impacts on Social/Regional Development

The evaluation procedure is shown in Figure 8.1.

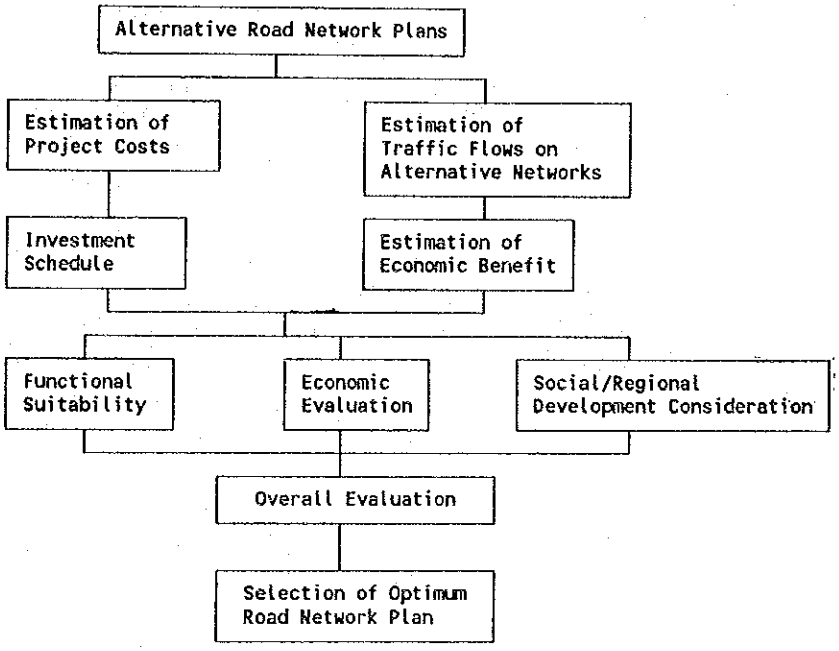


Figure 8.1: Evaluation Procedure

The evaluation is not carried out for each highway project but rather for the proposed network as a whole, since this study aims to formulate a Highway Master Plan.

Three alternative network plans are prepared for P.Malaysia as discussed in Chapter 6, while only one plan is identified for the Sabah-Sarawak region.

The main objectives of the evaluation are to select the optimum network plan for Peninsular Malaysia and to examine the viability of the proposed network for Sabah-Sarawak.

8.2 Functional Suitability

The following indicators are used to compare the level of services to be provided by each alternative network.

(1) volume/capacity ratio
(2) travel speed
(3) trip length

8.2.1 Network Plan For Peninsular

With regard to the alternative network plans for the Peninsular, the following observations are noted on examination of results from the traffic assignment.

(1) Volume/Capacity Ratio

The average volume/capacity (v/c) ratio on the present highway network in P.Malaysia is calculated to be 0.527 at present. However, this average ratio is predicted to increase to 2.164 by the year 2010 if no road development is undertaken until then (the "Do-Nothing" scenario discussed in Chapter 5). This situation indicates that most of the main corridors will be heavily congested and the national road transport system will be almost paralysed.

Compared with this "Do-Nothing" scenario, all the alternative plans however show a drastic and significant improvement in the overall average v/c ratio, ranging from 0.675 to 0.696 for P.Malaysia in 2010, which is an acceptable level by transport planning standard. Although Alternative 2 network plan gives the best v/c ratio, the difference among the alternatives is not so significantly large.

Table 8.1: Level of Services by Alternative Network for Peninsular Malaysia, 1991 & 2010

Case	1991	2010			
Indicators		Do-Nothing	Alternative 1	Alternative 2	Alternative 3
Total Road Length (km)	7690*	8570**	11740	10850	10020
Average Travel Speed (km/hr)	50.2	23.1	58.9	60.0	59.8
Average Trip Length (km/trip)	34.4	47.4	42.0	42.3	42.4
Average Volume/Capacity Ratio	0.527	2.164	0.686	0.675	0.696

Note: * Including Expressway, toll Highway and Federal trunk Road
** Including the under construction sections on N-S Expressway and the committed projects in SMP.

(2) Average Trip Length

In general, the average trip length increases in response to increase mobility and accessibility in accordance with the growth in socio-economic activities, particularly the growth of vehicle ownership and urbanized areas. Hence, the average trip length is predicted to grow from 34.4 km in 1991 to 47.4 km in 2010 in the "Do-Nothing" scenario.

However, the increase in trip length may also include detours made to avoid overcrowded links. By implementing any of the alternative network plans, the average trip length is predicted to shorten in all the cases.

(3) Average Travel Speed

The average travel speed will decrease from 50.2 kph in 1991 to about 23.1 kph or 46% of the present condition by the year 2010 if no new road developments are implemented during the two decades. Compared to this situation, all the alternative plans are predicted to improve the average travel speed, to a level even better than the present condition. Among them, the highest travel speed can be brought about by Alternative 2.

(4) Conclusion

Alternative 2 is the superior alternative network plan and Alternative 3 is the least desirable plan among the three alternatives from the service level viewpoint. However, the difference is not decisively large. By and large, all the alternatives are considered as acceptable in terms of the service level, namely although the volume/capacity ratios in all three plans will slightly increase from the present ratio, they are still below 0.7 and the average travel speeds in all three plans are predicted to improve with the establishing of a better highway network.

8.2.2 Network Plan for Sabah and Sarawak

As for the network plan for Sabah and Sarawak, no alternative plan is identified. Therefore, the comparative observation is made between "Do-Nothing" scenario and the proposed network plan.

(1) Volume/Capacity Ratio

As for Sabah, the average volume/capacity ratio is 0.419 at present and will, grow to 2.0 by the year 2010 under the "Do-Nothing" scenario condition. By implementing the proposed network by the year 2010, the volume/capacity ratio will recover to a satisfactory level, i.e. 0.618.

The volume/capacity ratio in Sarawak also indicates that most of the roads will be overcrowded by the year 2010 under the "Do-Nothing" scenario condition, and will be able to regain a smooth traffic flow if the proposed network is realized.

(2) Average Trip Length

The average trip length in Sabah will increase from 75.5 km in 1991 to 81.8 km in 2010 due to detours and congestions if no roads are developed. The average trip length however will reduce to 63.3 km under the proposed network plan. In the case of Sarawak, the average trip length will increase from 51.8 km in 1991 to 64.3 km in 2010 under the "Do-Nothing" scenario, and will further increase to 65.7 km under the proposed network plan. This is because some of the river transport are replaced by road transport in the proposed network case and there will be an increase in mobility in the state.

(3) Average Travel Speed

The average speed in Sabah is expected to decrease from the present 42.2 kph to 23.0 kph, i.e. 45% by the year 2010 compared with the present situation if no roads are developed. The average travel speed however is predicted to increase by about 20% from the present level to 51.0 kph if the proposed network is implemented.

Also for the state of Sarawak, a significant improvement in travel speed can be expected by realizing the proposed network. Average travel speed is predicted to increase from the present 39.8 kph to 53.8 kph by year 2010.

Table 8.2: Level of Services for Sabah and Sarawak, 1991 & 2010

	Indicators	1991	2010	
			Do-Nothing	Proposed Network
Sabah	Total Road Length (km)	1116.0	1116.0	2005.0
	Average Travel Speed (km/hr)	42.2	23.0	51.0
	Average Trip Length (km/trip)	75.5	81.8	63.3
	Volume/Capacity Ratio	0.419	2.000	0.618
Sarawak	Total Road Length (km)	1213.0	1213.0	2443.0
	Average Travel Speed (km/hr)	39.8	29.0	53.8
	Average Trip Length (km/trip)	51.8	64.3	65.7
	Volume/Capacity Ratio	0.189	1.081	0.376
Sabah & Sarawak	Total Road Length (km)	2329.0	2329.0	4448.0
	Average Travel Speed (km/hr)	41.0	26.2	52.6
	Average Trip Length (km/trip)	70.0	75.8	64.2
	Volume/Capacity Ratio	0.311	1.571	0.504

(4) Both the proposed highway network plans in Sabah and Sarawak will be able to bring about sufficiently smooth traffic conditions by the year 2010. The proposed highway development plans are able to provide an improved volume/capacity ratio of below 0.7 and an average travel speed of 20~35% higher than the present condition for both states.

8.3 Economic Evaluation

The economic evaluation of the alternative road network plans is made by comparing benefits derived from improved service levels with costs accrued from the implementation of each of these alternative plans. In order to estimate the benefits and costs, the transport conditions should be compared between the "Proposed Network" case and "Base Case". "Base Case" here denotes the existing highway network with the committed road projects including the entire length of the North-South Expressway scheduled to be completed by early 1994.

The cost estimates of the proposed network plan excludes all the committed projects, which are under implementation within the framework of the Sixth Malaysia Plan. Hence, the implementation period of the proposed network plan is assumed to be 15 years from 1996 to 2010. Thus, investment cost is incurred throughout this period.

On the other hand, the benefit flow is assumed to begin in 1999 because some projects will be completed in 1998 and the benefit continues theoretically until the end of the project life. In this study, the benefits are counted up to the year 2020 for convenience, and instead of counting the benefit thereafter, the residual value of the investment is taken into account.

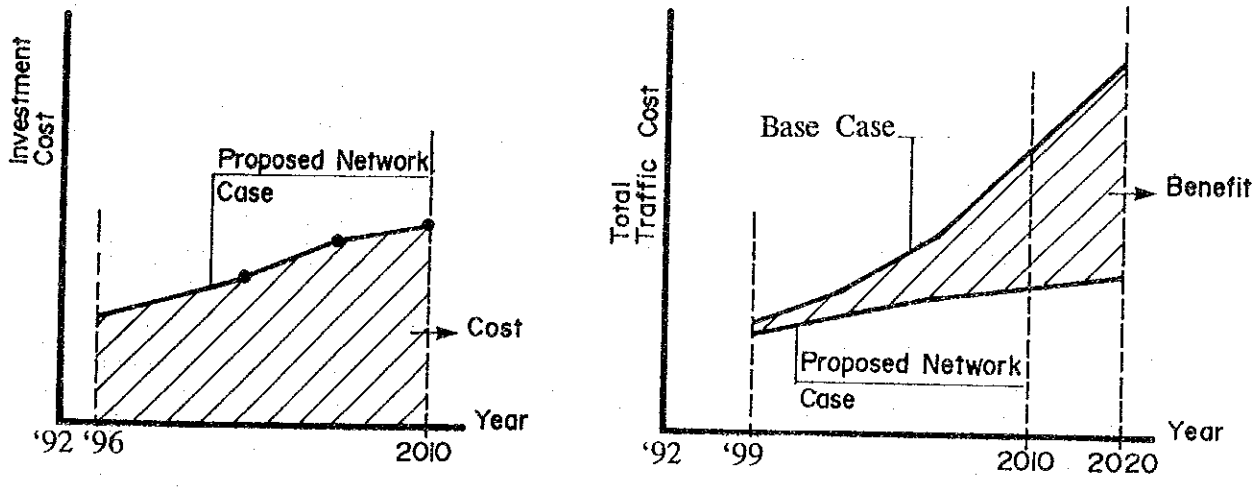


Figure 8.2: Cost and Benefit

Among the various benefits derived from the implementation of the road network plan, the following factors are counted as the economic benefits.

a. Savings in vehicle operating cost
b. Savings in travel time cost

In addition to these direct benefits, several other direct and indirect benefits can be identified, eg., increased comfort in vehicle operation, increased traffic safety, the promotion effect of regional development, increase in land price etc.. These benefits, however, are not counted in this study since they are difficult to be measured in monetary terms. Even though they could be quantified, the estimates are unreliable and sometimes may cause double counting of the benefits.

8.3.1 Economic Cost

The economic costs of the alternative road network plans were already described in the preceding chapter. The total economic costs for the alternatives are summarized in Table 8.3.

As the implementation schedule of each project which comprises the network is not decided yet, the annual investment is assumed to grow in proportion to the GDP growth projected in Chapter 4.

Assuming that the project life is 30 years, the economic residual value in 2021 is calculated to be RM 11,720 million, RM 10,534 million, RM 9,796 million for the three alternatives in Peninsular respectively, RM 2,365 million for Sabah and, RM 2,696 million for Sarawak.

Table 8.3: Total Economic Costs of Alternative Network Plan

(RM million)

Region		Financial Cost	Economic Cost
Peninsular Malaysia	Alternative 1	40,110.9	38,105.4
	Alternative 2	36,051.6	34,249.0
	Alternative 3	33,526.7	31,850.4
Sabah		8,092.3	7,687.7
Sarawak		8,810.0	8,369.5

8.3.2 Economic Benefit

(1) Vehicle Operating Cost

The vehicle operating cost is calculated for representative vehicles in Malaysia by surveying the current market prices and reviewing past studies on operating cost.

The cost is assumed to consist of distance related cost and time related cost.

A. Vehicle Price

As the representative vehicle, the ones commonly used in Malaysia are selected as shown in Table 8.4. The economic cost is calculated by deducting the tax portion from the financial cost i.e., sales price.

Table 8.4: Vehicle Price and Characteristics

(RM in 1992 price)

	Passenger Car (1)	Van (2)	M.Lorry (3)	H.Lorry (4)	Bus (5)
Fuel Type	G	D	D	D	D
Sales Price	31,406	34,208	66,150	109,951	148,691
Excise Duty	3,014	3,582	6,450	8,634	Exempted
Sales Tax	2,067	2,746	4,945	66,20	5,604
Net Price	26,325	27,880	54,755	94,697	143,087
Annual Mileage* (km/yr)	20,000 (16,000)	34,000 (27,200)	71,000 (56,800)	71,000 (56,800)	71,000 (56,800)
Annual Usage * Hours (hr/yr)	1,200	1,474	2,890	2,890	2,890

Note : 1) Ave. price of Proton Saga Iswara 1.3S(Non-metallic) and 1.5S(metallic)
2) Ford Econovan (ST 63 FM1 - 2184 CC)
3) Mercedes Benz 709/42
4) Mercedes Benz L 1314/42
5) Ave. Price of Hino AK 176K,and Mercedes Benz OF 1315/51
( ) indicates the annual mileage for gravel road

Source * : Axle Load Study
Estimated with reference to the Feasibility Study on the Tatau - Kapit Trunk Road Project in Sarawak , JICA August 1985.

B. Running Cost (Distance Related Cost)

(i) Fuel and Lubricant Oil

The market fuel prices per litre as of mid - September , 1992 was RM 1.11 ~ 1.13 for premium, RM1.06 for regular and RM0.648 ~ 0.655 for diesel. The international crude oil price is between US$19 and US$22 per barrel at present, which is close to the target price of OPEC (Organization of Petroleum Exporting Countries), i.e. US$21/per barrel.

Hence, the crude oil price is expected to remain at the present level for the time being. As a result, the present market prices of fuel and lubricant oil will be used for estimating the vehicle operating cost. The economic fuel cost is calculated by subtracting the tax portion from the market price.

Table 8.5: Fuel and Lubricant Oil Cost

(RM/litre)

Fuel & Lubricant	Financial Cost	Economic Cost
Premium	1.11 ~1.13	0.618 ~0.638
Regular	1.06	0.556
Diesel	0.648 ~0.655	0.558 ~0.565
Gasoline Engine Oil	6.6 ~6.75	6.27 ~6.41
Diesel Engine Oil	4.23 ~4.47	3.89 ~4.11

Source : Petronas

(ii) Tyre Cost

The financial cost of tyre is obtained through market price survey in Kuala Lumpur as shown in Table 8.6. The unit tyre cost per km is obtained by using the current price and the average tyre life.

Table 8.6: Tyre Cost

(RM) Tyre consumption

Vehicle Type	Size	No of Tyres (Incl.Spare)	Sales Price	Excise Duty & Sales Tax	Net Price	No. of Tyre/10000km
Passenger Car	155SR13	4 (5)	565.55	53.05	512.50	0.8(1.6)*
Van	600x14x8PR	4 (5)	690.90	67.40	623.50	0.9(1.8)*
M.Lorry	900x2014PR	6 (7)	4115.93	385.63	3730.30	1.26(2.52)*
H.Lorry	1000x2014PR	10 (11)	6750.15	637.45	6112.70	2.08(4.16)*
Bus	900x2014PR	6 (7)	4121.95	391.65	3730.30	1.26(2.52)*

Note * The figures in the parentheses indicate tyre consumption for gravel road

Source : 1) Axle Load Study

2) Estimated with reference to the Feasibility Study on the Tatau - Kapit Trunk Road Project in Sarawak

(iii) Maintenance Cost

Maintenance cost consists of parts cost and maintenance labour cost. Parts cost is calculated by setting the parts cost ratio to vehicle price. Labour cost is calculated by using labour hour and unit labour cost.

These key factors and unit prices are determined with reference to the past studies.

(iv) Vehicle Depreciation Cost

Vehicle depreciation cost is usually divided into time related depreciation cost and distance related cost. The proportion between the two components normally used by the World Bank is employed as shown in Table 8.8.

Table 8.7: Parts Cost and Maintenance Labour Cost

	Passenger Car	Van	M.Lorry	H.Lorry	Bus
Parts Cost Ratio to Vehicle Price	3% (4%)	5% (6.5%)	8.5% (11%)	10% (13%)	10% (13%)
Maintenance Labour Hours/1000km	1 (1.3)	1.2 (1.6)	20 (32)	24.5 (39)	30 (48)
Financial Unit Labour Cost RM/hr	6.78	6.78	6.78	6.78	6.78

Note : ( ) is applied for gravel road
Source : 1) Axle Load Study
2) Estimated with reference to Year Book of Transportation Statistics, Axle Load Study Klang Valley Transport Study, Feasibility Study on Tatau - Kapit Trunk Road Project etc.

Table 8.8: Vehicle Life and Salvage Value

Vehicle Type	Life	Salvage Value	Proportion
Passenger car	10 yrs (8 yrs)	20%	50% : 50%
Van	10 yrs (8 yrs)	20%	30% : 70%
Lorry	10 yrs (8 yrs)	15%	30% : 70%
Bus	10 yrs (8 yrs)	15%	30% : 70%

Note : The figures under "Proportion" show the time related and the distance related depreciation cost respectively.
( ) indicates the vehicle life on gravel roads.

(v) Unit Running Cost

Unit running cost is calculated and summarized as shown in Table 8.9.

Table 8.9: Unit Running Cost

(RM/km in 1992 Price)

Peninsular Malaysia	FINANCIAL COST	CAR	VAN	M.LORRY	H.LORRY	BUS
	1) FUEL COST	0.11	0.11	0.19	0.25	0.25
	2) LUBRICANT OIL	0.009	0.012	0.028	0.031	0.026
	3) TYRE COST	0.009	0.012	0.074	0.128	0.074
	4) MAINTENANCE	0.053	0.057	0.210	0.311	0.407
	5) DEPRECIATION	0.062	0.055	0.052	0.086	0.121
	6) TOTAL	0.243	0.246	0.554	0.806	0.878
	ECONOMIC COST	CAR	VAN	M.LORRY	H.LORRY	BUS
	1) FUEL COST	0.060	0.080	0.130	0.170	0.170
	2) LUBRICANT OIL	0.009	0.011	0.027	0.029	0.024
	3) TYRE COST	0.008	0.011	0.067	0.116	0.067
	4) MAINTENANCE	0.045	0.048	0.192	0.285	0.393
	5) DEPRECIATION	0.051	0.045	0.042	0.074	0.116
	6) TOTAL	0.173	0.195	0.458	0.674	0.770
Sabah & Sarawak	FINANCIAL COST	CAR	VAN	M.LORRY	H.LORRY	BUS
	1) FUEL COST	0.11(0.14)	0.09(0.12)	0.16(0.21)	0.21(0.27)	0.19(0.25)
	2) LUBRICANT OIL	0.009(0.009)	0.011(0.011)	0.025(0.025)	0.027(0.027)	0.025(0.025)
	3) TYRE COST	0.009(0.019)	0.012(0.025)	0.074(0.148)	0.128(0.255)	0.074(0.148)
	4) MAINTENANCE	0.053(0.086)	0.057(0.091)	0.211(0.339)	0.312(0.502)	0.403(0.651)
	5) DEPRECIATION	0.062(0.096)	0.055(0.086)	0.052(0.085)	0.086(0.138)	0.121(0.189)
	6) TOTAL	0.243(0.350)	0.225(0.333)	0.522(0.807)	0.763(1.192)	0.813(1.263)
	ECONOMIC COST	CAR	VAN	M.LORRY	H.LORRY	BUS
	1) FUEL COST	0.060(0.070)	0.070(0.100)	0.120(0.161)	0.160(0.210)	0.160(0.210)
	2) LUBRICANT OIL	0.009(0.009)	0.010(0.010)	0.024(0.024)	0.025(0.025)	0.023(0.023)
	3) TYRE COST	0.008(0.017)	0.011(0.022)	0.067(0.134)	0.116(0.231)	0.067(0.134)
	4) MAINTENANCE	0.045(0.073)	0.048(0.075)	0.197(0.317)	0.286(0.459)	0.390(0.629)
	5) DEPRECIATION	0.051(0.080)	0.045(0.070)	0.042(0.074)	0.074(0.118)	0.116(0.182)
	6) TOTAL	0.173(0.249)	0.184(0.277)	0.450(0.709)	0.661(1.043)	0.756(1.178)

Source : Estimated by Study Team.

Note : The Figures in the parentheses indicate the unit costs for gravel road.

The total running cost is estimated from the total vehicle running distance multiplied by the above unit running cost.

C. Fixed Cost (Time Related Cost)

(i) Depreciation Cost

The time related depreciation cost is calculated by subtracting the distance related depreciation cost from the total depreciation cost.

(ii) Capital Opportunity Cost (Interest Cost)

The interest rate is assumed to be 12% per year which is normally employed as the opportunity cost in Malaysia.

The capital opportunity cost is calculated from the residual value of a vehicle multiplied by this interest rate.

(iii) Crew Cost

The crew wage is estimated by updating the data compiled in past studies.

(iv) Overhead and Insurance Cost

This cost includes insurance, licensing fees and overhead cost for retaining the vehicle and crew.

Table 8.10: Crew Wage and Overhead/Insurance Cost (RM)

	Van	M.Lorry	H.Lorry	Bus
Crew wage (RM/hr)				
Financial Cost	6.48	11.75	14.55	11.75
Economic Cost	5.51	9.99	12.37	9.99
Overhead & Insurance(RM/yr)				
Financial Cost	5000	11,800	16,400	16,400
Economic Cost	3600	9,200	12,700	12,700

Source : Axle Load Study

(v) Unit Fixed Cost

The Unit fixed cost is calculated as shown in Table 8.11.

The total fixed cost is estimated from the total vehicle running time multiplied by the above unit fixed cost.

Table 8.11: Unit Fixed Cost

(RM/hr in 1992 Price)

Peninsular Malaysia	FINANCIAL COST	CAR	VAN	M.LORRY	H.LORRY	BUS
	1) DEPRECIATION	1.028	0.546	0.547	0.911	1.276
	2) INTEREST	1.545	1.328	1.209	2.100	3.318
	3) CREW COST	-	6.48	11.75	14.55	11.75
	4) OVERHEAD	0.796	3.392	4.083	5.675	5.675
	5) TOTAL	3.369	11.746	17.589	23.236	22.019
	ECONOMIC COST	CAR	VAN	M.LORRY	H.LORRY	BUS
	1) DEPRECIATION	0.858	0.443	0.447	0.776	1.226
	2) INTEREST	1.545	1.328	1.209	2.100	3.318
	3) CREW COST	-	5.508	9.988	12.368	9.988
	4) OVERHEAD	0.796	2.442	3.183	4.394	4.394
	5) TOTAL	3.199	9.721	14.827	19.638	18.926
Sabah & Sarawak	FINANCIAL COST	CAR	VAN	M.LORRY	H.LORRY	BUS
	1) DEPRECIATION	1.028(1.284)	0.546(0.682)	0.574(0.718)	0.932(1.165)	1.276(1.595)
	2) INTEREST	1.545	1.328	1.352	2.158	3.318
	3) CREW COST	-	6.36	11.53	14.28	11.3
	4) OVERHEAD	0.796	3.392	4.083	5.675	5.673
	5) TOTAL	3.369(3.625)	11.626(11.762)	17.539(17.683)	23.045(23.278)	21.799(22.118)
	ECONOMIC COST	CAR	VAN	M.LORRY	H.LORRY	BUS
	1) DEPRECIATION	0.858(1.073)	0.443(0.553)	0.500(0.625)	0.798(0.997)	1.226(1.533)
	2) INTEREST	1.545	1.328	1.352	2.158	3.318
	3) CREW COST	-	5.410	9.810	12.140	9.810
	4) OVERHEAD	0.796	2.442	3.183	4.394	4.394
	5) TOTAL	3.199(3.414)	9.623(9.733)	14.845(14.970)	19.490(19.689)	18.748(19.055)

Note : The figures in the parentheses indicate the unit costs for gravel road.

(2) Travel Time Cost

Time value is assessed in terms of hourly productivity of the vehicle passengers.

As elaborated in Chapter 4, the 1991 Gross Regional Domestic Products (GRDP) of Peninsular Malaysia, Sabah and Sarawak were estimated to be RM 107,059 million, RM 11, 168 million and RM 11,081 million respectively.

The numbers of employment in 1991 were 5.566 million, 586 thousand, and 703.6 thousand, therefore, the annual value added productivity comes to RM 19,234 for Peninsular, RM 19,058 for Sabah and RM 15,749 for Sarawak, which are equivalent to RM 9.16/hr, RM 9.08/hr and RM 7.50/hr respectively by assuming the annual working time be 2100 hours. Likewise, the value added productivity for 2010 is estimated to increase to RM 20.1/hr, RM 20.4/hr and RM 16.5/hr respectively.

For estimating the travel time cost, these hourly values are applied to production - related trips only i.e., only the business trips are envisaged.
The time cost of the bus passengers is disregarded considering that the composition rate of business trips by bus might be extremely low in case of inter-regional trips.

Thus, the unit time cost is calculated as shown in Table 8.12.

Table 8.12: Unit Travel Time Cost

		Peninsular	Sabah	Sarawak
Hourly Productivity [2](RM/hr)	1991	9.16	9.08	7.50
	2010	20.10	20.40	16.50
Average Car Occupancy [1] Rate (person/veh.)		1.8	2.4	2.4
Unit Travel Time Cost [2] per vehicle (RM/hr)	1991	16.5	21.8	18.0
	2010	36.2	49.0	39.6
Business Trip' Composition (%)		17.3		

Source : 1) Car Owner Interview Survey 1991
2) Estimated by Study Team

Travel time cost is obtained from the time savings in terms of veh-hr multiplied by the business trip composition, then multiplied by the unit travel time cost per vehicle in the above Table.

(3) Savings in River Transport Cost

In the case of Sarawak, the proposed network plan includes new roads to areas where the present transport is exclusively dependent on the river for both passengers and cargoes. The vehicle operating costs of the roads are already taken into account. The savings in river transport cost should be counted as a benefit after replacing the river transport with the new road. The unit river transport cost is estimated as shown in Table 8.13.

The savings in river transport cost is estimated as follows by using the traffic assignment results.

$$S^t = \sum_k Cp \cdot V^t_k \cdot Nk + \sum_k Cc \cdot V^t_k \cdot Wk$$

where :-
- S^t : Savings in river transport cost in year t
- Cp : Unit passenger transport cost (RM/km)
- V^t_k : Vehicle running distance for the section replaced by a new road for vehicle type k (veh. km)
- Nk : Average number of passengers for vehicle k (passenger/veh)
- Cc : Unit cargo transport cost (RM/ton)
- Wk : Average loading cargo volume (tons/veh.)

Table 8.13: River Transport Cost In Sarawak

Passenger Transport Cost			Cargo Transport Cost		
	Express Launch	Long Boat (40Hp)		River Cargo vessel (50t)	Long Boat (40Hp)
Unit Cost (RM/passenger km)[1]	0.114 (0.107)	0.586 (0.456)	Unit Cost (RM/ton.km)	0.086 (0.079)	1.789 (1.378)
Composition Rate [1]	50%	50%	Composition Rate	70%	30%
Ave. Unit Cost [1] (RM/pass. km) ('84 price)	0.35 (0.282)		Ave. Unit Cost (RM/ton. km) ('84 price)	0.597 (0.469)	
Price Adjustment [2] Factor ('84-'92)	1.138		Price adjustment Factor ('84-'92)	1.138	
Ave. Unit Cost (RM/pass. km) ('92 price)	0.398 (0.321)		Ave. Unit Cost (RM/ton. km) ('92 price)	0.679 (0.534)	

Note The figures in the parenthesis represent the economic cost
Source: 1) Feasibility Study on the Tatau-Kapit Trunk Road Project in Sarawak JICA August 1985
2) "Consumer Price Index in Sarawak" from Economic Report '91/'92

(4) Estimation of Economic Benefit

The economic benefits derived from the proposed network plans are estimated as shown in Tables 8.14 and 8.15.

The total benefit of the alternatives in Peninsular is estimated at RM 320 million, RM 356 million, RM 310 million in 1999 for Alternatives 1, 2, 3 respectively and RM 18,670 million, RM 20,257 million, RM 18,410 million in 2010 respectively (at 1992 prices) by assuming that the vehicle operating cost grows at a constant growth rate from 1991 to 2010.

Table 8.14: Economic Benefit of Alternative Network Plans in Peninsular Malaysia

(RM million)

	Alternative 1		Alternative 2		Alternative 3	
	1999	2010	1999	2010	1999	2010
VOC* Savings (Running Cost)	34.6	1,094.6	33.6	1,059.6	29.3	932.9
VOC Savings (Fixed Cost)	217.8	12,147.9	245.8	13,332.6	212.2	12,086.8
Travel Time Savings	68.0	5,427.2	76.4	5,864.8	68.0	5,389.8
Total	320.4	18,669.7	355.8	20,257.0	309.5	18,409.5

Note: * Vehicle Operating Cost

Table 8.15: Economic Benefit of Proposed Network Plans in Sabah and Sarawak

(RM million)

	Sabah		Sarawak	
	1999	2010	1999	2010
VOC* Savings (Running Cost)	5.6	146.9	1.2	154.1
VOC Savings (Fixed Cost)	65.1	1,449.8	20.2	696.6
Saving in River Transp. Cost	-	-	1.7	11.9
Travel Time Savings	24.7	967.7	9.7	648.6
Total	95.4	2,564.4	32.8	1,511.2

Note: * Vehicle Operating Cost

Likewise, the total benefit of the proposed plans in Sabah and Sarawak is estimated at RM 95 million, RM 33 million in 1999 and RM 2,564 million, RM 1,511 million in 2010 respectively. The benefit after the year 2010 is assumed to be constant without growth, considering that it would be a more conservative evaluation.

(5) Evaluation

A. Peninsular

The total economic benefit and cost streams are compared by each alternative, assuming the discount rate of 12% per annum. The results of the evaluation are shown in Table 8.16. It is obvious that the total discounted benefit is much higher than the total discounted cost in any case, therefore, all the alternative network plans as a whole are economically viable. In terms of the internal rate of return (IRR), benefit-cost ratio (B/C), as well as the net present value (NPV), Alternative 2 shows the highest indicators. As a result, Alternative 2 is the most feasible network plan from the national economic viewpoint.

Table 8.16: Evaluation Indicators of Alternative Network Plans for Peninsular Malaysia

	Alternative 1	Alternative 2	Alternative 3
Internal Rate of Return (%)	26.4%	29.8%	29.2%
B/C Ratio	2.74	3.34	3.24
Net Present Value (RM million)	17,607.9	21,129.6	18,859.1

B. Sabah

In the case of Sabah, the B/C ratio is calculated as 2.1, NPV is RM 2,304.1 million and IRR is 23.7 %. Thus, the proposed network plan for Sabah is economically feasible. (Refer to Table 8.17)

C. Sarawak

For Sarawak, the B/C ratio is estimated at 1.04, NPV is RM 87.3 million and IRR 12.4% . Hence, the proposed network plan for sarawak is also economically feasible.

Table 8.17: Evaluation Indicators for Sabah and Sarawak

Indicators	Sabah	Sarawak
IRR* (%)	23.7%	12.4%
B/C Ratio	2.11	1.04
NPV* (RM million)	2,304.1	87.3

Note: * Refer to Table 8.16

8.4 Social and Regional Development Consideration

In order to provide a better access to the residents in the rural areas and promote regional development particularly for the less-developed areas, the development of highway network will be an important factor. In this sense, a future highway network having a wider coverage area would be considered as a better alternative.

As an indicator of the level of highway network development, the road development index which was elaborated in chapter 3 is employed.

Table 8.18 shows the Road Development Index for inter-urban Highway Network by areas and alternatives.

The longest network among the three alternatives in Peninsular Malaysia will be developed by Alternative 1 and followed by Alternative 2, therefore, the road development indices of the alternatives are also in this order.

Table 8.19 shows the road development indices for highway in the foreign countries, which are mostly much higher compared with the existing condition in Malaysia. In order to reach the level of the developed countries by 2010, i.e., the index higher than 0.2, Alternative 1 or Alternative 2 should be selected.

As for Sabah and Sarawak, the road development indices are extremely low at present.

The indices will be significantly improved by adopting the proposed network plans. However, they will still remain at a lower level compared with Peninsular, particularly in Sarawak. The road development level in the two states by 2010 will be comparable to the present level in Peninsular Malaysia. As the two states continue to grow with a higher population and demand for transport and hence a denser highway network, the indices will further improve.

Table 8.18: Road Development Index for Inter-Urban Highway Network by Areas and Alternative Plans

Year	Indicator		P. Malaysia	Sabah	Sarawak	Malaysia
1991	Highway Length (km)		7,690	1,116	1,213	10,019
	Population ('000)		15,084.0	1,592.1	1,814.0	18,490.1
	Area (km^2)		131,598	73,620	124,449	329,667
	Road Develop. Index		0.173	0.103	0.081	0.128
2010	Population ('000)		21,954.6	2,765.9	2,779.8	27,500.4
	Highway Length (km)	Alternative 1	11,740			16,188
		Alternative 2	10,850	2,005	2,443	15,298
		Alternative 3	10,020			14,468
	Road Develop. Index	Alternative 1	0.218			0.170
		Alternative 2	0.202	0.141	0.131	0.161
		Alternative 3	0.186			0.152

Source: 1) Highway Inventory Study, 2) Year book of Statistic '90
3) Study Team Estimates

Table 8.19: National Road Development Index for Highway in Foreign Countries

Countries	Highway Length* (km)	Population ('000)	Area ('000 km^2)	Highway Development Index
Germany **	39,829	61,200	248.7	0.323
France	35,600	55,870	551.0	0.203
England***	27,296	57,080	230.0	0.238
Italy	51,448	57,440	301.3	0.391
Japan	51,596	123,410	377.8	0.239
USA	739,134	246,330	9,372.6	0.486

Source : World Road Statistics, 1986-1990 (IRF)
Doro Gyosei (Road Bureau, Ministry of Construction, Japan, '90)
Note * : including motorway (Expressway), Highways, main or national roads defined by the statistics.
** : Federal Republic
*** : Highway length for England includes a part of regional roads which provide linkages between cities.

8.5 Recommended Road Network

(1) Peninsular

Alternative 2 provides us with the best economic evaluation indicators, therefore this is the most feasible amongst the three.

Also in terms of functional suitability, Alternative 2 shows the best results, i.e. lower V/C ratio and higher travel speed. Moreover, in terms of road development indicator for highway, it is able to produce a more than 0.2.

Consequently, Alternative 2 is recommended for the Highway Network Master Plan for Peninsular Malaysia (see Figure 6.18).

However, considering the effects of highway development on social / regional development, it is more desirable in the long run that the minor highways, which are included in Alternative 1 but excluded in Alternative 2 are to be examined and considered for implementation by the corresponding state governments (see Figure 6.17).

(2) Sabah

As for Sabah, the proposed network plan was found to be economically feasible. In terms of functional suitability, the plan is acceptable from the transport planning aspect.

Accordingly, the proposed network plan is recommended as the Highway Masterplan for Sabah. (Refer to Figure 6.22)

(3) Sarawak

The proposed network plan for Sarawak was also found to be economically justified. Also from the viewpoint of functional suitability, the plan is considered to be acceptable.

As a result, the proposed network plan is recommended as the Highway Masterplan for Sarawak. (Refer to Figure 6.22)

CHAPTER 9

IMPLEMENTATION PLAN

FEDERAL TRUNK ROAD 01 SARAWAK,
RIVER CLOSING

CHAPTER 9 : IMPLEMENTATION PLAN

9.1 Examination of Development Funds

(1) Past Performance and Allocation of The Federal Government Development Funds

During the two five year plan periods in 1970's, i.e., the Second Malaysia Plan (SMP) and Third Malaysia Plan (TMP), the total Federal Government development expenditure grew from RM 9,793 million to RM24,937 million with an extremely high growth of 155% in current prices.

This high growth has continued into the Fourth Plan period. However with the exacerbation of the world-wide economic recession and the resulting declining trend of Malaysia's economy reaching bottom level in 1985, the development expenditure was cut off for the Fifth Plan period, 24% reduction in current prices from the previous plan period.

From the second half of the FMP period, a quick economic recovery was brought about through the adjustment measures undertaken to reduce the budgetary deficits, the liberal trade and investment policy to promote private investments, combined with the improvement in the external market conditions.

Reflecting the recovery of the economy, the development allocation for the Sixth Plan was revised upward from RM 35,300 million in the FMP to RM55,000 million in the Sixth Plan in terms of current prices.

The past allocation of the Federal Government Funds to the transport sector together with its break down to roads and bridges is summarized in Table 9.1.

Table 9.1 : Past Development Expenditure of Federal Government

in current price (M$ Million)

	Plan Period				
	1971-1975 2MP	1976-1980 3MP	1981-1985 4MP	1986-1990 5MP	1991-1995 6MP
Total Development Expenditure of Fed. Govt	9,793 (100%)	24,937 (100%)	46,320 (100%)	35,300 (100%)	55,000 (100%)
Allocation to Transport	1,234 (12.6%)	2,843 (11.4%)	6,990 (15.1%)	6,823 (19.3%)	10,759 (19.6%)
Allocation to Roads & Bridge	698 (56.5%)*	1,765 (62.1%)*	4,167 (59.6%)*	6,011 (88.1%)*	7,585**(70.5%)*
- Highways	663	1,577	3,543	4,850	6,299
- Rural Roads	35	188	624	1,161	1,286

Note: 1. The figures for 2MP - 5MP are actual expenditures and those for 6MP indicate the development allocation.
2. The figure in the parenthesis for Transport shows the percent share to total expenditure.
3. * indicates the percent share to the allocation to Transport.
4. ** : The service loan of about M$ 1.5 billion for privatization is to be spent out of the allocation to highways.

Sources: TMP,FOMP,FMP,SMP

The development funds are predominantly dependent on the government revenue which is closely related to the Gross Domestic Products (GDP). Hence, the correlation between the total development funds and GDP was examined by a regression analysis.

The resulting regression line and the correlation coefficient are as follows:

$$DF = 0.055542 \times GDP + 12349$$

Where DF : Development Funds
GDP : Gross Domestic Products
R : Correlation Coefficient (=0.883)

Since the correlation coefficient is sufficiently high, the total development funds for the Eighth and Ninth periods are estimated by using the above relationship.

As a result, the total development funds are estimated to be about M$ 96 billion and M$ 129 billion for the Eighth and Ninth plan periods respectively as shown in Table 9.2.

Table 9.2 : Estimation of Total Development Funds of Federal Government

in current price (RM million)

Plan Period	Development Funds	Gross Domestic Products	% to GDP
1971-1975 (2MP)	9,793	90,987	10.8
1976-1980 (3MP)	24,987	196,845	12.7
1981-1985 (4MP)	46,320	346,856	13.4
1986-1990 (5MP)	35,300	458,232	7.7
1991-1995 (6MP)	55,000	765,743	7.2
1995-2000 (7MP)	71,000	1,073,445	6.6
2001-2005 (8MP)	96,020	1,490,251	6.4
2005-2010 (9MP)	129,069	2,085,275	6.2

Note: 1. Development Funds for 1971-1991 are actual expenditures.
2. Development Funds for 6MP and 7MP are planned allocation.
3. Development Funds for 8MP and 9MP are estimated by a regression analysis.
DF = 0.055542GDP + 12349 (R = 0.883)
Where DF : Development Funds and GDP: Gross Domestic Products

Sources: TMP,FOMP,FMP,SMP,OPP2

In estimating the development allocation to highways for the period after the Seventh Plan, it is assumed that the percentage share of the highway development funds in the future will be maintained at about the same level as in the Sixth Plan period, considering that more than 90% of transport in the country is dependent on the road transport for both passengers and freight.

As shown in Table 9.3, the development allocation to highways is estimated to be about RM 8 billion, RM 11 billion and RM 15 billion for the 7th, 8th and 9th Plan periods respectively. As a consequence, the total accumulated allocation to highways for the years 1991-2010 is estimated at about RM 40 billion.

Table 9.3 : Estimation of Development Allocation to Highways

in current price (RM million)

Plan Period	Allocation to Highways	Development Funds	% share
1971-1975 (2MP)	663	9,793	6.8
1976-1980 (3MP)	1,577	24,937	6.3
1981-1985 (4MP)	3,543	46,320	7.6
1986-1990 (5MP)	4,850	35,300	13.7
1991-1995 (6MP)	6,299	55,000	11.5
1995-2000 (7MP)	8,165	71,000	11.5
2001-2005 (8MP)	11,042	96,020	11.5
2006-2010 (9MP)	14,843	129,069	11.5
Total (1991-2010)	40,349	351,089	11.5

Note : If the service loan for privatization is subtracted from the allocation to highways, the percentage share will decrease to 8.7%, therefore, in this case the total allocation to highways for the years 1991 - 2010 will be about RM 30 billion.

Source : TMP,FOMP,FMP,SMP

(2) Committed Projects

Various road projects are now under implementation by using the Federal funds within the framework of the Sixth Plan. Some of them are projects started in the Fifth Plan, and some are newly started in the Sixth Plan.

The allocation to the highway development in the 6MP may be spent up with these committed projects, therefore no additional road project will be started in the 6MP unless an additional allocation or some other resources including those from private sector become available.

Most of these committed projects will be completed within the plan period, however, some of them will be continued into the 7MP.

The major projects to be continued to the 7MP are shown in Table 9.4.

(3) Possibility of Other Resources

The total project cost required for the Highway Master Plan is about RM 53 billion, which exceeds the total estimated allocation of federal funds expected. Hence, the possibility of some other resources for highway development is examined below.

Table 9.4 Major Committed Projects to be Continued to 7MP

Project Road	Estimated Cost for 7MP (RM million)
1. Gua Musang - K.Terengganu	464.000
2. Baling - Gerik	269.000
3. Long Terawan - Nanga Mendanuit	142.844
4. Belaga - Bintulu	150.000
5. R.Sabindang - Long Terawan	107.155
Total	1,132.999

(i) State Funds

Each state has her own development funds which can be used for road development. According to the Sixth Malaysia Plan, the total development funds of The Federal and State Government for the Sixth Plan period are about RM 66 billion. As the Federal Government funds amounted to some RM55 billion, the rest of about RM 11 billion is mostly regarded as State Funds.

Table 9.5 : Development Funds of Public Sector

(RM million)

	FMP	SMP
Federal and State Governments	37,566	66,170
NFPE	20,153	37,830
Total	57,719	104,000
Federal Government	35,300	55,000

Source : SMP
Note : NFPE - Non Financial Public Enterprises

The state funds to be allocated to road development varies from state to state, ranging approximately from 10% to 30% depending on the circumstances of each state. Although the proposed highway network plan in this study is mainly financed by federal funds, certain portion of the network might be carried out by using state funds.

In the West Coast of the Peninsular, for instance, the distributors in the East to West direction connecting the parallel North to South federal routes (such as federal route 1, 5) are candidate projects to be financed by the corresponding states.

(ii) Privatization

Some of the proposed highway projects can be implemented by privatization. As stated in the Sixth Malaysia Plan, the Government has an intention to further promote privatization for developing infrastructures wherever it is possible.

Among the proposed highway development projects in this study, the following may be the candidate projects for privatization.

Table 9.6 Candidate Projects for Privatization

Project Roads	Indicative Construction Cost (RM million)
(1) Widening of N-S Expressway*	2,203.6
(2) East-West Expressway	2,069.1
(3) East Coast Expressway	2,928.5
(4) South Klang Valley Expressway	284.5
(5) KL Outer Ring Road	853.5
(6) Port Dickson-Seremban Highway	106.0
(7) Muar-Tangkak-Segamat Highway	264.9
Total	8,710.1

Note: *N-S Expressway had been privatized

9.2 Identification of Highway Projects

In general, road sections of the proposed future network may be classified into the following categories:-

(a) New road construction,
(b) Widening of existing road,
(c) Improvement of existing road,
(d) Those which requires no improvement

Among the above, those sections in categories (a) ~ (c) will require the investment. For determining the implementation priority, however, the following two (2) categories are considered:

(a) New road construction (b) Widening.

A road project should be identified as a minimum unit of the masterplan component, which can function by itself independently of other projects.

Hence, the new road sections and widening sections mentioned above are rearranged and segmented or aggregated into 72 projects for Peninsular Malaysia and 23 projects for Sabah and Sarawak, taking into account their function, work scale and independency.

The identified projects are mostly either widening or new construction, however, some of them include both widening and new construction because of their functional dependence or mutual co-relationship. The location of the project roads and their list are shown in Figures 9.1 and 9.2.

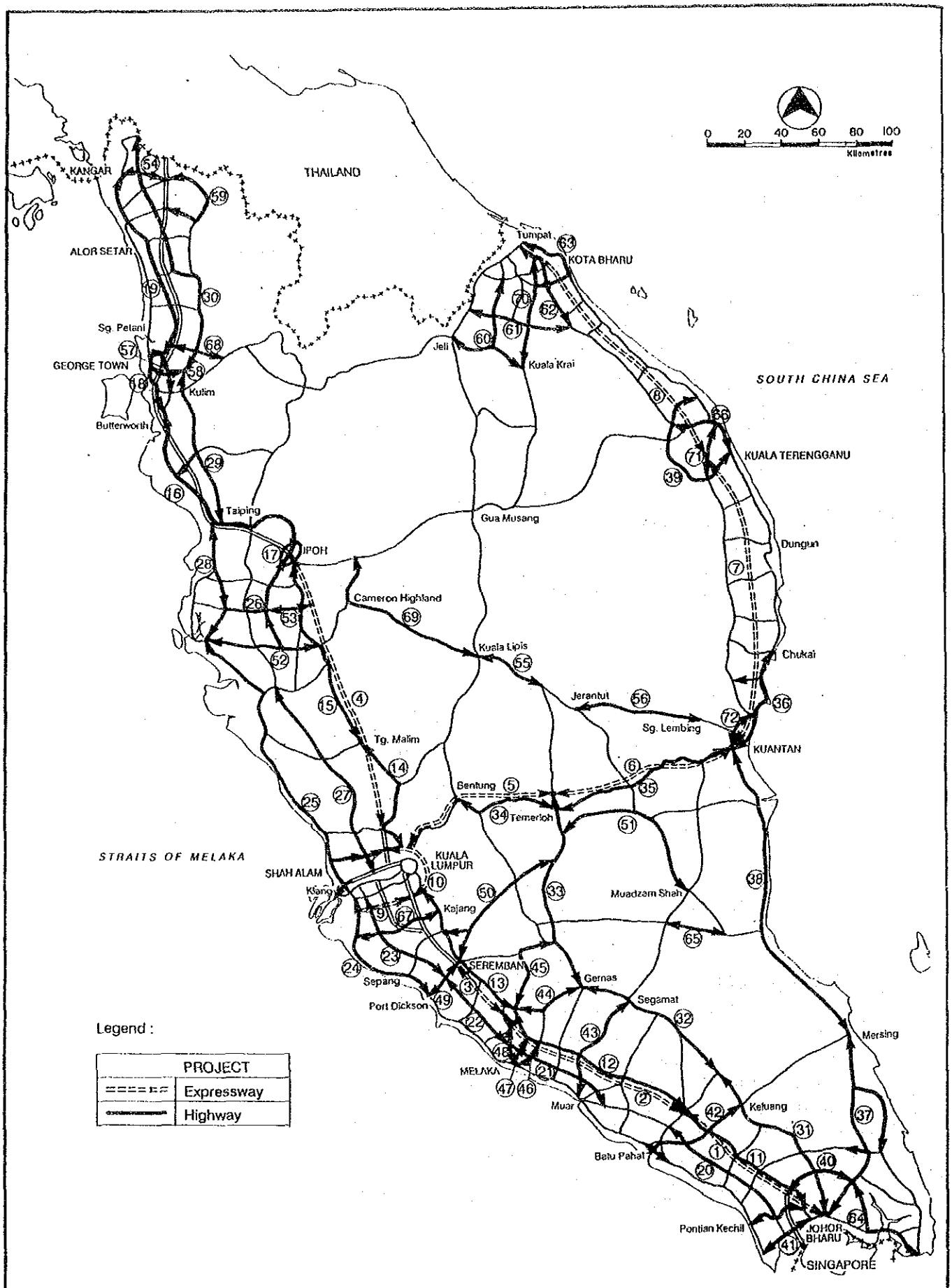


Figure 9.1 : Location of Project Roads in Peninsular

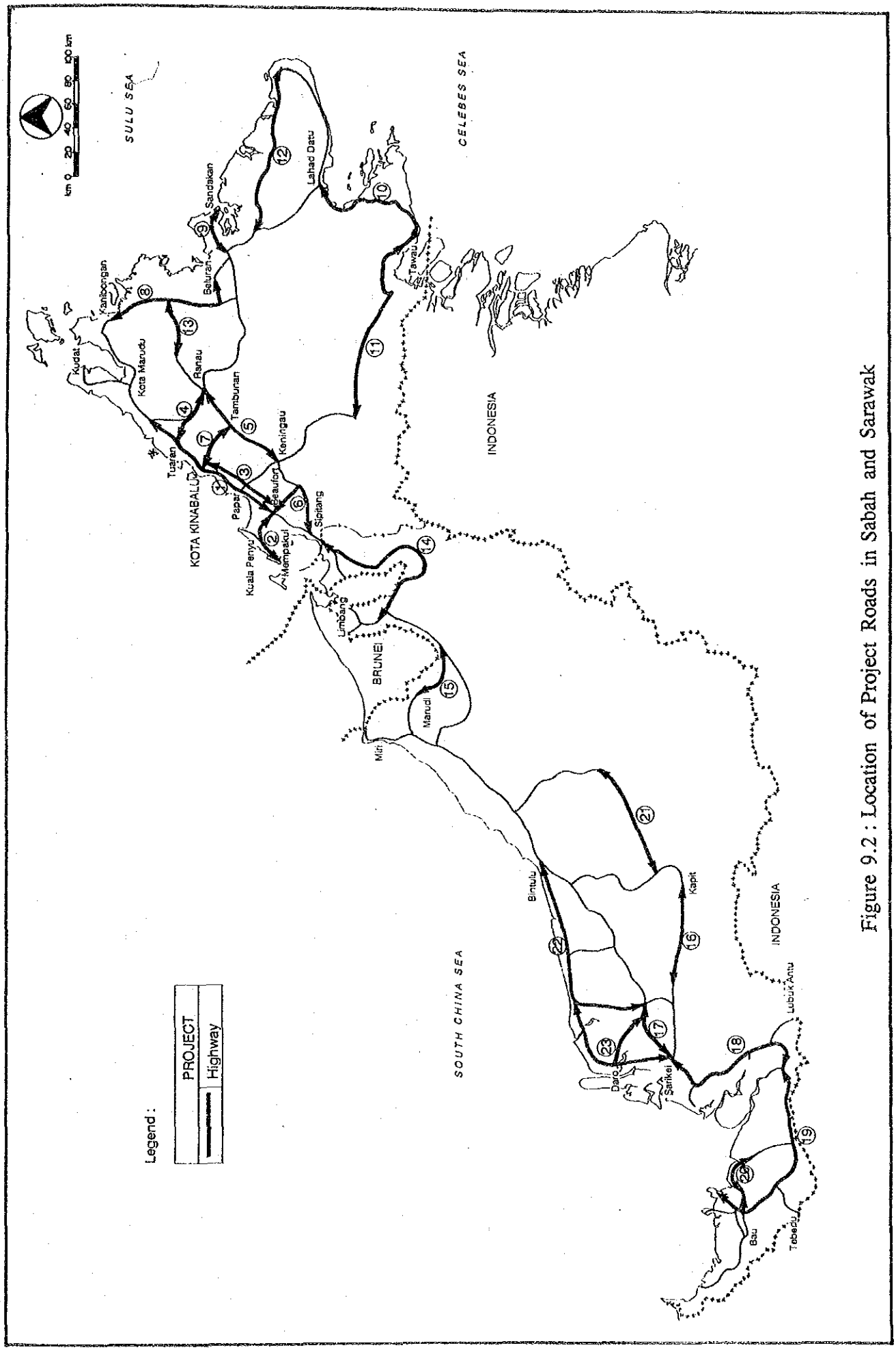


Figure 9.2 : Location of Project Roads in Sabah and Sarawak

9.3 Priority of the Project Roads

(1) General

The basic standpoints for determining the priority in this study are as follows:

1. In order to eliminate a prejudice or subjectivity, a purely technical approach will be employed.

2. For this purpose, some factors among those listed above, such as political reasons, regional balance etc, are excluded from the criteria.

3. A quantitative analysis is undertaken as much as possible. However, considering that there are also non quantitative factors of importance, the one which can be objectively judged should be employed as a qualitative factor.

The identification procedure of priority projects is shown in Figure 9.3.

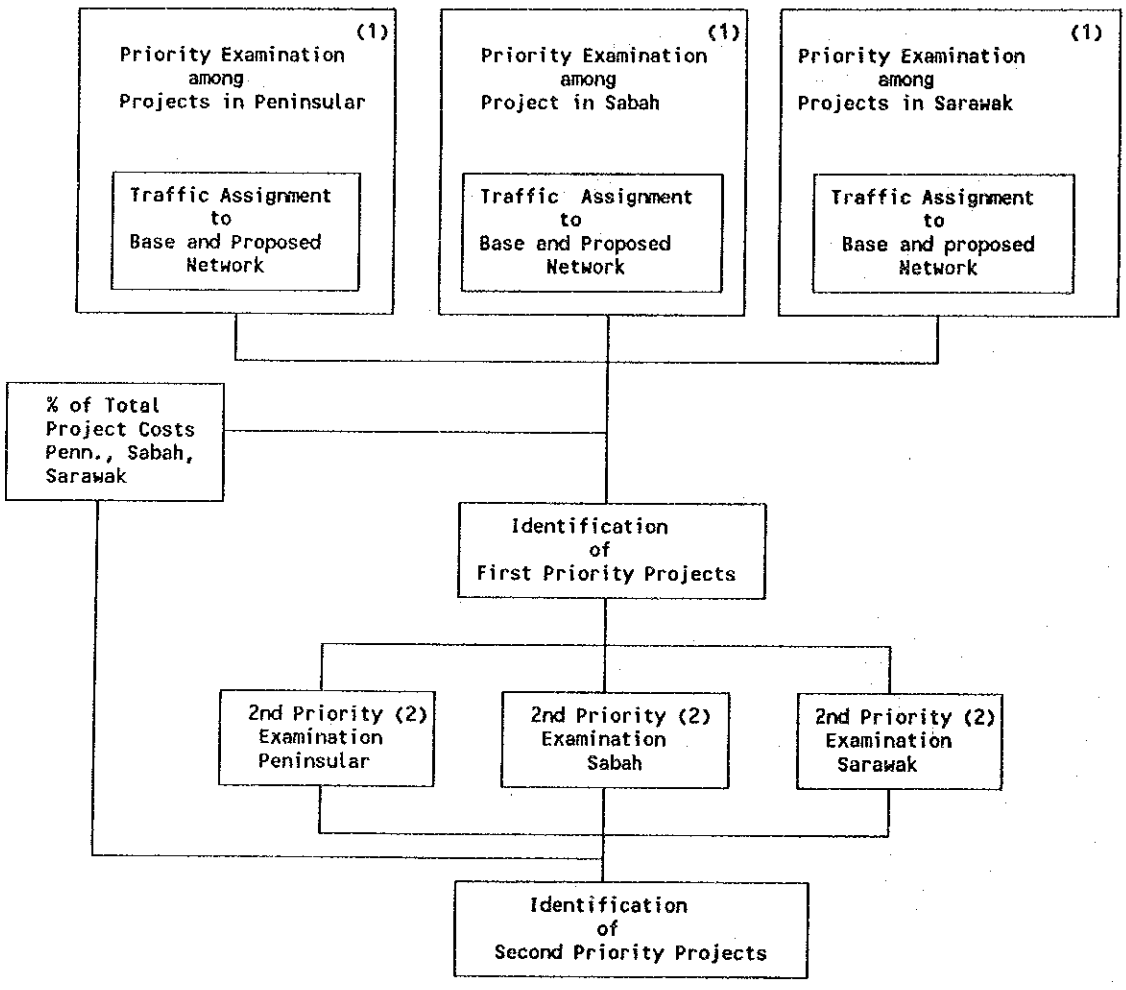


Figure 9.3 : Identification Procedure for Project Priority

(2) Considered Factors

(i) Qualitative Factor

Among the factors mentioned above, one of the most important qualitative factors is network configuration from the viewpoint of highway network planning. It is important that a network can function adequately.

For this purpose, it is necessary to formulate the network skeleton, ie., the national principal highway network elaborated in Chapter 6. Accordingly, if there exist a missing link in the principal highway network, it would be assumed as one of the first priority group.

The missing links in the principal highways are identified as the two sections below:

(a) The Major Highway section connecting Keluang - Segamat (which is identified as Project 32 in Table 9.1)

(b) The Major Highway section connecting Sabah - Sarawak (which is identified as Project SW 14 in Table 9.2)

(ii) Quantitative Factor

As for the quantitative factors, the following three will be considered in this study.

(a) Future Traffic Volume

One of the selected evaluation criteria for determining the priority ranking is the magnitude of future traffic volume on the proposed highway project. Generally, if the magnitude of future traffic volume on the project highway is large, then the project will be given a higher priority ranking than the others.

(b) Traffic Volume / Capacity Ratio

An another determinant factor for priority ranking is traffic volume/capacity ratio (v/c ratio), calculated under the conditions without the proposed project. A project with higher v/c ratio should be given a higher priority than others.

The v/c ratio is measured by referring to the project road itself when it is a widening project and by referring to the nearest parallel road when it is a new construction.

(c) Cost Effectiveness

An another factor for ranking the highway project is cost - effectiveness of the proposed construction or widening works. A project with a higher cost - effectiveness shall be given a higher priority than the others.

Cost effectiveness of a highway project can be expressed as follows :-

$$\epsilon = f(Q, L, I)$$

Where; ϵ = Cost effectiveness
Q = Traffic volume
L = Length of project
I = Investment cost

(3) Priority of The Project Roads

(i) Procedure

Based on the above qualitative and quantitative analyses, the group of first priority projects were selected according to the following procedure:

1. Firstly, the two projects "Project No.32" and "Project SW 14" selected through the qualitative approach are listed at the top for the Peninsular and Sarawak.

2. Secondly, projects are picked up by region according to the order of the total score so that the total project cost is nearest to the target share.

3. If there are several substitutive (parallel) projects in the highest priority group, only one project will be selected and others will be eliminated.

4. Taking into account that the North-South Expressway is now under construction, the widening project of Federal Route 1 will be given a lower priority on account of network configuration.

(ii) Target Shares for the Projects

The target shares of the Projects are determined based on the expected development fund allocation to highways as shown in Table 9.7.

(iii) Results of Priority

The resultant first priority projects for Peninsular, Sabah and Sarawak are shown in Figure 9.4 and Figure 9.5. respectively. Likewise, the second priority projects are selected as shown in Figure 9.6 and Figure 9.7.

Table 9.7: Target Shares for the Projects

	Total Project Cost(RM'000)	7 MP (1996-2000)	8 MP (2001-2005)	9 MP (2006-2010)
Peninsular	28,321	6,800	9,065	12,464
Sabah	4,790	1,150	1,528	2,101
Sarawak	6,344	1,520	2,032	2,795
Total	39,455	9,470	12,625	17,360

9.4 Implementation Program

The total cost to realize the highway network masterplan is estimated to be about RM51,780 million at 1992 price excluding the committed projects. Of this, about RM39,455 million are for new road construction or widening projects and the rest, RM12,325 million are for the improvement of existing highways.

Based on the project priority analysis in the previous section, the implementation schedule ranking of projects is prepared as shown in Table 9.8. The first priority projects are assumed to be undertaken in the 7th Malaysia Plan period.

However, it should be noted that if an additional budget is prepared or if a project can be implemented by private sector without a substantial government expenditure, some of the second priority projects can be started within the 7MP period.

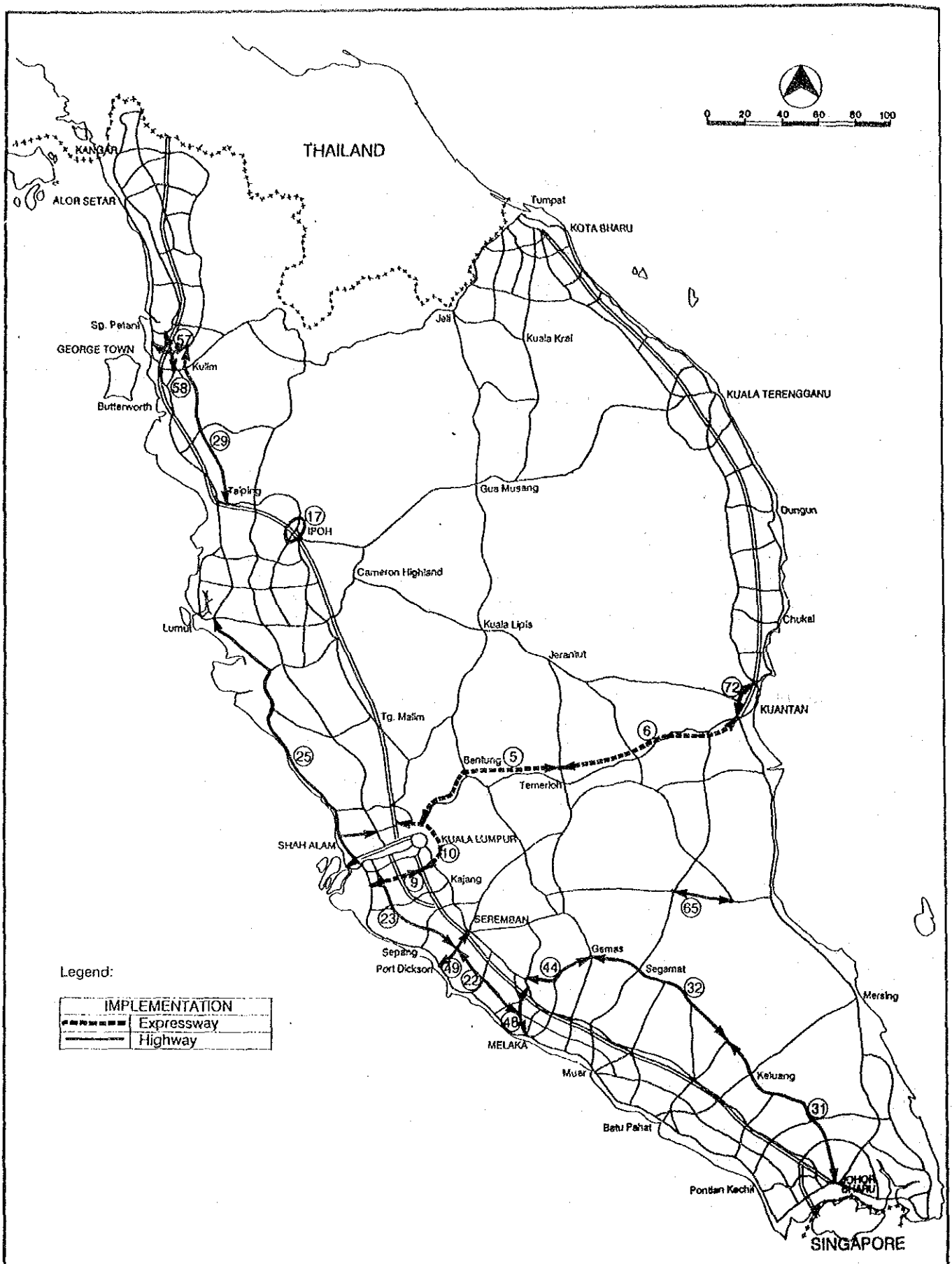


Figure 9.4 : First Priority Projects in Peninsular

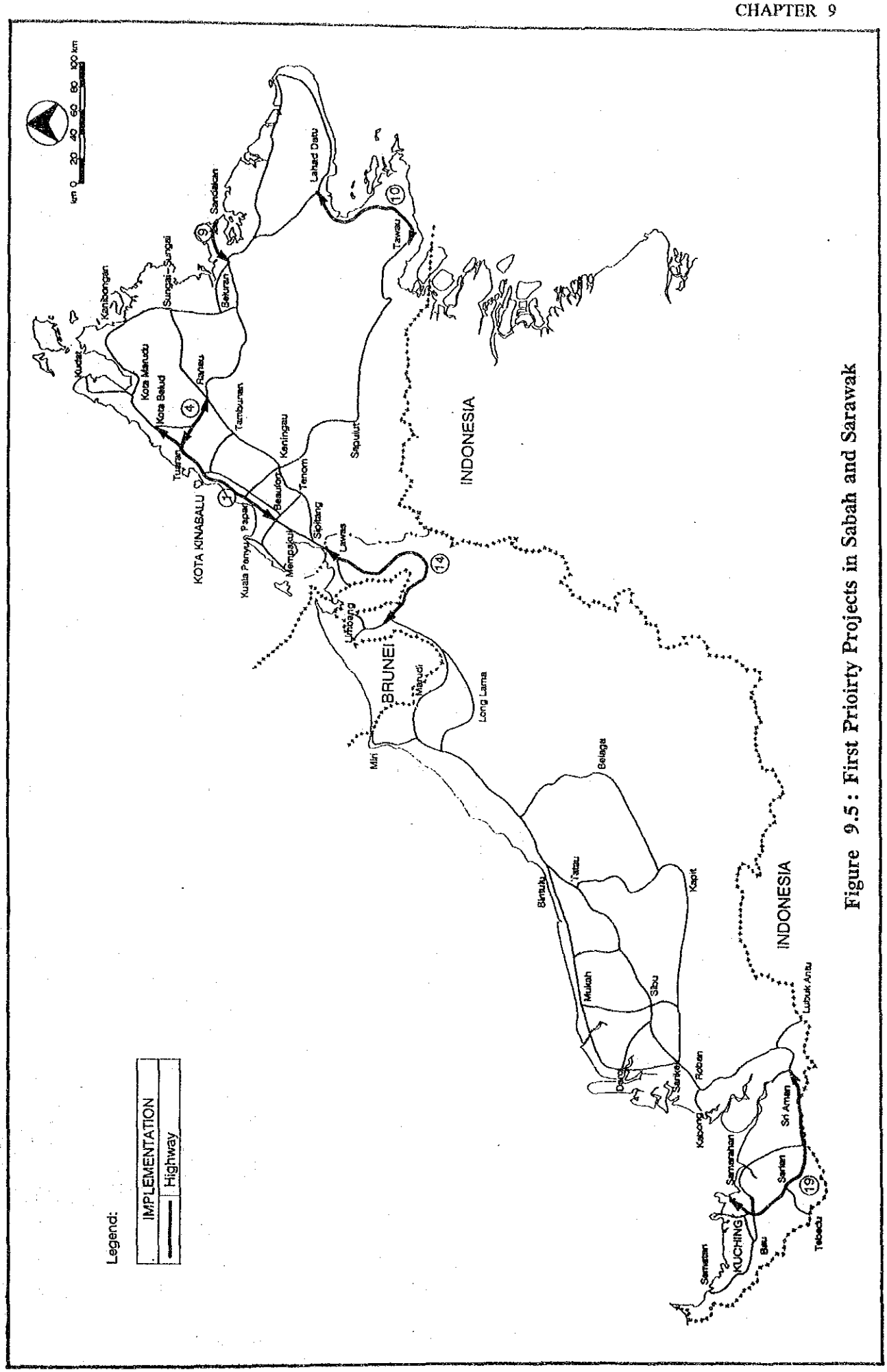


Figure 9.5 : First Prioirty Projects in Sabah and Sarawak

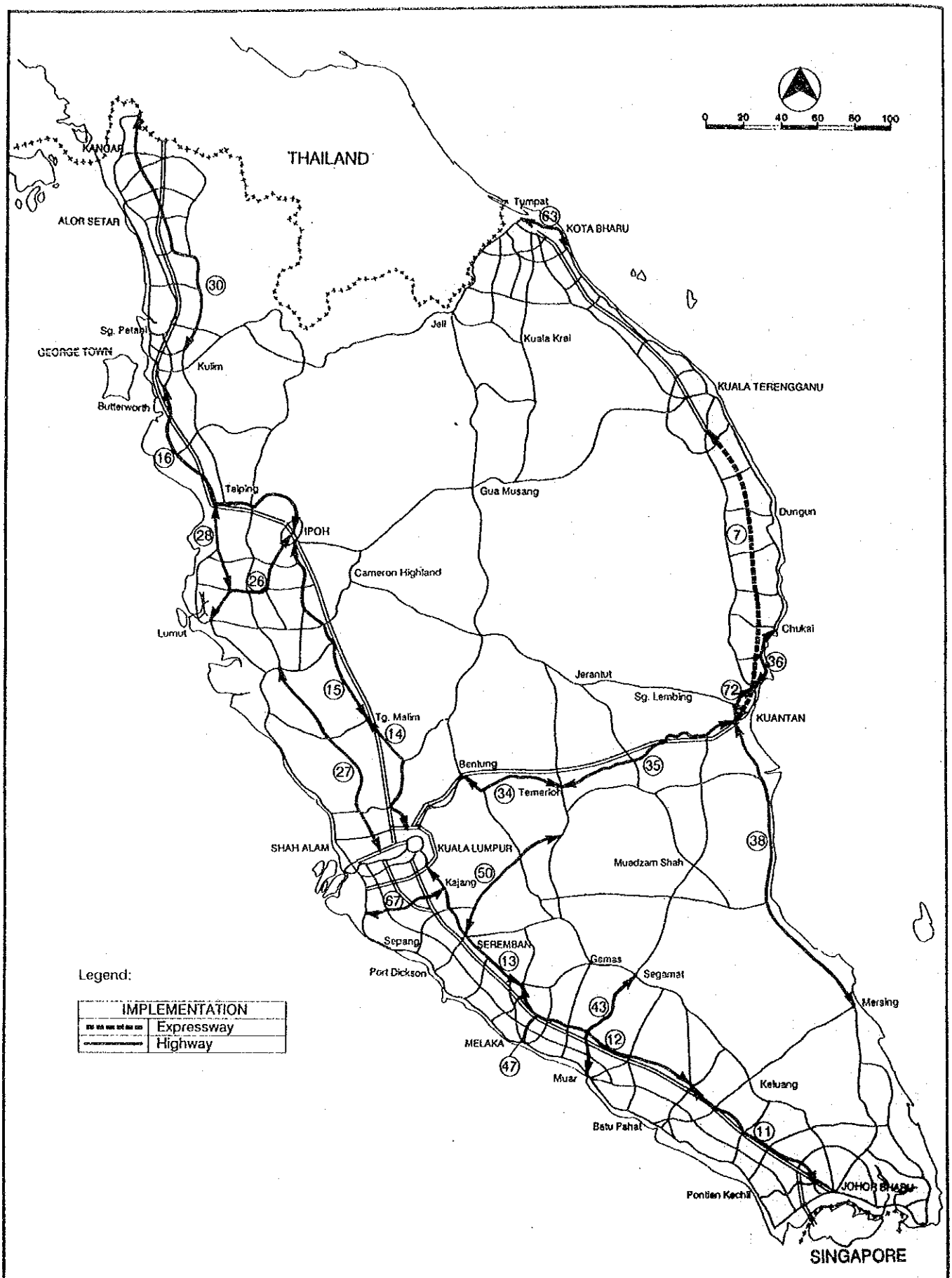


Figure 9.6 : Second Priority Projects in Peninsular

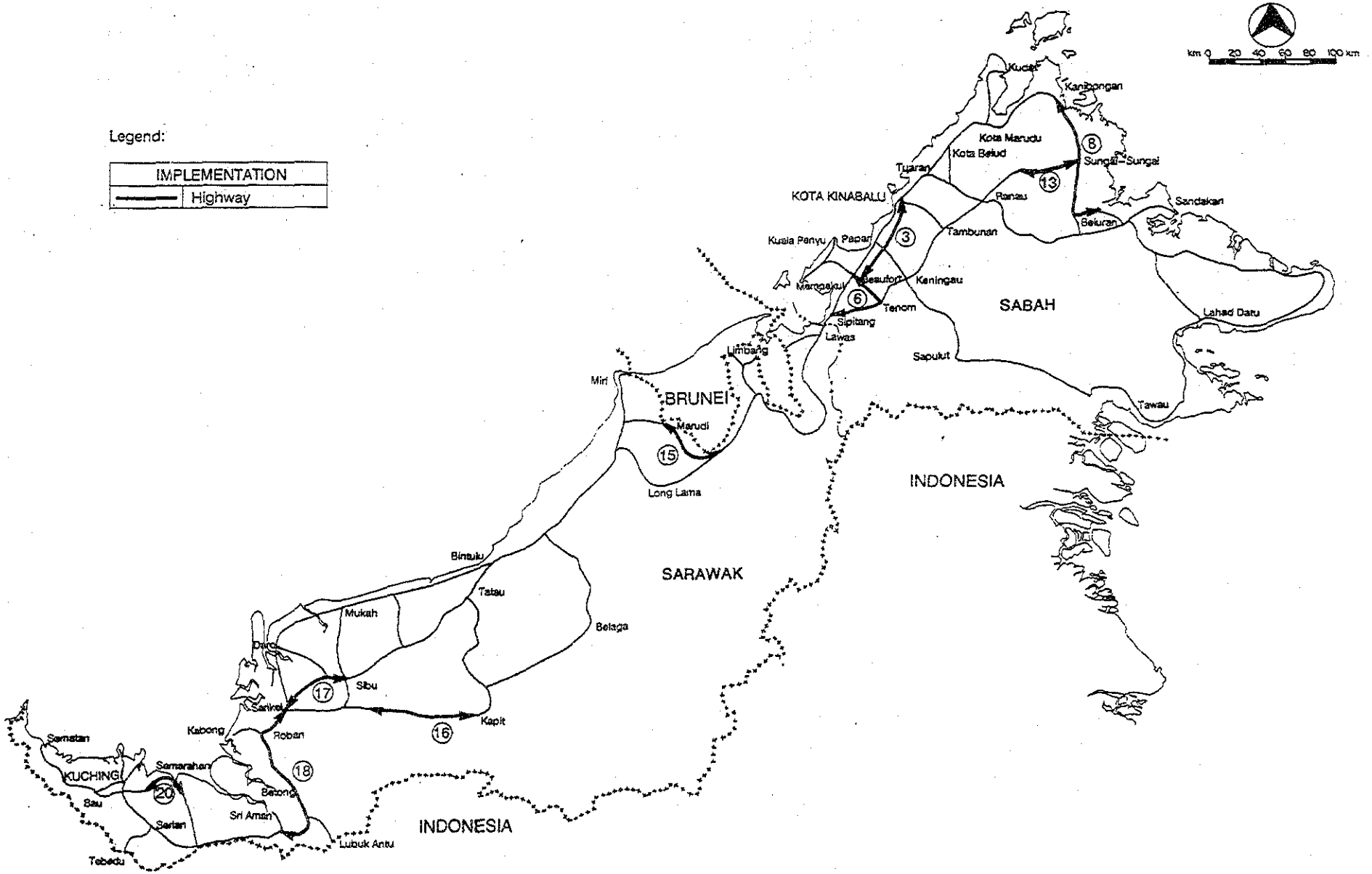


Figure 9.7 : Second Prioirty Projects in Sabah and Sarawak

TABLE 9.8 : Proposed Implementation Schedule of Highway Projects

Rank	Project No.	Project Name	Investment Amount RM Million	Year '95	'00	'05	'10	Note
1	32	Keluang–Gemas Widening	353.805		------			
2	10	KL Outer Ring	853.462		------			P
3	57	Bukit Minyak–K.Batas (Butterworth Bypass)	105.000		------			
4	23	Port Dickson–Shah Alam New Road	328.104		------			
5	25	Klang–Lumut Widening	782.366		------			
6	17	Ipoh Ring Road Wide	92.926		------			
7	9	South Klang Valley Expressway	284.478		------			P
8	72	Kuantan Bypass	101.215		------			
9	22	Melaka–Port Dickson New Road	396.852		------			
10	5	E–W Expressway (KL–Temerloh)	1511.527		------			P
11	29	Changkat Jering–Bukit Mertajam Widening	278.405		------			
12	65	Bt. Seruk–Kg. Petuh New Road (K.Rompin Access)	111.479		------			
13	31	JB–Keluang Widening	527.653		------			
14	6	E–W Expressway (Temerloh–Kuantan)	557.562		------			P
15	48	Melaka–Alor Gajah	36.700		------			
16	44	Tampin–Gemas Widening	127.751		------			
17	58	Telok Air Tawar–Padang Serai New Road (Butterworth Access)	100.000		------			
18	49	Port Dickson–Seremban Widening	105.966		------			P
19	15	Federal Route I Widening (Tanjong Malim–Ipoh)	371.222			------		
20	13	Federal Route I Widening (Melaka–KL)	455.763			------		
21	14	Federal Route I Widening (KL–Tanjong Malim)	254.567			------		
22	11	Federal Route I Widening (JB–Yon Peng)	394.626			------		
23	12	Federal Route I Widening (Yon Peng–Melaka)	685.833			------		
24	47	Melaka–Ayer Keroh Widening	55.050			------		
25	67	Teluk Datuk–Kajang Widening	194.497			------		
26	35	Temerloh–Kuantan Widening Federal Route II	662.514			------		P
27	34	Bentong–Temerloh Widening Federal Route II	251.921			------		P
28	28	Changkat Jering–Lumut Widening	216.820			------		
29	27	KL–Teluk Intan New Road	377.693			------		
30	16	Federal Route I Widening (Ipoh–P.Pinang)	449.877			------		
31	26	Lumut–Ipoh Widening	346.911			------		
32	63	Kota Bharu Coastal Road	441.762			------		
33	43	Muar – Segamat	264.913			------		P
34	7	East Coast Expressway (Kuantan–K.Trengganu)	1790.899			------		P
35	38	Federal Route III Mersing–Kuantan Widening	751.308			------		
36	50	Seremban–Kemayan Road	621.820			------		
37	30	Bukit Mertajam–Thai Border Road	522.474			------		
38	1	N–S Expressway Widening (JB–Yon Peng)	508.567				------	AP
39	2	N–S Expressway Widening (JB–Melaka)	519.269				------	AP
40	3	N–S Expressway Widening (Melaka–Seremban)	336.273				------	AP
41	4	N–S Expressway Widening (Rawang–Ipoh)	839.485				------	AP
42	8	East Coast Expressway (K.Trengganu–Kota Bharu)	1137.574				------	P
43	18	Federal Route I Widening (P.Pinang–Sg. Petani)	169.359				------	
44	19	Federal Route I , VII Widening (Sg. Petani–Kangar)	508.336				------	
45	20	Pontian–Batu Pahat New Road	449.054				------	
46	21	Pagoh–Melaka New Road	340.051				------	
47	24	Port Dickson–Klang Widening	644.505				------	
48	33	Gemas–Temerloh Widening	426.492				------	
49	36	Kuantan–Chukai Widening	162.909				------	
50	37	Federal Route III JB–Mersing Widening	643.981				------	
51	39	K.Trengganu Outer Circle	448.135				------	
52	40	Kulai–Kota Tinggi Widening	115.717				------	

TABLE 9.8 : Proposed Implementation Schedule of Highway Projects

Rank	Project No.	Project Name	Investment Amount RM Million	Year '95	'00	'05	'10	Note
53	41	JB–Gelang Patah New Road	276.355				------	
54	42	Batu Pahat–Keluang Widening	318.723				------	
55	45	Tampin–K.Pilah–Bahau Widening	170.335				------	
56	46	Melaka–Jasin Widening	95.500				------	
57	51	Mengkarak–Ibam New Road (Temerloh–K.Rompin Connection)	385.783				------	
58	52	Lumut (Pangkor)–Tapah New Road	290.722				------	
59	53	Perak Tengah–Dipang New Road	82.405				------	
60	54	Kangar–Changlun New Road	104.793				------	
61	55	K.Lipis–Jerantut New Road	215.066				------	
62	56	Jerantut–Lembing (Kuantan) New Road	523.109				------	
63	59	Nerang–Jitra Access	114.168				------	
64	60	Jeli–K.Krai New Road	270.941				------	
65	61	Federal Route IV(Jeli–Pasir Putih) Widening	266.000				------	
66	62	Kota Bharu–Pasir Puteh Widening	231.976				------	
67	64	Pengerang–Kota Tinggi New Road	448.367				------	
68	66	K.Trengganu Coastal Road Widening	219.066				------	
69	68	Sg. Petani–Baling Widening	86.289				------	
70	69	K.Lipis–Cameron Highland New Road	757.368				------	
71	70	K.Krai–Kota Bharu Widening	294.167				------	
72	71	K.Trengganu–K.Berang Widening	154.554				------	
		SUB–TOTAL excluding project with *AP*	**26117.521**					
		SUB–TOTAL	**28321.115**					
1	SB–9	Kg. Segaliud–Sandakan Widening	199.986		------			
2	SB–1	Beaufort–K.Kinabalu–Kota Belud Widening	450.695		------			
3	SB–10	Lahad Datu–Tawau Widening	396.724		------			
4	SB–4	Tamparuli–Ranau	279.979		------			
5	SB–6	Tenom Access Road	378.574			------		
6	SB–3	Beaufort–Papar–K.Kinabalu Road	302.278			------		
7	SB–8	Kanibongan–Kg. Sualong New Road	270.510			------		
8	SB–13	Ranau–Sg. Sungai New Road	479.818			------		
9	SB–2	Mempakul–Beaufort Widening	172.179				------	
10	SB–5	Keningau–Ranau Widening	575.781				------	
11	SB–7	Tambunan–K.Kinabalu Widening	253.020				------	
12	SB–11	Sapulut–Tawau New Road	786.653				------	
13	SB–12	Bukit Garam–Lindungan Buani New Road	243.514				------	
		SUB–TOTAL	**4789.711**					
1	SW–14	Nanga Mendamit–Sabah/Sarawak Border New Road	1195.124		------			
2	SW–19	Kuching Port–Sri Aman Widening	757.151		------			
3	SW–17	Sarikei–Sibu New Road	155.920			------		
4	SW–16	Kanowit–Kapit New Road	634.644			------		
5	SW–18	Sri Aman–Sarikei Widening	518.604			------		
6	SW–20	Samarahan–Simunjan New Road	144.328			------		
7	SW–15	Miri–Long Terawan New Road	532.863			------		
8	SW–21	Kapit–Belaga New Road	911.293				------	
9	SW–22	Sibu–Bintulu Coastal Road	383.319				------	
10	SW–23	Sarikei–Daro–Sibu Road	1111.229				------	
		SUB–TOTAL	**6344.475**					
	Others	Highway Improvement in Peninsular	6956.414		------	------	------	
	Others	Highway Improvement in Sabah	3302.600		------	------	------	
	Others	Highway Improvement in Sarawak	2065.554		------	------	------	
		SUB–TOTAL	**12324.568**					
		GRAND TOTAL excluding projects with *AP*	**223510.24**					
		GRAND TOTAL	**51779.869**					

Note: AP : Projects Already Privatized
P : Possibility to be privatized
The Third Priority Projects (in 2010) is not ranked yet
The continuation projets from 6th Malaysia Plan are excluded

CHAPTER 10

CONCLUSIONS AND RECOMMENDATIONS

NORTH SOUTH EXPRESSWAY NORTHERN IPOH

CHAPTER 10 : CONCLUSIONS AND RECOMMENDATIONS

10.1 Proposed Highway Network Development Plan

10.1.1 Highway Network Development Plan in Peninsular Malaysia

The proposed highway network plan in Peninsular Malaysia will consist of about 10,850 km of highway which is shown in Table 10.1 and Figure 10.1. The hierarchy of the proposed roads will be classified into 3 main categories, namely the Principal Highway (i.e. Expressway and Major Highway), Minor Highway and the Primary Road.

Table 10.1: Summary of Proposed Highway Network for P.Malaysia to 2010

		Existing * 1991 (km)	Future 2010 (km)
Principal Highway	Expressway	409	1394
	Major Highway	5630	4114
Minor Highway			1826
Primary Road		1651	3516
Total		7690	10,850

Note : * Existing Length are based on Inter-Urban Highway Network

The functional hierarchy of the of the proposed highway network configuration is described below:-

(1) Principal Highway System (Expressway)

The expressway network connects National Capital and Regional Centres according to the urban hierarchy, and the Principal Growth Areas of industrial development ensuring high transport accessibility and reliability. The total Expressway within the Principal Highway System for Peninsular Malaysia is 1,394 km.

The North-South Expressway along the West Coast which will be fully completed by the year 1994 will play an important role. It is expected that the traffic flow along the corridor will be improved tremendously.

The expressway network is also proposed in the East Coast, which will be extended between Kuantan and Kota Bharu. This extension is expected to stimulate industrialization and mitigate economic imbalance between the West Coast and the East Coast.

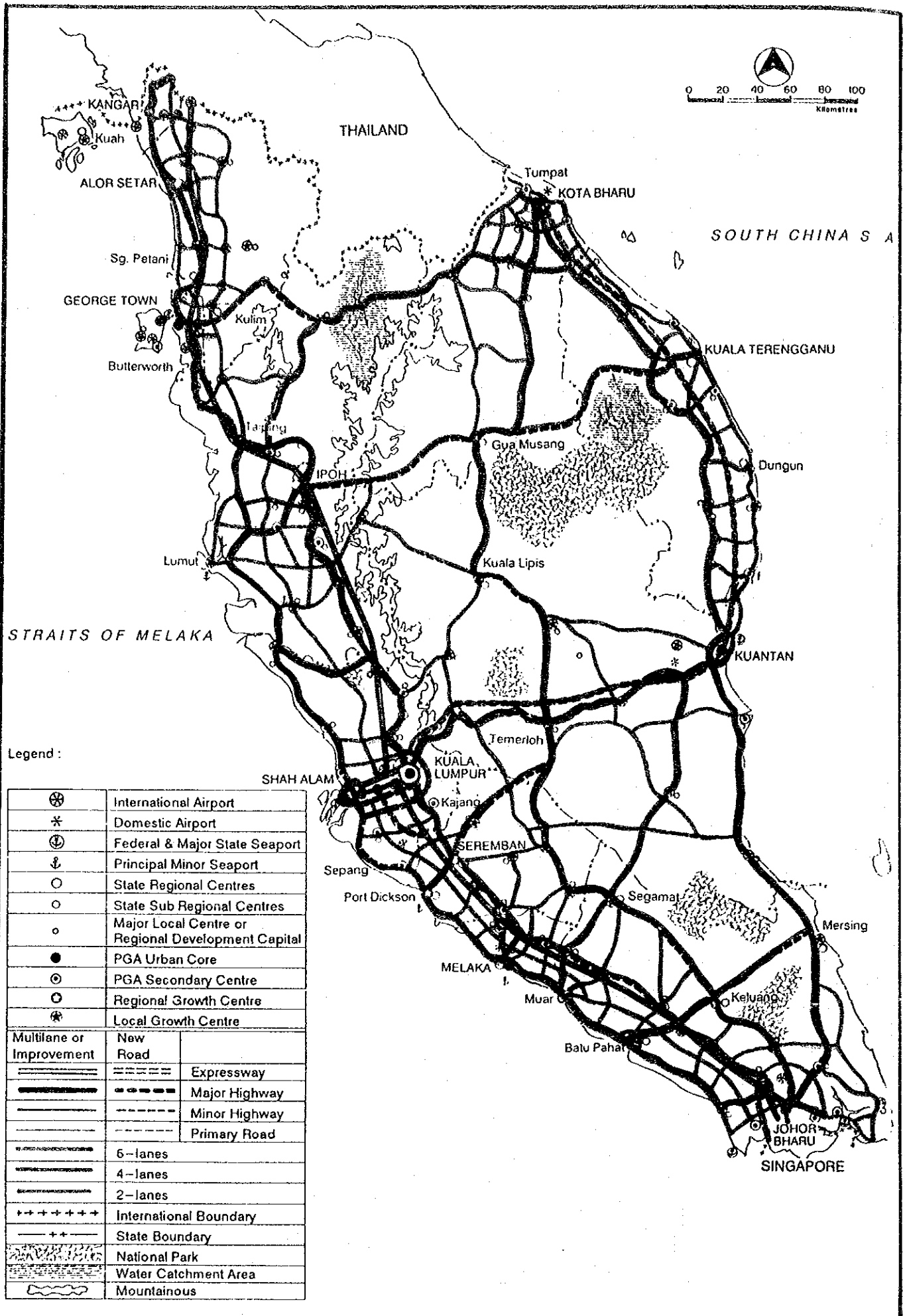


Figure 10.1 : Proposed Highway Network in Peninsular Malaysia to 2010

(2) Principal Highway System (Major Highway)

The nationwide network configuration in Peninsular Malaysia consists of eight (8) corridors, where three stretches are identified along the north-south bound and five (5) in the west-east bound.

The North-South Corridor
The north-south corridors are located along the:-

West Coast,
East Coast and
Central Spine.

The West Coast
As mentioned above, the North-South Expressway will be completed by the year 1994. To supplement the huge traffic demand that will be generated due to the high economic growth in that area, it is proposed that Federal Routes 1 and 5 be upgraded.

The East Coast
In the East Coast corridor, the Major Highway constitutes the Federal Routes 3 and 14. The proposed projects northwards of Kuantan are mainly concentrated in the major towns where the expressway will be extended. On the other hand, road widening along the Federal Route 3 from Kota Bahru to Johor Bahru is necessary.

The Central Corridor
The Central corridor begins in Kota Bharu passing through Gua Musang, Kuala Lipis, Temerloh, Kuala Pilah, Segamat and ends in Johor Bahru. This Central corridor is located along less developed areas and it is therefore important to improve the accessibility to these areas to avoid concentration of urbanization and industrialization in the West Coast corridor and to achieve balanced development in the country. The main project for this corridor is to develop a Principal Highway from Johor Bahru to Temerloh.

The formation of strong linkages between the three north-south corridors are principally proposed with the purpose of achieving a balanced development in the country. With this in view, five (5) linkages are proposed:-

i. Pulau Pinang - Kota Bharu
ii. Ipoh - Kuala Terengganu
iii. Kuala Lumpur - Kuantan
iv. Kuantan - Muar and
v. Batu Pahat - Mersing.

(3) Minor Highway and Primary Road Systems

The minor highway and primary road systems also play an important role in forming the national highway network by complementing the Principal Highway System. In order to attain balanced landuse between regions or areas, the network

configuration must be planned with some spacing and continuity. Minor Highwaysand Primary Roads are therefore proposed to form a ladder pattern network configuration taking into account the existing and future landuse.

The proposed projects are mainly located in the West Coast corridor which is the leading economic growth area in Malaysia.

10.1.2 Highway Network Development Plan in Sabah and Sarawak

(1) Principal Highway System

The proposed highway network in Sabah and Sarawak is shown in Figure 10.2,Table 10.2. The most important criteria in selecting the proposed network is to have a direct link between the two states. The second criteria is the linkages between the scattered towns within 200 km to 400 km distance.

The proposed Principal Highway System includes the construction of a road which connects the two states and the linkage between Kota Kinabalu and Tawau in Sabah.

(2) Primary Road System

The Primary Road System links the interiors and coastal areas which are currently inadequate. The traffic demand is comparatively low because the towns and villages are scattered in the areas. However, the development of a highway system will reduce socio-economic imbalances among regions and will promote racial harmony.

Table 10.2: Summary of Proposed Highway Network in Sabah and Sarawak to 2010

	Sabah		Sarawak	
	Existing * 1991 (km)	Future 2010 (km)	Existing 1991 (km)	Future 2010 (km)
Principal Highway	759	892	629	972
Minor Highway	-	-		35
Primary Road	357	1,113	584	1436
Total	1116	2005	1213	2443

Note : * Existing Road Length are based on Inter-Urban Highway Network

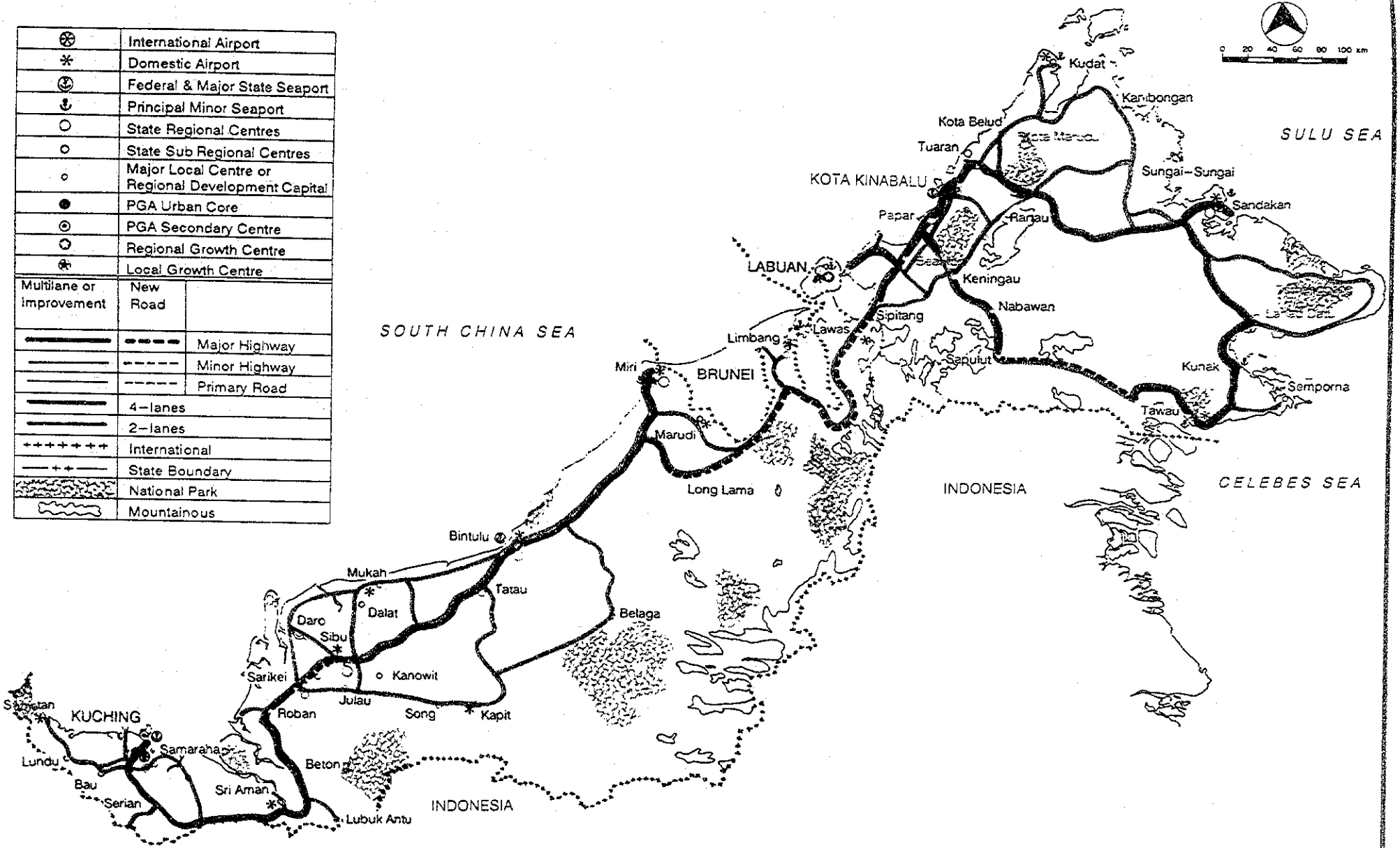


Figure 10.2: Proposed Highway Network Plan in Sabah and Sarawak to 2010

10.2 Investment Requirements

The total investments required for realizing the proposed future highway network described above between 1996 and 2010 are estimated to be approximately RM 53.0 billion. Tables 10.3 and 10.4 show investment requirements for highway development to year 2010 by road function and project type respectively.

Based on the amount of funds allocated for road development since 2MP to 6MP, even if some of the proposed projects are assumed to be implemented by privatization scheme, the investment requirements may not be sufficiently met. Therefore, it is suggested that :-

1. The Government considers allocating a higher highway and bridge development funding in the coming 7MP, 8MP and 9MP plans.

2. A portion of the road user charges (such as road tax, and other users revenue) should be channelled to the development of highways.

Table 10.3 : Investment Requirements by Road Function to 2010

(in RM million)

Category	Peninsular	Sabah	Sarawak	Malaysia
Expressways	8,134.1	-	-	8,134.1
Major Highways	14,030.5	4,213.2	3,724.2	21,967.9
Minor Highways	7,022.2	-	118.6	7,140.8
Primary Roads	6,917.0	3,879.1	4,967.2	15,763.3
Total	36,103.8	8,092.3	8,810.0	53,006.1

Table 10.4 : Investment Requirements by Project Type to 2010

(in RM million)

Category	Peninsular	Sabah	Sarawak	Malaysia
New Construction	14,871.3	2,315.5	5,513.9	22,700.7
Improvement	7,048.7	3,302.6	2,065.6	12,416.9
Widening	14,182.8	2,474.3	1,230.5	17,887.6
Total	36,103.8	8,092.3	8,810.0	53,006.1

10.3 Implementation Programme

The technical and economic studies carried out in this study reveal that the following project should be preferably implemented according to the implementation schedule as shown in Chapter 9 in Table 9.8. The financial phasing requirement is indicated in Table 10.5.