development program in the country's national transport policy, there is little chance for rail transport to compete with road transport. Any improvements to the existing rail infrastructure along the three rail lines in the country may increase demand for rail transport but would only marginally affect the national transport system in the future.

Air and marine transport are limited although they have recorded substantial increases in the past 10 years. In terms of real numbers, air passenger traffic for instance is limited in producing any sizable impact on the overall transport system.

2.3 Transport Demand in Peninsular Malaysia

Table 2.3 shows the estimated transport demand by transport modes in 1991. The yearly traffic demand of Passenger and Freight mode in Peninsular Malaysia were 4,871 million passenger and 640 million tonnes respectively.

Table 2.3 : Estimated Transport Demand by Modes in Peninsular Malaysia, 1991

MODE	Passenger Traffic		Freight Traffic	
	Number ('000 Pass/Year)	%	Number ('000 Tonnes/Year)	%
Road	4,861,852	99.8	630,534	98.5
Rail	6,564	0.1	4,258	0.7
Air	2,845	0.1	15	0.0
Maritime	-	-	5,031	0.8
Total	4,871,261	100.00	639,838	100.00

Sources : Estimated by Study Team

Road transport is the major component in Peninsular Malaysia. About 99.8% of total passenger traffic and 98.5% of total freight traffic was using road transport in 1991.

2.4 Road Traffic Characteristics in Peninsular Malaysia

2.4.1 Road Traffic Demand

(1) Total Road Traffic Demand

The total traffic demand in Peninsular Malaysia on the roads was estimated at some 7.1 million trips a day in 1991. Taking into account the distance travelled, there were some 122.35 million vehicle-kilometre of traffic a day on the existing road network. In terms of passenger-kilometre carried by this volume of traffic, the amount was estimated at 242.4 million passenger-km a day.

Table 2.4: Total Daily Traffic Demand in Peninsular Malaysia, 1991

	Item	Quantities
1.	Total Vehicle Trips	7.08 million trips
2.	Total Passenger	13.45 million pp.
3.	Total Commodity	1.77 million ton
4.	Total Vehicle-Km	122.35 million veh.km
5.	Total Passenger-Km	242.35 million pass.km
6.	Total Ton-Km	67.72 million ton.km

Source : Study Team's Computation based on OIS and RIS/RCS 1991

(2) Vehicle Type

Figure 2.1 shows the total vehicle trips by vehicle types in Peninsular Malaysia. Out of the total 7.1 million vehicle trips, 74.4% was by passenger cars, 21.1% by vans and lorries, 2.1% by bus and 2.4% by taxi. The percentage of passenger car trips were above 70%.

(3) Trip purpose of Passenger Car Trips

From the total of 5.27 million passenger car trips, 1.07 million trip purposes (20.2%) were 'To Work'; 0.91 million trips (17.3%) for 'Business'; 1.24 million trips (23.4%) 'Private Purposes; 2.05 million trips (38.9%) 'To Home' and the remaining 0.2% 'To School' trips. Share of work trips among the total passenger car trips were higher in KL (28.9%) and Selangor (24.6%). Figure 2.2 below shows the share of total passenger car trips by trip purpose.

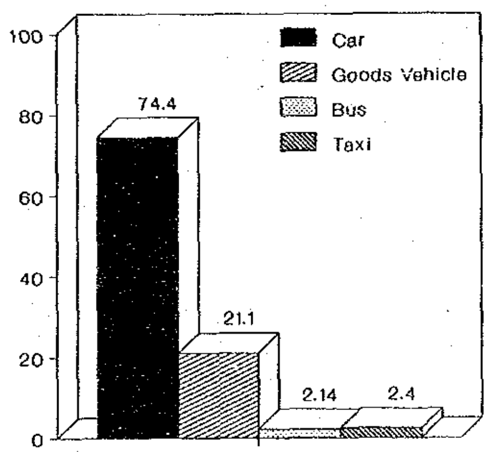


Figure 2.1: Percentage Share of Daily Total Vehicle Trips by Vehicle Type in P. Malaysia

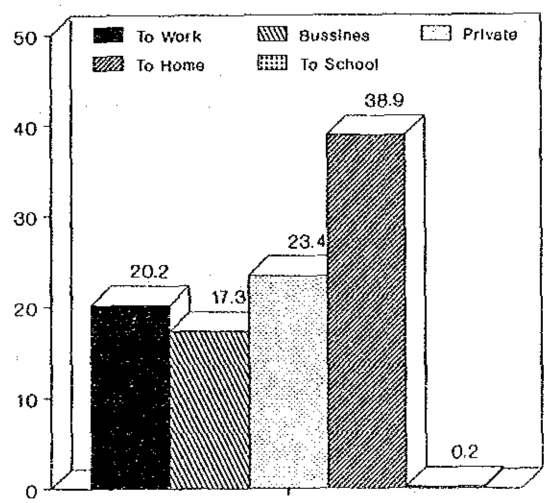


Figure 2.2: Percentage Share of Daily Total Passenger Car Trip by Trip Purpose in P. Malaysia

(4) Freight Traffic by Commodity Type

Of the total 122.35 million veh.km of transport a day in P.Malaysia, 32.16 million veh.km or 26.3% were for the transport of goods by lorries and commercial vans.

Out of the 32.16 million veh.km, 16.75 million veh.km or 52.1% were actually unladen trips. This indicates that goods transport operation is still rather inefficient in P.Malaysia and management system of freight transport by road needs further improvement.

In terms of commodity transported, primary products like agriculture products, timber and timber products, and minerals accounted for 4.14 million veh.km or 12.9% of the total, secondary products consisting of metals, consumer goods, and chemicals 8.23 million veh.km or 25.6%, mixed goods 1.44 million veh.km or 4.5% and 'others' 5%.

By total ton.km of goods transported, primary products accounted for 20.56 million ton.km or 30.4%, secondary products 35.8 million ton.km or 52.8%, mixed goods 7% and others 9.7%.

Figure 2.3 shows the share of total ton.km of freight transport by commodity type in Peninsular Malaysia.

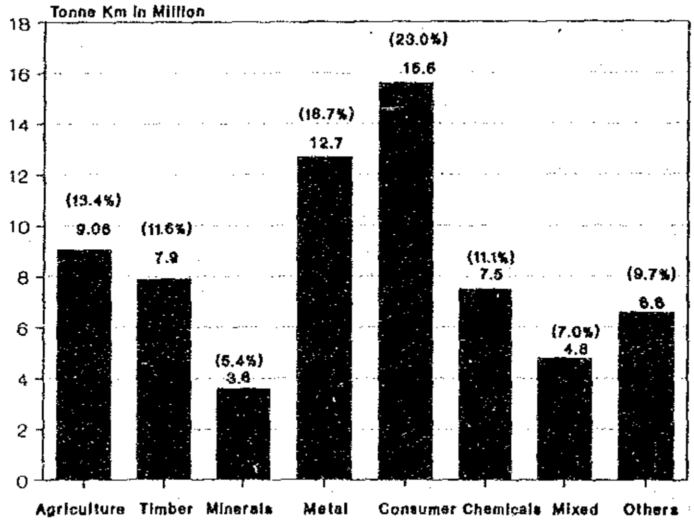


Figure 2.3: Daily Total Freight Traffic by Commodity Type in P.Malaysia

2.4.2 Road Traffic Characteristics

(1) Trip Productions

Trip production as used in this study refers to the number of trips produced within the study area per type of vehicle per day.

The average trip production in P.Malaysia was estimated at 3.5 trips per vehicle a day using the results of the OIS.

The average trip production rate for passenger car was found to be about 3.4 trips per vehicle a day in Peninsular Malaysia. For goods vehicles, the rate was about 3.6 trips, while buses and taxis were 7.1 and 6.1 trips respectively. Trip production rates for public vehicles like buses and taxis as expected were higher than private vehicles.

Table 2.5: Trip Production Rate by Vehicle Type in P.Malaysia in 1991

	Trip Production Rate (Trip/Vehicle/Day)
Passenger Car	3.4
Goods Vehicle	3.6
Bus	7.1
Taxi	6.1
Average	3.5

Source: OIS Survey in 1991

(2) Trip Generation and Attraction

Trip generation as described in this Study is defined as the total number of vehicle trips generated from a traffic zone while trip attraction is the amount of vehicle trips attracted to a traffic zone.

Figure 2.4 shows the total vehicle trip generation and attraction by mode in each state in Peninsular Malaysia. The states of Selangor and Kuala Lumpur in the central region, Johor in the South Region, Perak and Pulau Pinang in the North Region stand out as the major trip generation and attraction areas as these are the most populated areas with high employment levels.

(3) Vehicle Trip OD Pattern in P.Malaysia

The vehicle trip desire lines indicate how the trips generated from each of the traffic zones are attracted in proportion to the other zones. These lines thus display a pattern of travel between zones.

Figure 2.5 shows the total vehicle trip OD desire lines between states for P.Malaysia. There were some 600,000 trips a day between Selangor and KL. Travel desire between Johor and Singapore was also found to be substantially large at 36,000 trips a day. The travel desire line between P.Pinang and Kedah was 28,000 trips a day indicating the importance of Kedah as a hinterland to Penang. Travel desire of N.Sembilan with Selangor and Kuala Lumpur was about 19,000 and 10,000 respectively. Trip volume between the east coast states was only within the range of 7000 a day.

OD pattern clearly displays the prominence of KL-Selangor in the Central Region, Johor in the South Region, Penang in the North Region and Pahang in the East Region. The pattern also conveys the configuration of road network or road accessibility. Desire lines between Kelantan, Trengganu with P.Pinang, Perak are rather negligible due to the lack of direct road linkages. whereas desire lines between Pahang with KL, Selangor and Johor are sizeable with the good direct road linkages.

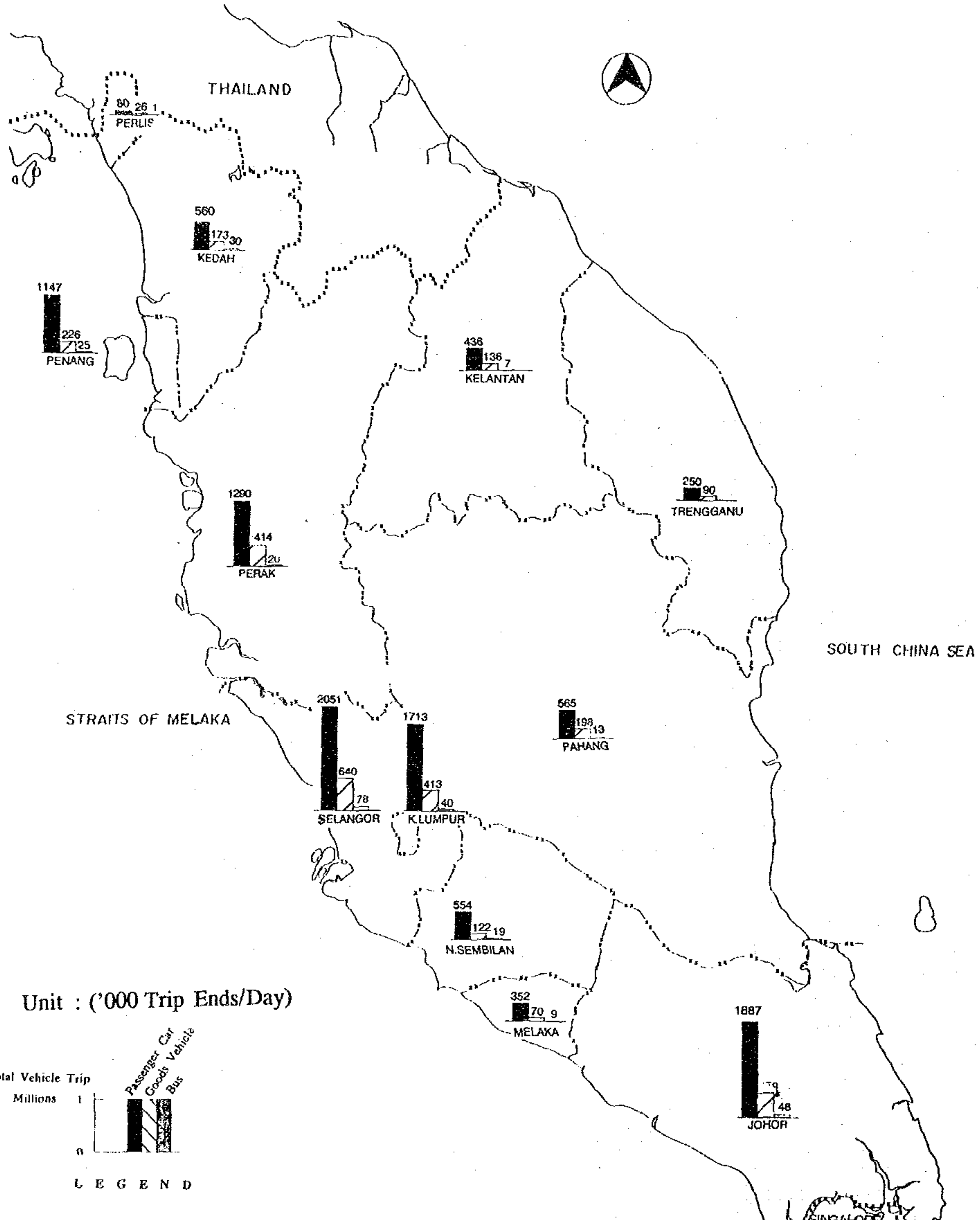
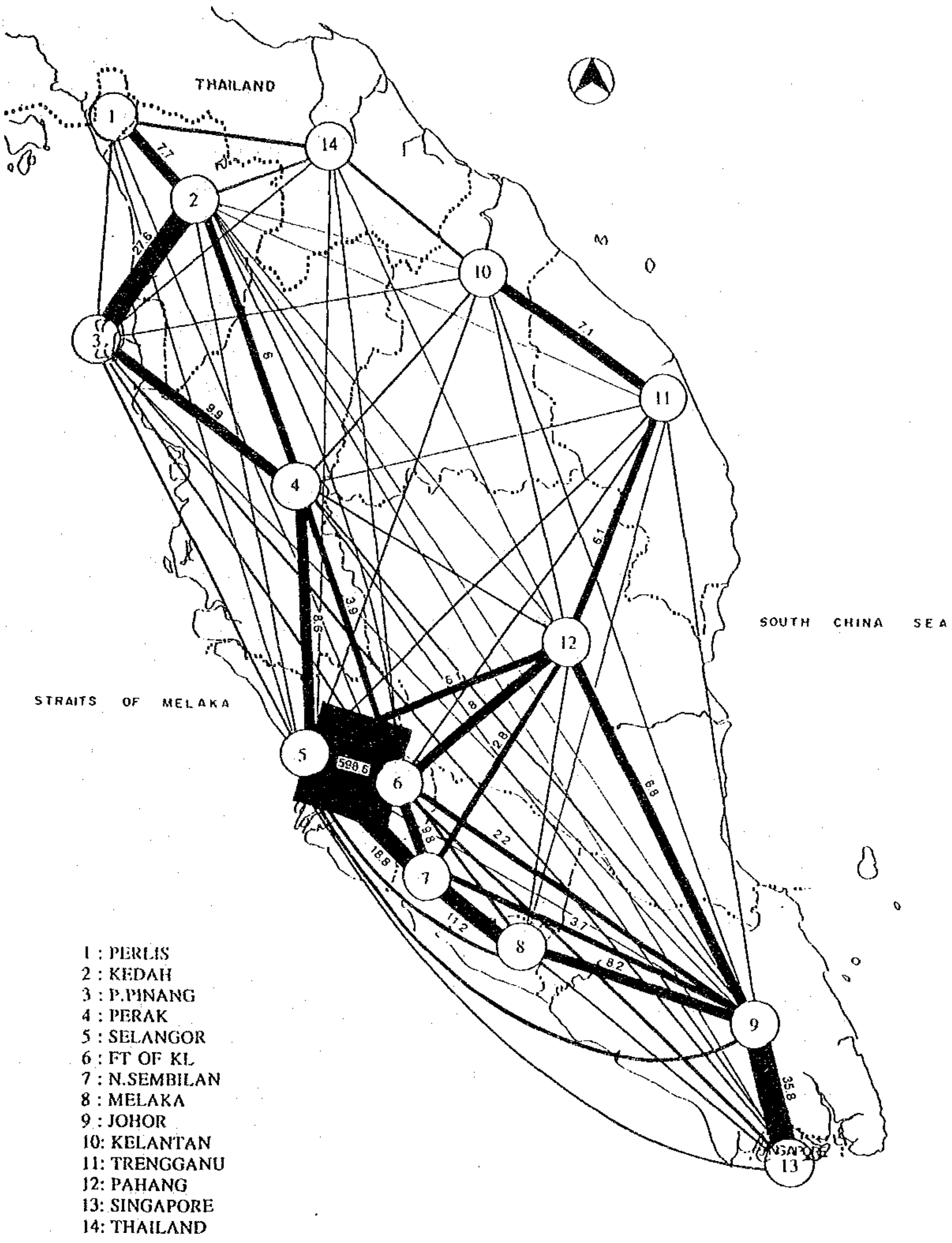


Figure 2.4: Daily Total Vehicle Trip Generation and Attraction by Vehicle Type and State in Peninsular Malaysia, 1991



Unit : ('000 vehicle/day)

Figure 2.5: Vehicle Trip OD Pattern in P.Malaysia in 1991

(4) Trip Length

One of the important characteristics of vehicle trips is the trip length distribution. Figure 2.6 shows the vehicle trip length distribution curves by vehicle types in P.Malaysia. The population mean trip length for the total vehicle population was 17.2 km. The trip length distribution for passenger cars (includes taxi) display a similar pattern to the total. For goods vehicles (lorry and vans), the average trip length was found to be about 21.5 km. Trip lengths for commercial vehicles and buses were found to be much longer than passenger cars and taxis.

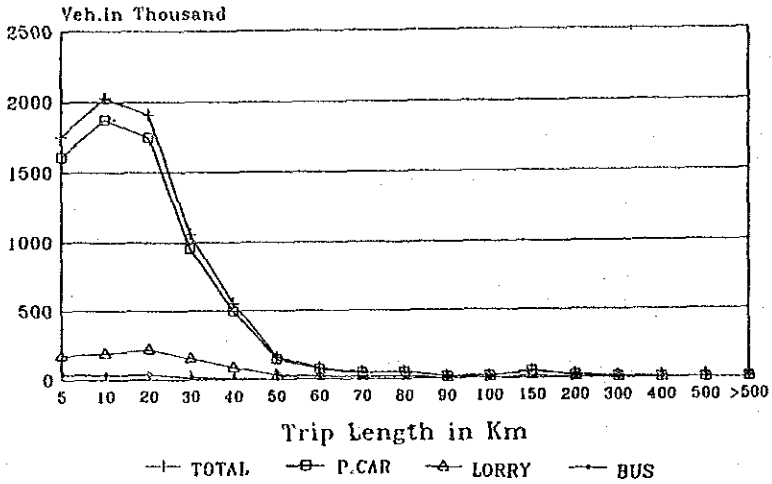


Figure 2.6 : Trip Length Distribution by Vehicle Type in P.Malaysia

(5) Travel Speed

Travel speeds on Federal Routes in P.Malaysia were surveyed and the results revealed that the major federal routes do support an average speed of 50-70 kph. Sections of the N-S expressway is consistently able to support an average travel speed of 80-90 kph.

However, variations of travel speed between sections are significant on federal routes particularly Route 8,2and 1. Average travel speeds on Route 2 from KL to Kuantan varies from 52 kph to 75 kph. Improvements and upgrading of federal routes to maintain consistent travel speeds is important so as to ensure better traffic safety as well as service level.

2.5 Road Traffic Characteristics in Sabah and Sarawak

(1) Trip Production

Based on the results of the Travel Mode Survey, the trip production rate in Sabah and Sarawak was found to be 4.1 trips/veh and 3.5 trips/veh respectively.

Table 2.6: Trip production Rate by vehicle Type in Sabah and Sarawak in 1991

Mode	Sabah	Sarawak
Passenger Car	4.07 (841)	3.48 (968)
Goods Vehicle	4.47 (77)	3.32 (65)
Bus	4.50 (10)	7.00 (2)
Taxi	3.50 (2)	11.50 (2)
Average	4.11 (930)	3.50 (1037)

Source: Travel Mode Survey in 1991
Note: Number in bracket denotes number of samples

(2) Trip Generation and Attraction

Due to limitation of data in Sabah and Sarawak, trip generations and attractions for the two states were estimated using models developed for Peninsular Malaysia. The results of estimated trip generation and attraction for Sabah and Sarawak are given in Figures 2.7 and 2.8. Kota Kinabalu in Sabah and Kuching in Sarawak are the areas showing the greatest trip generation and attraction volumes.

(3) Vehicle Trip OD Pattern

The Vehicle Trip OD Patterns are plotted for Sabah and Sarawak and shown in Figures 2.9 and 2.10. In Sabah, strong desire line was found between K.Kinabalu and Beaufort, Lahad Datu with Tawau. East to west desire lines were not significant due largely to the poor road linkages. Desire lines in Sarawak were small except for Kuching with Sri Aman. The OD Patterns clearly reflect the low road development level in Sarawak.

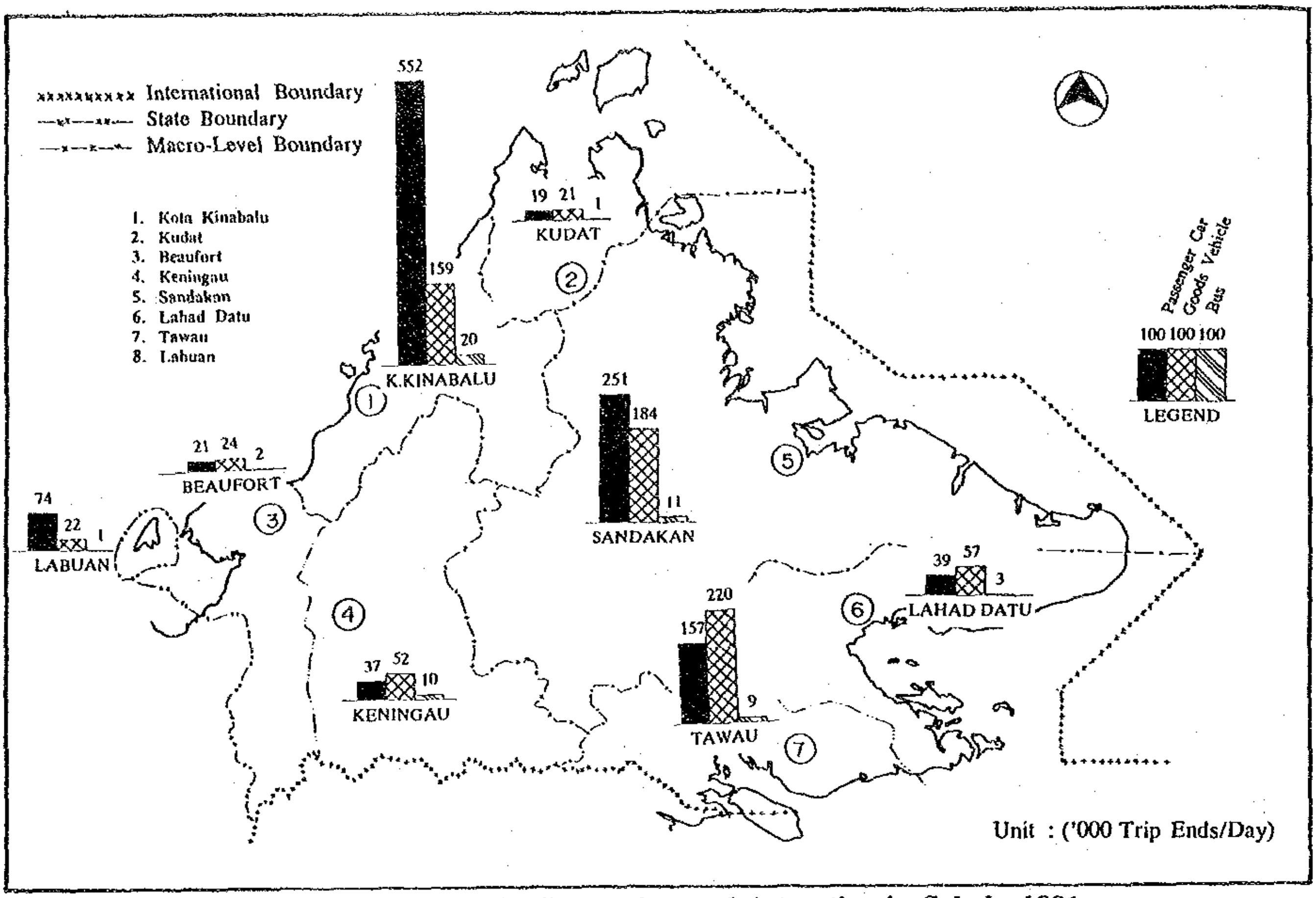


Figure 2.7: Trip Generation and Attraction in Sabah, 1991

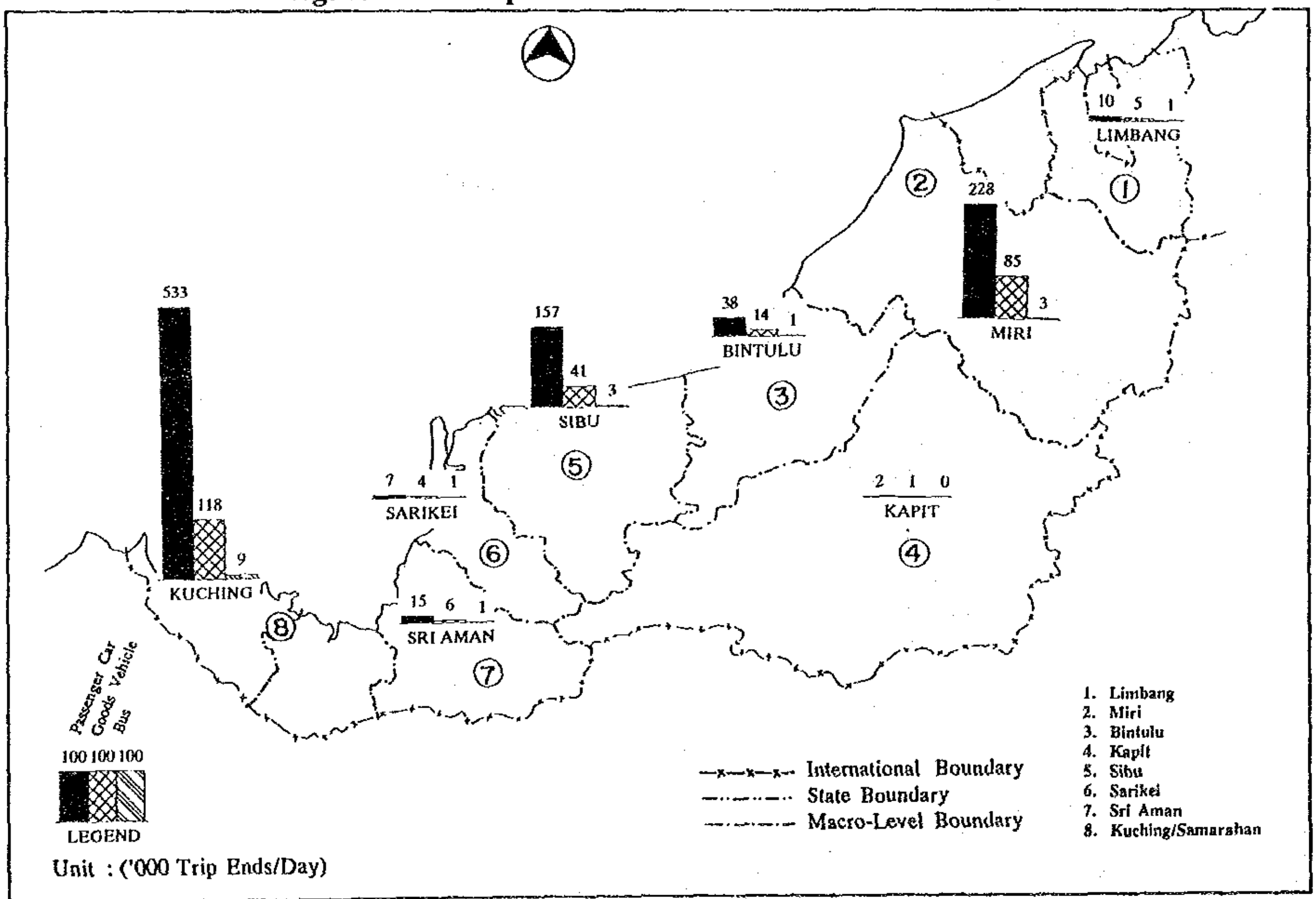


Figure 2.8: Trip Generation and Attraction in Sarawak, 1991

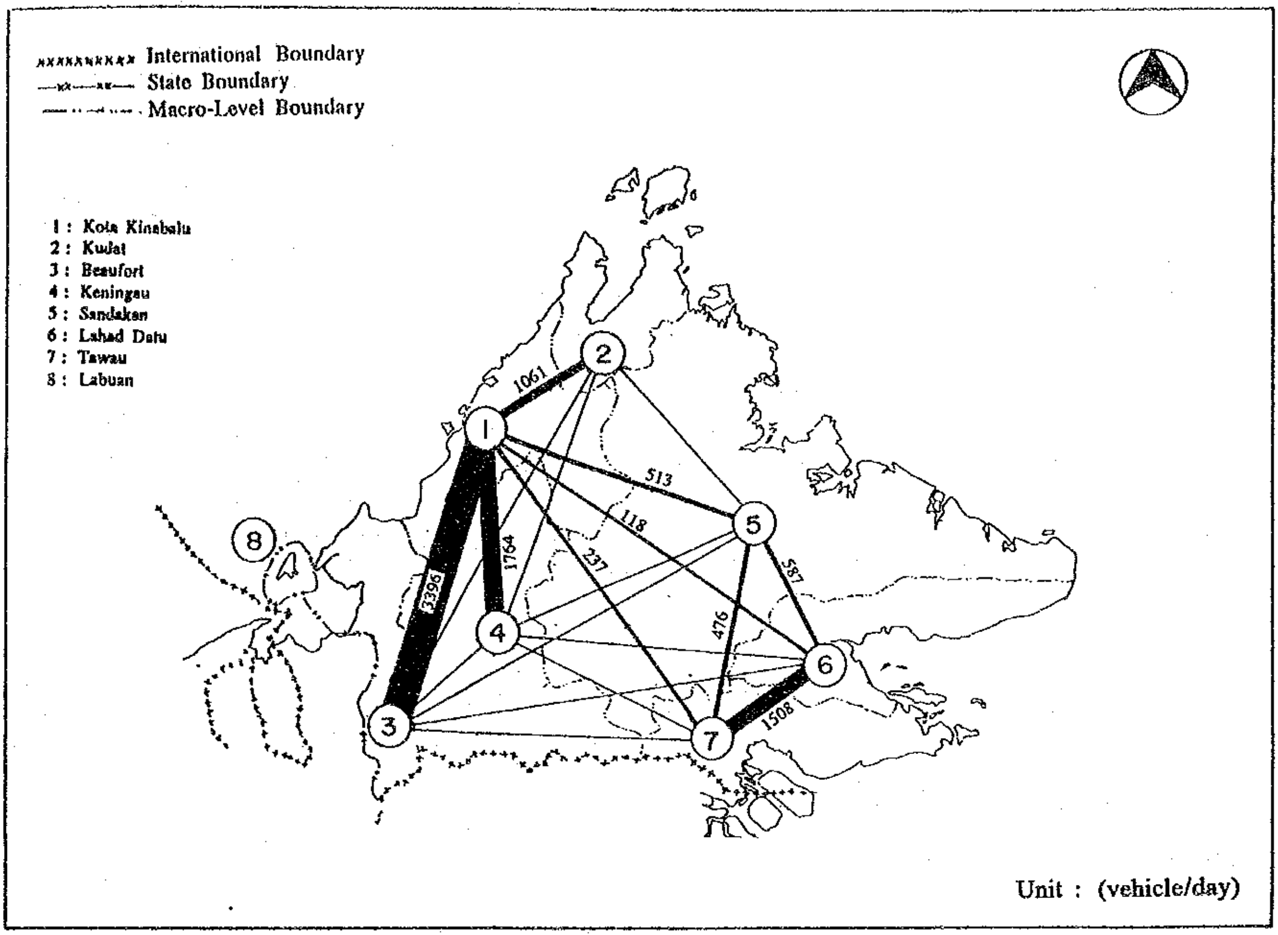


Figure 2.9: Vehicle Trip OD Pattern in Sabah in 1991

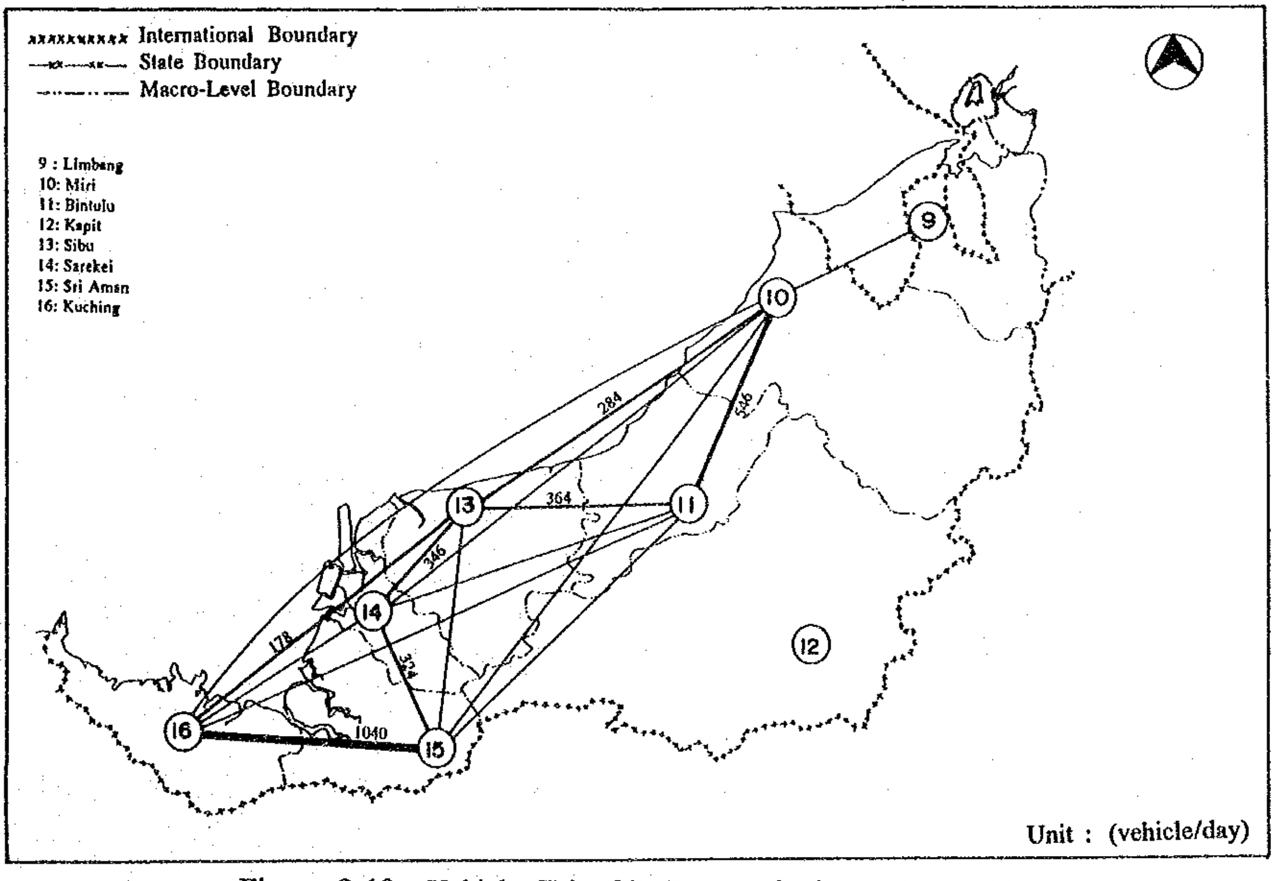
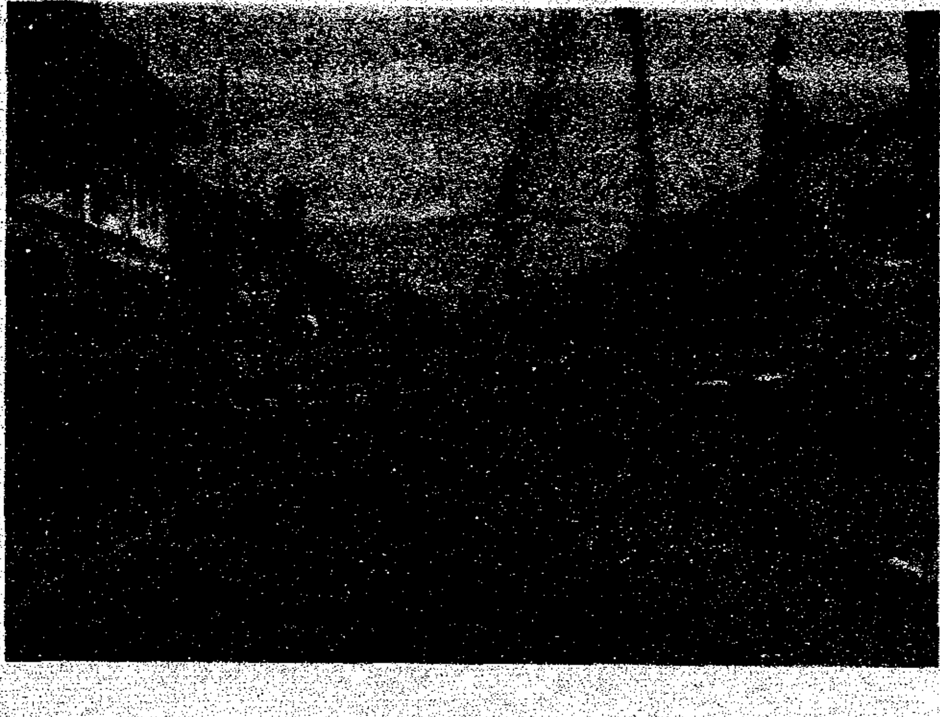


Figure 2.10: Vehicle Trip OD Pattern in Sarawak in 1991

CHAPTER 3

EXISTING HIGHWAY NETWORK CONDITIONS



FEDERAL ROUTE NO 1 ON THIS SIDE OF IPOH

CHAPTER 3 : EXISTING HIGHWAY NETWORK CONDITIONS

3.1 Existing Highway Network Configuration

The present highway network in P.Malaysia is formed by the North-South Expressway, the Karak Highway and other arterials classified as Federal and State Roads. Of the total 49,909 km of classified roads in P.Malaysia, 10,102 km or about 21% are Federal Roads. Highway network in Sarawak is a simple trunk road of about 1300 km running along the coastal region of the state. The network in Sabah on the other hand consists of two major routes, one along the east coast and the other connecting this to the west coast.

The configurations of these highway networks are shown in Figures 3.1 and 3.2. Highway network in P.Malaysia is more or less a ladder type of network with the expressway and two federal routes running from north to south on the east and west coast of the Peninsular.

Out of the total 63,455 km of highway in the country, however, a total of 16,291 km are to be studied in this Study consisting of the North-South Expressway and some 117 highway routes. This consists of 409 km of expressway, 8,887 km of Federal Trunk Road and 6,995 km of major State Roads. This study network is derived based on examination of their classification and function in the existing network. Since this is a 'masterplan level' planning of a highway network for the country, most of the federal routes and major state roads have been included while minor state roads, urban and access roads are not.

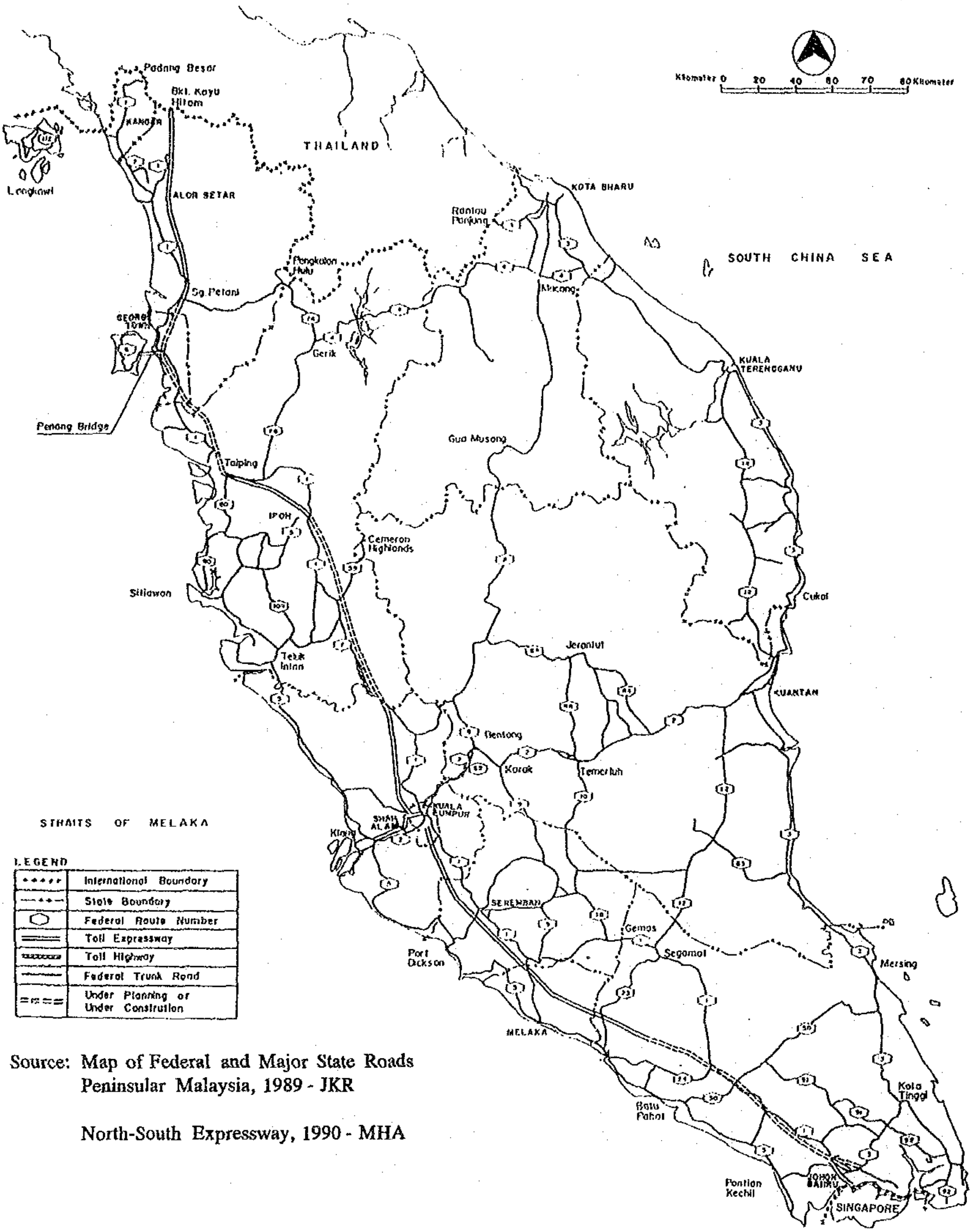
Table 3.1: Road Length in Malaysia, 1990

(in kilometer)

Category	P. Malaysia	Sabah	Sarawak	Total
Expressway	409 (815)*	-	-	409 (815)*
Toll Highway	132	-	-	132
Federal Roads	10,102	1,116	1,213	12,431
State Roads	39,266	7,542	3,665	50,473
Total	49,909	8,658	4,878	63,445

Source: Sixth Malaysia Plan

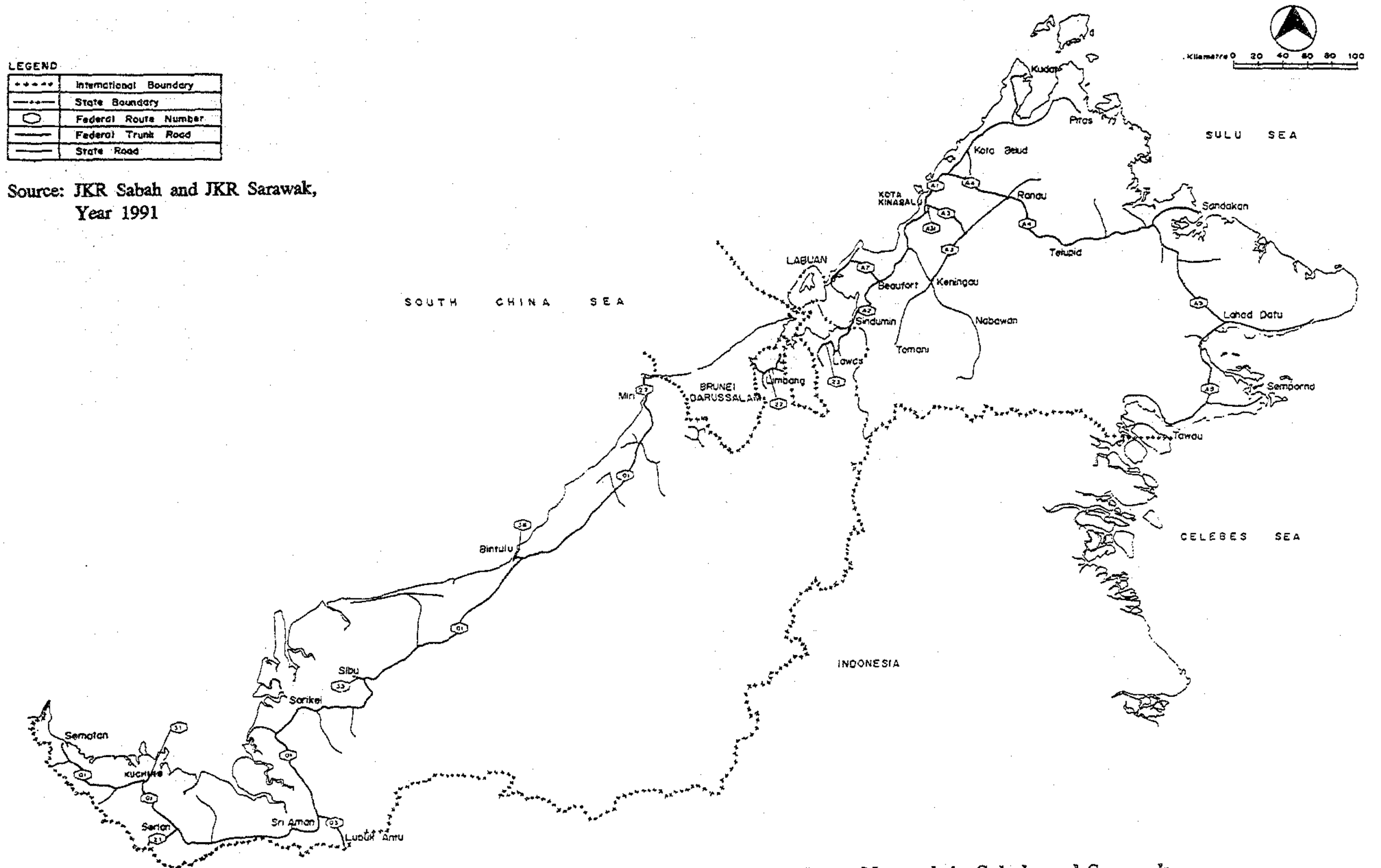
Note : * Total Length of North-South Expressway and New Klang Valley Expressway



Source: Map of Federal and Major State Roads Peninsular Malaysia, 1989 - JKR

North-South Expressway, 1990 - MHA

Figure 3.1 : Existing Highway Network in Peninsular Malaysia



Source: JKR Sabah and JKR Sarawak, Year 1991

Figure 3.2 : Existing Highway Network in Sabah and Sarawak

Table 3.2 : Study Road Length by Classification

(in kilometer)

	Road System	Expressway	Highways	Primary Roads	Sub-Total	Secondary	Total
Peninsular	Expressway	409 (815)[1]	-	-	409	-	409
	Federal Trunk Roads[2]	-	5,630	461	6,091	467	6,558
	Major State Roads	-	-	1,190	1,190	3,338	4,528
	Total	409 (815)	5,630	1,651	7,690	3,805	11,495
Sabah	Federal Trunk Roads	-	759	357	1,116	-	1,116
	Major State Roads	-	-	-	-	779	779
	Total	-	759	357	1,116	779	1,895
Sarawak	Federal Trunk Roads	-	629	584	1,213	-	1,213
	Major State Roads	-	-	-	-	1,688	1,688
	Total	-	629	584	1,213	1,688	2,901
Malaysia	Expressway	409 (815)	-	-	409	-	409
	Federal Trunk Roads	-	7,683	737	8,420	467	8,887
	Major State Roads	-	-	1,190	1,190	5,805	6,995
	Total	409 (815)	7,683	1,927	10,019	6,272	16,291

Note: The length by road classification are based on the analysis by the Study Team
Major State Roads based on the JKR state road maps
[1] North-South Expressway and New Klang Valley Expressway length in bracket denotes the total length including under construction sections.
[2] Federal trunk road includes Tanjong Malim-Slim River Toll Highway section, Johor Bharu Senai Highway and North Klang Strait Bypass.

3.2 Natural Conditions

(1) Topographic Features

Briefly described, the topographic features of Peninsular Malaysia are characterized by a distinct mountainous spine rising to a maximum height of 2,180 meters with rivers flowing down from the Main Range to the east and west coasts of the Peninsular. Foothills and the river basins are generally rolling to flat terrains.

In Sarawak, mountainous areas are confined to mainly the southern portion of the state while they occupy a central position in Sabah. The highest level being about 4000 meters with rivers flowing towards the north in Sarawak and towards the east as well in Sabah.

These topographic features greatly influence the rainfall distribution pattern in the country. The spine in the Peninsular forces heavy precipitation on the east coast during the North-east monsoon season. Heavy rainfall is found in the hilly and mountainous areas of both Sabah and Sarawak. Heavy and concentrated rainfall in the east coast of P.Malaysia by far is the single major factor that influence road operation and design. Floods and land slides brought on by heavy rain have caused many failures in the past.

The relevance of a topographic study is to identify areas with potential physical constraints to highway development. Except for the main range proper in

P.Malaysia, the mangrove coastal areas and southern mountainous areas in Sarawak and Sabah, there is in fact little physical constraints to road construction. Rivers such as Rajang may be a factor to contend with due to its width that require long spanning bridges. Details of topographic study are contained in the Technical Report on Topography and Geology.

(2) Geology

The mountains in Malaysia are mainly of granitic rocks with intersperse of limestones outcrops. River basins are chiefly alluvial in nature while river estuaries are formed of silt sediments as mangrove wetland. Granite rocks are therefore an important source of construction material for the highways. Soft silts in swampy areas is not load bearing and should be avoided when aligning highways.

3.3 Road Administration

In Peninsular Malaysia, roads are classified on the basis of jurisdiction and general purpose into Federal, State, Rural, Municipal and Other Roads. For Sabah and Sarawak, roads are currently classified more according to their functions although there is an effort to change this to be in line with that of the Peninsular. In Sabah, roads are categorized into Class I, II or III roads, depending on their service as trunk, district or local roads. In Sarawak, roads are designated as Trunk, Secondary, Improved Feeder and Feeder Roads depending on the average daily traffic volumes.

There is no significant changes to the classification system of roads. For the purpose of administration, roads in Malaysia are classified according to the source of funds allocated for construction and maintenance of these roads. The description of these five categories are given in the table below.

Table 3.3 : Road Classification According To Administration

Category	Descriptions
Federal Roads	Federal roads are roads that are gazetted under the Federal Road Ordinance and are usually roads that link the major towns and cities, the different states and also the entrance/exit points to the country. Federal roads also include roads leading to Land Development Schemes and to Federal Institutions. These roads are constructed and maintained using funds from the Federal Government. They come under the jurisdiction of Federal Public Works Department.
Toll Expressway and Highway	These are highways linking the major towns and cities and are constructed and maintained by Malaysian Highway Authority as alternative routes to the Federal Roads. However, starting from 31.11.1988,most of the toll highways are being privatized.
State Roads	These are roads built to upgrade the standard of linkage of intra state and also to provide a road network within the states. The construction and maintenance of these roads are funded by the Federal and State Governments. These roads are under the jurisdiction of the State Public Works Department.
Municipal and Local Council Roads	These roads which are located within the Municipal and Local Council areas are constructed and maintained by the Municipal or the Local Authorities. These include also the roads in residential estates constructed by developers but consequently surrendered to the local authorities or municipalities. The funds for the construction and maintenance of these roads are from the Municipal and Local Council Budgets but subsidized by the Federal Government.
Other Roads	These are rural roads which are constructed and maintained by the District Office and the allocation comes from the State Government.

3.4 Physical Conditions of the Existing Highway Network

The formulation of a national highway network development plan calls for an understanding of the existing highway network within the Study Area, particularly its physical and geometrical conditions.

In order to obtain a fairly precise description of the physical and geometrical conditions of the existing roads, a road inventory of the national highway network (consisting of expressway and federal trunks roads as defined by the scope of the study) is prepared using data from various existing sources and confirmed with site observations.

(1) Number of Lane

95 per cent or approximately 8,400 km of Federal Trunk Roads is of 2-lane single carriageway sections, most of which are in rural areas. Some routes especially routes 1, 2 and 4 are provided with climbing lanes.

Two lane dual carriageway (or three lane or more) is the feature of Federal Trunk Roads in urban areas and access roads to ports and airports especially on Route 1, 2, 3, 6, 15 and 17.

The North-South Expressway and the New Klang Valley Expressway are a 2 lane dual carriageway and 3 lane dual carriageway respectively. Widening works to 3 lane dual carriageway are in progress for the North-South Expressway segment from Kuala Lumpur to Seremban.

Table 3.4: Inventory on Number of Lane for Federal Trunk Roads

(in kilometer)

Description	1-lane Single Carriageway (<5.50m)	2-lane Single Carriageway	2-lane Dual Carriageway	>3 lane Dual Carriageway	Total
Peninsular	157 (2%)	6,220 (95%)	118 (2%)	68 (1%)	6,558 (100%)
Sabah & Sarawak	96 (4%)	2,233 (96%)	0.00 (0%)	0.0 (0%)	2,329 (100%)
Total	253 (2.9%)	8,439 (95.0%)	118 (1.3%)	68 (0.8%)	8,887 (100%)

Note : Excluding Toll Expressway

(2) Pavement Conditions

Table 3.5 shows the percentage of paved roads in Malaysia. About 85% of roads in P.Malaysia and only 35% in both Sabah and Sarawak are paved.

Table 3.5 : Share of Paved and Unpaved Roads in Malaysia

	P. Malaysia		Sabah		Sarawak		Total	
	Length	%	Length	%	Length	%	Length	%
Paved	42,205	84.6	2,981	34.4	1,704	34.9	46,890	73.9
Unpaved	7,704	15.4	5,677	65.6	3,174	65.1	16,555	26.1
Total	49,909	100.0	8,658	100.0	4,878	100.0	63,445	100.0

Source: Sixth Malaysia Plan

All the federal trunk road in P.Malaysia including most segments of the existing expressway are paved with asphalt concrete. Cement concrete is also used in many sections of the newly completed New Klang Valley Expressway and some parts of The North-South Expressway.

Table 3.6: Type of Pavement of Federal Trunk Roads in Malaysia

	P. Malaysia		Sabah		Sarawak		Total	
	Length	%	Length	%	Length	%	Length	%
Asphalt Concrete	6,558	100.0	505	45.0	873	72.0	7,936	89.0
Cement Concrete	0	0	0	0	0	0	0	0
Bitumen or Macadam	0	0	611	55.0	340	28.0	951	11.0
Total	6,546	100.0	1,116	100.0	1,213	100.0	8,875	100.0

source: study team's estimates

In P.Malaysia, shoulders of all the state roads and 86% of federal roads under study are not paved. Most of the shoulders are just compacted gravel and earth and turfed in some places.

Asphalt concrete is also used for paved road in Sabah and Sarawak. Most of the unpaved roads are in a poor condition with rough riding surface that are generally unsuitable for saloon cars. Many sections of these gravel roads deteriorate badly during the wet season with some becoming not passible.

(3) Deficient Carriageway Width

Deficient Carriageway width refers to sections that are found to be sub-standard with respect to their designated width. Among the routes under study, as much as 4,587 km are found to be deficient in their designed carriageway width. Figures 3.3 and 3.4 show the Highway Section with Deficient carriageway width.

More than 50% of the existing federal trunk roads nationwide examined in this Study are actually found to be deficient in their designed carriageway width. As much as 84% of these deficient roads are in the Peninsular.

Table 3.7: Length of Federal Trunk Roads Found With Deficient Carriageway Width

	Deficient Carriageway Length	Total Length	Percentage of Deficient
P. Malaysia	3,816 km	6,558 km	58.2 %
Sabah & Sarawak	771 km	2,329 km	33.1 %
Total	4,587 km	8,887 km	51.6 %

Source: study team's estimates

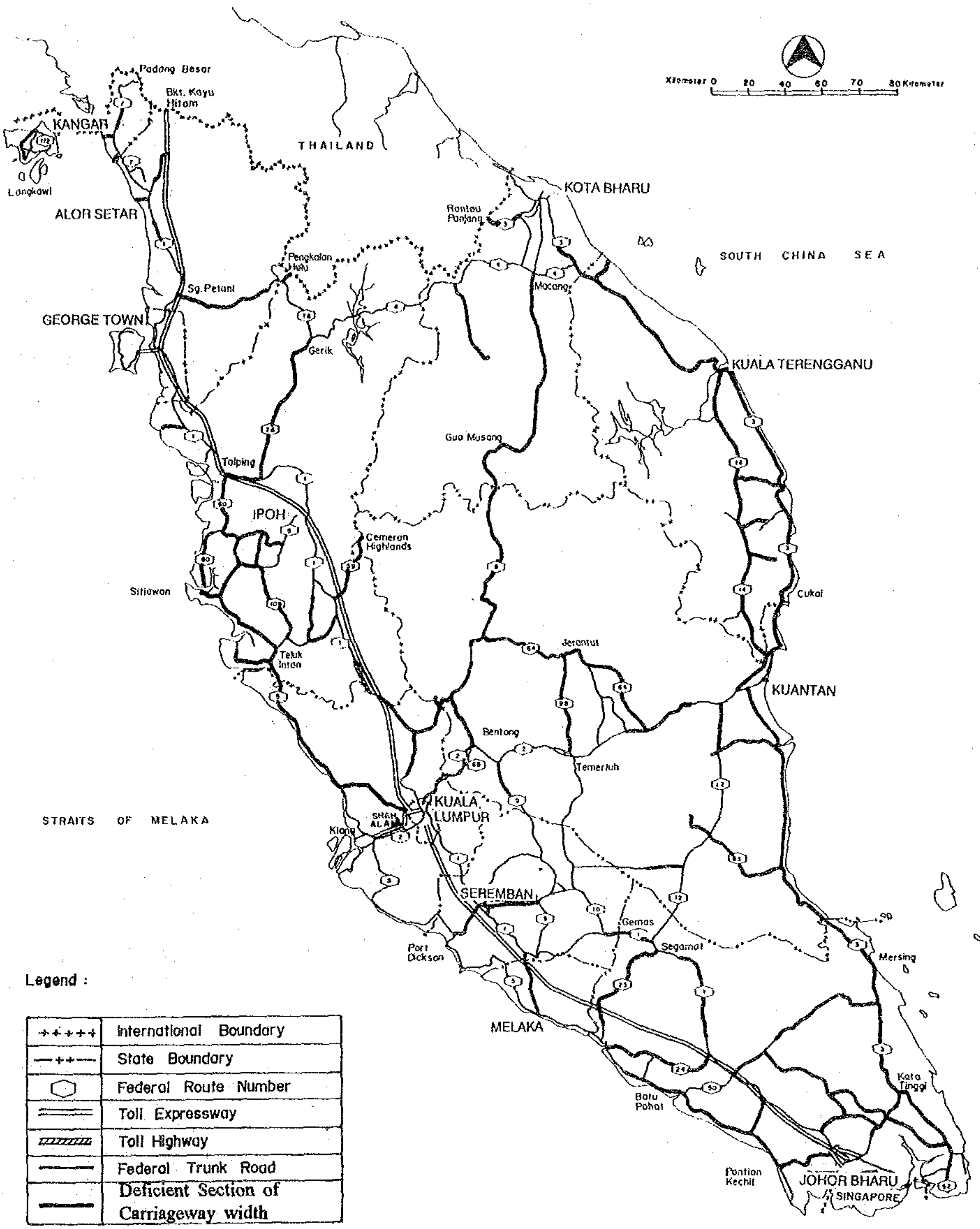
(4) Deficient Horizontal Alignment

Deficient Horizontal Alignment refer to sections that are found to be sub-standard with respect to their designated minimum radius of curvature.
Due to lack of detail data on road alignment, sections of roads examined in this Study that are deficient in horizontal alignments are identified by analyses of terrain and from actual site observations. The results are depicted in Figure 3.5.

(5) Routes Reliability

Utilizing data from JKR Flood Control Center, locations of flood and road failures such as slope failures and erosions for the past three years are identified in Figure 3.6. Most of these are considered as minor road failure since the damages could be repaired within a day. A major slope failure in 1991 at km 48 of Kuala Lumpur - Karak Highway forced the closure of this important highway for 2 days, causing heavy losses to the economy.

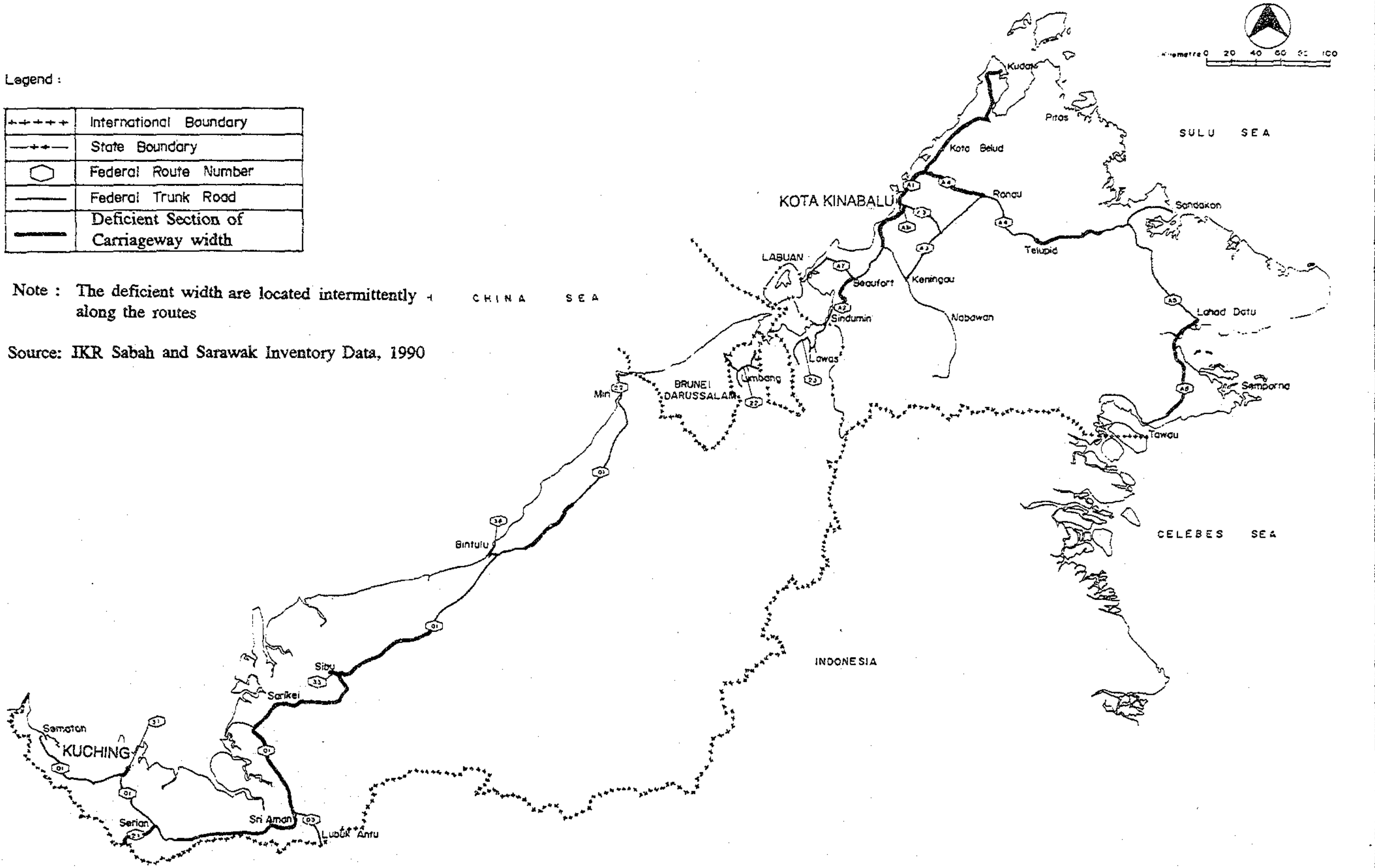
According to these data, more than three quarter of road failures occurred in the states of Perak and Terengganu. Meterological data show that rainfall in these states are among the highest in the country with 3,000 to 4,250 mm annually. Overall, floods accounted for 80 percent of the total failures. The other 20 percent are also caused by slope failures and erosions which are also brought on by concentrated heavy rainfall.



Note : The deficient width are located intermittently along the routes

Source: JKR Inventory Data, 1990

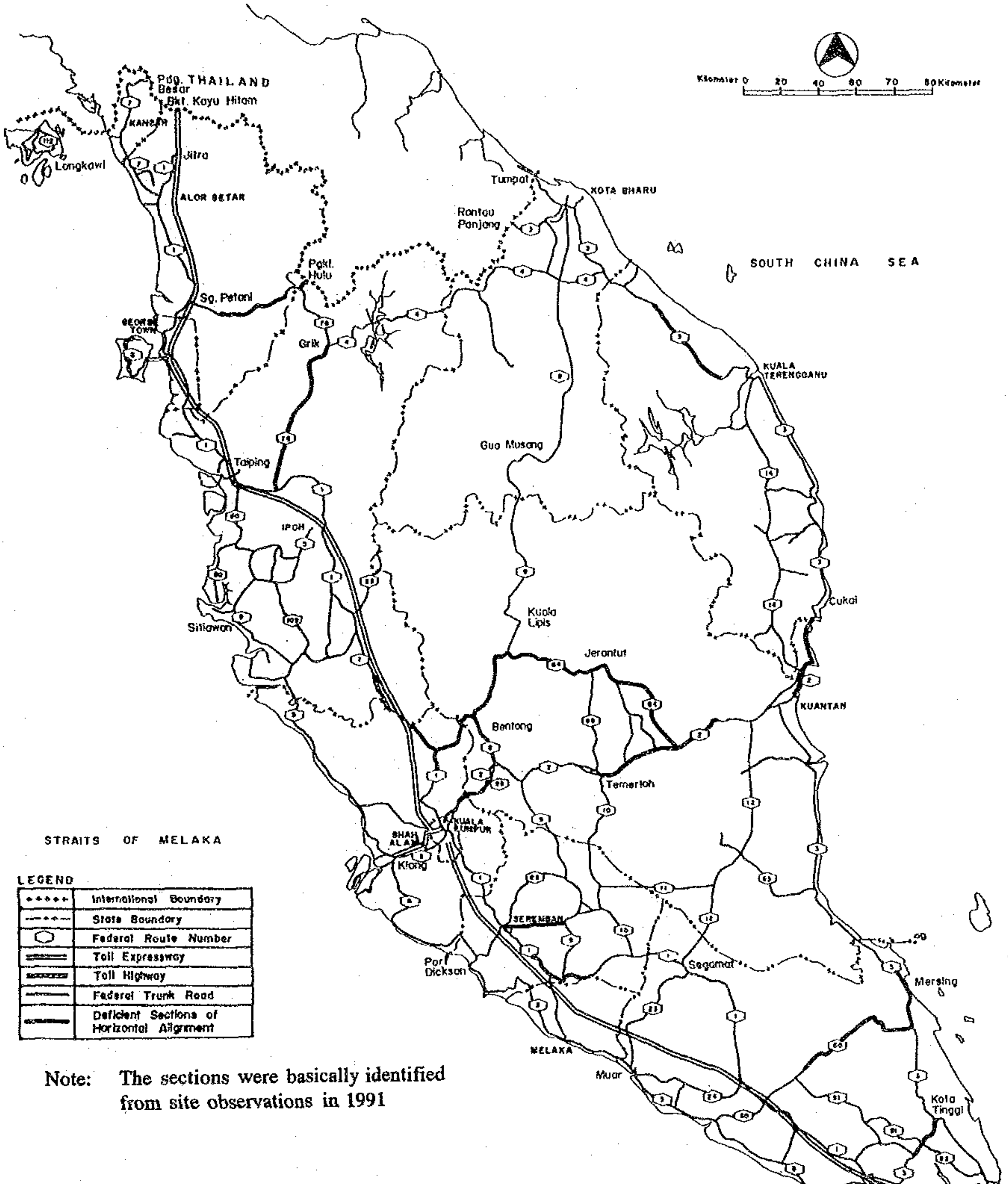
Figure 3.3: Highway Section with Deficient Carriageway Width in Peninsular Malaysia



Note : The deficient width are located intermittently along the routes

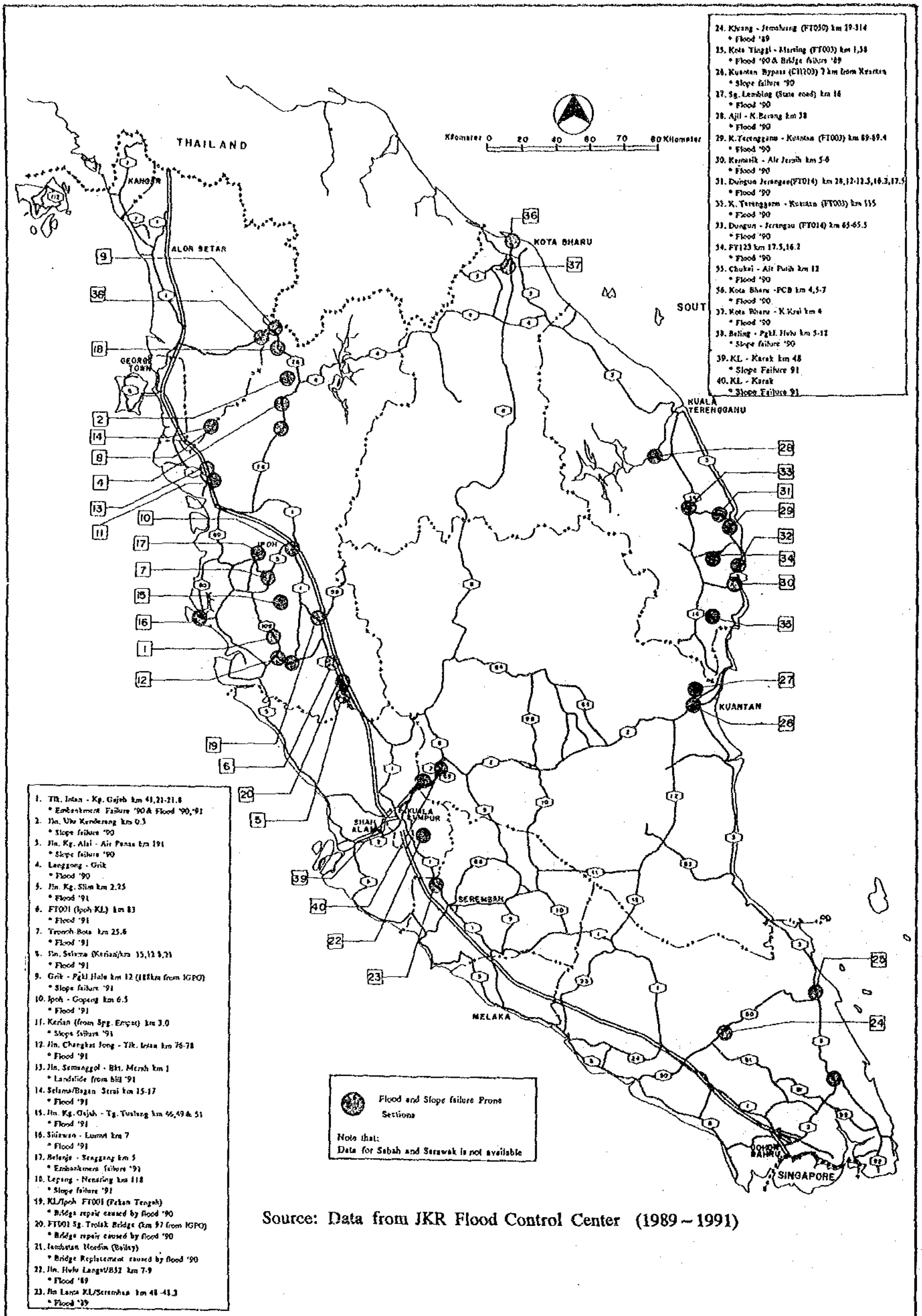
Source: IKR Sabah and Sarawak Inventory Data, 1990

Figure 3.4: Highway Section with Deficient Carriageway Width in Sabah and Sarawak



Note: The sections were basically identified from site observations in 1991

Figure 3.5 : Highway Sections With Deficient Horizontal Alignment in Peninsular Malaysia



Source: Data from JKR Flood Control Center (1989 ~ 1991)

Figure 3.6 : Route Reliability Analysis on Highway in Peninsular Malaysia

3.5 Examination of the Accessibility on Existing Highway Network

As an introduction to accessibility concept, this section will analyze only the accessibility condition in Peninsular. The degree of accessibility between two points can be utilized in analyzing the efficiency and sufficiency of a certain network configuration. Accessibility can be represented by travel time and or a detour rate estimated from the ratio of actual road distance to aerial direct distance.

A detour rate of between 1 and 1.5 implies a route that provides high accessibility between the two points in terms of distance only. On the other hand, a detour rate of more than 1.5 implies a route with low accessibility, which indicates problems and issues that needs to be solved.

Low accessibility can be due to poor road conditions or traffic congestion which will be discussed later.

(1) Accessibility Between Major Centres

Figure 3.7 denotes graphically the detour rates between National Capital, National Regional Centres and State Regional Centres. Most of them range from 1.1 to 1.3 except for some linkages. The existing network therefore provide a relatively high level of accessibility between centres. Some linkages do indicate detour rates of more than 1.5. Such linkages are observed to be between the northern region and eastern region as shown in Figure 3.7.

In order to provide equal accessibility, alternatives such as providing new direct access links should be considered to the linkages between the northern and eastern region.

(2) Accessibility to the North South Expressway Interchange (North South Highway)

The North South Expressway is the main interstate trunk road that runs along the west coast of Peninsular from the border of Thailand southward to Singapore. The total length of the North - South Expressway is approximately 775 km and the whole stretch is scheduled to be completed and opened to traffic by 1994.

Since the expressway is expected to play a significant role as a major infrastructure to encourage national economy, it is important to ensure that there is adequate accessibility to the Expressway Interchanges. The access time to the Interchange is desirably half an hour based on the data obtained from developed countries as shown in Table 3.8.

Figure 3.8 shows two areas with different access times from the interchanges on the expressway corridor (the area to be serviced by an expressway). The first is physically visualized as an area within 20 km radius from the interchanges (access time 0.5 hour) while the second as the area beyond this 20 km radius but within the west coast corridor (access time exceeding 0.5 hour).

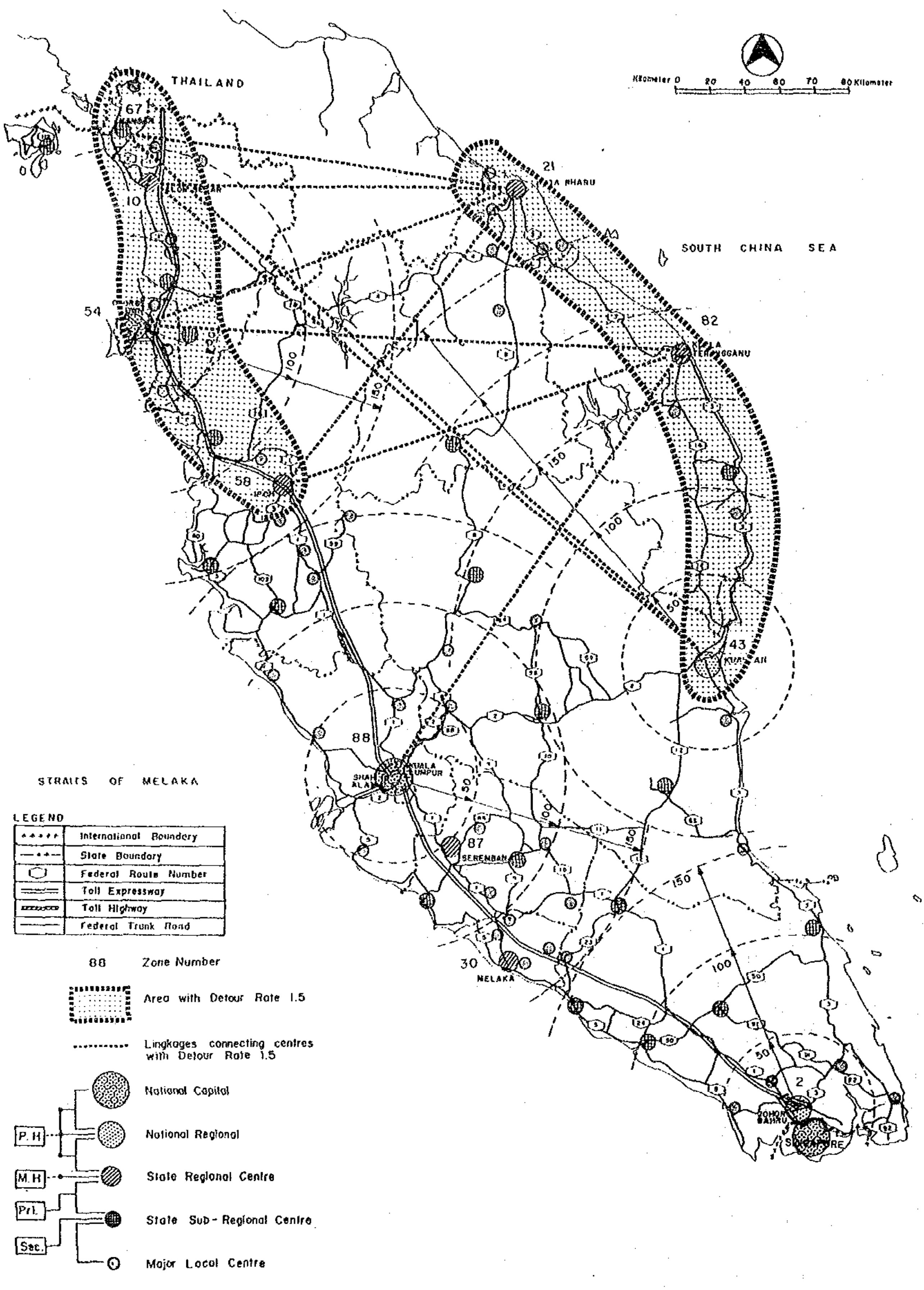


Figure 3.7 : Detour Rate Between Major Centres

Table 3.8 : Access time to Expressway Interchange

Country	Access Time to IC					
	$0 \sim 0.5^h$	$0.5 \sim 1.0^h$	$1.0 \sim 1.5^h$	$1.5 \sim 2.0^h$	More than 2.0^h	
U.S. (West)	79 (100)	0	0	0	0	79 (100)
U.S. (East)	102 (98)	2 (2)	0	0	0	104 (100)
Germany	147 (96)	6 (4)	0	0	0	153 (100)
Italy	65 (81)	8 (10)	4 (5)	3 (4)	0	80 (100)
France	75 (70)	11 (10)	4 (4)	5 (5)	12 (11)	107 (100)
U. Kingdom	189 (94)	10 (5)	1 (0.5)	0	1 (0.5)	201 (100)
Japan	274 (69)	42 (11)	34 (8)	14 (3)	36 (9)	400 (100)

Note: Number in brackets denotes corresponding percentage.

It can be seen that locations falling within the second area type (exceeding 0.5 hour) include Perlis, interior of Kedah, coastal areas of Perak, interior of Negeri Sembilan and east coast of Johor. In the formulation of the highway network development plan, existing accessibility to expressway interchanges would be reviewed further to include some other issues such as:

i) providing access to hinterland,
ii) enhancement of industry distribution, and
iii) to provide better access to the tourism areas such as Pulau Pangkor and Port Dickson.

3.6 Traffic Volume and Capacity Analysis on the Existing Highway Network

Using traffic volume on Federal Trunk Roads in 1990 in P.Malaysia, Sabah and Sarawak, V/C analyses were carried out and sections found to have traffic congestion problems are shown in Figure 3.9.

Traffic congestions are found in the outskirts of all state capitals except Kangar and Alor Setar in P.Malaysia. Federal Route 1 is congested except for sections having parallel North-South Expressway sections that have been opened to the public. Federal Route 2 is congested from Port Klang to Temerloh. Sections in urbanized areas are also congested.

In contrast, there is no serious traffic congestion in Sabah and Sarawak.

Traffic congestion and poor traffic flow is also greatly influenced by the proportion of heavy vehicles in the traffic stream. In P.Malaysia, for example, the states of Johor and Pahang have more than 20% heavy vehicles in the traffic stream while Selangor, Perak, Penang, Trengganu and N.Sembilan have more than 15%. These states therefore generally have higher congestion problems.

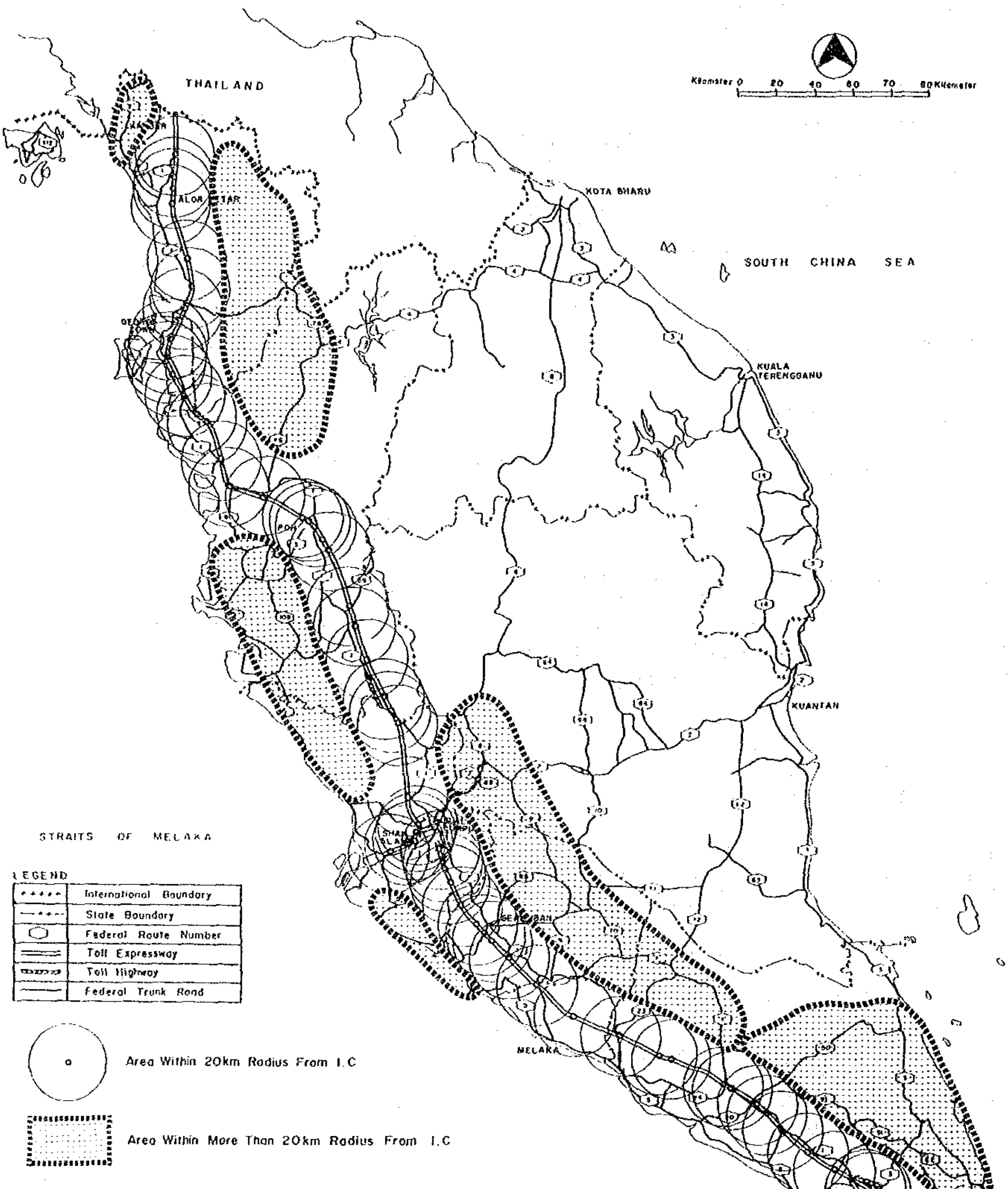
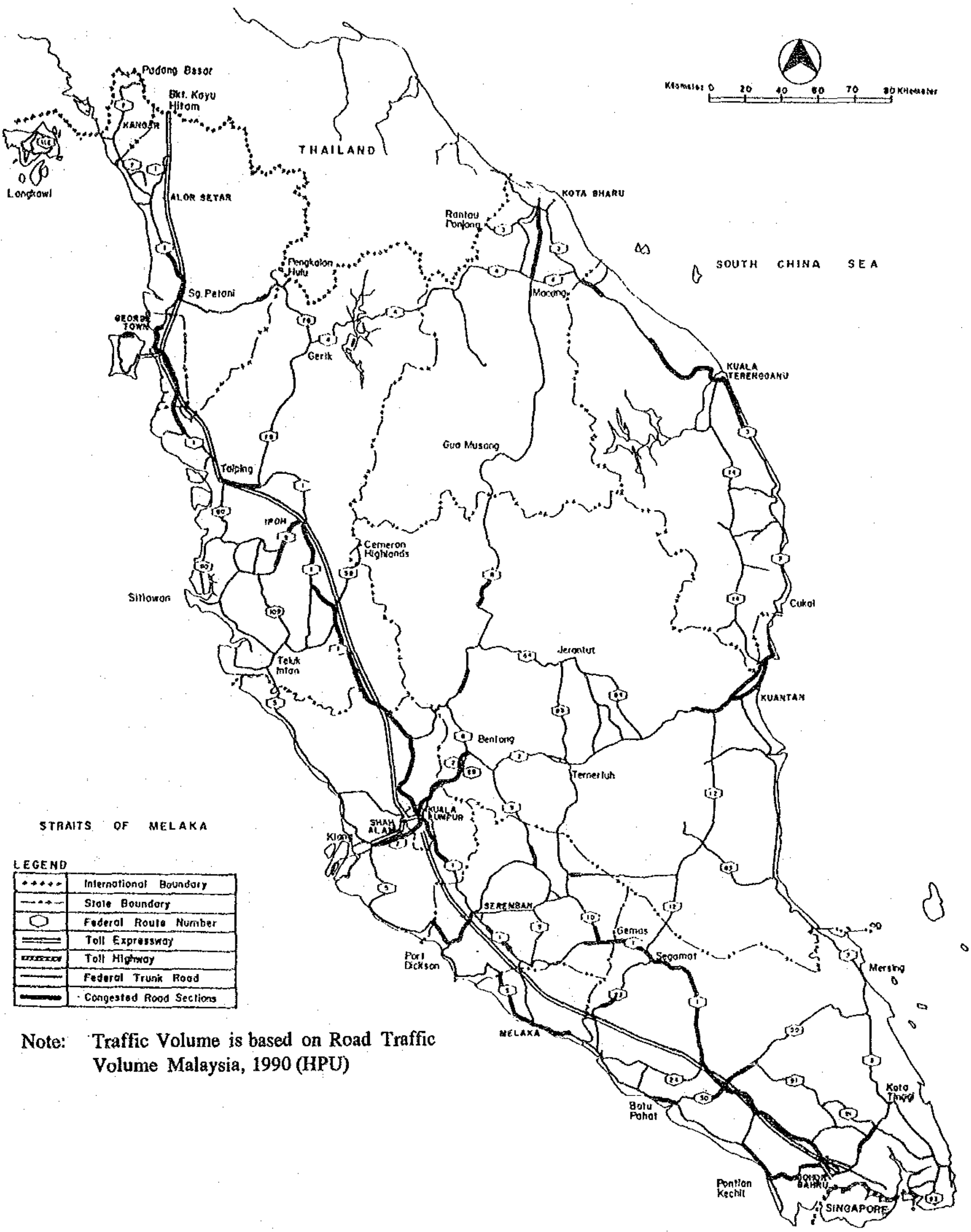


Figure 3.8 : Areas Within 20km Radius and More Than 20km Radius From Interchanges on The Expressway Corridor



Note: Traffic Volume is based on Road Traffic Volume Malaysia, 1990 (HPU)

Figure 3.9 : Traffic Congestion Sections on Existing Highway Network in Peninsular Malaysia

3.7 Road Development Level in Malaysia

One of the important implications from the assessment of past road development plans is that road network improvement and expansion had directly or indirectly contributed to the country's economy. The road development level is one of the tools that can examine the quantity of road network at macro level and is widely practised in Japan. Within the road development level, there are four indicators that are commonly used:

Table 3.9 : Road Development Level Indicators

Indicator	Abbr.	Description	Unit
Road Service Level (RSL)	L/P L/V L/$	Total road length per unit of population Total road length per unit of vehicle ownership Total road length per unit of GDP	km/1000 person km/vehicle km/US$100 mil
Road Density	L/A	Total road length per unit of total area	km/km^2

Note : L = Road Length; P = Population; V = Number of Vehicle; $: GDP; A : Area

(1) International Comparison

As Malaysia strives toward an industrialized country status by year 2020, she must chart some of the development policies and targets with reference to the attainments of the present developed countries. For road development in this country, it is pertinent to assess the present and future road development level by comparing with those of the developed countries. To know the position of Malaysia in the ASEAN context, Indonesia is also included as a comparison in this analysis. A fifth indicator called the **Road Development Index (RDI)** is introduced to assess the countries on a constant basis. The equation used is :-

$$RDI = \frac{L}{\sqrt{(P \times A)}}$$

Table 3.10 shows the comparison of the indicators between Malaysia and the 5 developed countries (USA, W.Germany, England, France, Italy and Japan) and Indonesia. The findings gathered from the table are :

1. The road development level for Malaysia is still lagging in comparison to the developed countries

2. The high level of road service levels in terms of L/$ indicate that Malaysian GDP has not reached the level that is needed to push the road development levels to a level that is comparable with the developed countries.

Table 3.10 International Road Development Level and Service Level

Country Name	Area ($x100km_2$) (A)	Population (x1,000) (P)	Road Length (Km) (L)	Gross Product (100million US$)	Number of Motor Vehicles Registered (x10000)	Road Development Index	Road Density Level (Km/Km^2)	Road Service Levels		
								(Km/1000 per.)	(Km/10000 veh)	(Km/100 million US$)
U.S.A	9,373	246,330	6,230,000	45,267	18,347	4.10	0.66	25.29	334.57	137.63
West Germany	249	61,200	491,000	11,239	3,104	3.45	1.97	6.05	158.18	43.69
England	244	57,080	340,000	6,888	2,467	2.88	1.39	5.96	137.82	49.36
France	552	55,870	810,000	8,767	2,534	4.61	1.47	14.50	319.65	92.39
Italy	301	57,440	300,000	7,507	2,548	2.28	1.00	5.22	39.96	39.96
Japan	378	122,610	1,110,000	23,873	5,245	5.16	2.94	9.05	211.63	46.50
Malaysia	330	18,010	63,445	318	553	0.82	0.19	3.50	113.90	198.11
Indonesia	1,919	164,050	230,000	660	254	0.41	0.12	1.40	905.51	348.48

Data Sources :

1. World Road Statistics 1989 and for West Germany, the length of road is from 1986 Statistical Handbook of Japan
2. Doro Gyousei (Road Bureau of Construction Department in Japan 1990)
3. JKR Road Mileages Summary and K.L City Hall, 1990
4. Sixth Malaysia Plan

Note;

(1) Road Length : Total length of roads and highways

(2) Road Development Index $D=L/\sqrt{A*P}$ P : population (1,000 persons)
A : Area (km^2)
L : Road Length (km)

(2) Regional Comparison

The objective of analyzing road development indicators by regions in Malaysia is to identify region or regions that lack adequate road networks so that priority can be set for the road development in these regions. The RDI, RD and RSL for the west and east coasts of Peninsular Malaysia; Sabah; Sarawak and Malaysia are analyzed and summarized in Figure 3.10.

A summary of observations based from the above comparison is shown in Table 3.11.

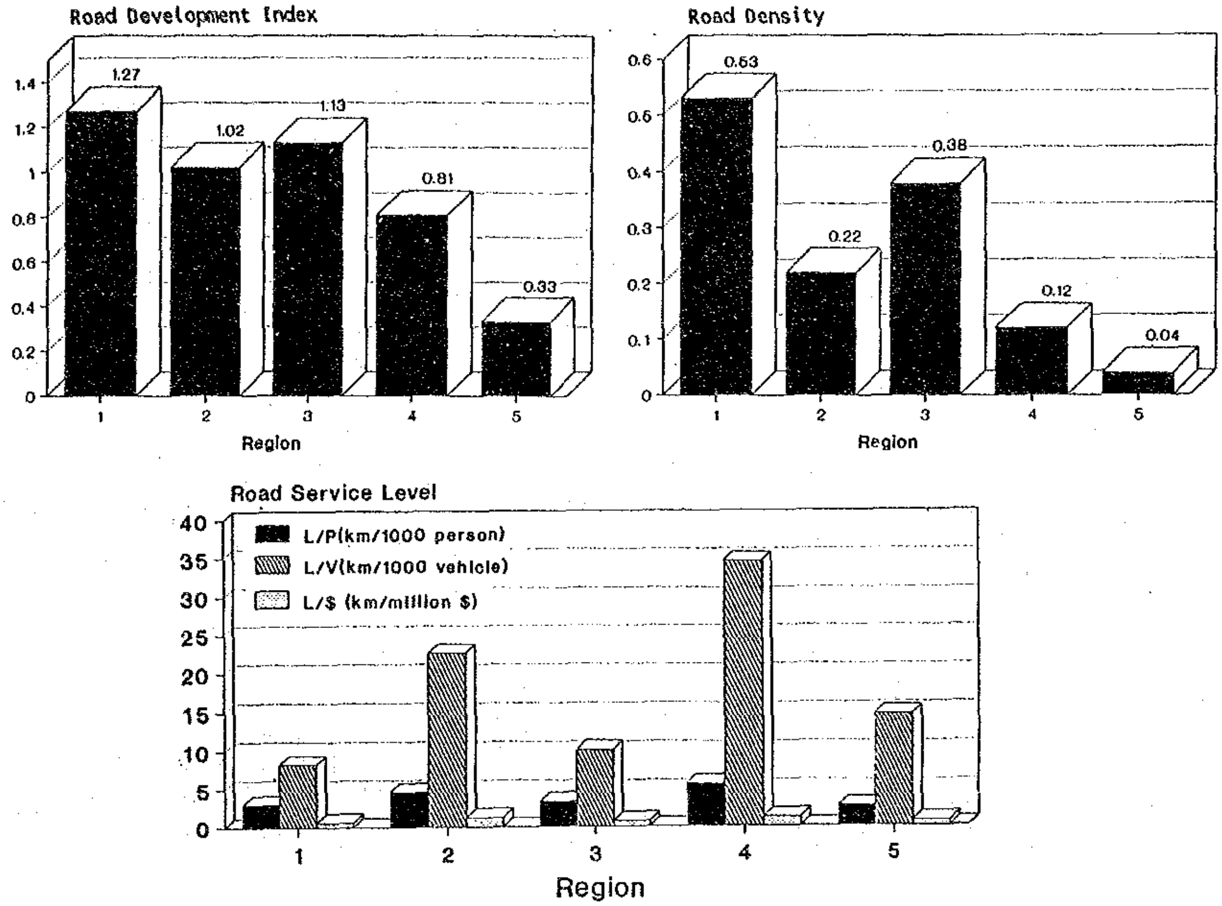
Table 3.11 : Road Development and Service Levels by Regions

Regional Comparison Indicators	Peninsular Malaysia	Sabah and Sarawak
Road Development Index	The index for West Coast is higher than the East Coast but not large differences between them	The index for Sabah and Sarawak is lower than for Peninsular Malaysia
Road Density	RD is in the East Coast is lower than the West Coast	RD for Sabah and Sarawak is lower than for Peninsular Malaysia
Road Service Levels **L/P** **L/V** **L/$**	RSL is higher in the East Coast than in the West Coast	RSL is higher in Sabah and Sarawak than in Peninsular Malaysia

The table above indicates that the road density is highest in West Coast compared to other regions. However, Road Service Level is lower than the other regions. In addition, Sabah and Sarawak shows high Road Service Level eventhough the Road Density and Road Development index is lower. This is caused by the following factors:-

(1) Imbalance in population density and industrialization.
(2) Imbalance in road development investment per person, per vehicle or per unit of GDP.
(3) Insufficient infrastructure development caused by existing imbalance development pattern.

Therefore, it can be concluded that highway network development in the West Coast must be further encouraged while it is equally important to develop highway network system in East Coast, Sabah and Sarawak to support industrialization in these regions.



Legend:

1: West Coast of Peninsular	2: East Coast of Peninsular	3: Peninsular
4: Sabah	5: Sarawak	

Figure 3.10: Comparative Analyses of Road Development Levels by Region in Malaysia

3.8 Road Traffic Safety

The number of fatalities in road accidents per 100,000 persons has increased from 17.7 persons in 1981 to 21.7 persons in 1989 which is the highest figure in the past ten years. For every 10,000 registered vehicle in Malaysia, there are 7.4 deaths from road accidents in 1989. These figures reflect the level of road traffic safety in the country which are about 2.4 times and 5 times in corresponding rates of fatalities in Japan.

Road traffic accidents in Malaysia is characterized by the high number of motor cyclists among the accident casualties. Of the total 30,037 road accident casualties in 1989, 49% are either motorcyclists or their pillion riders. More and more pedestrians are also involved in road accidents. For 1989, pedestrians accounted for 14% of the total casualties.

It is found that one out of every four buses and one out of every seven taxis are involved in road accidents every year. In 1989, one out of every 3 taxis are involved in road accidents. These rates are alarmingly high. Traffic accidents on the expressways are increasing very rapidly as more and more vehicles use the expressways. The concern here is the high fatality rate among accidents on the expressways. On the KL-Seremban Expressway, there are 1683 accidents from June 1990 to May 1991. Out of these 58 are fatal.

3.9 Problems Facing Existing Road Transport in Malaysia

Problems and issues on existing road transport and highway network are summarized below:

(1) Need to Strengthen the Present Highway Network

The existing highway network in P.Malaysia is a partially developed network with two main axes from north to south and one from east to west. Linkages between some regions are still weak such as between the east coast states and Penang or Kedah.

The completion of the North-South Expressway will influence the traffic flow to a great extent in the west coast of P.Malaysia. For efficient usage of highway network along this important corridor, the improvement of existing federal roads and major state roads at the regional level is very important.

New linkages are particularly needed in the central corridor and the east coast states to encourage regional development programs. To ensure total reliability of road transport, alternative routes or mitigation measures for flood and landslide prone areas must be implemented.

Highway networks in Sabah and Sarawak are in their infant stage. Moreover, there is no direct linkage between the two states. A network should be planned to bring basic services and amenities to the hinterland areas of both states. Such network links will also encourage development to the vastly undeveloped areas in the interior.

(2) Need to Mitigate Traffic Congestion

The completion of the North-South Expressway is expected to temporary relieve traffic congestion along Federal Route 1 in the west coast of P.Malaysia. Widening and upgrading of this Federal Route should be considered. Traffic congestion on Federal Route 2 and other trunk road sections within major urban areas and their conurbations will deteriorate in the near future. Urban bypasses are needed for fast growing urban conurbations in both the east and west coasts of P.Malaysia to help relieve traffic congestion around urban areas.

(3) Need To Strengthen Road Structure and Alignment

Sections of existing federal highways having under capacity problems and which are suffering from low travel speed and traffic bottlenecks must be identified and improved. Along with this effort is the need to strengthen the road structures and alignment of some deficient sections of the federal highways such as Grik-K.Kangsar Road in Perak. The improvement plan should therefore aim at providing the federal routes with the adequate capacity for performing the intended functions of these highways.

Alignment selection should strike a balance between topographic features, composition of traffic, cost and safety level for routes running through hilly and mountainous regions. The constructions of more sophisticated facilities such as tunnels and steel bridge should be pursued if only to serve the alignment needs and reduce the lost of environmental features and surface vegetation.

For Sabah and Sarawak, increasing the paving rate of federal and state roads is a high priority job. The existing federal and major states routes must be improved to be all season roads.

(4) Need to Rationalize the Role of Road Transport

The present share of road transport in the country is overwhelmingly high. The fact remains however that this share is not going to come down so quickly in future given the versatility of this mode of transport and the weakness of other modes. If no efforts are made to shift some of the traffic demand to other modes, large investments will be needed in the near future to continuously expand the road infrastructures in the country.

Certain freight transport such as long haul general cargoes can in fact be shifted to rail transport. Long distance passenger rail transport should be improved to shoulder some of the traffic demand in the future.

(5) Need to Consider Traffic Safety

The present road traffic safety level in Malaysia is worrisome. Accident statistics show the very high accident and fatality rates in the country compared to the developed nations. It is important to consider the factor of traffic safety in highway planning such as ensuring better horizontal and vertical alignments, sight distance, gradient, road surface conditions, geometrics and lighting. The Government has recognized road safety as a national problem and has in fact set a target of reducing fatalities caused by road traffic accidents by 30% by the year 2000.

CHAPTER 4

SOCIO ECONOMIC FRAMEWORK STUDY

FEDERAL ROUTE NO 1 BUTTERWORTH

CHAPTER 4 : SOCIO-ECONOMIC FRAMEWORK STUDY

4.1 Introduction

The approach of estimating the socio-economic framework to the year 2010 for the planning of a future highway network in Malaysia is outlined in the figure below:

Step 1	**Macro-Level Forecasting** Estimate and forecast socio-economic indicators at National Level.
Step 2	**State Level Forecasting** Estimate and forecast socio-economic indicators by state but using the national level as control.
Step 3	**Micro or District Level Forecasting** Estimate and forecast socio-economic indicators by district(traffic zone) but using state totals as control.

Figure 4.1: Approach in Estimating and Forecasting Future Socio-economic Indicators

The socio-economic indicators at macro level were obtained from the Economic Planning Unit (EPU) of the Prime Minister's Department. The socio-economic indicators at state and district levels were estimated by the Study Team based on the EPU's targets.

4.2 National Socio-Economic Framework to The Year 2010

Table 4.1 summarizes the macro socio-economic framework of Malaysia from 1980-2010. The population of the country has been increasing from 14 million in 1980 to 18 million in 1990 and is expected to increase to 27.5 million by the year 2010. The annual increasing rate of the total population is expected to be 2.1% during the period 1990-2010, dropping by 0.5% from the rate of 2.6% in 1980-1990 period.

In contrast, the number of labour force has been increasing at a higher rate than the population which was about 3.3% in the 1980s and the growth rate is expected to be 2.7% in 1990-2010 period with a total of 12.1 million in 2010. This was brought about by a relative increase in the working age population, defined as those in the age group of 15-60 as well as the increase in female participation in the labour force. The labour force participation ratio is expected to increase from 66.5% in 1990 to 68.0% in 2000 and 69.7% by the year 2010.

The total employment in Malaysia is forecasted to increase at a rate of 2.9% per annum, a little lower than the rate of 3.2% during the 1980-1990 period. Among the factors that influenced the increase in employment are the high speed expansion of the national economy and the improvement in the labour productivities. This has resulted the higher increase of the employment compared to the labour force and therefore decreases the unemployment rate to 3.0% by the year 2010.

The GDP per-capita shows an increasing pattern, i.e from 4.5 thousands ringgit per population in 1990 to 11.86 thousands ringgit per population by the year 2010 at 1978 prices.

The GDP of the country is expected to grow at a rate of 7.26% per annum for the next twenty years as shown in Table 4.2. The growth of GDP during the period of 1990-2010 will be led by the expansion in the secondary and tertiary sectors. The manufacturing sector is forecasted to grow at a higher rate i.e 9.26% and is expected to has a share of 41.13% by the year 2010. The expansion in the primary sector will be affected by the slower growth of the agriculture and mining sectors. The growth in the tertiary sector will originate primarily from the utilities sector, while the Government services will be substantially reduced to 6.4% of the total GDP by the year 2010 compared to 10.7% in 1990.

Table 4.1: Macro Socio-Economic Indicators, 1980-2010

Indicators	1980	1990	2000	2010	Average Annual Growth Rate (%)	
					1980-1990	1990-2010
Population ('000 persons)	13,879.2	18,010.2	22,660	27,500.4	2.6	2.1
Labour Force ('000 persons)	5,108.9	7,046.5	9,365	12,104.8	3.3	2.7
Employment ('000 persons)	4,816.9	6,621.0	8,986	11,736.0	3.2	2.9
Unemployment Ratio (%)	5.7	6.0	4.0	3.0		
No. of Households ('000 households)	2,558.9	3,613.8	4,760.5	6,071.7	3.5	2.6
GDP Per-Capita ('000/person, at 1978 prices)	3.13	4.40	5.00	11.10	3.60	4.70

Source: 5thMP, 6thMP, OPP2 and EPU

Table 4.2: Gross Domestic Products by Industry of Origin, 1985-2010

(Unit: Million $ at 1978 prices)

INDUSTRY	1985	1990	1991*	1995	2000	2010	GROWTH RATE (%) 1990−2000	2000−2010	1990−2010	Composition Ratio (%) 1990	2010
Agriculture	11854	14820	15369	17593	20855	28715	3.5	3.2	3.4	18.7	9.3
Mining	5958	7749	7880	8338	8869	5511	1.4	−4.6	−1.7	9.8	1.8
Manufacturing	11263	21323	23828	36761	57855	125394	10.5	8.0	9.3	26.9	41.1
Construction	2738	2844	3078	4178	5581	12046	7.0	8.0	7.5	3.6	4.0
Utilities	948	1515	1669	2432	3915	8470	10.0	8.0	9.0	1.9	2.8
Transport	3630	5502	6089	9037	14218	29372	10.0	7.5	8.7	7.0	9.6
Wholesale	6911	8722	9526	13420	19665	47162	8.5	9.1	8.8	11.0	15.5
Finance	5121	7669	8416	12079	16511	41320	8.0	9.6	8.8	9.7	13.6
Goverment	6957	8479	8860	10448	13096	19499	4.4	4.1	4.3	10.7	6.4
Others	1301	1660	1796	2432	3404	8714	7.4	9.9	8.6	2.1	2.9
Imputed Bank Services	−1834	−4076	−4597	−7361	−13835	−30703	13.0	8.3	10.6	−5.1	−10.1
Import Duties	2246	2947	3175	4230	5519	9382	6.5	5.4	6.0	3.7	3.1
GDP at purchasers' value	57093	79154	85089	113587	155653	304882	7.0	7.0	7.0	100.0	100.0
Primary sectors	17812	22569	23249	25931	29724	34226	2.8	1.4	2.1	28.1	10.5
Secondary Sectors	14001	24167	26906	40939	63436	137440	10.1	8.0	9.1	30.1	42.1
Tertiary Sectors	24868	33547	36356	49848	70809	154537	7.8	8.1	7.9	41.8	47.4
TOTAL	56681	80283	86511	116718	163969	326203	7.4	7.1	7.3	100.0	100.0
Adjusted by Sectors											
Primary sectors	17941	22252	22867	25235	28216	31989	2.4	1.3	1.8	28.1	10.5
Secondary Sectors	14103	23827	26464	39841	60219	128457	9.7	7.9	8.8	30.1	42.1
Tertiary Sectors	25049	33075	35758	48511	67218	144436	7.3	7.9	7.6	41.8	47.4
TOTAL	57093	79154	85089	113587	155653	304882	7.0	7.0	7.0	100.0	100.0

4.3 Regional Socio-Economic Framework to the Year 2010

(1) Population

Table 4.3 illustrates the distribution of population by State. The average annual rate differs between states due to the differences in the fertility level, inter-state migration and the changes in geographical distribution of the population.

In terms of state population, the states of Perak, Melaka, Negeri Sembilan, Pulau Pinang, Kedah and Johor experienced lower growth rate than the national average in the 1980s due to the heavy migration of the population to other states namely Selangor and Kuala Lumpur.

The high growth rates of population in Pahang, Trengganu and Kelantan were influenced by the large number of settlers to the new land development schemes as well as the high fertility rates and the attachment of the local population to their hometowns.

Higher growth rates of the population in 1980-1990 period were experienced by Sabah and Sarawak and they were mainly caused by the natural growth and in the case of Sabah the high growth was also influenced by the influx of international migrants mainly from Indonesia and the Philippines. Being the most developed, industrialized and urbanized states, Selangor and Kuala Lumpur are the main destinations of the migrants from other states.

The trend of population is assumed to be the same in the future. From these annual growth rates as summarized in Table 4.3, it is clear that migration and immigration (as in Sabah's case) have played an important role in the population growth rates of states than fertility and mortality.

Table 4.3 : Population Growth by State, 1980-2010

(Unit: '000 Persons)

State	1980	1990	1991*	2000	2010	Growth Rate (%)		Composition Ratio (%)	
						1980-1990	1990-2010	1991	2010
1. Johor	1644.9	2108.6	2163.3	2670.2	3223.2	2.5	2.1	11.8	11.6
2. Kedah	1120.6	1366.9	1400.2	1666.1	2005.5	2.0	1.9	7.6	7.3
3. Kelantan	897.8	1168.6	1199.1	1480.0	1860.4	2.7	2.4	6.5	6.8
4. Melaka	466.6	543.1	553.7	635.3	740.2	1.5	1.6	3.0	2.7
5. N.Sembilan	575.9	683.7	695.9	815.8	961.6	1.7	1.7	3.8	3.5
6. Pahang	802.2	1127.3	1154.7	1460.3	1858.5	3.5	2.5	6.2	6.8
7. P.Pinang	958.2	1159.0	1182.0	1357.8	1557.7	1.9	1.5	6.4	5.7
8. Perak	1812.3	2098.1	2132.1	2403.1	2756.2	1.5	1.4	11.5	10.0
9. Perlis	148.8	187.1	191.8	231.6	279.1	2.3	2.0	1.0	1.0
10. Selangor	1521.6	2206.5	2292.3	2987.4	3538.7	3.8	2.4	12.4	12.9
11. Trengganu	543.1	757.2	783.8	1011.0	1295.2	3.4	2.7	4.2	4.7
12. Kuala Lumpur	981.0	1302.8	1334.9	1600.5	1878.3	2.9	1.8	7.2	6.8
PENINSULAR	11473	14708.9	15083.8	18319.1	21954.6	2.5	2.0	81.6	79.8
13. Sabah	1055.1	1535.4	1592.2	2086.4	2765.9	3.8	3.0	8.6	10.1
14. Sarawak	1351.1	1765.9	1814.0	2255.0	2779.9	2.7	2.3	9.8	10.1
MALAYSIA	13879.2	18010.2	18490.0	22660.5	27500.4	2.6	2.1	100.0	100.0

Note * : Estimated by Study Team

Sources : 5MP, 6MP, OPP2, EPU

(2) Gross Domestic Product (GDP)

Table 4.4 summarizes the GDP at state level. Selangor attributes the highest share of the 1990 total GDP which was about 18.3% followed by Kuala Lumpur (12.5%) and Johor (10.6%). The changes in the distribution of GDP among the states is one of the underlying cause of inter-state migration where employment opportunities played an important role.

In the past years, Trengganu, Sarawak and Sabah have the highest growth rates of the GDPs which were about 11% and 9% respectively. The high growth of GDPs were largely attributed by the exploitation of crude petroleum and natural gas. Selangor, Johor, Kuala Lumpur, Melaka and Pulau Pinang experienced high rates of GDPs due to the increasing growth of the secondary and tertiary sectors mainly the manufacturing sector as the dominant industry.

Based on the forecasted growth rates and the growth rates during 1980-1990 period, the states can be classified as follows:

Group 1: States whose GDPs are expected to grow at relatively highest speed compared with the past trend: Kedah, Kelantan, Negeri Sembilan, Pahang and Perak.

Group 2: States whose GDPs are expected to grow at relatively higher speed compared with the past trend: Johor and Perlis.

Group 3: States whose GDPs are expected to grow at relatively lower speed compared with the past trend: Melaka, Pulau Pinang, Selangor and Kuala Lumpur.

Table 4.4: Gross Domestic Products by State, 1980-2010

(Unit: Million $ at 1978 prices)

State	1980	1990	1991*	2000	2010	Growth Rate (%)	Composition Ratios (%)	
						1990-2010	1990	2010
1. Johor	4682	8515	9188	20099	42903	8.4	10.6	13.2
2. Kedah	2299	3604	3858	8102	18168	8.4	4.5	5.6
3. Kelantan	1305	2063	2212	4435	10358	8.4	2.6	3.2
4. Melaka	1046	1976	2147	4062	8197	7.4	2.5	2.5
5. N.Sembilan	1934	2650	2863	5276	10398	7.1	3.3	3.2
6. Pahang	2492	3749	4009	8163	18588	8.3	4.7	5.7
7. P.Pinang	3413	5798	6371	10850	19730	6.3	7.2	6.0
8. Perak	5046	7146	7660	13449	27430	7.0	8.9	8.4
9. Perlis	329	564	603	1101	2369	7.4	0.7	0.7
10. Selangor	6846	14663	16106	32487	60820	7.4	18.3	18.6
11. Trengganu	1964	5497	5709	9183	14328	4.9	6.8	4.4
12. Kuala Lumpur	6097	10068	10981	18910	33677	6.2	12.5	10.3
PENINSULAR	37453	66293	71706	136118	266965	7.2	82.6	81.8
13. Sabah	3077	7021	7420	13536	29746	7.5	8.7	9.1
14. Sarawak	2980	6969	7386	14315	29492	7.5	8.7	9.0
MALAYSIA	43510	80282	86511	163969	326203	7.3	100.0	100.0

Note : GDP is the one before adjustment by Imputed bank service charge (less) and Import duties (add)

* : Estimated by Study Team

Source: 5MP and EPU

Group 4: States whose GDPs are expected to grow at relatively lowest speed compared with the past trend: Trengganu, Sabah and Sarawak.

Based on the above characteristics, it can be pointed out that the existing growth poles i.e. Pulau Pinang, Selangor and Kuala Lumpur, the GDP growth rates are relatively lower than the past trends that implies the industrial dispersion from the growth poles to the neighbouring states such as from Pulau Pinang to Kedah and from Kuala Lumpur and Selangor to Negeri Sembilan and Melaka. On the other hand, the exploitation of crude oil does not effect the GDP of Sabah and Sarawak whereas it constitutes a big contribution to Trengganu.

As a conclusion, it is assumed that the distribution of the GDP among the states is expected to improve in the future.

(3) Labour Force and Employment

The total working age population is expected to grow at 7.5% per annum during the period of 1990-2010. It is estimated that the labour force will reach about 12 million by the year 2010.

Selangor, Sabah and Trengganu have the highest growth of labour force during the period of 1990-2010 which is about 2.8%, partly caused by the inflow of workers into these states. As shown in Table 4.5, Selangor, Johor and Perak recorded the highest number of labour force with totals of 890 thousand, 860 thousand and 820 thousand in 1991 respectively and this trend is expected to be same until the year 2010. Although Perlis recorded the lowest number of labour force, however the growth rate for 1990-2010 period is the same with the national rate i.e 2.7%.

Table 4.5 : Labour Force by State, 1990-2010

(Unit : '000 Persons)

State	1990	1991	2000	2010	Growth Rate (%) 1990–2010	Participation Ratios (%) 1990	2010
1. Johor	835.9	860.5	1111.1	1437.1	2.7	67.4	70.7
2. Kedah	501.3	515.2	665.8	860.2	2.7	62.4	65.4
3. Kelantan	429.2	441.9	571.1	737.8	2.7	62.5	65.5
4. Melaka	203.4	208.0	268.8	347.7	2.7	63.7	66.8
5. N.Sembilan	251.9	257.4	332.5	429.5	2.7	62.7	65.7
6. Pahang	450.9	463.5	598.3	773.9	2.7	68.0	71.3
7. P.Pinang	422.3	432.1	558.4	721.5	2.7	62.0	65.0
8. Perak	805.6	821.4	1060.9	1371.2	2.7	65.3	68.4
9. Perlis	73.4	75.5	97.5	126.0	2.7	66.7	69.9
10. Selangor	856.4	892.8	1152.9	1489.9	2.8	66.0	69.2
11. Trengganu	288.5	299.6	387.0	500.3	2.8	64.8	67.9
12. Kuala Lumpur	521.3	535.8	691.6	894.3	2.7	68.0	71.3
PENINSULAR	5640.1	5803.7	7495.9	9689.4	2.7	81.7	81.6
13. Sabah	622.4	647.6	836.0	1080.9	2.8	68.9	72.2
14. Sarawak	784.0	799.5	1032.6	1334.5	2.7	74.7	78.3
MALAYSIA	7046.5	7250.8	9364.5	12104.8	2.7	66.5	69.7

Sources: Estimated by Study Team

Employment is expected to increase in all the states by the year 2010 with the highest employment in Selangor, Johor, Sarawak and Kuala Lumpur. Employment in Kuala Lumpur will exceeds the labour force in 2010 where it provides job opportunities mainly in tertiary sector.(See Table 4.6).

Manufacturing, trade and commerce and tourism are expected to provide new employment opportunities to the states which also influenced the increase in the number of employment at the state level.

Table 4.6 : Employment by State, 1990-2010

(Unit: '000 Employees)

State	1990	1991	2000	2010	Growth Rate (%) 1990-2010	Composition Ratios (%)	
						1991	2010
1. Johor	783.1	809.7	1077.9	1399.9	2.9	11.8	11.9
2. Kedah	426.7	437.3	588.4	777.1	3.0	6.4	6.6
3. Kelantan	345.6	354.9	483.1	655.1	3.2	5.2	5.6
4. Melaka	193.2	200.7	262.2	337.4	2.8	2.9	2.9
5. N.Sembilan	234.6	241.3	314.7	405.3	2.8	3.5	3.5
6. Pahang	404.7	421.1	559.1	738.6	3.1	6.1	6.3
7. P.Pinang	441.8	466.1	586.8	743.0	2.6	6.8	6.3
8. Perak	731.8	752.3	980.6	1288.0	2.9	11.0	11.0
9. Perlis	63.3	64.5	85.2	112.9	2.9	0.9	1.0
10. Selangor	847.6	896.7	1137.3	1430.5	2.7	13.1	12.2
11. Trengganu	252.8	259.0	347.0	462.0	3.1	3.8	3.9
12. Kuala Lumpur	650.4	662.3	860.4	1075.2	2.5	9.7	9.2
PENINSULAR	5375.6	5565.9	7282.7	9425.0	2.8	81.2	80.3
13. Sabah	563.3	586.1	769.1	1036.6	3.1	8.5	8.8
14. Sarawak	682.1	703.6	934.5	1274.4	3.2	10.3	10.9
MALAYSIA	6621.0	6855.6	8986.3	11736.0	2.9	100.0	100.0

Sources: Estimated by Study Team

4.4 Socio-Economic Indicators at District Level

The Study Team has completed six types of socio-economic indicators framework at district/traffic zones level which will be utilized for forecasting the traffic demand as shown in Appendix.

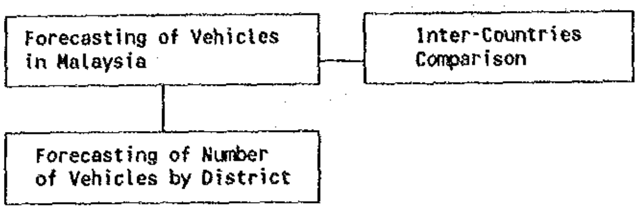
On working with the socio-economic indicators, the Study Team has adopted as many available data/information as possible which is thought to be useful for the forecasting process and applying minimum assumptions in order to substitute the lack of basic data.

It can be found that in some districts, the GDPs are higher compared to the districts that are more urbanized. This is mainly caused by the high estimation of GDP especially in agriculture sector. As a result, the GDP per-capita at these districts are higher than the urbanized districts which explained the productivities per population of a district and not the income level.

4.5 Forecasting of Number of Vehicles

(1) General

The number of Vehicles is an important factor in forecasting vehicle traffic demand. This study employs the following two (2) steps forecasting procedure:-



In this study, the long-term forecasting models are to be used to forecast the number of vehicles in the year 2010. The following are used:-

(a) Time series vehicle forecasting model
(b) Structure model

(2) Forecasting of Vehicles in Entire Malaysia

Vehicle ownership in the year 2010 is forecasted by using time series data of vehicle ownership in Malaysia. In forecasting the vehicle ownership, the trend type model incorporated with saturation rate of vehicle ownership in future is employed as shown below:-

$$Y = \frac{K}{1 + e^{A1-A2\ YR}}$$

Where;	Y	:	vehicle ownership (vehicles per 1000 population)
	K	:	Saturation rate of vehicle ownership
	A1,A2	:	Parameters
	YR	:	Year

Using the forecasted vehicle ownership and population, the number of vehicles are forecasted as follows :-

$$N = P * Y$$

Where;	N	:	Number of vehicles
	P	:	Population

Table 4.7 shows the results of vehicle ownership forecasting model calibration.

Table 4.7 : Vehicle Ownership Forecasting Models, Malaysia

Type of Vehicle	Formula	Coefficient
Car	$\frac{400}{1 + e^{106.9538 - 0.05322\,YR}}$	0.962
Bus	$\frac{25}{1 + e^{68.2757 - 0.03292\,YR}}$	0.988
Lorry	$\frac{100}{1 + e^{95.5106 - 0.04759\,YR}}$	0.949

Source: Study Team's analysis

Using the calibrated models and the estimated population, the number of vehicles in Malaysia are calculated as follows:-

Table 4.8: Number of Vehicles in Malaysia, 2010

Type	Vehicle Ownership in 2010 (vehicle per 1000 pop.)	Population ('000)	Number of Vehicles ('000)
Car	201.84		5,550.7
Bus	2.71	27,500.4	74.5
Lorry	53.63		1,474.8
Total	258.18		7,100.0

(3) Forecasting of Vehicles by Areas

Using linear regression model in with the GDP as the independent variables, the number of vehicles by states are analyzed. The following linear regression model is obtained:-

Table 4.9 : Number of Vehicle Forecasting Models, by State

Vehicle Type	Formula	Coefficient
P. Car	- 10,981 + 24.9448GDP	0.944
Bus	- 166 + 1.6175POP	0.730
Lorry	- 1,805 + 7.2319GDP	0.909

Study Team's analysis
Note: GDP: Gross Domestic Product
POP: Population

Using the number of vehicle forecasting models and GDP in 2010, the number of vehicles are estimated as shown in Table 4.10.

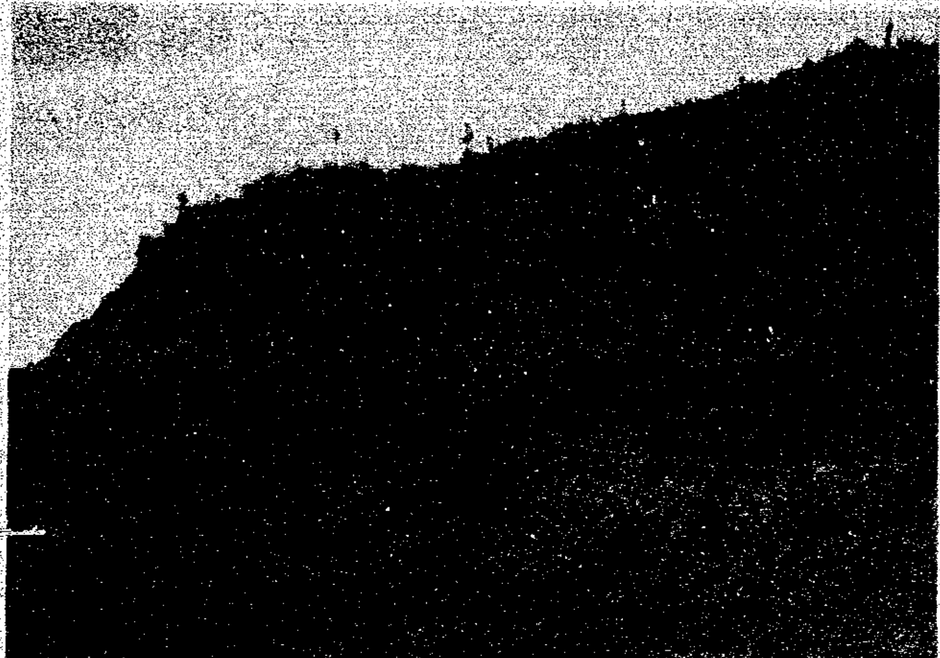
Table 4.10 : Forecasted Future Vehicle Number, 2010

(in '000)

Area	Type	1980	1990	2000	2010	Average Annual Growth Rate (%)	
						1990-2000	2000-2010
P.Malaysia	Car	729.1	1567.9	2883.0	4645.6	6.28	4.89
	Bus	13.1	21.5	35.9	57.6	5.26	4.84
	Lorry	223.3	435.5	748.5	1139.3	5.57	4.29
	Total	965.5	2024.9	3667.4	5842.5	6.12	4.77
Sabah	Car	86.4	140.0	248.6	456.5	5.91	6.27
	Bus	0.8	4.0	7.4	13.2	6.35	5.96
	Lorry	42.6	82.1	134.6	231.6	5.07	5.58
	Total	129.8	266.1	390.6	701.3	5.62	6.03
Sarawak	Car	56.4	137.7	261.2	448.6	6.61	5.56
	Bus	0.7	1.3	2.3	3.8	5.87	5.15
	Lorry	15.3	36.8	64.3	103.8	5.74	4.91
	Total	72.4	175.8	327.8	556.2	6.43	5.43
Malaysia	Car	871.9	1845.6	3392.8	5550.7	6.28	5.05
	Bus	14.6	26.8	45.6	74.6	5.46	5.05
	Lorry	281.2	554.4	947.4	1474.7	5.50	4.52
	Total	1167.7	2426.8	4385.8	7100	6.10	4.94

CHAPTER 5

TRAFFIC DEMAND FORECASTING



FEDERAL ROUTE NO 4

CHAPTER 5 : TRAFFIC DEMAND FORECASTING

5.1 Introduction

One of the most important task in the formulation of a national highway network development plan is the estimation or forecasting of vehicle traffic demand for the target year. Although the object is to plan for a highway network catering for vehicle traffic, the approach must consider the long term multi-modal policy that encourage the shifting of traffic demand from an over-burdened mode to others in achieving a more balanced transport system. The approach in forecasting future traffic demand is given in Figure 5.1 below:

Step 1	**Macro-National Level Forecasting** Forecasting multi-modal traffic demand under "Do-Nothing" Scenario.
Step 2	**Macro State Level Forecasting** Forecasting of multi-modal traffic demand under "Do-Nothing" and "Do-Something" Scenario.
Step 3	**Micro District Level Forecasting** Forecasting of vehicle traffic demand under "Do-Something" Scenario.

Figure 5.1: Approach For Forecasting Future Traffic Demand

Similar to the approach in forecasting future socio-economic framework, future traffic demand forecasting has to adopt the macro to micro approach. Total traffic demand at the national level and for each of the states are first forecasted. At this level, the mode share between road and other modes in future is examined. The resultant vehicle traffic demand is then used as a control for estimating traffic demand at the micro or traffic zone (district for P.Malaysia) level.

In examining the impact of future traffic demand in year 2010 on the highway network, a "Do-Nothing Case" analysis is used to evaluate the traffic impacts of the forecasted future travel demand on the existing highway network. The results of such an analysis thus can be used as a yardstick in evaluating the effects or performances of "Do-Something" cases such as improvement to the existing highway routes or construction of new highways.

The traffic forecasting method used in this Study basically follows the four-step method of :

(1) Trip Production
(2) Trip Generation & Attraction
(3) Modal Split
(4) Trip Assignment

Traffic forecasting is done separately for P.Malaysia, Sabah and Sarawak as these are three separate entities as far as vehicle traffic movement is concerned. When analyzing future traffic demand on the proposed future highway network however, Sabah and Sarawak will be treated as one entity with a new proposed linkage between the two states.

5.2 Macro Level Traffic Demand Forecasting For Peninsular Malaysia To Year 2010 Under "Do-Nothing" Scenario

5.2.1 Multi Modal Trip Production Rates

Several mathematical forecasting methods such as multiple linear regression, growth factor, average trip production rate method and vehicle base method are used to predict total future trip production. Results of these methods are then compared and evaluated. Details of these forecastings by different methods are given in the Technical Paper on Traffic Demand Forecasting.

Multiple linear regression approach calibrates the regression model using the time series traffic demand data and socio-economic indicators to predict the future traffic demand. The growth factor method is based on a growth rate of socio-economic indicator that has high correlation coefficient with traffic demand. The trip production rate method uses trip rate in terms of trip per population and ton per unit of GDP. Future traffic demand will be estimated with number of forecasted future population and GDP.

The vehicle base method is able to predict only vehicle traffic demand based on number of vehicles and production rates such as number of trips a day/vehicle, average number of passenger/vehicle and average freight in ton/vehicle. Figure 5.2 shows the concept in determining the future trip production.

The data used for trip production forecasting are past road traffic demands between 1980 to 1990 initially estimated based on HPU traffic census data (traffic volume on screen lines) and HNDP traffic survey data (1991 traffic volume and average occupancy rate and load factor).

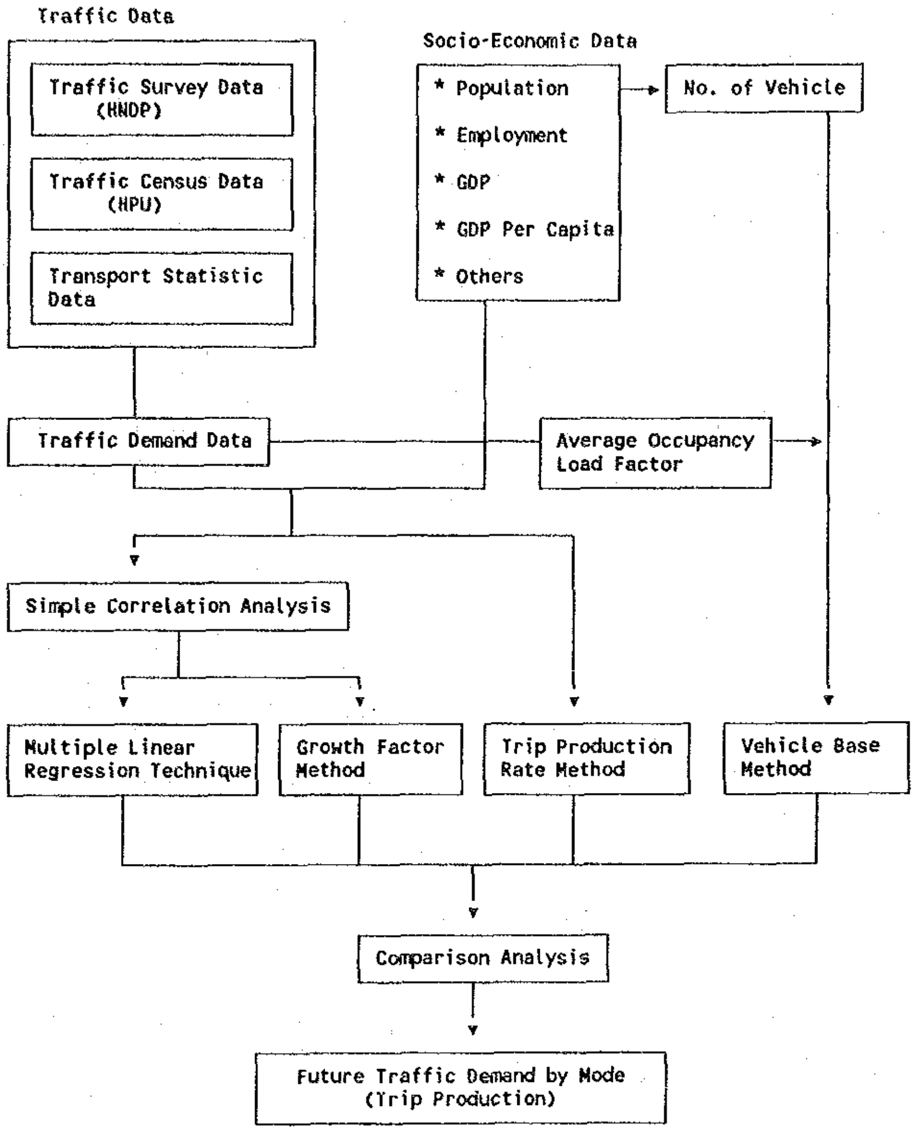


Figure 5.2 : Process of Determination of Trip Production in Peninsular Malaysia

A comparative analysis of the results of future trip production by the various methods was carried out[1]. Results from the Multiple Linear Regression Method are found to be the most acceptable as the other methods tend to overestimate or underestimate future trip production rates. The selection of this method is also supported by the following factors:

(1) The correlation coefficients are high,
(2) The total passenger and freight traffic demand forecasted by multiple regression method is approximates the average of the three methods,
(3) More than one independent parameters are considered in the model than the single factor used in the other methods.

[1] The details of this comparison can be found in the Technical Report on Traffic Demand Forecasting.

Table 5.1 shows the total future traffic demand for passenger and freight as well as the trip production rates by vehicle type using the Multiple Linear Regression Method.

Table 5.1: Future Trip Production Rates by Vehicle Type

		1980	1991	2010
Total Passenger ('000/year)	P.Car	3,453,172	3,566,626	10,499,893
	Bus	1,195,253	1,295,226	2,489,929
	Railway	6,257	6,564	13,907
	Air	2,583	2,845	13,028
	Total	4,657,265	4,871,261	13,016,757
	Elasticity*	-	1.25	1.00
Total Freight ('000 tonne/year)	Lorry	560,235	630,534	2,357,001
	Railway	4,296	4,258	12,813
	Air	13	15	58
	Water	4,143	5,019	20,592
	Total	568,687	639,838	2,392,464
	Elasticity**	-	0.92	0.93
Trip Production Rate (trip/veh/day)	P.Car	3.91	3.40	2.87
	Bus	6.41	6.72	3.77
	Lorry	2.26	3.38	3.77
	All Vehicle	3.54	3.43	3.07

Note: * Elasticity of Passenger Traffic to the GDP per capita
** Elasticity of Freight Traffic to the GDP

Table 5.1 also shows the elasticity of traffic demand to socio-economic indicators. The socio-economic indicators applied here are GDP per Capita for passenger traffic and GDP for freight traffic. The elasticities from 1980 to 1991 indicated 1.25 and 0.92 for passenger traffic and freight traffic respectively.

Generally, traffic demand in relation to economic development of a country follows a cycle of three stages. In the first stage, growth of traffic demand is generally higher than economic growth rate. In the second stage, growth of traffic demand stabilizes and balanced with economic growth. In the final stage, growth of traffic demand is lesser than rate of economic growth.

Developed countries like the USA and Japan have shifted into the third stage. Experience in Japan for example showed that the periods of 1955-1960 and 1970-1980 indicated elasticities for passenger traffic demand of 1.47 and 0.41 respectively which coincide with the period of rapid economic expansion after the war and the period of stable economic growth.

Malaysia can be said to be approaching the stage of balance traffic demand growth with economic expansion. The elasticity of traffic demand for Malaysia is thus approaching 1.0.before declining to less than 1 after achieving the developed nation status by 2020. Elasticity of forecasts for 2010 in Table 5.1 show a value of 1.0 for passenger and 0.93 for freight.