Chapter 2 PRESENT CONDITION OF LAND USE AND URBAN TRANSPORT

2. PRESENT CONDITION OF LAND USE AND URBAN TRANSPORT

2.1 Present Land Use and Population Distribution

2.1.1 Population

According to the 1970 census, the total population in the State of Penang was 777,000: 434,000 in Penang Island and 343,000 in Province Wellesley. The growth rate of population in the State of Penang during 1947 to 1970 was 2.4 percent per annum, while in Penang Island it was 2.2 percent per annum and in Province Wellesley 2.8 percent per annum. (See Table 2.1)

Table 2.1 Population Trend

	Population			Annual Growth Rate	
	1947	1957	1970	'47 - '57	'57 - '70
WEST MALAYSIA	4,908,086	6,278,758	8,801,399	2.5%	2.6%
PENANG STATE	446,321	572,100	776,770	2.5%	2.4%
PENANG ISLAND	262,705	338,866	433,760	2.6%	1.9%
PROVINCE WELLESLEY	183,616	233,234	343,010	2.4%	3.0%

Source: Population census

2.1.2 Land Use

In the Study Area at present, the size of areas devoted to major categories of land use is roughly as follows:

Table 2.2 Existing Land Use

Land Use	Penang Island*		Province Wellesley*	
	(ha.)		(ha.)	
Residential	2,700	(18.4)	3,180	(14.4)
Commercial	400	(2.7)		
Institutional	390	(2.7)		
Industrial	360	(2.5)	1,510	(6.9)
Open Space and Others	10,850	(73.7)	17,340	(78.7)
Total	14,700	(100.0)	22,030	(100.0)

Note: ( ) in percentage , * Study Area only

The characteristics of general land use within the Study Area can be described as follows:

1. Most of George Town consists of built-up areas except for the mountainous terrain in its vicinity, with population density more than 124 persons per hectare.

2. In other areas in Penang Island, there are still many areas of undeveloped and under-developed land. At present, areas in Bayan Lepas are being developed by the Penang Development Cooperation (PDC).

3. In Province Wellesley, good agricultural land is extensive, especially paddy land. Some of the areas in and around the vicinity of Butterworth are already developed, while other areas are now in the process of being developed.

2.2 Road Conditions

2.2.1 Network Configuration

The major road network in the Study Area is shown on the map in Fig. 2.1. In George Town, the network consists mainly of partially developed radial and ring roads with many of the roads consisting of wide single carriage-ways. The road network in the other areas consists of only trunk roads with wide single carriage-ways and local roads, mostly with narrow single carriage-ways.

Typical Wide Single Carriage-Way

The variation in road width and lack of separation for frontage use results in congested bottlenecks along many sections of the major road network. For instance, Jalan Jelutong, one of the radial roads, suffers from frequent traffic congestion because of intensive and mixed use by private-cars, trucks, buses, trishaws, and the loading and unloading of vehicles. Also, bottlenecks occur along Jalan Bagan Luar in Province Wellesley due to the varying width of the carriage-way.

2.2.2 Right-Of-Way

The right-of-way of the major roads in the Study Area ranges from 24' to 100' in width. Most of the roads in George Twon fall within 30' to 100' category. A comparatively wider road is Jalan Ayer Itam which is mostly 100' wide. In Province Wellesley, most of the roads range from 25' to 58' wide. Even Jalan Bagan Luar, New Chain Ferry Road and Jalan Besar which are trunk roads are only 24' and 49' wide.

2.2.3 Intersections

Intersections can conveniently be classified as follows:

1. Grade-separated intersections
2. At-grade intersections with signal
3. At-grade intersections without signal
4. Roundabouts

There are no grade-separated intersections at present. There are twenty-two (22) signalized intersections in the Study Area: eighteen (18) signalized intersections in Penang Island and four (4) in Province Wellesley.

At-grade Intersection with Signal

On major roads there are nine (9) roundabouts in Penang Island and three (3) in Province Wellesley. The other intersections are at-grade and non-signalized intersections.

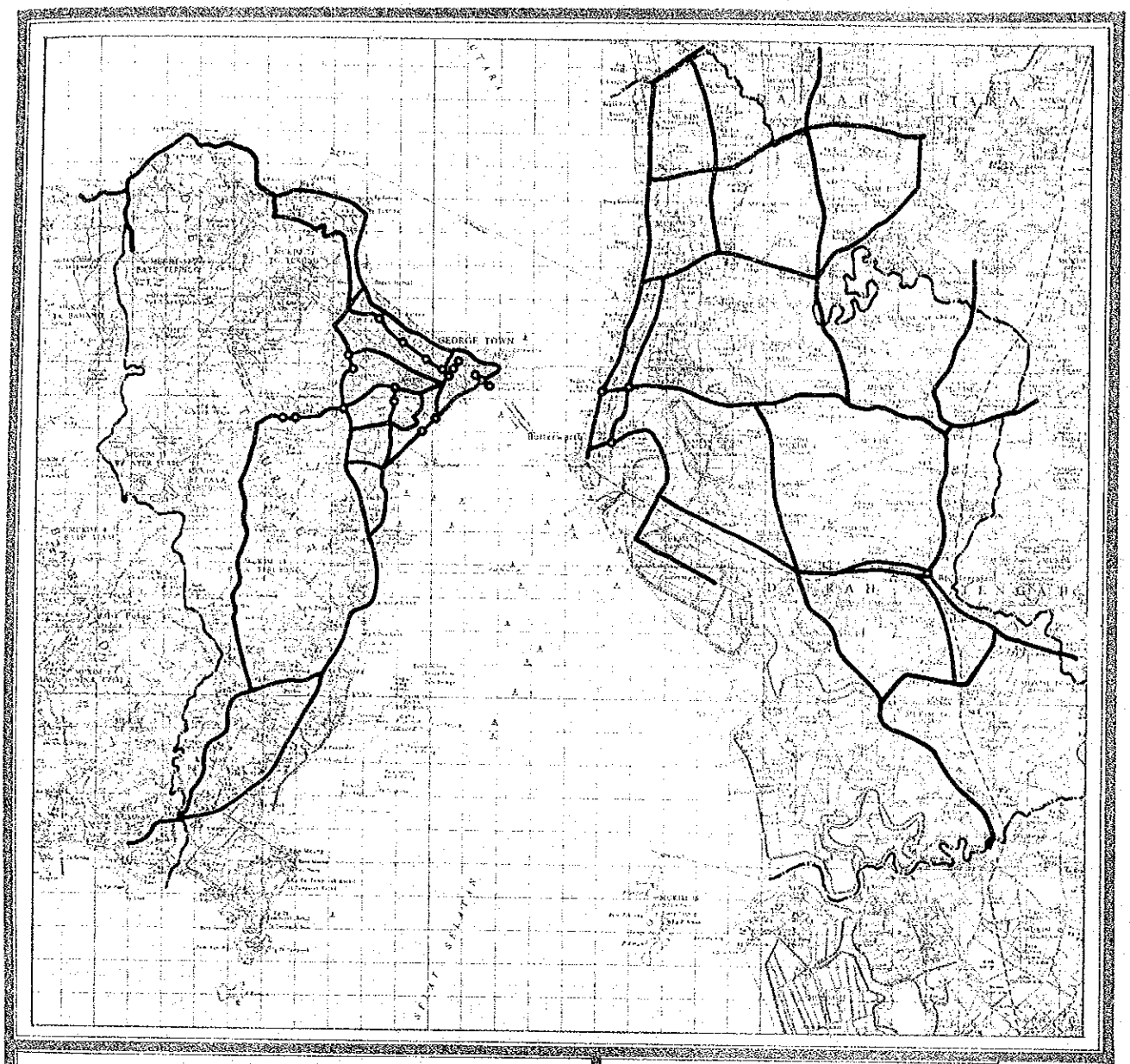


Fig.2.1 EXISTING ROAD NETWORK WITH SIGNALIZED INTERSECTIONS

PENANG URBAN TRANSPORT STUDY

URBAN TRANSPORT STUDY IN GREATER METROPOLITAN AREAS OF GEORGETOWN, BUTTERWORTH AND BUKIT MERTAJAM

Page.

2.3 Traffic Characteristics

2.3.1 Origin and Destination Survey

(1) Contents of survey

In order to make a proper plan for traffic which meets the existing traffic demands, it is necessary to obtain the starting point (origin) and the ending point (destination) of each trip made. Therefore, the "Origin and Destination Survey" (Car O-D Survey) was planned and carried out on June 1979. The contents of the survey are described as follows.

Table 2.3 Contents of Car O-D Survey

TYPE OF SURVEY	SURVEY METHODS	SURVEY ELEMENTS	PURPOSE OF SURVEY
Owner-interview survey	Interview at the owner's home sampled from registration cards	∘ vehicles (car,van, truck, bus, taxi) ∘ motorcycles	To determine the volume of internal trip movements
Cordon-line survey	Interview by the road-side	∘ vehicles ∘ motorcycles	To determine the number of vehicles entering or passing through the study area from other areas.
	Count of the traffic volume	∘ vehicles ∘ motorcycles ∘ bicycles	
Ferry survey	Interview on the ferry	∘ vehicles using ferry ∘ passengers using ferry	To verify the situation of ferry utilization for studying the bridge construction project
	Count of the ferry users	∘ vehicles ∘ motorcycles ∘ bicycles ∘ pedestrians	
Screen line survey	Count of the traffic volume	∘ vehicles ∘ motorcycles ∘ bicycles ∘ pedestrians ∘ trishaws	To verify the results of the owner-interview survey.

(2) Zoning

The state of Penang is divided into two (2) areas: Internal area and External area. The Internal area is identified as the

Study Area since it is and will be the greater metropolitan area of the State.

The internal area is divided into fifty-nine (59) zones using the border of mukims and other miscellaneous factors. (See Table 2.4 and Fig. 2.2; Zoning Map)

Table 2.4 Traffic Zone Code

AREA		LARGE ZONE CODE	MIDDLE ZONE CODE	SMALL ZONE CODE	NUMBER OF ZONES
INTERNAL AREA	PENANG ISLAND	1	11	111	1
			12	121, 122, 123, 124, 125	5
			13	131, 132, 133	3
			14	141, 142, 143	3
		2	21	211, 212	2
			22	221	1
		3	31	311	1
			32	321, 322, 323	3
			33	331, 332, 333, 334, 335	5
		4	41	411, 412, 413	3
		SUB-TOTAL	10		27
	PROVINCE WELLESLEY	5	51	511, 512, 513, 514	4
			52	521, 522, 523, 524, 525	5
		6	61	611, 612	2
			62	621, 622, 623	3
		7	71	711, 712, 713	3
			72	721, 722, 723	3
			73	731, 732, 733, 734	4
			74	741, 742	2
		8	81	811, 812	2
			82	821, 822	2
		SUB-TOTAL	10		30
		TOTAL	20		57

Note: Zone codes are made up of the following 3 digits.

2	1	2	----- small zone (most detailed zone in this survey)

2	1		----- middle zone (for data summary purposes)

2			----- large zone (for the purpose of outlining of traffic movement)

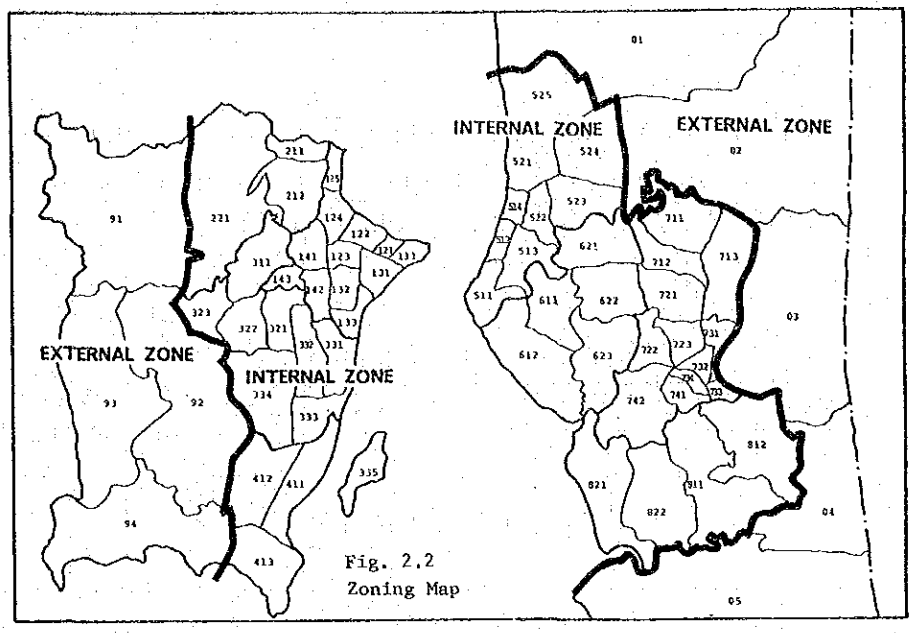


Fig. 2.2
Zoning Map

(3) Results of owner interview survey

The total sample size and sampling rate of the owner interview survey are as follows:

Table 2.5 Sample Size of Owner Interview Survey

		VEHICLE	MOTORCYCLE	TOTAL
POPULATION OF VEHICLES (IN INTERNAL AREA)		70,500	105,100	175,600
SAMPLE SIZE	HOME INTERVIEW SURVEY	6,352	5,454	11,806
	PRIVATE COMPANY/GOVERNMENT ORGANIZATION INTERVIEW SURVEY	562	57	619
	TAXI INTERVIEW SURVEY	210	-	210
	TOTAL	7,124	5,511	12,635
	SAMPLE RATE	10.1%	5.2%	7.2%

(4) Cordon line and screen line survey

Twelve (12) survey stations on the cordon line and seven (7) survey stations on the screen line were established. On the cordon line more than 8,000 of the drives were interviewed, about 34 percent of total traffic volume.

(5) Ferry survey

Passengers and drivers on the ferry between George Town and Butterworth were interviewed with the size of the survey samples as follows:

Table 2.6 Sample Size of Ferry Interview

(7.00am - 7.00pm)

	GEORGE TOWN TO B'WORTH			B'WORTH TO GEORGE TOWN			BOTH DIRECTION		
	TOTAL	SMAPLE	%	TOTAL	SAMPLE	%	TOTAL	SAMPLE	%
MOTOR VEHICLES*	4,184	609	14.56%	4,269	591	13.84%	8,453	1,200	14.2%
MOTOR CYCLES**	5,798	219	3.78%	6,177	192	3.11%	11,975	411	3.4%
PEDES-TRIANS	14,309	517	3.61%	13,476	440	3.27%	27,785	957	3.4%

* Excluding motorcycles & bicycles

** Including bicycles

2.3.2 Trend of Vehicle Ownership

During the period 1965 to 1979, the number of vehicles registered in the State of Penang has been increasing rapidly at an average rate of almost 10 percent per annum. (See Table 2.8) The growth rate of motor-cycles was considerably higher than that of cars before 1975. However, during the 1975 to 1979 period the growth rate of cars surpassed that of motor-cycles due to consumption increasing in proportion to the increasing family income with this trend expected to continue in the future.

On the other hand, Table 2.7 shows that the number of vehicles registered in Peninsular Malaysia has been increasing at an extremely high rate. The growth rate of motor-cars was above 10 percent during the period 1970 to 1977 and that of motor-cycles was above 15 percent during the same period. The growth rate for the entire Peninsular Malaysia was a little higher than that in the State of Penang.

Table 2.7 Motor Vehicle Registration*

Peninsular Malaysia, 1965 - 1977

(Unit: thousand vehicles)

	1965	1970	1975	1977	Average Annual Growth Rate (%)		
					1965 - '70	'70 - '75	'75 - '77
Car	154.3	231.5	398.0	492.3	8.4	11.5	11.4
Taxi	5.2	6.7	9.0	10.9	5.2	6.0	10.0
Lorry	41.9	55.8	92.2	112.0	5.9	10.5	10.0
Bus	3.8	5.9	8.7	10.5	9.2	8.0	10.0
Sub-Total	205.2	299.9	507.9	625.7	7.9	11.1	10.9
M/Cycle	175.8	350.0	722.3	951.1	14.8	15.6	14.9

* Excluding tractors, road rollers, etc.

Source of data: Road Transport Department.

Table 2.8 Motor Vehicle Registration*

Penang State, 1965 - 1979

(Unit: vehicles)

	1965	1970	1975	1979	Average Annual Growth Rate (%)		
					1965 - '70	'70 - '75	'75 - 79
Car	20,975	28,326	45,578	65,352	6.2	10.0	9.4
Taxi	214	294	386	474	5.5	5.6	5.3
Lorry	3,211	5,469	8,475	11,404	11.2	9.2	7.7
Bus	400	512	786	1,073	5.1	8.9	8.1
Sub-Total	24,800	34,601	55,225	78,303	6.9	9.8	9.1
M/Cycle	27,126	47,432	89,311	124,984	11.8	13.5	8.8
Total	51,926	82,033	144,536	203,287	9.6	12.0	8.9

* Excluding tractors, road rollers, etc.

Source of data: RIMV

2.3.3 Trip Production

On the basis of the 1979 O-D survey, the total number of trips produced in the Study Area (referred to as trip production) was 683,400 per day.

Totals of 58 percent or 397,000 trips are produced by motor-cycles and 35 percent or 236,000 trips by private cars. Compared to other ASEAN countries, it can be noted that motor-cycle trips contribute a far greater share to total trip production than car trips.

Table 2.9 Daily Number of Trips by Vehicle Type

	Number of Trips (thousand)	%
Private Car	236.0	34.5
Lorry	28.4	4.2
Taxi	2.7	0.4
Bus	19.0	2.8
(Sub-Total	286.1	41.9)
Motor-Cycle	397.3	58.1
Total	683.4	100.0

Source: Origin and Destination Survey, 1979

On the basis of this data, the following daily trip rates were determined;

Total vehicle trips per capita	0.94 trip/capita
by Motor-cycle per capita	0.55 trip/capita
by Motor car per capita	0.39 trip/capita
Trips per registered vehicle	3.91 trip/vehicle
Trips per registered motor-cycle	4.82 trip/motor-car.

Table 2.10 shows the trip purposes of private cars and motor-cycles.

Table 2.10 Daily Number of Trips by Trip Purpose

(thousand)

	Private Car		M-Cycle		Total	
	Trips	%	Trips	%	Trips	%
To work	66.4	28.1	113.4	28.5	179.8	28.4
Business	33.4	14.2	40.9	10.3	74.3	11.7
Private	53.1	22.5	87.8	22.1	140.9	22.2
To home	83.2	35.2	155.2	39.1	238.4	37.7
Total	236.1	100.0	397.3	100.0	633.4	100.0

Source: O-D Survey, 1979

Approximately 42 percent of private car trips are work trips, 22 percent are private personal trips and the remaining 35 percent are return trips. The composition of trip purpose of motor-cycles is almost the same as that of private cars with less business trips.

2.3.4 Trip Generation and Attraction by Zone

Trip generation and attraction by zone in the Study Area is illustrated in Fig. 2.3.

The largest volume of trips generated and attracted are in zone 1 with 342,400 p.c.u., about 59 percent of the total in the Study Area and zone 5 with 77,100 p.c.u. (about 13 percent of the total).

Trip generation and attraction in the other areas is considerably smaller than that in zone 1.

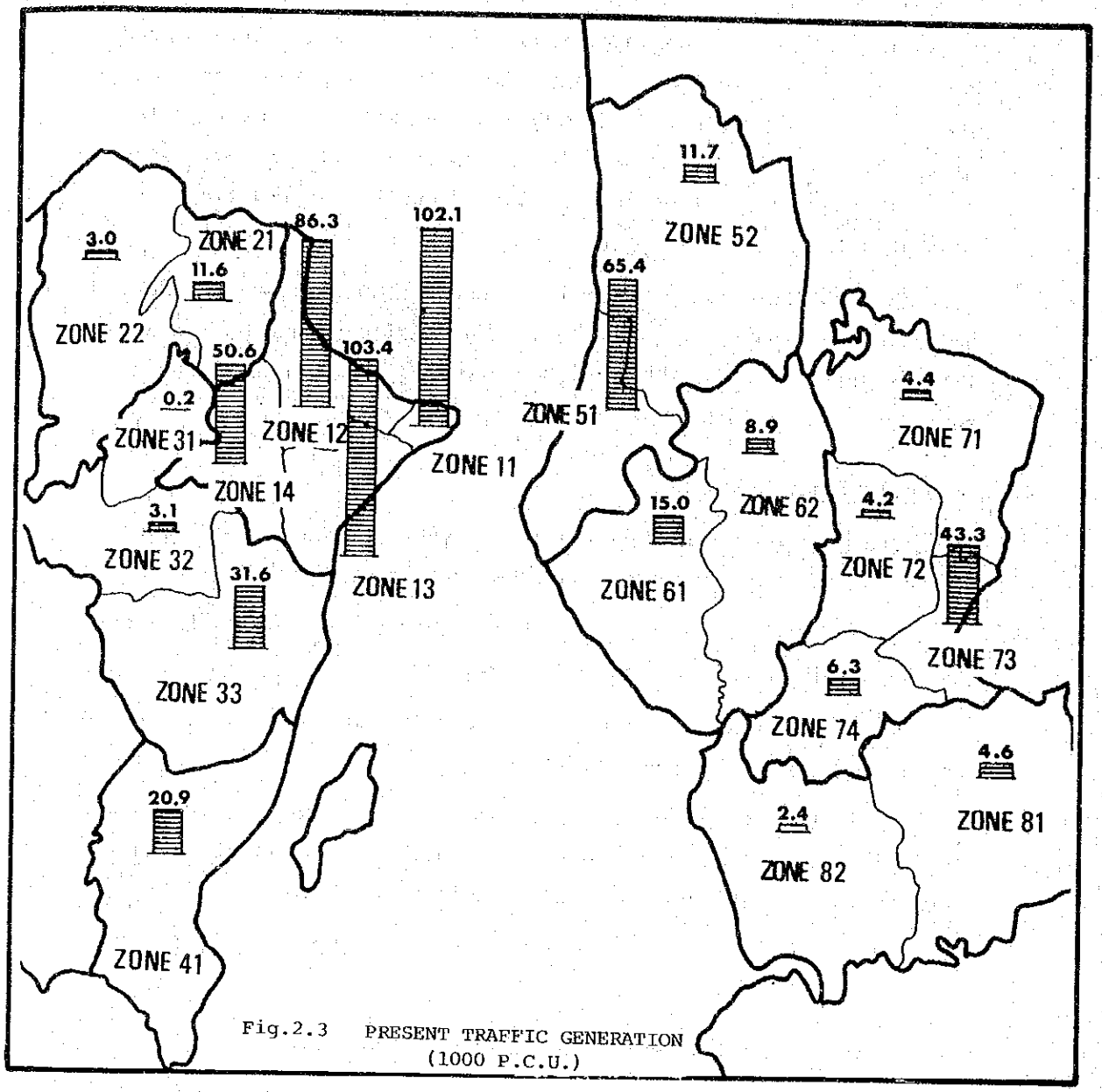


Fig.2.3 PRESENT TRAFFIC GENERATION
(1000 P.C.U.)

2.3.5 Traffic Flow in Major Roads

The traffic flow on major roads is estimated and illustrated in Fig. 2.4. In George Town, the traffic volume on the cordon line of the C.B.D. is approximately 86,000 per day excluding motor-cycle. That on the city-limit cordon line is about 75,000 per day. Based on these figures, most of the inflow and outflow of traffic is concentrated in the C.B.D.

The traffic flow in other towns such as Butterworth and Bukit Mertajam is comparatively smaller. The traffic volume on the cordon line of Butterworth is about 57,000 per day, while that in Bukit Mertajam is only 25,000 per day.

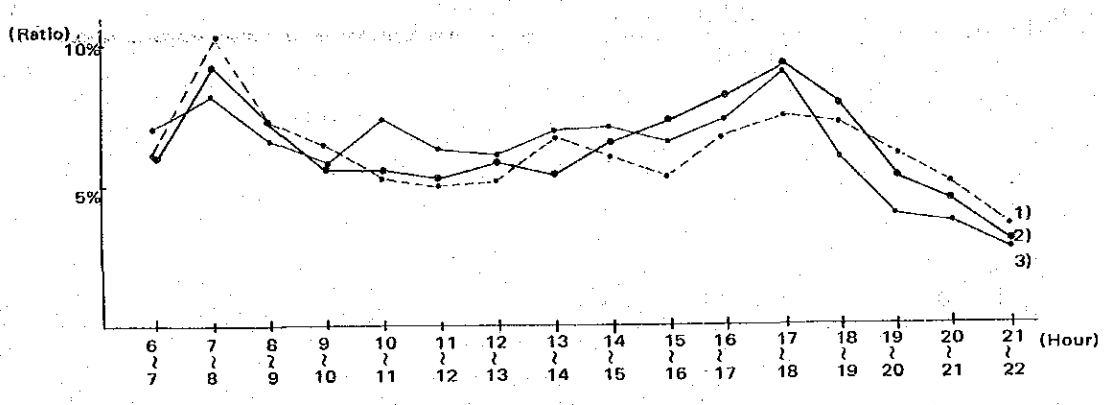
2.3.6 Hourly Fluctuation

The pattern of hourly flow of all vehicle types is slightly different between the C.B.D. and the suburbs.

On the roads in the C.B.D. there are three (3) peaks in a day: in the morning, at noon and in the evening.

In the suburbs, the hourly flow pattern has only two (2) peaks: in the morning and in the evening.

The ratio of the peak-hour volume to the 16 hours (6.00am to 10.00pm) volume is at most 10 percent which means that the fluctuation is rather flat as shown in the following figure:



1) Screen Line Survey (Tanjung Tokong)
2) Cordon Line Survey (Bayan Lepas)
3) J.K.R. Traffic Census (Bayan Lepas)

Fig. 2.4 Typical Hourly Fluctuation of Traffic Volume

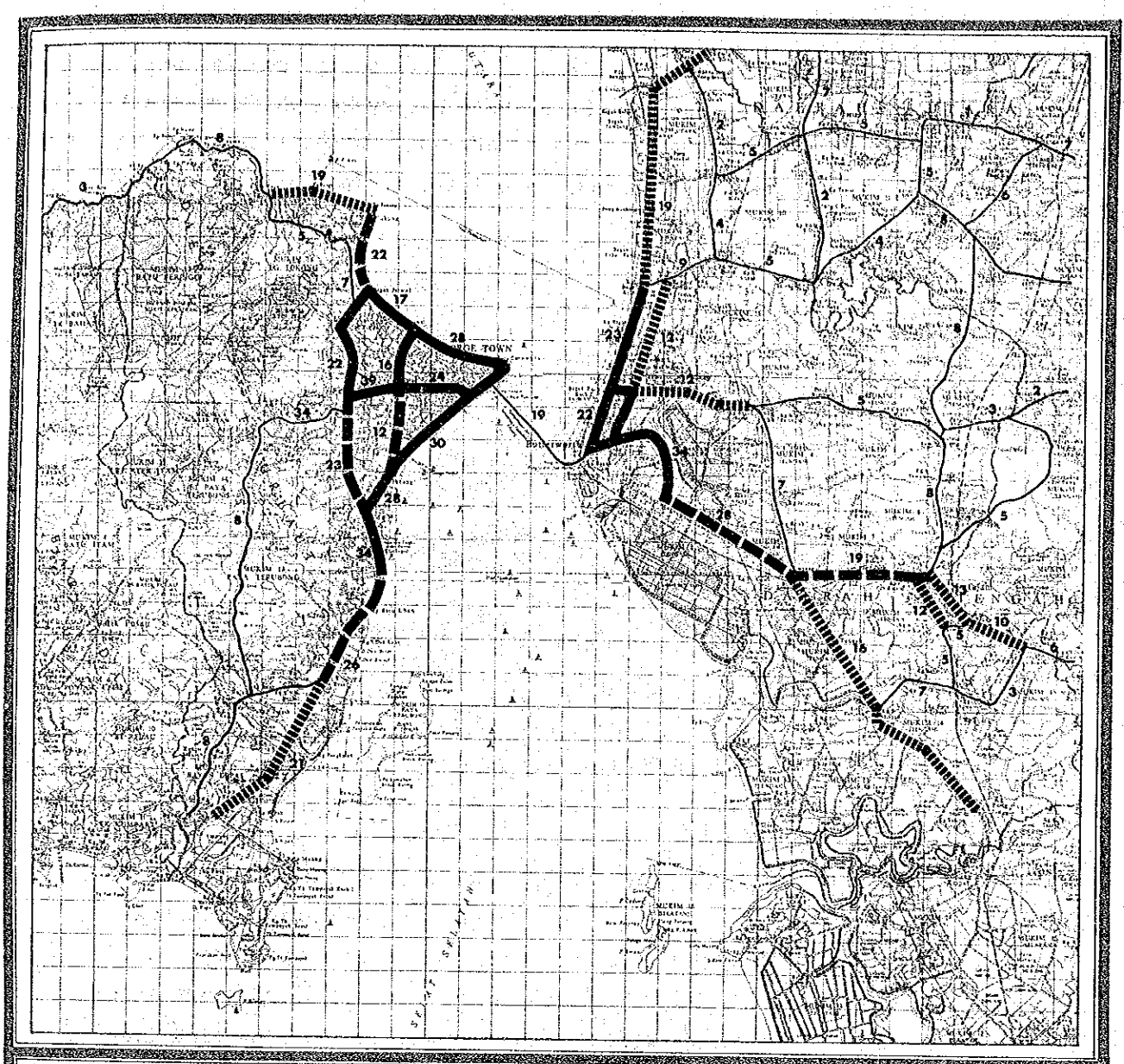


Fig.2.5 TRAFFIC VOLUME ON MAJOR ROADS (1979)

NORTH

Degree of Congestion

- Above 2.0
- 1.5 - 1.9
- 1.0 - 1.4
- Below 1.0

No. Traffic Volume (1000 P.C.U.)

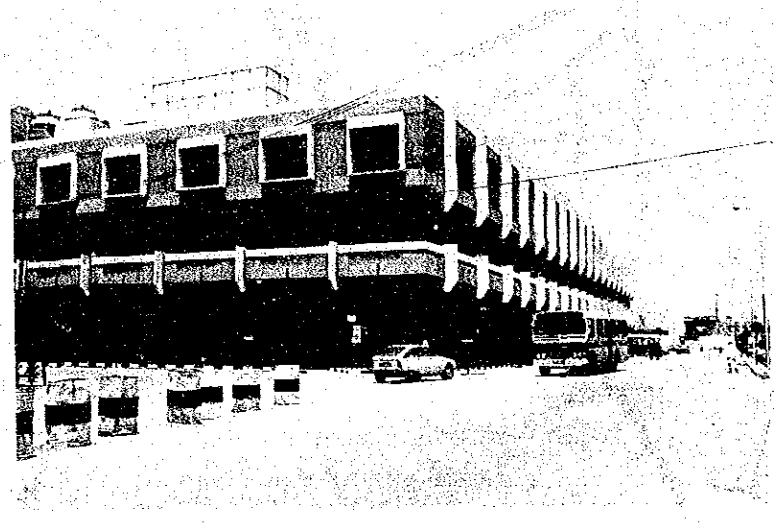
PENANG URBAN TRANSPORT STUDY

URBAN TRANSPORT STUDY IN GREATER METROPOLITAN AREAS OF GEORGETOWN, BUTTERWORTH AND BUKIT MERTAJAM

Page.

2.4 Bus Transport

At present, there are two (2) kinds of bus transport: one is the scheduled-bus system, the other is the private bus system which consists of factory buses and school buses. These modes of transport satisfy a large part of public transport demand. A brief description is presented below.

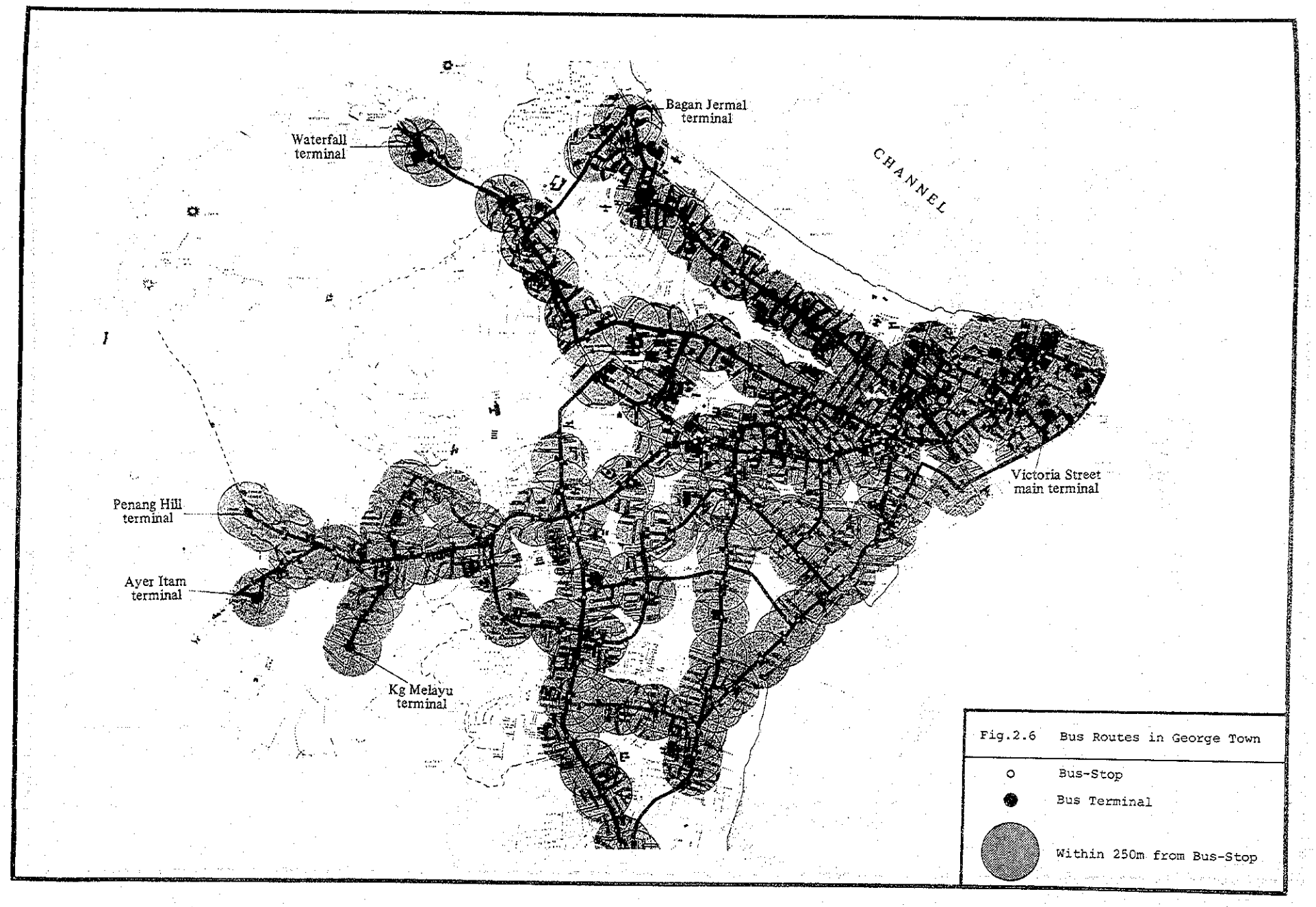


Bus Transport Terminal at Butterworth

2.4.1 Scheduled-Bus System

There are at present about 410 buses authorized to operate in the State of Penang. Most of these buses are large types ranging from those with a seating capacity of 30 passengers, to large single-deck buses with a seating capacity of about 55 passengers. Approximately 258,000 daily passengers travel to their destinations by these buses. In 1979, approximately 20 percent of passenger trips was by bus.

Scheduled buses are operated by either private transport companies or the Penang Municipality Council. The route coverage of all bus operations in the urban area is shown in Figs. 2.6 and 2.7. Fare levels are the same for all bus operators and are set by the Road Transport Licensing Board in the Ministry of Public Enterprise.


Bagan Jermal terminal
Waterfall terminal
CHANNEL
Victoria Street main terminal
Penang Hill terminal
Ayer Itam terminal
Kg Melayu terminal
Fig.2.6 Bus Routes in George Town
Bus-Stop
Bus Terminal
Within 250m from Bus-Stop

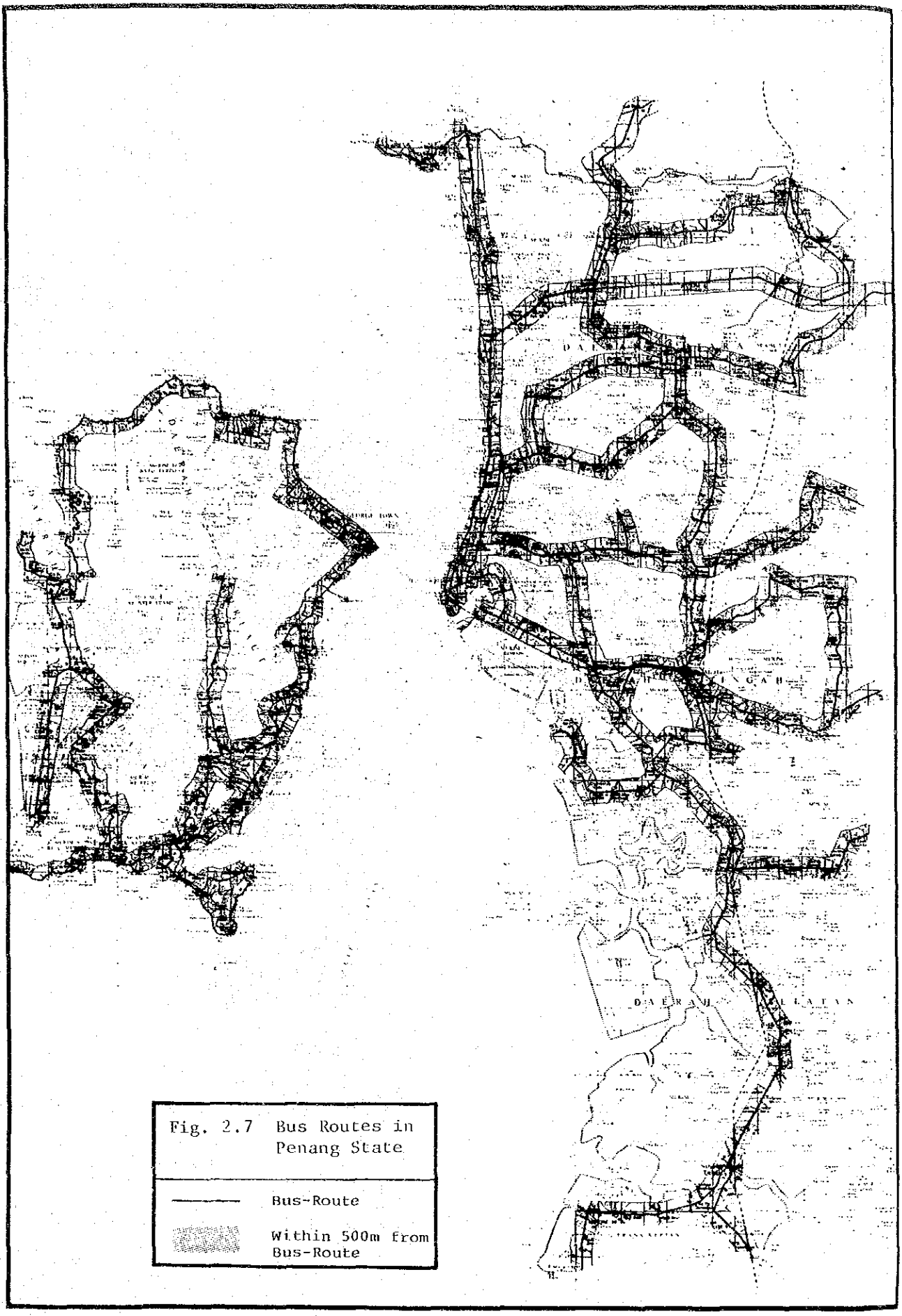


Fig. 2.7 Bus Routes in Penang State

2.4.2 Factory and School Buses

The private bus system which is popular in the State of Penang is sub-divided into two (2) types: one is the Factory Bus (bas kilang) and the other is the School Bus (bas sekolah).

The factory bus provides services for factory workers commuting to and from work. The school bus provides services to school children going to and returning from school.

Approximately 32,000 workers and about 22,000 school children travel daily to the factory and to school by these modes of transport.

Most of the factory buses and school buses are managed by private enterprises. 320 factory buses and 190 school buses are registered in the State of Penang. Most factory bus fares are paid by the factories. However, school bus fares are paid individually on a monthly or yearly basis.

2.5 Taxi

There are at present some 470 taxis registered in the State of Penang, of which three quarters are in Penang Island and the remainder in Province Wellesley.

In 1979, the number of taxi trips in the internal area was 2,700 trips per day. The composition of taxi trips to total trips excluding motorcycle trips is approximately 1 percent in the internal area and about 6 percent in the external area.

At the moment, most taxis mainly provide services for long-distance trips, unlike in Kuala Lumpur or other major metropolitan areas in South-East Asia. The fare rates of taxis are set at 60 cents for the first mile and 20 cents for each subsequent half mile as regulated by the Ministry of Communications. However, most taxis do not use their meters and thus fares vary depending on negotiations with the passengers.

2.6 Trishaw

In 1978, there were about 2,500 registered trishaws in the State of Penang, of which approximately 1,500 were in Penang Island and about 1,000 in Province Wellesley.

On this basis, the total number of trishaw trip movements is estimated to be approximately 5.82 trips per day and the number of passengers carried, about 14,500 persons. Most trishaws provide services for short distances (within 3 kilometers).

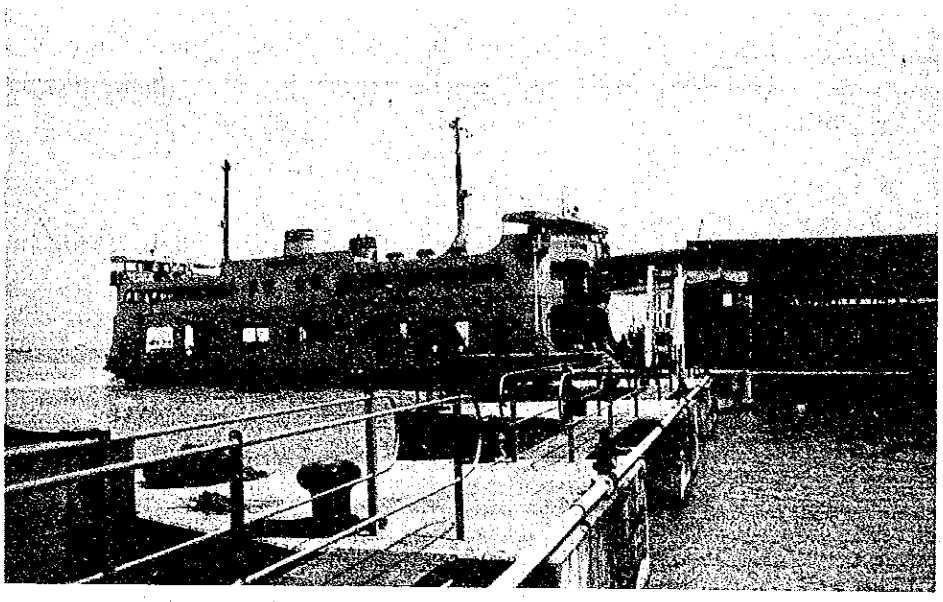
Trishaw

The fare-rates of trishaws are settled by negotiating with the passengers.

2.7 Ferry System

The ferry service between Penang Island and Province Wellesley is over 30 years old, and is the only means of public transport for passengers and vehicles across the straits. The ferry service is under the administration of the Penang Port Commission (PPC), which also has supervisory functions for the Port of Penang.

At present, there are three (3) berths for the ferry, two (2) of them are for single-deckers which carry both passengers and vehicles and the other one (1) for the double-deckers which carry only vehicles on both decks. The total number of vessels operated is eleven (11), of which eight (8) are old-type ferries called single-deckers and the remainder are new type ferries.



Ferry

These ferries operate 24 hours daily. During busy periods, ferries travel to and fro with, about a 5 to 7 minute interval.

In 1978, there were 26 million passengers, 1 million bicycles, 4 million motor-cycles, 3.2 million cars and 0.6 million trucks that made use of ferries.

2.8 Harbour

The port of Penang handles about 20 percent of cargoes handled in all the ports of Malaysia, making it the second largest port in Malaysia. The hinterland of the port includes the whole of North West Peninsular Malaysia and the southern region of Thailand. The channel is 1.75 miles wide at its throat. The port is located partially on the island and partially in Province Wellesley.

During the Third Malaysia Plan period, the Port Commission is to undertake several major development projects, including the sixth berth of the Container Terminal opened in 1978, the Bulk Cargo Terminal just completed in 1979, and the Vegetable Oil Pier scheduled to be constructed soon.

Furthermore, a new port at Butterworth is being studied and is planned to include a container terminal.

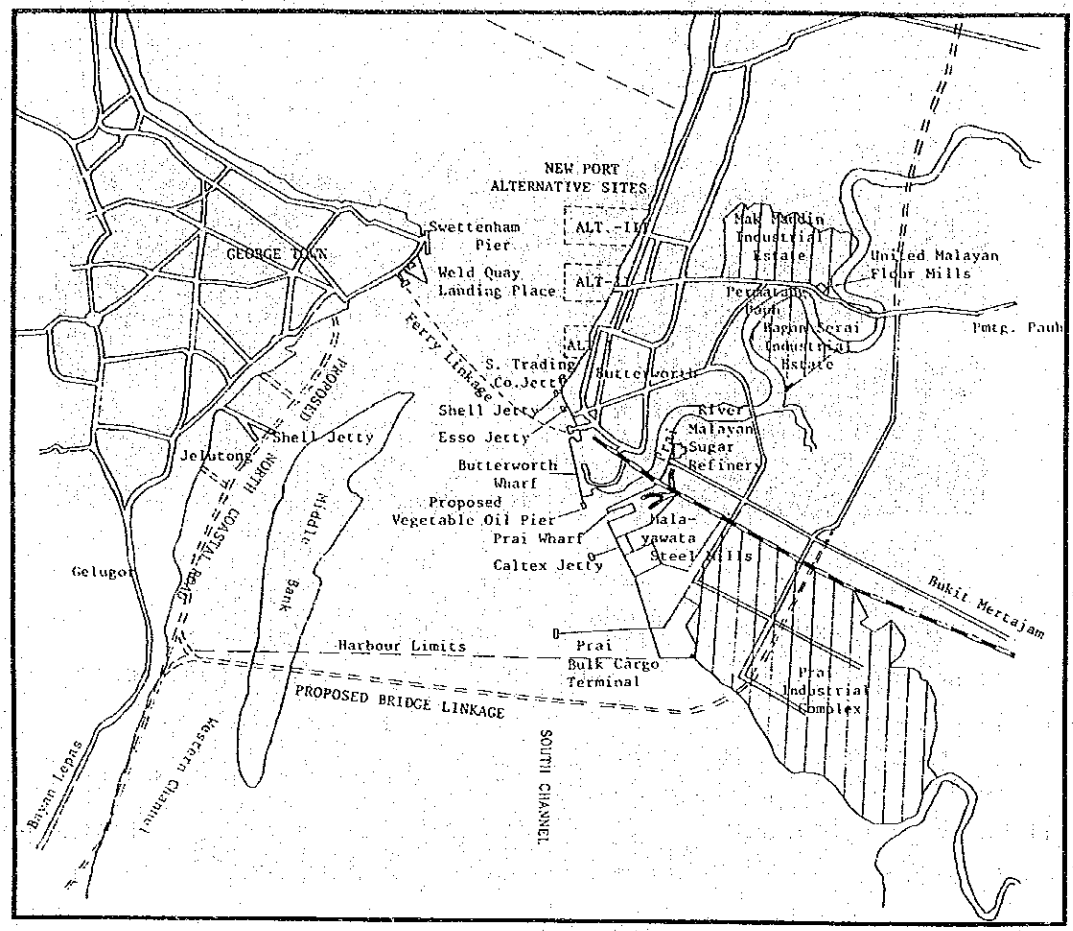


Fig. 2.8 Location of Ports

2.9 Airport

Penang International Airport is located at Bayan Lepas in the southern part of Penang Island, and is the second largest international airport in Malaysia.

This airport has a 3,354m x 45m runway with ILS, VOR/DME equipment and a modern terminal building which is the first in Malaysia to have passenger-loading bridges.

The airport is both a stop-over point on the inter-continental routes originating in Europe and servicing South East Asia as well as for domestic services. In 1978, 100 domestic flights and 80 international flights a week served for embarking and disembarking passengers.

The trend of passengers and cargo at Penang Airport has increased consistently throughout the past ten years.

2.10 Railway

Malayan Railways provide services for the entire Peninsular Malaysia and is one of the links in the land trunk transport system. The railway network consists of three (3) main routes:

1. Padang Besar - Alor Star - Bukit Mertajam - Ipoh - Kuala Lumpur
2. Kuala Lumpur - Seremban - Johor Bahru
3. Pasir Mas - Gemas

The total length of the routes is about 1,640 km.

In the State of Penang, there are nine (9) stations: Butterworth, Prai, Bukit Tengah, Bukit Mertajam, Simpang Ampat, Nibong Tebal, Penanti, Tasek Glugor and Pinang Tunggal. At present, the following trains are in daily operation: 10 trips between Padang Besar and Butterworth and 12 trips between Butterworth and Kuala Lumpur, including freight train.

Regarding the annual number of passengers boarding and alighting at each station in Penang, information is available only for Butterworth and Bukit Mertajam: 1,194,000 and 81,000 passengers in 1978, respectively.

2.11 Tourism

Penang, one of the famous holiday resort areas in the East Pacific Area, is endowed with beautiful beaches and scenery. In 1978, approximately 160,000 tourists visited Penang. The number of tourists in Peninsular Malaysia in 1977 was about 2 million, with Penang contributing a share of 7.4 percent. During the period 1970 to 1978, a high growth rate of over 19.0 percent per annum of tourists was recorded in Penang.

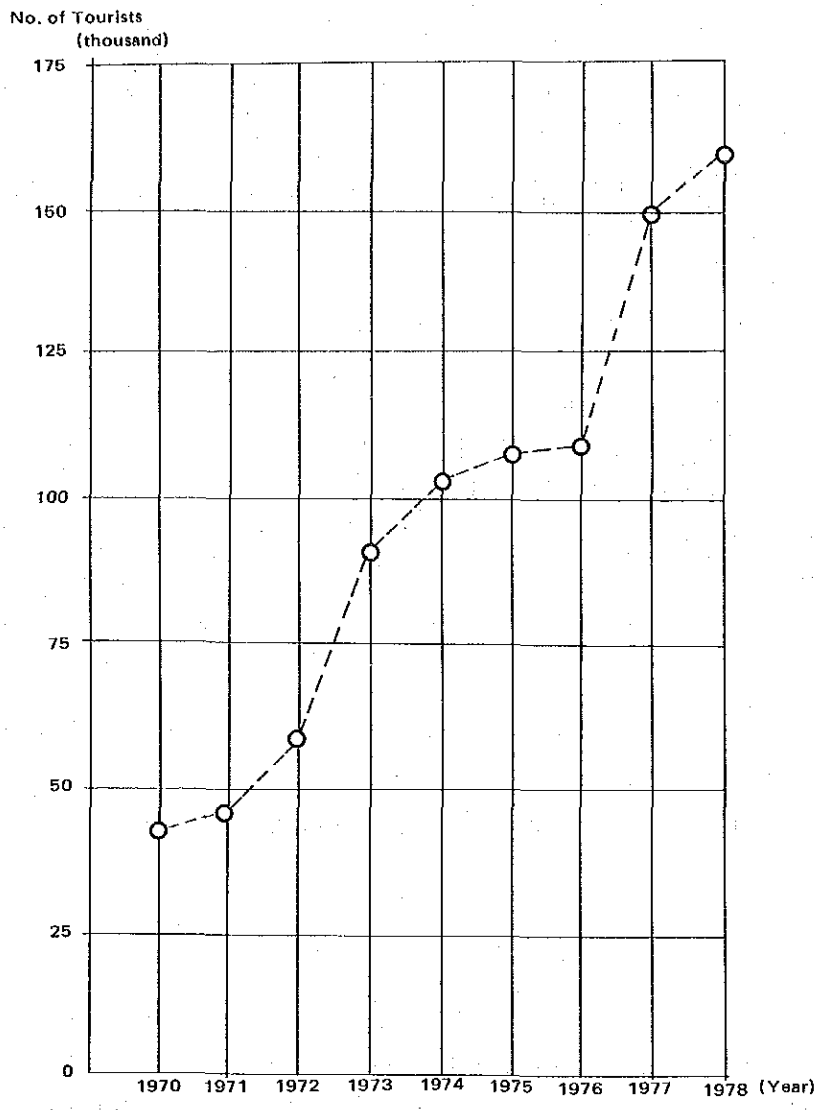


Fig. 2.9 Number of Tourist Arrivals in Penang Island

Chapter 3 LAND USE AND POPULATION PLANS

3. LAND USE AND POPULATION PLANS

3.1 Regional and National Context

The Third Malaysia Plan (TMP)* provides a broad context for Government action at the national level.

The objectives stated are:

1. To reduce the incidence of poverty in the rural areas throughout the country, among paddy cultivators, rubber smallholders, coconut smallholders, shifting cultivators, fishermen, estate workers, residents of New Villages, agricultural labourers and the Orang Asli by:

   (i) expanding employment opportunities through new land development, establishment of new growth centres and the absorption of excess labour by other sectors of the economy;

   (ii) enhancing the productive role of the rural poor by increasing their access to land, water supplies, credit, markets extension advice and other public facilities including electric power;

2. To reduce the incidence of poverty among the urban poor by:

   (i) expanding employment opportunities in manufacturing and construction including the promotion of small-scale industries;

   (ii) improving their real income through the provison of low-cost housing and other public services;

3. To enhance the quality of life of all Malaysians, and in particular the poor, through the expansion of education, health services, family planning facilities and housing;

4. To increase the share of the Malays and other indigenous people in employment, in mining, manufacturing and construction and the share of other Malaysians in agriculture and services so

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* Third Malaysia Plan, 1976 - 1980

that by 1990 employment in the various sectors of the economy will reflect the racial composition of the country;

5. To raise the share of the Malays and other indigenous people in the ownership of productive wealth including land, fixed assets and equity capital. The target is that by 1990, they will own at least 30 percent of all equity capital, with 40 percent being owned by other Malaysians;

6. To foster the development of entrepreneurship among the Malays and other indigenous people so as to effectively contribute towards the creation by 1990 of a strong and viable commercial and industrial community among them;

7. To encourage and support private investment both domestic and foreign;

8. To promote further utilization of the country's abundant human and natural resources; and

9. To develop and expand the social and physical infrastructure of the economy to effectively support the attainment of the above objectives.

The fMP also provides the regional development policies and and the restructuring of the society.

The TMP also provides the regional development policies and strategies. These are mainly as follows:

(1) To reduce the current regional imbalance through industrial expansion.

(2) To continue the new land development policy.

(3) To spread urban development rather than perpetuate its polarization in particular regions.

(4) To promote integrated development of new growth centres with their hinterland.

The policies and program of the Penang Urban Transport Study need therefore to be directed at achieving these national and

regional objectives.

"Penang Metropolitan Area is the highest developed community center in the north-western part of Peninsular Malaysia".

Considering the above, the basic goals and objective of the development of Penang Metropolitan Area can be identified as follows:

* To utilize the existing infrastructure and investment as far as is practicable
* To attempt to minimize the possible diseconomies of new urban and industrial development and to increase the efficiency of the existing urban functions
* To establish a restructured society
* To promote integrated development of new growth centres in conjunction with rural development

3.2 Socio-Economic Framework

In accordance with the regional and national context, statistical projections for growth in population, Gross National and Regional Products, employment, family income and car ownership were made.

The resulting framework is as stated below:

3.2.1 Population

The planned population in the State of Penang is expected to increase from 946,000 in 1979 to 1,090,000 in 1985 and to 1,555,000 by the year 2000. The average growth rate during the 1970-2000 year period is 2.4 percent annually. Within the Study Area, it is expected to increase from 723,900 in 1979 to 836,900 in 1985 and to 1,200,000 by the year 2000.

3.2.2 G.D.P and G.R.P

Despite the serious oil crisis, the economic growth of Malaysia has increased significantly during the last 9 years. The average annual growth rate of the Gross Domestic Product (G.D.P.) was recorded at about 7 percent.

On the other hand, the economy of the State of Penang has also recorded high and rapid rates in the Gross Regional Product of 9.6 percent in the last 9 years.

On the basis of the past trends and economic perspective prepared by the Third Malaysia Plan, the growth rate of G.D.P and G.R.P in the State of Penang is predicted as shown in Table 3.2.

3.2.3 Employment

The labour force projection is made by taking into consideration the following factors:

* A higher composition of age in population
* An increase in the participation ratio
* A decrease in the unemployment rate

The employed population in the State of Penang is expected to increase from 294,000 in 1979 to 350,700 in 1985 and to 541,700 by the year 2000.

In the Study Area, the employed population will be expanded from 239,000 in 1979 to 296,000 in 1985 and to 488,000 by the year 2000.

Employment by the industrial sector is shown in Table 3.3.

3.2.4 Household Income

Average monthly household income in the State of Penang is expected to increase from M$516 in 1979 to M$642 in 1985 and to M$1,050 by the year 2000. The average growth rate of real income will thus be 3.5 percent in the 22 year period.

3.2.5 Vehicle Registration

On the basis of household income projection, the number of vehicles in the Study Area is expected to increase from 175,000 in 1979 to 218,000 in 1985 and to reach 390,000 by the year 2000.

The number of vehicles by type is shown in Table 3.4.

Table 3.1 Population Projection

	1970[1)]	1979[2)]	1985[2)]	2000[2)]
Study Area	593,827	723,860	836,940	1,207,000
Penang State	776,124	946,580	1,090,100	1,556,000

Notes : 1) National Census
2) Projected by the Team

Table 3.2 Projection of Gross Regional Product

(Million dollars at 1970 prices)

	1970	1975	1979[1)]	1985[2)]	2000[2)]
Penang State	795	1487	1957	3280	10,700
Malaysia	10,708	17,365	24,000	3810	115,100

Notes : 1) Projected by the Team
2) Used in medium estimation

Table 3.3 Projection of Employed Population

		1979[1)]	1985[2)]	2000[2)]
Study Area Total		237,290	296,510	489,260
	Primary	16,400	14,150	5,700
	Non-Primary	220,890	282,360	483,560
Penang State Total		294,000	350,700	541,700
	Primary	53,690	46,330	21,670
	Non-Primary	240,310	304,370	520,030

Notes : 1) Estimated by the Team
2) Projected by the Team

Table 3.4 Vehicle Registration

(In thousand vehicles)

	1970[1)]	1979[1)]	1985[2)]	2000[2)]
Study Area	70	175	219	391
Cars	31	70	95	236
Motor-cycle	39	105	124	155
Penang State	82	203	261	471
Cars	35	78	110	279
Motor-cycle	47	125	151	192

Notes : 1) RIMV

2) Projected by the Team

3.3 Relating Development Plans

Major area development projects to be implemented by the Penang Development Corporation (P.D.C.), such as promoting industrial developments and housing developments are listed below.

Penang Island	* Bayan Lepas Jerjak Isl.	500 ha	(Industry)
	* Bayan Baru	1300 ha	(New Town)
Prov. Wellesley	* Bandar Sebran Jaya	560 ha	(Housing
	* Mak Mandin	114 ha	(Industry)
	* Prai Industrial Estate and others	847 ha	(Industry)

Those development plans are used as the basis for land use planning described in the following section.

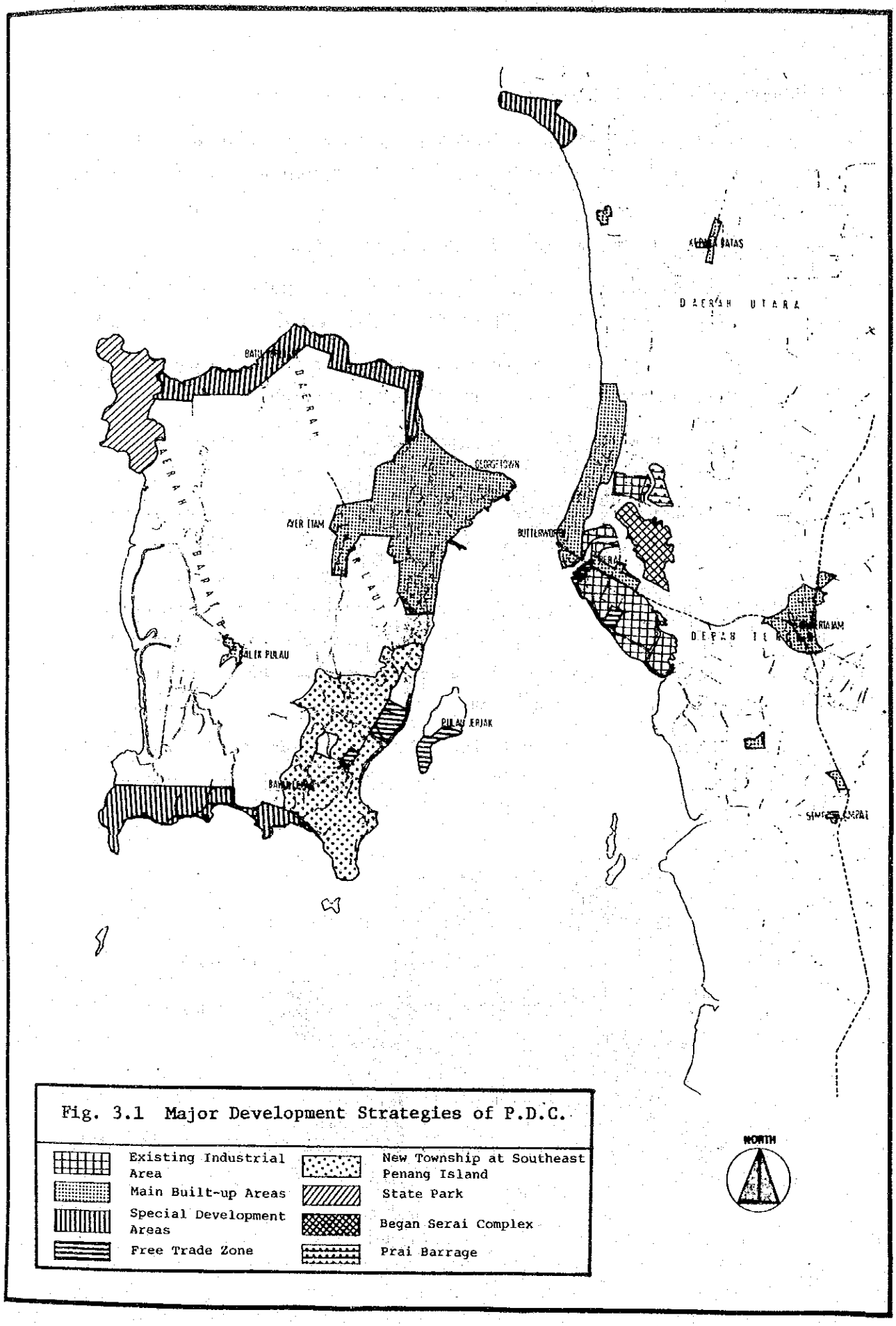


Fig. 3.1 Major Development Strategies of P.D.C.

- Existing Industrial Area
- Main Built-up Areas
- Special Development Areas
- Free Trade Zone
- New Township at Southeast Penang Island
- State Park
- Began Serai Complex
- Prai Barrage

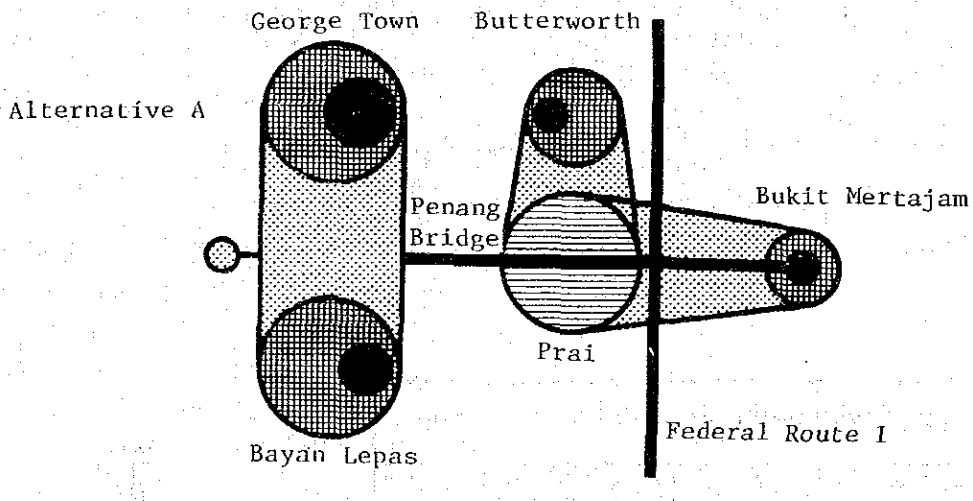
3.3 Conceptual Development Pattern

In line with the basic goals and objectives for development, the team prepared three (3) alternatives of conceptual development patterns for the year 2000.

Alternative A: Penang Is. low, Butterworth high

1. Structually, for Penang Island, there are two (2) major urban cores. One is George Town and the other Bayan Lepas.
2. The area between the two cores will be urbanized, thus making the coast of Penang Island a single urban corridor.
3. As far as major land use is concerned, the industrial area, in the future will not be expanded in Penang Island.
4. In Butterworth, to the north, west and south of the existing urbanized area, there are many areas of land suitable for development. The location of industrial areas, the new port and the highway pattern should be such that they are functionally interlinked so that the fullest advantage can be obtained from them. There should also be no negative side effects for any residential areas nearby.

The improved Federal Route I should be as far away from existing urban areas as possible so that land for future expansion of the build-up areas will be reserved.



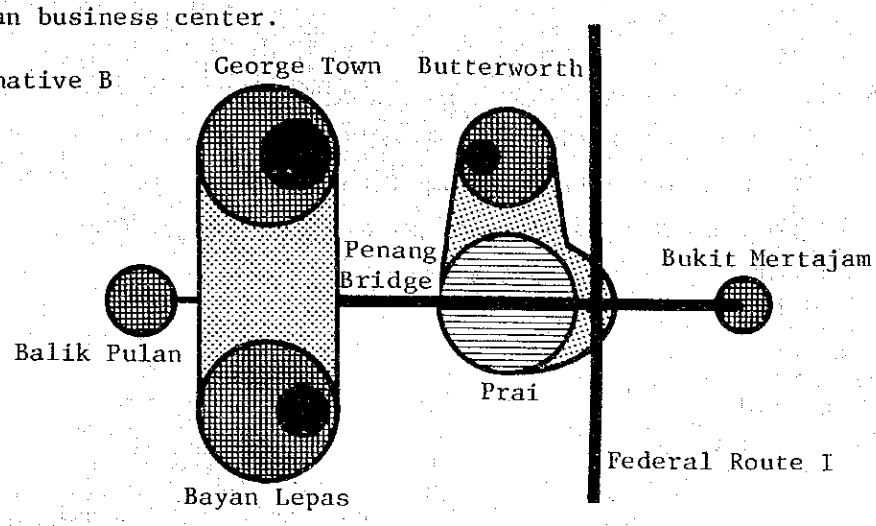
Alternative B: Penang Is. high, Butterworth low

1. Penang Island will be composed of two (2) major cores and one (1) secondary-core. The development of Balik Pulau in the external area is expected to be the secondary-core.

2. Urbanization in Butterworth will proceed at a slower rate and Bukit Mertajam will also develop on a small scale into a more or less self-contained district center.

As an alternative to Plan A, Penang Island will develop comparatively more as a residential area while Butterworth will serve as an business center.

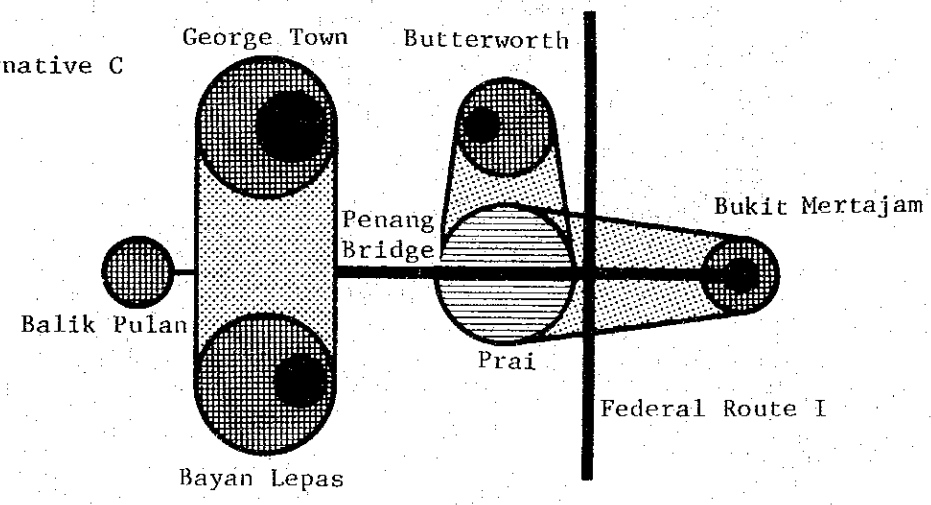
Alternative B



Alternative C: Both Penang Is. and Butterworth high

Alternative C is a combined plan between Alternative A and B. For Penang Island, development pattern B is adopted and for Butterworth, development pattern A is employed. The areas along the Federal Route I from Prai to Simpang Ampat will also be urbanized.

Alternative C



Alternative C is considered the most likely choice for the study area for the following reasons:

1. This plan is basically aimed at self-contained development for both Penang Island and Province Wellesley.

2. This plan follows the current development trends and current government policies.

3. For Province Wellesley, it is desirable to expand the existing urban area to Bukit Mertajam.

   For Penang Island, Balik Pulau will be the new development core for future development.

4. It seeks to maximize the advantages which Province Wellesley has over Penang Island for industrial development in terms of suitable land, availability of labour force, reduction in transport costs and the already planned improvements to the transport system, including a new container port.

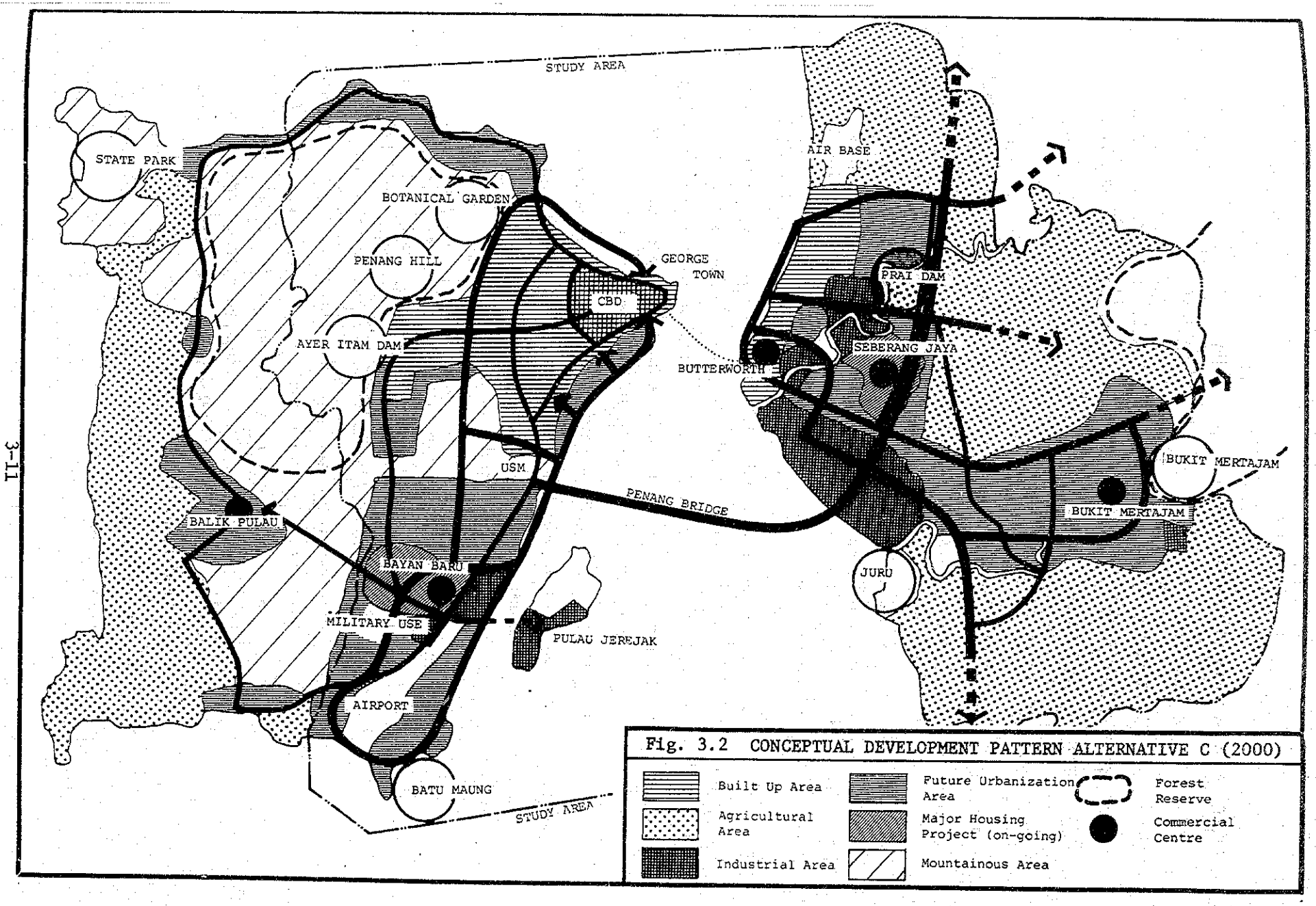


Fig. 3.2 CONCEPTUAL DEVELOPMENT PATTERN ALTERNATIVE C (2000)

3.4 Land Use and Population Distribution

3.4.1 Land Use Plan

Based on the conceptual land use plan of Alternative C as well as on the interim zoning plan, land use up to the year 2000 is planned in detail as described below.

(1) Development Policies

(a) Residential areas

Within the study area, future increases in population will produce the need for about 4,800 hectares of residential area. It should be possible to supply one half of this on Penang Island and the other half in Province Wellesley.

Considering the recent development pressure on Penang Island and the potential for residential development, the Beyan Lepas area is expected to continue to develop. In addition, it should also be possible to give Penang a high density residential area within the city of George Town if an adequate urban renewal program is undertaken.

In Province Wellesley, there are many suitable areas for residential development to expand towards Bukit Mertajam along the existing Federal Route 1.

(b) Commercial areas

The following allocation plan is projected.

1. The Central Business District (CBD) of George Town is defined as the Regional Center not only for the State of Penang, but also for the northern part of Peninsular Malaysia. The importance of this regional center is expected to grow in proportion to its development. The expansion of the CBD will be towards the north of the reclamation site where the Dispersal Road will be constructed.

2. The Bayan Baru area will comprise the second urban core in Penang Island.

3. The tourist industry will develop rapidly in the seaside area in the north of Penang.

4. The CBD of Butterworth, defined as a sub-regional center, is expected to have increased development in the commercial and industrial sectors. There will also be a subsequent expansion of the marine port in proportion to the increasing population and industrial activities.

5. The commercial area of Bukit Mertajam will comprise the second urban core in Province Wellesley.

(c) Industrial areas

The industrial area in Penang Island should not be expanded to more than what is planned at present. The major development site for industry should be located in Province Wellesley for the following reasons:

1. There is an abundance of suitable land for industrial development.

2. Transport facilities such as the container port, the Federal Route I, the supporting road of the East-West Highway and other roads, will be expanded.

3. It will contribute to the creation of job opportunities and to an increase in income levels which at present are lower than in Penang Island.

(2) Future land use

Based on the policies mentioned earlier and on an estimation of future space demand, future land use was planned and is summarized in the following table.

Table 3.5 Projected Land Use

(hectare)

	Penang Island		Province Wellesley		Total		Change
	1979	2000	1979	2000	1979	2000	1979 to 2000
Residential	2,700	5,100	3,100	5,100	5,800	10,200	+4,400
Commercial	210	600	160	420	370	1,020	+ 650
Industrial	360	320	1,020	1,930	1,380	2,250	+ 870
Institutional	730	1,140	-	700	730	1,840	+1,110
Open Space	390	740	1,620	1,280	2,010	2,020	+ 10
Others	10,300	7,300	16,200	13,100	26,500	20,400	-6,100
Total	14,690	15,200	22,100	22,530	36,790	37,730	+ 940*

* Supplied from reclamation of land.

3.4.2 Population Distribution Plan

Projected future population in the State of Penang is distributed to each traffic zone by the method of multiplying future residential areas by population density.

Size of residential areas by zones was obtained from the land use plan. Therefore only population density has to be determined.

According to the guidelines of the interim zoning plan, five (5) types of population density were planned:

1. Low 40 persons/ha.
2. Low - Medium -1 60 persons/ha.
   -2 80 persons/ha.
   -3 100 persons/ha.
   -4 120 persons/ha.
3. Medium 150 persons/ha.
4. High - Medium 200 persons/ha.
5. High 300 persons/ha.

These population densities were adopted for use at residential areas of each traffic zone according to the present population density, type of development and accessibility to the central areas of George Town, Butterworth and Bukit Mertajam. (See Fig. 3.3)

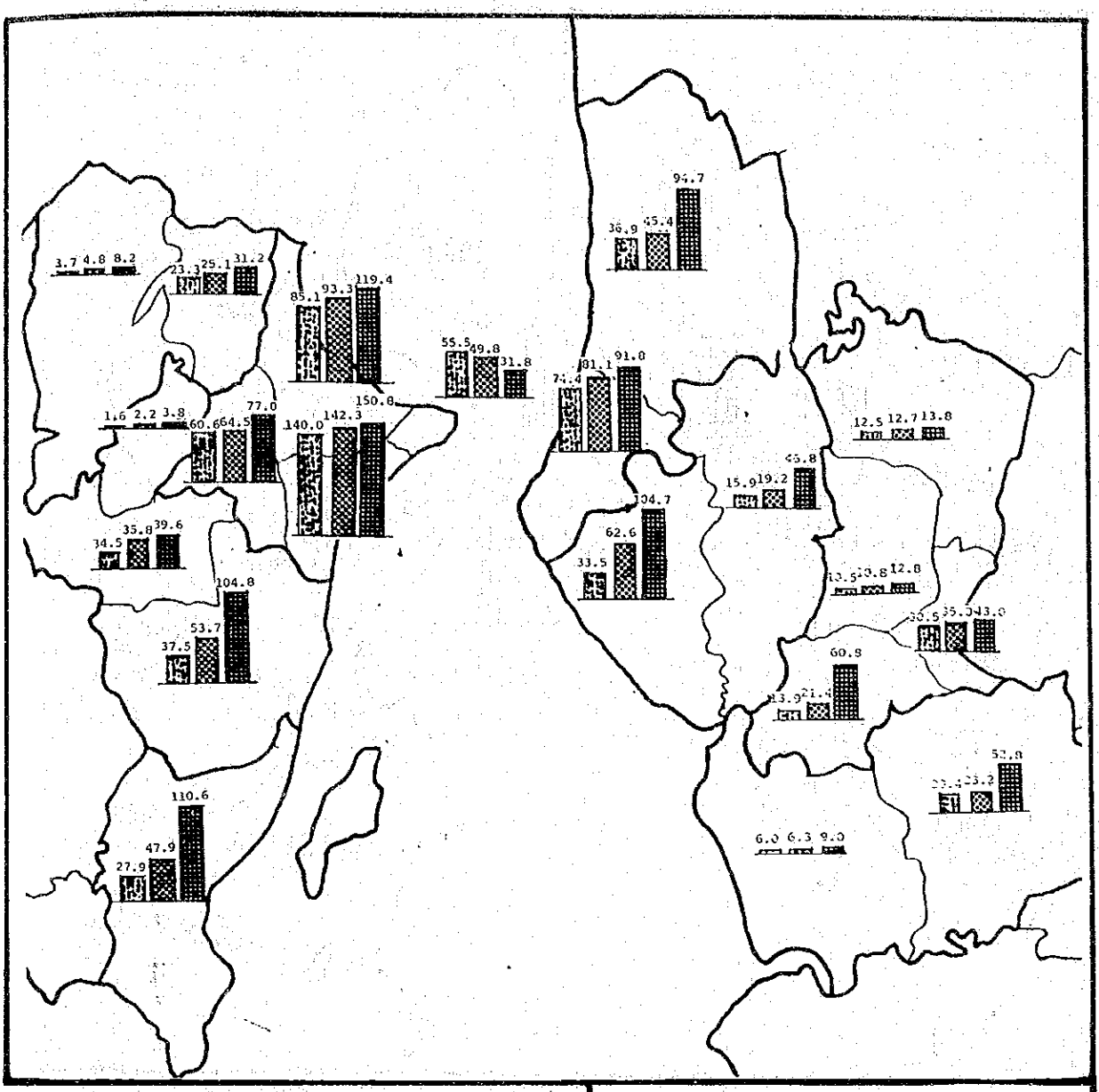


Fig.3.3: POPULATION DISTRIBUTION PLAN
(In thousand)

The distribution plan of employed population by work place was made on the basis of projected employment in the State of Penang. The results are shown in Fig. 3.4.

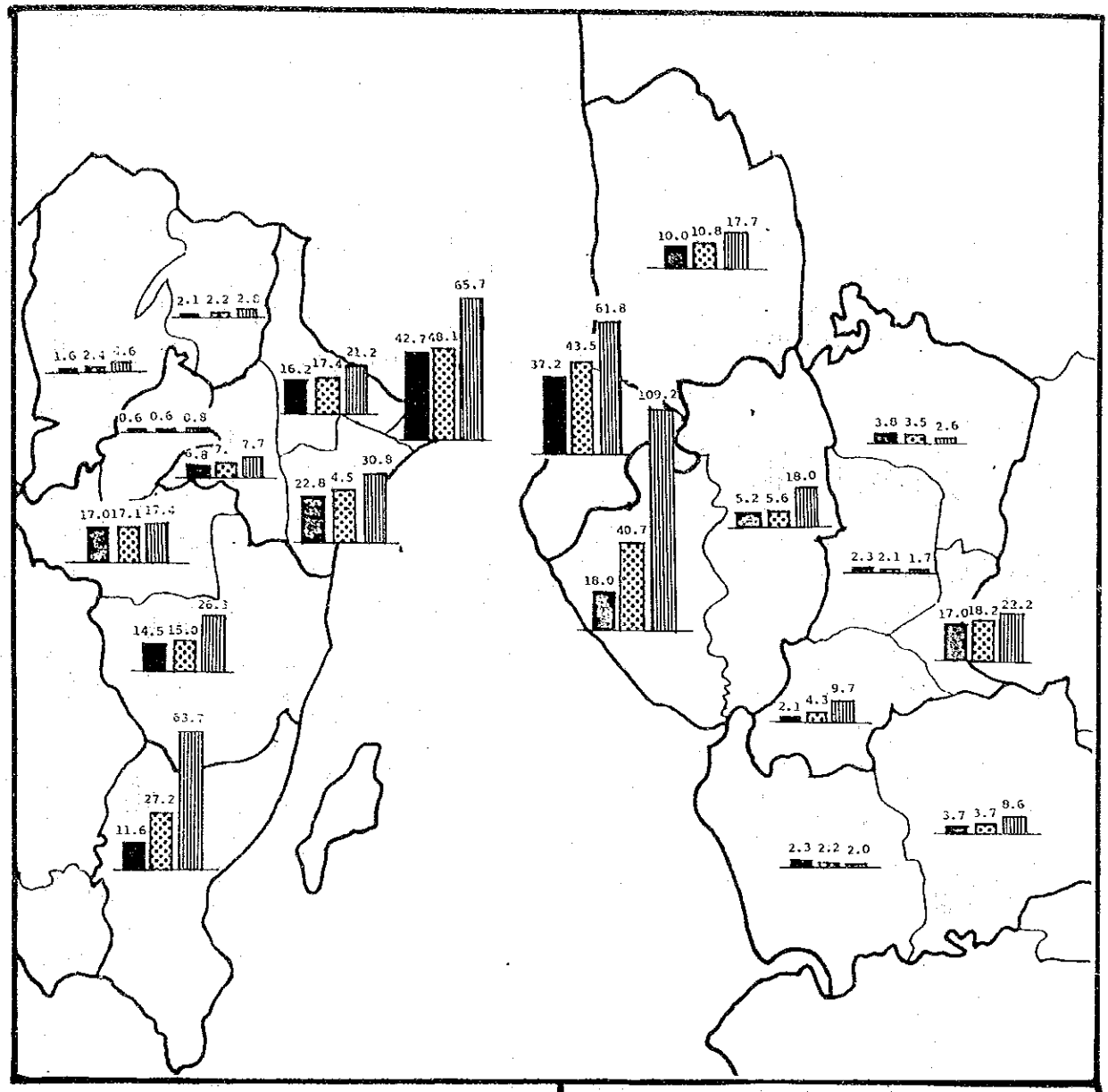
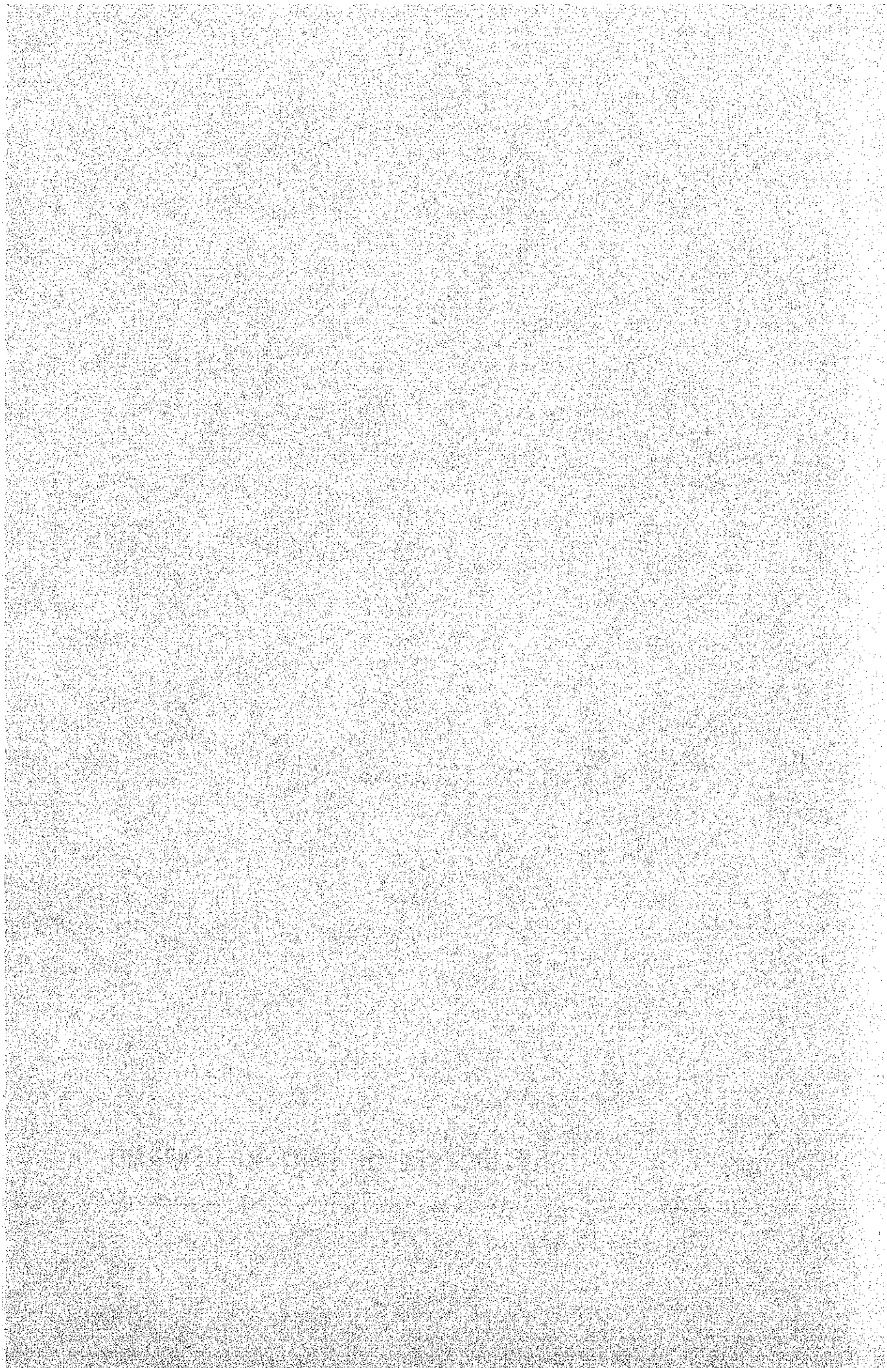


Fig.3.4: EMPLOYED POPULATION DISTRIBUTION PLAN (In thousand)

Chapter 4 PROJECTION OF TRAFFIC DEMAND



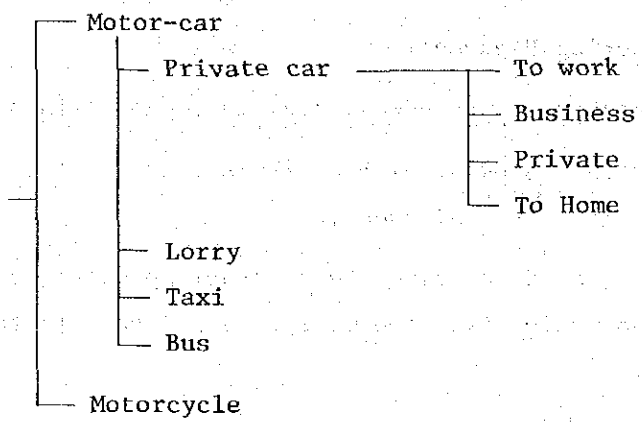
4. PROJECTION OF TRAFFIC DEMAND

4.1 Procedure

The general procedure adopted for traffic projection is illustrated in Fig. 4.1.

Data used in the projection of traffic demand for the Study Area was obtained from the vehicle-owner interview survey and other related surveys conducted in 1979 under this study.

The projection is made primarily by vehicle type and trip purpose, since these are the principal factors used in the projection process: namely,



The projection procedure is described below. (see Fig. 4.1)

Firstly, traffic models are constructed on the basis of socio-economic and land use data, these models are listed as follows:

- Trip production model
- Trip generation and attraction model
- Trip distribution model
- Parking demand model
- Traffic assignment model

In these models, an attempt is made to formulate the relationship between traffic demand and land use.

Using these models, as well as the future socio-economic and land

use data as input data, trip production of vehicles in the Study Area is made by multiplying the product of trips per vehicle, times the number of vehicles projected. Trip generation and attraction are estimated on the basis of the population distribution pattern related to each vehicle type and trip purpose.

Basically, the gravity model is applied in estimating trip distribution. In the gravity model, travel time between zones is taken to be the resistance factor.

In the initial step, the vehicular O-D volume is assigned to base network. The base network consists of the existing network and committed development projects which are shown below.

* Federal Route 1
  (Alor Star - Changkat Jering Highway)
* Penang Bridge which connects Province Wellesley to Penang Island.
* The supporting road of the East-West Highway (this road is basically sanctioned although, it is not aligned yet).

Finally, programs are formulated to solve the transport problems on the basis of the available information from the traffic assignment to the base network.

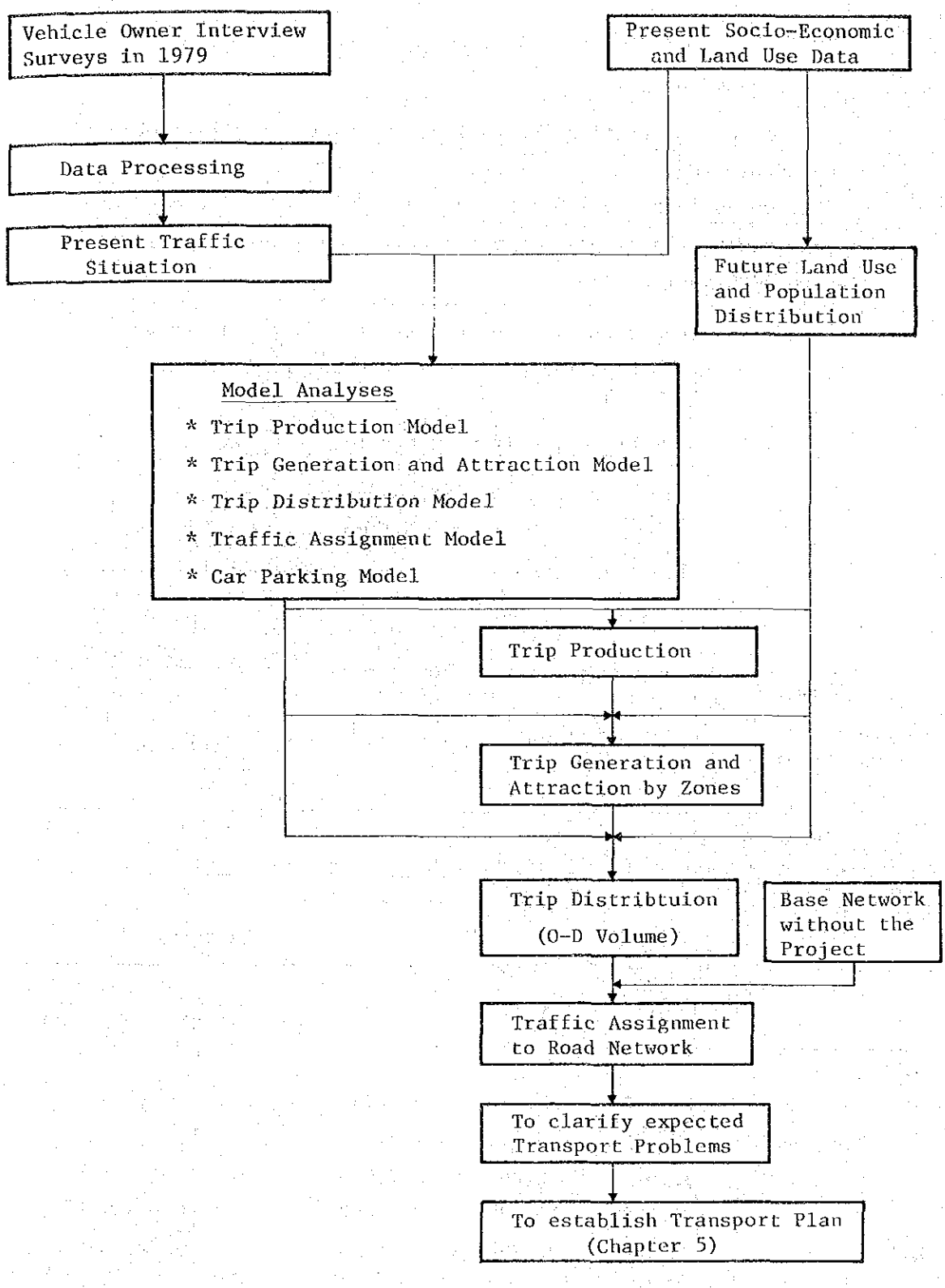


Fig. 4.1 General Procedure for Traffic Projection

4.2 Results of Traffic Projection

4.2.1 Trip Production

Based on the traffic projection, the average daily number of trips of passenger car unit (PCU) in the Study Area is projected to be 776,600 in 1985 and 1,538,100 by the year 2000. The average annual growth rate of passenger car unit is 4.7 percent during the 1985 to 2000 year period.

In this projection, it can be noted that external trips are expected to have a higher growth rate than internal trips.

Table 4.1 Projected Trip Production in P.C.U.

Study Area, 1979, 1985 and 2000

(In thousand PCU)

	1979	1985	2000	Annual Growth Rate (%)	
				1979-1985	1985-2000
Internal Trips	551.2	692.2	1287.5	3.9	4.2
External and Through Trips	58.6	84.4	250.6	6.2	7.5
Total	609.8	776.6	1538.1	4.1	4.7

Table 4.2 Projected Trip Production by Trip Purposes and Types

Study Area, 1979, 1985 and 2000

(In trips)

	1979	1985	2000	Annual Growth Rate %	
				1979-1985	1985-2000
Motor-Car					
To work	68,490	91,280	223,880	5.0	6.1
Business	35,750	47,410	103,660	4.8	5.4
Private	55,910	75,380	178,630	5.1	5.9
To home	86,690	115,620	249,040	4.9	5.2
Lorry	33,140	50,290	123,400	7.1	6.1
Taxi	3,700	7,800	29,100	13.2	9.1
Bus*	19,210	25,050	52,200	4.5	4.7
Motor-cycle	409,170	451,200	463,400	1.6	0.2

* Excluding Scheduled Buses.

4.2.2 Trip Generation and Attraction

Fig. 4.2 shows the projected daily trip generation by zones.

Under-developed areas such as Bayan Lepas and the Prai Industrial Estate will become one of the major generators of trips, and generally speaking, decentralization of zonal trip generation will therefore occur.

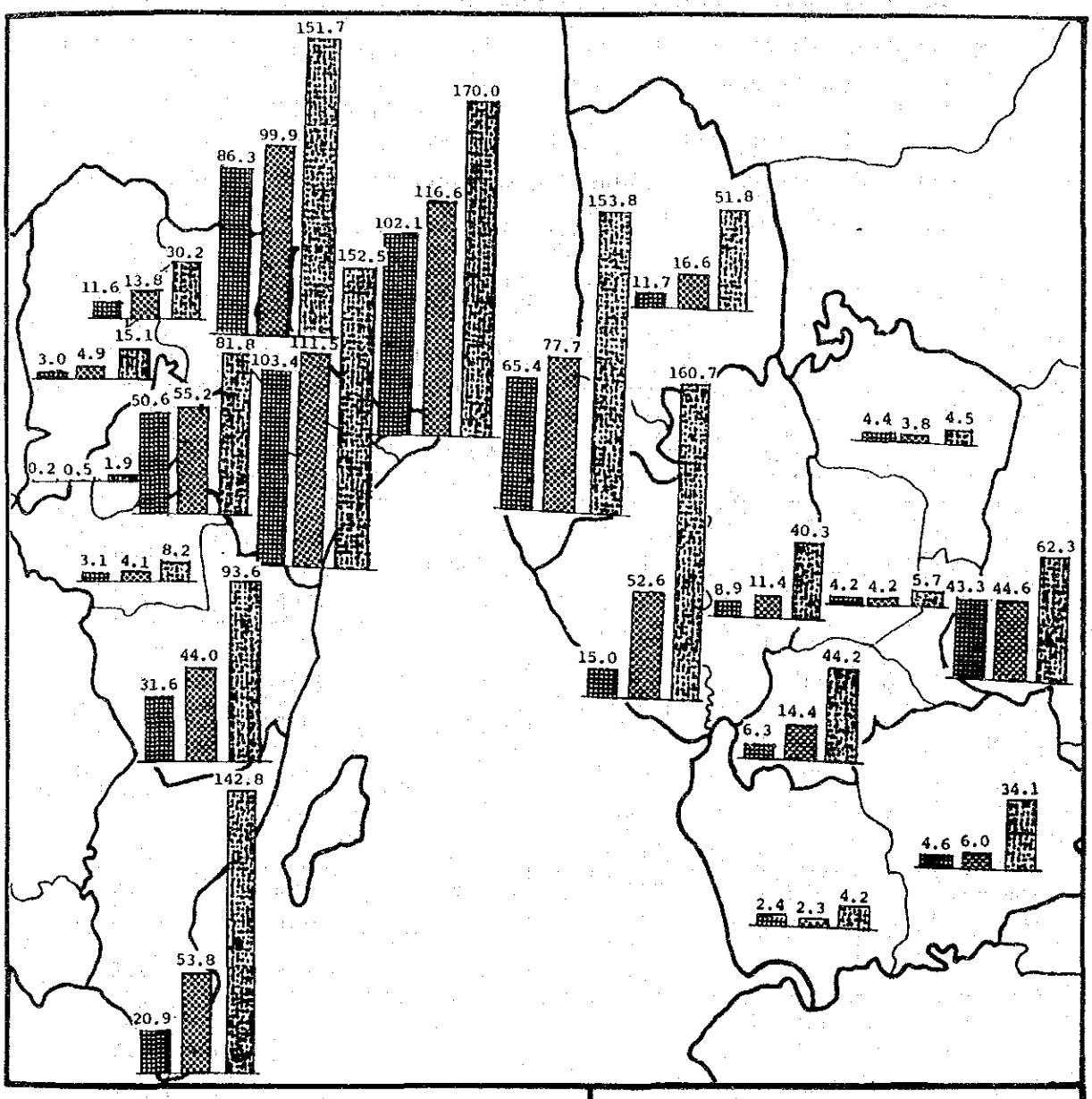


Fig. 4.2 Projected Trip Generation by Zones

4.2.3 Future Trip Distribution

O-D tables for the future are estimated by using the future trip generation, trip attraction and time distance between each zone pair together with the gravity model which is derived from the present traffic data.

The desired lines show that the movement of vehicles is increasing due to the reduction in time distance. This is brought about by the improvement of the road network, especially by the construction of the Penang Bridge.

Regarding internal trips, Province Wellesley shows more rapid growth rate than Penang Island due to a higher rate of population and employment growth.

Table 4.3 Vehicle O-D Table

(Unit: 1,000 p.c.u. per day)

O \ D		Internal Area		External Area		Total
		Penang Island	Province Wellesley	Penang Island	Province Wellesley	
Internal Area	P.I	399.9	6.2	3.8	3.1	413.0
		480.6	10.5	8.1	4.5	503.7
		786.2	23.7	26.3	11.5	847.7
	P.W	6.1	138.9	0.2	20.9	166.1
		10.2	190.9	0.4	28.0	229.5
		23.3	454.3	1.9	82.0	561.5
External Area	P.I	3.8	0.2	0.0	0.1	5.9
		8.1	0.5	0.0	0.3	8.9
		26.3	2.0	0.1	1.3	29.7
	P.W	3.2	20.8	0.1	1.8	25.9
		4.8	27.7	0.1	1.9	34.4
		11.7	81.5	1.3	4.7	99.2
						609.8
						776.6
						1538.1

upper in year 1979
middle in year 1985
lower in year 2000

4.2.4 Traffic Volume on Traffic Lines

Figs. 4.3 and 4.4 show the daily traffic volume on traffic lines in 1985 and in the year 2000 respectively. When conparing the traffic volume on traffic lines in 1985 and the year 2000, with 1979, the following conclusions can be made.

(1) Traffic volume on C.B.D cordon line of George Town

The daily traffic volume on the C.B.D cordon line is as follows:

	Daily Traffic Volume	Percent Increase
1979	147.9 thousand PCU	-
1985	172.2 thousand PCU	116
2000	293.9 thousand PCU	171

If the present service level on the road is maintained, it will be necessary to increase the traffic capacity 1.7 times the present capacity by the year 2000.

(2) Traffic volume on the boundary of George Town

The daily traffic volume on the cordon line of the boundary of George Town is as follows:

	Daily Traffic Volume	Percent Increase
1979	62.9 thousand PCU	-
1985	105.7 thousand PCU	168
2000	239.1 thousand PCU	226

An increase in traffic volume between George Town and Bayan Lepas is expected because of the Bayan Baru Development Project presently under construction.

(3) Traffic Volume on Prai River

The daily traffic volume on Prai River is projected as follows:

	Daily Traffic Volume	Percent Increase
1979	27.0 thousand PCU	-
1985	64.2 thousand PCU	237
2000	187.4 thousand PCU	291

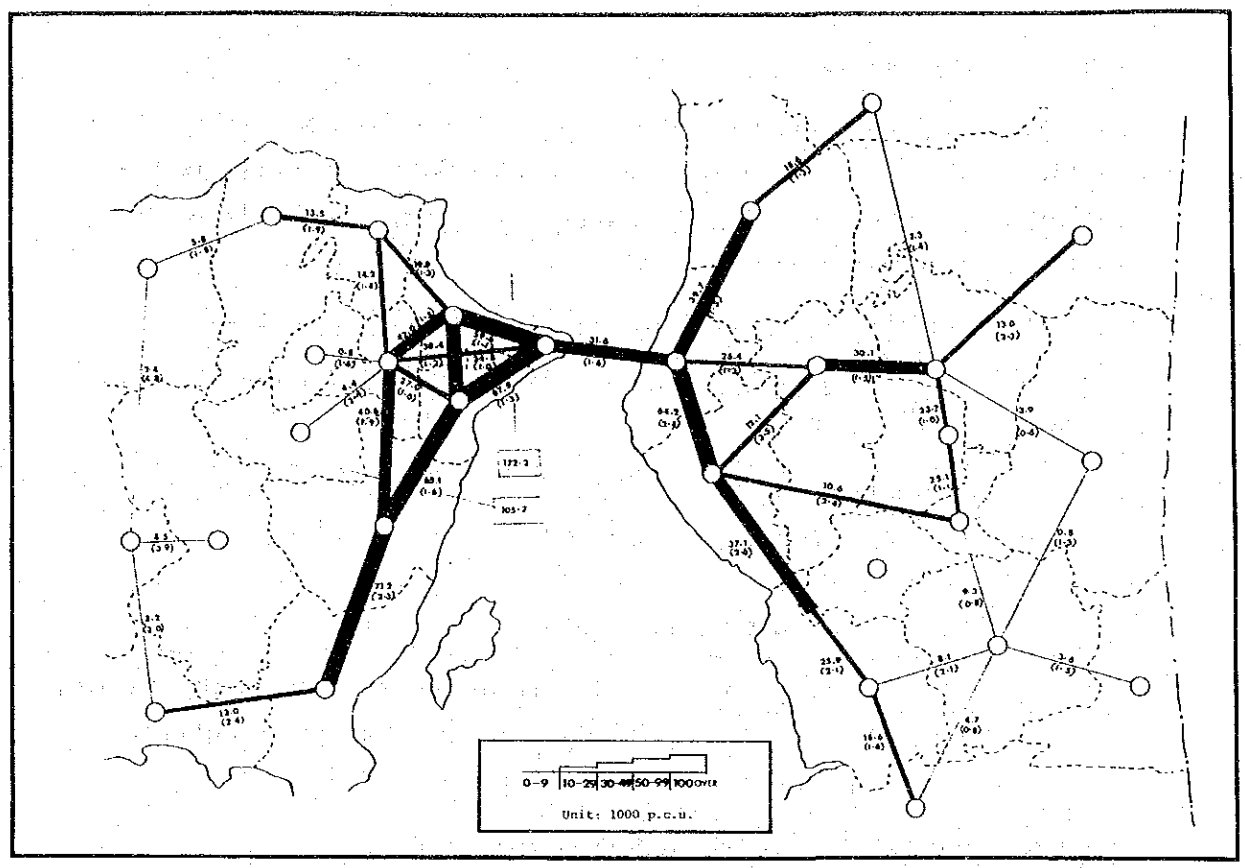


Fig. 4.3 Daily Traffic Volume on Traffic Lines (1985)

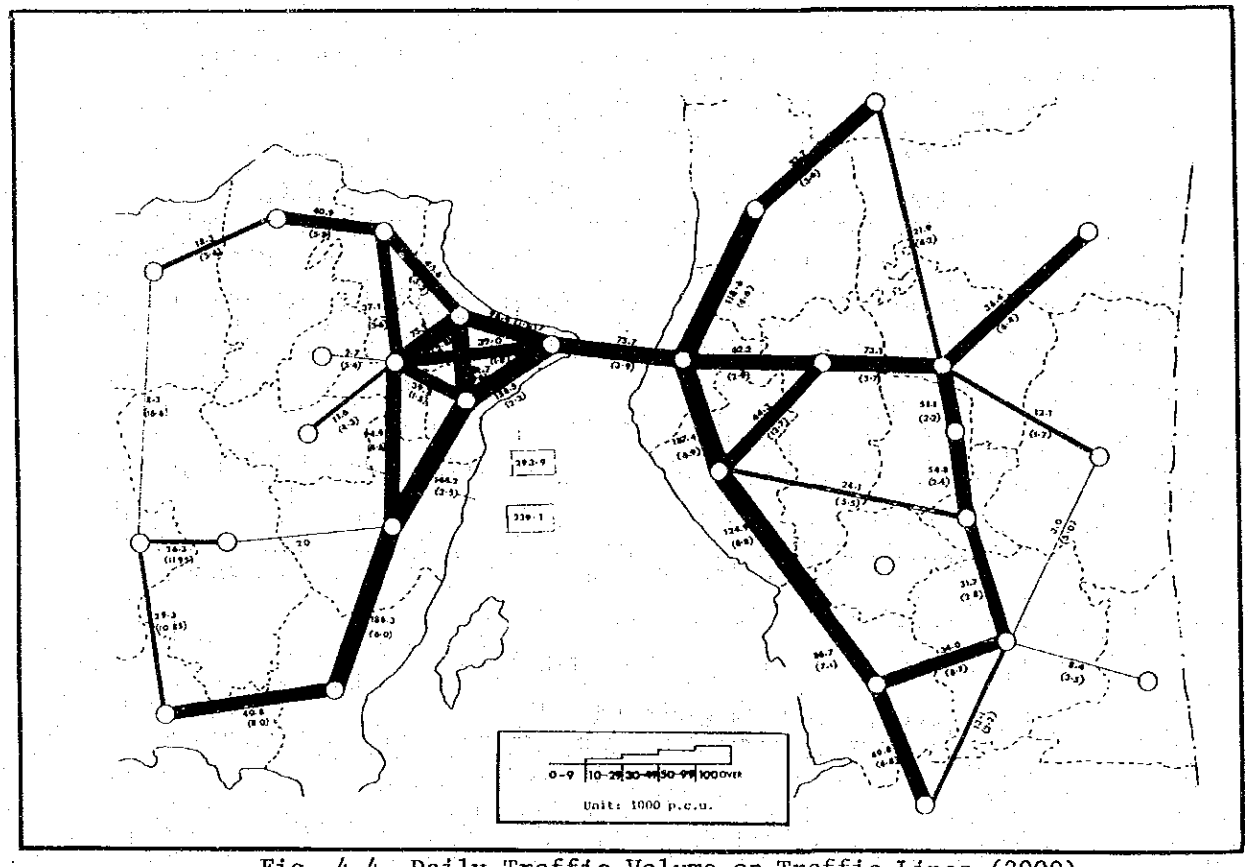


Fig. 4.4 Daily Traffic Volume on Traffic Lines (2000)

The largest increase in traffic volume can be expected on Prai River, due to the following factors:

a. The Prai Industrial Estate and the New Container Harbur will generate a large amount of traffic.

b. The growth rate of population in Province Wellesley is relatively higher.

4.3 Foreseeable Transport Problems

1. By the year 2000, 1,200,000 people are expected to live in the Penang Metropolitan Area.

   The regional economic projections predict an increase of the G.R.P with an average growth rate of 8.1 percent.

   With the increase in family income level, car ownership will increase and many motor-cycle owners will change to car use. Therefore, a serious problem in terms of road and parking capacity can be expected.

2. The total traffic demand in the year 2000 will increase 2.5 times over that in 1979.

   In order to maintain the existing level of transport services in the year 2000, it will be necessary to provide 2.5 times more transport capacity. To achieve this, a substantial amount of investment will be needed.

3. When the Penang Bridge is opened, a large number of vehicles will travel between Penang Island and Province Wellesley. Unless adequate provisions are made, the approach roads to the Penang Bridge will suffer congestion.