

GOVERNMENT OF MALAYSIA

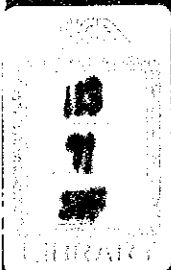
THE FEASIBILITY STUDY OF COMPUTERISED
AREA TRAFFIC CONTROL SYSTEM
IN PENANG, MALAYSIA

FINAL REPORT

SUMMARY
AND
RECOMMENDATIONS

JANUARY 1988

JAPAN INTERNATIONAL COOPERATION AGENCY



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国際協力事業団	
参入 月日 88. 3. 1	1/3
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PREFACE

It is with great pleasure that I present this Feasibility Study on Computerised Area Traffic Control System in Penang, to the Government of Malaysia.

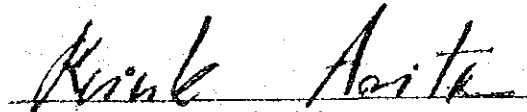
This report embodies the result of a feasibility study which was carried out in the Penang Island from July 1986 to January 1988 by a Japanese study team commissioned by the Japan International Cooperation Agency following the request of the Government of Malaysia to the Government of Japan.

The study team, headed by Mr. Kokuro Hanawa, and organized by Fukuyama Consultants International Co., Ltd. and Central Consultant Co., Ltd. had a series of close discussions with the officials concerned of the Government of Malaysia, conducted a wide range of field survey, and prepared the report.

I hope that this report will be useful as a basic reference for development of the region.

I wish to express my deep appreciation to the officials concerned of the Government of Malaysia for their close cooperation extended to the study team.

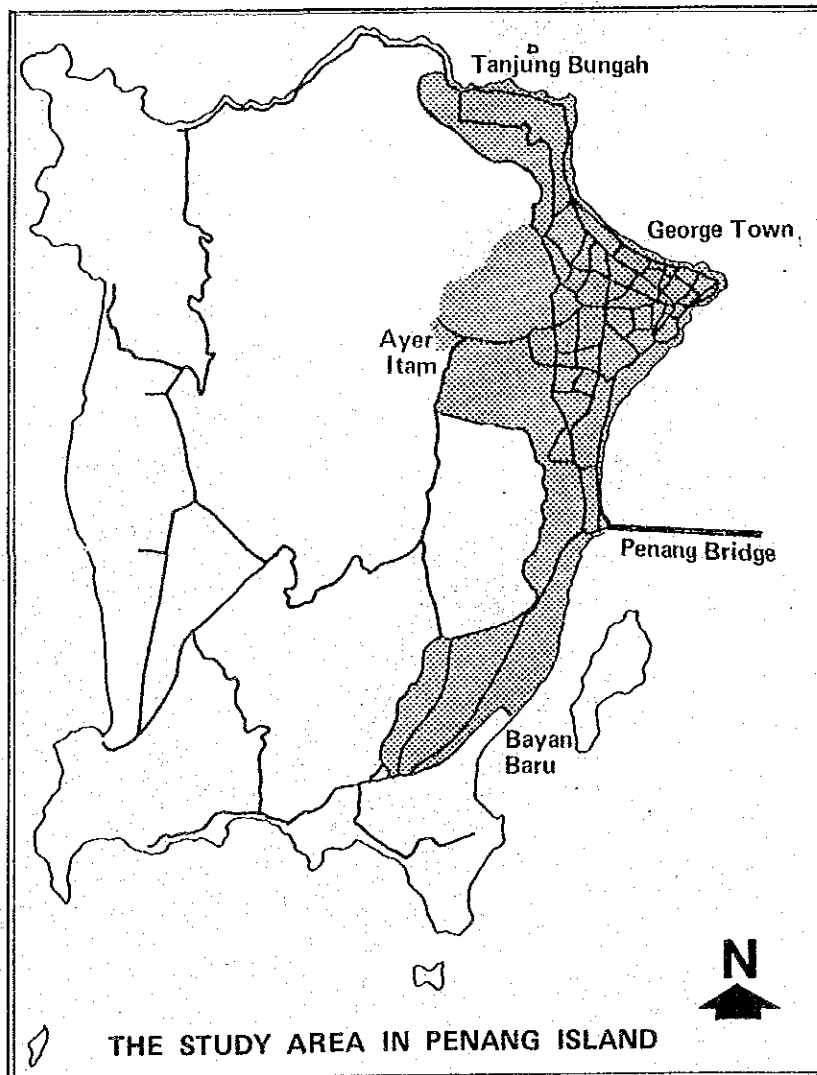
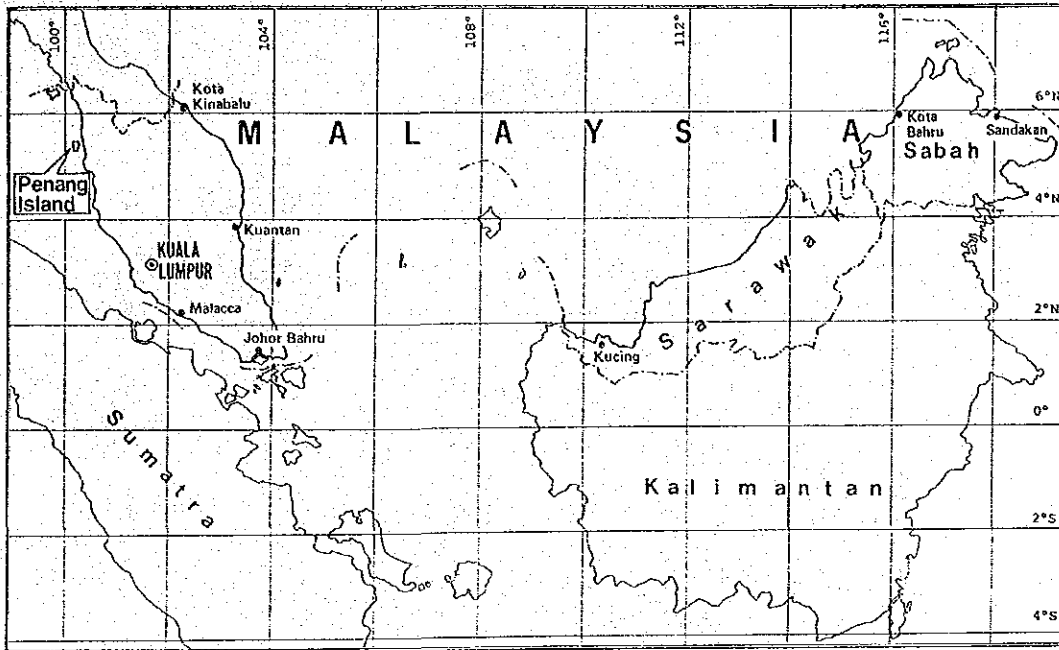
January, 1988

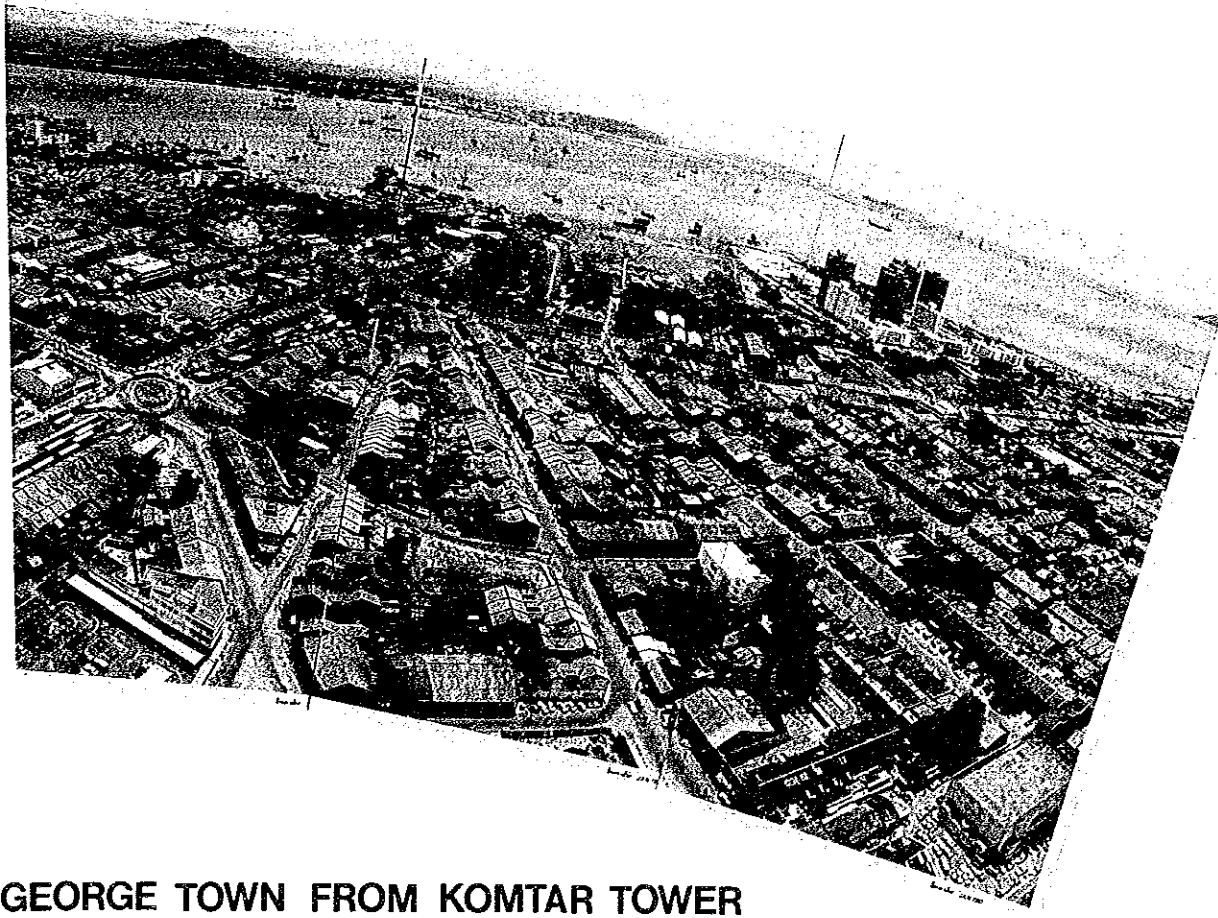
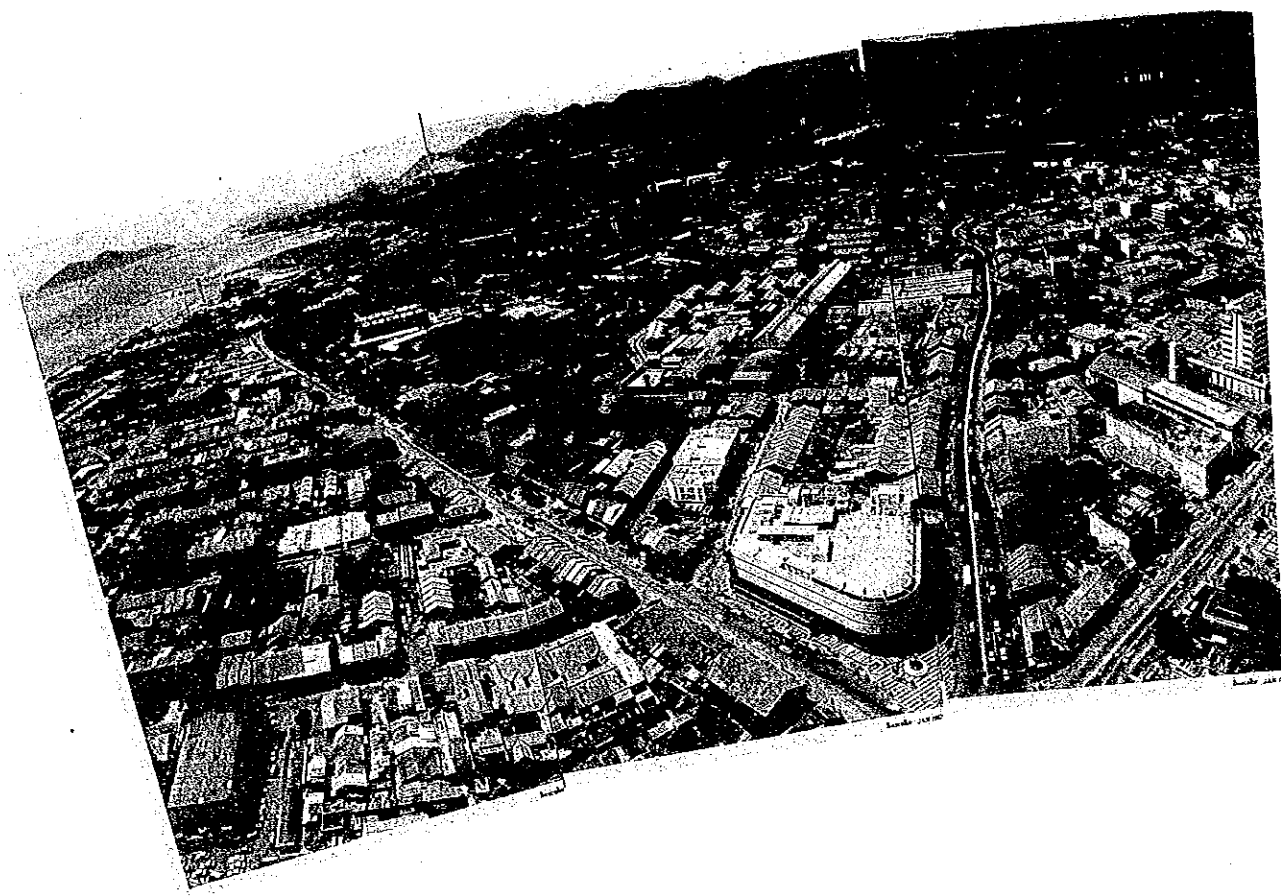


Keisuke Arita
President

Japan International Cooperation Agency

LOCATION MAP





A 360 DEGREE PANORAMIC VIEW OF GEORGE TOWN FROM KOMTAR TOWER

CONTENTS

OUTLINE OF THE STUDY

Background	(i)
Objective	(i)
Organization	(ii)
1. INTRODUCTION	1
2. PRESENT AND FUTURE TRANSPORT CONDITIONS AND PROBLEMS	2
2.1 Present Conditions	2
2.2 Future Conditions	2
2.3 Identification of Transport Problems and Planning Issues	4
3. PROPOSED OVERALL TRANSPORT POLICIES	7
4. PROPOSED TRANSPORTATION SYSTEM MANAGEMENT PLAN	8
4.1 ATC System Expansion Plan	9
4.2 Proposed Regional Transportation Plan	14
4.3 Proposed Central Area Transportation Plan	17
5. IMPLEMENTATION PROGRAMME AND COST	22
6. CONCLUSION	23

OUTLINE OF THE STUDY

Background

In response to the request of the Government of Malaysia, the Government of Japan has decided to conduct a Feasibility Study for the Expansion of the Computerised Area Traffic Control System to the Greater George Town, Central District Development 21 and Bayan Baru District in Penang, Malaysia (hereinafter referred to as "The Study"), and in accordance with relevant laws and regulations enforced in Japan. The Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of technical cooperation programmes of the Government of Japan has conducted the Study in close cooperation with the relevant Malaysian authorities.

With a population of 260,000, George Town is the third largest city in Malaysia and an important centre for commerce and tourism. To overcome urban transport problems such as traffic congestion that George Town had been facing, a request has been conveyed to the Japanese Government to carry out a comprehensive study for preparing the George Town Metropolitan Area Transport Masterplan. Such a study was conducted by the Japan International Cooperation Agency (JICA) in March 1979 and an Urban Transport Masterplan was consequently prepared in 1980. The Masterplan has recommended a series of proposals that include the construction of the Penang Outer Ring Road as a Long Term Road Network Improvement Measure as well as short term or interim measures such as reorganization of bus network, parking regulation and control, intersection improvement and the implementation of an Area Traffic Control (ATC) System.

Consequently, with the acceptance of these proposals by the Malaysian Government, a Feasibility Study for the Outer Ring Road was conducted in 1981-1982 by JICA. In addition, technical experts have been dispatched to Penang for further technical cooperation and the undertaking of traffic management system planning.

With the completion of the Penang Bridge and the comprehensive Central Area Redevelopment Project (KOMTAR Project) in 1985, the volume of urban traffic has increased manyfolds, further aggravating urban transport problems in Penang. The Penang Municipality therefore decided to implement the first stage of the Area Traffic Control (ATC) System in 1985 with the help of the Government of Japan who contributed various necessary equipment such as the central microcomputer control and information display board.

Based on the above background of urban transport planning in Penang, this Study has structured a comprehensive urban transportation system management plan in examining the feasibility of expanding the ATC System in Penang.

Objective

The objectives of this Study are :

- (1) To conduct traffic surveys and to formulate a comprehensive traffic management plan in the Study Area, including a pedestrian path network plan.

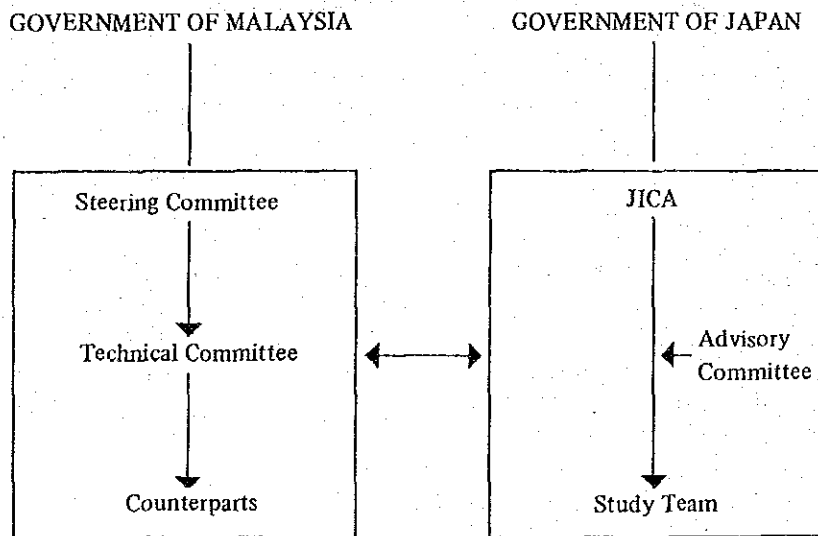
- (2) To formulate a future computerised Area Traffic Control (ATC) System for the Study Area.
- (3) To conduct the feasibility study of the proposed system.
- (4) To propose the most appropriate implementation programme for the future ATC System in the Study Area.

Organization

This Study is being carried out jointly by the Governments of Malaysia and Japan. The Malaysian Government has established two committees: The Steering Committee and the Technical Committee; the Japanese Government has set up an Advisory Committee.

These committees have been assisting the Study Team, providing it with advice and suggestions from time to time.

The organization set-up for this Study is shown in figure below:



Organisation Chart

The committees are made up of the following:

(1) Steering Committee, Malaysian Government

Chairman	Koo Hock Song	Director, Engineering Department, Municipal Council of Penang Island.
	Wong Peg Har	Rep. Chief Secretary, Economic Planning Unit, K.L.
	Alexius Y. A. Loo	Director, Highway Planning Unit, Ministry of Public Works, K.L.
	Ghani bin Salleh	Dean, School of Housing, Building and Planning, Universiti Sains Malaysia.
	Head of or Representative from	Economic Planning Unit, Penang State.
	Head of or Representative from	Public Works Department, Penang State.
	Head of or Representative from	Town and Country Planning Department, Penang State.
	Head of or Representative from	Road Transport Department, Penang.
	Head of or Representative from	State Police Department, (Traffic Section).
	Head of or Representative from	Telecoms Department, Penang.
	Head of or Representative from	Water Supply Authority, Penang State.
	Head of or Representative from	National Electric Board, Penang State.
	Head of or Representative from	Penang Port Commission, Penang.
	Head of or Representative from	Penang Development Corporation, Penang.
	Head of or Representative from	Structure Plan Unit, Municipal Council of Penang Island.
	Head of or Representative from	Transport Department, Municipal Council of Penang Island.
	Head of or Representative from	Engineering Department (Road Sections), Municipal Council of Penang Island.

	Seki, Taichi (Fukui, Teru)	JICA Expert, Highway Planning Unit, K.L.
	Oyamatsu, Toshihiko	JICA Expert, Municipal Council of Penang Island.
(2)	Technical Committee, Malaysian Government	
Chairman	Koo Hock Song	Director, Engineering Department, Municipal Council of Penang Island.
	Ong Eng Poe	Highway Planning Unit, Ministry of Public Works.
	A. Thevarajah	Director, Public Works Department, Penang State.
	Zainol Rashid Zainuddin	Public Works Department, Penang State.
	Anwar Ahmad	Public Works Department, Penang State.
	Idris bin Abd. Rahim	Town & Country Planning Department, Penang State.
	S. Ambalawan	Deputy Director, Registration and Inspection of Motor Vehicle, Penang.
	Ng See Ghee	Inspector, Penang Police Headquarters.
	Rahim	Inspector, Penang Police Headquarters
	Hassim Mat	School of Housing, Building and Planning, Universiti Sains Malaysia.
	Abdul Jamal Mohd. Johar	Controller of Telecoms, Penang.
	Hj. Shafie Hj. Abd. Hamid	Controller of Telecoms, Penang.
	Khoo Say Keong	Penang Port Commission.
	Roslan Ishak	National Electric Board, Penang State.
	Jaseni Maidinsa	Water Supply Authority, Penang State.
	Tan Kim Pah	Penang Development Corporation.
	Mohd. Bazid Hj. Kahar	Penang Development Corporation.

Tan Thean Siew	Project Manager, Structure Plan Unit, Municipal Council of Penang Island.
Ong Siew Foon	Transport Department, Municipal Council of Penang Island.
Tan Swan Teck	Deputy Director, Engineering Department, Municipal Council of Penang Island.
Ang Aing Thye	Engineering Department, Municipal Council of Penang Island.
Khoo Say Boon,	Engineering Department, Municipal Council of Penang Island.
Seki Taichi (Fukui, Teru)	JICA Expert, Highway Planning Unit, Ministry of Public Works.
Oyamatsu, Toshihiko	JICA Expert, Municipal Council of Penang Island.

(3) **Advisory Committee, Japanese Government**

Chairman	Katakura, Masahiko	Professor, Tokyo Metropolitan University.
	Asano, Mitsuyuki	Ministry of Construction.
	Hayashi, Koujiro	Urban Development Public Corporation.
	Fujii, Toshio	Tokyo Expressway Public Corporation.

(4) **Study Team**

Hanawa, Kokuro	Team Leader
Nabeshima, Yasuo	Transportation Planner.
Nakata, Katsuyasu	Urban Transport Planner.
Yamamoto, Toshinori	Traffic Engineer I.
Takahashi, Shunichi	Traffic Engineer II.
Sato, Takashi	Traffic Control System Planner.
Kaminaga, Akira	Transport Facility Planner.
Suzuki, Toshio	Transport Economic Analyst.
Takanashi, Naoki	System Analyst.

	Takagi, Michimasa	Public Transport Planner
(5)	Counterpart Engineers	
	Tan Swan Teck	Engineering Department, Municipal Council of Penang Island.
	Ang Aing Thye	Engineering Department, Municipal Council of Penang Island.
	Kasa Ismail	Engineering Department, Municipal Council of Penang Island.
	Hassim Mat	School of Housing, Building, and Planning, Universiti Sains Malaysia.
	Tan Thean Siew	Project Manager, Structure Plan Unit, Municipal Council of Penang Island.
(6)	Local Engineers	
	Chin Kar Keong	Fukuyama Consultants International
	Ooi Peng Hong	Fukuyama Consultants International
	Chua Mok You	Fukuyama Consultants International
	Danny Tang	Fukuyama Consultants International

1.0 INTRODUCTION

This Study was undertaken to formulate a transportation system management plan for the target year 2000 in the Study Area covering the eastern part of Penang or better known as Greater George Town and Bayan Baru District (see Figure 1). The Study in particular has examined the feasibility of an ATC System Expansion Plan for this area.

The Study encompasses the following tasks :

- (1) Examining the present and future transport conditions and problems,
- (2) Establishment of urban transportation planning issues and policies,
- (3) Proposal of a Transportation System Management (TSM) Plan

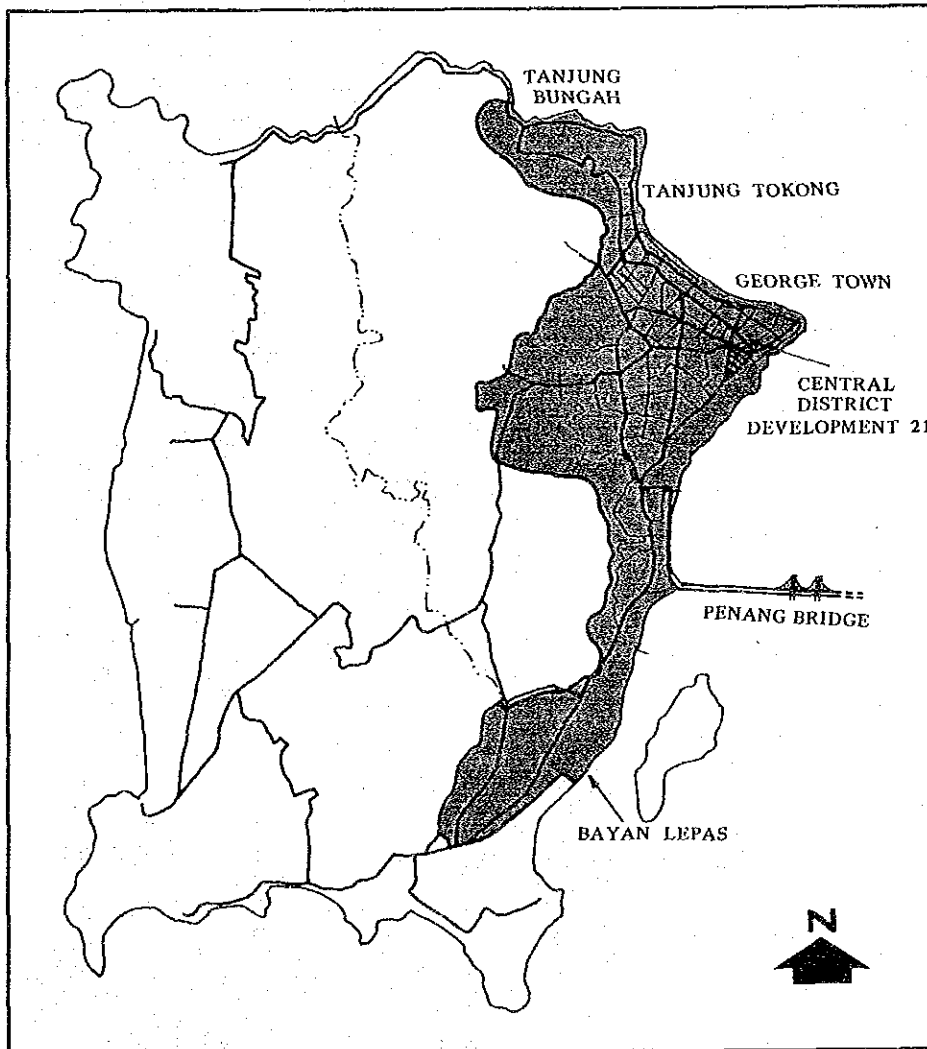


Figure 1 : Study Area

2.0 PRESENT AND FUTURE TRANSPORT CONDITIONS AND PROBLEMS

2.1 Present Conditions

Much effort have been shown by the planning and implementing authorities in improving transport facilities in the Study Area to alleviate various transport problems. Nevertheless, problems such as the daily occurrences of traffic congestion and accident or the declining trend of bus passenger volume are still prevailing. Appropriate countermeasures have to be undertaken for improving the existing transport facilities and as well as for the planning of new transport facilities.

2.2 Future Conditions

Future population distribution and traffic demand patterns in the Study Area are forecasted based on the regional development scenerio as depicted in Figure 2. As can be seen in Figure 2, the development of Bayan Lepas as a growth centre for the southern region would create a large traffic desire to George Town. Traffic demand on this corridor in year 2000 is estimated to increase two-folds from its existing volume. Likewise, the thoroughfare between Ayer Itam and George Town is expected to experience greater traffic demand. These increases in traffic demand will inevitably aggravate the existing transport problems if no remedial measures are undertaken.

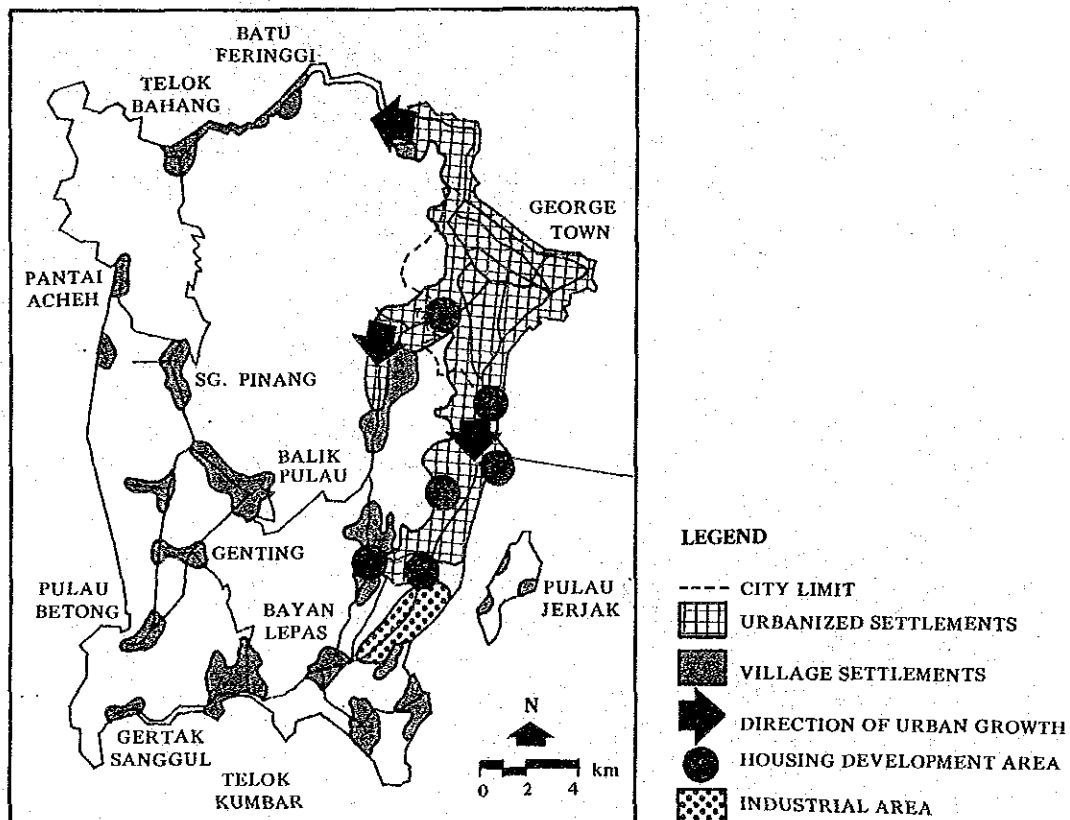
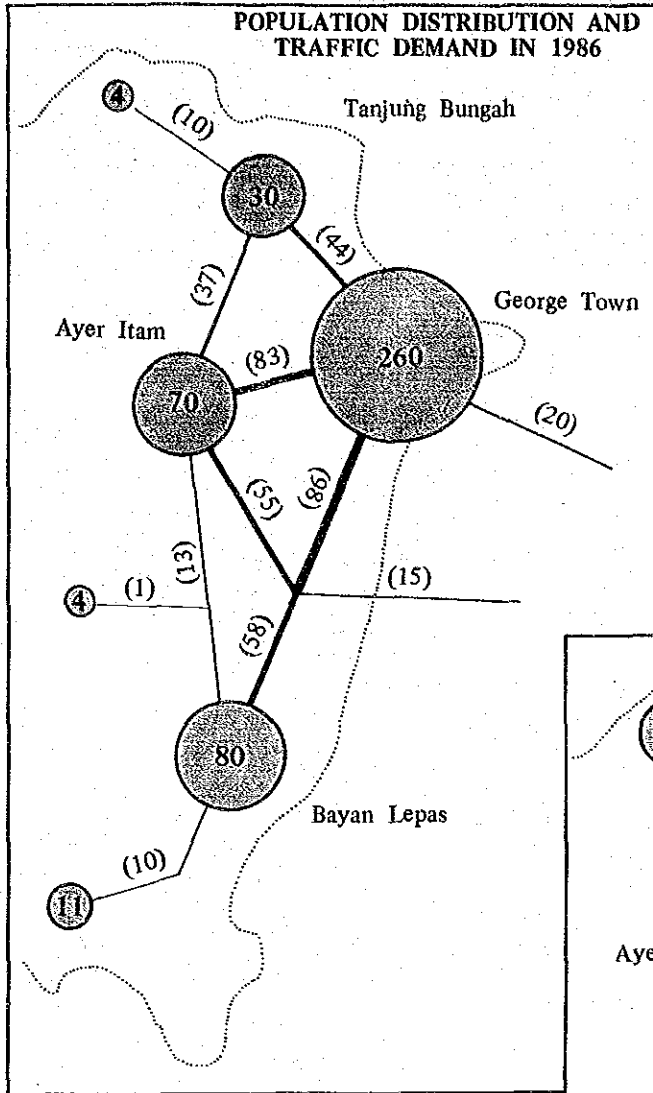


Figure 2 : Regional Development Pattern



POPULATION DISTRIBUTION

Area	1986	1990	2000
Penang Island	535,200	568,000	667,400
Study Area	437,200	460,900	517,600
(George Town)	256,800	254,600	283,500
(Other Area)	180,400	206,300	234,100

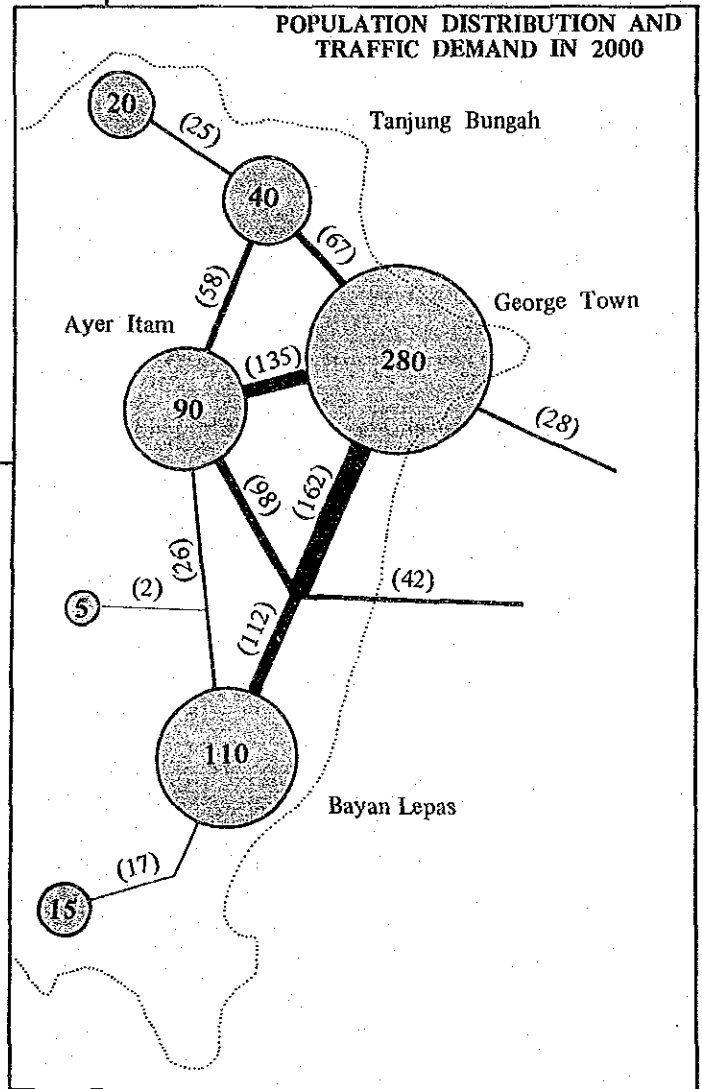
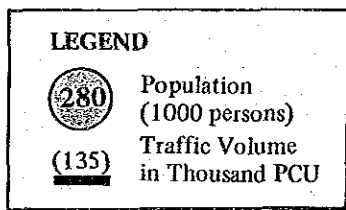


Figure 3 : Changes in Population and Traffic Demand (1986–2000)

2.3 Identification of Transport Problems and Planning Issues

Based on the analyses of various traffic surveys conducted by the Study Team and the forecast of future traffic volumes in the year 1990 and 2000, the present and future transport problems are elucidated and presented in Figure 4. The figure also shows the five (5) identified planning issues.

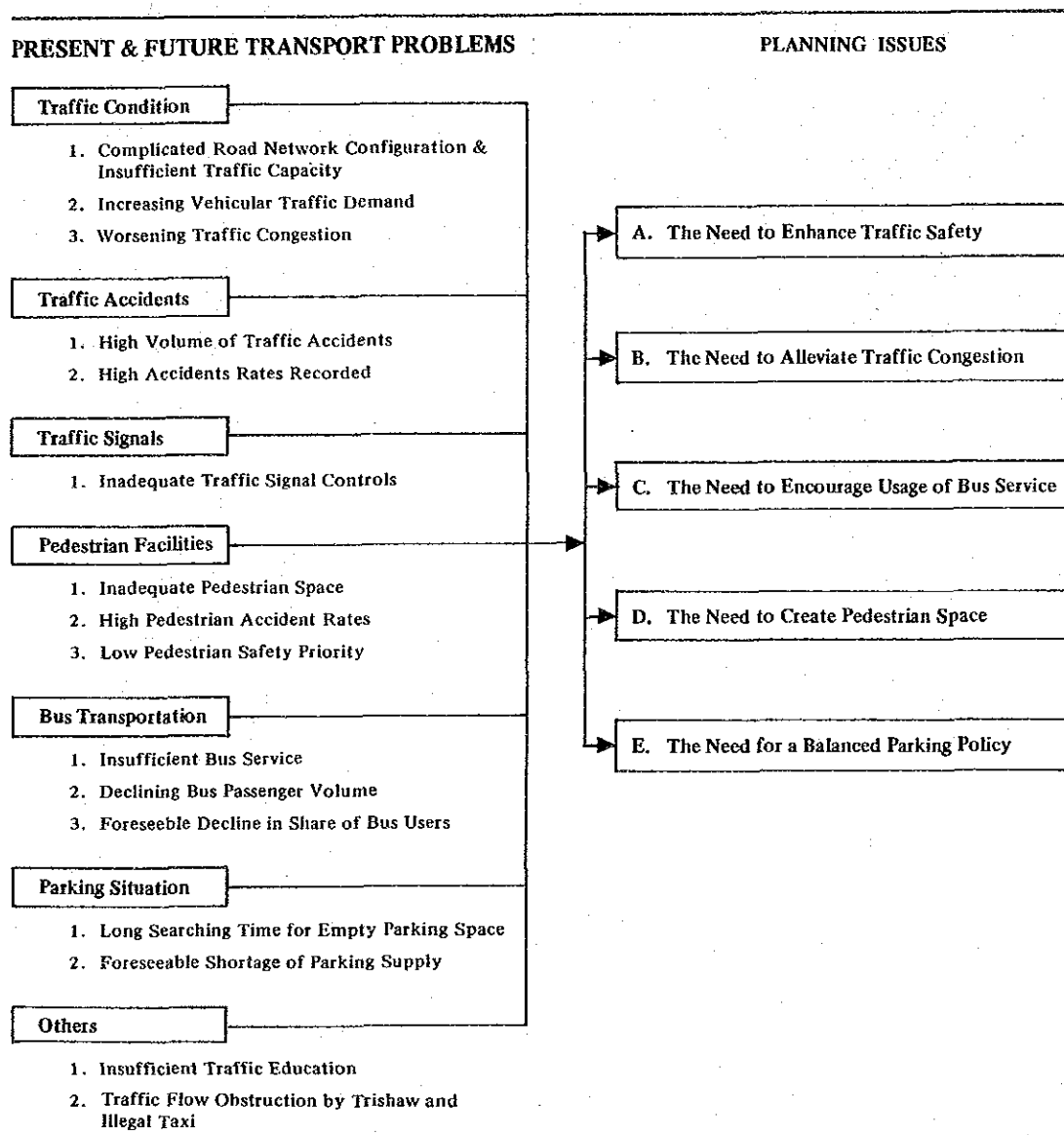
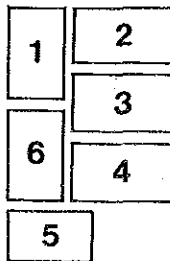
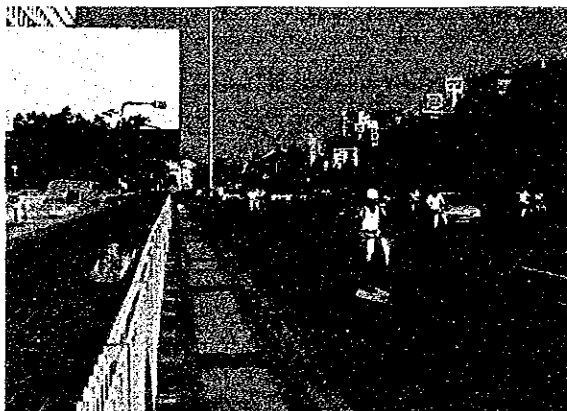
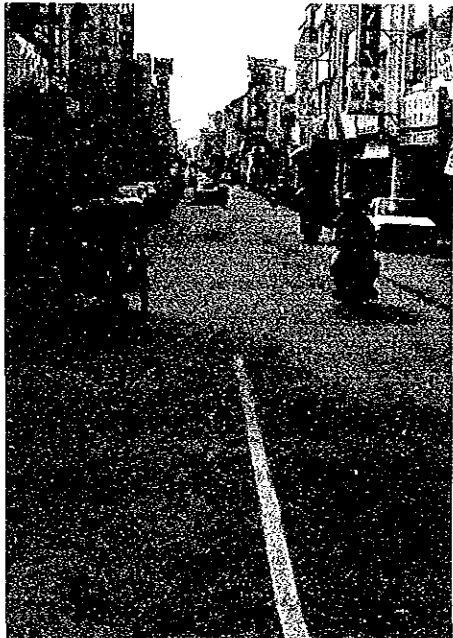
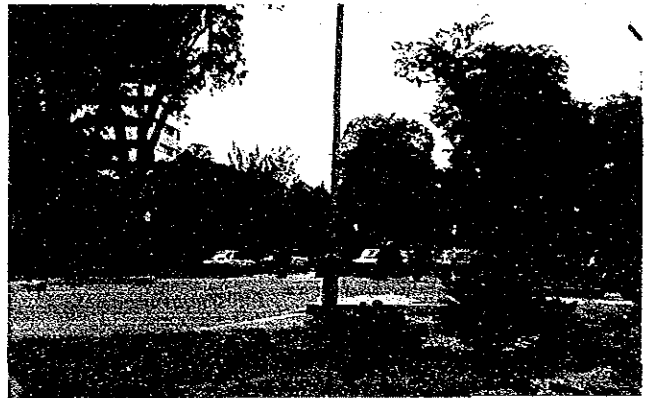
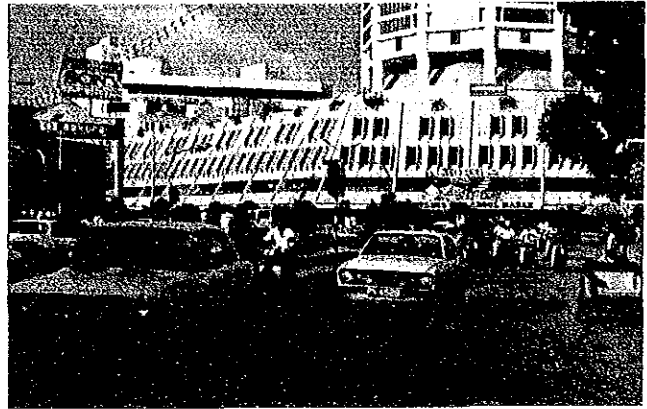
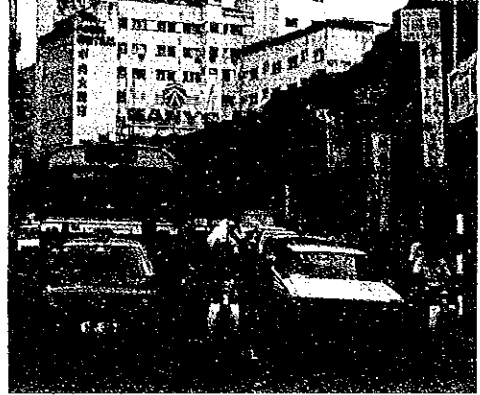


Figure 4 : Present and Future Transport Problems and Planning Issues

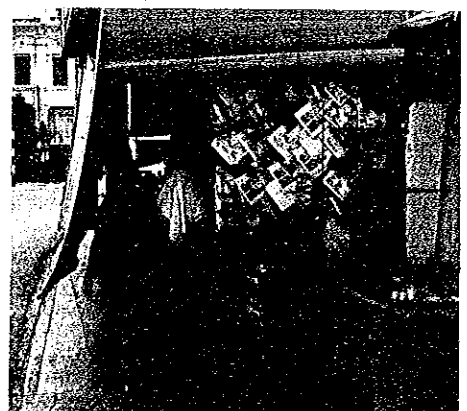
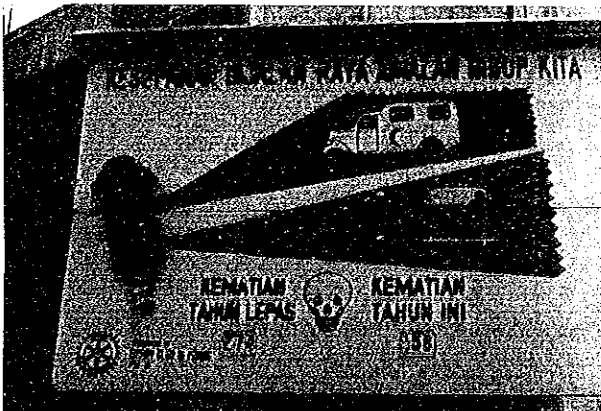


1. Traffic condition along Jelutong Road during the evening peak.
2. The second highest delay time has been recorded at Magazine Circus.
3. Traffic condition along Northam Road during the morning peak.
4. The highest delay time was recorded at the Perak Road/Dato Keramat Road Intersection.
5. Traffic Condition around KOMTAR along Magazine Road.
6. Absent or faded lane markings encourages careless or undisciplined driving habits.



- 7. The crowded Prangin Bus Terminal.
- 8. The heavily trafficked Penang Road Shopping Street.
- 9. Poor facilities at the Jetty Bus Terminal.
- 10. Improved pedestrian path along Penang Road Shoppers and pedestrians now can stroll in a safe and conducive atmosphere.
- 11. One of the many examples of pedestrian space taken over by street vendors.
- 12. A reminder to the road users – "274 fatal accidents last year and 58 this year." Accident rate in Penang Island has been alarmingly high.
- 13. An example of a bus stop needing improvement.

7	8
13	9
	10
12	11



3.0 PROPOSED OVERALL TRANSPORT POLICIES

In order to improve the economic efficiency of urban transportation and also to promote economic and regional development in the Study Area, it is essential to ensure a satisfactory level of traffic safety in the course of providing mobility for people and goods. It is also important to minimise the adverse impacts on the natural environment and social community.

Given these goals, the following basic transport policies are proposed :

- TP-1** To ensure safety for pedestrians and other road users whether by car, motorcycle or bicycle in the Study Area.
- TP-2** To create lively and refreshing urban space where tourists and shoppers congregate and ensuring public safety, convenience and comfort of walking.
- TP-3** To provide easy accessibility to the Central Area to commuters and shoppers via public transport by improving the frequency and dependability of bus services.
- TP-4** To provide a balanced transportation system consisting of both public and private modes in meeting the future transport demand through the implementation of appropriate and timely measures.
- TP-5** To implement a beautification programme that blends with the area's historical and cultural heritage and further enhances the image of a garden city for the urban area.
- TP-6** To utilize existing transport facilities more efficiently so as to increase the economic benefit of the transportation investments.

The proposed Transportation System Mangement Plan (hereinafter called TSM Plan) is based on the abovementioned transport policies.

4.0 PROPOSED TRANSPORTATION SYSTEM MANAGEMENT PLAN

The proposed TSM Plan consists of the following three (3) component plans formulated in accordance to the spatial area of concern of each individual plan, viz:

- (1) ATC System Expansion Plan in the entire Study Area
- (2) Regional Transportation Plan
- (3) Central Area Transportation Plan

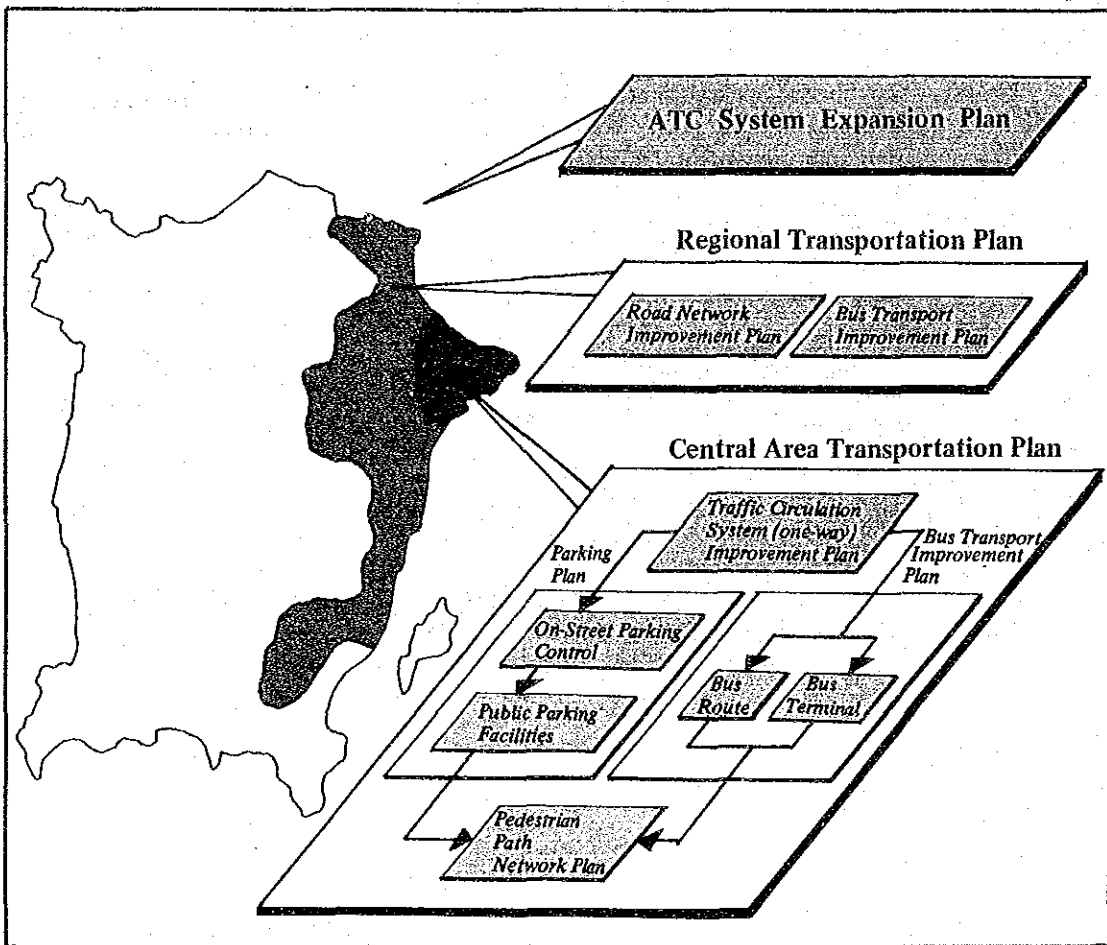


Figure 5 : Spatial Area of Concern of Each Individual Plan

4.1 ATC System Expansion Plan

A. ATC System Perspective Plan

The future comprehensive ATC system is geared towards traffic surveillance and/or control, covering the Greater Metropolitan Areas of George Town, Bayan Lepas, the Coastal Road, the Penang Bridge, and further on Butterworth and Bukit Mertajam, even if traffic in these areas is managed and controlled by different traffic authorities.

Implementation of the ATC System Perspective Plan will thus result in the installation of area traffic control system for an area covering not only Penang Island but also part of the mainland as depicted in Figure 6. Much benefit can be expected from this implementation.

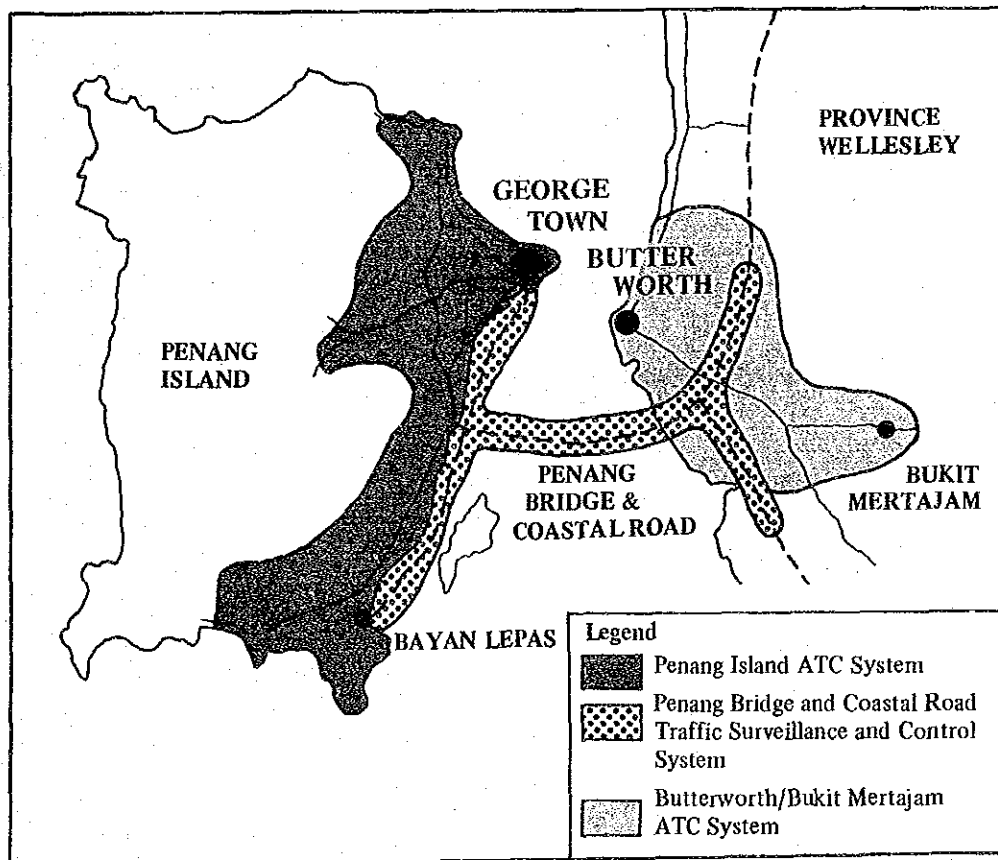


Figure 6 : ATC System Perspective Plan

However, this Study is concerned with the installation of an ATC System in Penang Island which has the highest priority in the abovementioned perspective plan.

B. Effect of Stage I ATC System Installation

1. Outline of Stage I ATC System

In 1987, the first stage of the Penang Island ATC System (hereinafter called Stage I ATC System) was undertaken by the Municipal Council of Penang Island (MPPP). The Stage I ATC System consists of :

- (1) Centralised signal system controlling sixteen (16) intersections, including two (2) mid-block pedestrian signals. (see Figure 7).
- (2) Closed Circuit Television (CCTV) System controlling two (2) cameras installed at key locations.
- (3) Channelization and geometric improvements at major intersections.
- (4) Improvement of lane markings and traffic signs.

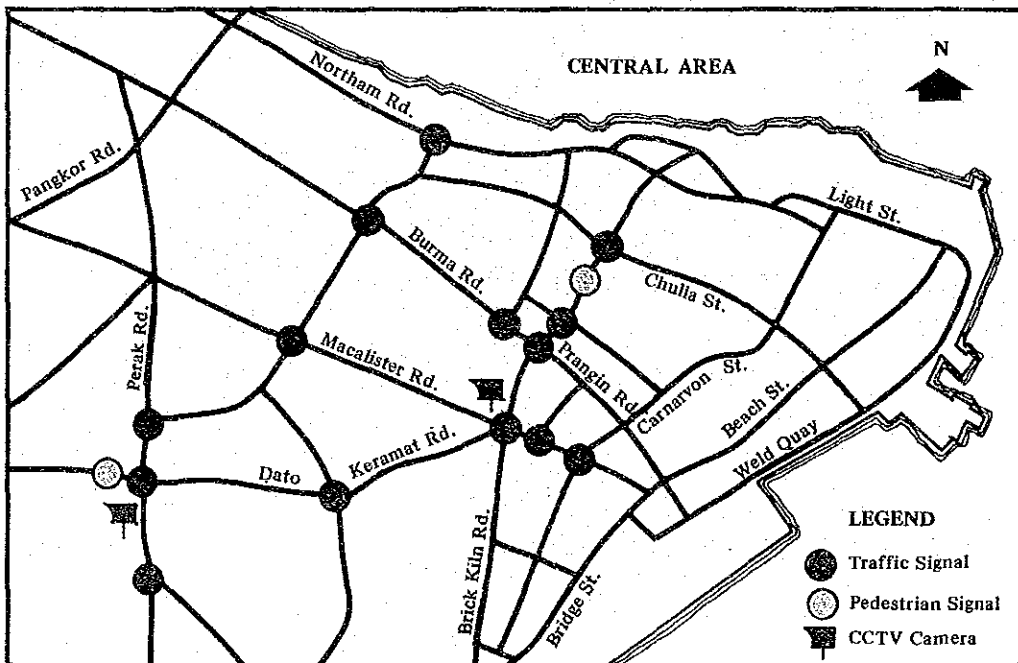


Figure 7 : Signal Locations in Stage I ATC System

2. Effect of Stage I ATC System

Analyses of Survey results show that the operation of Stage I ATC System has resulted in the reduction of travel and delay time. It is estimated that within one year the benefit derived from savings in the annual transport cost is about 1.4 times the installation cost.

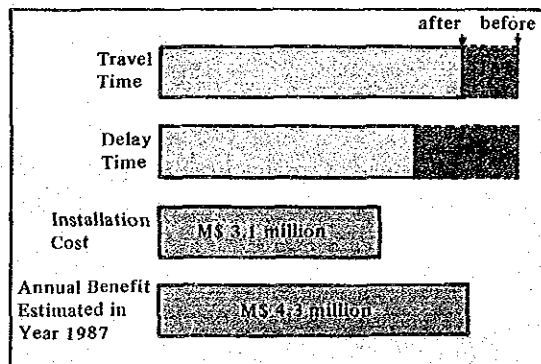


Figure 8 : Comparison of 'Before' and 'After' Installation of Stage I-ATC System

C. Proposed ATC System Expansion Plan

1. Conceptual Hardware Structure Plan

Four (4) major systems are provided for traffic control in Penang Island, namely the signal control system, driver information system, CCTV system and statistical data collection system.

The signal control system is comprised primarily of a host computer and three (3) micro-computers i.e. front-end processors (FEP) : two FEPs for George Town and one FEP for Bayan Lepas. Each of these FEPs has a total capacity for controlling sixty-four (64) traffic signals and one hundred (100) vehicle detectors. All FEPs are connected to the host computer via communication lines.

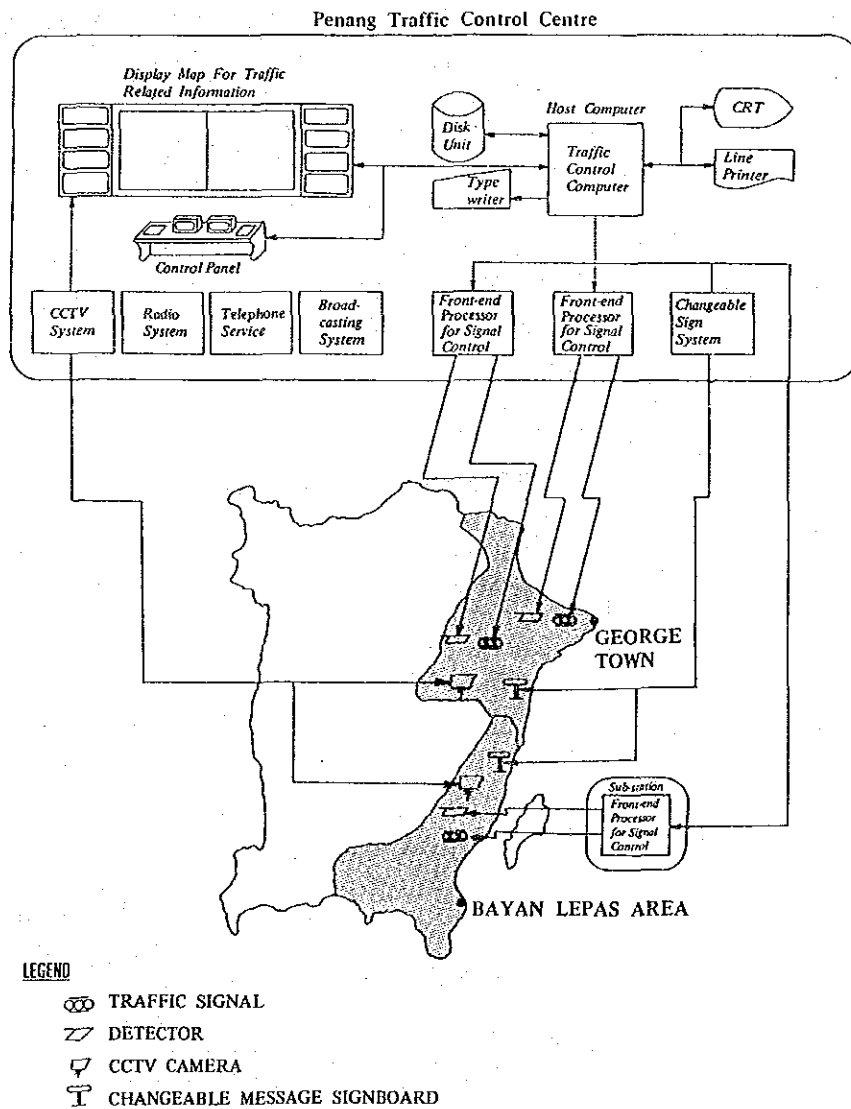


Figure 9 : Main Hardware Structure Plan

2. Staging Plan

Installation of the ATC System equipment units is to be undertaken in accordance to the staging plan as shown in Table 1. With the completion of the ATC System Expansion Plan, a total of one hundred and forty-nine (149) intersections will be signalized and controlled by the ATC System. Installation cost for this expansion plan (including a host computer and three FEPs) is about M\$37 million.

Table 1 : Staging Plan for the Expansion of ATC System

(M\$1,000, 1986 Price)

	Coverage Area	No. of Equipment			Operation Year	Installation Cost
		Signal Set	CCTV Camera	Sign Boards		
Stage I	Central Area	16	2	0	(1987)	
Stage II	George Town	44 5 *	8	0	1991	7,850
Stage III	George Town and its suburbs	59	6	2	1995	19,987
Stage IV	Bayan Lepas	25	2	2 3**	1998	9,158
Total	Study Area	149	16	7		36,995

Note : Stage I is in operation since April 1987.

* Five (5) sets of signals will be installed in Bayan Lepas area.

** Three (3) changeable message sign boards will be installed in George Town.

3. Effects of ATC System Expansion Plan

With the implementation of the ATC System Expansion Plan, the following six (6) beneficial effects can be expected :

- (1) Alleviation of traffic congestions
- (2) Ability to monitor malfunctioning equipment units
- (3) Ability to facilitate emergency vehicle users
- (4) Ability to control vehicle speed
- (5) Ability to control traffic volume at certain locations
- (6) Reduction of noise and air pollution

In addition, incidents can be detected by the CCTV cameras and the information can be relayed to drivers via the driver information boards. Automatic recording of traffic volume and compilation of statistical reports can be facilitated by the statistical data collection system.

4. Economic Evaluation

Among the many beneficial effects of the ATC System, the reduction in delay time and fuel consumption (resulted from a decrease in vehicle idling) can be interpreted in monetary benefits. Figure 10 shows the estimated benefit of the ATC System Expansion Plan.

An economic evaluation based on the estimated benefit and the total economic cost of ATC system (including operation cost and renewal cost) is carried out. The economic indicators show that the ATC System Expansion Plan is economically feasible (Table 2).

Furthermore, a sensitivity analysis performed on the economic evaluation indicates the feasibility of the plan even when the benefit is reduced by 20% and the cost is increased by 50%.

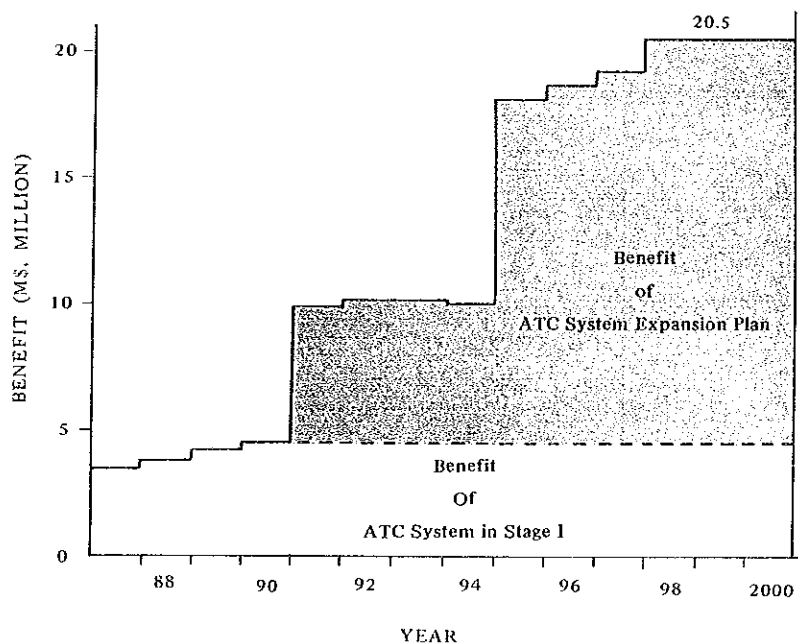


Figure 10 : Estimated Benefit of ATC System Expansion Plan

Table 2 : Economic Indicators of Proposed ATC System Expansion Plan

Indicator	Value
Internal Rate of Return (%)	22.70
Benefit Cost Ratio	2.30
Net Present Value (1,000 M\$)	24,919.00

5. Management and Operation of the System

The proposed ATC system will have its control centre at KOMTAR, and to be managed and operated by a team of 6 specialists. This team will consist of a senior engineer (manager), a traffic engineer, an electronic engineer and three operating engineers.

4.2 Proposed Regional Transportation Plan

In view of the future expansion of the urbanized area and the countermeasures taken to cope with the resulting increase in transport demand, the following transportation plans are necessary to ensure public safety and to secure mobility for the people.

- Road Network Improvement Plan
- Bus Transport Improvement Plan
- Traffic Safety Measures and Others

The proposed Regional Transportation Plan is comprised of the abovementioned transportation plans as illustrated in Figure 11.

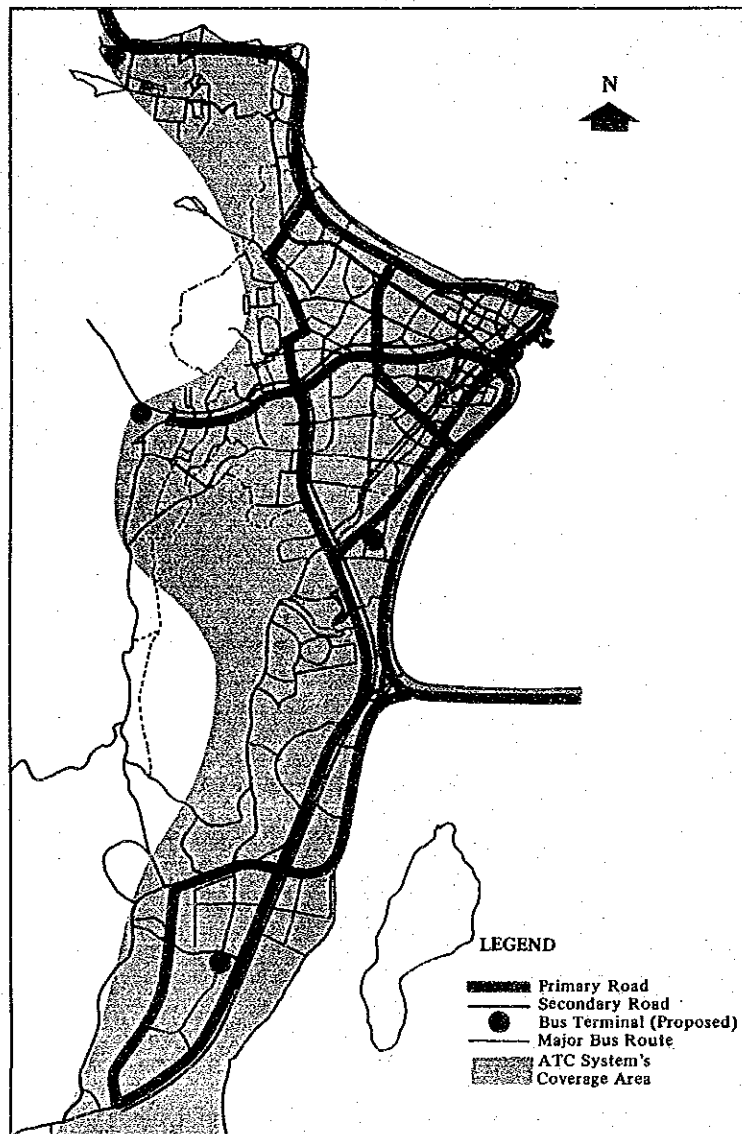


Figure 11 : Proposed Regional Transportation Plan

A. Road Network Improvement Plan

In response to the increasing traffic demand and in establishing a hierarchical road network in the Study Area, the implementation of the following roadway projects are necessary by the year 2000.

1. New Construction

(1) Primary Roads:

- | | |
|------------------------|--------|
| a. Coastal Road | 4.3 km |
| b. Weld Quay Extension | 4.1 km |
| c. South Coastal Road | 3.4 km |

(2) Secondary Roads:

- | | |
|---|--------|
| a. Ayer Itam By-pass | 4.0 km |
| b. New Pair Road | 4.9 km |
| c. Van Praagh Road Extension
(Hamilton Road – Weld Quay Extension) | 1.7 km |

(3) District Roads:

- | | |
|---|--------|
| a. Free School Road Extension
(Free School Road – Patani Road) | 0.8 km |
| b. Trengganu Road Extension
(Ayer Itam Road - York Road) | 0.4 km |
| c. Boundary Road Extension
(Boundary Road – Batu Gantong Road) | 1.2 km |

2. Road Improvement

- | | |
|-----------------------------------|--------|
| (1) Dato Keramat Road Improvement | 0.5 km |
| (2) Perak Road Improvement | 0.5 km |

B. Bus Transport Improvement Plan

The following Bus Transport Improvement Plan is proposed in the Study Area in order to upgrade the existing bus services by making bus ride more attractive and convenient.

1. Execution of a Bus Transport Study
2. Introduction of a Bus Fleet Renewal Programme
3. Construction of a new CBD Bus Terminal and improvement of local bus terminals and major bus stops.

C. Traffic Safety Measures and Others

Solutions to transport problems are not merely restricted to the implementation of traffic control system or road network improvement.

Other measures include public education on traffic safety and proper enforcement of traffic regulations, improvement of road markings that help alleviate the transport problems.

In this respect, the following measures are proposed.

1. Improvement of Pedestrian Facilities
2. Accidents Data Processing
3. Promotion of Traffic Safety Education
4. Stricter Enforcement of Traffic Rules and Regulations
5. Improvement of Road Markings and Traffic Signs
6. Control and Conservation of Trishaw
7. Control of Illegal Taxi
8. Control of Hawker Movement
9. Preservation of Environment

4.3 Proposed Central Area Transportation Plan

The main objectives of the Central Area Transportation Plan are to improve traffic safety and to secure mobility for the populace in order to encourage economic activities in the Central Area.

In this plan, vehicular traffic, bus traffic and pedestrian traffic are the three (3) types of mobility which are to be increased by a balanced and orderly utilization of road space. The net result will be related to the increase in economic activities within the Central Area.

Conceptually, the Central Area Transportation Plan consists of two (2) main axes namely the 'Pedestrian and Vehicle Segregation Axes' and the complementary 'Pedestrian Path Axes' as shown in Figure 12.

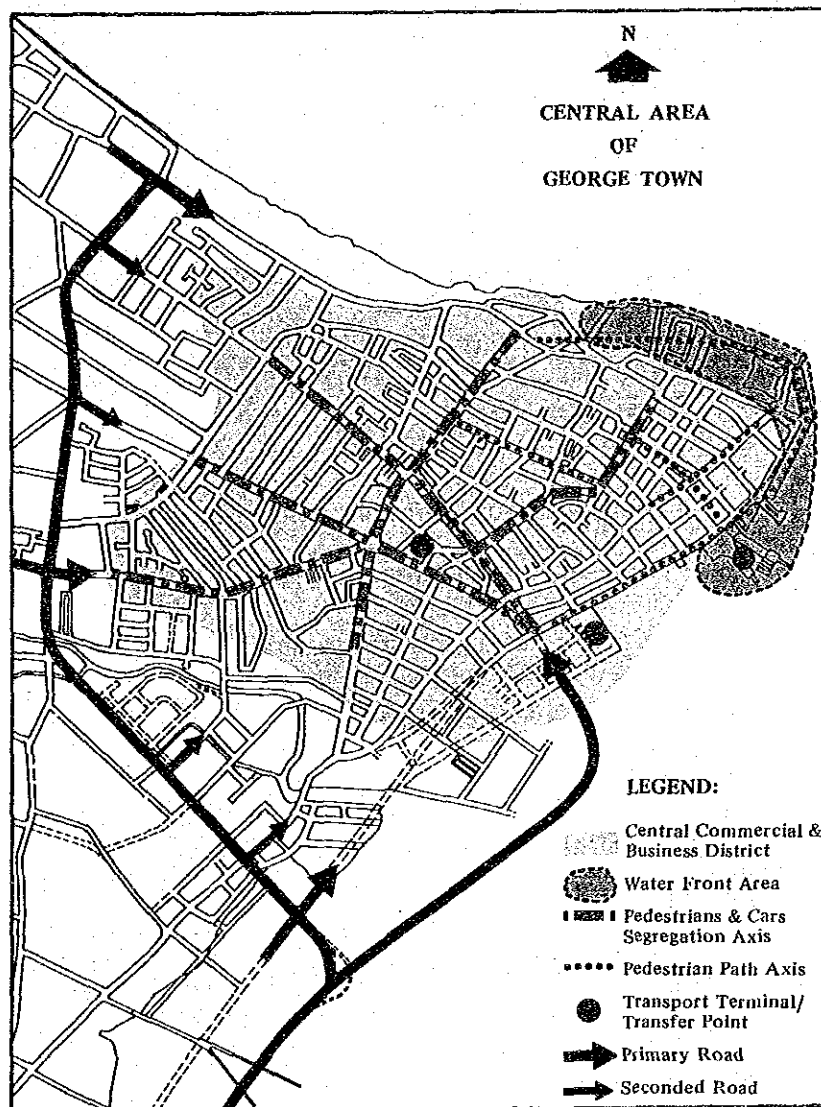


Figure 12 : Concept of Central Area Transportation Plan

Based upon the preceding concept, the following four (4) transportation plans in the Central Area are proposed:

A. Traffic Circulation Improvement Plan

A good circulation system provides for a more efficient and smoother traffic flow and is widely used as a traffic management technique especially in heavily trafficked urban areas.

In this Study, several alternatives are evaluated and the proposed long term plan is to be implemented concurrently with the opening of North Coastal Roads (see Figure 13 (a)).

B. Bus Transport Improvement Plan

A bus-stop improvement plan and a bus terminal relocation plan for the Central Area are proposed for improving the existing bus services in terms of amenities, dependability and convenience (see Figure 13(a)).

1. Bus-stop Improvement Plan

Bus-stop facilities at about 40 locations in the Central Area are proposed to be improved urgently.

2. CBD Bus Terminal Plan

Several candidate sites for the relocation of Prangin Bus Terminal are identified and evaluated. A CBD Bus Terminal is proposed to be sited on a reclaimed land near the entrance of North Coastal Road based on the following standpoints:

- a. Convenience to existing bus commuters
- b. Future development prospects in the vicinity

The total floor area necessary for the CBD Bus Terminal is about 16,000 square meters and the bus terminal should be ready in time with the opening of North Coastal Road.

C. Pedestrian Path Network Plan

The installation of a pedestrian path network in the city enhances pedestrians' safety and provides amenities for walking. As a result, it is possible to ensure traffic safety and mobility in the city.

A pedestrian network constituting 10.8 km in total length of footpath as shown in Figure 13 (b) is proposed to be installed by 1995.

D. Parking Plan

It is necessary to strengthen on-street parking control on primary and secondary roads in order to secure sufficient road space not only for the traffic demand within the Central Area but also for pedestrian paths.

Nevertheless, it is not desirable to exclude vehicular traffic movement from the Central Area from the standpoint of economic development. Therefore the construction of parking facilities by both public and private sectors is also proposed.

The proposed Parking Plan in the Central Area is depicted in Figure 13 (b). By the year 2000, 1,600 on-street parking lots will be removed and replaced through the construction of five (5) public parking buildings having a combined capacity of about 2,000 parking lots.

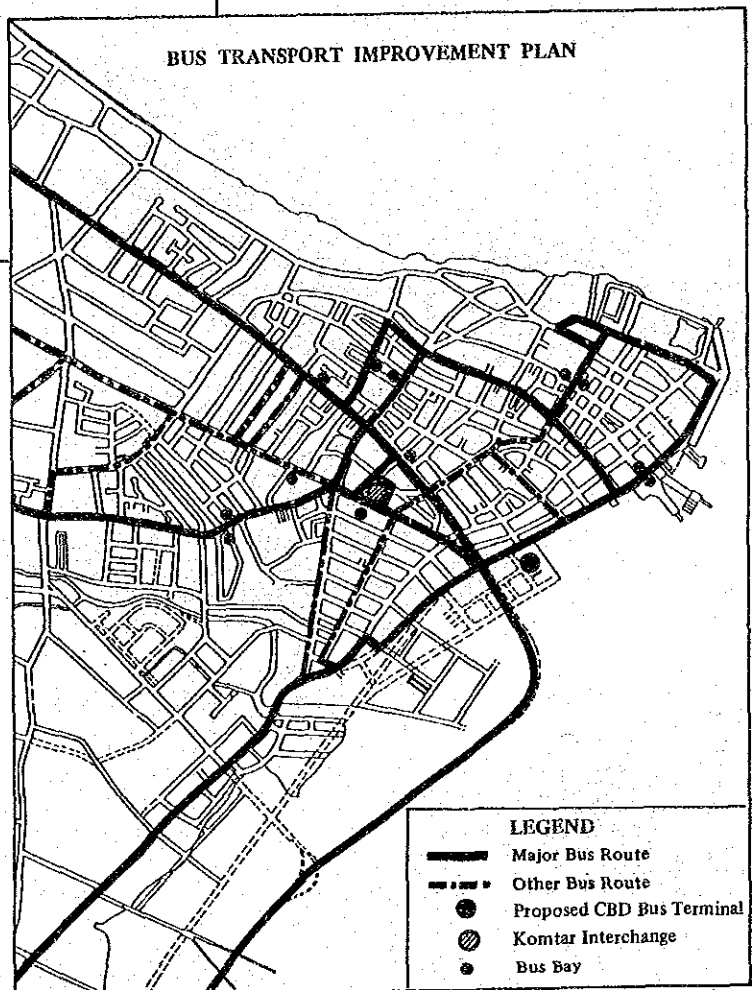
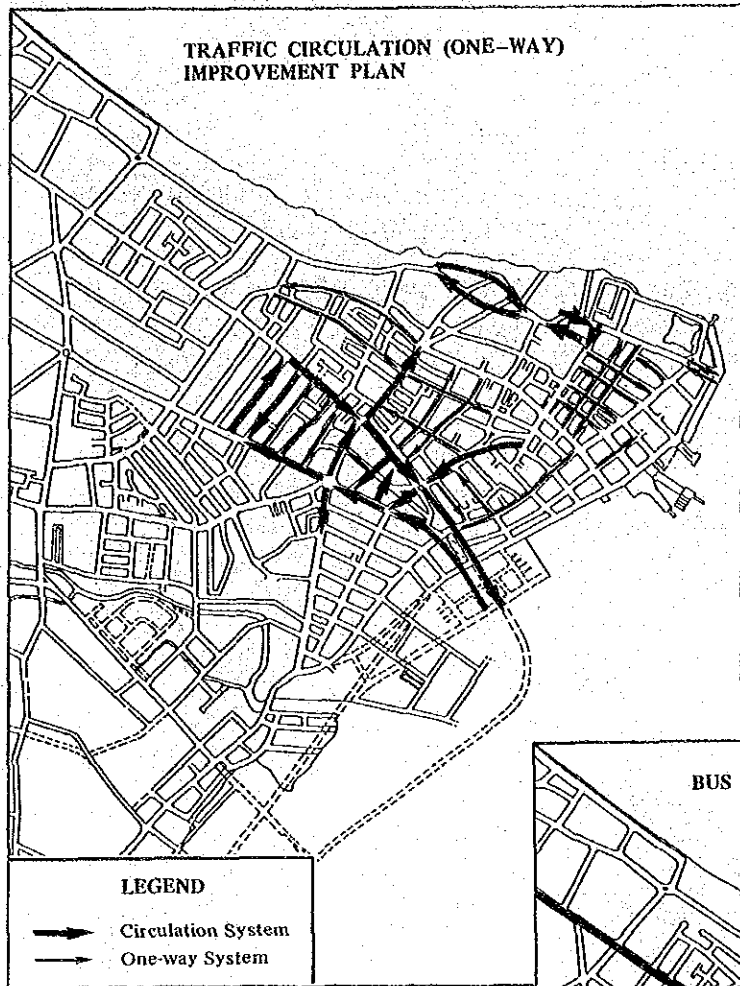


Figure 13 (a) : Proposed Central Area Transportation Plan

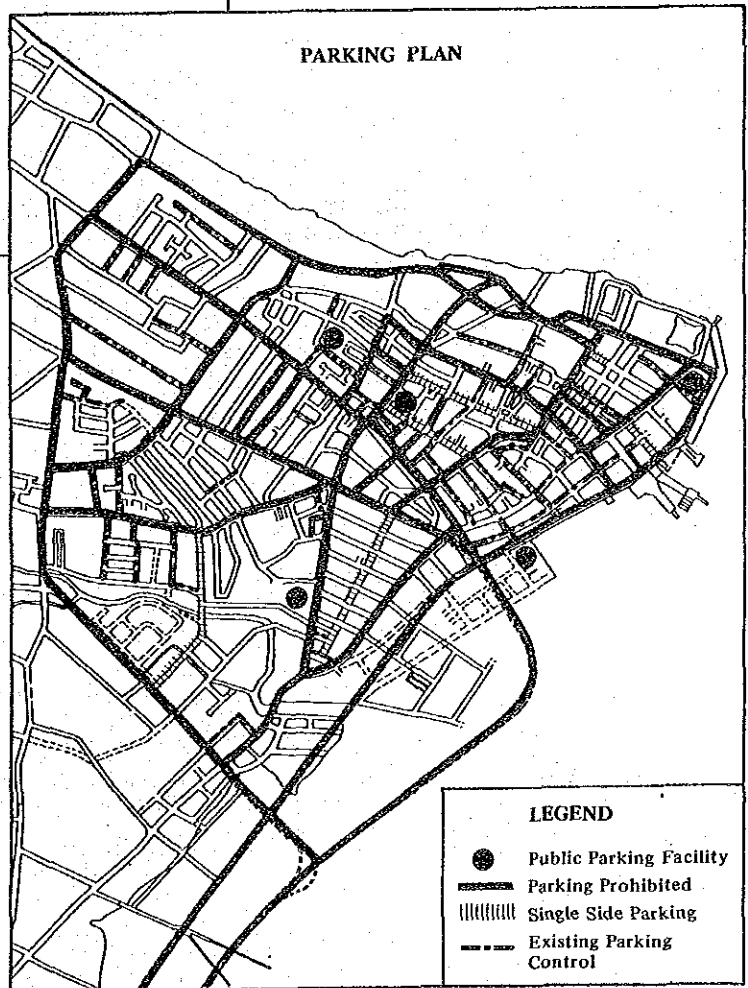
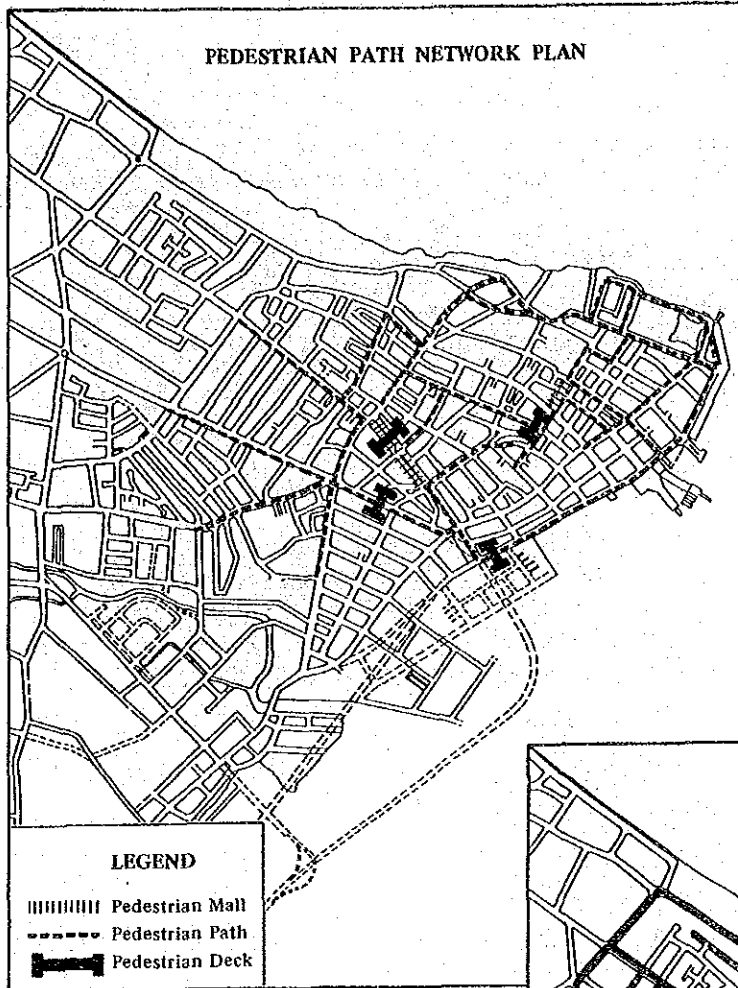


Figure 13 (b) : Proposed Central Area Transportation Plan

5.0 IMPLEMENTATION PROGRAMME AND COST

The implementation programme for various measures proposed in the TSM Plan is separated into three (3) phases as shown in Table 3 and described below :

(1) Phase 1 (1988 – 1990)

In this phase, existing on-going projects are expected to be completed. The major new works to be started in Phase 1 are projects under the Road Network Improvement Plan, Pedestrian Path Network Plan and ATC System Expansion Plan – Stage II.

(2) Phase 2 (1991 – 1995)

The construction of North Coastal Road that links Penang Bridge to the Central Area is expected to begin and complete in Phase 2. Upon its completion, changes to the traffic circulation system in the Central Area, construction of a new CBD Bus Terminal to accommodate the relocation of Prangin Bus Terminal and the implementation of the ATC System Expansion Plans – Stage III will take place.

During this period, many of the TSM measures would have been accomplished that marks the maturity stage of the proposed TSM Plan.

(3) Phase 3 (1996 – 2000)

The TSM Plan will be completed in this phase with the completion of the ATC System Expansion Plan.

Table 3 : Phasing Plan for the Proposed TSM Plan

Component	Phase 1 1988-1990	Phase 2 1991-1995	Phase 3 1995-2000	Beyond 2000
Road Network Improvement				
Traffic Circulation System Plan				
On-street Parking Control				
Construction of Public Parking Facility				
Construction of Bus Terminals				
Introduction of New Bus Fleet				
Pedestrian Path Network Plan				
ATC System Expansion Plan				
Implementation Cost in M\$ million	18.9	140.0	129.9	Total 288.8

6.0 CONCLUSION

Table 4 indicates the implementation programme for the proposed TSM Plan that cost a total of about M\$289 million. The respective implementing body for each project is also indicated. Based on financial analyses and an investigation on the financial aspects of the implementing bodies, it is necessary to consider the following points:

- (1) It is necessary to acquire federal funds or subsidies or even low-interest rate foreign loans secured through the Federal Government to finance the implementation of ATC System Expansion Plan. Total implementation cost of this plan is about M\$54 million, of which the ATC system cost including intersection improvement cost is about M\$37 million.
- (2) It is necessary to acquire federal funds or subsidies for the Weld Quay Extension Project which costs M\$60 million.
- (3) It is necessary to begin as soon as possible the preparation work for the new CBD Bus Terminal such as determination of the implementing body, acquire the required land area and to seek long-term, low-interest loans for the project.
- (4) The construction and management of public parking building should be undertaken either by a public corporation or a private sector with special considerations given to the problem of high land cost in the CBD, such as leasing of public land to the project implementor.
- (5) It is necessary to consider low-interest foreign loan for the purchase of new bus fleet and at the same time to conduct a study to formulate a Bus Transport Masterplan.

Table 4 : Implementation Cost of Proposed TSM Plan

(Unit : M\$ million)

Component Plan	Size	Unit	Implementation Body			
			MPPP	State	Public Corporation /Others	Total
ATC System Expansion Plan						
System Cost	133	Signal Set				
	14	Camera	35.3	—	—	35.3
	7	Sign Board				
Intersection Improvement	133	Interaction	1.7	—	—	1.7
Operation Cost			6.5	—	—	6.5
Renewal Cost	65	Signal set	10.0	—	—	10.0
Road Improvement Plan						
Construction Cost	25	km	72.2	121.7	—	193.9
Improvement Cost	1	km	1.0	—	—	1.0
Traffic Circulation System Improvement Plan						
System Modification/ Intersection Improvement Cost	16	Intersection	0.5	—	—	0.5
Bus Transport Improvement Cost						
CBD Bus Terminal	1	Building	—	—	7.4	7.4
Other Terminals/ Stops Improvement Cost	5	Lot	—	—	1.7	1.7
	120	Stop	—	—		
Bus Fleet Improvement Cost	140	Bus	—	—	11.2	11.2
Bus Transport Study			—	1.0	—	1.0
Pedestrian Path Network Plan	10.8	km	3.8	—	—	3.8
Parking Plan						
Public Parking Building	5	Building	—	—	14.8	14.8
Total			131.0	122.7	35.1	288.8

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