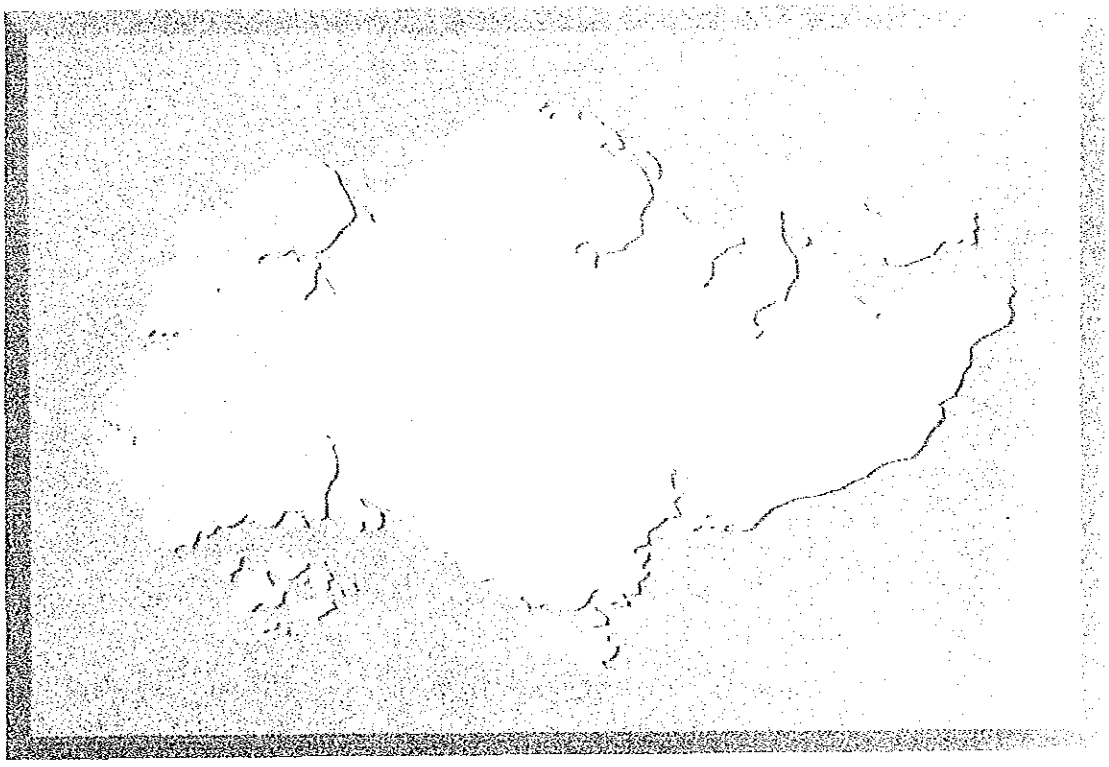
REPUBLIC OF SINGAPORE

SINGAPORE URBAN TRANSPORT IMPROVEMENT STUDY (SUTIS)

FINAL REPORT

(MAIN TEXT)



NOVEMBER 1988

Japan International Cooperation Agency

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PREFACE

In response to a request from the Government of the Republic of Singapore, the Government of Japan decided to conduct a study of the Urban Transport Improvement Project in Singapore and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Singapore a study team, led by Mr. Shizuo IWATA, comprising experts from ALMEC Co., Ltd. and the Pacific Consultants International Co., Ltd. three times; firstly from September 1987 to January 1988, secondly from March 1988 to July 1988, and lastly in August 1988.

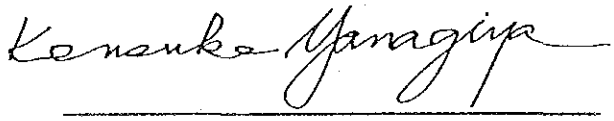
The team had discussions with the officials concerned of the Government of the Republic of Singapore and conducted field surveys.

After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the development of the Project and to the promotion of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Singapore for their close cooperation extended to the team.

November 1988



Kensuke Yanagiya
President
Japan International Cooperation Agency

November 1988

His excellency Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

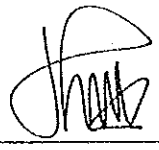
Dear Sir,

We are pleased to formally submit herewith the final report on "Singapore Urban Transport Improvement Study (SUTIS)". This study report comprising an Executive Summary, a Main Text and five (5) Technical Reports, embodies the results of the study undertaken by ALMEC Corporation in a joint-venture with Pacific Consultants International from August 1987 to November 1988.

The main objective of the study for the first phase was to study, on a schematic basis, the introduction of new transit systems in large-scale new towns and other potential areas. For the second phase, to examine in detail, the feasibility of a case study for the selected areas. We hope that this study would be of valuable assistance to the Government of the Republic of Singapore for the future development of its transportation schemes.

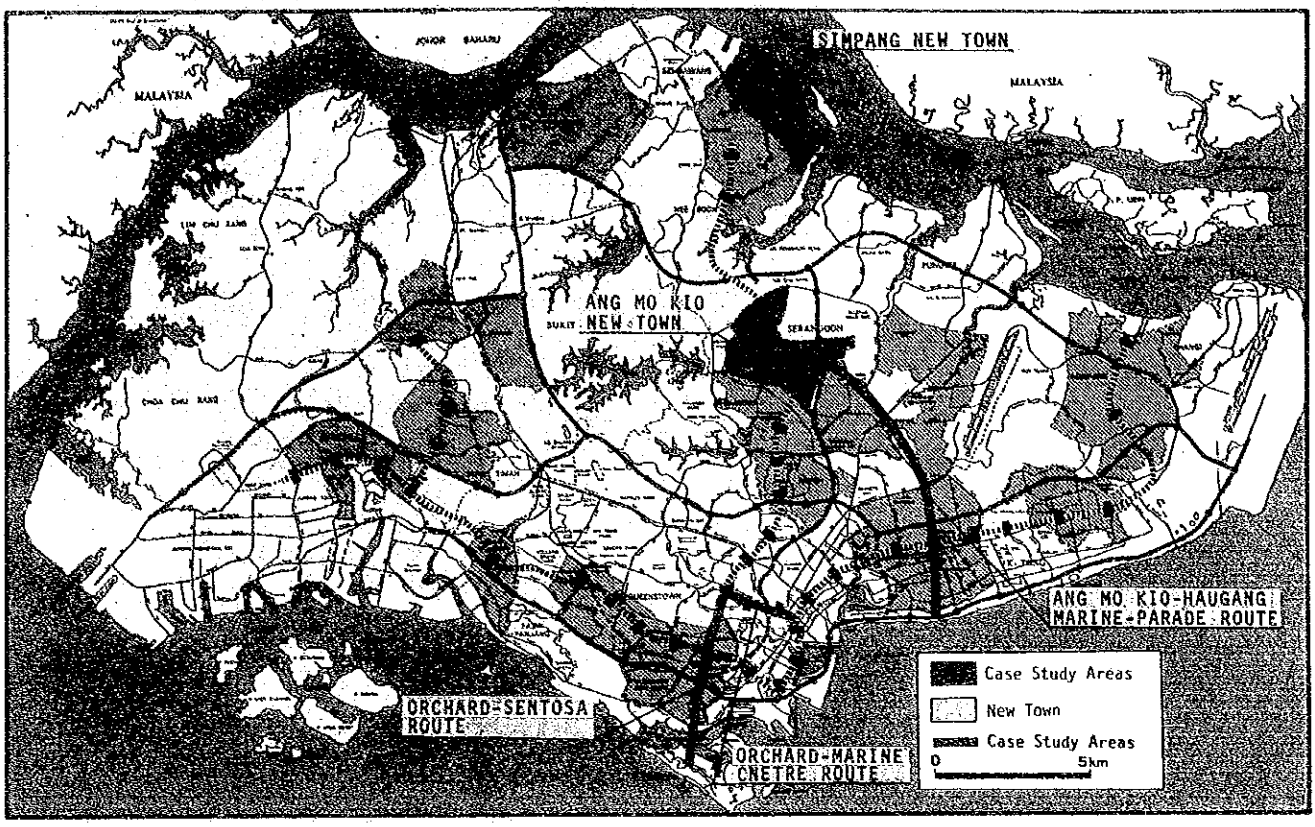
We wish to express our appreciation and sincere gratitude to the officials of your Agency, Advisory Committee, the Embassy of Japan in Singapore as well as to the officals of the agencies concerned in the Government of Singapore, particularly the Public Works Department, for the assistance and cooperation extended to the Study Team.

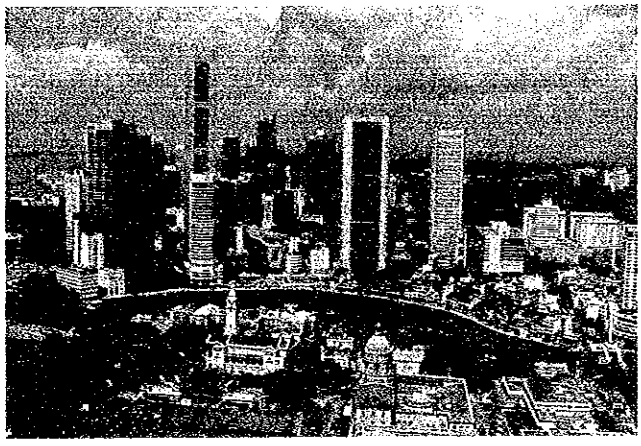
Very truly yours,

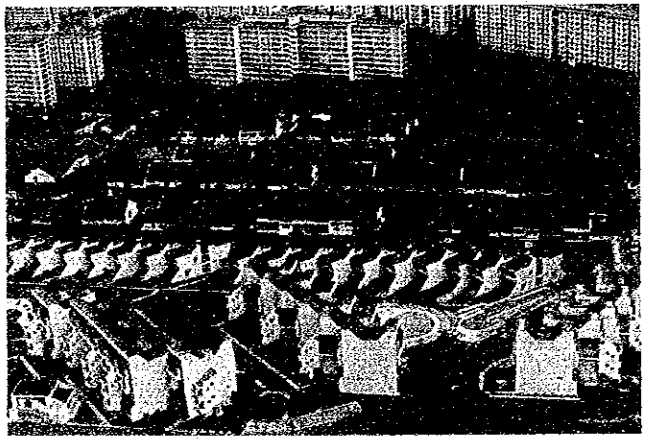


SHIZUO IWATA
Team Leader
The Singapore Urban
Transport Study (SUTIS)

LOCATION OF THE STUDY AREAS







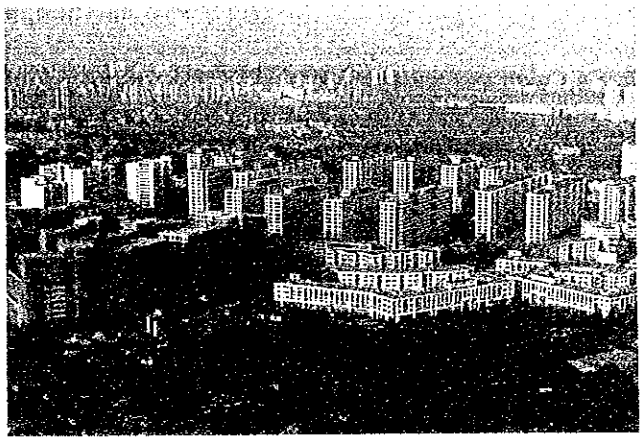


TABLE OF CONTENTS

Page

Page

LIST OF TABLES

List of Tables
page 2 .....

List of Tables
page 3 .....

List of Tables
page 4 .....

LIST OF FIGURES

List of Figures
page 2 .....

List of Figures
page 3 .....

LIST OF APPNDICES

1. INTRODUCTION

1. INTRODUCTION

1.1 Study Objectives

The Singapore Urban Transport Improvement Study (SUTIS) was commissioned to the JICA Study Team based on the scope of work agreed upon. The study commenced in September 1987 with the following main objectives:

a) To study schematically, as a first phase, the introduction of new transit systems in large-scale new towns which are being developed and/or are in the process of development, now and in the future, taking into account the existing construction programs of expressways and the Mass Rapid Transit (MRT) with a view to improving the towns' public transport system and environment.

b) To examine, as a second phase, the feasibility of introducing a new transit system, as a case study, in selected area(s) identified in the first phase.

This Draft Final Report summarizes all the findings and results of both phase one and phase two studies undertaken between September 1987 and July 1988.

1.2 Outline of Activities

A. Phase One Study

The major activities undertaken during phase one, among others, are as follows:

a) Discussion of Inception Report: held on 14 and 15 September 1987.

b) Conduct of studies covering:

i) Supplemental transport surveys, including a limited home interview survey (HIS) for Ang Mo Kio new town residents, a PWD officials survey and a bus transport survey at Ang Mo Kio bus interchange.

ii) Feeder transport demand analysis.

iii) Study on Housing Development Board (HDB) new towns.

iv) Comparison of existing new transit systems.

v) Preliminary planning on the improvement of the feeder transport system for identified areas.

vi) Environmental study for new towns.

vii) Selection of study areas and possible systems for further study in phase two.

c) Conduct of regular meetings between the PWD counterpart team and JICA study team to discuss technical papers and coordinate the study activities: A total of eight meetings were held on 21 September, 6 and 16 October, 3 and 17 November, 3, 15 and 29 December. Adhoc meetings were also held frequently throughout the period.

d) First SUTIS Steering Committee meeting: This was held on 19 December 1987 to discuss the progress, problems and preliminary findings of the study.

e) Regular JICA Advisory Committee meetings to discuss the progress and issues of the study: A total of four meetings were held in Tokyo on 1 September, 20 October, 30 November 1987, and 17 February 1988.

f) Preparation of Interim Report which summarizes the major findings and results of the phase one study.

B. Phase Two Study

Phase Two commenced on March 1988 to further study the introduction of new transit systems for the selected study areas. Major activities undertaken during this phase are as follows:

a) Discussion of Interim Report: held on 24 March 1988. The report was accepted and the coverage of the study was specified as follows:

Systems: The type of new transit systems to be investigated will be those with automated guideways and intermediate transit capacities.

Study Areas: The following areas were selected for further study:

i) Ang Mo Kio New Town: This area represents a typical developed new town. Detailed study was be undertaken.

ii) Simpang New Town: The area is being planned and therefore considered suitable for a case study to examine the feasibility of an integrated new town development with a new transit system. Conceptual plans were prepared and its feasibility examined.

iii) Other Areas: For preliminary study and conceptual planning, the following areas were also included:

- Ang Mo Kio/Hougang/Bedok Route
- Orchard Road/Marina Centre Corridor
- Orchard/Sentosa Route

b) Conduct of studies covering:

i) Supplemental transport surveys, including a limited home interview survey (HIS) for Ang Mo Kio new town residents, a PWD officials survey and a bus transport survey at Ang Mo Kio bus interchange for the situation after the opening of MRT, and a pedestrian survey along Orchard Road.

ii) Conduct of a more detailed case study for Ang Mo Kio new town to include demand analysis, route planning, systems and operation planning, facility planning and construction cost estimate and project evaluation.

iii) Conduct of case studies in a lesser depth for Simpang new town, Ang Mo Kio/Hougang/Marine Parade Route, Orchard/Sentosa Route, Orchard/Marina Centre Corridor.

c) Conduct of regular meetings between PWD counterpart team and JICA study team on 22 March, 5, 12, 19 and 29 April, 10 and 27 May, 10 June and 7 July.

d) SUTIS Steering Committee Meeting: The second meeting was held on 24 March 1988 to discuss the Interim Report. The third meeting was held on 9 July 1988 to discuss the progress of the study. The fourth meeting was held on 10 August to discuss the Draft Final Report.

e) Regular JICA Advisory Committee meetings to discuss the progress and important issues of the study: A total of six meetings were held on 17 February, 29 March, 26 May, 26 July, 6 September and 31 October, 1988.

f) Preparation of Draft Final Report which summarizes the results, conclusions and recommendations of the study.

g) Preparation of Technical Reports: Five technical reports have been prepared to provide more detailed information relevant to the major aspects of the study. They are as follows:

i) Supplemental Transport Surveys
ii) Existing Feeder Transport System and Demand
iii) Study on HDB New Towns
iv) Environmental Surveys
v) Comparison of Available New Transit Systems

1.3 Study Team Organization

The study was conducted by the Study Team with the support of the JICA Advisory Committee in consultation with the Steering Committee of the Singapore Government. The members of the respective study organizations are as follows:

1) Members of the JICA Advisory Committee

Chairman:	Dr. Hideo Nakamura	Professor - Tokyo University
Member:	Mr. Chikashi Saitoh	Ministry of Construction
	Mr. Ryuji Masuno	Ministry of Transportation
	Mr. Eiji Toyoda	Ministry of Transportation
	Mr. Morikuni Akiguchi	Ministry of Construction

2) Members of the Steering Committee of the Singapore Government

Chairman:	Mr. Chua Koon Hoe	3 Deputy Director - General, PWD
	Ms. Lim Soo Hoon	Deputy Director (Land Transport), Min. of Communications and Information
	Mr. Ho Cheok Sun	Director (Infrastructure), Min. of National Development
	Mr. Wong Eng Seng	Director of Roads, PWD
	Mr. Joseph Yee	Director of Building Control, PWD
	Mr. G. Menon	Head, Roads Transportation Branch (RTN), PWD
	Mr. Lam Chuen Fong	Head, Roads Planning & Design Branch (RP & D), PWD

3) Study Team

JICA Study Team

Mr. Shizuo Iwata	Team Leader/Transport Planning
Mr. Yoshikazu Umeki	Transport Demand Forecasting
Mr. Naoshi Okamura	Systems Analysis
Mr. Katsuhide Nagayama	Urban/Land Use Planning
Mr. Yasuhiko Kurosawa	Public Transport Planning
Mr. Kazuyuki Ohtsuka	Transport System Design
Mr. Masanao Koyama	Operation Planning
Mr. Shiu Ichikawa	Transport Facility Planning
Mr. Masashi Hattori	Environmental Assessment
Mr. Tadashi Ishikawa	Transport Facility Planning/ Engineering
Mr. Tadashi Shoyama	Economic/Financial Analysis

PWD Counterpart Team

Mr. Lam Chuen Fong	Head (RP & D)
Mr. Chin Kian Keong	Executive Engineer (RCN)
Mr. Chang Sieu Chian	Executive Engineer (RTN)
Mr. Looi Teik Soon	Engineer (RP & D)
Mr. Leo Chin Jian	Engineer (RP & D)
Mr. Tan Weng Seng	Senior Technical Officer (RP & D)

2. URBAN TRANSPORT DEVEROPMENT

2. URBAN TRANSPORT DEVELOPMENT

2.1 Urban Development Profile

2.1.1 Urban Growth

Singapore, with a population of 2.5 million distributed over 620 sq kms of land, was founded in 1819. In 1959, it achieved internal self-government; in 1963 it became a State of the Independent Federation of Malaysia and in 1965, a fully independent Republic.

The physical growth of Singapore is concentric in pattern with a somewhat heavier thrust of development along the main traffic arteries that fan out from the city center. The principal direction of growth has been northward and eastward along the main traffic arteries. The expansion westward has been slow, being hampered by large tracts of military land and the presence of a hilly terrain on the western ranges.

Land under clearance or vacant forms the single largest category of land use (16%) comprising some 9,318 ha, 80% of which are committed for public development or under various stages of clearance and planning. Residential use (15%) and agriculture (14%) share the next two largest land use categories. The fourth largest land use is transportation (13%). Together, these four categories of land use account for some 59% of the total land area of Singapore. (See table 2.1 and Figure 2.1.)

Singapore is one of the few countries where urban planning has been successfully implemented. The first Town Planning Act was issued in 1822 by Mr. Thomas S. Raffles to appoint the Committee to arrange the planning of the town. His instructions were "to line out the different streets and highways which should as far as practicable be at right angles". The parallel streets from Beach Road inwards as far as Bencoolen Street, north of the River, constitute the oldest portion of the town. It was around 1840 when Chinese settlers began building Chinatown with a dense network of streets on the right bank of Singapore River, while the Europeans settled on the opposite bank. The city has grown, but it was only in 1920 when population had reached the half million mark. By 1940 to 1950, Singapore started facing more and more serious urban problems such as the proliferation of squatter settlements and disorderly concentration of temporary tenements, lack in essential services, which had been worsened by population growth, continued rural-urban migration, land scarcity, and rising demand for increasing land areas to accommodate new wants and activities generated by rising incomes. Later, these problems have been further aggravated by the necessity to provide land for defense requirements, water catchment areas

Table 2.1

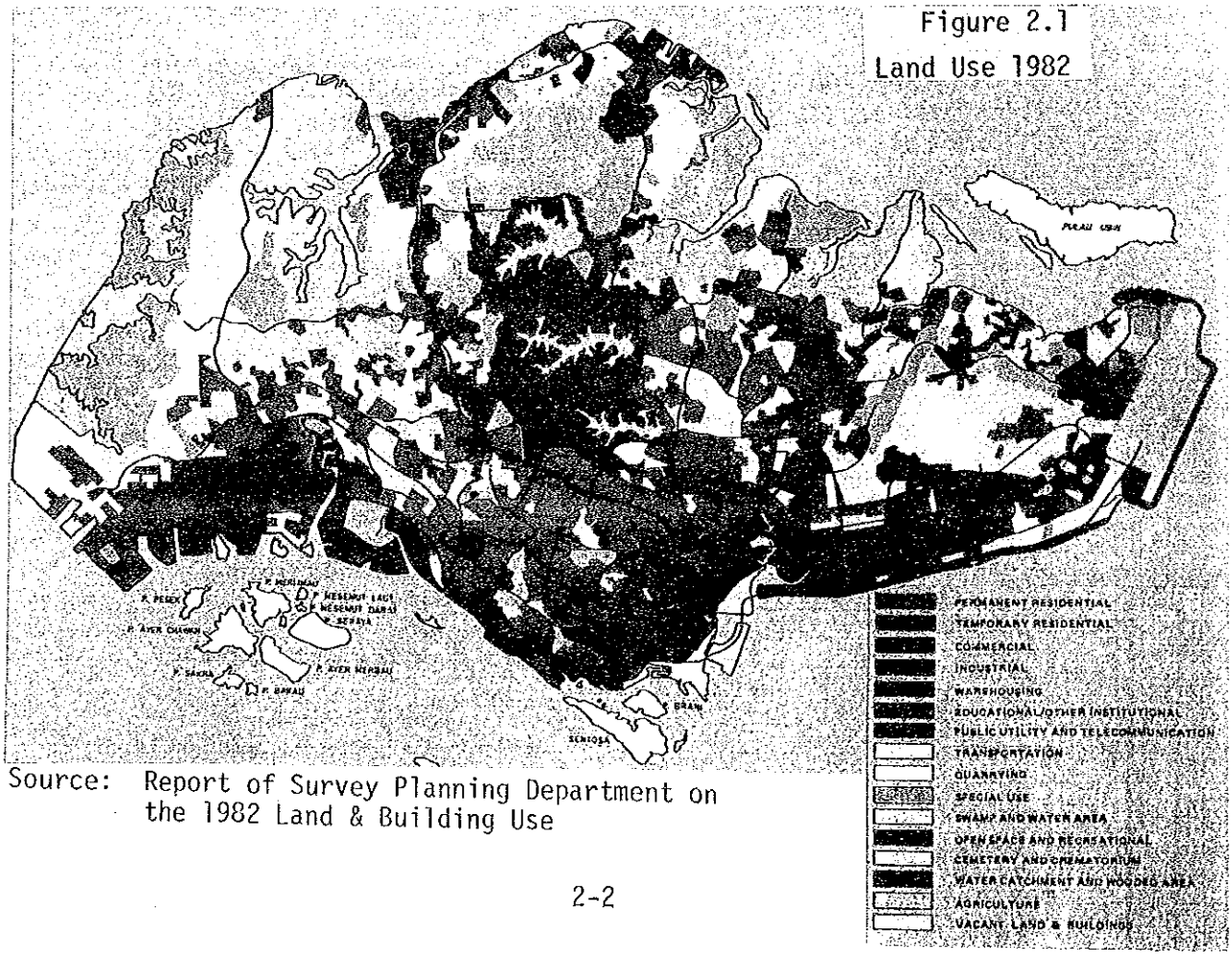
Changes in Land Use Between 1967 and 1982

Land Use	1967 Area in ha.	1967 (%)	1982 Area in ha.	1982 (%)	Increase/Decrease Area in ha.	Increase/Decrease (%)
Residential	7,484	(13.8)	8,716	(15.3)	1,232	(16.5)
Commercial	710	(1.3)	803	(1.4)	92	(13.1)
Industrial & Warehouse	728	(1.3)	3,345	(5.9)	2,620	(360.0)
Educational/Institution	1,471	(2.7)	2,506	(4.4)	1,035	(70.4)
Transportation	2,656	(4.9)	7,457	(13.1)	4,801	(180.8)
Utilities	438	(0.8)	1,002	(1.8)	564	(128.8)
Sub-Total (Urban Use)	13,859	(25.5)	24,351	(42.7)	10,492	(75.7)
Agricultural	14,282	(26.3)	8,101	(14.2)	-6,181	(-43.3)
Reserved and Others	26,162	(48.2)	24,588	(43.1)	-1,574	(-6.0)
Total	54,303	(100.0)	57,040	(100.0)	2,737	(5.0)

Source: 1982 Land Building Use: Report of Survey Planning Department, Ministry of National Development

Figure 2.1

Land Use 1982



Source: Report of Survey Planning Department on the 1982 Land & Building Use

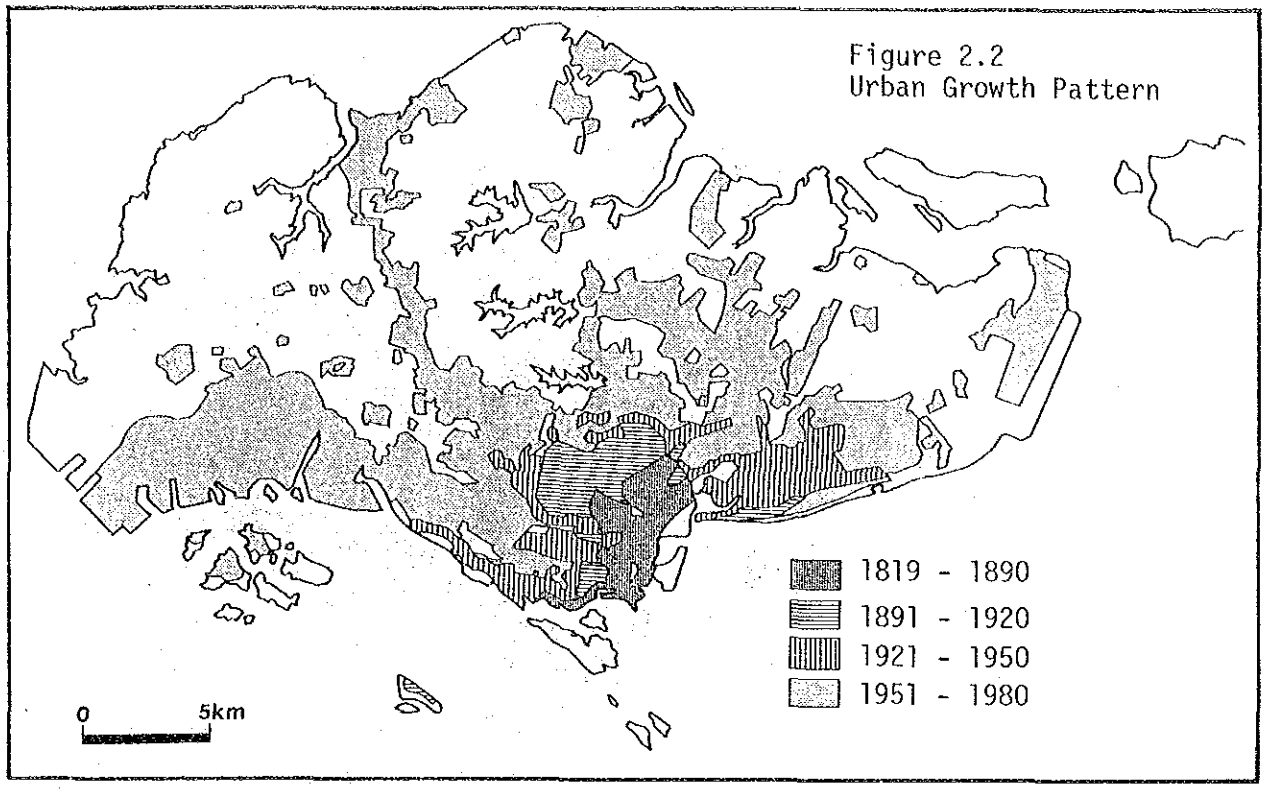


Figure 2.2
Urban Growth Pattern

civil aviation, public transportation, etc. Figure 2.2 shows a simplified growth pattern of Singapore.

Population is not evenly distributed, as shown in Table 2.2 and Figure 2.3 Heavy concentration is observed in areas along the three major transport corridors and in the area around the northeast periphery of the CBD. Employment is fairly widely distributed, as shown in Figure 2.4, although there is a higher concentration in the CBD (approximately 24% of the total employment), adjoining town areas (37%) and the Jurong/Clementi area (15%).

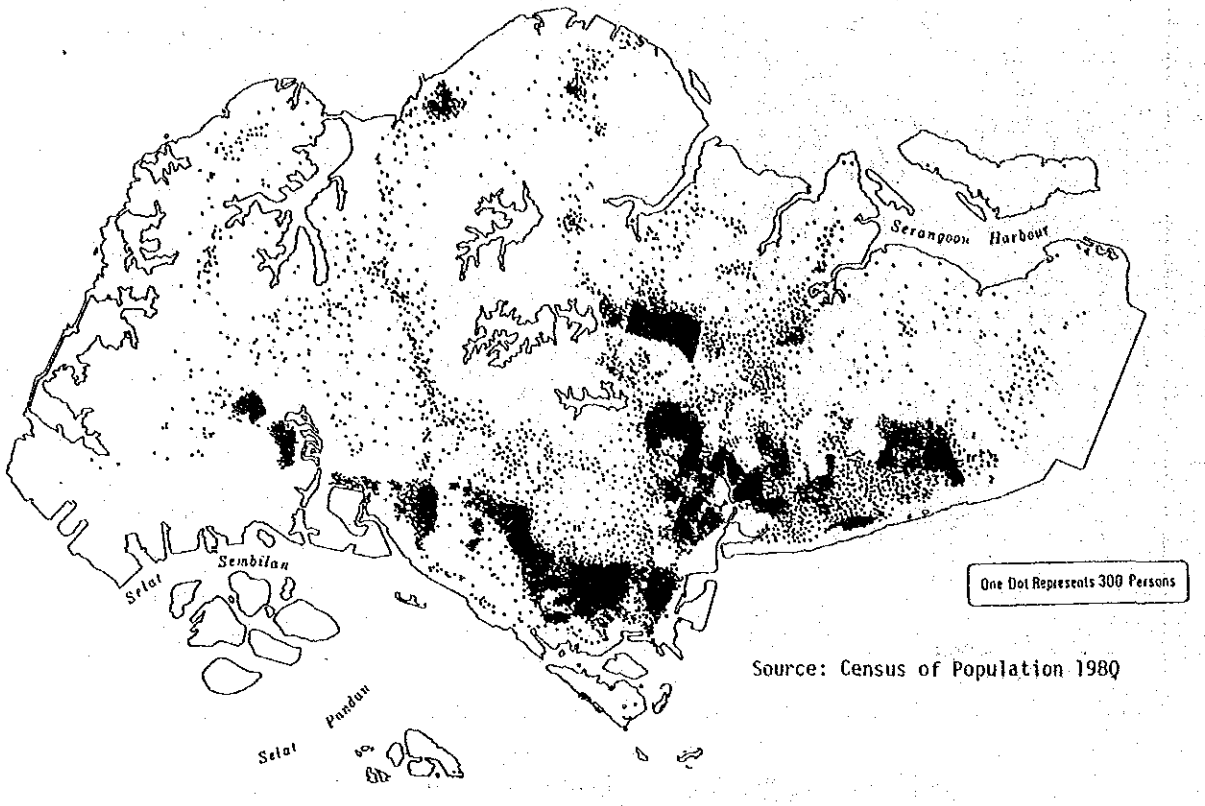
The distribution of population and employment is expected to change as follows:

a) Population of the central area and town area will decrease, while a considerable increase in other parts of the mainland is anticipated.

b) On the other hand, the locations of employment would not change much from the existing distribution pattern.

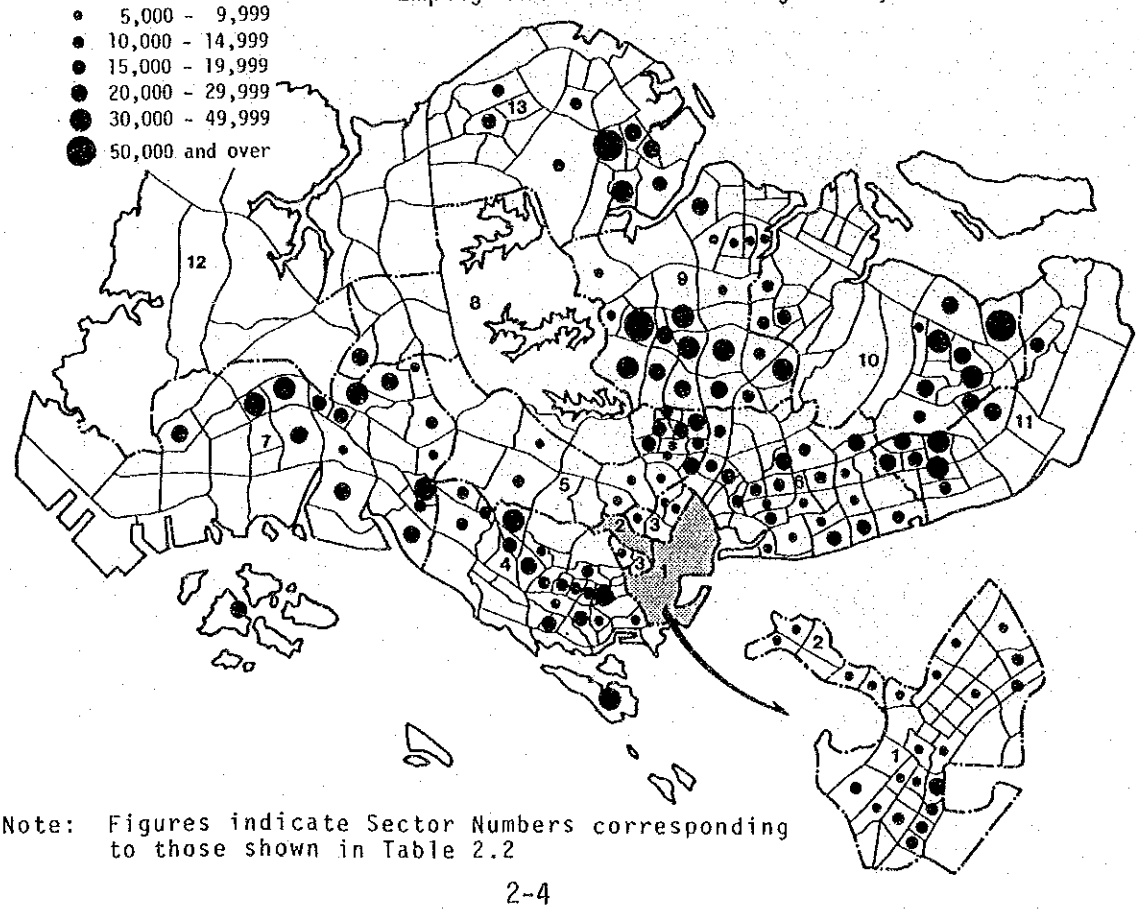
c) Although the basic urban structure with a mono business/ commercial activity center caters both for local and international people/entities, bus-centers with diversified functions will likely be created around several strategic locations.

Figure 2.3
Population Distribution, 1980[1/]



Source: Census of Population 1980

Figure 2.4
Employment Distribution by Zone, 1980



Note: Figures indicate Sector Numbers corresponding to those shown in Table 2.2

Table 2.2

Distribution of Population and employment

Sector 1/	1980		1990		1990/1980	
	Population ooo (%)	Employment ooo (%)	Population ooo (%)	Employment ooo (%)	Population	Employment
A. CENTRAL AREA						
1. Central	153.4 (6.3)	223.0 (20.3)	131.3	239.8	0.86	1.08
2. Orchard	3.9 (0.2)	39.0 (3.6)	5.5	58.2	1.41	1.49
Sub-total	157.3 (6.5)	262.0 (24.3)	136.8 (5.1)	298.0 (24.1)	0.87	1.14
B. TOWN AREA						
3. Farrer Park/ River Valley 2/	41.2 (1.7)	16.3 (1.5)	47.7	18.6	1.16	1.14
4. Tiong Bahru/ Queenstown/ Telok Blangah	489.1 (20.3)	154.3 (14.3)	433.1	155.9	0.89	1.01
5. Bukit Timah/ Toa Payoh	293.9 (12.2)	93.6 (8.7)	266.4	88.6	0.91	0.95
6. Kallang/Geylang	428.2 (17.8)	139.1 (12.9)	369.6	152.3	0.86	1.09
Sub-total	1,252.4 (52.0)	403.3 (37.4)	1,116.8 (41.4)	415.4 (33.5)	0.89	1.03
C. ISLAND AREA						
7. Clementi/Jurong	222.0 (9.2)	106.7 (14.9)	374.1	190.3	1.69	1.18
8. Bt. Panjang/ Bt. Batok	55.5 (2.3)	21.3 (2.0)	88.5	26.3	0.63	1.23
9. Thomson/ Serangoon/ Ang Mo Kio	321.5 (13.4)	73.6 (6.8)	385.6	83.6	1.20	1.14
10. Tampines	54.8 (2.3)	32.9 (3.1)	274.9	43.6	5.02	1.33
11. Bedok/Changi	212.4 (8.8)	53.0 (4.9)	217.5	95.6	1.02	1.80
12. Lim Chu Kang	42.5 (1.8)	17.6 (1.6)	20.7	14.2	0.49	0.80
13. Woodlands/ Sembawang	84.8 (3.5)	41.9 (3.9)	82.4	57.9	0.97	1.83
Sub-total	993.5 (41.3)	401.0 (37.2)	1,443.7 (53.5)	511.5 (41.4)	1.45	1.28
SUB TOTAL(MAINLAND)	2,403.2 (99.8)	1,066.3 (99.0)	2,697.3 (99.9)	1,224.9 (99.1)	1.12	1.15
D 14. off shore	4.8 (0.2)	10.8 (0.1)	2.7 (0.1)	11.1 (0.9)	0.56	1.03
TOTAL	2,408.0 (100.0)	1,077.1 (100.0)	2,700.0 (100.0)	1,236.0 (100.0)	1.12	1.15

Source: Comprehensive Traffic Study, Phase

1/ See Figure 2.4 for sector boundaries; sector names are for location identification only.

2/ Sector 3 consists of two parts, separated by the Orchard Road corridor (Sector 2).

2.2 Urban Transport System

2.2.1 Network

Singapore's urban transport system has been predominantly catered by roads, while the Mass Rapid Transit (MRT) system has started its partial operation in November 1987 after a careful assessment of various studies undertaken over a decade. (See Figure 2.5.)

There are, at the end of 1986, 2,686 km of public roads including 77 km of expressways and 460 km of major arterial roads. The expressways, comprising east-west and north-south links, provide vital interisland services. It is expected that the whole system will be completed by mid-1990. The total length of the expressways will be approximately 150 kms. The total arterial roads are configured as such to supplement the expressways via interchanges. No major expansion of the arterial roads is expected in the future. (See Table 2.3.)

Table 2.3

Road Development in Singapore

Item		1975	1980	1985	1986	AGR (%) 1975-86
Road Length (Kms)	Paved Roads	1,722	2,048	2,507	2,573	3.7
	Expressway	] 263	39	73	77	] 6.7
	Major Arterial		313	435	458	
	Collector	122	157	202	210	5.1
	Local	1,337	1,539	1,797	1,828	2.9
	Unpaved	451	308	138	113	-11.8
	Total	2,173	2,356	2,645	2,686	1.9
Area (sq. kms)	Total Area	597	618	621	622	0.4
	Built-Up Area	228	275	299	300	2.5
Road Density (km/sqm)	To Total Area	3.6	3.8	4.3	4.3	-
	To Built-Up Area	9.5	8.6	8.8	8.9	-

Source: Public Works Department, Survey Department.

The MRT is a conventional electrically-driven railway system, 67 kms long, with 21 kms underground and operates through the most densely populated areas. It has the following operationally separate lines:

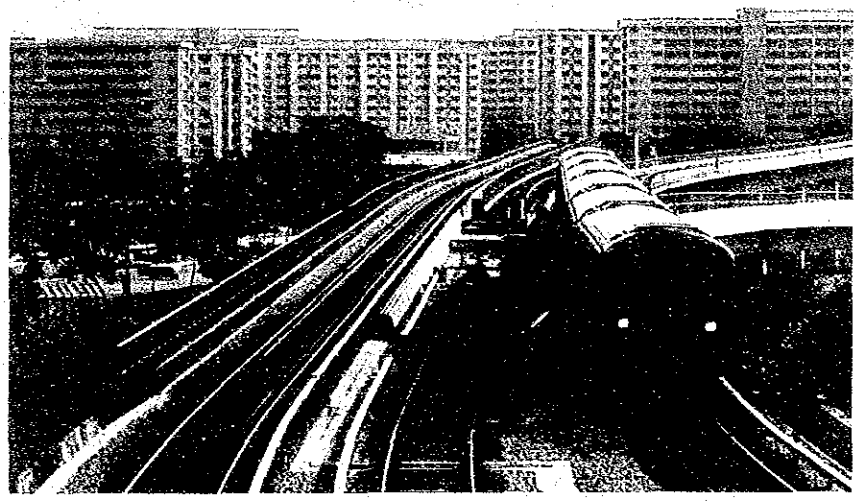
a) A North-South Line from Yishun to Marina Bay (22 kms)

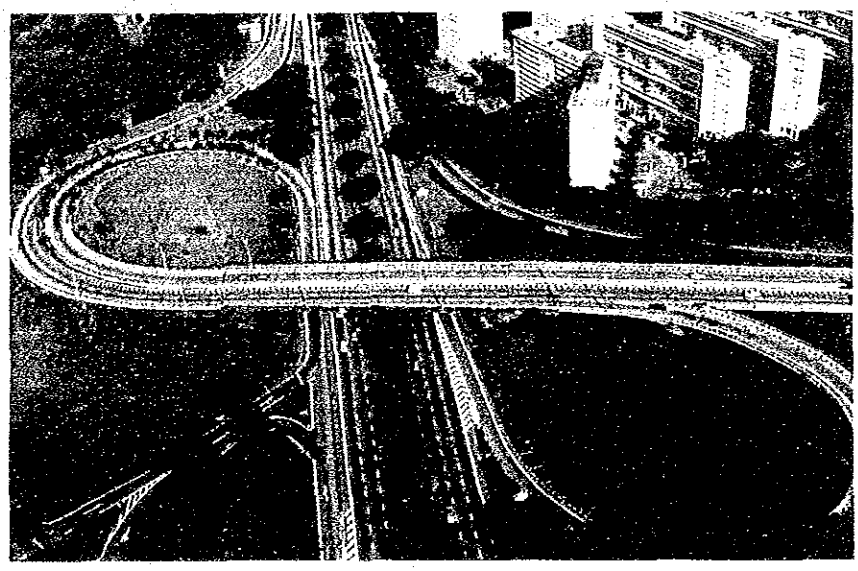
b) An East-West Line from Pasir Ris to Boon Lay (39 kms.) with a western branch between Jurong town and Bukit Panjang (6 kms)

The system has 42 stations, 15 underground and 27 above ground. Passenger coaches and underground stations are all air conditioned. It is expected that the whole system will be completed by 1990.

The MRT system connects major new towns to each other and with Orchard Road corridor and the CBD. Passenger transfers between the N-S and the E-W lines will take place at City Hall and Raffles Place Stations on the same platforms; namely, transfers between the northern and eastern sections at City Hall Station, and transfers between the northern and western sections at Raffles Place Station.

Bus network covers the whole island with extensively developed routes as shown in Figure 2.6. The bus system comprises clearly distinguished trunk and feeder services which are linked via purpose-built bus interchanges.





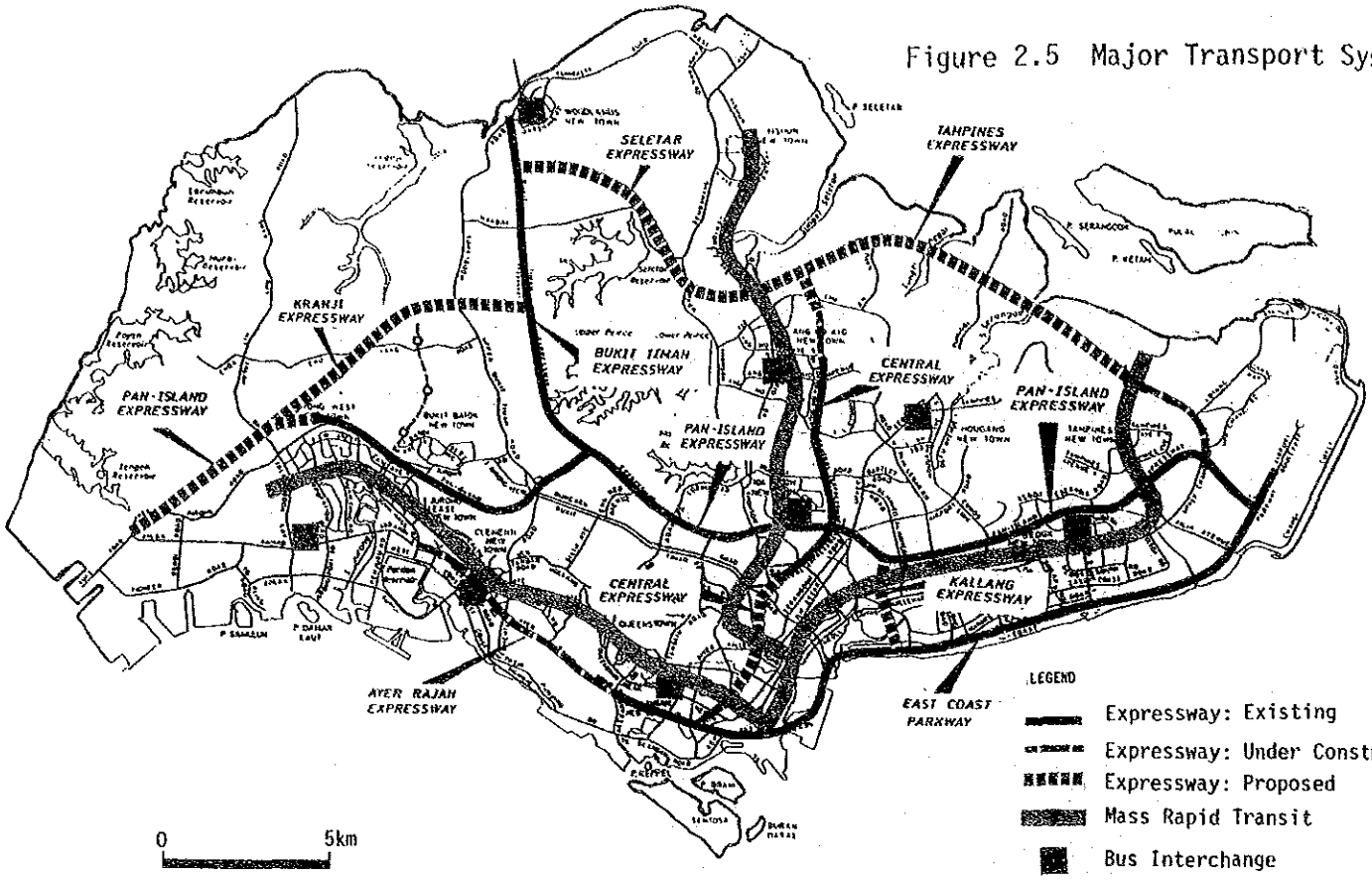


Figure 2.5 Major Transport Syst

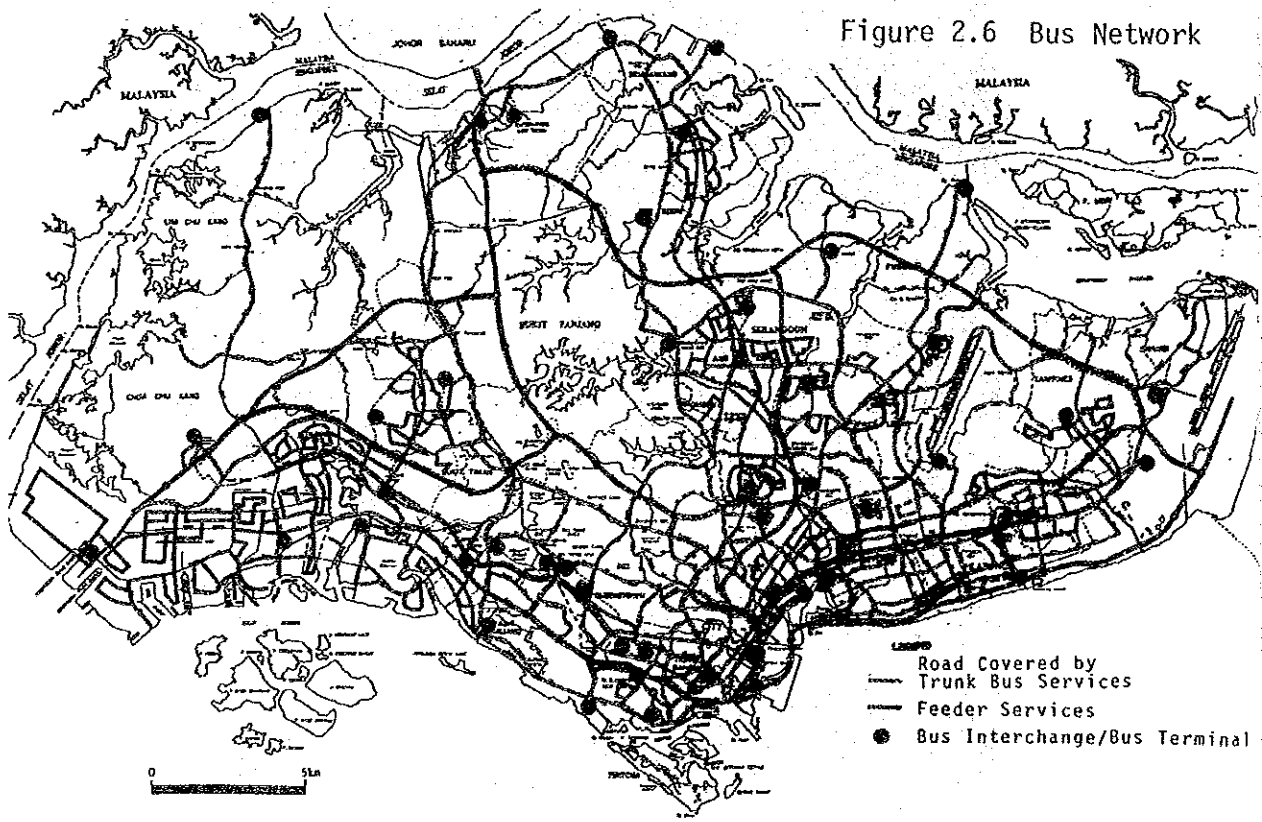


Figure 2.6 Bus Network

2.2.2 Transport Demand

Urban transport demand as of 1981, totalled about 3.7 million trips/day and is estimated to reach 4.2 million by 1990. The average annual growth rate estimated for the 1980-90 period is about 1.5%, which is slightly higher than that of the population (approximately 1.1% per year). For the 1990-2000 period, a slightly higher growth rate of 1.7% per year for transport demand is assumed. Modal-split between public and private transport modes would basically remain the same throughout the above periods. The fundamental underlying factors are as follows:

a) Current policy on restricting ownership and usage of cars will be continued.

b) Public transport will be further improved to provide an alternative transport mode.

Ownership of private cars in Singapore is low compared to its overall level of economy. This is due to the enforcement of an effective car ownership control. Early planning studies warned that the car population will grow so tremendously from 136,000 in 1973 to about 400,000 by early 1990, unless car ownership is restrained and that the resultant magnitude of traffic demand would be completely incompatible with the urban environment. Government measures currently taken on car ownership control are fiscal ones in the form of increased import duties, registration fees and annual road taxes.

Comprehensive transport demand data is available and sourced from the 1980/81 HIS conducted by MRTC. It is, however, to be noted that the figures are different from those shown in Table 2.4 and need proper adjustment in the course of further analysis in this study. The summaries of the overall transport demand in terms of motorized person trips are shown in Tables 2.5 and 2.6. These characteristics are, as follows:

a) Overall level of daily traffic demand is 4.3 million motorized person trips. Out of this, approximately 1 million or 24% of the total are to/from the CBD, while 2.5 million or 59% of the total are distributed among the remaining areas. As shown in Figure 2.7, the traffic distribution indicates that considerable non-CBD-related traffic exists, particularly, the demand along the circumferential route.

   The traffic moving within zones account for 17% or 0.7 million/day, which is one of the important potential feeder traffic.

Table 2.4 Growth of Transportation Demand

Time Period / Mode		1980 000 (%)	1990 000 (%)	2000 000 (%)
Daily Traffic Volume (No. of Trips)	Public	1,937 (53.0)	2,270 (53.7)	2,655 (53.4)
	Private	1,718 (47.0)	1,956 (46.3)	2,319 (46.6)
	Total	3,655 (100)	4,226 (100)	4,974 (100)
Morning Peak	Public	311 (59.2)	372 (60.3)	439 (60.3)
	Private	214 (40.8)	245 (39.7)	289 (39.7)
	Total	525 (14.4)	617 (14.6)	728 (14.6)
Evening Peak	Public	348 (55.7)	394 (56.9)	467 (57.0)
	Private	277 (44.3)	298 (43.1)	352 (43.0)
	Total	625 (17.1)	692 (16.4)	819 (16.5)
Off-peak	Public	1,278 (51.0)	1,504 (51.6)	1,749 (51.0)
	Private	1,227 (49.0)	1,413 (48.4)	1,678 (49.0)
	Total	2,505 (68.5)	2,917 (69.0)	3,427 (68.9)
Population (000)		2,408	2,700	3,000
Average Household Size		4.74	4.10	3.50
No. of Cars		153,900	220,000	250,000

Source: Papers Prepared by PWD for SUTIS Contact Mission

Table 2.5 Distribution of Person Trips by Area and Purpose

No. of Trips/day

Area / Purpose	Intra-zone ooo (%)	To/from CBD ooo (%)	Between the remaining zones ooo (%)	Total ooo (%)
to work/school	189.8 (25.5)	324.7 (31.8)	831.0 (32.6)	1,345.5 (31.2)
Business	75.3 (10.1)	133.1 (13.1)	205.2 (8.0)	413.6 (9.6)
Private	184.1 (24.8)	206.5 (20.3)	389.1 (15.3)	779.7 (18.1)
To home	293.7 (39.5)	355.2 (34.8)	1,124.2 (44.1)	1,773.1 (41.1)
Total	742.9 (100.0) (17.2) -	1,019.5 (100.0) (23.6) -	2,549.5 (100.0) (59.2) -	4,311.0 (100.0) (100.0) -

Source: 1980/81 HIS,MRTC

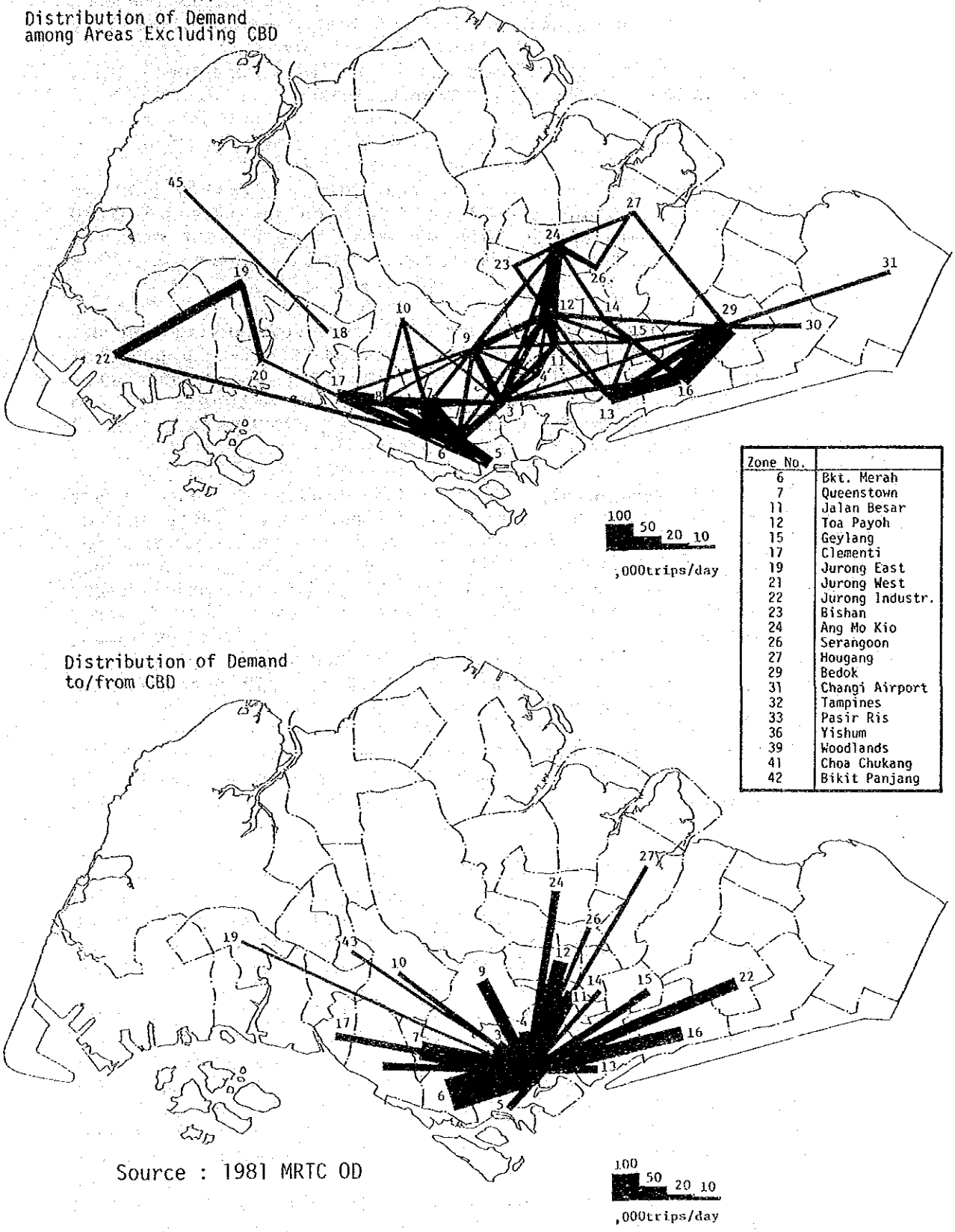
Table 2.6 Distribution of Person Trips by Area and Mode

No. of trips/day

Area / Mode	Intra-zone ooo (%)	To/from CBD ooo (%)	Between the remaining zones ooo (%)	Total ooo (%)
Public	359.6 (48.4)	520.9 (51.6)	1,451.4 (56.9)	2,331.9 (54.1)
Private	383.2 (51.6)	498.6 (48.9)	1,098.1 (43.1)	1,980.0 (45.9)
Total	742.8 (100.0) (17.2) -	1,019.5 (100.0) (23.6) -	2,549.5 (100.0) (59.2) -	4,311.9 (100.0) (100.0) -

Source: 1980/81 HIS,MRTC

Figure 2.7
Distribution of Inter-zonal Trips (Private and Public Modes) 1980



Zone No.	
6	Bkt. Merah
7	Queenstown
11	Jalan Besar
12	Toa Payoh
15	Geylang
17	Clementi
19	Jurong East
21	Jurong West
22	Jurong Industr.
23	Bishan
24	Ang Mo Kio
26	Serangoon
27	Hougang
29	Bedok
31	Changi Airport
32	Tampines
33	Pasir Ris
36	Yishum
39	Woodlands
41	Choa Chukang
42	Bikit Panjang

Source : 1981 MRTC OD

c) The traffic to/from CBD includes a relatively high percentage of non-home based traffic, while that between the remaining zones consists of home based traffic. The latter traffic comprising mainly of "to work/school" trips relies more on the public transport mode.

2.2.3 Road Transport

Overall service level of road transport is fairly high in Singapore. A congestion-free situation has been attained through the simultaneous implementation of different measures in addition to the effective control of car ownership. They are:

a) **Area License Scheme coupled with increased parking charges:** Six hundred twenty hectares of the most built-up parts of the city were defined as Restricted Zone. Private cars are discouraged from entering the CBD between 7:30 and 10:15 am by charging them with fees (with the exception of cars carrying 4 or more persons).

b) **Traffic management:** Other traffic management measures are also implemented and enforced effectively. These include one-way streets, computerized traffic signal controls for all traffic lights within the city area, box junctions, bus lanes, banning of on-street parking along all major roads, banning of heavy vehicle movements within the city area during peak periods, pedestrian crossing facilities, among others. Traffic congestion, which PWD regularly monitors by helicopter, is usually solved by adjusting traffic signal phasing or by channelization.

c) **Road Development:** As explained in section 2.2.1, specific efforts have been taken in road development. In the last decade or so, PWD had spent roughly S$2 to 2.5 billion.

d) **Upgrading of Public Transport:** In the early 1970s, the bus industry was reorganized and modernized to compensate the restricted movements using private transport. The development of MRT further intends to strengthen and increase the attractiveness of the public transport system.

At the same time, however, overall road traffic has been increasing gradually, but at a faster rate than road development. It is, therefore, estimated that traffic congestion will accrue various locations of roads especially around the fringes of the CBD. Critical areas include a considerable length of PIE, around the intersection of CTE near Toa Payoh, and a certain section of ECP. Although there are possibilities of expanding PIE from three lanes to four lanes per direction, it is feared that the overall traffic situation along the expressways and both inner and other ring roads might become worse.

On the other hand, the CBD would continuously enjoy the present situation in the coming years due to the ALS. Compared to the traffic level of 1975, that of 1987 is lower by 65% and even that of 1990 will be lower by 30%. Table 2.7 shows a comparison of road travel speeds for different major roads. Although the figures need to be updated, the tendency of a decreasing service level is indicated. The heavier congestions during evening peak hours, particularly along some roads in and around the CBD are mainly due to through-traffic.

2.2.4 Public Transport Services

Bus services in Singapore are provided by Singapore Bus Services (SBS), Trans-island Bus Services (TIBS), City Shuttle Services (CSS), Scheme A and Scheme B. SBS and TIBS are publicly owned, while the others are privately owned and operated. The services consist of trunk services and feeder services. The former mainly provides direct routes to cover major traffic generating sources, which also cater to short distance trips along the routes. Feeder bus services are short distance services operated mainly in new towns and industrial areas for passenger collection, distribution and local travel.

SBS provides 217 services including 76 feeder services and 4 weekend only services. TIBS provides 20 services including 8 feeder services in Woodlands and Yishun New Towns. CSS provides several services between housing estate and the CBD. Beside these bus services, supplementary bus services are operated during peak hours, such as school buses and private-hire coaches called Schemes A and B. Scheme A provides contract services for commuters, while Scheme B provides services between residential areas and the CBD or industrial shuttle areas. An outline of the bus services in Singapore is shown in Table 2.7.

Table 2.7

Outline of Bus Service in Singapore

Bus Service Type		No of Routes	No of Buses owned	No of Bus Trips /day	Bus Ridership million/year	Bus Ridership ooo/day
Public Bus	SBS [1]	218 (Trunk 141)[5] (Feeder 77)	2,289 [4]	33,760	843 [2]	2,310
	TIBS [1]	22 (Trunk 14) (Feeder 8)	329 [1]	4,450	86	235
	CSS [3]	9	113	750	22	75
Scheme B [3]		37	444	640	8	26.5
TOTAL		286	3,175	39,600	959	2,646.5

Table 2.8

Average Road Travel Speeds for Overall Road Traffic and Bus Traffic[1]

Area/Road		MORNING PEAK SPEED 1972	MORNING PEAK SPEED 1981	OFF-PEAK SPEED 1972	OFF-PEAK SPEED 1981	EVENING PEAK SPEED 1972	EVENING PEAK SPEED 1981
Overall Traffic							
RESTRICTED ZONE	Bras Basah Road	27.2	23.6	20.2	17.5	20.5	14.6
	New Bridge Road	26.6	27.7	33.8	21.9	30.9	14.4
	Orchard Road	27.2	28.0	28.5	21.5	27.4	22.7
	Robinson Road	40.5	25.6	26.6	21.2	28.0	5.9
	Shenton Way	24.3	32.6	32.8	35.0	20.2	35.4
	South Bridge Road	21.0	21.8	17.4	16.6	21.9	28.3
	Stamford Road	20.6	22.8	35.0	18.2	19.9	18.2
	Alexandra Road [1]	36.3	27.4	37.0	32.9	33.6	36.6
	Keppel Road [1]	32.3	39.6	39.7	37.1	44.5	39.4
	Mountbatten Road [1]	42.7	36.3	45.5	41.6	39.0	31.8
	Nicoll Highway [1]	53.1	44.3	54.1	44.9	54.7	45.0
	Scotts Road	33.3	28.0	33.5	29.0	27.0	30.1
	Telok Blangah Road [1]	43.0	38.8	40.4	32.2	29.8	29.0
	Thomson Road [1]	29.4	19.5	37.5	35.3	27.7	14.8
	Upper Serangoon Road [1]	21.8	15.5	37.2	27.7	28.0	24.5
OUTER RING ROAD AND BEYOND	Adam/Lornie Roads	47.1	43.4	53.3	48.7	49.5	40.0
	Bukit Timah Road	42.9	39.0	48.0	45.0	29.0	44.0
	Dunearn Road	51.5	39.7	58.5	43.1	51.5	34.1
	Paya Lebar Road	35.2	26.4	39.8	35.2	35.4	15.9
	Upper Ayer Rajah Road	54.9	34.5	54.2	42.7	62.9	51.4
	Upper Serangoon Road	27.4	27.0	36.6	26.4	38.2	27.1
Bus Traffic							
RESTRICTED ZONE	Bras Basah Road	19.4	16.6	17.6	18.3	[2]	(3)
	New Bridge Road	19.5	24.2	18.7	19.2	[2]	8.2
	Orchard Road	22.3	18.6	20.0	17.7	[2]	13.1
	Robinosn Road	[3]	[3]	[3]	16.8	[2]	12.5
	Shenton Way	21.0	19.6	27.7	21.3	[2]	18.4
	South Bridge Road	20.5	17.2	15.4	19.0	[2]	11.0
	Stamford Road	18.9	21.3	16.7	19.0	[2]	8.2
WITHIN OUTER RING ROAD	Alexandra Road (2)	24.2	24.8	24.3	21.2	[2]	16.9
	Keppel Road (2)	29.6	28.8	34.2	28.7	[2]	21.0
	Mountbatten Road (2)	29.0	27.7	28.2	29.4	[2]	22.0
	Nicoll Highway (2)	48.5	40.5	38.6	39.0	[2]	30.5
	Scotts Raod	23.7	18.2	23.4	21.0	[2]	10.6
	Telok Blangah Road (2)	27.2	18.7	29.4	26.1	[2]	16.6
	Thomson Road (2)	24.1	18.8	24.9	20.0	[2]	19.7
OUTER RING ROAD AND BEYOND	Adam/Lornie Roads	31.4	36.3	39.8	30.7	[2]	[3]
	Bukit Timah Road	29.9	27.8	36.3	34.0	[3]	24.8
	Dunearn Road	16.5	[3]	36.6	30.1	[2]	24.9
	Paya Lebar Road (2)	21.9	20.6	26.0	19.6	[2]	13.9
	Upper Ayer Rajah Road(2)	42.4	21.4	50.9	31.0	[2]	23.5
	Upper Serangoon Road (2)	21.3	17.6	25.1	14.8	[2]	22.4

Source: Comprehensive Traffic Study Phase A

1/ Average morning and evening peak speeds are given for direction of predominant traffic. Off-peak speeds represent two-way traffic flow.

2/ No evening peak bus travel speeds reported in 1972.

3/ No data available for comparison.

As was previously shown in Figure 2.6, the route structure of trunk services is very extensive. SBS alone operates a total round trip distance of about 5,200 kms for trunk services. The characteristics of the route structure are as follows:

a) Major traffic generating sources (residential and employment areas) are linked by more than one bus service with slightly different vias.

b) Trunk routes are, however, particularly concentrated in the CBD. As shown in Table 2.9, 95 out of 137 trunk routes or about 70% of the total ply roads in the CBD.

Table 2.9

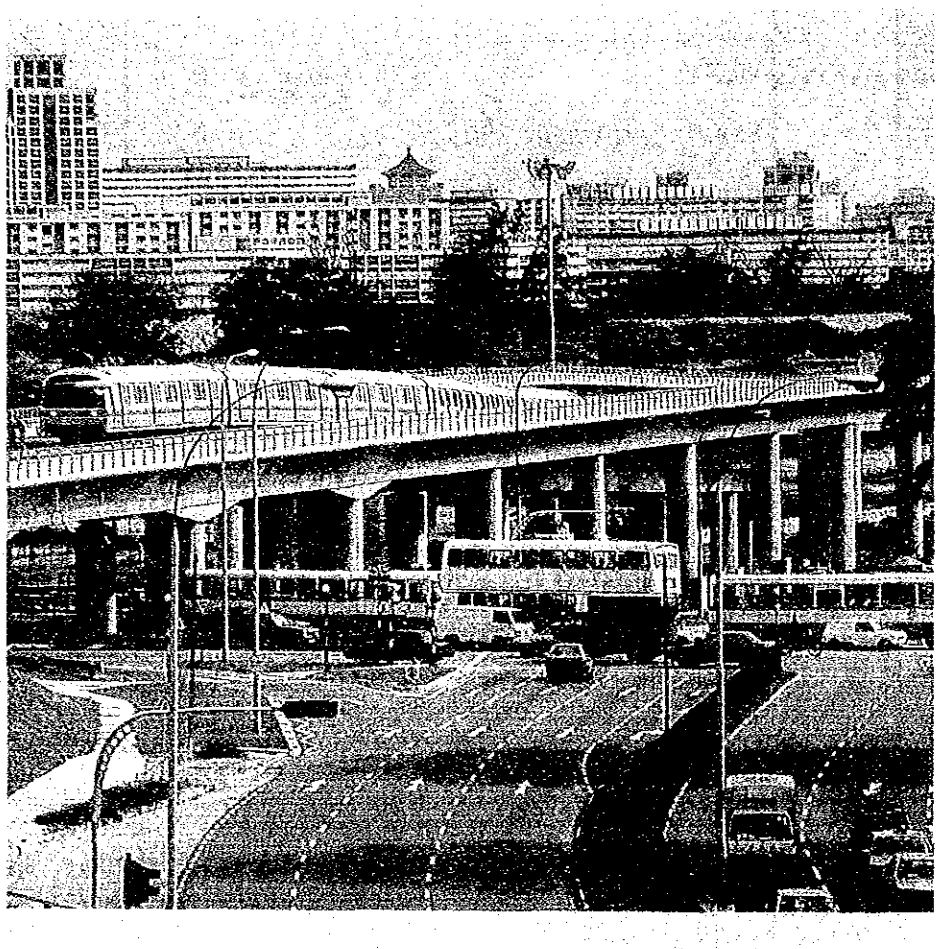
Location of Trunk Bus Routes

Route Type	No. of Routes	% to Total
to/from CBD	50	36.5
Passing-through CBD	45	32.8
Others	42	30.7
Total	137	100.0

Source: SBS, Mini Bus Guide 1986

Trunk and feeder bus routes are structured to supplement each other (as clearly indicated in Figure 2.6), wherein bus interchanges play significant roles. There are, at present, 12 bus interchanges mainly provided in new towns. Passenger transfer between trunk and feeder buses can be done on the same platform. Feeder bus services in Singapore are also provided by two major public transport operators: Singapore Bus Service Ltd. (SBS) and Trans-island Bus Service Ltd. (TIBS), the same as trunk bus services. There are, as of 1987, 84 services of which 65 operate in HDB new towns, while 19 in other areas including Jurong Industrial Area and HDB estate. The total round trip distance of feeder bus routes is 658 kms of which 445 kms or 68% are operated in HDB new towns. Average route length (round trip) of feeder bus routes is fairly short (7.8 kms), except for Jurong Industrial Area.

The typical bus service for new towns is a combination of trunk service and feeder service via bus interchanges. The former provides inter-area trunk transport, while the latter provides intra-new town services. These new towns, however, are not always served by the above type of bus service. Twelve out of 20 new towns are provided with bus interchanges and 14 with feeder bus services. The remaining 6 new towns are not served by feeder bus services either because trunk bus services are extensively available (Geyland and Jalan Besar New Towns) or because they are still at the early stage of development (Bishan, Choa Chu Kang, Pasir Ris and Bukit Panjang new towns). Even in new towns with feeder bus services, there are a considerable number of bus services which only pass through the new towns.



2.3 New Town Developments

The physical planning of new towns has been made based on the following concepts:

a) satellite development

b) optimization of scarce land resources

c) provision of a housing environment better than that from where the residents came from

d) application of the neighbourhood principle

Generally speaking, new towns are planned satellite developments. They are essentially very large residential developments that are comprehensively planned, usually with facilities to support the new community so that it can lead to an adequate existence, fairly independent from the city and other major centers. Their appeal lies in the fact that they offer new and better ways in the organization of the urban environment for work and living, in comparison to the traditional alternative of a contiguous physical expansion within the metropolis. Singapore's new towns have a unique characteristic in that they are almost exclusively all high-rise, high-density public housing development. Each has a large population and many of them develop rapidly. They enjoy a fair degree of self-sufficiency in terms of day-to-day needs for the family, as well as, recreation and, to a certain extent, work opportunities. However, because of the relatively small size of the republic, the new towns are functioning more as nodes within a highly compact and interrelated urban system rather than as satellites. Within this system that is emerging, the new towns are interlinked by a high capacity transportation network that should offer the best in decentralization and good accesibility to the various major activity centres (Housing A Nation March 1985 HDB).

During the early periods, emphasis was given to find a viable alternative to the slums/squatter housing. Therefore, the initial building programmes had to concentrate on low-cost units. With the rising standards of living and expectations of better-quality housing, larger and improved models of flats were designed and a more comprehensive housing was planned and developed. Efforts have been taken to improve HDB physical planning and design work covering flat design, building block design, site planning and new town planning to meet the ever increasing demand of quality environment.

The existing new towns, either completed or ongoing, are summarized in Table 2.10 and their locations are shown in Figure 2.8. The existing new towns have different scales of developments. This is so, not only because of the difference in planned size but, also, in the different speed of development. They can be categorized into three types, namely:

a) Large-scale New Town: with approximately 50,000-70,000 dwelling units or a population of 200 to 300,000 including Bukit Merah, Bedok, Ang Mo Kio, Woodlands, Tampines, Jurong West and Yishun.

b) Medium-scale New Town: with approximately 30,000-45,000 dwelling units or a population of around 150,000 including Toa Payoh, Queenstown, Jalan Besar, Geylang, Hougang, Pasir Ris, Choa Chu Kang and Bukit Panjang.

c) Small-scale New Town: with approximately 20,000 to 28,000 dwelling units or a population of around 100,000 including Bukit, Batok, Clementi, Jurong East, Serangoon and Bishan.

Large-scale new towns are expected to provide a total of 423,800 dwelling units, while those completed (including those under construction as of 31 March 1986) have reached 302,750 with an overall completion ration of 71%; medium-scale new tonws have similarly 305,100 planned units, 184,980 completed units and a completion ration of 61%; small-scale new towns and 117,000 planned units have 93,590 completed units with a completion ratio of 80%. The planned and present development scale of the new towns are also illustrated in Figure 2.9

The speed of the new towns development is shown in Figure 2.10. Two epoch-making new towns initiated in the 1960s -- Queenstown and Toa Payoh -- had only reached their final stage of construction around 1975, while others which started after 1970 usually grew much faster, with the exception of Woodlands. It took only about five years for Ang Mo Kio anwd Bedok New Town to reach their planned scale of development. New towns construction which started in the 1980s have also been growing rapidly. For the two new towns of Toa Payoh and Queenstown, redevelopment has been taking place since 1985.

The tendency for the land area of new towns to become larger as their location gets further from the CBD is not necessarily true as shown in Figure 2.11. The development size of a new town appears to be dependent mainly on the availability of land where the project was/would be executed. On the other hand, the development density of the residential area of the new town is related to the distance between a new town and CBD. Those new towns located within 10 km from the CBD have high population densities. Toa Payoh's net density is as high as 1000 persons/ha., while most of the new towns located more than

Table 2.10 Profile of HDB New Towns

CORRIDOR	NEW TOWN	LAND USE: TOTAL AREA :HA	RESID'L AREA: HA	(%)	OTHER MAJOR USE 1/	PLANNED SIZE: NO.OF DWELG UNITS	ESTD POP. :000	DENSITY PERSONS/HA: GROSS	NET	CURRENT SIZE (as at Mar'86): ESTD POP. :000	(%) COMPL -ETION	FIRST YEAR HDB FLAT COMPLTD	TRANSPORT FEATURES: DISTANCE TO CBD :KMS	NO.OF MRT STATN	NO.OF EXPRY I.C.	NO. OF BUS I.C.
EAST	① Geylang	1,085	173	(10)	C.I.	37,300	142	131	821	131	(92)	1962	4- 6	2	5	-
	② Bedok	974	285	(29)	I	57,100	217	223	761	201	(93)	1967	11-14	2	2	1
	③ Tampines	1,035	377	(36)	-	65,400	249	241	660	137	(55)	1981	15-19	2	6	-
	④ Pasir Ris	998	208	(21)	C.I	36,000	136	136	654	1	(1)	1987	19-22	1	3	-
	SUB-TOTAL	4,092	1,043	(25)		195,800	744	182	713	470	(63)	-				
NORTH -EAST	⑤ Serangoon	634	123	(19)	-	21,000	80	126	650	50	(63)	1977	7- 9	-	3	-
	⑥ Hougang	1,196	245	(21)	I	41,000	156	130	637	109	(72)	1974	8-11	-	-	1
	SUB-TOTAL	1,830	368	(20)		62,000	236	129	641	159	(67)	-				
NORTH	⑦ Jalan Besar	813	152	(19)	C.I.E	37,400	142	175	934	136	(96)	1962	3- 4	1	5	-
	⑧ Toa Payoh	417	167	(40)	E	44,200	168	403	1,006	152	(90)	1966	6- 9	2	4	1
	⑨ Bishan	704	115	(16)	I	22,000	84	119	730	45	(54)	1972	9-10	1	-	-
	⑩ Ang Mo Kio	742	248	(33)	C.I	49,500	188	253	758	183	(97)	1975	10-15	2	3	1
	⑪ Yishun	919	315	(34)	-	60,000	228	248	742	163	(71)	1977	17-21	1	-	-
	SUB-TOTAL	3,595	997	(28)		213,100	810	225	812	679	(84)	-				
NORTH WEST	⑫ Bukit Panjang	475	173	(36)	-	30,000	114	240	659	36	(32)	1986	18-22	-	3	-
	⑬ Chua Chu Kang	466	211	(45)	-	35,000	133	285	630	14	(11)	1977	21-24	1	1	-
	⑭ Woodlands	1,244	358	(29)	I.R	66,000	251	201	701	86	(34)	1973	20-25	-	1	-
	SUB-TOTAL	2,185	742	(34)		131,000	498	228	671	136	(27)	-				
WEST	⑮ Bukit Merah	854	263	(31)	I.E	60,800	231	270	878	218	(94)	1962	3- 7	2	5	1
	⑯ Queenstown	716	183	(26)	I.E	40,600	154	215	842	127	(82)	1962	7-10	2	3	-
	⑰ Clementi	433	146	(34)	I	25,000	95	219	651	89	(94)	1977	12-15	1	3	1
	⑱ Jurong East	300	129	(43)	-	21,000	80	267	620	73	(91)	1980	17-22	1	2	-
	⑲ Bukit Batok	813	170	(21)	R	28,000	106	130	624	97	(92)	1977	14-19	2	2	-
	⑳ Jurong West	932	422	(45)	I	65,000	247	265	585	132	(53)	1981	21-25	2	2	1
	SUB-TOTAL	4,048	1,313	(32)		240,400	913	226	695	736	(81)	-				
TOTAL	-	15,750	4,463	(28)		842,300	3201	203	717	2180	(68)	-				

Source: worked out by the Study Team based on the information obtained from HDB

1/ C: Commercial, I: Industrial, E: Educational, R: Recreational

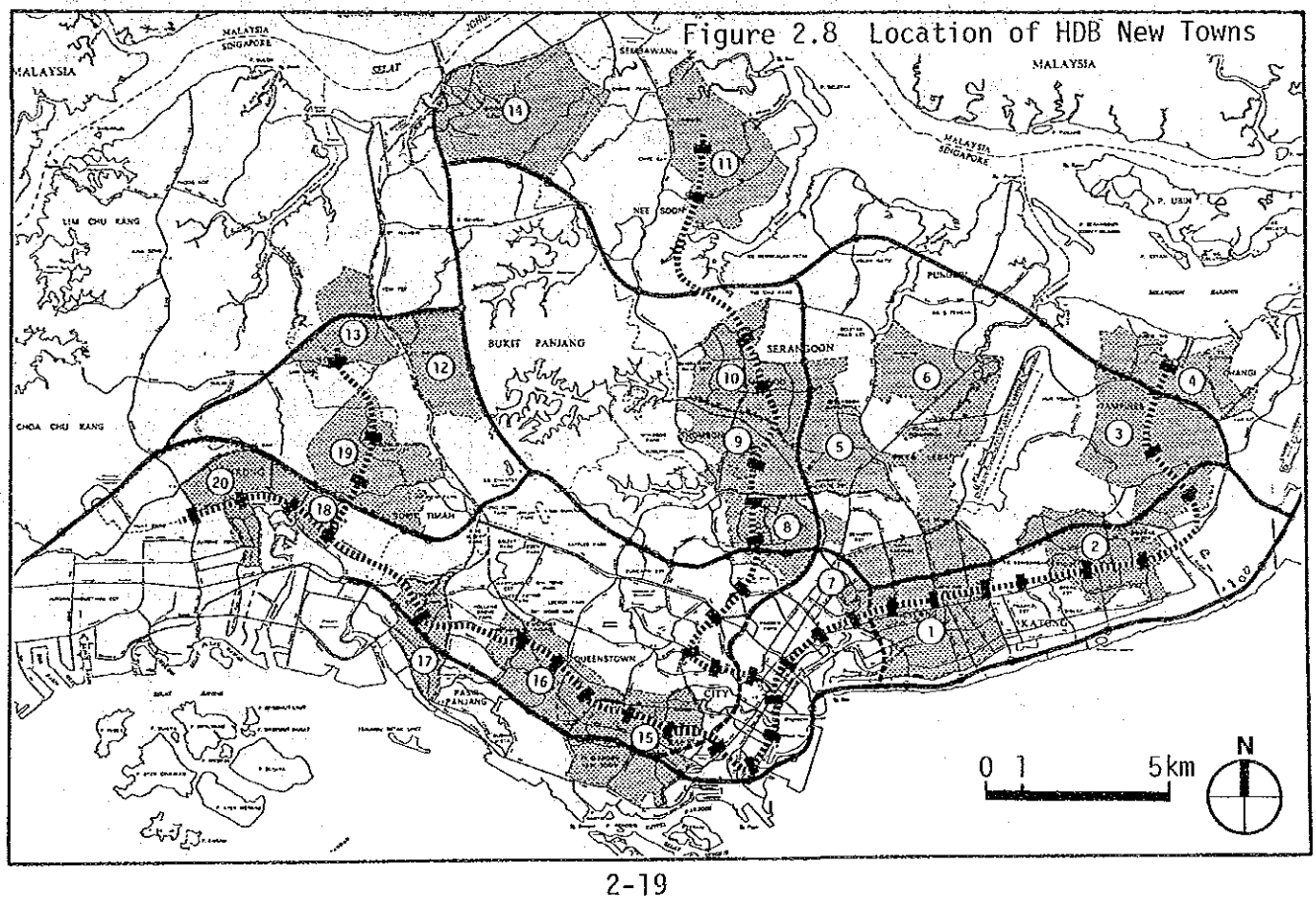


Figure 2.8 Location of HDB New Towns

Figure 2.10

New Town Development Process

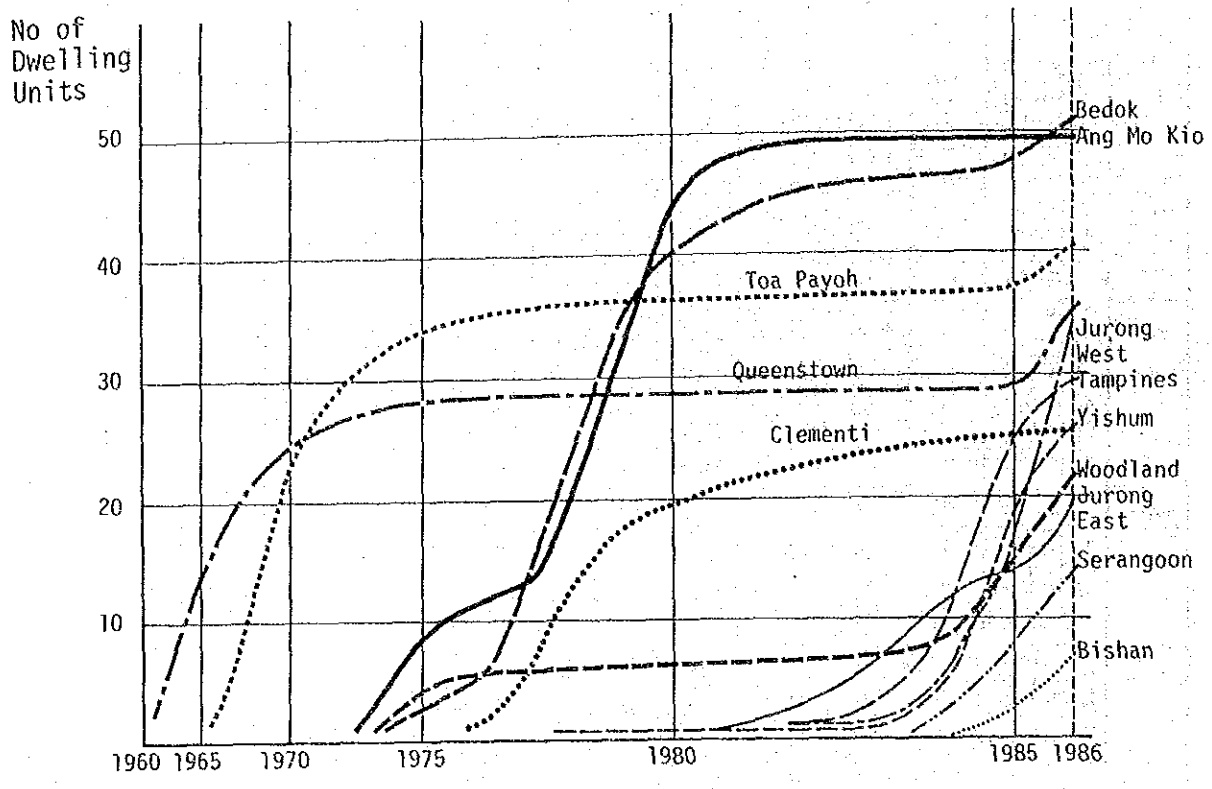


Figure 2.9

Planned and Present Development Scale of New Towns

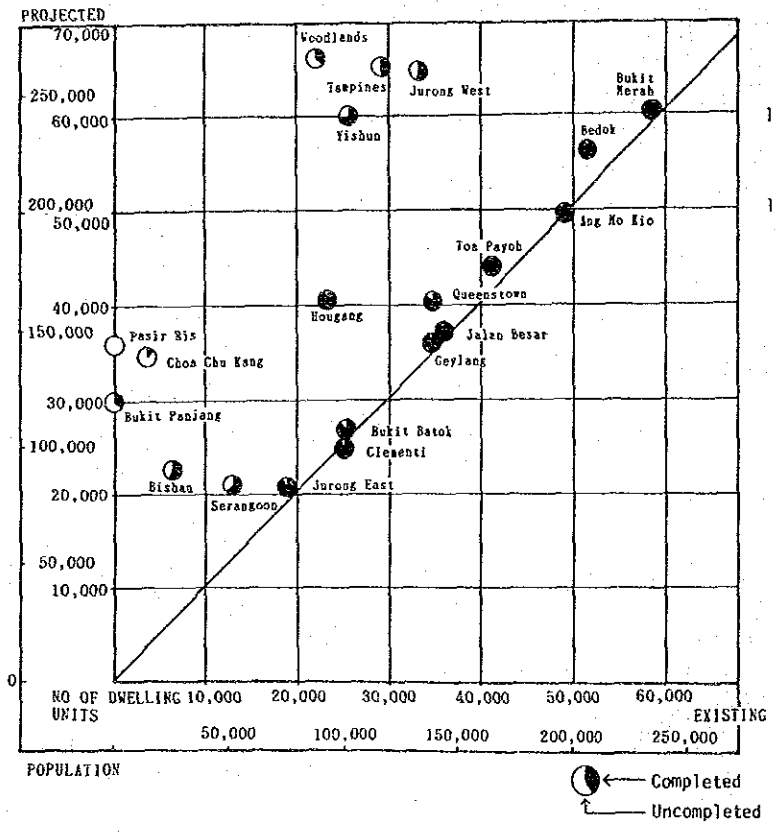
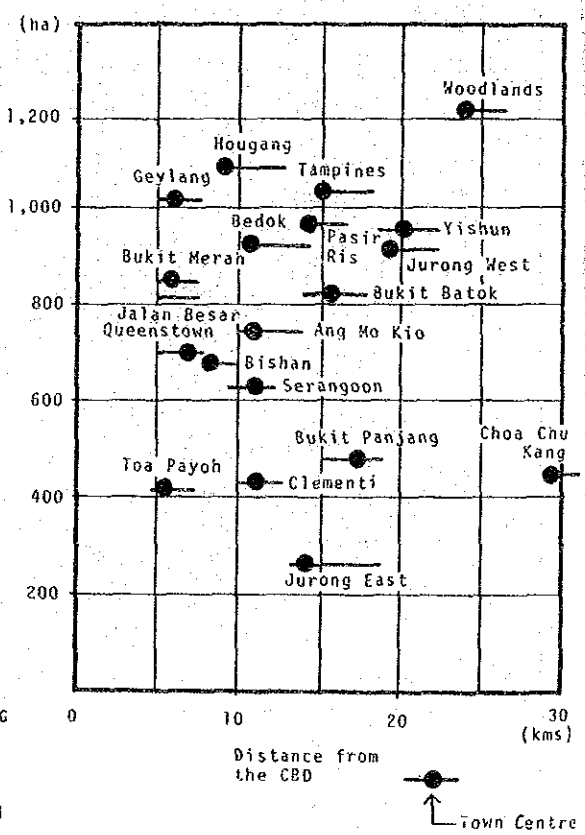


Figure 2.11

Relation between New Town Project Area and Distance from the CBD



10 km from the CBD have population densities between 600 and 800 persons/ha. Jurong West New Town has the lowest net population density of 585. Moreover, new developments are generally located further from the CBD.

New towns are planned on a neighbourhood principle. In the neighbourhood concept, a new town is divided into neighbourhoods of around 4,000 to 6,000 dwelling units. Each neighbourhood houses about 20,000 to 30,000 people which is sufficient to support basic community and shopping facilities provided in a neighbourhood center, located within walking distance (three to five minutes) for most residents. These neighbourhoods are further divided into precincts, each comprises of 500 to 1,000 dwelling units and The each houses between 2,500 to 5,000 people to enhance social interaction among residents. A town center is provided in each new town and is normally located in its geographical center. Generally, for a new town of 40,000 dwelling units, some 41% of the land are set aside for housing development, 10% for schools, 20% for industries, 4% for the town center, 3% for institutional use, 7% for sports/open space development and the remaining 15% for roads and other infrastructure services. Table 2.11 compares land use distribution among the selected new towns and prototype new town, while Figure 2.12 shows the typical land use plan of one of the latest new towns. Planning/design concepts and standards (although revisions and improvements have regularly been made), are quite similar among new towns.

As all new towns are similarly planned on a neighbourhood concept, the physical structure does not vary much. Each new town has a town center and most of them have bus interchanges/terminals. This section, therefore, looks into the new towns with particular regard to the transport network. With the opening of the MRT (which is expected to form the dominant public transport trunk system), the transport network of new towns can be assessed in relation, firstly, with the MRT and, secondly, with the expressways. Other factors to be considered are:

a) location of town center and other major traffic generating sources in new towns, such as industrial area, tertiary school, etc.

b) existence and location of bus interchange/terminal in relation to MRT and expressways.

Accordingly, the new towns can be characterized, as shown in Figure 2.13.

Table 2.11

Comparison of Landuse Distribution of New Towns

Land Use	Toa Payoh New Town 36,758 dwelling units Constructed in 1965-77		Ang Mo Kio New Town 49,483 dwelling units Constructed in 1973 - 82		Prototype New Town 40,000 dwelling units Post 1982	
	Land area		Land area		Land area	
	(ha)	(%)	(ha)	(%)	(ha)	(%)
1. Commercial (Town Centre & Neighbourhood Centres)	33.5	9.0	54.0	7.6	86	13.7
2. Residential	150.4	40.3	248.2 2/	34.8	207	33.1
3. Schools	49.8 1/	13.4	58.6	8.2	73	11.7
4. Open Space	12.7	3.4	42.2	5.9	23	3.7
5. Sports Complexes	11.3	3.0	11.7	1.7	13	2.1
6. Institutions	19.0	5.1	32.3	4.5	23	3.7
7. Industry	47.0	12.6	128.5	18.0	120	19.2
8. Major Roads	44.5	11.9	116.7	16.4	75	12.0
9. Utilities & Others	4.8	1.3	20.9	2.9	5	0.8
Total	373.0	100.0	713.4	100.0	625	100.0
Gross New Town Density	99 du/ha 436 persons/ha		69 du/ha 304 persons/ha		64 du/ha 282 persons/ha	

Sourse: Housing A Nation, HDB March, 1985

1/ Includes all existing schools within the new town boundary though not provided by HDB

2/ Excludes 5 private estates which fall within the new town boundary.

Figure 2.12

Structural Model and Typical Land Use Plan of New Town

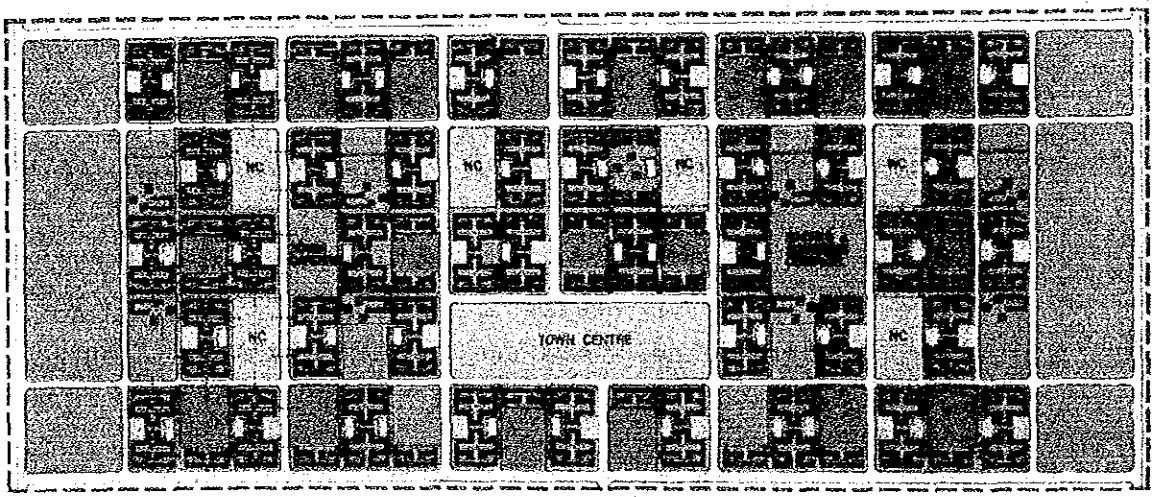
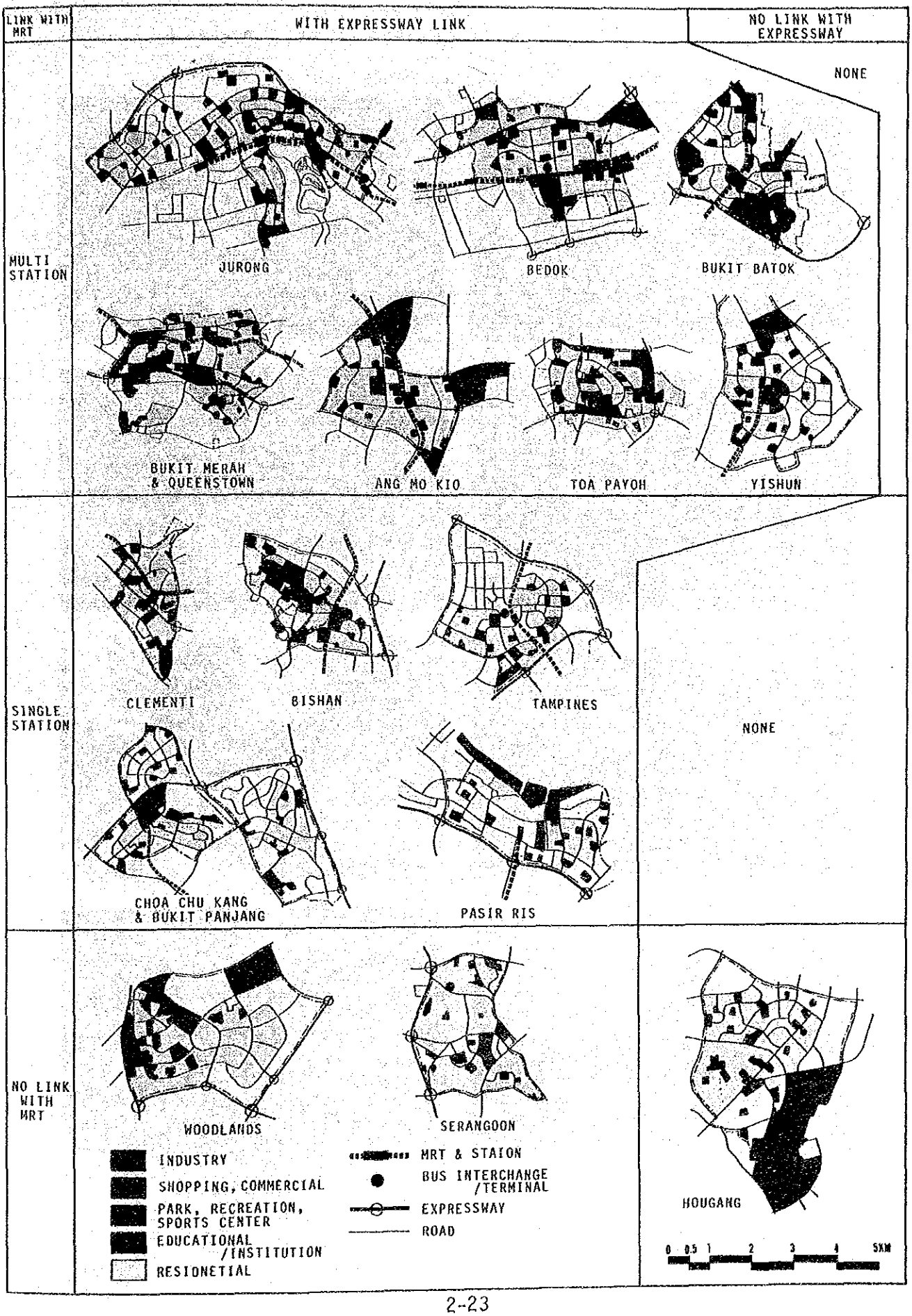
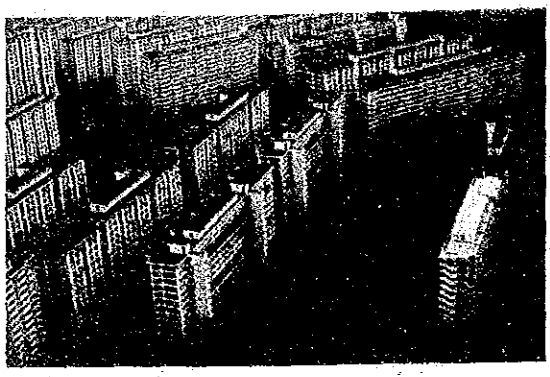
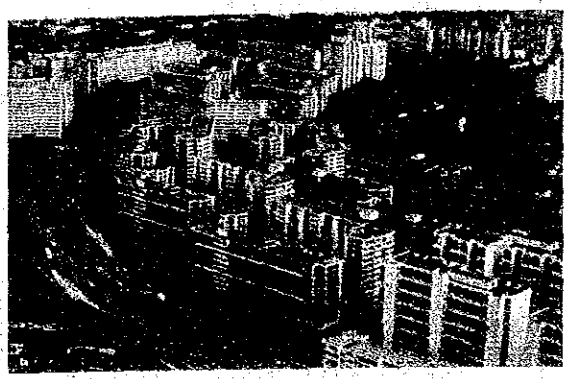
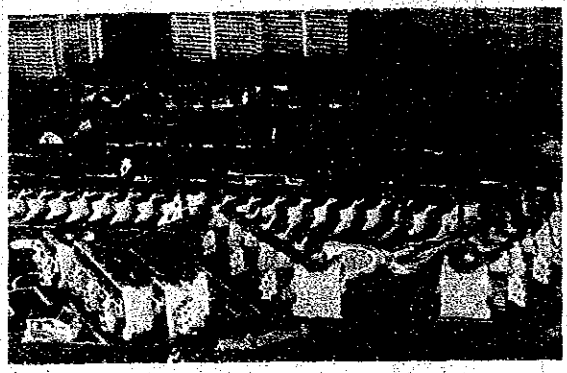
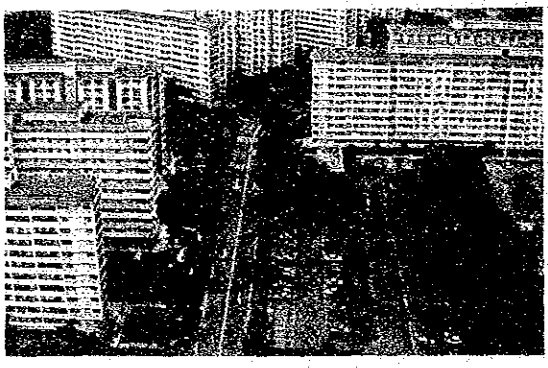


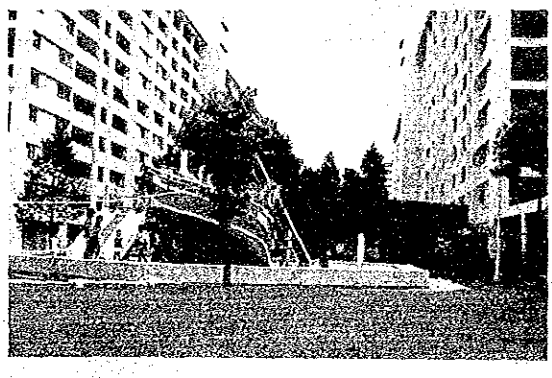
Figure 2.13

Physical Characteristics of New Towns






2.4 Singapore's Urban Transport Issues

Singapore is considered to be one of the few metropolises being relatively free from so-called urban transport problems such as traffic congestion, excessive environmental pollution, and high accident rate, among others. This is largely due to the successful and simultaneous implementation of several measures and policies, supported by financial, institutional and technical capabilities. They include:

a) extensive road network;

b) well-controlled land use and urban development;

c) discouraged ownership of private vehicles;

d) extensive implementation of traffic control and management, including Area Licensing Scheme for CBD;

e) well developed bus transport system; and,

f) strong/effective enforcement capabilities.

Development of MRT and further expansion of expressways will, also, contribute to the improvement of the situation.

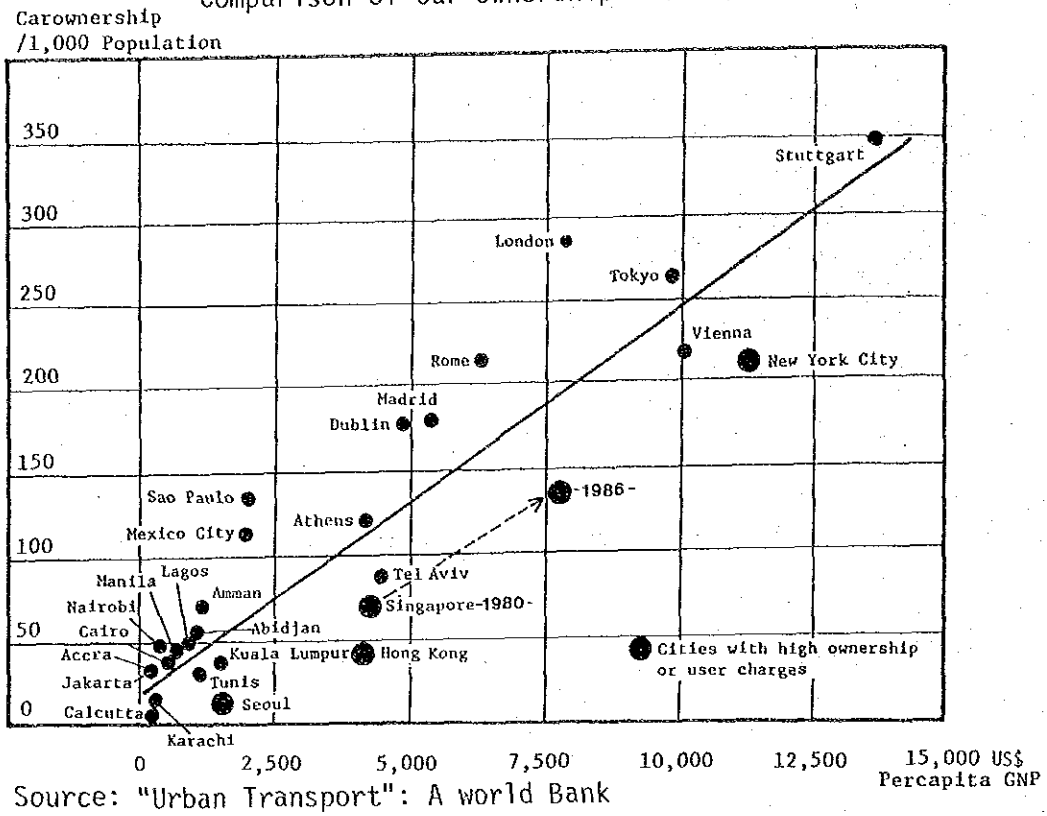
While much has been done on the supply side, demands have been changing rapidly at the same time. The economy has grown tremendously and is expected to grow further. The average GDP of Singaporeans has reached S$16,500 per capita in 1987. Expenditure pattern of the people has been changing and more people demand improved level of services and various activities. The major areas of concern in the future society of Singapore would be, as follows:

a) **Increased demand for diversified services and activities:** Affluence with dispensable income and leisure time would change the activity pattern of the people who will demand much more diversified quality services. This will affect the physical development particularly for commercial and recreational activities. Not only will existing developments require renewal, but, also, new urban centers or activity centers would likely be created in various strategic locations.

b) **Increased demand for car ownership:** Singapore is one of the countries where high ownership and user charges are imposed to discourage private car transport. Since the Singaporeans' potential capabilities for car ownership are considerably higher than the normal level as indicated in Figure 2.14, people would demand a more relaxed policy on car-ownership. And this would likely happen even if better alternative public transport modes are provided.

Figure 2.14

Comparison of Car-Ownership Levels, 1980



Source: "Urban Transport": A World Bank

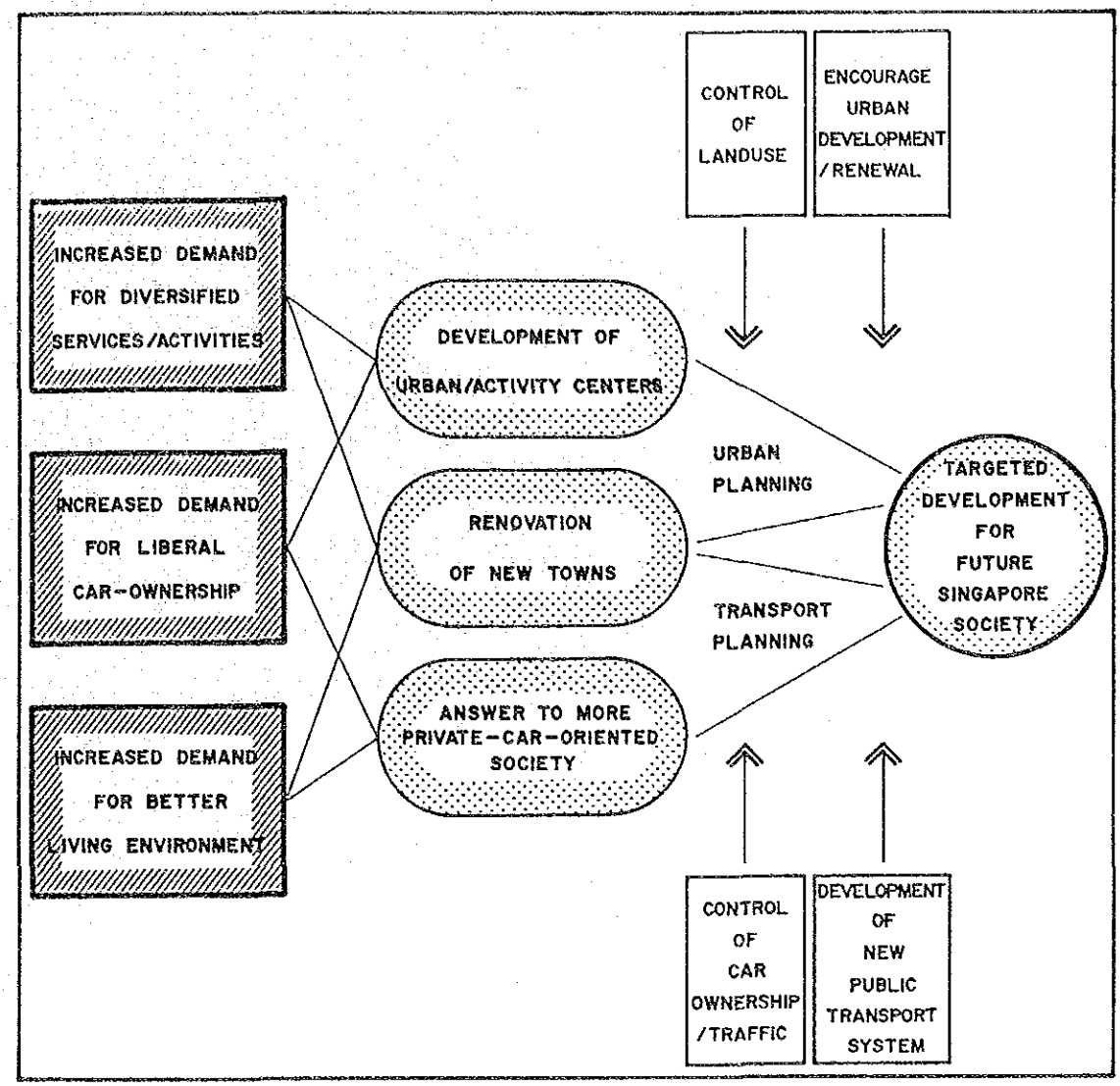
c) **Increased demand for a better living environment:** The quality of living environment would be another major concern of the people. Although the people of Singapore, at present, express general satisfaction, growing concerns are already observed on problems caused by traffic (traffic noise, vibration) and dust in the air (according to the interview survey conducted for Ang Mo Kio new town residents). Anticipated changes in the affluent society for better living conditions might be more drastic, with a) and b) above. One, would be the demand on wider choices of residential types or living environment, and the other, a more private car-oriented society.

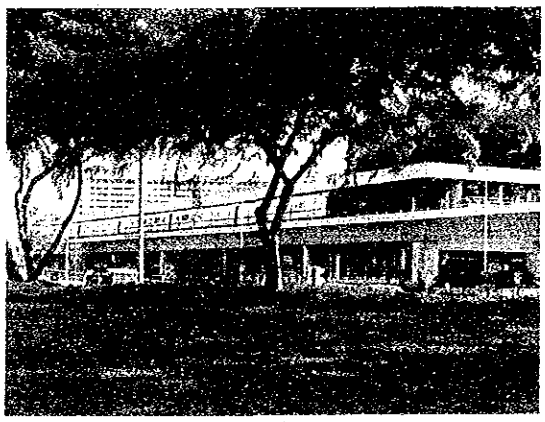
In addition to the above internal requirements, Singapore would also have to meet the demand from the international society, either in terms of tourism or other business activities. An efficient and quality urban system in Singapore would continuously be the important attraction to the external society.

The above discussions are summarized and illustrated in Figure 2.15. This implies that continuous efforts would be required to meet these anticipated changes and the increasing demand. Also, there would be ample areas where a new transport system could contribute to realize the targeted development, by creating a competitive new public transport system and encouraging urban development.

Figure 2.15

Urban Transport Issues and Planning Directions





3. FEEDER TRANSPORT SERVICES

3. FEEDER TRANSPORT SERVICES

3.1 Role of Feeder Transport

Feeder traffic may be understood, for practical planning purposes, as all types of traffic other than those involving long trip lengths and large traffic volumes, as shown in Table 3.1. It may be specifically defined as folows:

a) Portion of a trip made by sub-modes other than the representative mode: Access/egress portion of a linked trip is included in this category. This is typically seen in feeder traffic to/from bus interchanges or MRT stations.

b) Local traffic: This includes all traffic which distributes within a limited area such as a new town, industrial area, CBD, etc.

c) Traffic distributed outside the trunk transport system: This includes inter-zonal traffic with relatively long trip lengths which, however, is not served by the trunk transport system.

Table 3.1

Concept of Feeder Traffic

Traffic Volume \ Trip Length	Short	Long
Small	Feeder Traffic	Feeder Traffic
Large	Feeder Traffic	Trunk Traffic

Feeder transport, therefore, may be composed of all types of transport modes. In this context, even the traffic using MRT or trunk bus is considered as feeder traffic when its trip length is short. A significant feature of feeder traffic is that it forms a part of linked trips and must be understood in the modal chain. Among the existing modes, interchange of traffic takes place as shown in Table 3.2. The actual modal interchange pattern is shown in Table 3.3, as derived from the 1988 HIS survey on Ang Mo Kio new town. This gives an indication on the market size for feeder transport. Approximately 40% of those who use public transport as their

Table 3.2

Modal Interchanges of Present Feeder Transport

Main Mode \ Feeder Mode	Walk	Motor Cycle	Car	Taxi/ Carpool	Feeder Bus	Trunk Bus	MRT	School Transt	Contract/ Company Transt
Motorcycle	○	-	-	-	-	-	-	-	-
Car	○	-	-	-	-	-	-	-	-
Taxi/Carpool	○	-	-	-	○	-	-	-	-
Feeder Bus	○	-	-	-	○	○	-	-	-
Trunk Bus	◎	○	○ Kiss & Ride Park & Ride	○	◎	◎	○	-	○
MRT	◎	○	○ Kiss & Ride Park & Ride	○	◎	◎	-	-	○
School Transt.	○	-	-	-	-	-	-	-	-
Contract/ Company Transt.	○	-	-	-	-	○	-	-	-

Note : ◎ indicates significant demand exist
○ indicates certain demand exist
- indicates insignificant demand

Table 3.3

Modal Interchange of Inter-Town Trip of Ang Mo Kio New Town
(From Town to Outside Only)

(%)

Main Mode \ Access Mode	Walk (Direct)	Motor-Cycle	Car	Car-pool	Taxi	MRT	Trunk Bus	Feeder Bus	Scheme B	School/ Company Bus	Others	Total
Motorcycle	100	-	-	-	-	-	-	-	-	-	-	100
Car	99	-	-	-	-	-	-	1	-	-	-	100
Car-pool	87	-	-	-	-	-	-	13	-	-	-	100
Taxi	100	-	-	-	-	-	-	-	-	-	-	100
MRT	54	-	2	-	-	-	3	41	-	-	-	100
Trunk Bus	51	-	-	-	-	-	7	42	-	-	-	100
Feeder Bus	83	-	-	-	-	-	-	17	-	-	-	100
Scheme B	100	-	-	-	-	-	-	-	-	-	-	100
School/Company Bus	98	-	-	-	-	-	-	2	-	-	-	100
Others	100	-	-	-	-	-	-	-	-	-	-	100

Source : SUTIS 1988 HIS

main transport mode requires feeder transport service in the new town.

As cities grow and the transport system becomes congested, the provision of door-to-door services becomes increasingly difficult and uneconomical, both for private and public transport. Efficiency and economy of the transport system, then, becomes a predominant factor in transport planning. This usually leads to the hierarchical configuration of transport activities, particularly, the segregation of trunk transport and feeder transport with provision of purpose-built interchanges. Singapore's public transport system is, also, configured in such a way that trunk bus provides line-haul services, while feeder bus provides access/egress services via bus interchanges, particularly, in many new towns. The supplemental surveys conducted in this Study indicate that the residents in new towns normally spend 20 to 30 minutes including riding time in feeder buses. The above figures more or less are common to all new towns with feeder bus services. On the other hand, the travel time of trunk bus varies by new town. For example, those between CBD and the respective new towns take 25 minutes for Bukit Merah, 40 to 45 minutes for Ang Mo Kio and Bedok, and about an hour for Jurong. This means that, in many cases, people spend equal time for feeder transport.

It has been clearly proven that the increase in transport service level has to be discussed from the viewpoint of improving door-to-door transport services. This is, particularly, the case in Singapore where the existing system is clearly distinguished between trunk and feeder transport. Taking into account the time distribution between trunk and feeder services, the improvement of feeder transport becomes a critical factor for the improvement of door-to-door transport. The recent opening of MRT, for example, has reduced the travel time of trunk transport between Ang Mo Kio new town and CBD from 40 minutes to 20 minutes, while 20 to 25 minutes are still required to get to the MRT. The impact of MRT is considered significant for trunk transport. It can be said that the quality of services of MRT is far better than that of bus and even becomes competitive with private car along the trunk transport section.

In order to look into the transport demand characteristics in Singapore, with particular regard to the feeder transport, a number of supplemental surveys were conducted as shown in Table 3.4.

Table 3.4

Outline of Supplemental Transport Surveys

Study Stage	Name of Survey	Survey Period	Survey Outline	Major Purpose
Phase I	1. Limited HIS for Ang Mo Kio Residents	31 Oct - 7 Nov 1987	Interview with 739 households and their members	1. Trip characteristics of the residents. 2. Feeder bus utilization and assessment. 3. Opinions on new town environment.
	2. Bus Traffic Survey at Ang Mo Kio Bus Interchange	27 Oct - 29 Oct 1987	Bus traffic count, interview with 4700 bus passengers	1. Bus and bus passenger traffic volume at Ang Mo Kio Bus Interchange. 2. Characteristics of feeder bus passengers. 3. Distribution of bus passenger traffic demand.
	3. PWD officials Survey	16 Oct - 19 Oct 1987	Questionnaire survey with 613 PWD officials	1. Overall feeder transport utilization and its assessment by PWD officials. 2. Pre-survey for HIS.
Phase II	4. Limited HIS for Ang Mo Kio Residents	23 April - 9 May 1988	Interview with 1050 households and their members	1. The trip characteristics and their changes after the opening of MRT.
	5. Bus Traffic Survey at Ang Mo Kio Bus Interchange	8 April - 13 April 1988	Bus traffic count, Interview with 2600 bus passengers	1. Changes in bus traffic and utilization after the opening of MRT.
	6. PWD Officials Survey	30 March 1988	Interview with 370 PWD officials	1. Changes in travel pattern after the opening of MRT.
	7. Bus Waiting Time Survey	13 April 1988	Observation at feeder bus stops in Ang Mo Kio	1. Comparison of actual waiting time and perceived waiting time.
	8. Orchard Road Pedestrian Survey	23 - 25 May & 1 July 1988	Interview with pedestrians at Orchard/Scotts Road	1. Pedestrian traffic volume in Orchard area. 2. Walk characteristics.

3.2 Existing Feeder Transport System

3.2.1 Feeder Bus

1) Feeder Bus System in New Town

Feeder bus is the most widely practiced feeder transport mode in Singapore. The services cover major HDB new towns, Jurong Industrial Area and other housing and industrial estates. They ply within the new towns or industrial areas for passenger collection and distribution to/from the bus interchange and also for local travel within the area.

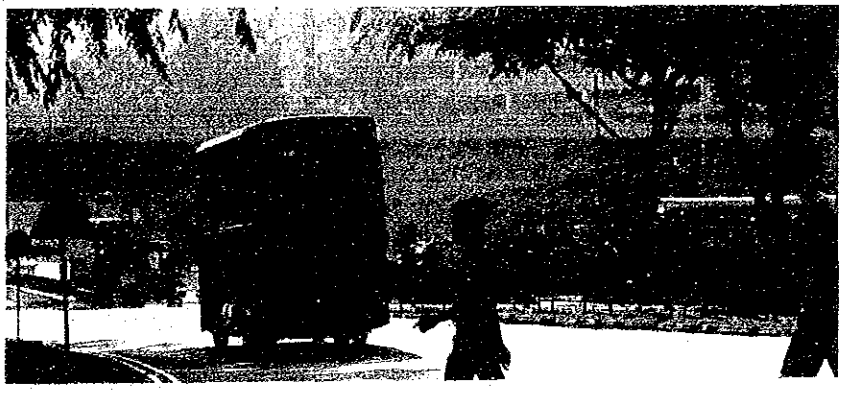
In 1987, there were 84 feeder bus services, out of which 65 services or 77% operate in HDB new towns, while 19 operate in the other areas including Jurong Industrial Area and HDB housing estates as shown in Table 3.5. The feeder bus service network was shown earlier in Figure 2.6 with trunk bus routes.

The total round trip distance of feeder bus routes are 658 kms, out of which 445 kms or 68% are operated in HDB new towns. The total daily cash rides for feeder buses are 569,000 persons out of which 530,000 of 93% are those in HDB new towns. Among the 20 existing HDB new towns in Singapore, 14 of them offer feeder bus services.

Table 3.5
Feeder Bus Services in Singapore, 1987

Service Area	No. of Routes	Total Round Trip Distance (km)	Ave. Route Length Round Trip Dist (km)	Bus Stop	
				Total No.	Ave. Spacing (m)
HDB New Towns	65	445	6.8	1,068	420
Jurong Industrial Area	10	156	15.6	270	580
HDB Estates	2	15	7.5	39	380
Other Area	7	42	6.0	109	380
Total	84	658	7.8	1,497	440

Source: SBS



2) Usage of Feeder Bus

According to the PWD Officials survey (approximately 600 respondents, half of them residing in HDB new towns), feeder bus service is used by 42% of the officials, who reside in HDB new towns providing feeder bus services. (Refer to Table 3.6)

Table 3.6

Percentage of Feeder Bus Users of New Town

New Town No.	New Town Name	% of User
1	Ang Mo Kio	40.0
2	Bedok	43.4
4	Bukit Batok	22.7
7	Clementi	27.8
9	Hougang	43.5
11	Jurong East	56.3
12	Jurong West	61.5
15	Serangoon	20.0
16	Tampines	52.4
17	Toa Payoh	52.0
19	Yishun	45.5
	Average	41.5

Source: PWD Officials Survey, 1987

According to the Home Interview Survey (HIS, 1988) in Ang Mo Kio New Town, feeder bus services are used by 41% of MRT users and 42% of trunk bus users (refer to Table 3.3).

For local travel, feeder bus service carries 50% of the motorized mode trips moving within Ang Mo Kio New Town.

3) Feeder Bus Operations

Feeder bus services, as well as, trunk bus services in HDB new towns are provided by two major public transport operator namely; the Singapore Bus Service Ltd. (SBS), and Trans Island Bus Service Ltd. (TIBS). TIBS provides 7 services in Woodlands and Yishun new towns, while SBS provides 59 for the other new towns.

The feeder bus operation in new towns is summarized in Table 3.7. The characteristics of 66 feeder buses are given, as follows:

a) Short Route Distance: The average round trip distance of these feeder services is 6.9 km and 86% cover a route distance less than 10 kms.

b) Wide Coverage of Service Areas: The average spacing between bus stops is 410 meters. The residential areas in new towns are generally well covered by feeder bus services mostly within 250 to 300 meters from bus stops.

c) Frequent Service: An average bus service operates every 5.1 minutes for peak hours and 7.8 minutes during off-peak hours. The most frequent service operates every 3 minutes for peak hours.

d) Long Operating Hours: Feeder bus service usually operates from 0500 hours through 2400 hours (departure time at interchange/terminal), approximately thirty minutes earlier or later than trunk bus operation. Some services operate until 0100 hours of the following day.

e) Cheap Bus Fare: Feeder bus service has a flat fare system. The fare level is set at 15 cents or 30 cents. This is cheaper than that of trunk bus services. Most feeder services in new towns charge only 15 cents.

4) Bus Interchange

a) Location and Facilities: Feeder bus services mostly originate or terminate at a bus interchange to be connected with trunk bus services. At present (1988), thirteen new towns are provided with bus interchanges. Bus interchanges are usually located at or near the town centre of new towns. An example of the location and layout of a bus interchange in Ang Mo Kio New Town is shown in Figure 3.2. In the bus interchange, feeder bus services use sawtooth bus berths separated into alighting and boarding only.

Table 3.8 gives an indicative level of bus passenger traffic at bus interchanges in selected new towns. The total number of bus passengers at the bus interchange reaches approximately 20,000 to 30,000 for three hours during the morning peak period. A bus survey conducted in Ang Mo Kio bus interchange shows that about 155,000 of boarding and alighting passengers use the bus interchange for 16 hours (from 0600 to 2200 hours); during peak hours, about 3,000 passengers crowd the interchange for about 15 minutes only which results in congestion at the bus interchange.

Table 3.7

Feeder Bus Operation in HDB New Towns

New Town	No of Feeder Bus Routes	Total Trip Distance (kms)	No of Bus Stops	Ave. Bus Stop Spacing (m)	Area Covered by 250m (% to Total A)	No of Buses allocated	No of Scheduled Trips/ Day	Kms Run/ Bus/Day	No of Trips/ Bus/	Average Speed (kph)	Frequency peak/ off peak	No of Cash Rides/ Day
1. Ang Mo Kio	7	55.2	141	390	100	55	1,417	223	26	14.0	3.7/6.0	89,837
2. Bedok	10	78.5	172	460	100	64	1,487	182	23	14.3	5.0/7.8	102,323
3. Bukit Batok	4	20.4	56	370	95	15	661	225	44	14.6	4.8/6.9	20,102
(4. Bishan)	-	-	-	-	-	-	-	-	-	-	-	-
5. Bukit Merah	5	20.1	56	360	100	22	929	170	42	11.6	3.9/6.3	34,044
(6. Choa Chu Kang)	-	-	-	-	-	-	-	-	-	-	-	-
7. Clementi	4	16.9	42	400	100	9	406	191	45	9.1	8.8/10.6	14,783
(8. Geylang)	-	-	-	-	-	-	-	-	-	-	-	-
9. Hougang	5	34.8	82	420	90	24	899	203	29	13.1	5.6/8.4	37,915
(10. Jalan Besar)	-	-	-	-	-	-	-	-	-	-	-	-
11. Jurong East	4	35.8	89	400	100	27'	721	239	27	16.5	4.4/6.5	39,131
12. Jurong West	6	74.9	191	390	80	42'	804	239	19	16.1	5.7/8.9	61,954
(13. Pasir Ris)	-	-	-	-	-	-	-	-	-	-	-	-
14. Queenstown	2	13.2	32	410	90	6	157	173	26	15.3	9.1/10.8	2,297
15. Serangoon	2	8.8	23	380	100	4	187	206	47	14.7	9.8/12.2	3,516
16. Tampines	5	26.6	59	380	70	22	1,011	244	46	14.6	4.1/6.3	35,117
17. Toa Payoh	5	25.4	58	420	100	30	885	150	30	13.3	4.8/7.4	47,521
18. Woodlands	2	10.8	22	490	65	6	305	276	51	18.6	7.2/9.9	14,300
19. Yishun	5	34.3	75	457	85	16	656	281	41	18.1	8.1/12.8	26,800
(20. Bukit Panjang)	-	-	-	-	-	-	-	-	-	-	-	-
Total	56	455.7	1,110	410	-	342	10,325	206	30	14.9	5.1/7.8	530,139

Source: worked out based on the information provided by SBS (1987)

1) estimated based on; no. of scheduled trips x average route length (round trip)/no. of buses allocated

2) includes 19 double deckers, otherwise all single deckers

Table 3.8

Boarding and Alighting Activities at New Town Interchanges/Terminals (AM Peak - 6:00 to 9:00 Hours)

New Towns	Month of Survey	Total Alighting From Feeder Services	Total Boarding On Trunk Services	Total
Ang Mo Kio 1/	Jul 87	12,604	17,438	30,042
Bedok 1/	May 87	13,422	16,448	29,870
Bishan	Jul 87	-	492	492
Bukit Batok	Sep 87	3,258	2,569	5,827
Bukit Panjang	Jul 87	-	977	977
Clementi 1/	May 87	1,493	2,505	3,998
Hougang 1/	Sep 87	4,580	3,646	8,226
Jurong East 1/	Jul 87	4,500	5,638	10,138
Tampinese	Jul 87	8,533	16,794	25,327
Toa Payoh 1/	Apr 87	6,768	12,059	18,827

Source : SBS

1/ These new towns are provided with bus terminals.

2/ The traffic counts are for all bus services (i.e. SBS, TIBS, CSS and Scheme 3) terminating/originating from the town interchange/terminal. Traffic counts on trunk services running through the town are not included.

b) Transfer at Bus Interchange: Table 3.9 shows the transfer pattern by mode to/from feeder and trunk bus services at Ang Mo Kio bus interchange. It shows that 40 to 45% of passengers at the bus interchange transfer between feeder bus and trunk bus. Moreover, 11.5% of feeder bus passengers transfer from feeder bus to feeder bus and 17% of trunk bus passengers from trunk bus to trunk bus at the bus interchange.

Table 3.9

Distribution of Transfer Passengers by Mode

Mode	To/From Feeder Bus	To/From Trunk Bus
1. MRT	23.3	11.5
2. Trunk Bus	45.4	17.0
3. Feeder Bus	11.5	42.3
4. Walk	15.7	22.4
5. Others	4.1	6.8
Total	100.0	100.0

Source: SUTIS Bus Survey at Ang Mo Kio Bus Interchange.

5) Assessment of Feeder Bus Services

According to the survey conducted for PWD officials, feeder bus services are appreciated, as follows:

a) Access to the nearest bus stop:[1/] Average walk time is 4.9 minutes. Most people consider it good/ acceptable when the walk time is less than 5 minutes, while 33% feel bad when the time falls between 5.1 to 8 minutes. Walking conditions to bus stops are generally good. However, when the walkway is not paved, 31% feel bad/very bad. When street lights are not installed, and shades are not provided, 63% and 61% feel bad/very bad, respectively. In Ang Mo Kio new town, the average walking time is 4.9 minutes.

1/ Additional observation survey conducted at bus stops in 1988 indicates that the waiting time during peak hours and off-peak hours are about 3 minutes and 5 minutes, respectively. The 1988 HIS shows about 7.3 and 10.3, respectively.

b) Waiting time at bus stop: Average waiting time is 8.2 minutes and 12.7 minutes during peak and off-peak hours, respectively. PWD officials accept it as favorable when the waiting time is less than 5 minutes during peak hours or less than 10 minutes during off-peak hours. For the ranges of waiting time where average waiting time increases, 41% and 60% feel bad/very bad during peak hours and off-peak hours, respectively. The supplemental survey conducted in Ang Mo Kio new town indicated an average waiting time of about 3 minutes during peak and 5 minutes during off-peak hours.

c) Facilities at bus stop: Shelters are provided for more than 90% of the bus stops, while seats and bus information are provided for 86% and 41% of the bus stops, respectively. If there is no shelter, 77% feel bad/very bad. For non-availability of seats and bus information, 75% and 61% feel bad/very bad, respectively.

d) Waiting time for transfers at bus interchange[2/]: Those from feeder to trunk buses are 8.1 minutes and 11.6 minutes for peak and off-peak hours, respectively; while those from trunk to feeder are 7.1 minutes and 10.6 minutes. For these ranges of waiting time, 27%-37% during peak hours and 53%-59% during off-peak hours feel bad or very bad. However, in Ang Mo Kio new town alone, the waiting time is much shorter as observed at the bus stops.

e) Transfer and waiting condition at bus interchange/terminal: Thirty-one percent and 34% of the people assessed the transfer and waiting conditions at the bus interchange/terminal as bad or very bad, respectively.

f) Environment at bus interchange: Environmental conditions at bus interchanges seem to be one of the major concerns of most people. Those who consider bad or very bad for cleanliness, noise, air pollution and space are 32% and 45%, respectively.

g) Bus operation: Operating conditions of feeder buses were, also assessed by PWD officials, as shown in Table 3.10. People's concerns are on service frequency during off-peak hours, operating hours for off-peak hours, and various discomforts in buses such as heat, noise, and air pollution.

2/ The 1988 HIS results indicate 6.4 and 9.4 minutes for feeder bus and 8.0 and 11.5 minutes for trunk bus during peak and off-peak hours, respectively.