5.6.2 Carriageway Structure

1) Concrete Structure vs. Steel Structure

Alternatives for carriageway structure are basically concrete structure or steel structure. In Singapore, concrete structure, including PC, is commonly used for most of the major structures. (Refer to Appendix 5.C for a comparison of the structural design between Singapore and Japan.) Rigid framed bridges are very rare. This is mainly due to the following reasons:

- Cost of steel structure is high: A preliminary estimate made in the study indicates that per km cost for steel structure with 20 to 30m spans is roughly S$12 million, while for concrete structure is S$6 million.

- Steel structure requires regular maintenance.

- Local engineering and industrial support for steel structure are scarcely available.

Accordingly, the concrete structures are primarily used except for the following situations:

a) Long span which exceeds about 50 meters

b) Section where horizontal radius becomes less than 50 meters

2) Type of Structure Studied and Selected

Alternative superstructures were compared for the following types (refer to Appendix D):

- Simple 2 main girder type
- Posttensioned concrete simple 2 main girder type
- 3 span continuous cellular slab beam
- 3 span continuous 2 main girder

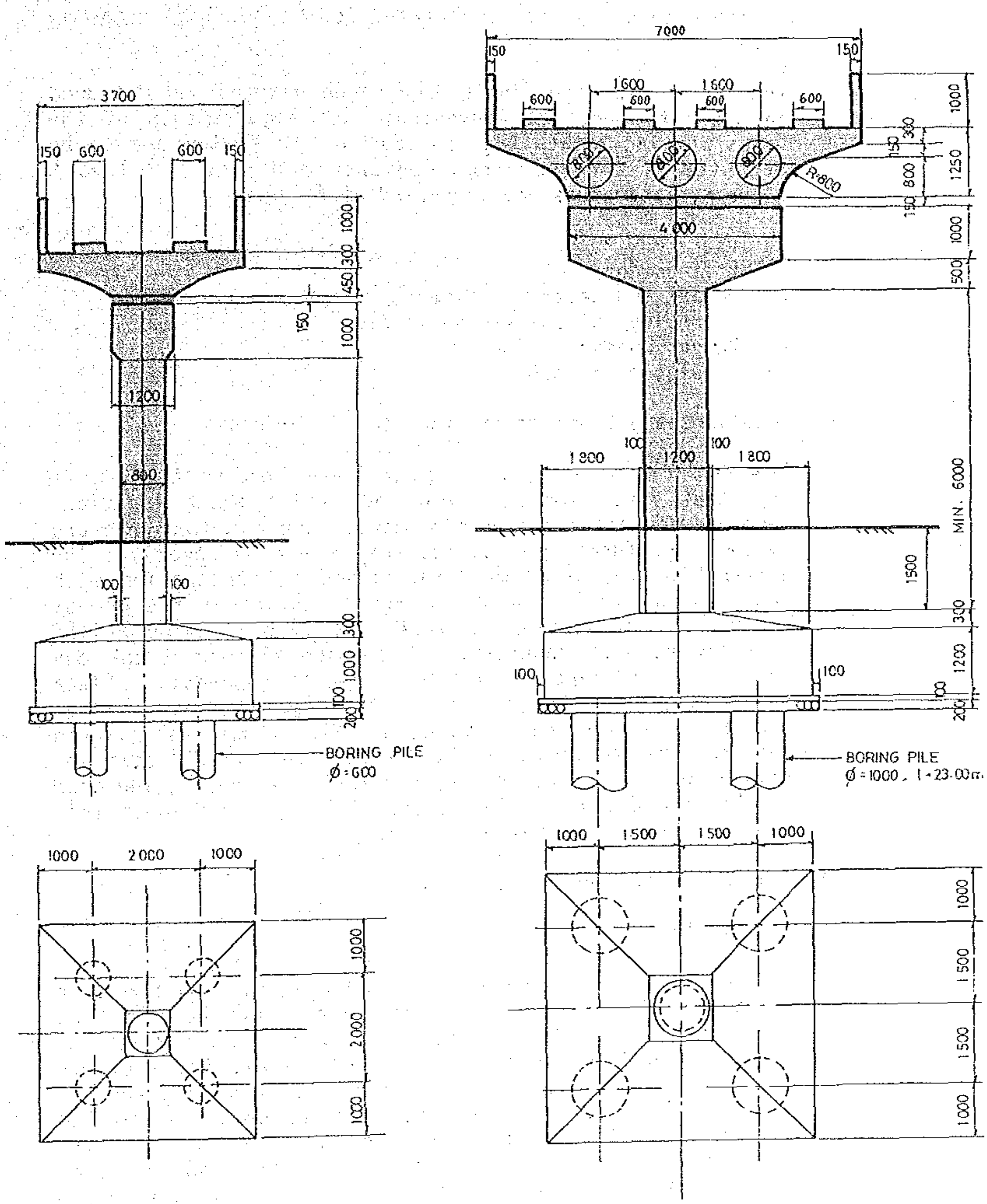
The results indicate that simple 2 girder types are less expensive for straight sections but it is likely more expensive for those with small radius curvatures. In order to reduce the top level of the support surface, the cellular slab beam type is preferred. It is, therefore, recommended to apply the cellular slab beam for the structure of the system.

3) Typical Features of Structures

Typical cross sections for double and single track sections are shown in Figure 5.17, which indicates that boring type piles should be adopted because they create less noise, dust and vibration problems during piling.

Figure 5.17

Typical Cross Sections for Double and Single Track Structures



5.6.3 Station and Terminal

1) Planning Considerations

Stations and terminals are the direct contact points of the system with users and are located in the heart of communities.

The stations and terminals need to be planned and designed in order to meet the convenience and requirements of the users, to facilitate the function of the system and to be accepted by the local residents/communities. Relevant planning parameters are specified as follows:

a) User-requirements
b) Environment
c) Social and aesthetic aspect
d) Technology of the system itself
e) Budget consideration
f) Regulatory aspects

2) Locations and Types of Stations and Terminals

The determination of station location is the first important aspect to be considered, since their locations have a trade-off relationship between users convenience and system's performance (particularly travel speed). The alternative locations were identified in conjunction with route planning. The most important station is the one at Ang Mo Kio MRT station, because it will be located at the Town Centre and transfer point between MRT and trunk bus where a significant amount of traffic is generated. Since one of the main functions of the system is to provide smooth feeder service primarily to MRT, it has been planned that the station be constructed right over the MRT station; both of which will be connected directly without going down to the ground level. More detailed information about this station will be explained later.

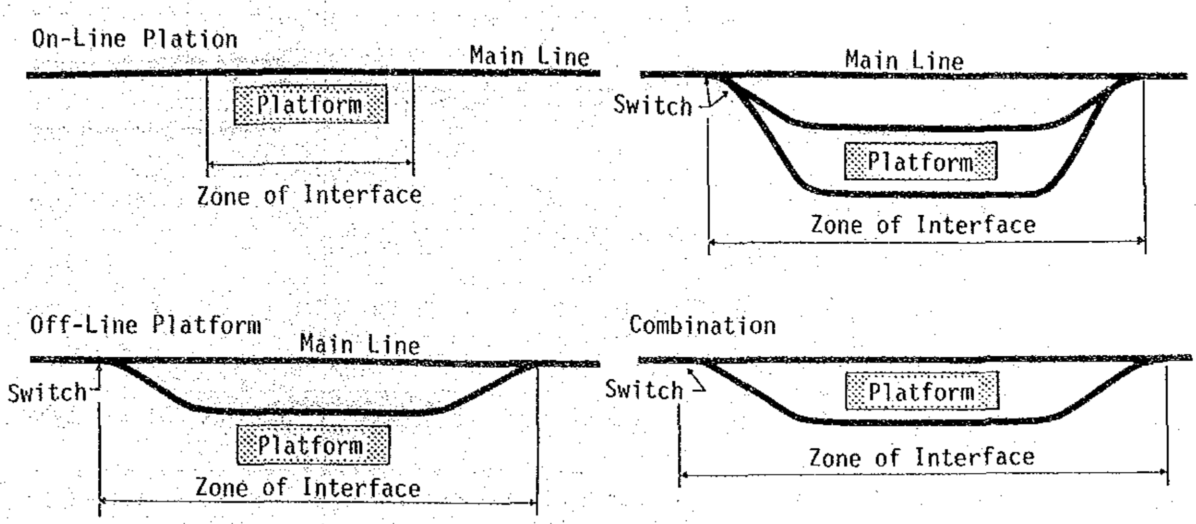
3) Station Facilities and Structures

A. Platform:

Functionally, there are two types of stations; one is the on-line station and the other is the off-line station. At the on-line station, the train stops on the main line, while the off-line station has a branch line to stop a train. (See Figure 5.18.) The zone of interface for on-line stations is confined to the length of the platform at which train vehicles berth. For off-line stations, the interface zone extends outward from the platform to the switch where

Figure 5.18

Types of Platforms



connecting tracks join the main line. Generally, even if all stations are established as on-line stations, a simple operation is performed without any serious problem. In the case of an extreme short headway, when a train is at a stop the following train enter into the stop. In this case, off-line stations are sometimes required. When the carriageway is constructed on the road, the width of the station would be restricted. In addition to this, from the view point of the operation, on-line stations can provide specified services.

There are two types of platforms according to the locations of the track and platform, one is the island type and the other is the lateral type of platform (refer to Figure 5.19). Island platforms offer the most efficient use of platform space, furnishing, and vertical circulation for elevated or underground platforms. The island platform results in a more efficient concourse area, as passengers need not decide on train direction until they reach the platform. The island platform is recommended when the platform and concourse are on separate levels. However, the provision of a concourse on separate levels will increase the height, make the structure massive and increase cost. Accordingly, the lateral type of platform is normally adopted for similar projects.

In this study, modified island type of platform is also proposed. This type of platform is particularly effective for Ang Mo Kio new town where the tracks are separately constructed along the both sides of the roads. When the separate platforms are connected with a deck at the same level, passengers can transfer from one direction to

Figure 5.19

Comparison between Island and Lateral Type of Platform

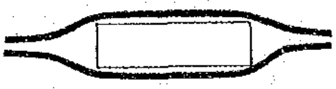
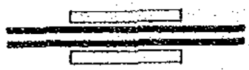
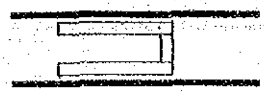
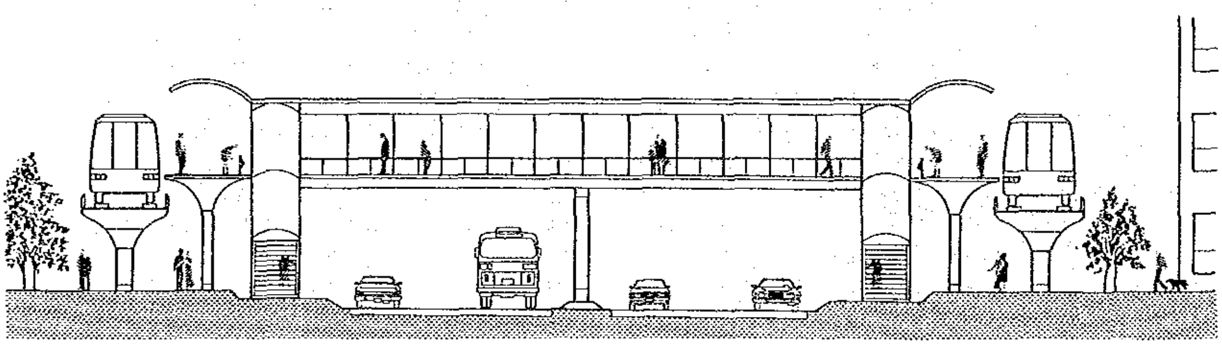
	ISLAND TYPE	LATERAL TYPE	MODIFIED ISLAND TYPE
Figure			
Alignment	- Alignments must be curved near the station at both sides. - Extension of platform is difficult, riding comfort is affected.	- Space between traks is uniform. - Extension of platform is easy.	Same as lateral type
Function	- One platform for both directions.	- 2 platforms are necessary.	Same as lateral type
Space Required	- Maximum width at station area can be lessened. - Additional space is required at both ends of platform.	- Width of platform area is larger.	Same as lateral type
Facilities and Operations	- Common stairs and escalator can be for both direction passengers. - One man can control the platform for both directions.	- Separate approach/ stairs are necessary. - More personnel might be required.	Same as lateral type Same as lateral type

Figure 5.20

Conceptual Cross Section of Typical Intermediate Station



another without crossing the tracks. At the same time the connecting deck can be used as pedestrian bridge for non passengers. (See Figure 5.20)

The size of the platform depends on the traffic volume and the length of the train. Passenger traffic volume of approximately 4,000 per hour per direction and a two-car-train with a capacity of 75 passengers/car being operated at two to three minutes requires a platform with 3m width and 35m length.

The platform components are those which relate to the guideway interface and offer passenger protection and comfort. One such item is the platform roof. A roof over the platform shelters and protects patrons from the weather while they wait or while they are boarding and alighting from the vehicles. The roof shall cover the entire platform extending far enough to shield patrons moving from or into vehicles. Screens are placed on the side; vertical circulation elements are screened as well. Vehicle screen walls and doors will not be provided can also be provided for safety and comfort (air conditioning) reasons but require additional high costs. It is advisable to provide simple stations like bus stops.

B. Access/Egress Facility

The width of the staircase connecting the platforms depends on the number of passengers during peak hour. Experience in commuter survey conducted in Tokyo indicates that the number of passengers leaving the platform using the staircase is 1.52 per meter (width of staircase) per second. For approximately 200 passengers at a peak minute, the required width of the staircase is approximately two meters (200 x 1/60 sec x 1/1.52 passengers/m/sec = 2.2m). Giving allowances for handrail and those who move slowly, 3 meters are required.

Consideration must be given to the elderly and the handicapped. An elevator will be provided for each platform of grade-separated stations. To assist blind persons, textured warning strips will be applied on the floor area in front of the elevators and signs will be shape-coded and tactile. No escalator will be installed at the stations.

C. Fare Collection Facility:

Facilities and layout vary depending on the fare collection systems. The alternatives are discussed in section 5.7. When vending machines and turnstiles are to be provided, the facilities will require certain spaces.

A typical section of a standard station is shown in igure 5.21, while the locations for stations are shown in Appendix 5.E.

4) Ang Mo Kio Central Station

For Ang Mo Kio central station, the basic alternatives are either to construct the station underground or above MRT. The former provides a direct link with the underground passage which connects the bus interchange and the MRT station, while the latter provides a more direct link with the MRT platform. In either case, the construction will involve certain difficulties and require more careful work.

Underground alignment around the MRT station must be studied in detail to adjust various obstacles such as piers and footing of MRT, underground utilities, signal posts, etc. One of the advantages of underground alignment will be the aesthetic aspect to the community. The outline alignment and cross section of the station are shown in Appendix 5.F and the location of the underground utilities are shown in Appendix 5.G.

Comparison of preliminary estimated costs for the underground station and above the MRT station, including approaches, are rougly S$9 million and S$5.6 million, respectively.

Construction of the central station above the MRT will involve less difficulties in construction and more direct access to MRT, although the platform level of the proposed system would be as high as 13 meters above ground level. As shown in Figures 5.22 and 5.23, the platform is linked both with the ground level and MRT platform by an elevator and escalator/stairs, respectively. The height difference between the MRT platform and that of the proposed system is about 4 meters. This plan would involve the following:

i) Moving the equipment room installed on MRT platform

ii) Construction of additional support column necessary for escalators and stairs

iii) Transfer of underground utilities

iv) Aesthetic aspect for landscape around the station

Figure 5.21

Conceptual Plan and View of Typical Intermediate Station

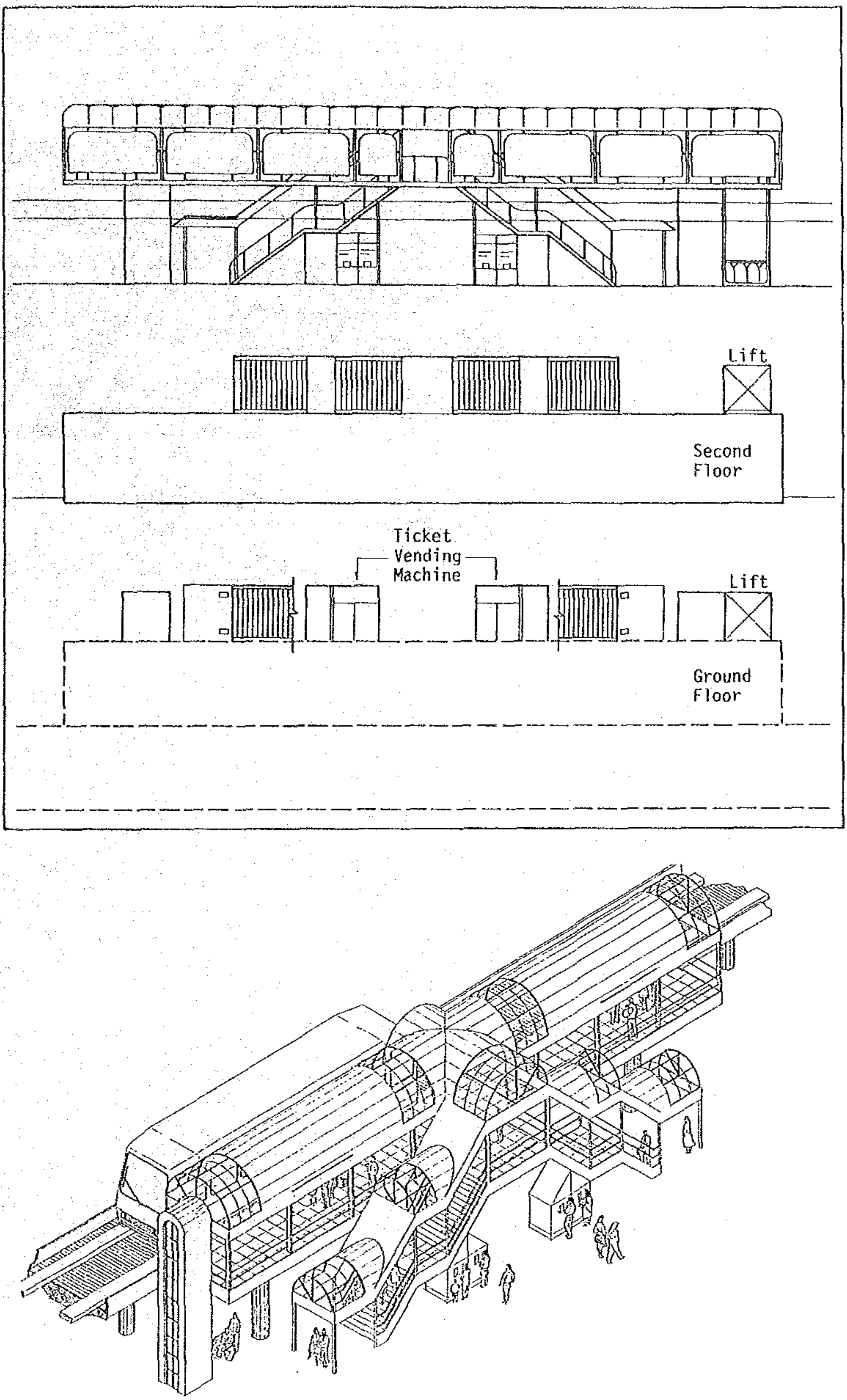
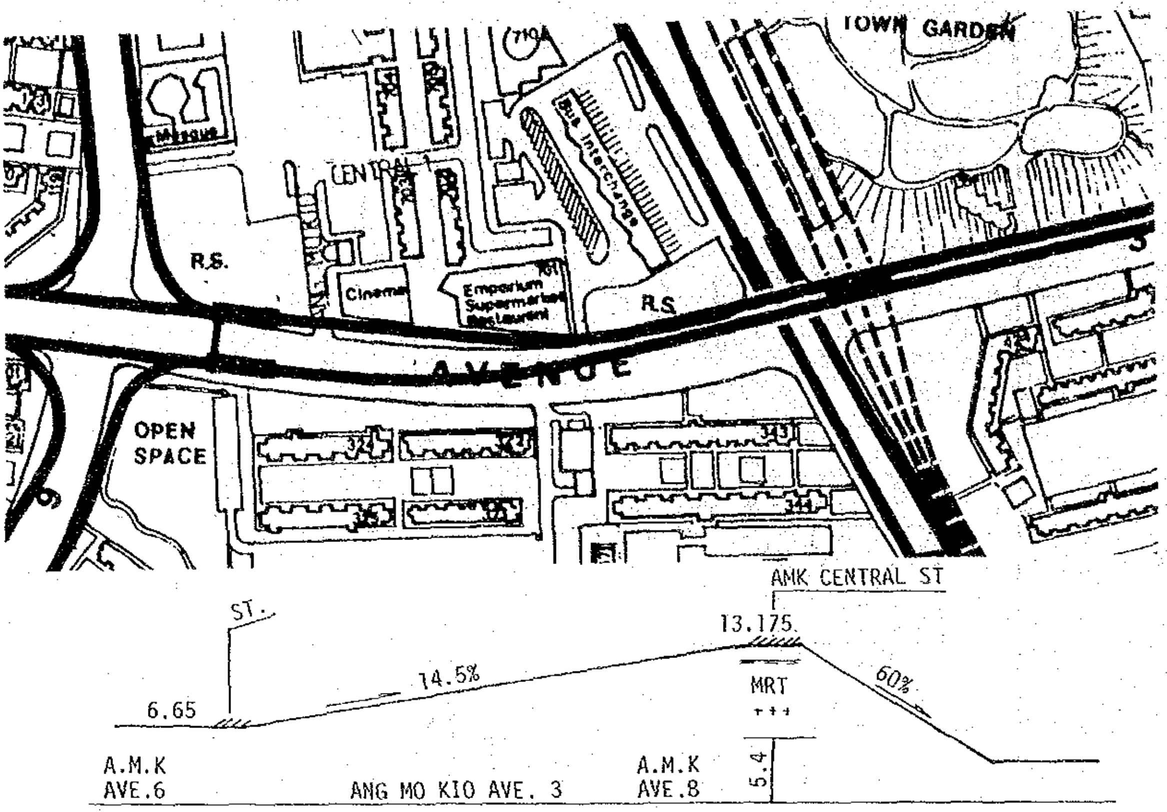


Figure 5.22

Ang Mo Kio Central Station



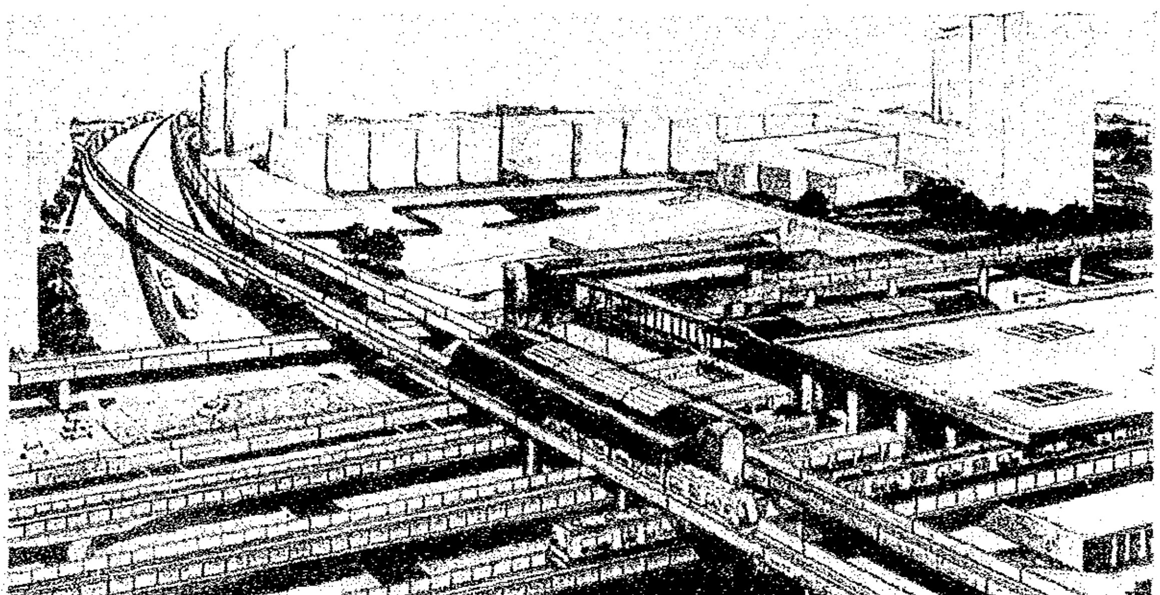
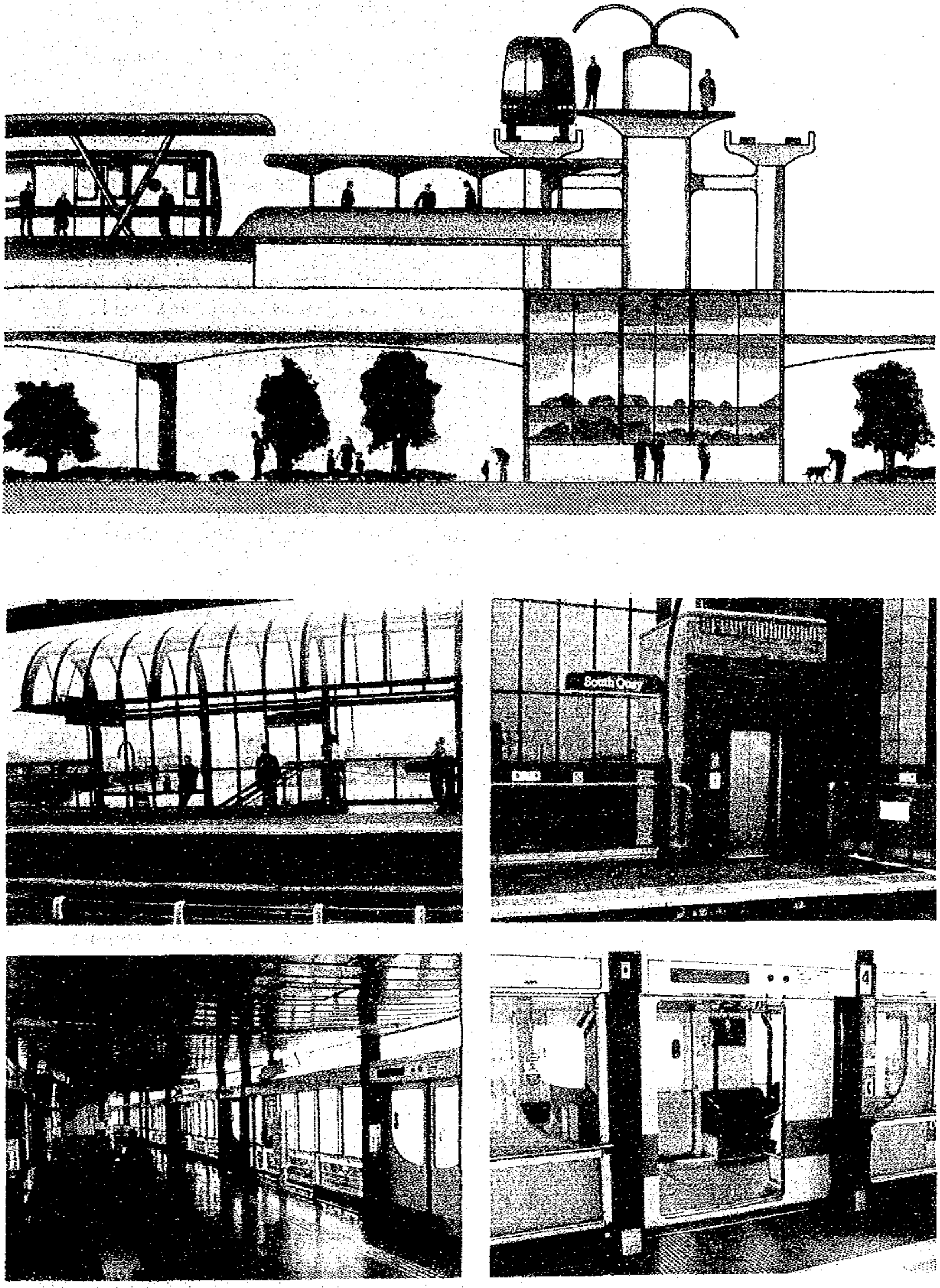


Figure 5.23
Conceptual Illustration for Ang Mo Kio Central Station



5.6.4 Depot/Workshop

1) Function

The main functions of the depot/workshop are:

a) Inspection and repair, including spare parts control
b) Cleaning and washing
c) Stabling

The inspection/repair work is composed of routine, periodical and emergency tasks. Their respective schedules and descriptions are:

A) <u>Daily and Routine Inspection</u>: Prior to daily operation, trains are inspected to check if the basic subsystems function smoothly. Ocular check will be done when vehicles return at the depot. Routine inspections will be done every 48 hours or 1,600 kilometer run.

B) <u>Monthly Inspection</u>: Operating conditions of major subsystems are inspected. They include propulsion system, brake, door and others.

C) <u>Annual Maintenance</u>: The above major subsystems will be disassembled and checked.

D) <u>Two Year Maintenance</u>: Major parts will be overhauled and overall conditions inspected in detail.

E) <u>Temporary Inspection</u>: When and where necessary, vehicles will be inspected. Schedule shall consider the time of purchase, major accident, significant repair, more than 6 months suspension of operation, etc.

2) Location and Layout

Depending upon the number of vehicles, it is common practice to separate the workshop for heavy maintenance/repair from routine/daily inspection and light maintenance. This is because testing equipment, tools and spare parts stock facilities are different from each other, therefore, more efficient space utilization and work can be expected when they are separately provided. However, the estimated number of vehicles required initially is not large, in which case the depot and workshop functions can be provided in the same yard.

There are two types of depot:

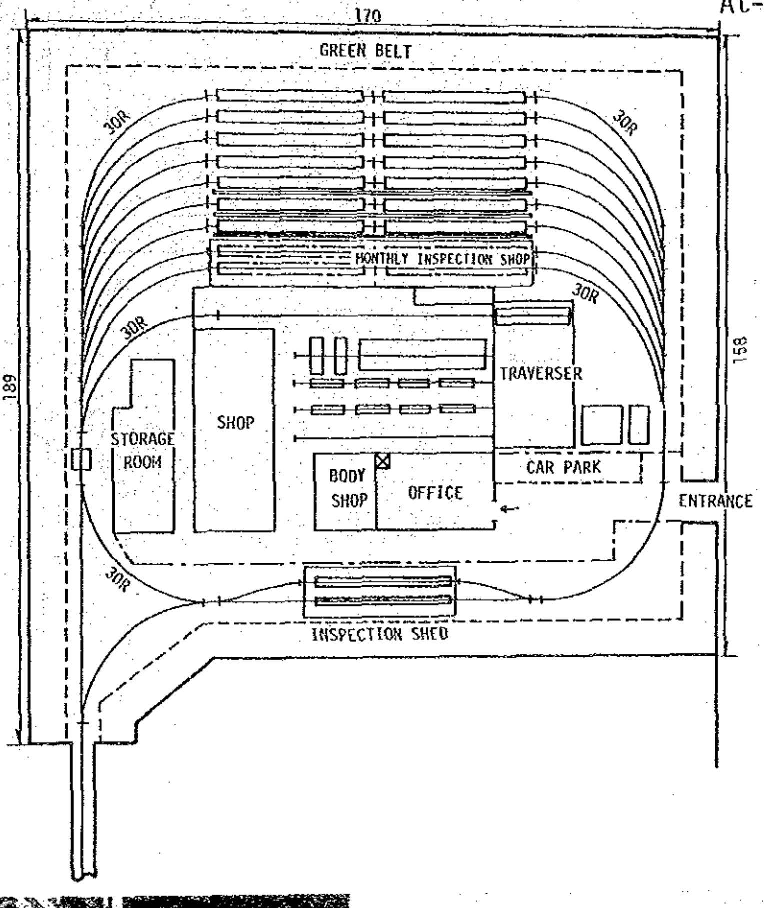
a) At-grade type : This will accomodate all depot function and facilities in a single at-grade space. This requires approximately three heaters including buffers.

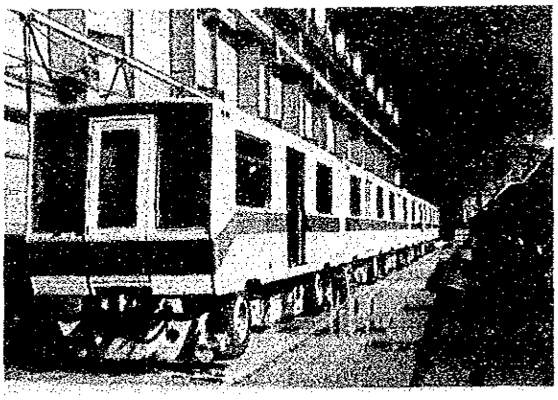
b) Two storied type : This intends to save space by dividing depot function. Upper story is used for stabling, while the ground level for workshop. As shown in Figure 5.24, required space is approximately 1.7 but construction cost will roughly be S$38.3 million, about 40% higher than at-grade type of S$26.8 million.

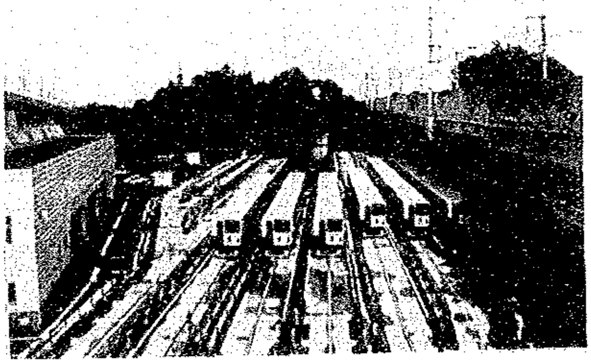
Figure 5.24

General Layout Plan for Depot

At-grade type

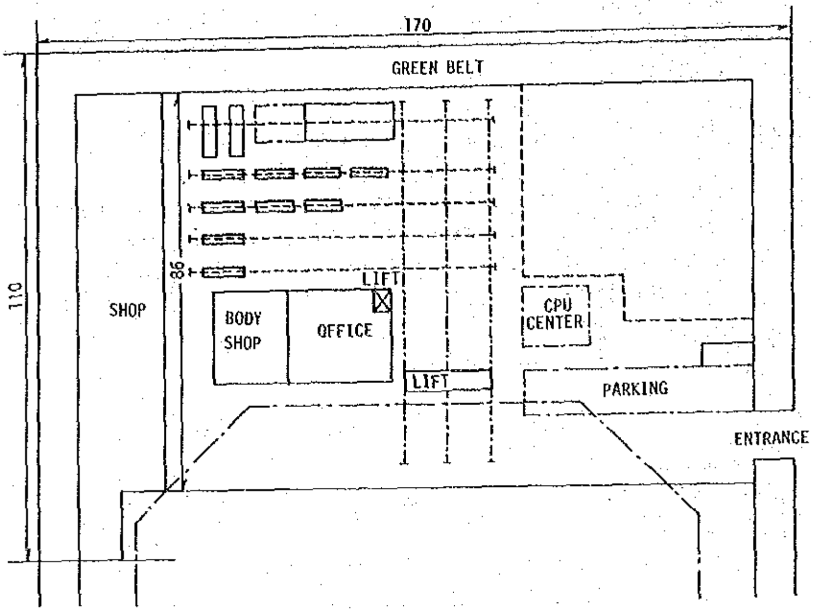




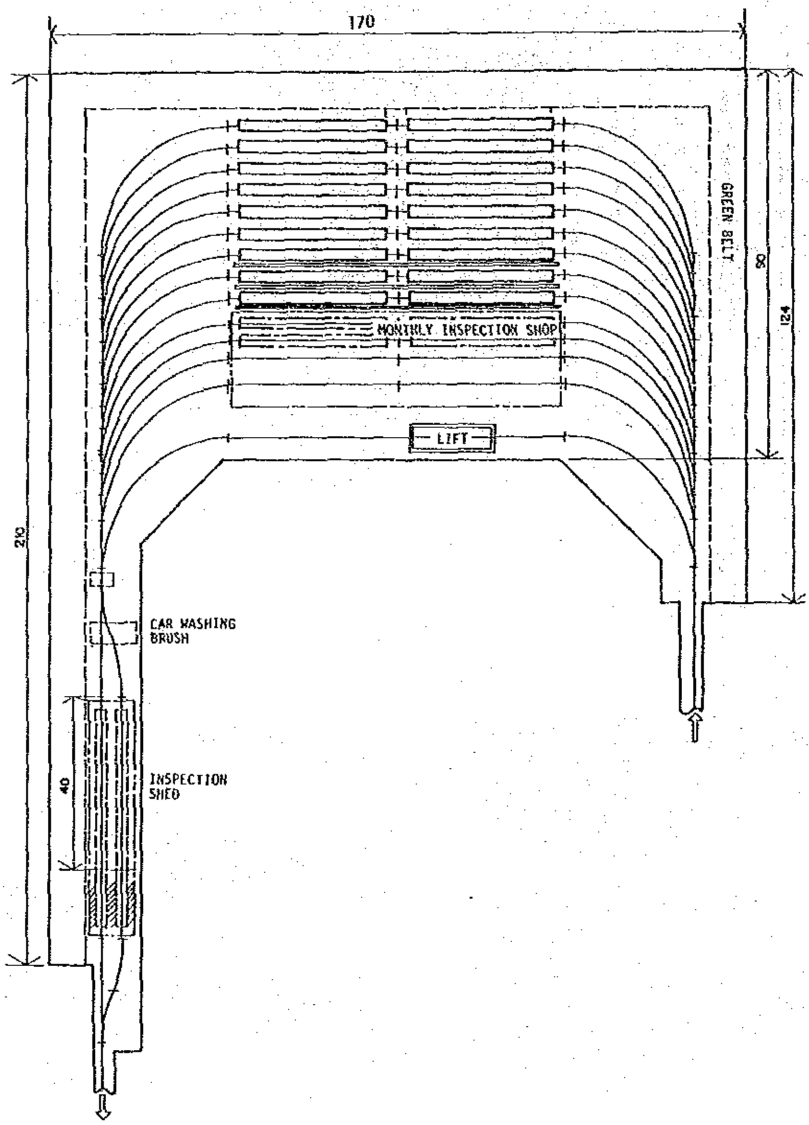


Two storied type

1F



2F



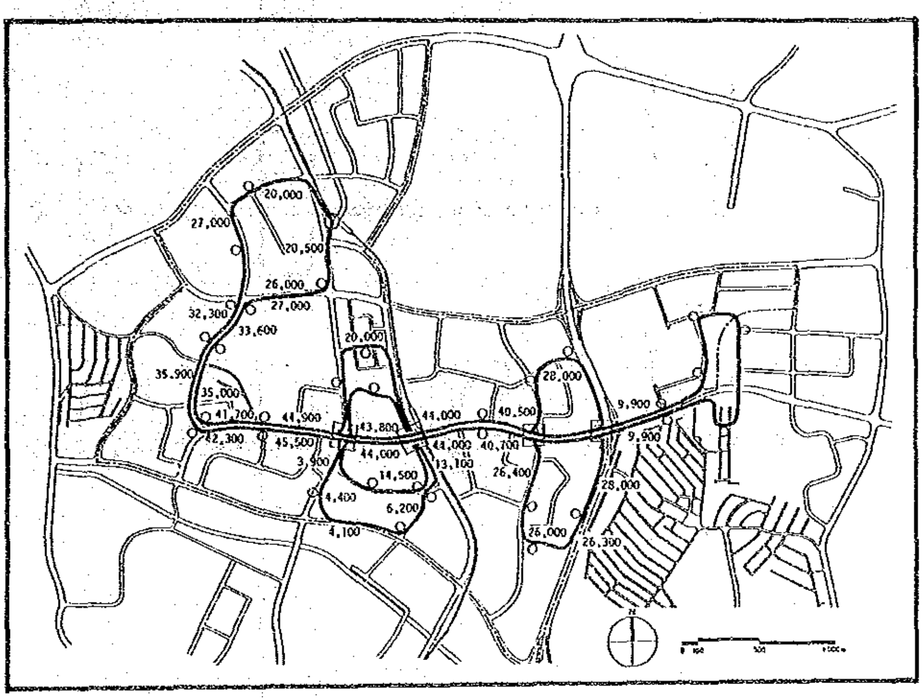
5.7 Operation of the System

5.7.1 Demand Distribution

The estimated passenger demand was further elaborated in order to provide a basis for scheduling train operation. Based on the traffic distribution for Ang Mo Kio New Town, which was estimated by analyzing the results from the 1988 HIS, 1981 MRTC OD and 1988 Ang Mo Kio Bus Survey, traffic was assigned to the proposed route, as illustrated in Figure 5.25. Peak hour traffic volume was approximated at 14% of the daily volume.

Figure 5.25

Estimated Traffic Distribution of the New Transit System

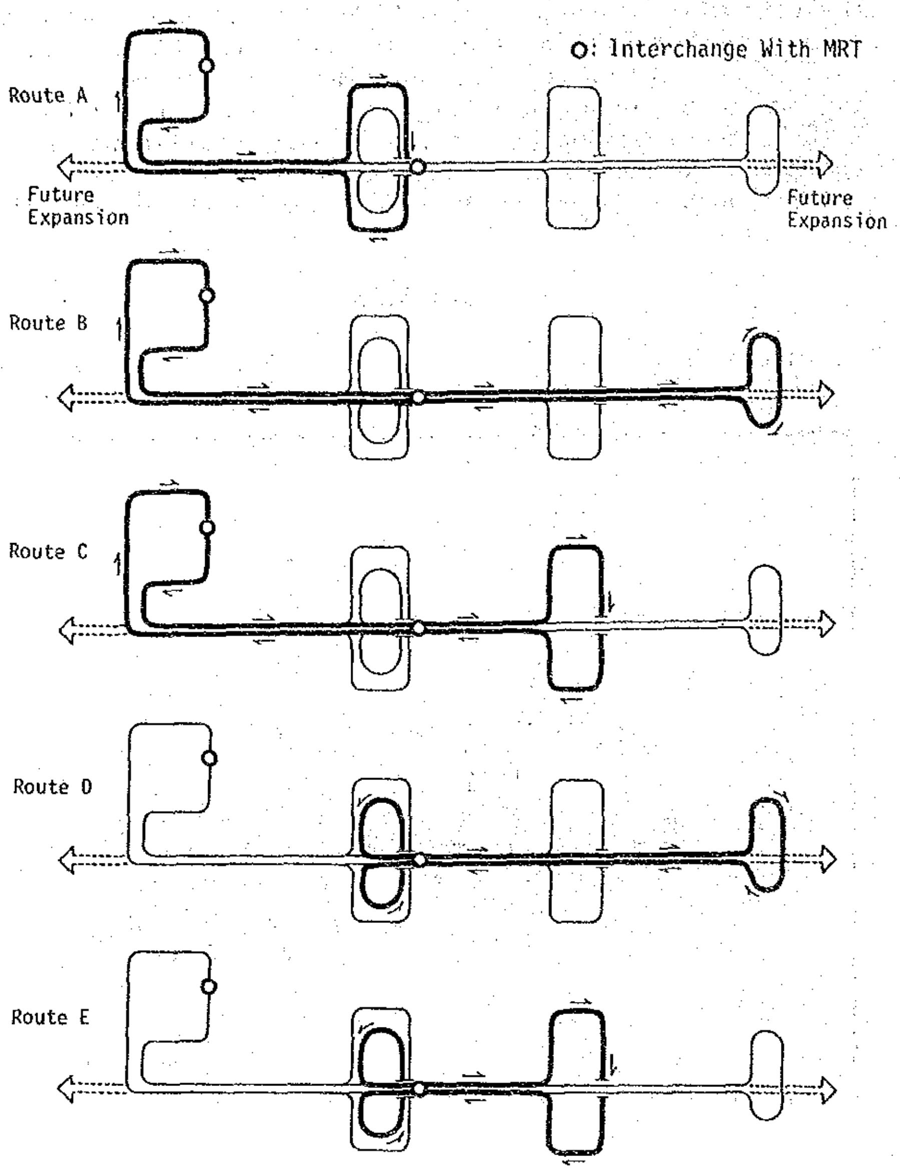


5.7.2 Train Scheduling

Routes are configurated in such a way that a variety of operation patterns are possible depending upon the changes in demand. Of the five possible services shown in Figure 5.26, three services were selected to meet the estimated demand pattern. The operational characteristics of the three services are summarized, as shown in Table 5.22. With the combination of the three services, the busiest section along Ang Mo Kio Avenue 3 is provided with the services of two minutes headway.

Figure 5.26

Layout of Routes and Operation Indices



Operation Index by Route

Route	Length (Km)	No. of Stops	Turn Around Time (min)	Scheduled Speed (Kph)
A	9.5	21	27	21.1
B	12.8	28	36	21.5
C	11.7	27	33	21.3
D	8.7	20	26	20.0
E	7.6	18	25	19.1

Since all the service routes are based on loop operation without complex switching, line capacity can be utilized to a maximum extent. The possibility of minimizing headway to one minute has been examined. For practical application, the minimum headway will be one and a half minutes. The number of required cars are determined by minimum headway and train composition. In this system, the maximum sectional transport capacity is estimated to be 18,000 passengers/hour/direction (4-car train x 75 passengers/car x 60 frequencies/hour or one minute headway). Practically, it is about 12,000 (one and a half minutes headway).

Table 5.22

Operational Characteristics of Selected Services

Item	Service			Total Operation
	A	B	E	
Service Kms	9.5 km	12.8 km	7.6 km	21.6 km of single track
No. of Sta.	20	28	18	29
Ave. Station Spacing (m)	475	456	422	420
Max. Speed (kph)	60	65	60	60 - 65
Scheduled Speed (kph)	21.1	21.5	19.1	19 - 22
Turn-around Time (min)	27	36	24	-
Headway (min)	6	6	6	3
No. of Train	4	7	4	A total of 15 trains
No. of Cars/ Train	4	4	4	4
No. of Cars Required	16	28	16	A total of 68 including 8 spare cars or 4 trains
Frequencies/day	121	122	121	A total of 243 at the most crowded section
Train kms/day	1,149.5	1,556.7	923.2	A total of 3,629.5
Car kms/day	4,598.0	6,226.9	3,692.9	A total of 14,517.8

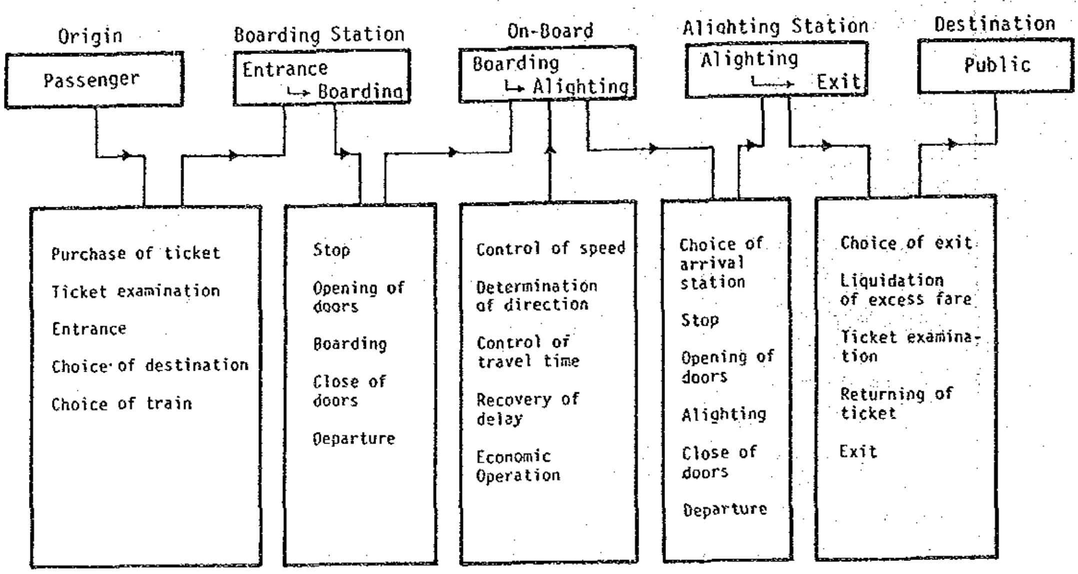
5.7.3 Control System

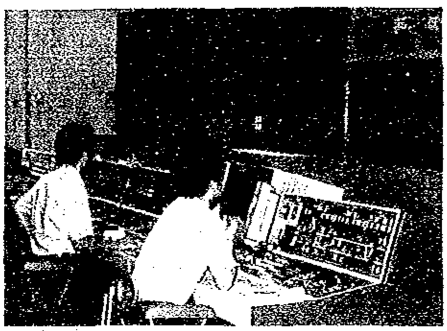
The proposed system is based on full automation. The advantages of full automation at present are not definitely justified, when compared with its relatively high cost, both for the control system and vehicles. However, at the same time, technological developments will work to push down the cost of automation. For such a system like Ang Mo Kio, which has a relatively complex route configuration compared with other existing new transit systems and intends to operate at short headways, an automatic control would be most ideal.

The transport system is composed of the activities shown in Figure 5.26. Automation is related with those activities which are further summarized in Table 5.24.

Figure 5.27

Composition of the Transport System





The overall control centre will have the following functions:

a) to obtain relevant operating information
b) to control train dispatching and operation
c) to control activities at station
d) to control power supply
e) to control disaster prevention

The outline of the control system is illustrated in Figure 5.27.

Table 5.23

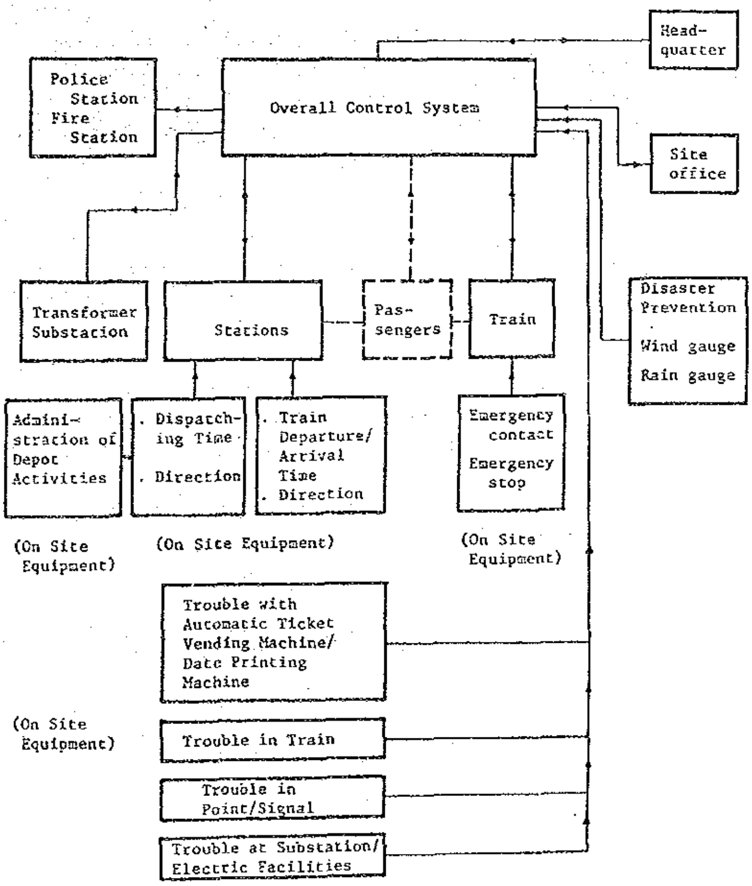
Transport Activities and Automation

Activities		Manual	Partial Automation	Full Automation
Station Management	1) Exchange	M	A	A
	2) Ticket Selling	M	A	A
	3) Payment of Change	M	A	A
	4) Ticket Examination	M	M	A
	5) Ticket Collection	M	M	A
	6) Liquidation of Excess Fare	M	M	A
	7) Information, Broadcasting	M	M	A
Train Crew		Two-man System	One-man System	Unmanned/ Automated
Train Operation	1) Opening and Closing of Doors	M	M	A
	2) Start and Acceleration	M	M	A
	3) Control of Speed	M/A	M/A	A
	4) On-board Broadcasting	M/A	M/A	A
Control Centre Activities	1) Communication by twin wireless radio	M	M	M
	2) Emergency Stop Command	M/A	M/A	A/M
	3) Dispatcher Phone	M	M	M
	4) CCTV	M	M	M
	5) Train Route Setting	M/A	M/A	A/M

Note: M: Manual
A: Automated

Figure 5.28

Outline of Central Control System



5.7.4 Electric Power Supply

Electricity will feed the power. An industrial standard power voltage of 440v, 3-phase, 50HZ will be used. It is advantageous to apply said power due to its availability (the same is used for air conditions and the lighting system). In addition, it is posible to minimize cost using the system prevailing in the market.

The outline of the system is described as follows:

1) Transformer Substation

a) Received Transformer Substation

Electricity will be supplied to each station by the city line. Therefore, it is not necessary to establish the received transformer sub-station.

b) Power Feeding Transformer Substation

The power feeding transformer substation will be set by a small capacity type (500kw - 700kw), with an interval of approximately 700 - 1,000 meters.

This substation will be set in the station precinct with accomodations in the cubicle, together with a vacuum circuit breaker, transformer, and protective relay rack.

The total supply of electric power is about 2kw, brokendwon as follows: lighting in the station precinct, 1k; emergency power source by storage batter, 300w; public address system, 500w; and reserved sources of electricity, 200w.

c) Contact Line

Contact Line is used in three-phase, three-wire trolley bar system.

This system is one phase grounding and uses one of three phase lines shared for guide wall rail and makes it two wires itself in order to minimize cost.

In case of power failure, an emergency measure to be adopted is the manual disconnection of a switch, which is set at the boundary of the power feeding.

2) Station Lighting and Source of Electricity for Machinery

The attached machinery of electric power source is set in the power feeding transformer substation.

3) Source of Electricity for Maintenance of the Signalling System

A power source of battery floating charge will be used primarily.

4) Outline of the System for Electric Power Supply

The system for power supply from the line of the electric company is shown in Figure 5.29.

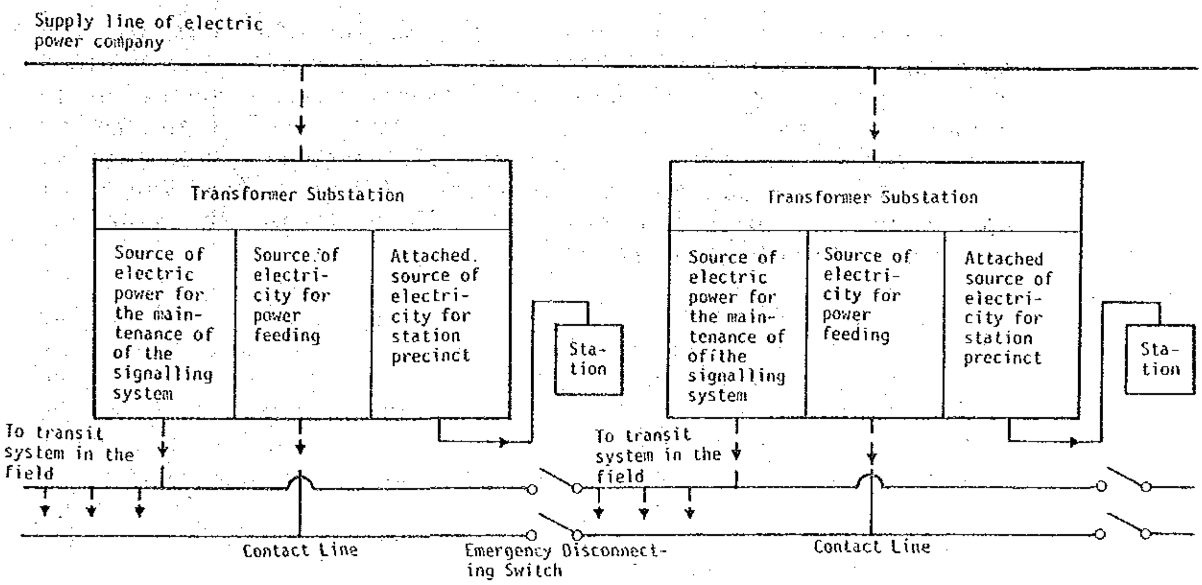
The system is similar to that used in the headquarters building, total control centre, and maintenance depot.

5) Estimated Demand of Electric Power

Demand of electric power of Ang Mo Kio system was estimated based on an average consumption of 3kwh/car-km. A total of 43,550 kwh is needed daily.

Figure 5.29

Diagram of the System for Power Supply



5.7.5 Fare Collection System

Since train operation is fully automated, fare collection might as well be fully automated, too. Fare collection system depends upon the fare system. For Ang Mo Kio, the possible fare system is as follows:

- Flat fare
- Through-ticketing with MRT

Through-ticketing with MRT is ideal for users. If this method is applied, the proposed system and MRT would be highly benefitted, although passenger patronage depends on the fare level. In this case study, flat fare, which is currently practiced with the feeder bus system, has been assumed. Flat fare will make it possible to simplify the facilities, which will include the following:

a) Automatic ticket vending machine
b) Coin Changer
c) Automatic date stamping machine
d) Fare collection box

5.7.6 Emergency Measures

Assurance in safety is one of the major concerns of the operator and society. This is particularly true to the various AGT systems. During the early new transit system operation in Japan, an attendant was assigned on-board fully automated train, mainly to relieve the anxiety of passengers and, partly, to monitor the automatic operation. After a few years of operation, this psychological aspect is no longer an issue and human operation became the practice.

In the Ang Mo Kio system, the control centre will monitor the activities and will react properly to any trouble. The monitoring and communication system is illustrated in Figure 5.29. Relief can be done by another train or equipment from the ground or by the equipment installed in the car or emergency passage installed along the carriageway. Some of these are shown in Figure 5.30.

5.7.7 Operation Organization and Personnel

In order to operate and manage the proposed system, a separate organization with proper staffing is required as shown in Figure 5.31. Seventy-six staff members and approximately 250 man days a year of contract workers will be required.

Figure 5.30

Outline of Communication System for Safety Control and Emergency Measures

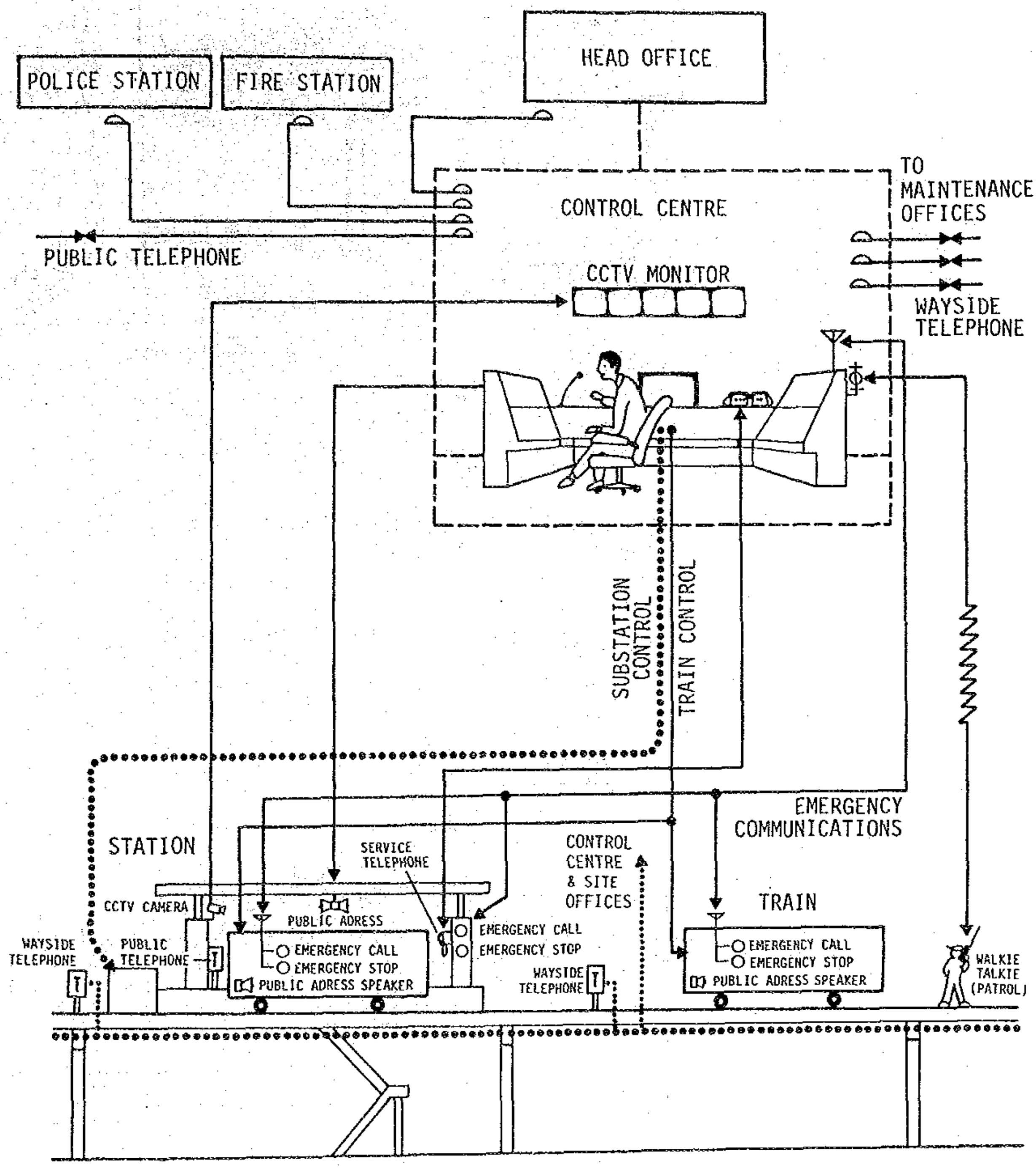


Figure 5.31

Examples of Emergency Relief Equipment

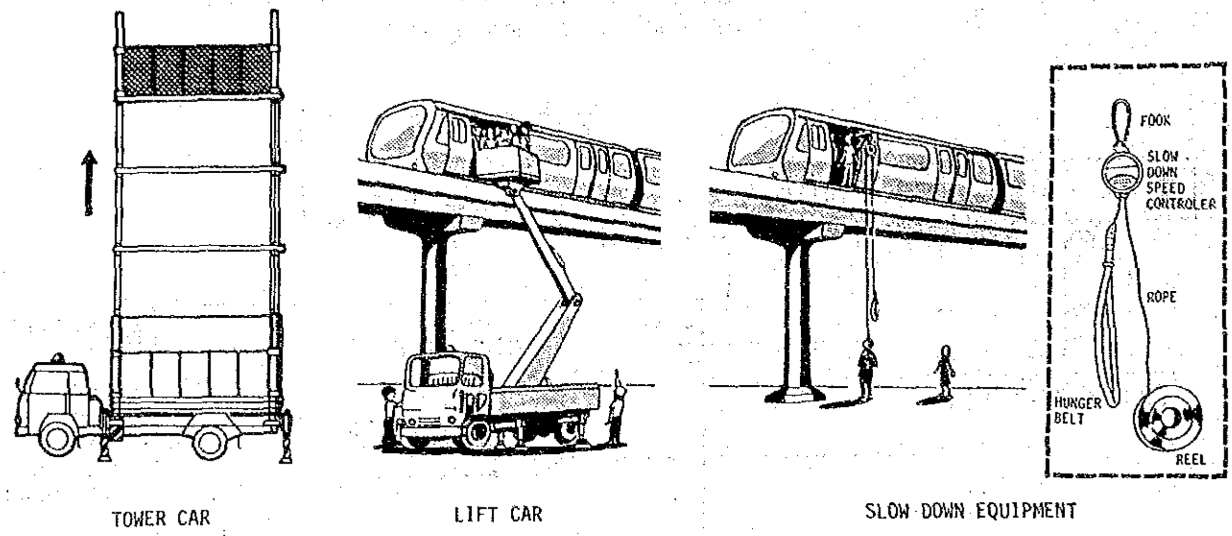
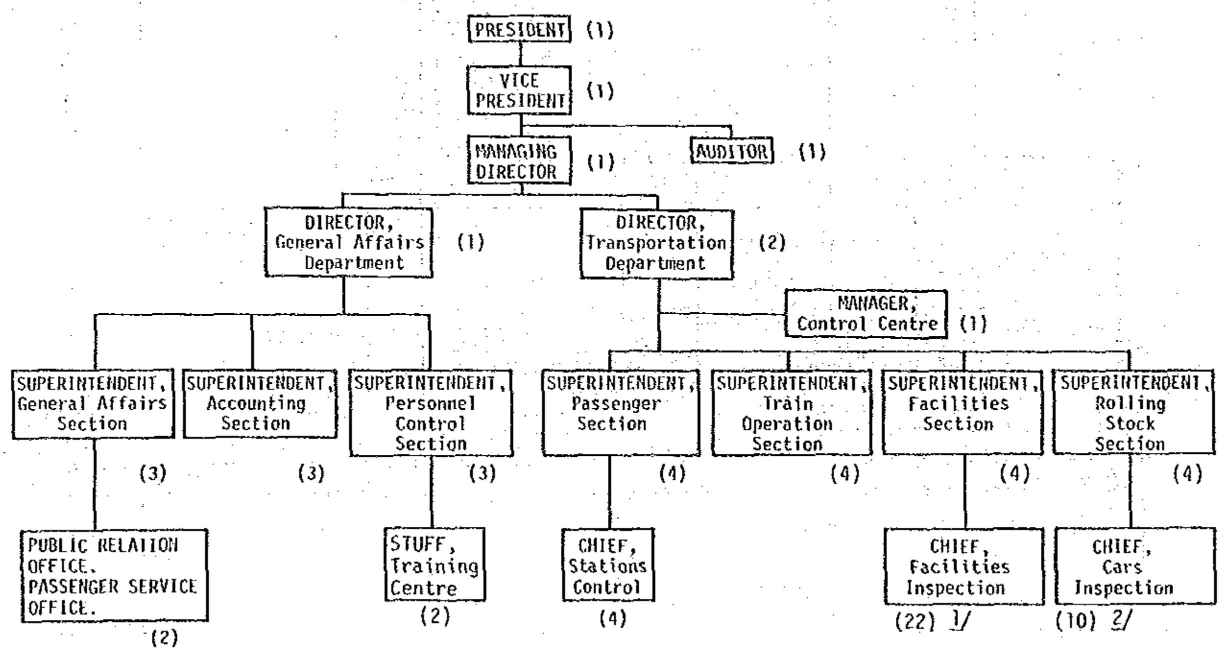


Figure 5.32

Organization Chart and Staff Requirement
for Ang Mo Kio System



Note:
1/ requires additional 220 mandays a year of contract workers
2/ requires additional 30 mandays a year of contract workers

5.8 Cost Estimate

5.8.1 Construction Cost Estimates

The construction cost of the proposed system was estimated for the following categories:

a) Civil Works
b) Stations/terminals and buildings
c) Depot
d) Vehicles
e) Power supply system
f) Control/signal/telecommunications system
g) Other Subsystems

Civil Works Cost was estimated based on the following:

- Preliminary design was made for the main infrastructure to estimated quantities by input. Unit prices of major work items were obtained from PWD and from the experience of relevant private firms in Singapore. The unit prices are shown in Appendix 5.H.

- Construction cost is expressed in 1988 prices. No price escalation is considered in the estimate.

- It is assumed that no taxes/duties will be exempted.

- Land acquisition and compensation are not included.

- Cost of relocating underground utilities is included.

An exercise was made to compare the construction costs of two single-track guideways and one double-track guideway for the carriageway. The results are shown in Appendix 5.I and summarized in Table 5.24.

Table 5.24

Comparison of Single-Track and Double-Track Guideways (Civil Works Only)

Guideway	Estimated (S$000/km)
Double-Track (A)	12,957
A Single-Track	6,977
Two Single-Tracks (B)	13,954
Ratio: (A)/(B)	1.08

As the difference is only about 8%, it is recommended that single track guideway be used mainly for aesthetic reasons and convenience of access to the stations. The estimated cost for civil work is shown in Appendix 5.J.

Stations and buildings costs were estimated for a central station, 21 intermediate stations, two other stations and other buildings.

Depot cost was estimated based on the layout including track facility, shed and equipment.

Vehicle costs were estimated by analyzing carefully the prevailing prices of similar systems in comparison with the specifications and performance.

Power supply, control/signalling/telecommunication systems costs were estimated based on the analysis of similar existing systems.

As summarized in Table 5.25, the total investment cost is estimated to be $354 million or $16 million/km (single track length). Of the total investment costs, infrastructure cost including civil works and station/building, shares 44%, while vehicle cost is 20% of the total.

Table 5.25

Summary of Investment Costs for Proposed Ang Mo Kio System

Item	Amount: S$ 000	%
1. Civil Work	131,310	37.0
2. Station/Building	23,210	6.6
3. Depot	26,800	7.6
4. Vehicles	70,720	20.0
5. Power Supply	48,490	13.7
6. Control/Signalling /Telecommunications	53,610	15.1
Total	354,140	100.0
Cost/km (Single track length) : 16,400		

provided. Assuming that an average station is provided with an escalator and screen doors and associated facilities, the estimated costs for these optional components are roughly as follows:

a) escalator (one person width) : S$350,000
b) screen doors and control : S$314,000 (S$38,000 x 4 cars or 8 doors + S$10,000 for control)
c) additional architectural work: S$100,000

Total : S$764,000/station

For a total of 28 stations, except Ang Mo Kio Central Station, it is estimated that approximately S$21 million is additionally required. The estimates are more or less similar to the estimated amount of station/building costs shown in Table 5.25.

5.8.2 Operating Cost

The operating cost of the system consists of the following:

a) Maintenance of vehicles: In 1985, the average actual cost of similar systems in Japan was $32,000/car. Considering the differences in the prices of industrial materials, 70% of the above or $22,400/car is assumed.

b) Maintenance of equipment and facilities: Based on previous experiences of a similar nature, $53,000/km and $67,000/km were allocated for the guideway and electric cable track, respectively.

c) Electric consumption: 3 Kwh, including operation of air condition equipment is assumed for one car-km.

d) Manpower: The cost was estimated based on the assumed organization and prevailing wages in Singapore.

e) Overhead: 10% of the costs of a), b), c), and d) above are assumed.

Accordingly, the operating cost is estimated to be S$7.6 million/year or S$20,720/day, as summarized in Table 5.26.

Table 5.26

Estimated Operating Cost for Proposed
Ang Mo Kio System

Item	Amount: S$ 000	%
1) Vehicle Maintenance	1,523	20.1
2) Maintenance of Equipment and Facilities	2,592	34.3
3) Electric Consumption	1,431	18.9
4) Manpower	1,330	17.6
5) Overhead	688	9.1
Total: per year	7,564	100.0
per day ($)	20,723	-

5.9 Project Evaluation

5.9.1 Approach

This section intends to evaluate the proposed project from the following viewpoints:

Economic: This refers to the economic viability of implementing the project by comparing the project cost and benefits expected to be derived from the project. It is anticipated that the nature of the project requires the assessment of intangible benefits rather than tangible benefits.

Financial: The financial viability of the project will be a major concern for decision makers. Since the present feeder bus services are operated based on a relatively low fare (15 cents per trip), the proposed system should maintain a reasonable level of fare, although its expected service level is higher than the existing feeder bus services.

Environmental: One of the significant positive impacts of the proposed system is its contribution to the improvement of environmental conditions, especially in terms of air pollution and noise, which are perceived by the residents as the most important aspect among various environmental problems in the new town.

5.9.2 Economic Evaluation

The types of benefits expected from the project comprise those related to transportation, environment, urban development and others. Beneficiaries and extent of the impact vary depending upon the project. These can be summarized as shown in Table 5.27. Of the benefits, however, the tangible ones are limited. An exercise was made to evaluate the project based on the following tangible benefits:

- savings in travel time
- reduction in vehicle operating cost

It is considered that the proposed system would likely reduce the average travel time by three to five minutes per trip. (When average on-board travel time of existing feeder bus is assumed to be 10 minutes, increase in scheduled speed from 14 kph to 21 kph will reduce the travel time to 6.7 minutes; when the average on-board travel time is 15 minutes, the reduced travel time is 10 minutes). Assuming that the average savings in travel time is 5 minutes and that time value is $3.1/hour, the total time saving for 180,000 passengers a day will reach $17 million a year. Savings from vehicle operating cost is approximately $0.5 million a year, which is estimated as

Table 5.27

Expected Benefits and Beneficiaries

Type of Benefits \ Beneficiaries	Transport User		People in the Influence Area		Society	
	System User	Non System User	Residents	Non Residents	Industries	Government
A. Transportation						
1) Increase in Reliability to Public Transport	○	—	—	—	△	○
2) Increase in Punctuality	○	—	—	—	—	—
3) Savings in Travel Time	○	△	—	—	—	—
4) Reduction in Vehicle Operating Cost	△	—	—	—	○	—
5) Increase in Riding Comfort	○	—	—	—	—	—
B. Environment						
1) Increase in Amenity	○	○	○	○	—	○
2) Reduction in Noise	○	○	○	○	△	○
3) Reduction in Air Pollution	○	○	○	○	△	○
4) Impact on Landscaping	★	★	★	★	—	★
C. Urban Development						
1) Impact on Land use	—	—	★	★	★	★
2) Encouragement of Integrated Development	○	—	○	○	○	○
D. Others						
1) Dissemination of New Technology	—	—	—	—	○	○
2) Savings in Investment/Maintenance of Alternative Transport Facilities	—	—	—	—	—	○
3) Savings in Energy	—	—	—	—	○	○

Note : Symbols represent the following,

○ : Positive Impact

△ : Positive Limited Impact

— : Insignificant Impact

★ : Impact could be positive or negative follows:

- total operating cost of existing feeder bus services: 55 units x $350/day/bus (operating cost) = $19,250/day or $7,026 thousand/year for the traffic level of 130,000 passengers a day
- estimated operating cost of the proposed system: $7,564 thousand/year

Further assumptions and procedures are explained in Appendix 5.K and resultant EIRRs and Benefit Cost Ratios are shown in Table 5.28.

Table 5.28

Estimated EIRRs and B/C Ratio of the Proposed Project

Item	Assumed Reduction in Travel Time			Estimated Time Value($/hr)
	3 min	5 min	7 min	
EIRR (%)	4.6	8.5	11.6	3.1 for 1988 4.0 for 1992 6.6 for 2000 8.1 for 2010
B/C Ratio at 2% Discount Rate	1.5	2.5	3.4	

Considering that the benefits from limited items alone give an attractive return, it can be concluded that the project is economically viable. It is to noteworthy that the effects of environmental improvements are immediately obtained upon the completion of the project, while further urban development takes a longer period of time.

An energy saving effect is also significant. as shown in Table 5.29, the estimated energy consumption of new transit system is almost less than a half of bus.

Table 5.29

Comparison of Energy Consumption of Selected Transport Modes

Modes	Energy Consumption/Vehicle			Energy Cons./Pass	
	kwh/carKm	Crude Oil 1/ Equivalent liter/carKm	Index	Average Passenger Capacity	Index
1) Subway	2.69	0.25	54	140	23
2) Monorail	2.66	0.25	54	125	26
3) LRT	2.50	0.23	50	100	30
4) Bus	-	0.46	100	60	100
5) New Transit System					
- Kobe Portliner	2.67	0.25	54	75	43
-Saitama Ina Line	1.63	0.15	33	65	30

Source: worked out based on annual statistics of Private Railway operation

1/ estimated based on conversion rate of 0.093 liter of crude oil for 1 kwh

5.9.3 Financial Evaluation

The financial viability of the proposed system is a concern of the Government. A relatively, heavy initial investment is often discouraging and imposes a heavy load after the opening of the system. A financial evaluation was made based on the following:

a) Annual breakdown of initial investment: It is assumed that the project will be constructed in three years as shown in Table 5.30. Reinvestments on vehicles, signalling/telecom/control systems and other subsystems are required, 20 years after its the opening.

b) Depreciation: Depreciation for various facilities/equipment is assumed, as shown in Table 5.31.

c) Equity: Two alternative cases are assumed, namely: 15% and 30% of the initial investments.

d) Interest rate for loans: 7% is assumed both for long-term as well as short-term loans.

Table 5.30

Disbursement Schedule of Investment Cost

Work Item	1989	1990	1991	Total
1) Civil Work	26,260	52,530	52,520	131,310
2) Station/Building	2,320	9,280	11,610	23,210
3) Depot	-	13,400	13,400	26,800
4) Vehicles	14,140	21,220	35,360	70,720
5) Power Supply	4,850	14,550	29,090	48,490
6) Signal/Telecom/ Control/Other Subsystems	5,360	16,080	32,170	53,610
Total	52,930	127,060	174,150	354,140

Table 5.31

Estimated Depreciation

Item	Useful Life	Initial Investment	Annual Depreciation
1) Civil Work	40	131,310	3,283
2) Station/Building	45	23,210	516
3) Depot	30	26,800	893
4) Vehicles	20	70,720	3,536
5) Power Supply	30	48,490	1,616
6) Signal/Telecom/ Control/Other Subsystems	20	53,610	2,681
Total		354,140	12,525

The results are summarized in Table 5.32 and explained as follows:

a) If the government shoulders all infrastructure and systems costs, except vehicle cost, the operation of the system will give an FIRR of 14.5% at the fare level of 30 cents flat while if the fare is set to 20 cents, the FIRR will be down to 4.3%. With the former case, the net profit can be expected from the first year after the opening of the proposed system.

b) If the government shoulders only the infrastructure cost of civil works (guideway) and stations/buildings at the fare level of 30 cents flat, the FIRR becomes only 2.7%. However, if the fare level is increased to 40 cents, the FIRR is 7.0%.

Table 5.32

Summary of Financial Analysis for Ang Mo Kio New Town System

Description of Case / Item	Base Case: Govt. to shoulder all investment except vehicles		Alternative Cases: Case A: Civil work/ station are shouldered by Govt.		Alternative Cases: Case B: Base case with decreased fare		Alternative Cases: Case C: Case A with increased fare	
No. of Pass/day	180,000		180,000		180,000		180,000	
Fare (¢)	30		30		20		40	
Revenue: (S$000/yr)	19,710		19,710		13,140		26,280	
Invest Cost (S$ 000)	70,700		199,600		70,700		199,600	
Open & Maint. (S$000/yr)	7,564		7,564		7,564		7,564	
Depreciation (S$000/yr)	3,536		8,726		3,536		8,726	
Operating Profit (S$000/yr)	8,610		3,420		2,040		9,990	
FIRR (%)	14.5		2.7		4.3		7.0	
Equity (%)	15	30	15	30	15	30	15	30
Interest Rate (%)	7.0		7.0		7.0		7.0	
First Year Net Profit Generated	1992	1992	-	-	2009 1/	2001 2/	1997	1993
First Year Accumulated Net Profit Generated	1994	1992	-	-	-	only 2011	2003	1997
Remarks	1/ deficit in 2012 thereafter 2/ deficit in 2012 and 2019							

5.9.4 Environmental Assessment

The environmental impact of the project is complex and explained further in this section. As summarized in Table 5.33 the impacts on various environmental aspects are caused by changes in the traffic pattern and the construction of modified related facilities due to the new transit system. Positive impacts are mainly expected from the reduction in bus traffic. Visual effects are larely dependent on the design and location of the facilities and perception of the relevant people. There are also a number of aspects which could have a positive or negative effect depending on how they are handled.

1) Noise and Air Quality of the Community

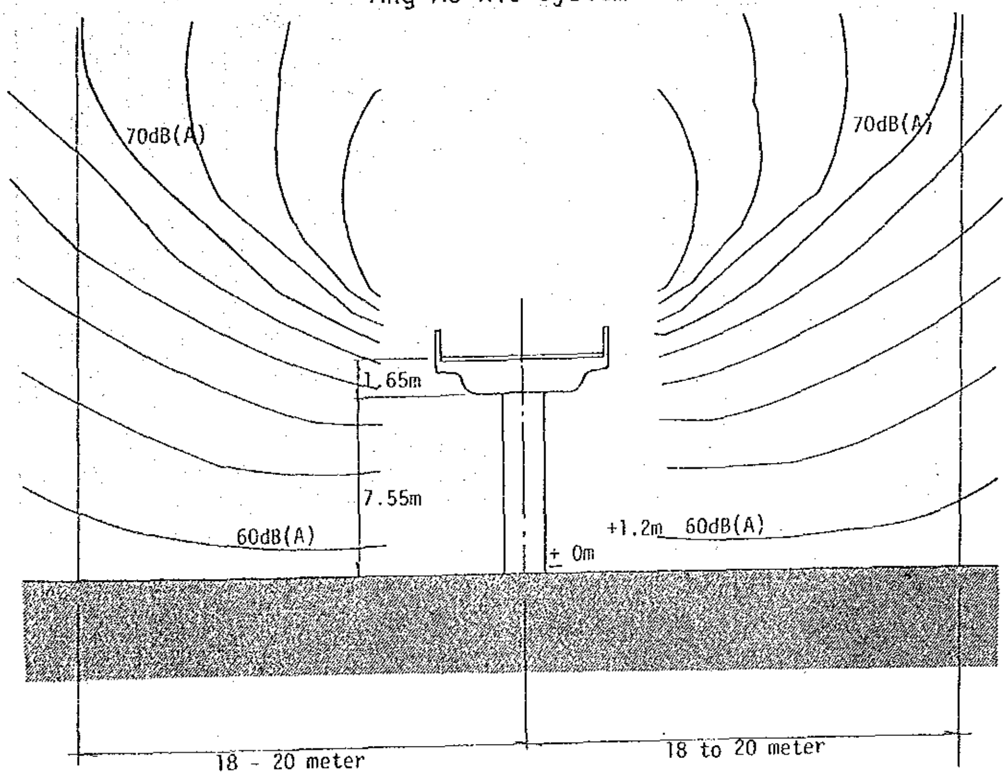
Effects of noise are twofold: One is noise which the proposed new transit system may generate and the other is the reduction in noise level due to the decreased bus traffic.

<u>Noise emanating from the system</u>

A comprehensive survey has been undertaken by Kobe city for the Portliner system. Noise emanating from the system has been estimated, as shown in Figure 5.33. The noise contour indicates that higher locations are affected more than the lower locations. For example, those who walk along the system will experience a noise level of only 60 dB(A).

Figure 5.33

Estimated Noise Contour of the Proposed Ang Mo Kio System



However, when the distance from the system is approximately 18 to 20 meters, a contour line of 70 dB(A) will never reach buildings. Considering the existing physical structure of the existing new town and further improvements expected in the near future from the system itself, the noise emanating from the system would not disturb the living environment. This is so, under the Singapore conditions that sufficient buffers are normally provided between major roads and blocks.

Table 5.33

Environmental Consequences due to New Transit System

Impact and Possible Consequences			NTS User	Road User	Commu-nity
Impact on Traffic	Reduction in Bus Traffic	Reduction in Noise and Air Pollution	○	○	○
Impact on Traffic	Reduction in Bus Traffic	Removal/Re-placement of Bus Facility	—	△ Saved space can be used for other purposes	
Impact on Traffic	Reduction in Bus Traffic	Improvement of Road Traffic Safety	△	○	○
Impact on Traffic	Generation of NTS Traffic	Improvement of Transport Amenity	○	—	—
Impact on Traffic	Changes in Pedestrian Traffic flow	Modification to Pedestrian Facilities	*	*	*
Impact on Traffic; Construction on NTS Facilities	Changes in Pedestrian Traffic flow; Station	Impact on Landuse	○	—	○
Construction on NTS Facilities	Station; Structures	Visual Effects	*	*	*
Construction on NTS Facilities	Structures	Blocking of Sunlight and Foliage	—	—	—

○ : Positive impact
△ : Positive limited impact
— : Insignificant impact
* : Impact could be positive or negative

Reduction in Bus Traffic Noise: Generally speaking, automobile noise is mainly emitted from engine, air intakes and exhaust pipes, cooling fans, drive trains, tires and so on. Actually, however, various factors, such as traffic volume, the types of vehicles, running speed. structure of roads, etc., are completely interwoven to create the automobile noise problems at roadsides. The average power level of a vehicle is a function of running speed and the composition of large and small vehicles, and could be calculated by the following equation when the factors are known.

$$Lw = Lp + 0.2V + 10 \log_{10} (a_1 + Na_2)$$

Where, Lw : Average power level of a vehicle, (dB(A))
V : Average running speed of a vehicle, (km/h)
a_1 : Composition of small vehicles
a_2 : Composition of large vehicles whereas $a_1 + a_2 = 1.0$
Lp : Basic power level of a vehicle, (dB(A))
N : Contribution of large vehicles compared to small vehicles in terms of noise level. In general, a figure from 8 to 10 is used.

The above equation shows that the large vehicle contributes to noise level more than a small vehicle. It indicates that when the number of large vehicles is reduced, the noise level is reduced effectively. For example, when the composition of large vehicles is 30 percent, and reduce to 10 percent, the average power level will be reduced by 2 to 3 dB. Further decrease in noise due to acceleration of buses at the intersections and bus stops can also be expected.

Combined noise effects: Noise emission of the new transit system is every two to five minutes, while that of buses is rather continous. Although it is difficult to specifically quantify the effects, it is clear that the noise due to the traffic will be decreased, particularly along the roads where bus traffic was heavy.

Air Pollution: Although the present situation of the new town with regards to air pollution is within the safety criteria, except at the bus interchange, the pollutants being exhausted from feeder buses can be reduced.

Table 5.33 shows that the emission gas, especially nitrogen oxides of large vehicles, is very large in comparison to that of small vehicles. This indicates that when the no. of buses are reduced, emission gas will be reduced considerably, especially nitrogen oxides which is the main cause of air pollution.

Table 5.34

Emission Factors

g/km/unit

Vehicle Type	Running Speed (km/hr)	NOx	CO
Large vehicle	60	3.82	1.64
	80	3.51	1.38
Small vehicle	60	0.49	1.40
	80	0.78	0.91

Source: Emission Factors of Vehicle Exhaust Gas for use of Environmental Impact Prediction (Draft), Ministry of Construction, Japan 1986.

2) Noise and Air Quality of Stations and Within Vehicles

Needless to say, the air quality at stations and within vehicles will be imporved significantly. This is particularly true for bus interchanges and within vehicles. Noise quality will also be improved both at stations and within vehicles. A survey record indicates that the noise levels within feeder bus and new transit system are about 75 dBA and less than 70 dBA, respectively.

3) Conditions Encountered by Passengers in Occupying, Boarding and Waiting

Improvements in transport amenities can also be expected in various activities of travel. Regarding riding comfort, buses can provide more seats while the proposed new transit system only about 20 of 75 passenger capacity. The estimated occupying condition of the latter near Ang Mo Kio central station during peak hours is about 90% load factor; the heaviest sectional traffic of about 6,000 passengers/hour/direction against a carrying capacity of 6,750 for a three-car train at two minutes headway. The occupying condition of 100% load factor still can have a passenger to read a pocket in the car. Considering that the vehicle is air conditioned and the average travel time is less than 10 minutes, the in-vehicle environment is much better than that of the existing feeder bus. Boarding and alighting from the vehicles can be done smoothly, while passengers have to use the stairs to reach the platform (except the disabled for whom a lift is provided at all stations). Waiting conditions for the proposed system will be better at grade-separated platforms, therefore less effects of road traffic.

4) Changes to Pedestrian Traffic Flow

Pedestrian traffic flow will change in many places. Heavy concentration at existing bus interchange areas might be dispensed due to the increase in number of stations in the town centre (See Figure 5.15). Pedestrian traffic due to transfers among MRT, trunk bus and feeder bus will also change considerably. Transfers between trunk bus and feeder transport (feeder bus at present and new transit system in the future) will become inconvenient but that between MRT and feeder transport will become convenient. It is expected that further expansion of MRT will increase the passenger flow between MRT and feeder transport; therefore, the overall improvement of transfer activities is also expected.

5) Interference on Street Space

Construction of structures and stations requires sizeable spaces mainly in existing street spaces. It is feared that especially two/three tier cris-crossing at traffic junctions will interfere with the activities on road space. However, the existing roads have sufficient space to accomodate the light structures of the proposed system in most of the locations, except at the central station where complex structures need more careful investigation and design work. (See Figure 5.22)

6) Modification to Existing Facilities

Existing facilities are affected by the construction of the proposed system and need to be demolished, replaced or modified for the following areas;

<u>Removal/replacement of feeder bus facilities</u>: Most of the existing facilities such as bus bays, kerbside bus stop, bus shelters can be removed or replaced.

<u>Modification of Pedestrian-related facilities</u>: Changes in pedestrian traffic flow would require modification of various pedestrian-related facilities, such as overhead bridges, zebra crossings, etc. In order to encourage the use of the proposed system, the overall improvement of access to the stations needs to be duly taken into account. One of the proposed measures is to construct pedestrian bridges integrated with stations where pedestrian traffic flow is heavy.

ALternative Utilization of spared road space: Reduction in bus traffic would result in the use of road space for other purposes depending upon the area conditions. One of the possible modifications in existing road spaces is to meet the needs of pedestrians rather than those of automobiles. Any savings in road space obtained with the decrease in bus traffic could be directed to further improve pedestrian or non car transport environment.

7) Traffic Safety

Traffic accidents and problems related to the existing feeder buses can be eliminated.

8) Visual Effects

Although the visual impact due to the construction of the system is considered significant, it is hard to specifically assess its effect. Generally speaking, for such new towns like Ang Mo Kio where high-rise buildings and blocks prevail, the proposed grade-separated structures would not adversely affect the aesthetic features of the area. As MRT gives a positive visual impact in the Ang Mo Kio scenery, the lighter and modern structures and vehicles would add mobile accent to the landscaping.

Considerations given at this stage of the study are as folows:

- The carriageway of the system will be constructed in two single tracks along the sidewalk, so that the structure would not cover the street and interrupt the views of road users. The structure can be hidden by road-side trees.

- Stations will be simply designed.

9) Impact on Land Use

The proposed system would encourage more activities t the town centre and several neighbourhood centres where the stations are strategically allocated. Accessibilities to these locations will be significantly increased and communities in the new town will be more strongly united and interrelated.

10) Other Impact

Blocking of sunlight and foliage can be minimized due to the light structures of the system.

5.9.5 Management Aspect

Introduction of the new transit system would also affect the management of the exsiting feeder bus and raise an issue on how the new system should be managed. The proposed transit system with an extensive coverage could replace the existing feeder bus services completely except for the industrial areas near Yio Chu Kon MRT station. The said area and other peripheral areas where feeder buses serve will be replaced by the new transit system that can be continuously covered with modification of some trunk bus routes.

There are a number of alternative ways to operate the new system in Ang Mo Kio new town, if the Government can shoulder the basic infrastructure cost such as guideway structure and station costs. The possible organizations that can operate the new system are initially described as follows:

a) Present Feeder Bus Operator: As it is expected that the proposed system can be operated financially and independently under certain conditions, the proposed system can be continuously managed by the existing feeder bus operator. With this the manpower assigned for the feeder bus operation can be absorbed by the new transit operation and certain areas uncovered by the new transit system could be continuously served by the same operator with minimal input.

b) MRTC: It is also logical that MRTC would operate the new transit system because of the close relationship between MRT and feeder system both in terms of route structure, interchange function and facilities and especially demand characteristics in the new town. Since the main shortcoming of the present MRT system is a relatively poor access/egress or feeder system compared to its high level of service along MRT system itself, the further improvement and expansion of the MRT system should be directed towards the strengthening of such supplemental function and facilities. With this, the financial feature of the proposed system can be further considered such that the passengers benefits and patronage to the integrated system (MRT plus new transit system) are maximized.

c) HDB: For such compactly built new town as Ang Mo Kio and other new towns in Singapore, the feasibility of introducing a transport system like the proposed new transit system is high. With relatively short route length, the system can cover the large portion of new town activities. Considering that a new town is a large block, the proposed new transit system can also be considered a horizontally operated elevator which is regarded as a part of the building than of the transport system. In this context, the new transit system can be developed and managed by HDB in the total estate management. This concept is probably more applicable to the case of Simpang new town.

d) New Town Council: With the same thought as described for HDB, new town council or the residents themselves could manage the system. With the Government's contribution to the investment cost for civil work and station, the estimated annual cost to be shouldered by the new town are:

- depreciation : S$ 8.73 million/year
- operation and maintemance: S$ 7.56 million/year

Total : S$16.29 million/year

If this cost of S$16.29 million/year is shouldered by the new town residents, the average allotment per household is approxiamtely S$325/year (S$16.29 million ÷ 50,000 households according to 1988 HLS). Since the costs can also be shouldered by various establishments in the new town, the average household allotment will be less. With this the system can be operated free or with minimal additional charge.

6. CASE STUDY ON SIMPANG NEW TOWN

6. CASE STUDY FOR SIMPANG NEW TOWN

6.1 Study Objectives and Area

6.1.1 Background and Objectives

Basic needs in housing have been efficiently met by developing a number of large-scale new towns at various strategic locations most of which are directly linked with CBD via high standard trunk transport system such as expressways and MRT. Housing and necessary public services in those new towns are well provided at attractive prices to consumers. Completion of on-going developments would meet more than the anticipated quantitative demand in the future. Although the planning concepts for these new towns are basically the same, the Government has been undertaking minor modifications on planning and design standards to meet the changes in circumstances and requirements.

Simpang new town is being planned at the influx of new town planning and developments. Therefore, the basic objectives must be directed towards:

a) Seeking a new concept and planning standards for future public housing and community when the living standards become higher and the demands in quality life and environment increase.

b) Determining the role and rationale of introducing a new transit system to achieve targeted new town developments.

As transportation is an important component of new town development, planning and justification of the investment in transportation system can only be undertaken within a total development framework. However, considering the limitation and objectives of SUTIS, the case study would limit the coverage to the transportation aspect only with the assumption that existing planning concepts for overal new town development are basically applied.

The case study undertaken for Ang Mo Kio new town has revealed that if a new town and new transport system are planned and developed in an integrated manner, the possibility of achieving a better living environment and more efficient transport system would be much higher than introducing a new transport system into a developed new town. The objectives of this case study are set forth as follows:

a) To formulate a preliminary plan of new town for Simpang area based on the assumption that a new transport system will meet its traffic demand.

b) To assess the feasibility of the proposed new transport system from the economic, financial anwd environmental viewpoints.

6.1.2 Study Area

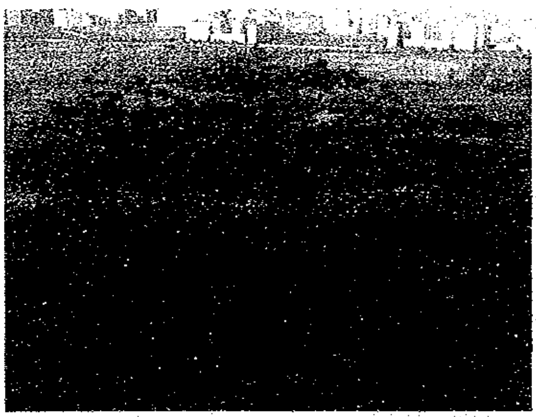
The proposed Simpang New Town is located at the northern part of the Island. The area, being currently cleared including reclamation, extends over approximately 700 ha to accommodate approximately 30,000 dwelling units or 120,000 people. A preliminary plan has been prepared by HDB.

6.2 Planning Concept

6.2.1 Existing New Town Planning Concept

1) Overall Planning Concept

At present, new towns are planned and developed based on the neighbourhood concept which has been broadly practiced worldwide. In the neighbourhood concept, a new town is composed of several neighbourhoods , each comprising 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 any neighbourhood center located within walking distance of three to five minutes for most residents. These neighbourhoods are further divided into precincts, each comprising 500 to 1,000 dwelling units. Each houses between 2,500 to 5,000 people to enhance social interaction among the residents. A standard neighbourhood is conceptually explained as shown in Figure 6.1. Additional facilities are further provided for the entire new town to satisfy various needs at different levels. These facilities and planning standards are shown in Table 6.1. A town center is provided in each new town and it is normally located in its geographcal center. Generally, for a new town of 40,000 dwelling units, 33% of the land is set aside for housing developments, 14% for commercial, 12% schools, 19% for industries. 6% for sports/open space and 13% for major roads and utilities. (Refer to Table 2.11.)



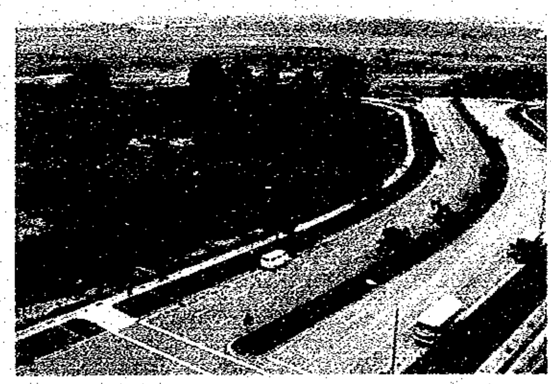
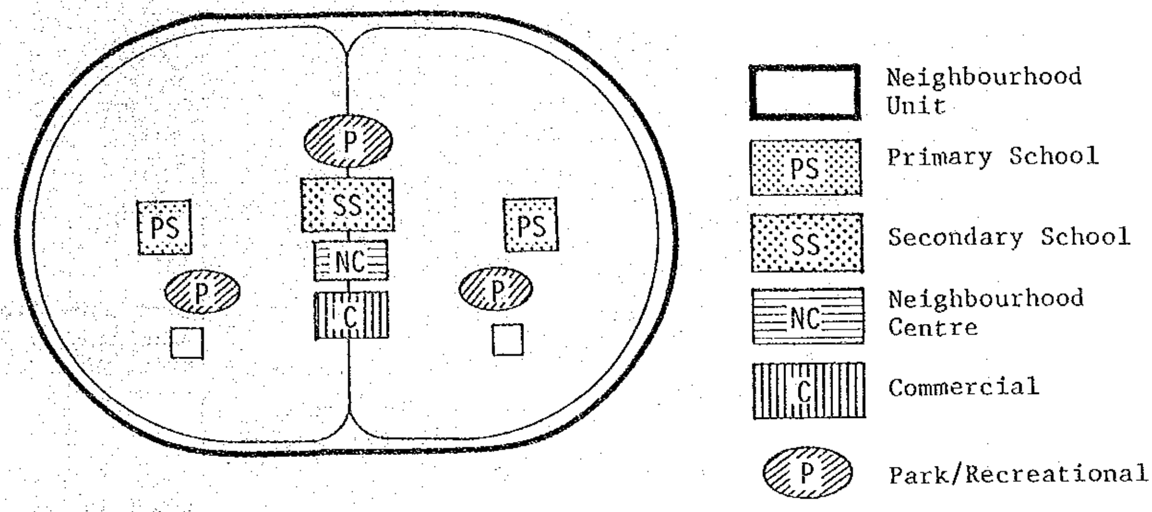


Figure 6.1

Outline Concept of A Standard Neighbourhood Unit



2) Transportation Planning

Roads: Transport services for existing new towns have been totally road-based until the opening of MRT. The roads are planned by HDB according to the set of road standards devised by PWD. The standards classify the roads into several categories such as primary distributors including expressways and major arterials, secondary distributors (or collectors) and local access streets. For each category of roads, standards are set with regard to reserve width, carriageway width, carriageway arrangements (single or dual), the number of lanes per carriageway, design speed, geometric features, etc. The hierarchy of roads in a typical HDB new town comprises the following:

a) Major Arterial: Dual carriageway roads with road reserve of 31.8 to 45.4 meters (or a total of 4 to 6 lanes).

b) Primary Access Road: This includes dual carriageway road (4 lanes), divided two-way road (4 lanes) and undivided two-way road (2 lanes).

c) Local Access Road: Undivided two-way road (2 lanes).

The typical cross sections selected from each category are shown in Figure 6.2.

Table 6.1

Facilities and Planning Standards for a New Town

Hierarchy	No. of Dwelling Units	Facilities to be provided 1/		
		Commercial	Institutional 2/	Sports and Recreation
	70	Shop (30-400sqm)		
Precinct	450	Office Space (60sqm)		
	500	Market Produce Lock-up Shop (40sqm)		
	600	Kiosk (5-15sqm)		
	750	Eating House (450sqm)		
	1,000	Restaurant (90-2000sqm)		Hard Courts for badminton, valley ball, etc. (16.5x 8.5m)
	2,300		Primary School (1.8ha)	
	2,500			Multi-Purpose Court (30x18m)
	3,000	Market Produce Shop (130sqm)		Precinct Garden (0.2ha)
Neighborhood	4,000		Community Centre (0.4ha)	Football Field (140x100m or 95x70m) Neighborhood Park (1-1.5ha)
	4,100		Secondary School (2.7ha)	
	6,000	Mini-Market (450sqm)		
	9,000		Chinese Temple (0.2ha)	
	12,000		Church (0.3-0.4ha	
	15,000	HDB Area Office (2000sqm)		
New Town	30,000 & Above	Emporium: 1-2 nos.(4500-6500sqm) Super Market: 1-2 nos.(1200sqm) Cinema: 2 nos. (1800sqm)	Polyclinic (0.5ha) Junior College site (6ha) Vocational Institute site (6ha) Mosque (3000m2) Library (0.3-0.4ha) Hindu Temple: 1/2 (0.2ha)	Swimming Complex (1.5ha) Sports Complex (3ha) Indoor Stadium (1.2ha) Town Garden (5-10 ha)

Source: Housing A Nation, HDB

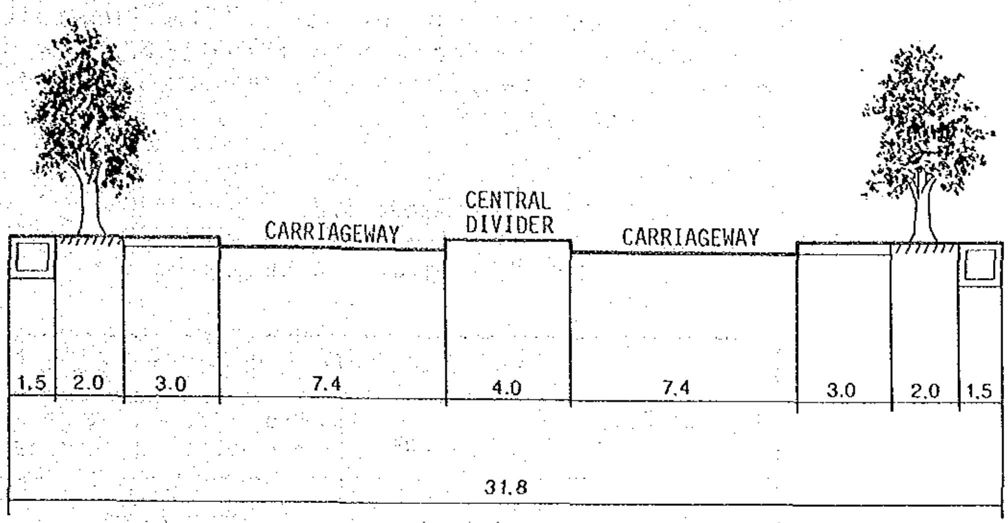
1/ No. of facilities is one unless specified.

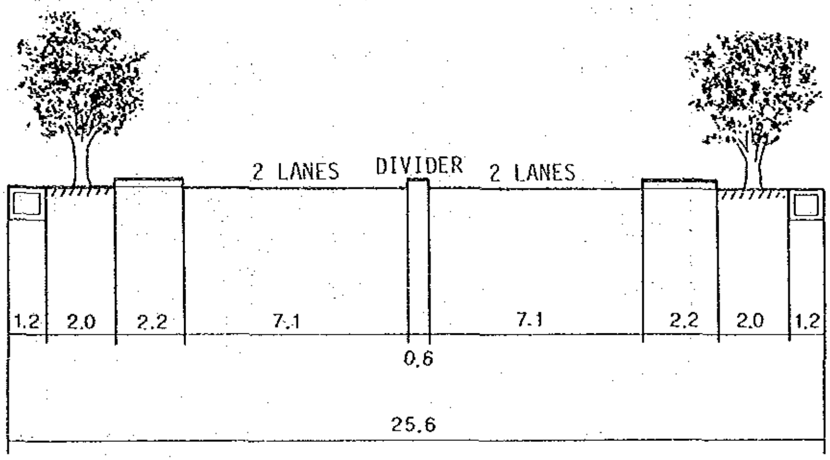
2/ Residents Committee Centre, Community Hall, Neighbourhood Police Post, Kindergarten, Child Care Centre, Senior Citizens' Club, etc. for non-profit communal uses are usually located at the ground floor void decks of the apartment blocks.

Figure 6.2

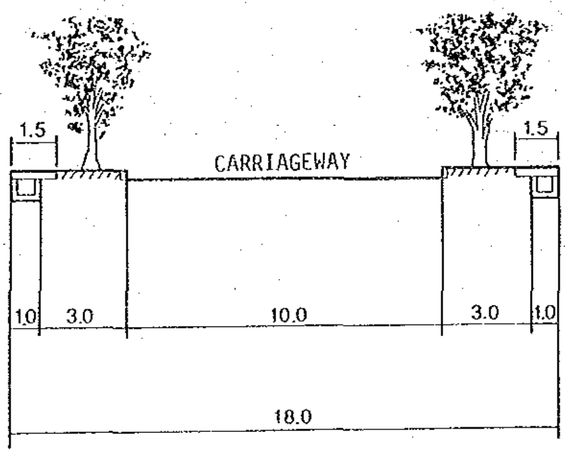
Standard Road Section for Major Roads in New Town

Primary Access Roads





Local Access Roads



Source :(Planning and Design) Public Works Department, Roads

Car Park: Since the car population boom in the early seventies, car park provision has become an integral consideration in the planning and design of HDB estates and new towns. The present car park provision standards are shown in Table 6.2. The weighted average for the existing new towns is one car park lot for 2.7 dwelling units. The latest standards for car parks are 4.2m x 2.4m for lot size and 5.4m for driveway which were reduced from 4.8m x 2.4m and 7.4m, respectively.

Table 6.2

Car Park Provision Standards

Type of Flat	Number of Dwelling Units to One Car Park		
	Pre-1984	Projected for 1986	Projected for 1990
1-Room	10.0	7.7	5.5
2-Room	5.0	5.2	3.9
3-Room	3.0	2.1	1.6
4-Room	1.5	1.7	1.4
5-Room	1.0	0.9	0.7
Executive	1.0	0.9	0.7
HUDC	1.0	0.9	0.7
Weighted Average	-	-	2.7

Bus Terminal/Facilities: Normally a large-scale new town is provided with a bus interchange at or around town centres where trunk bus service and feeder bus service interchange transfer passengers. It requires approximately 1.5 to 2.0 ha. as typically seen in Ang Mo Kio, Toa Payoh, Jurong new towns. Bus stops are provided at fairly close intervals. For example, Ang Mo Kio new town has 108 bus stops with shades and benches or a bus stop for every 250 meters. Thus, all the areas are provided with bus stops within 250 to 300 meter radius.

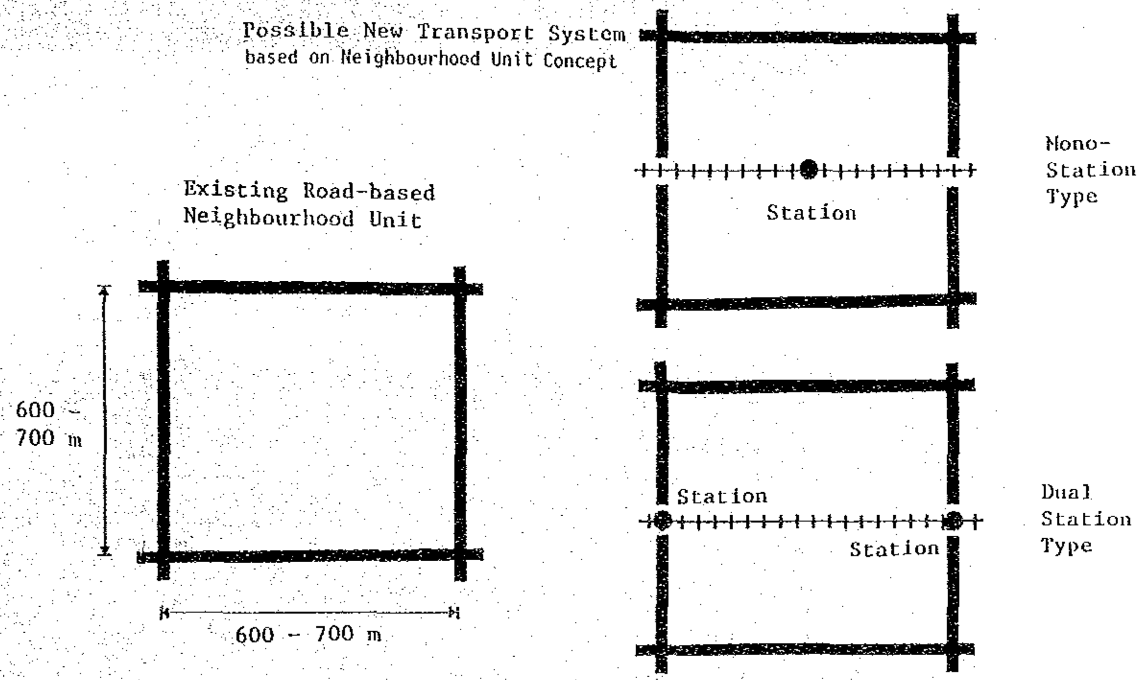
6.2.2 Planning Concept for New Town Integrated with New Transport System

1) Planning Concept at the Neighbourhood Level

Since a new town is planned based on the neighbourhood concept, adoptability of the new transport system to meet the accessibility requirements within the neighbourhood has to be examined. The present size of a standard neighbourhood unit is approximately 40 to 50 ha. Figure 6.3 shows that without altering the present size of the neighbourhood unit, a new transport system can be introduced with a reasonable accessibility to/from station (300 to 350m).

Figure 6.3

Basic Transport Structure and Neighbourhood Unit



A plan for a new transit system based on the neighbourhood concept is further illustrated in Figure 6.4. Although the new transit system at this level does not contribute to the transport within the neighbourhood unit, it will affect the allocation of land uses and facilities and the traffic movement significantly. The logical planning concept is to locate the neighbourhood centre and common community facilities at/around the station(s) to maximize accessibility for the residents, as well as visitors. The advantages of the proposed concepts over the conventional planning concept are further explained as follows:

Figure 6.4

Alternative Planning Concept for Neighbourhood Unit Integrated with New Transit System

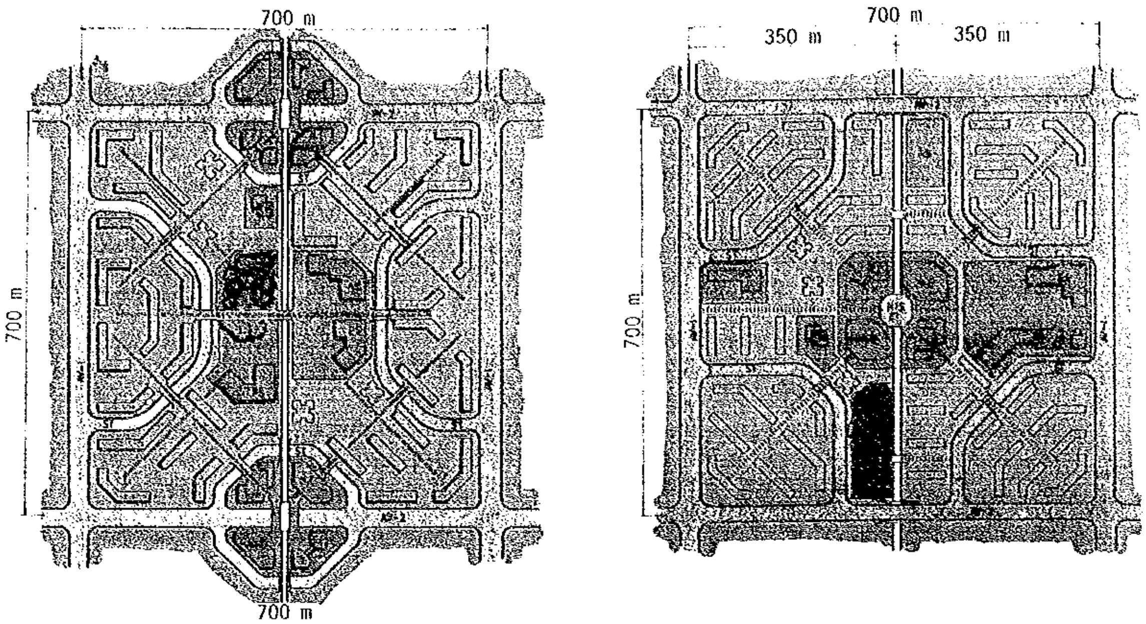
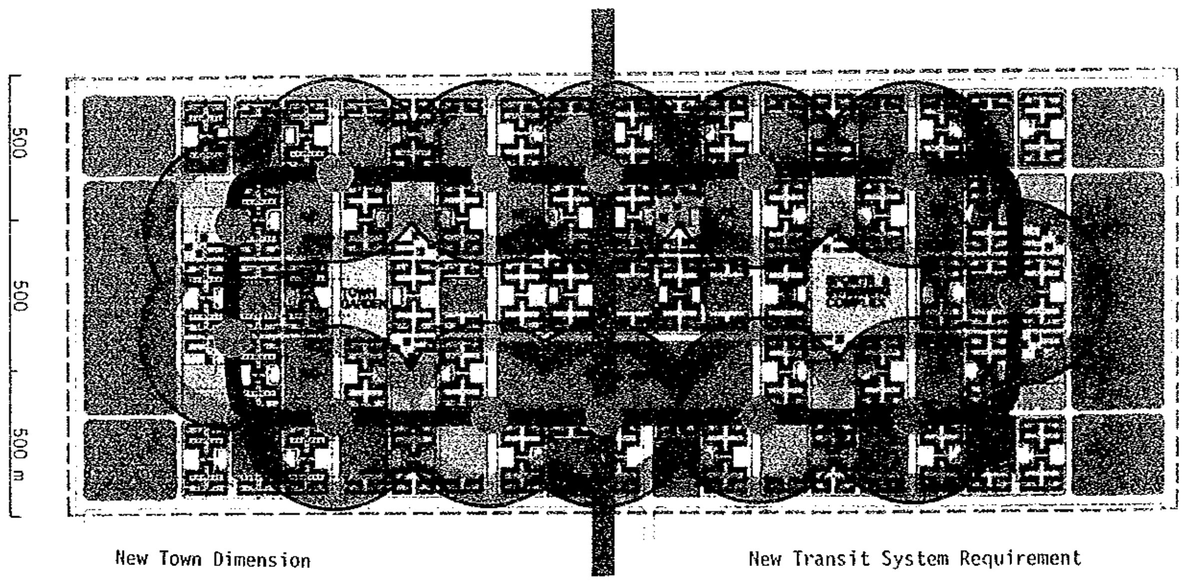


Figure 6.5

A Model of a New Town Integrated with a New Transit System



New Town Dimension

Area: 1600m x 4000m = 640ha

No. of Dwelling Units: 40,000

Planned Population: 150 - 200 thousand

Population Density: 230/ha (gross) 700/ha (net)

M R T

New Transit System Requirement

Route Length: approximately 8 km

No. of Stations: 11 to 12

Maximum Walking Distance: 300 meters

a) Pedestrian traffic and vehicular traffic can be better segregated.

b) Unity of a neighbourhood is more clearly and effectively achieved.

c) Entering and movement of vehicular traffic within the neighbourhood unit can be better controlled and reduced.

2) Planning Concept for New Town Level

This section provides that the planning concept at the neighbourhood level will work at the entire new town level. The basic function of the new transit system required at the new town level are:

- to provide an efficient link with main inter-city transport route/network.

- to provide efficient link among various land uses, particularly between residential areas and other destinations within the new town.

Figure 6.5 shows the possible integration of the new transit system and HDB new town model and indicates that the new transit system would fit to the planning concept.

6.3 New Town Development Plan

6.3.1 Planning Concepts

The physical characteristics of the Simpang area are summarized as follows:

i) Extending 4 kms northwest to southeast and 2 kms northeast to southwest, it covers roughtly 700 ha, including two off-shore islands; one island is 50 and the other is 90 ha.

ii) The terrain is flat and the northeast and southeast edges face Johore channel.

iii) The area immediately adjoins Yishun new town, with a planned size of 919 ha, 60,000 dwelling units and 228,000 population (roughly 70% completed as of March 1986).

iv) Approximate distance between CBD is 20 kms via MRT which will be extended to Yishun by 1989. Direct link with expressway is not planned.

The size of Simpang new town is set by HDB to accommodate 30,000 dwelling units or a population of about 120,000. According to present planning standards, only about 470 ha of land will be required to meet the above population; 230 ha of land will be in excess. With the availability of sufficient space, there will be ample opportunities to look into new directions in new town planning. Considering the discussions held on the future changes due to urban development, the following factors can be pointed out for planning considerations in Simpang new town.

a) Extra value must be added partly to meet future quality housing needs and partly to compensate the distance to from the CBD. Low rise and low density housing estates are among these areas.

b) The advantage of having a lengthy water front must be used to its maximum. Well-planned recreational facilities, particularly those of marine-based sports, would not only increase the value of the new town, but also benefit the non-residents.

c) The creation of a regional activity centre inthe north is considered as one of the issues in Singapore's overall urban development. With a fairly large population in the area, to include Yishun (planned population of 230,000), Woodlands (250,000), Sembawang, Ang Mo kio (200,000) and others, the possibility of building such a centre is higher in the near future. Instead of locating similar activities as seen in existing CBDs and other centres, new functions must be sought.

d) An efficient link between Simpang new town and the CBD must be provided. In order to minimize the distance to/from the CBD (approximately 20 kms), the proposed transport system must be linked with the MRT directly, via proper transfer facilities.

e) Separate feeder systems for Simpang and Yishun new town must be prepared. Both new towns are large enough to have their own feeder systems to link with the MRT. The integration of these two new towns would increase access time to the MRT.

6.3.2 Development Concept Plan

Conceptual plans are prepared, as shown in Figure 6.6. Both plans are based on the neighbourhood concept. However, the difference is that Plan A strictly follows the existing planning concepts while Plan B emphasizes the function of the town centre and marine-based recreational activities. Accordingly, the transport system is strengthened in the latter plan. Although the study team feels that the development of Simpang new town should be directed in accordance wth Plan B, further exercise and study will be done based on Plan A because the objective is to assess the feasibility of a transport system. Therefore, unless mentioned, Plan A will represent the development plan of Simpang new town. A more detailed drawing of Plan A is shown in Figure 6.7 and its space allocation by land use is summarized in Table 6.3.

Table 6.3

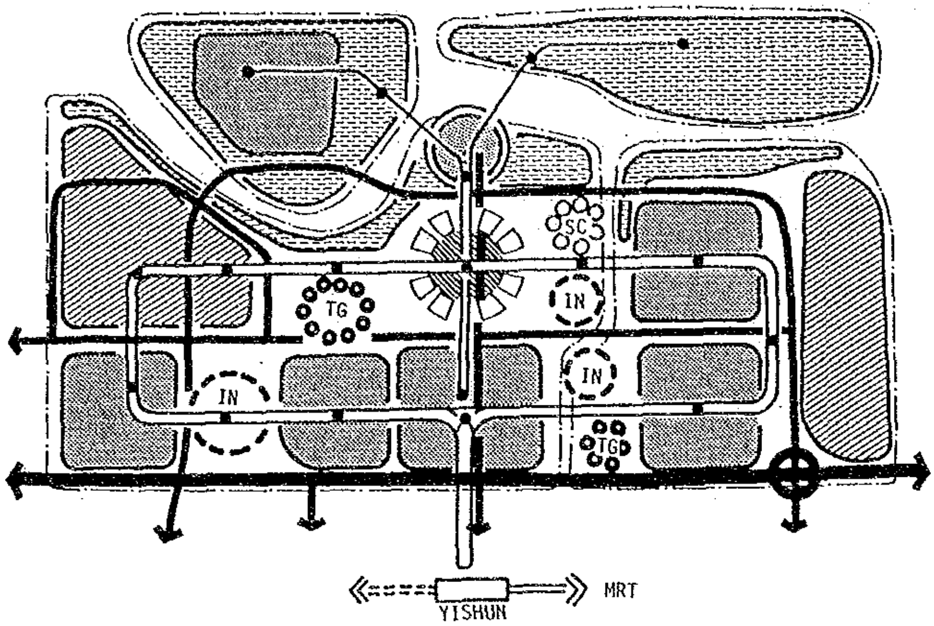
Land Use of Simpang New Town

Landuse	Area		Remarks
	ha	%	
1. Commercial	68	14.0	
1) Town Centre	44		
2) Neighbourhood Centre(NC)	24		6NC x 4ha
2. Residential	160	33.0	500du x 6 Neighbourhoods
3. Schools:Primary School (PS),Secondary Shool(SS)	50	10.3	12PS x 1.8ha 6SS x 2.7ha
4. Open Space:Neighborhood Park(NP),Town Garden(TG)	24	4.9	6NP x 1ha 2TG x 9ha
5. Sports Complex	10	2.1	
6. Institutions	20	4.1	
7. Industry	92	19.0	Two locations
8. Major Roads 1) Primary Access Rds 2) Local Access Rds	46	9.5	
9. NTS right-of way	11	2.3	11km x 10m
10. Utilities and Others	4	0.8	
Sub Total	485	100.0	
11. Additional Space	220		
1) Roads	20		
2) Recreational/Open Space	200		
TOTAL AREA	705		

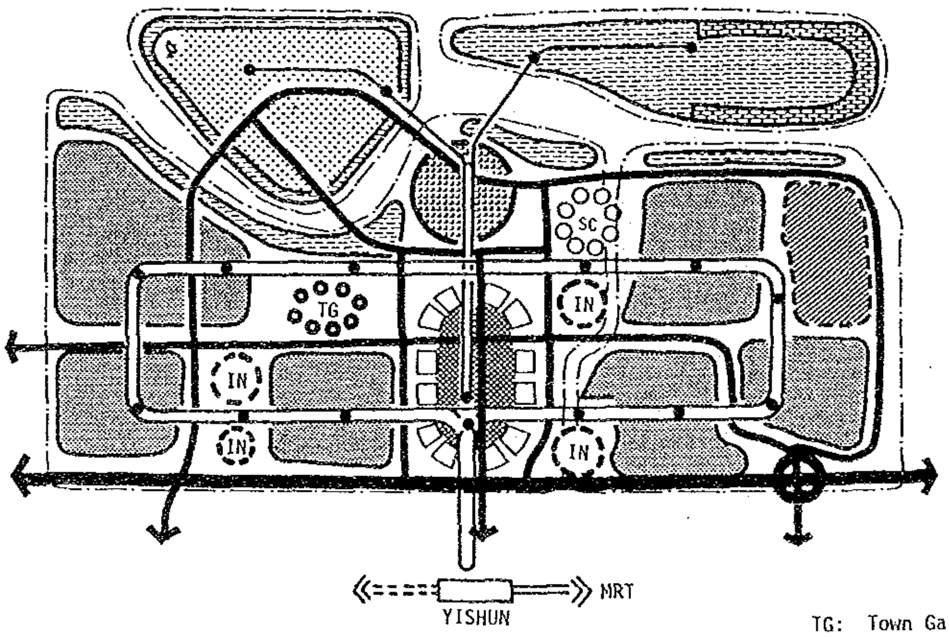
Figure 6.6

Planning Concept for Simpang New Town

(Alt. Plan A: Based on existing planning concept)



(Alt. Plan B: Based on extended planning concept)



TG: Town Garden
IN: Institutional
SC: Sports Complex

- Town Centre
- Strengthend Town Centre with business complex
- Amusement/Active recreational
- Recreational
- Residential
- Low density residential EMC
- Water front residential EMC
- Research Park
- Industrial
- New Transit System Route and Station
- Roads

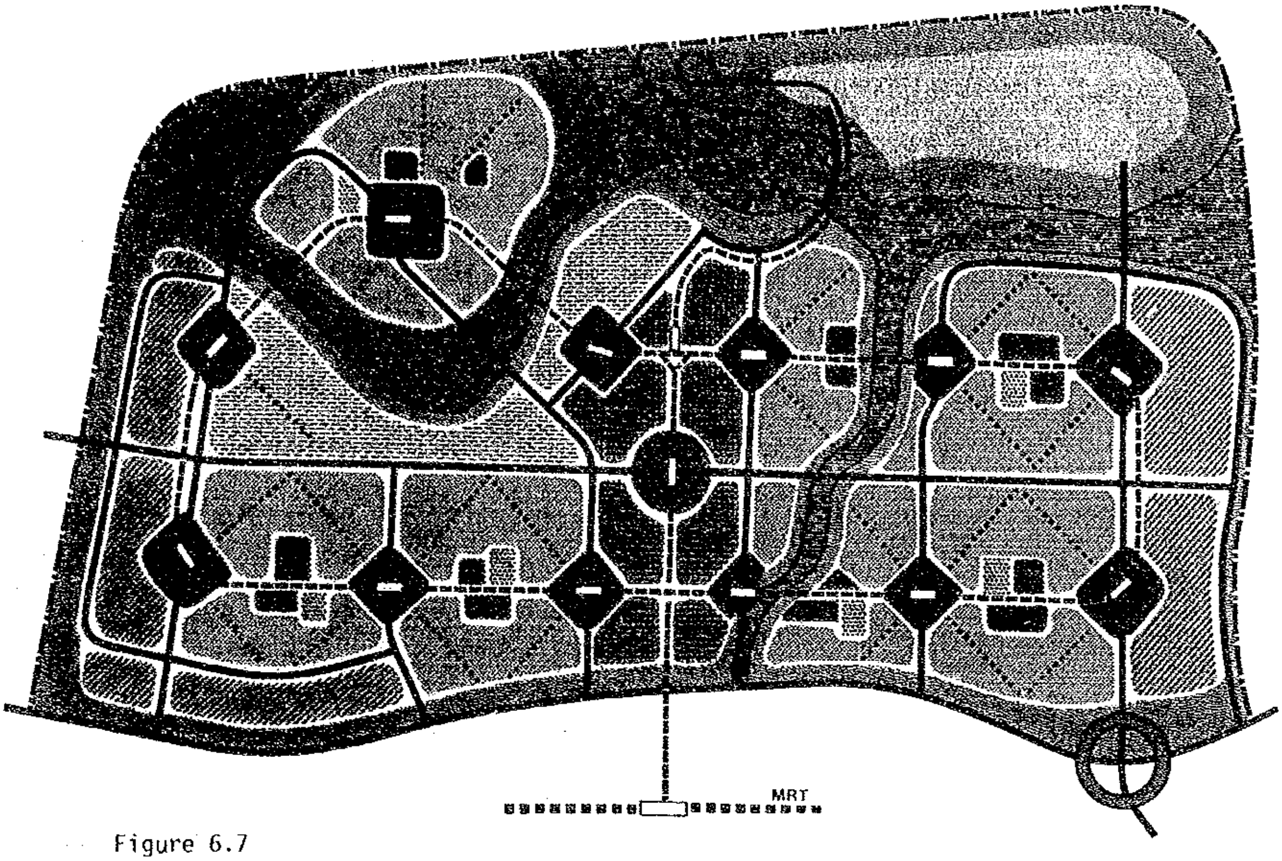


Figure 6.7

Conceptual Development Plan for Simpang New Town

As can be observed from the plan, the advantages of integrating the new town with the transport system are summarized as follows:

a) Based on the conventional planning concept of new towns, the catchment area of the proposed system is considerably extensive. A neighborhood unit comprising about 5,000 houses can be served by a single station within a reasonable walking distance.

b) By allocating community facilities and other traffic generating sources at or near the station, accessibility can be further improved.

c) The most expensive component of NTS investment is the structures. If the system can be constructed in a planned manner, the investment cost of the system can be drastically reduced.

The advantages are both on cost and demand aspects.

6.4 Transport System Plan

6.4.1 Transport Demand

The transport demand of Simpang new town was estimated based on the trip rate and travel pattern analyzed in Ang Mo Kio new town. As shown in Table 6.4, the total traffic demand is estimated to be about 307,000 person trips/day. Considering the geographical location and transport network of the country, it is likely that the people would rely more on MRT when a good feeder system is provided.

Simpang new town is designed in such a way that people can access to a station within the maximum walking distance of about 350 to 400 meters, or with average walking distance of about 200 meters. The entire area can be fully covered by frequent, comfortable and fast services. It is, therefore, not impossible to attract almost all public transport passengers and even expect considerable diversion from private transport. The estimated passenger ridership on the proposed system can be 150,000 to 200,000 passengers a day.

Table 6.4

Estimated Traffic Demands of Simpang New Town

No. of person trips/day

	Mode	Intra-Town	Inter-Town	Total
Residents	Public	32,200	94,600	126,800
	Private	5,900	28,100	34,000
	Walk	63,600	3,600	67,200
	Sub-total	101,700	126,300	228,000
Non-Residents	Public	9,100	52,700	61,800
	Private	3,500	13,300	16,800
	Sub-total	12,600	66,000	78,600
Total	Public	41,300	147,300	188,600
	Private	9,400	41,400	50,800
	Walk	63,600	3,600	67,200
	Sub-total	114,300	192,300	306,600

6.4.2 Transport System Plan

1) Route Plan

The basic objectives of the route plan are:

a) to provide direct and smooth connection with the MRT system at Yishun Station.

b) to enhance the inter-zonal communication and movement within the new town.

c) to provide a more economical and effective transport system than road system.

The main factors which will affect the physical route plan are location, size and shape of area, land use and demand level. The estimated potential demand for the system is considerably large and require a smooth connection with the MRT at the Yishun station. This means the proposed system has to provide a fairly large transport capacity and direct connection with MRT. Taking into account the land use and shape of the area, the most effective structure of the routes will be as shown in Figure 6.8. The characteristics of this plan are as follows:

a) Since the route is basically configurated avoiding the combination of loops and complex switchings, are headway can be minimized to one minute.

b) Availability of different types of services facilitate alteration of train scheduling depending on the change in demand distribution.

c) With relatively long station spacing which was made possible due to the integrated development, average scheduled speed becomes about 30 kms.

d) Loop routes within the new town will encourage the access to the various facilities and houses located in other neighbourhoods and strengthen the communication of the residents.

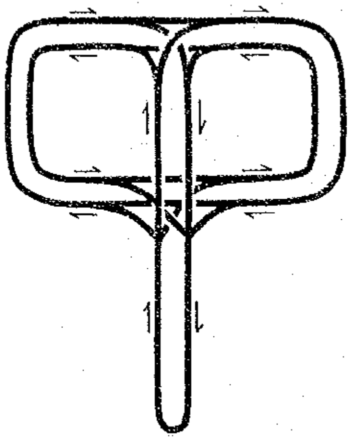
Although it is physically possible to serve Yishun new town with the proposed system, it is not recommended due to the following reasons:

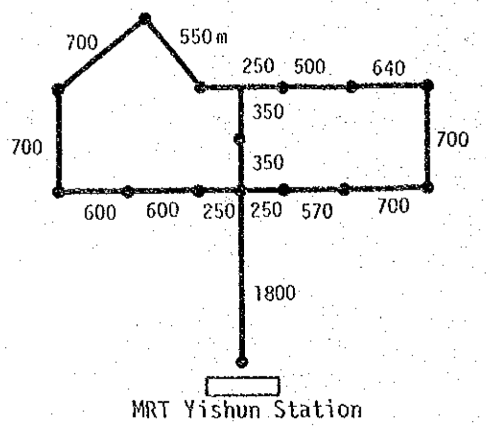
a) Transport demand of Simpang new town alone is large enough to justify the system. Similarly Yishun new town would be able to have its own system.

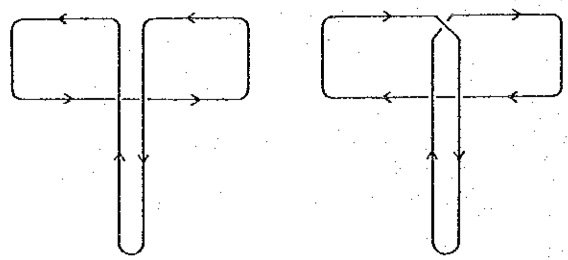
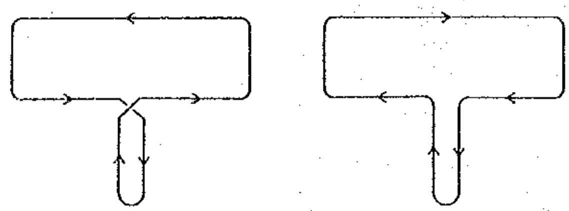
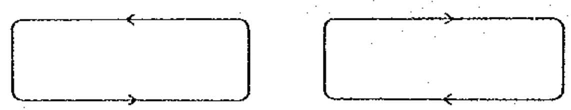
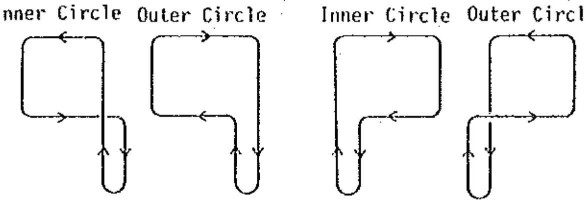
Figure 6.8

Route Structure of the Proposed System

Route Structure





	Description
Service 1 -Length : 20.6 km -Turnaround Time : 26 min 5 sec -Scheduled Speed : 27.6	INNER CIRCLE anti-clockwise movement OUTER CIRCLE clockwise movement 
Service 2 -Length : 11.2 km -Turnaround Time : 23 min 20 sec - Scheduled Speed: 28.9	
Service 3 -Length : 7.4 km -Turnaround Time : 16 min 55 sec -Scheduled Speed : 26.1	
Service 4 -Length : 7.9/7.5 km -Turnaround Time : 14 min 55 sec / 14 min 10 sec -Scheduled Speed : 28.7/29.7	Inner Circle Outer Circle Inner Circle Outer Circle 

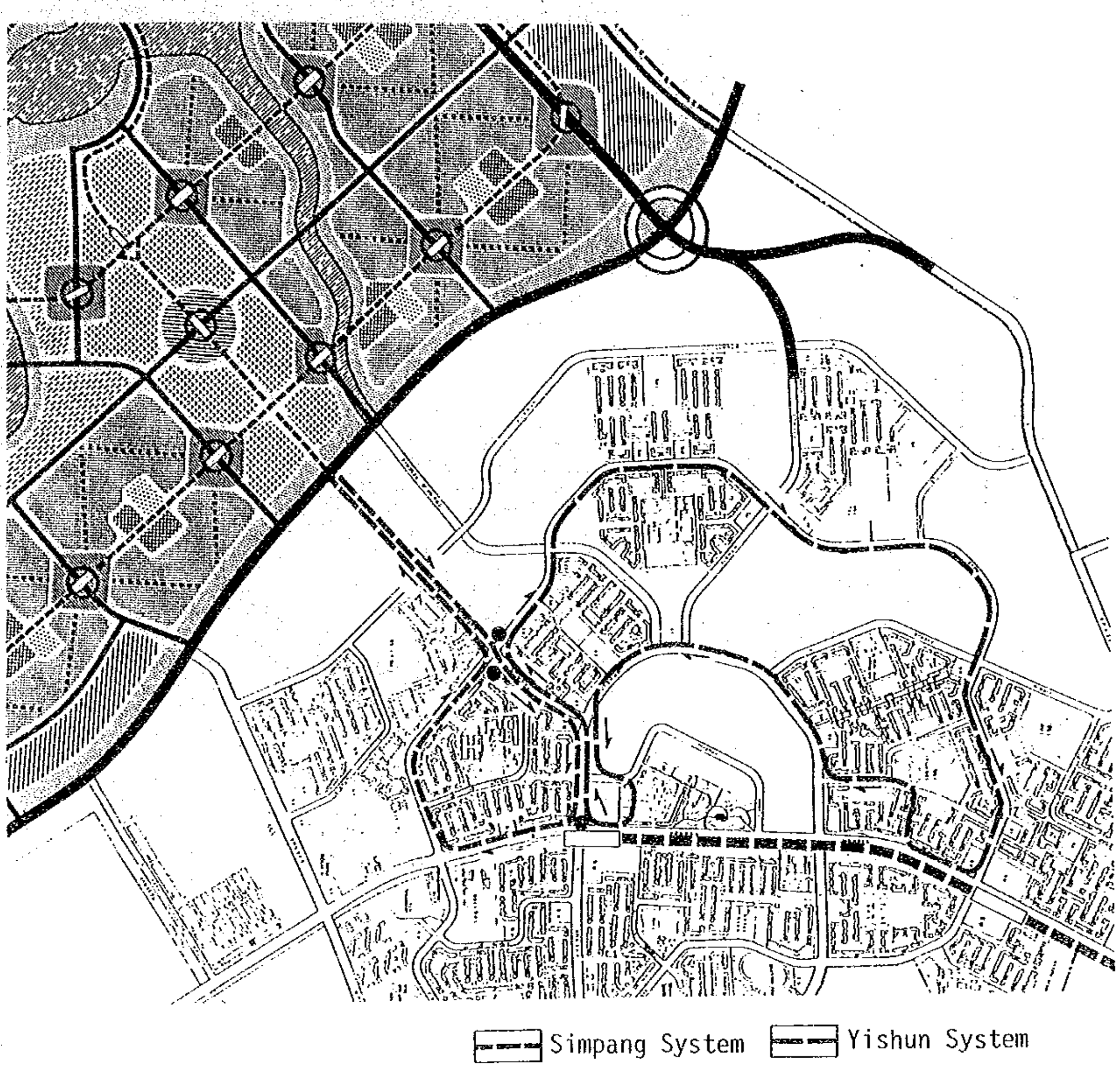
b) If the Simpang system is to serve Yishun new town, access portion to MRT will be overloaded. Detour will also decrease the service level to Simpang passengers.

c) A probable solution is to provide a station between Yishun MRT station and Simpang new town boundary.

The relationship with Yishun system can be conceptually understood as shown in Figure 6.9.

Figure 6.9

Relationship Between Simpang and Yishum System



2) Selection of the System and Typical Cross Sections of Structures

As it is expected that the proposed system can be constructed mostly at-grade, the Group I system would be the most adequate. As shown in Figure 6.10, it is lowering the guideway level when it crosses the pedestrian bridge and grading separately when it crosses the roads is proposed.

Stations will also be constructed according to the same planning concept. Not only stairs but also ramp and lift when and where necessary will be provided to facilitate the easy access and use of the stations, as shown in Figure 6.11.

Figure 6.10

Typical Cross section of the Proposed System

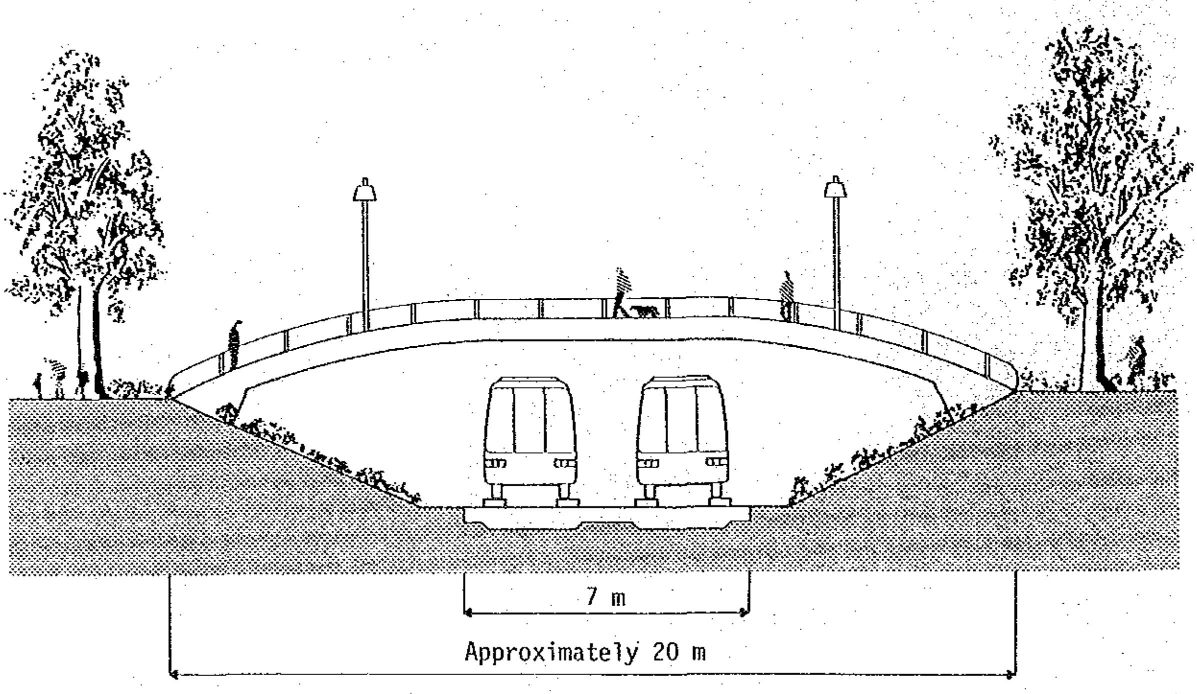
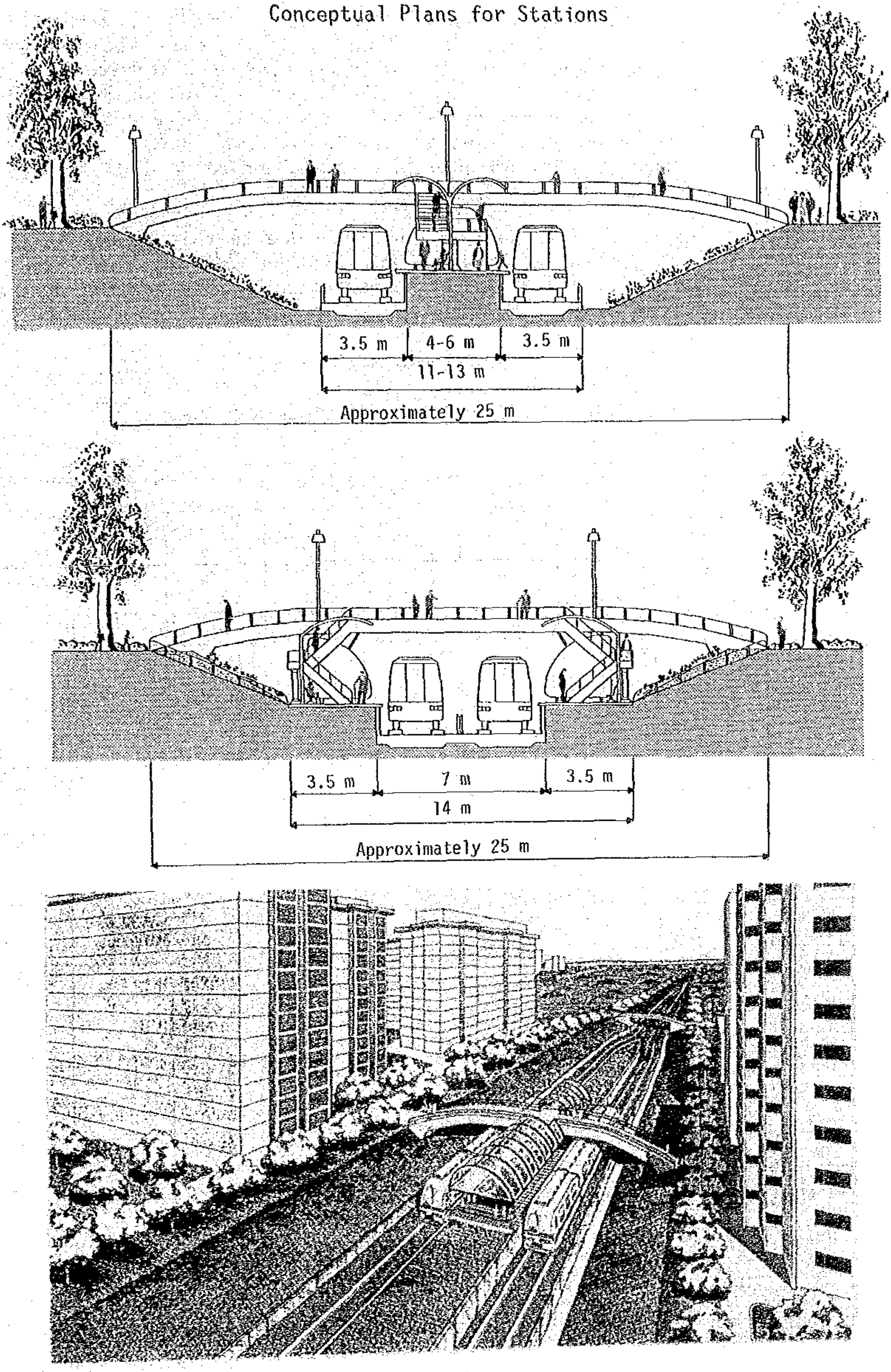


Figure 6.11

Conceptual Plans for Stations



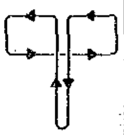
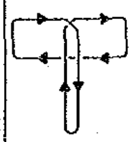
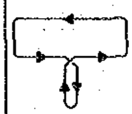
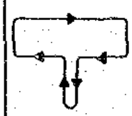
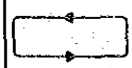
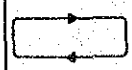
3) Operation

An operation plan can be prepared by combining different types of services depending upon the distribution of traffic demand. For the internal movement, service type 3 will be adequate, while the faster travel between MRT station can be better met with service 4. Services 1 and 2 have mixed functions of the above two types. In this exercise, operation plan was studied based on the services as shown in Table 6.5.

The critical portion of the route due to this operation is a section between Yishun MRT Station and New Town where most of the traffic is concentrated. The capacity of the system is greatly affected by the minimum headway of this section.

Table 6.5

Operation Characteristics of Simpang System

	Service Type						
	Service 1		Service 2		Service 3		Total Operation
	Inner Loop	Outer Loop	Inner Loop	Outer Loop	Inner Loop	Outer Loop	
							
Length (km)	12.0		11.2		7.4		1.25 km of double track
No. of Stations	15		13		12		14
Average Station Spacing (m)	800		860		610		600-800
Turn Around Time (min)	26.0		23.5		17.0		17-26
Maximum Speed (kph)	60		60		60		60
Average Stopping Time at Station (sec)	20		20		20		20
Scheduled Speed (kph)	27.7		28.5		26.1		26-29
Headway (min) - Peak - Off Peak	7 10	7 10	6 10	6 10	6 10	6 10	1.5-2.0 2.0-2.7
Frequencies/day	124	124	124	124	124	124	A total of 744 at the most crowded section
Required Rolling Stock: No. of Trains	4	4	4	4	3	3	A total of 22 trains
Required Rolling Stock: No. of Cars/Train	3	3	3	3	2	2	2/3
Required Rolling Stock: No. of Cars Required	12	12	12	12	6	6	A total of 69 cars including 9 spare cars
Total Train km/day	1,488	1,488	1,389	1,389	918	918	7,590
Total Car km/day	4,464	4,464	4,167	4,167	1,836	1,836	20,934

6.4.3 Cost Estimates

Cost estimate was made based on the information of Ang Mo Kio system. However, for civil work the physical conditions of the project site were duly considered. Breakdown of the civil works, station/building, and depot is shown in Appendix 6.A.

The estimated investment cost is approximately S$306 million as shown in Table 6.6. The investment cost/km is about S$11 million even with the inclusion of a grade-separated section between Yishun MRT station and the new town.

The operating cost is S$23,850/day as shown in Table 6.7.

Table 6.6

Estimated Investment Cost for Proposed Simpang New Town System

Cost Item	Amount (S$000)	%
1) Civil work		
a) Viaduct/Bridge[1/]	39,220	12.8
b) At grade Carriageway	44,660	14.6
Sub-Total	83,880	27.4
2) Station/Terminal and Building	19,370	6.3
3) Depot	27,850	9.1
4) Vehicles	71,760	23.5
5) Power Supply System	53,420	17.5
6) Control/Signalling/Telecom Systems	49,590	16.2
Total	305,870	100.0
Cost/Km (Single track length)	12,230	

1/ including approach portion between Yishun MRT Station and New Town of S$19.95 million.

Table 6.7

Estimated Operating Cost for Proposed Simpang New Town System

Cost Item	Amount (S$000)	%
1) Vehicle Maintenance	2,212	25.4
2) Maintenance of Equipment and Facilities	2,418	27.8
3) Electric Consumption	2,085	24.0
4) Manpower	1,199	13.8
5) Overhead: 10% of the above	771	9.1
Total: per year per day (S$)	8,705 23,849	100.0

6.5 Project Evaluation

The proposed project was similarly evaluated from the economic, financial and environmental viewpoints, as explained below.

6.5.1 Economic Evaluation

Although the economic aspect of this project must be argued not only from the transportation viewpoint but also from the point of view of being an integral part of new town development, discussions here are limited mainly to its transportation aspect to facilitate a better understanding of the effects of introducing a new transit system. Practically the second best alternative to the new transit system is a bus system.

1) <u>TransportCost of a New Transit System</u>

Comparing with the bus system, transport cost of the new transit system was estimated on average yearly/daily basis including fixed, operating and maintenance costs. The initial investment costs were translated into average annual costs for different opportunity costs of capitals, as shown in Appendix 6.B. The total transport cost is therefore:

i) Average annual fixed cost

- at 5% discount rate : S$20,940,000/year
- at 2% discount rate : S$14,821,000/year

ii) Operation and maintenance cost: S$ 8,705,000/year

Total at 5% discount rate: S$29,645,000/year or 81,220/day

Total at 2% discount rate: S$23,526,000/year or 64,450/day

2) <u>Transport Cost Based on Existing Bus System</u>

Financial information on feeder bus operation is not sufficiently available. The overall average operating cost of SBS bus is estimated to be $350/day for a single decker (as of 1985). Considering that buses will be equipped with air condition, operating cost (computed based on price escalation since 1985) will be roughly $400/day. The number of buses required to meet the same demand is estimated as follows:

i) Passenger capacity-kms to be provided by new transit system: 20,934 car-kms x 75 passengers/car = 1,570,050 passenger-kms/day

ii) Passenger capacity-kms to be provided by a standard existing feeder bus: 210 kms/day x 60 passengers/bus = 12,600 passenger-kms/bus/day

iii) No. of buses required (i)/ii): 125 units

Accordingly, the total transport cost of bus service based on the existing system is 125 units x $400/day = 50,000/day.

Average daily operation cost of bus is S$50,000/day, while that of new transit system is around S$64,500 to S$81,200/day. It is not known if the former includes the costs of bus interchange facilities, depot, garage, bus stops. However, the latter includes all the facilities including civilwork and station. Bus does not definitely include road construction and maintenance costs.

3) Savings due to Reduction in Road Space

The construction of a new transit system would meet considerable traffic demands both for inter and intra new town movements. An exercise made for standard neighbourhood unit indicates that the road space required for secondary and local access roads can be reduced due to its introduction. The estimated reduction based on the neighbourhood plans shown in Figure 6.4 is summarized in Table 6.8. It indicates that fairly large amounts of road space can be reduced even with inclusion of the space required for the new transit system. Assuming that the reduction rates are applicable to the entire new town, the total savings in road construction from reduced road space are as follows:

i) Percentage of road space in a prototype HDB new town: 12% of the total new town area

ii) Total land area of Simpang new town: 705 ha

iii) Total road space without New Transit System: 84.6 ha (705 x 0.12: Table 6.2)

iv) Road space which can be reduced due to New Transit System: 84.6 ha x 25% = 21.2 ha

v) Estimate road construction cost:

- Primary access road (31.5m) = S$3,190/m or S$101/sqm

- Local access road (15.4m) = S$2,120/m or S$138/sqm

- Assumed average road construction cost, including bridges: S$130/sqm

vi) Savings from reduced road space:
212,000 sqm x S$130 sqm = S$27.6 million

vii) Estimated cost of civil work of the proposed new transit system, excluding approach portion between Yishun MRT station and new town: S$83.88m - S$19.95m = S$63.93m (see Table 6.6)

The above exercise indicates that the expected savings from the reduced road space due to the new transit system is S$27.6 million, which is 43% of the total investment cost for civil work of the proposed system. Accordingly, the costs of the bus and new transit systems are summarized as follows:

i)	Annual average cost of the new transit system	: S$64,450/day (at 2% discount rate) S$81,220/day (at 5% discount rate)
ii)	Annual average savings of road construction	: S$ 2,798/day (at 2% discount rate) S$4,386/day (at 5% discount rate)
iii)	Annual average cost of bus system	: S$50,000/day

iv) Net increase due to the new transit system:
i) - ii) - iii) = S$11,650/day or S$4.3 million/year (at 2% discount rate)
S$26,834/day or S$9.8 million/year (at 5% discount rate)

Although the accuracy of the estimates and assumptions are to be examined further, it is concluded that the net increase in transport investment cost for Simpang new town is only S$4.3 to S$9.3 million/year. With this minimal increment of investment cost, the benefits which can be expected are enormous. For example, time saving of passengers alone reach S$18.9 million/year (200,000 passengers x 5 minutes x 1/60 x S$3.1/hour[1/] of time value x 365 days).

1/ Assumed time value of $3.1 is that of 1988

Table 6.8

Comparison of Road Space Required for Neighbourhood Unit "With" and "Without" New Transit System

Total Area of Neighbourhood Community: 49 ha

Plan Based on:	Road Type		Road Width (m)	Road Length (m)	Area (sqm)	Area % to the Whole Area
Existing HDB Concept	Ave-1: Primary Access		31.8	1,400	22,260 1/	4.5
	Ave-2: Secondary Access		26.2	2,100	36,680 1/	7.5
	Street: Local Access		18.0	2,100	37,800	7.7
	Total		-	5,600	96,740	19.7
NTS Based Concept, Alternative 1: (Mono Station)	Ave-1: Primary Access		31.8	1,400	22,260 1/	4.5
	Ave-2: Secondary Access		26.2	1,400	18,340 1/	3.8
	Street: Local Access		18.0	1,700	30,600	6.3
	Sub Total		-	4,500	71,200	14.6
	New Transit System		7+7 3/	700	9,800	2.0
	Total (Road + NTS)		-	-	81,000	16.6
	Saving	Road only	-	-	25,540	26.4 2/
		Road + NTS	-	-	15,740	16.3 2/
NTS Based Concept, Alternative 2: (Dual Station)	Ave-1: Primary Access		31.8	1,400	22,260 1/	4.5
	Ave-2: Secondary Access		26.2	1,400	18,340 1/	3.8
	Street: Local Access		18.0	1,800	32,400	6.6
	Sub Total		-	4,600	73,340	14.9
	New Transit System		7+7 3/	700	9,800	2.0
	Total (Road + NTS)		-	-	83,100	16.9
	Saving	Road only	-	-	23,400	24.2 2/
		Road + NTS	-	-	13,640	14.1 2/

Note: 1/ only half of the road space is included.

2/ % is against the road space of existing HDB concept plan.

3/ only 7 meter is required for carriage way, while additional 7 meter is included for maintenance.

6.5.2 Financial Evaluation

The proposed system was evaluatd from the financial viewpoint in a similar manner as made for Ang Mo Kio system.

a) Annual breakdown of the initial investment: It is assumed that the project will be constructed in three years, as shown in Table 6.9.

Table 6.9

Disbursement Schedule of Investment Cost for Simpang New Town System

S$000

Work Item	1989	1990	1991	Total
1) Civil Work	16,776	33,552	33,552	83,880
2) Station/Building	1,937	7,748	9,685	19,370
3) Depot	-	13,925	13,925	27,850
4) Vehicles	14,352	21,528	35,880	71,760
5) Power Supply	5,342	16,026	32,052	53,420
6) Signal and Others	4,959	14,877	29,754	49,590
Total	43,366	107,656	154,848	305,870

Reinvestments on vehicles, signalling/telecom/control systems and other subsystems are required 20 years after the opening.

b) Depreciation: Depreciation for various facilities/equipment is assumed as shown in Table 6.10.

Table 6.10

Estimated Depreciation

S$000

Work Item	Useful Life	Initial Investment	Annual Depreciation
1) Civil Work	40	83,880	2,097
2) Station/Building	45	19,370	430
3) Depot	30	27,850	928
4) Vehicles	20	71,760	3,588
5) Power Supply	30	53,420	1,781
6) Signal and Others	20	49,590	2,480
Total	-	305,870	11,304

The residual values are considered at the end of project life.

c) Equity: Two alternative cases are assumed, namely: 15% and 30% of the initial investments.

d) Interest rate for loans: 7% is assumed both for long-term as well as short-term loans.

The results are summarized in Table 6.12 and explained as follows:

a) If the government shoulders all infrastructure and systems costs, except vehicles, the operation of the system will give the FIRR of 15.6% at the fare level of 30 cents flat, while when the fare is set to 20 cents, the FIRR becomes 3.1%. With the former case, the net profit can be expected from the first year after the opening of the proposed system.

b) If the government shoulders only the infrastructure costs of civil work (guideway) and stations/buildings at the fare level of 30 cents flat, the FIRR is 3.4%, only while the fare of 40 cents flat becomes 7.9%.

c) Even without any involvement of the government, except land, the project can generate an FIRR of 3.4% with a 30-cent fare. If the fare can be increased to 50 cents, FIRR will become 7.2%.

6.5.3 Environmental Assessment

As discussed in Ang Mo Kio case study, the environmental conditions in terms of noise and air pollution can further be improved if the system is developed in an integral manner with new town. Significant improvements expected are as follows:

1) <u>Traffic Safety and Overall Amenity</u>

Pedestrians and vehicles can be much better segregated with the introduction of a new transit system as a major mode of public transport. If necessary changes in new town planning concepts are associated, the effects can be further increased and overall new town amenities can be significantly improved.

2) <u>Landscaping</u>

With the proposed system to be mainly constructed on the ground or in the open cut, any negative impact would be minimized. Instead, a well-designed system would add aesthetic amenity to new town scenery.

Table 6.11

Summary of Financial Analysis for Simpang New Town System

Description of Case / Item	Base Case: Govt. to shoulder all costs except vehicles		Alternative Cases					
			Case A: Civil work/ stations costs shouldered by Govt.		Case B: No Goverment involvement except land		Case C: Case A with increased fare	
No. of Pass/day	200,000		200,000		200,000		200,000	
Fare (¢)	30		30		40		40	
Revenue: (S$000/yr)	21,900		21,900		29,200		29,200	
Invest Cost (S$ 000)	71,800		202,600		305,900		202,600	
Open & Maint. (S$000/yr)	8,705		8,705		8,705		8,705	
Depreciation (S$000/yr)	3,588		8,777		11,304		8,777	
Operating Profit (S$000/yr)	9,607		4,418		9,191		11,718	
FIRR (%)	15.6		3.4		4.3		7.9	
Equity (%)	15	30	15	30	15	30	15	30
Interest Rate (%)	7.0		7.0		7.0		7.0	
First Year Net Profit Generated	1992	1992	-	2009[1]	-	2005[1]	1994	1992
First Year Accumulated Net Profit Generated	1992	1992	-	-	-	-	1998	1994
Remarks			[1] deficit from 2012 until 2021		[1] deficit in 2012 and 2019			

6.5.4 Comparison of Simpang and Ang Mo Kio New Transit System

The advantage of the integrated development is further examined by demonstrating the contrasting merits and demerits between the two systems of Simpang and Ang Mo Kio new towns.

Tranportation Efficiency: Superiority of Simpang system is clearly seen from Table 6.12. The advantages of the integrated developments in this context are:

- To cover the similar catchment area within the same walking distance of say 200 to 350 meters, the Simpang system requires a much less number of stations.

- Longer average station spacing enables the Sympang system to operate at much faster scheduled speed.

- Due to fast turn-around time, the car utilization of Sympang system is more efficiently done.

Moreover, the Sympang system can further enhance the service level by providing additional off-line station in between the on-line stations as illustrated in Figure 6.12. Trains can stop at these intermediate stations either during selected hours such as morning and evening according to school activities or at certain intervals, depending upon the traffic demand pattern.

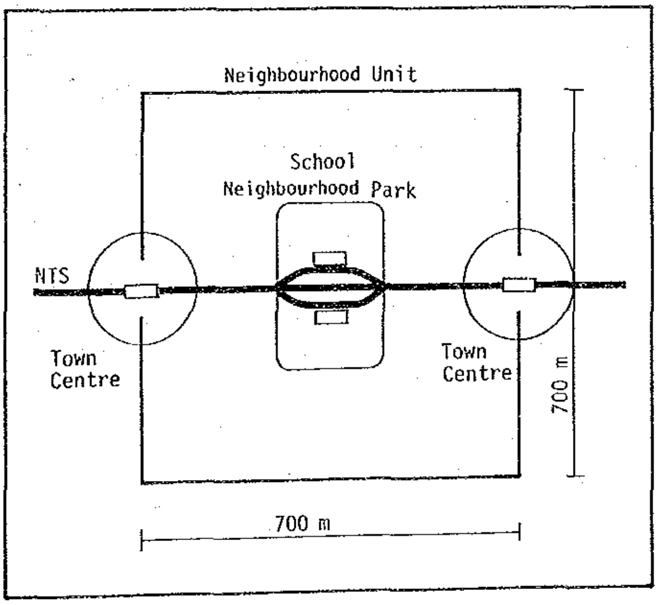
Table 6.12

Comparison of Major Physical and Operational Features of Simpang New Transit Systems

	Ang Mo Kio	Simpang
1. System Outline		
1) Route (single track) Length; Km	21.6	25.0
2) No. of Stations	29	14
3) Ave. Station Spacing (m)	420	800
2. Operation		
1) Scheduled Speed; Kph	19 - 20	26 - 29
2) No. of Cars Required	68 including 8 spares	69 including 9 spares
3) Total Train Kms/day	3,630	7,590
4) No. of Car/Train	4	2 - 3
5) Total Car Kms/day	14,518	20,934

Figure 6.12

Concept of Providing additional Intermediate Off-line Station for Neighbourhood Unit



Economy: Since the Sympang System can partly be constructed on the ground, the construction cost can also be reduced significantly. The costs of grade-separated and depressed carriageways are compared in Table 6.13. Ther per km cost of depressed structure (S$6.8 million) is almost a half of the grade-separated one, S$12.3 million.

Accordingly, the total costs of the two systems are also different as shown in Table 6.14. Per km construction cost of Ang Mo Kio system is S$16.3 million, while that of Simpang system is S$12.2 million, approximately 25% less.

Table 6.13

Comparison of Construction Costs Between Grade-Separated and Depressed Carriageways for Proposed New Transit System of Simpang New Town

Item	Unit	Unit Price :S$	Quantity	Amount S$000
A. Grade-Separated Carriageway: Viaduct and Bridge				
1) P. C. Girder	M3	1,080	5,730	6,188
2) Steel Girder	T	8,160	200	1,632
3) Pier R. C. (A)	M3	600	1,890	1,134
4) Pier R. C. (B)	M3	600	220	132
5) Driving Pile ø600	M	170	2,400	408
6) Earthwork[1/]	M3	980	670	657
7) Others	L.S			1,013
8) Contigency	L.S			1,116
Sub-total				12,280
B. Depressed Carriageway				
1) Earthwork	M3	18	28,050	505
2) Driving Pile ø600	M	170	20,000	3,400
3) Drainage	M	131	2,000	262
4) Slope Surface	M2	40	6,480	259
5) Slab Concrete	M3	500	2,400	1,200
6) Others	L.S			562
7) Contingency	L.S			619
Sub-total				6,807

[1/] Trench Sheet

Table 6.14

Comparison of Construction Costs of Ang Mo Kio and Simpang New Transit Systems

Item	Ang Mo Kio (21.6 km)[1/]		Simpang (25 km)[1/]	
	S$ 000	%	S$ 000	%
1) Civil Work	131,310	37.0	83,880	27.4
2) Station/Building	23,210	6.6	19,370	6.3
3) Depot	26,800	7.6	27,850	9.1
4) Vehicles	70,720	20.0	71,760	23.5
5) Power Supply System	48,490	13.7	53,424	17.5
6) Control/Signalling/Telecom	53,610	15.1	49,590	16.2
Total	354,140	100.0	305,874	100.0
Cost/km (Single track length)	16,270		12,230	

1/ Single track length

Table 6.15

Comparison of Operating Costs of Ang Mo Kio and Simpang New Transit Systems

Item	Ang Mo Kio (21.6 km)[1/]		Simpang (25 km)[1/]	
	S$ 000	%	S$ 000	%
1) Vehicle Maintenance	2,176	25.6	2,212	25.4
2) Maintenance of Equipment and Facilities	2,761	32.5	2,418	27.8
3) Electric Consumption	1,446	17.1	2,085	24.0
4) Manpower	1,330	15.7	1,199	13.8
5) Overhead	771	9.1	791	9.1
Total: per year	8,484	100.0	8,705	100.0
per day (S$)	23,244	-	23,849	-

1/ Single track length

Environment and Landuse: As discussed in the previous sections, a neighborhood unit integrated with a new transit system will provide almost an entire space exclusively for pedestrians in order that they will be free from excessive exposure to vehicular traffic. Simultaneously, the cars will be provided with sufficient road space and smooth circulation. Since the traffic noise emitted from the new transit system is minimal, overall environmental conditions of the Sympang development are expected to be better. One of the few areas which could be regarded as disadvantageous for the integrated development is the segregated landuse due to the depressed guideway of the new transit system. However, as explained in the previous sections, the two divisions of the community can be easily connected with pedestrian paths with minimal gradient. The road with an equivalent function to the new transit system will have a wide carriageway which will also divide the community and segregate the landuse.

7. OTHER AREAS

7. CASE STUDY FOR OTHER AREAS

7.1 Ang Mo Kio-Hougang-Marine Parade Route

7.1.1 Profile of the Study Area and Proposed Route

The influence area of the proposed route is shown in Figure 7.1. There are three new towns located along this route, namely, Serangoon, Hougang, and Marine Parade. The 1981 population along this route was approximately 230,000. In the year 1990, it has been estimated that the population will reach 290,000, taking into account that Hougang is not fully developed and is still undergoing construction.

Fifty per cent of the total population is concentrated at the southside of Pan-Island Expressway (PIE). It is estimated that the population of the northside in the future will increase due to the construction of Hougang New Town, while it will decrease in the existing New Town.

JTC's industrial complexes are located at Eunos and Hougang New Town. Employment along the route was approximately 66,000 in the year 1981. It is estimated that the total work force along this route will reach 104,000 in the year 1990, an increase ratio of 1.6 times.

This circumferential route connects with the MRT Stations in Ang Mo Kio in the north and Eunos in the east. The route passes Ang Mo Kio Avenue 3, Hougang Avenue 3, Jalan Eunos and still road with a total length of 12.6 kms. Most of these roads provide dual three lanes with central median and sidewalks. There is sufficient space for construction of structures of the new transit system on the sidewalks. The overall geographical features in this area slopes down from north toward south.

The route intersects with a number of trunk lines such as MRT and Central Expressway in Ang Mo Kio New Town, Yio Chu Kan Road, Upper Sergangoon Road, Macperson Road, PIE, MRT and ECP.

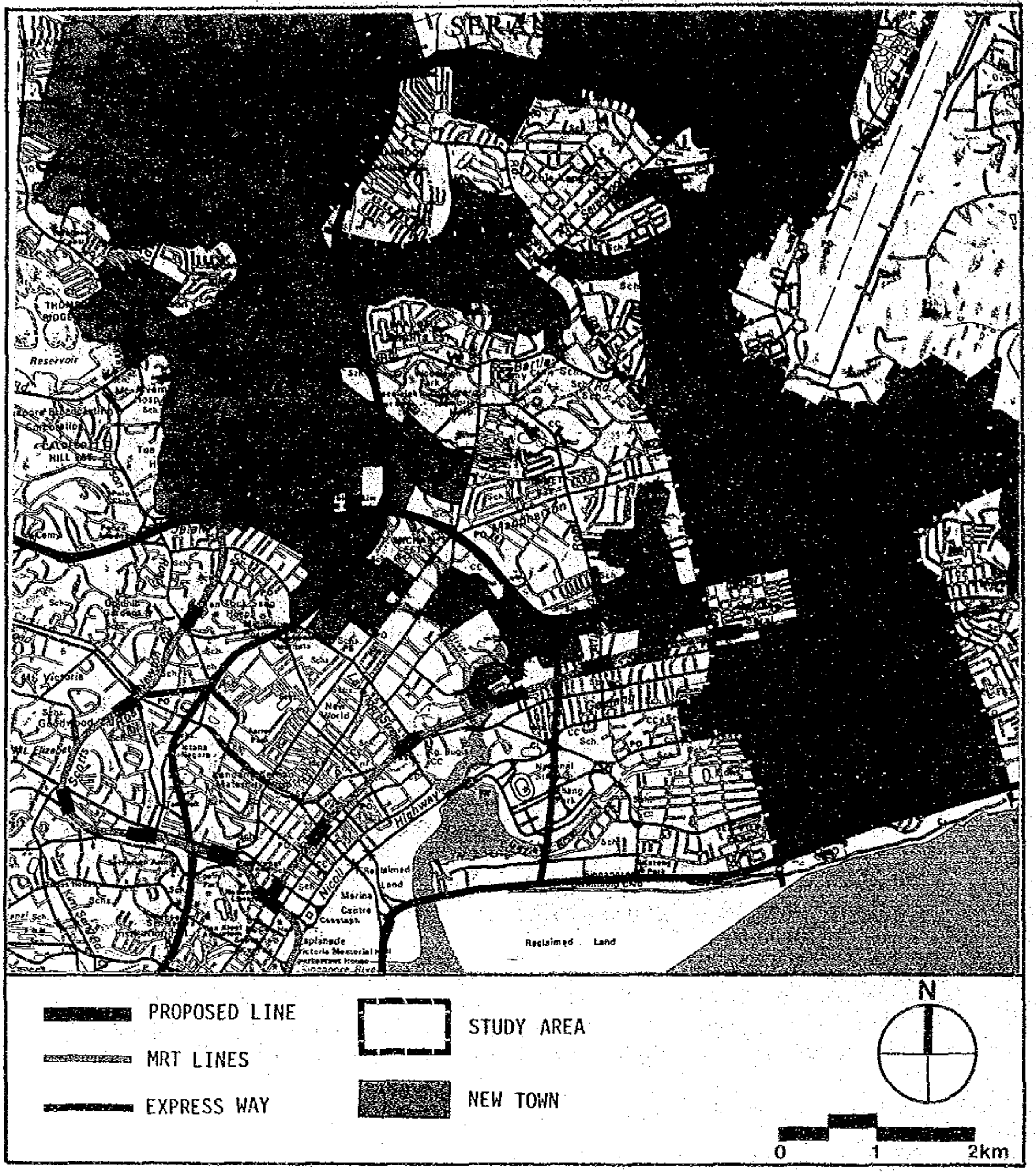
7.1.2 Traffic Demand

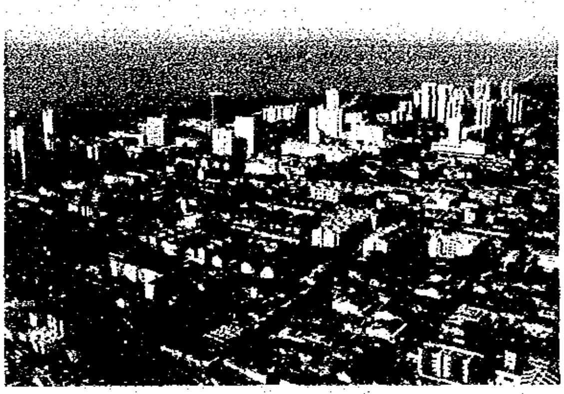
1) Overall Traffic Demand

The overall traffic demand of the influence area was estimated based on the 1990 OD table worked out by CTS instead of 1981, because the population of Hongang New Town has been increasing significantly since 1981. As is shown in Table 7.1, the total traffic demand is estimated to be 675,500 trips a day. Of the total, 129,600 are the traffic moving within the area, while the remaining 545,900 are those moving to/from other areas.

Figure 7.1

Ang Mo Kio-Hougang-Marine Parade Route





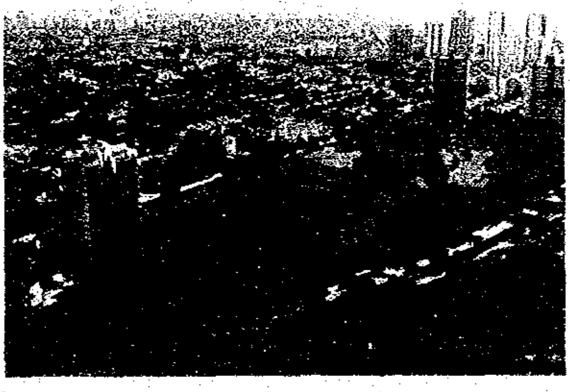


Table 7.1

Estimated Total Traffic Demand of the Influence Area, 1990

	Within the Area	To/From Other Areas				
		East Coast	Ang Mo Kio Toa Payoh and North	Other Areas	Sub-Total	Total
Public	72,900	94,600	75,100	73,900	243,600	316,500
Private	56,700	125,400	92,700	84,200	302,300	359,000
Total	129,600	220,000	167,800	158,100	545,900	675,500

Source: CTS 1990 Estimated OD Table

Types of potential traffic demand which would use the proposed system can be grouped into the following:

a) Traffic moving within the influence area

b) Feeder traffic to/from MRT or trunk bus

c) Traffic moving through along the route, particularly between north and east.

2) Estimated Traffic Demand of the Proposed System

a) Traffic Demand Moving within the Study Area

Assuming that 30% of intra-area demand using public mode and 10% of that using private mode would divert to the proposed system, it is estimated that a total of 27,500 passengers a day will use the route for intra-area movement.

b) Feeder Traffic Demand to/from MRT and Trunk Bus

It is expected that the proposed system will function as feeder transport to MRT and trunk bus. Assuming that 15% of public mode and 5% of private mode users moving to/from other areas use the proposed system to access MRT or trunk bus, feeder traffic demand using the system will be approximately 106,900 passengers a day as shown in Table 7.2.

Table 7.2

Estimated Feeder Transport Demand of Proposed System

to/from		East Coast	Ang Mo Kio Toa Payon and North	Punngol	Other Areas	Total
NTS Traffic Demand No. of Passengers a day	Public	14,200	11,300	400	11,100	37,000
	Private	6,300	4,600	1,400	4,200	16,500
	Total	20,500	15,900	1,800	15,300	53,500
Transfer Point		MRT Eunos Station	MRT Ang Mo Kio Station	Seran goon Road	MRT Eunos or Ang Mo Kio Station	-
Connecting Mode		MRT or Trunk Bus	MRT or Trunk Bus	Trunk Bus	MRT or Trunk Bus	-

c) Traffic Demand Moving along the Proposed Route between North and East

The traffic moving between the east and the north could be potentital demand of the proposed system. According to the 1990 CTC OD table, the above traffic demand totals approximately 82,000 trips a day comprising 38,000 trips and 44,000 trips for public and private mode, respectively. Assuming that 60% of the public mode users and 20% of the private mode users would divert to the proposed system, the number of passengers will be 31,600 a day.

d) Total Number of Passengers for the Proposed System

It is summarized that the total number of passengers who would use partly or entirely the proposed system is as follows: