THE KINGDOM OF THAILAND

# TRACK ELEVATION PROJECT
# OF
# EXISTING RAILWAY LINES
# IN
# THE BANGKOK METROPOLITAN AREA

## FEASIBILITY STUDY

JULY 1984

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

# THE KINGDOM OF THAILAND

# TRACK ELEVATION PROJECT
# OF
# EXISTING RAILWAY LINES
# IN
# THE BANGKOK METROPOLITAN AREA

## FEASIBILITY STUDY

JULY 1984

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

# PREFACE

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a feasibility study on the Project for Track Elevation of the Existing Railway Lines in the Bangkok Metropolitan Area and entrusted the study to the Japan International Cooperation Agency (JICA).

The JICA sent to Thailand a study team headed by Mr. Masashi Hatori, Director of the Japan Railway Technical Service, in August 1983, under the guidance of the Advisory Committee chaired by Mr. Ryosuke Hirota, Director of Facilities Division in National Railway Department, Secretariat to the Minister, Ministry of Transport.

The team held discussions with the authorities concerned of the Government of Thailand on the Project and conducted a field survey in the country. After the team returned to Japan, further studies were made and the present report has been prepared.

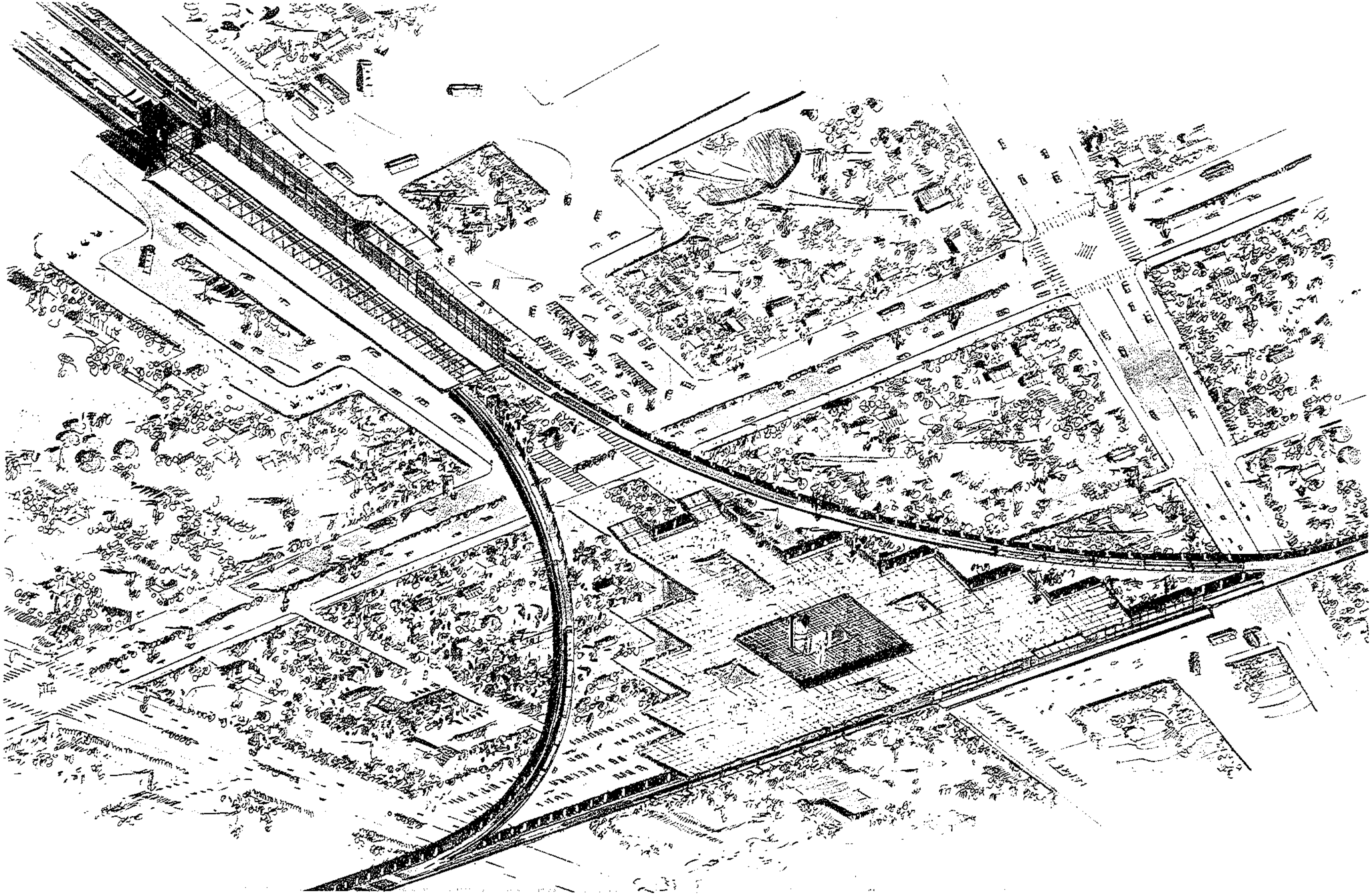
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

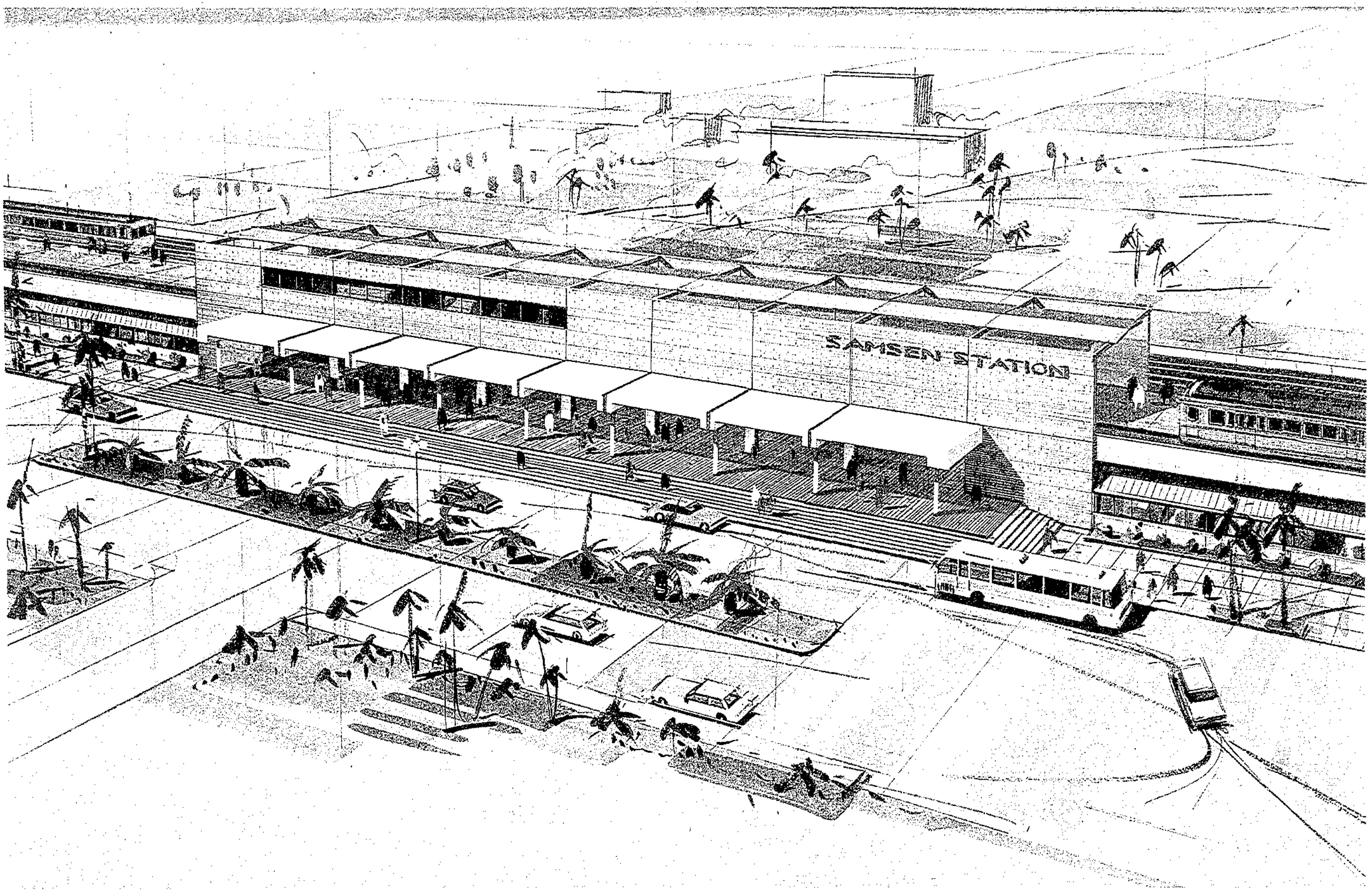
I wish to express my deep appreciation to the authorities concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

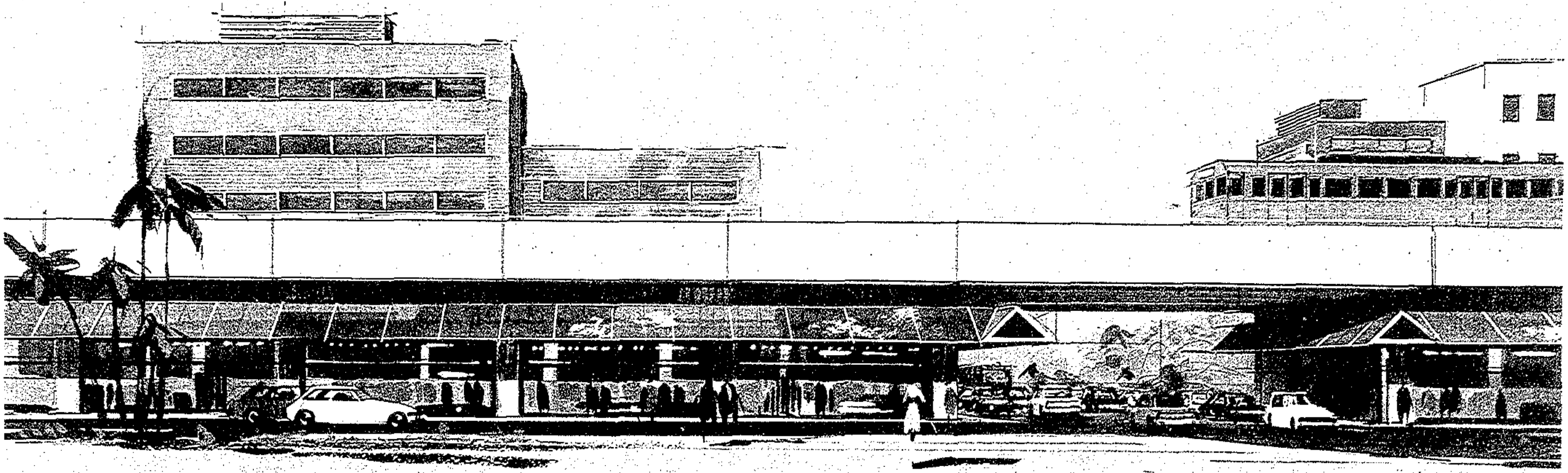
July 1984

Keisuke Arita

Keisuke Arita
President
Japan International Cooperation Agency




SAMSEN STATION



# SUMMARY AND CONCLUSION

# SUMMARY & CONCLUSION

## CHAPTER 1 INTRODUCTION

### 1. Objective of the Study

Urban traffic in the Bangkok Metropolitan Area depends mostly on roads. It is difficult, however, to deal with increasing urban traffic demand only by roads.

Furthermore, railway does not function effectively as an urban transport system due to the grade crossings with major urban road intersections.

The Study was conducted to evaluate the Track Elevation Project for eliminating railway grade crossings as a means of increasing train operation efficiency and safety as well as solving the ever worsening urban traffic problem in the Bangkok Metropolitan Area.

### 2. Outline of the Study

Upon request by the Government of the Kingdom of Thailand, the section for the proposed track elevation was determined as shown in Fig. 2.

An improvement of transport capacity, including additional train operation, was studied for the Greater Bangkok Area, taking into consideration the future public housing plan and land use plan.

Study cases are as follows:

Table 1 Cases to be Considered

| | | Proposed Elevated Section | |
|---|---|---|---|
| | | Alternative I (three lines) | Alternative II (two lines) |
| Demand Forecast | Case I (Natural Trend Type) | Case-I-3 | Case-I-2 |
| | Case II (High-level Service Type) | Case-II-3 | Case-II-2 |

Notes: 1. Demand Forecast

Case I: The present railway service level remains coping with the demand side. (Natural Trend Type)

Case II: High-level service is provided to urban railway passenger in accordance with changes on the supply side (High-level Service Type)

2. Proposed Track Elevation Section

Alternative I:

Northern Line; Bangkok ~ Bang Sue Station
Eastern Line ; Yoma Rat, Chit-La-Da Junction ~ Makkasan Station
Mae Nam Line ; Makkasan ~ Mae Nam Station
(3 lines: Total length is about 13 km)

Alternative II:

Northern Line and Eastern Line
(2 lines: Total length is about 10 km)

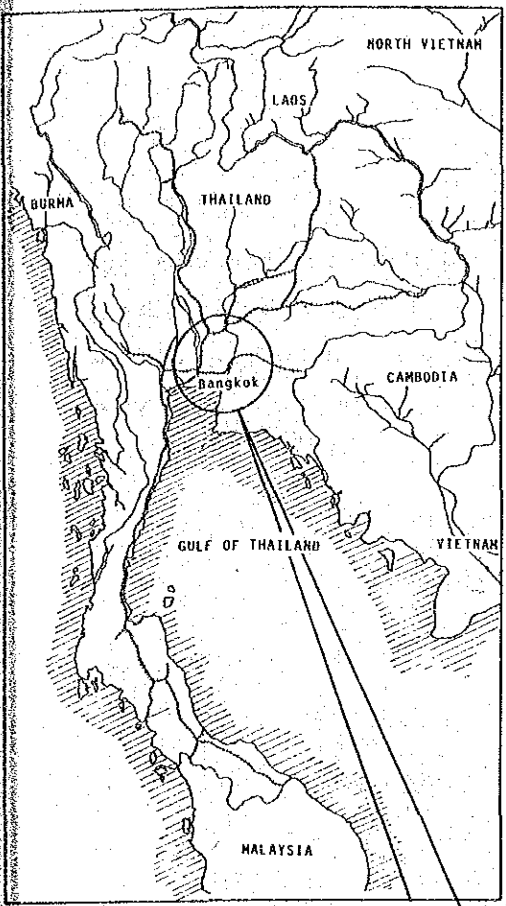


Fig. 1 Project Location Map

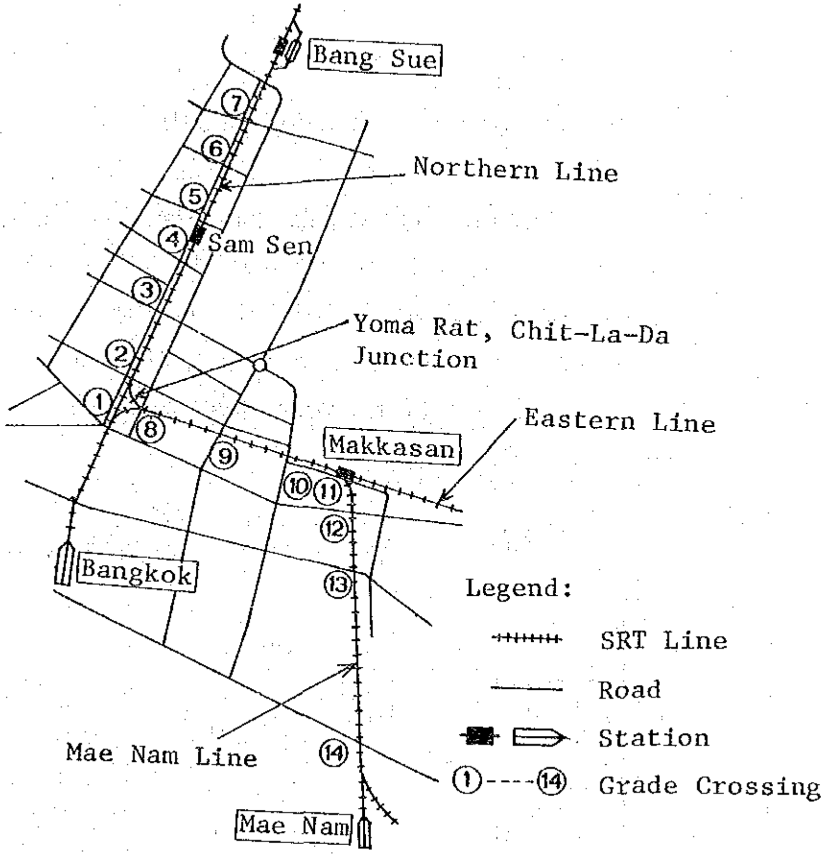


Fig. 2 Proposed Elevated Section

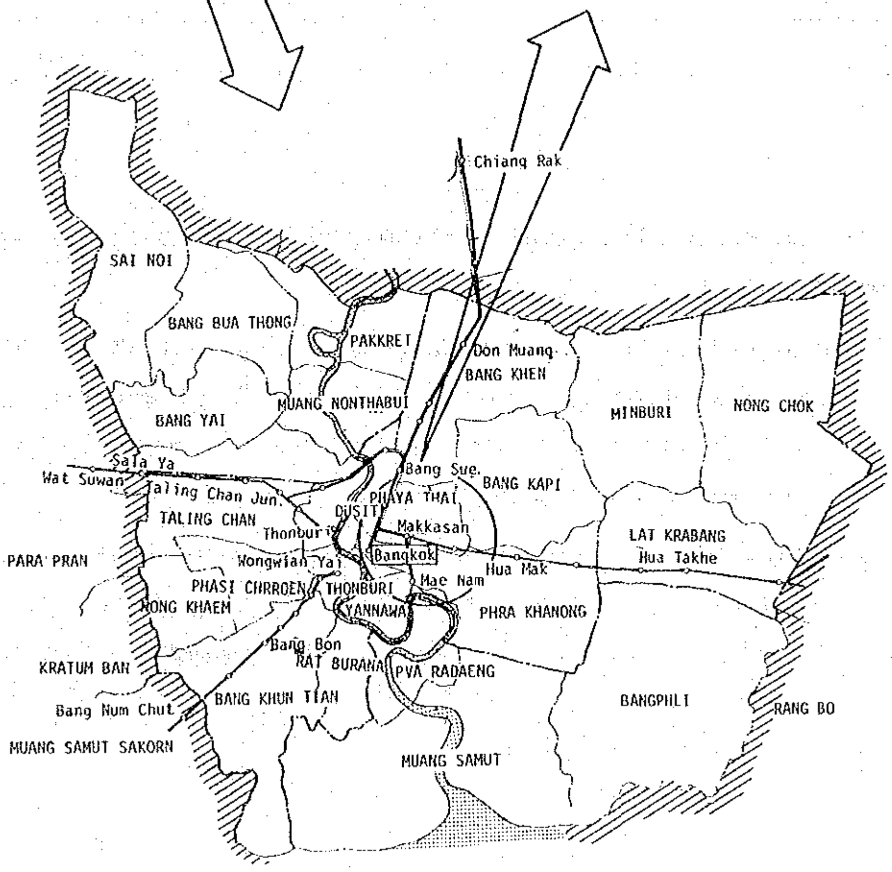


Fig. 3 Greater Bangkok Area

## CHAPTER 2 SOCIO-ECONOMIC FRAMEWORK

During the 20-year period between the First National Economic and Social Development Plan in 1961 and the Fourth Plan, the Thai economy achieved a remarkable 7% average annual growth. However, in the course of such economic growth, the problem of 'regional gaps in economic and social development occurred as shown in Table 2.

Table 2 National Income by Region (Nominal in 1982)

| Area | Total (Million Baht) | Per-capita National Income (Baht) |
|---|---|---|
| Bangkok Metropolis | 281,317 | 50,779 (2,208) |
| East | 121,372 | 33,518 (1,457) |
| West | 84,391 | 25,847 (1,124) |
| Central | 61,046 | 20,999 (913) |
| South | 87,275 | 14,376 (625) |
| North | 114,366 | 11,434 (497) |
| Northeast | 109,603 | 6,390 (278) |

Notes: 1. Data; NESDB "Gross Regional and Provincial Product 1982"
2. ( ) is US$.

In the Fifth Plan (1981 to 1986), the Government has stressed the following targets:

(1) To reduce the population growth rate to 1.5% by 1986.

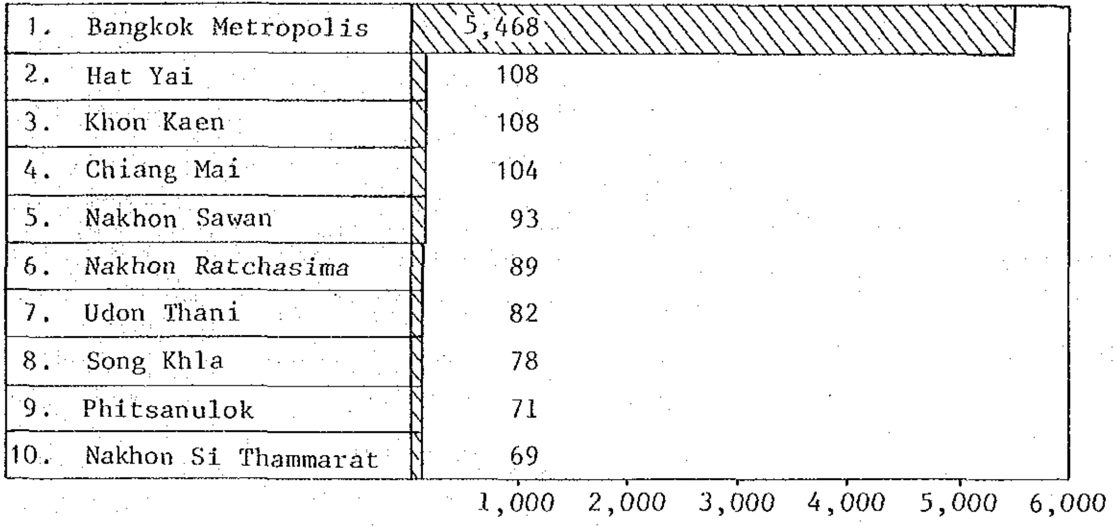
(2) To decentralize economic and industrial activities, assuming a 6.6% per annum GDP growth rate, in order to minimize the regional income gaps.

Thailand had a population of approximately 48.6 million at the end of 1982. The birth rate has gradually decreased to less than 2% annually within the last 5 years. The population in the Bangkok

Metropolitan Area, in contrast, has been growing at an average annual rate of more than 3.3% in the past 10 years, pointing to a trend towards more centralization of the population in the capital as seen in Table 3.

Table 3 City Population (as of the End of December 1982)

(Unit: 1,000 persons)



# CHAPTER 3 TRANSPORTATION

In the Bangkok Metropolitan Area, private cars and buses are typical means of transportation, comprising a greater than 88% share of the total number of trips. (Table 4.)

The railway traffic utilization rate of 0.3% is small in comparison with that of the more developed countries. Hence, more emphasis must be placed on the railway transport system.

Table 4 Result of Person Trip Survey

| Item | Composition (%) | Item | Composition (%) |
|---|---|---|---|
| 1. Private means | | 2. Public means | |
| (1) Car | 21.7 | (1) Small bus | 6.2 |
| (2) Motorcycle | 6.4 | (2) Heavy bus | 60.1 |
| (3) Samlor | 0.9 | (3) Train | 0.3 |
| (4) Taxi | 0.8 | (4) Boat | 0.5 |
| (5) School bus | 2.3 | Subtotal | 67.1 |
| (6) Truck | 0.8 | | |
| Subtotal | 32.9 | Total | 100.0 |

At present, however, it is difficult to increase train operation for urban transportation for the reasons cited below:

- Obstacles created by grade crossings in the Bangkok Metropolitan Area
- Restrictions in track capacity due to present signalling system
- Lack of train operation capacity in Bangkok Station Yard

## CHAPTER 4 DEMAND FORECAST

Passenger flow in the Greater Bangkok Area fluctuates according to the railway service level provided by SRT.

A demand forecast, taking these fluctuations into consideration, was carried out for the final target year of 2003 assuming that the proposed elevated section would be opened to traffic in 1991.

The following were considered:

- Passenger
  - Inter-zone
  - Urban
    - Natural Trend Type (Case I)
    - High-level Service Type (Case II)
- Freight — Inter-zone

The estimate results are as follows:

Table 5 Summary of Results of Demand Forecast

(1) Passenger traffic demand

(Unit: 1,000 persons)

| Year | | 1982 | 1991 | 1998 | 2003 | (2003)/(1982) |
|---|---|---|---|---|---|---|
| Inter-zone | | 25,606 | 37,661 | 46,907 | 53,105 | 2.07 |
| Urban | Case I | 6,836 | 9,070 | 10,175 | 10,793 | 1.58 |
| | Case II | 6,836 | 17,329 | 21,330 | 22,636 | 3.31 |

(2) Freight traffic demand

(Unit: 1,000 tons)

| Year | | 1981 | 1991 | 1998 | 2003 | (2003)/(1981) |
|---|---|---|---|---|---|---|
| Existing Lines | | 5,577 | 6,120 | 6,153 | 6,181 | 1.11 |
| Eastern Seaboard | Bangkok | - | 1,870 | 4,530 | 6,008 | |
| | Northern Link Line | - | 3,605 | 6,174 | 7,181 | |
| Total | | 5,577 | 11,595 | 16,857 | 19,370 | 3.47 |

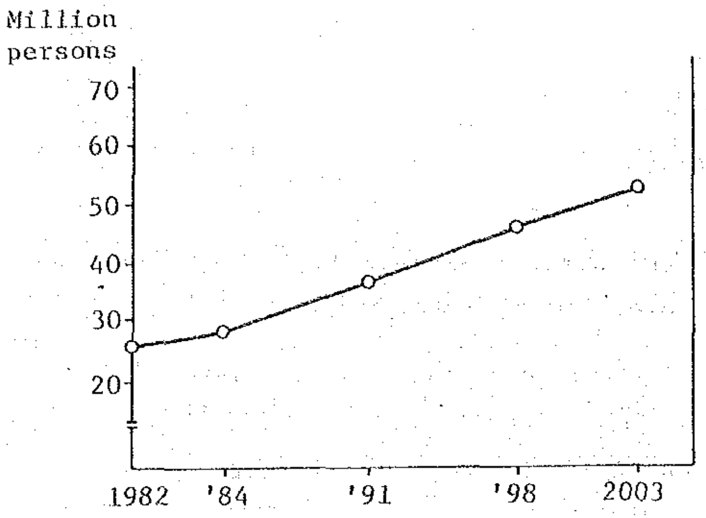


Fig. 4 Inter-zonal Passenger Traffic Volume

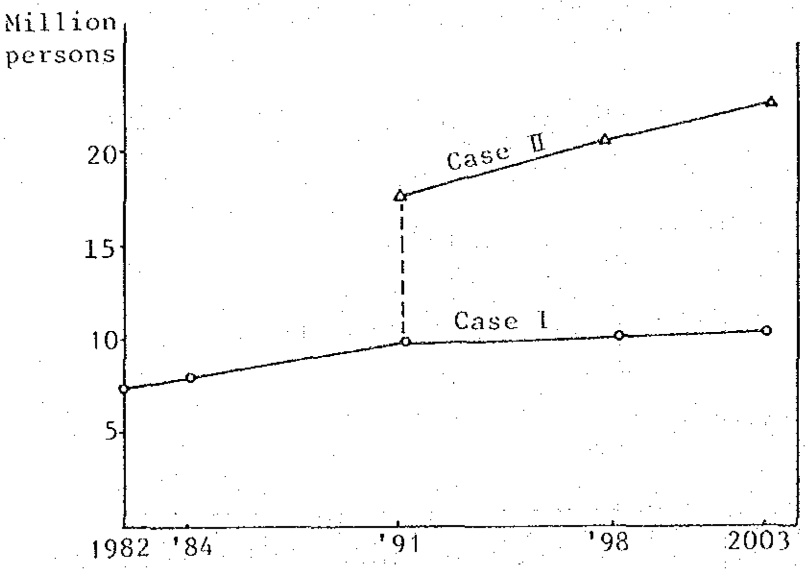


Fig. 5 Urban Passenger Traffic Volume

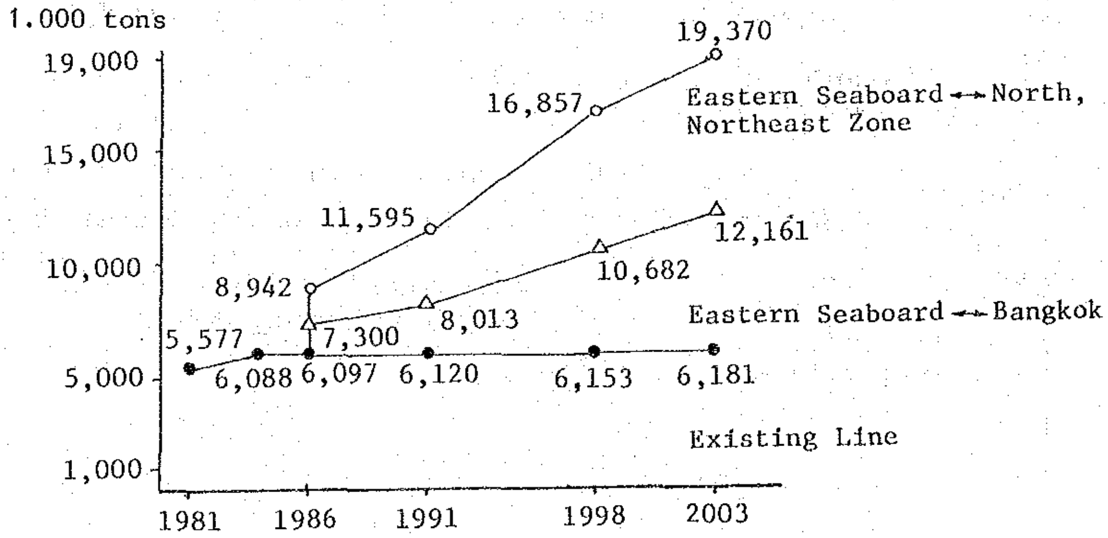


Fig. 6 Inter-zonal Traffic Volume

# CHAPTER 5 TRANSPORTATION PLANNING

In accordance with the traffic demand forecast in CHAPTER 4, transportation planning was set up. The basic principles for calculating the required number of trains and rolling stock are listed as follows:

- This planning is conducted on the basis of the existing motive power tractive system.
- Short-distance passenger trains for urban passenger traffic are planned using 6-car train consist with loading factor of 150%.
- Long/intermediate-distance trains for inter-zonal passenger traffic are planned to maintain the present level of service (e.g. loading factor and train consist.)
- Normal hauling capacity per freight train is to be set at the present level.

The number of required trains for the proposed elevated section is shown in Figs. 7 and 8.

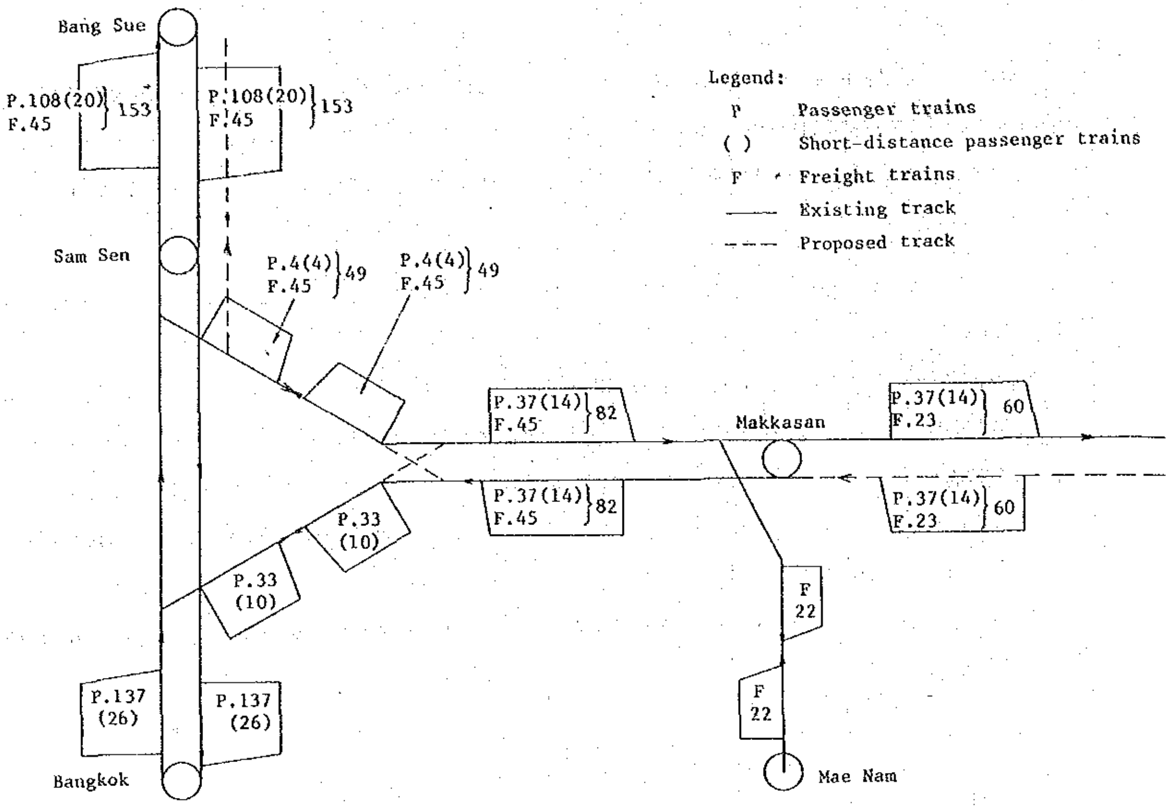


Fig. 7 Flow of Trains on Elevated Section (2003, Case I)

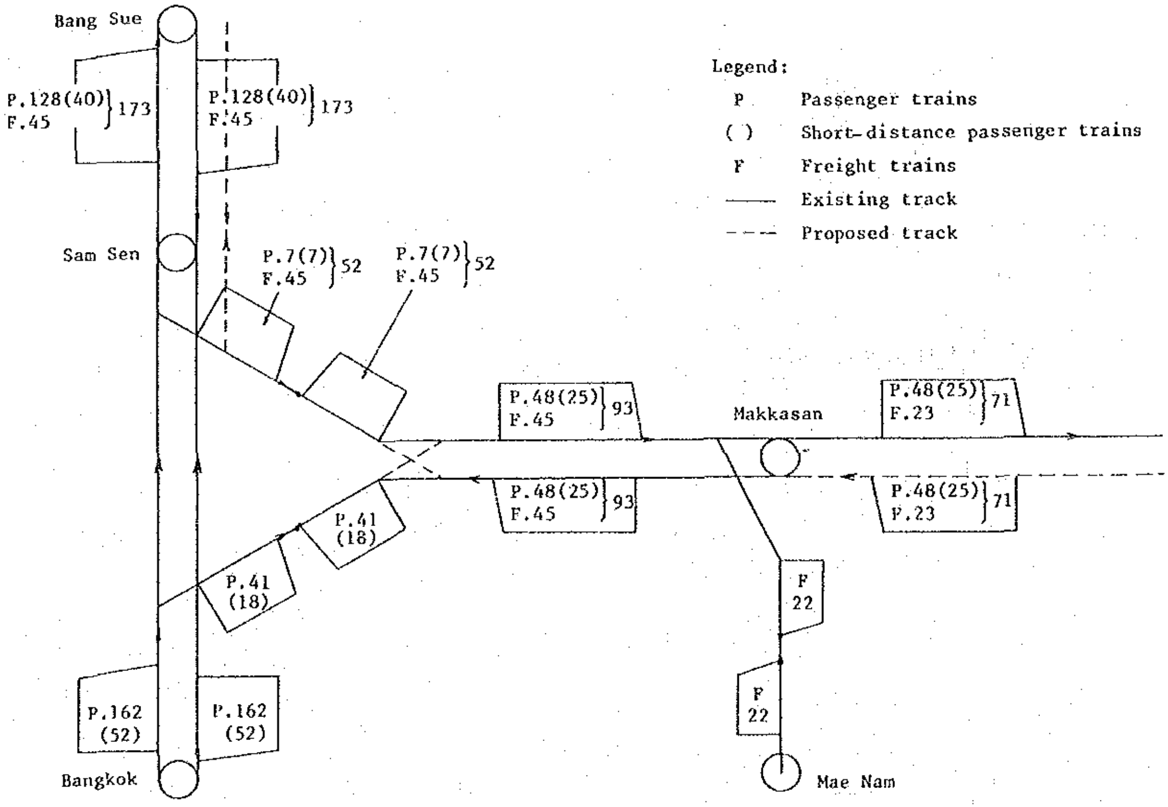


Fig. 8 Flow of Trains on Elevated Section (2003, Case II)

The number of passenger trains per hour during peak time at Bangkok Station is shown in Table 6.

Table 6 The Number of Passenger Trains per Hour during Peak Time at Bangkok Station

(each direction)

| Year / Line | 1983 | | | 1991 | | | | | | 2003 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Case I | | | Case II | | | Case I | | | Case II | | |
| | A | B | Total | A | B | Total | A | B | Total | A | B | Total | A | B | Total |
| Northern | 3 | 1 | 4 | 3 | 2 | 5 | 3 | 3 | 6 | 5 | 2 | 7 | 5 | 4 | 9 |
| Southern | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 2 | 1 | 0 | 1 | 1 | 1 | 2 |
| Eastern | 2 | 0 | 2 | 2 | 1 | 3 | 2 | 2 | 4 | 2 | 2 | 4 | 2 | 3 | 5 |
| Total | 5 | 1 | 6 | 6 | 3 | 9 | 6 | 6 | 12 | 8 | 4 | 12 | 8 | 8 | 16 |
| Headway (min.) | | | 10 | | | 7 | | | 5 | | | 5 | | | 4 |

Notes: A Intermediate/long-distance passenger trains (Sphere beyond 30 km from Bangkok station)

B Short-distance passenger trains (Sphere within 30 km from Bangkok station)

The required number of rolling stock in the Bangkok Metropolitan Area is shown in Table 7.

Table 7 Required Number of Rolling Stocks

(Unit: Cars)

| | | 1981 (in service) | Case I | | Case II | |
|---|---|---|---|---|---|---|
| | | | 1991 | 2003 | 1991 | 2003 |
| BMA | DL | 13 | 16 | 21 | 16 | 21 |
| | DRC | (4)<br>22 | (18)<br>71 | (24)<br>103 | (36)<br>89 | (48)<br>127 |
| | PC | 38 | 54 | 74 | 54 | 74 |
| | FC | 654 | 660 | 908 | 660 | 908 |

Note: ( ) is the number of DRCs for short-distance passenger Trains (included in the required number).

## CHAPTER 6 SOILS AND ENVIRONMENTAL IMPACT STUDY

### 1. Structure of Foundation

Based on the geological survery, concrete piles should be used for the foundation, driven down to the stiff clay strata 20 to 30 m below the ground surface.

### 2. Noise and Vibration Countermeasures

The following measures should be taken to reduce noise to levels comparable to or below those of peripheral areas.

° Provision of noise insulation walls
° Rail length extension
° Use of PC sleeper and rubber pads

No extraordinary measures to prevent vibration are called for at present. Utilization of deep piles for viaduct foundations will ameliorate conditions.

### 3. Height Limitations

The elevated structures will be approximately 10 m in height (at top of noise insulation walls). They will easily conform to local ordinances limiting height to 12 m or 20 m.

## CHAPTER 7 RAILWAY FACILITIES PLAN

The track alignment for the proposed elevated section is shown in Fig. 9. It is planned to be almost parallel to existing lines and within the SRT right of way.

The standard type of viaduct is illustrated in Fig. 10. The planned structure, the most cost-effective, is a rigid-frame bridge of reinforced concrete. It will be possible to locate various station, commercial and business facilities under the elevated track structure.

In areas outside the elevated section plans should be made for such major facilities as doubling of track, repair equipment and storage track for shuttling service as shown in Fig. 11. This will promote effective use of the various functions of the elevated track.

Automatic block system and three-aspect signals will be installed on the double-track line. A tokenless block system will be employed on the single-track line.

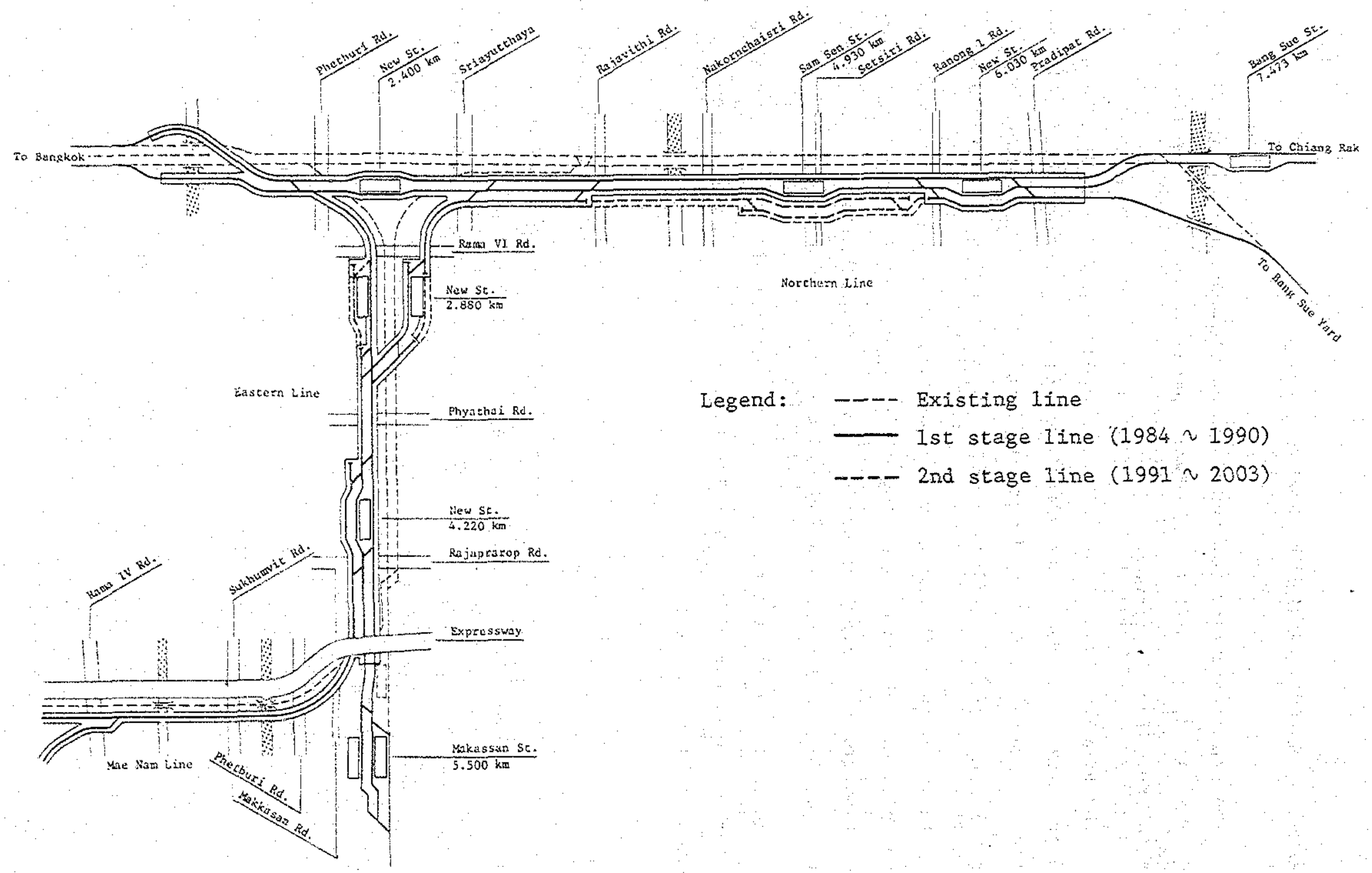


Fig. 9 Alignment of Proposed Elevated Section

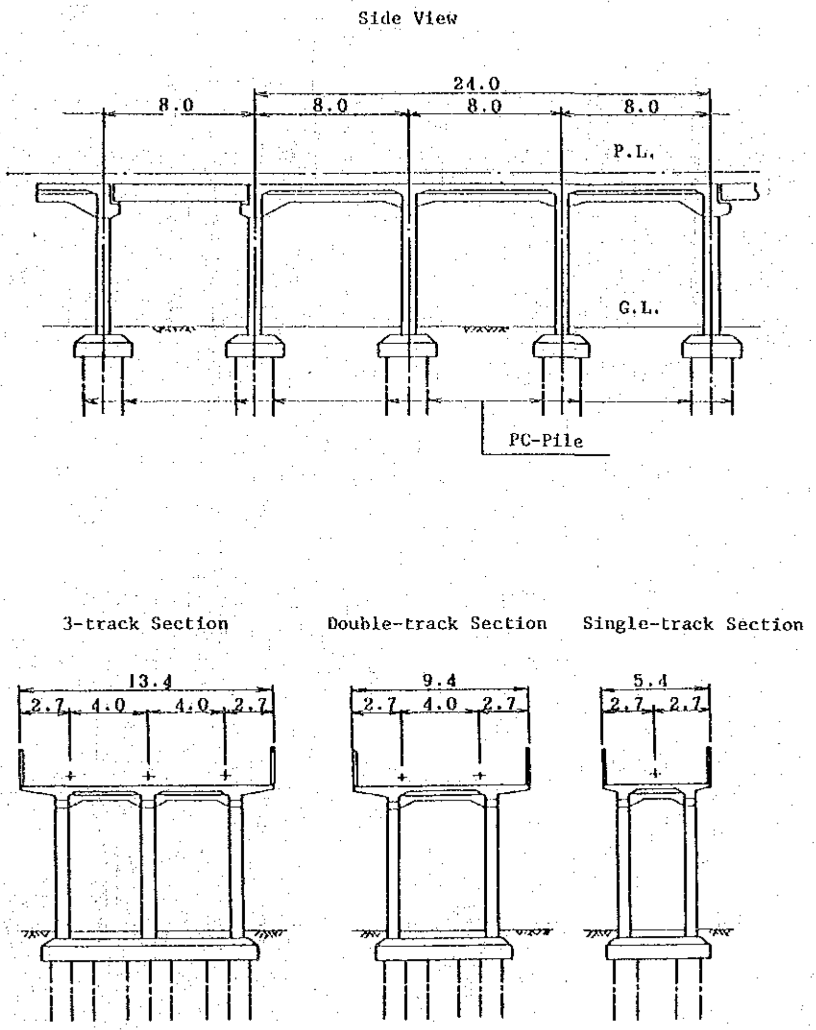
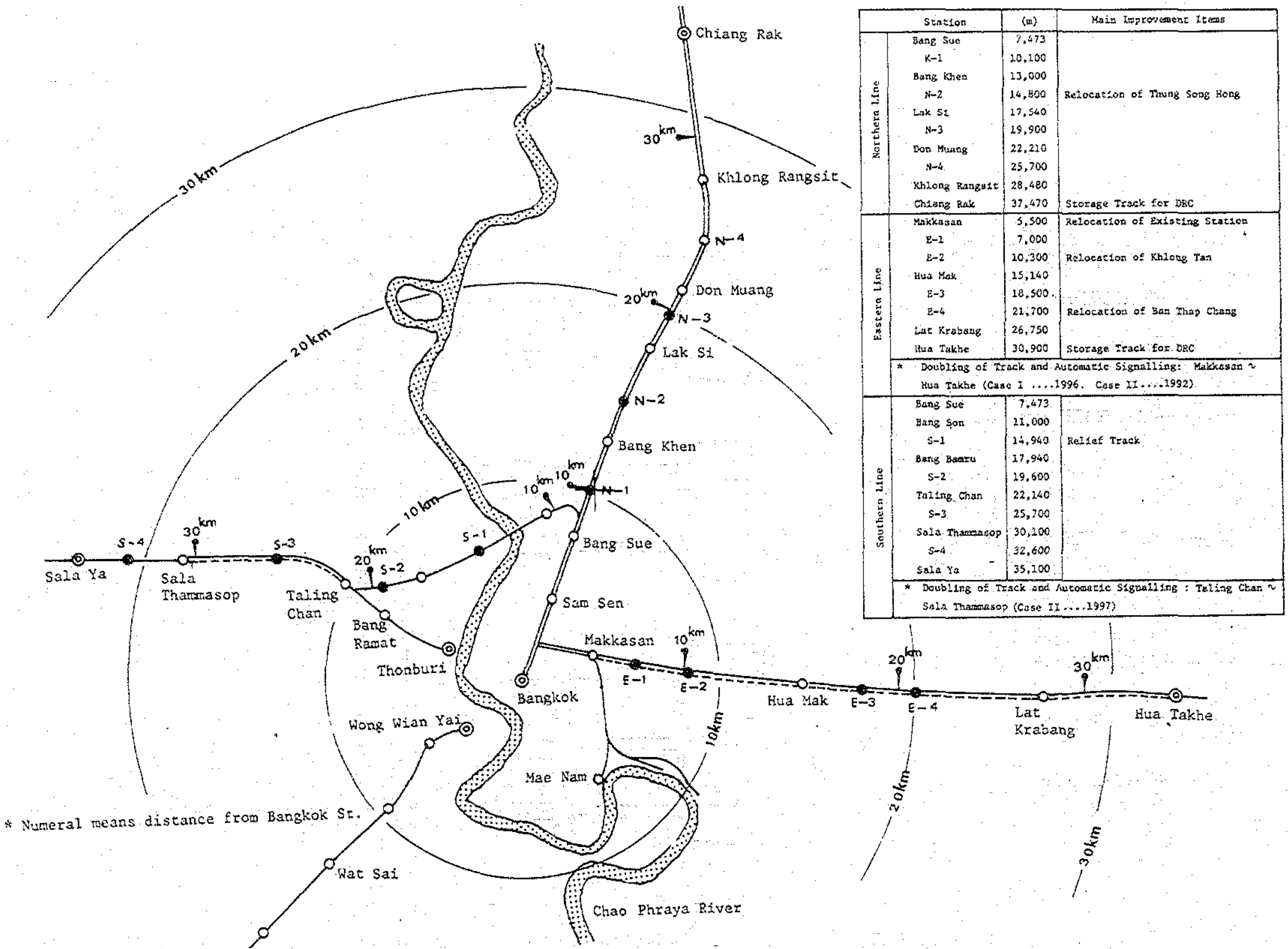


Fig. 10 Standard Spans and Sections for Elevated Structures



| | Station | (m) | Main Improvement Items |
|---|---|---|---|
| Northern Line | Bang Sue | 7,473 | |
| | K-1 | 10,100 | |
| | Bang Khen | 13,000 | |
| | N-2 | 14,800 | Relocation of Thung Song Hong |
| | Lak Si | 17,540 | |
| | N-3 | 19,900 | |
| | Don Muang | 22,210 | |
| | N-4 | 25,700 | |
| | Khlong Rangsit | 28,480 | |
| | Chiang Rak | 37,470 | Storage Track for DRC |
| Eastern Line | Makkasan | 5,500 | Relocation of Existing Station |
| | E-1 | 7,000 | |
| | E-2 | 10,300 | Relocation of Khlong Tan |
| | Hua Mak | 15,140 | |
| | E-3 | 18,500 | |
| | E-4 | 21,700 | Relocation of Ban Thap Chang |
| | Lat Krabang | 26,750 | |
| | Hua Takhe | 30,900 | Storage Track for DRC |
| | * Doubling of Track and Automatic Signalling: Makkasan ~ Hua Takhe (Case I ....1996. Case II....1992) | | |
| Southern Line | Bang Sue | 7,473 | |
| | Bang Son | 11,000 | |
| | S-1 | 14,940 | Relief Track |
| | Bang Bamru | 17,940 | |
| | S-2 | 19,600 | |
| | Taling Chan | 22,140 | |
| | S-3 | 25,700 | |
| | Sala Thammasop | 30,100 | |
| | S-4 | 32,600 | |
| | Sala Ya | 35,100 | |
| | * Doubling of Track and Automatic Signalling : Taling Chan ~ Sala Thammasop (Case II ....1997) | | |

* Numeral means distance from Bangkok St.

Fig. 11 New Station and Relocation of the Existing Station on STudy Area

## CHAPTER 8 INVESTMENT SCALE AND SCHEDULE

The First Stage is the completion of Track Elevation work in 1990 as shown in Fig. 9. The Second Stage is the investment on the required facilities in accordance with the increase in railway transportation after 1991 as shown in Figs. 9 and 11. The investment scale and schedule are shown in Table 8.

Table 8 Investment Scale and Schedule

(Unit: Mil. Baht)

| | | Item | Stage I (1984 ∿ 1990) | Stage II (1991 ∿ 2003) | Total |
|---|---|---|---|---|---|
| Case I | Alternative I (3 Lines) | Elevated Section | 2,412.9 | 324.1 | 2,737.0 |
| | | Unelevated Section | 493.0 | 410.9 | 903.9 |
| | Alternative II (2 Lines) | Elevated Section | 1,964.6 | 324.1 | 2,288.7 |
| | | Unelevated Section | 493.0 | 410.9 | 903.9 |
| Case II | Alternative I (3 Lines) | Elevated Section | 2,412.9 | 324.1 | 2,737.0 |
| | | Unelevated Section | 624.4 | 501.6 | 1,126.0 |
| | Alternative II (2 Lines) | Elevated Section | 1,964.6 | 324.1 | 2,288.7 |
| | | Unelevated Section | 624.4 | 501.6 | 1,126.0 |

The rolling stock costs for increases in demand are shown in Table 9. It is to be noted that these costs would be required regardless of the implementation of the Track Elevation Project.

Table 9 Rolling Stock Costs

(Unit: Mil. Bhat)

| Case | Alternative | Cost |
|---|---|---|
| Case I | Alternative I | 1,577.8 |
| | Alternative II | 1,577.8 |
| Case II | Alternative I | 1,813.0 |
| | Alternative II | 1,813.0 |

# CHAPTER 9 UTILIZATION PLANNING UNDER ELEVATED TRACKS

Several locations along the proposed track elevation (e.g. the area around Sam Sen Station and Chit-La-Da Junction in Northern Line, wayside area on the Eastern Line and the area surrounding the grade crossing on the Mae Nam Line) are available for commercial use. Other locations can be utilized as business areas.

With the track elevation, wayside areas presently separated by the present railway line can be integrated to facilitate their development. As these areas play an important role in the economy, side road plans should be established, and public facilities should be introduced under the track elevation.

Table 10 Utilization Planning under Elevated Track

(Unit: m$^2$)

| | Station Facilities | Commercial Facilities | Business Facilities | Other Facilities |
|---|---|---|---|---|
| Northern Line | 1,200 | 10,600 | 8,600 | 24,000 |
| Eastern Line | 1,200 | 25,400 | 3,500 | 0 |
| Mae Nam Line | 0 | 1,500 | 12,800 | 0 |
| Total | 2,400 | 37,500 | 24,900 | 24,000 |

# CHAPTER 10 GRADE SEPARATION AS ALTERNATIVE TO RAILWAY TRACK ELEVATION

Grade separation by flyover and/or underpass has been considered as an alternative to the railway track elevation.

When the flyover and the underpass are compared, the flyover is found to be superior. Flyover construction would be difficult, since the Northern Line and the Eastern Line are parallel to and very close to roads, especially the expressway running along the Mae Nam Line. Disadvantages of constructing flyovers are that land purchase and the demolition of some commercial and residential areas would be unavoidable.

The construction costs for flyovers are listed for each railway line as follows:

Table 11 Construction Costs

(Unit: Mil. Baht)

| | Road Name and No. of Flyovers | | Cost |
|---|---|---|---|
| Northern Line | Phetburi, Sriayutthaya, Rajavithi Nakornchaisri, Setsiri/Ranong I, Pradipat | 6 | 788.7 |
| Eastern Line | Rama VI, Phyathai, Rajaprarop | 3 | 441.8 |
| Mae Nam Line | Makkasan, Phetburi, Sukhumvit, Rama IV | 4 | 1,104.2 |
| Total | | 13 | 2,334.7 |

Note: Land purchase and compersation cost, engineering fee and contingency are included.

# CHAPTER 11 ECONOMIC ANALYSIS

## 1. Economic Analysis Methods and Study Cases

In this economic analysis, a "With/without the Project" analysis method was adopted to evaluate the economic viability of the Project from the viewpoint of the national economy.

The net flow, which is the difference in investment, operating and maintenance costs, and benefit between "With the Project" and "Without the Project" (Flyovers construction being implemented), was used to calculate the Economic Internal Rate of Return (EIRR) in the following four cases, as shown in Table 13.

For reference, the case in which no flyovers are constructed in "Without the Project" was also analyzed.

Table 12 Alternative Matrix

| | | Name of Case | With the Project | Without the Project |
|---|---|---|---|---|
| CASE-I | Alternative I | Case-I-3 | Track elevation in line with the "Natural Trend Type" | Flyovers in line with the "Natural Trend Type" |
| | Alternative II | Case-I-2 | | |
| CASE-II | Alternative I | Case-II-3 | Track elevation in line with the "High-level Service Type" | Flyovers in line with the "High-level Service Type" |
| | Alternative II | Case-II-2 | | |

## 2. Benefit

| Quantified Benefits | Unquantified Benefits |
|---|---|
| (1) Time saving benefit<br>(i) for road vehicles at railway grade crossings<br>(ii) for railway passenger<br>(2) Fuel saving benefit<br>(3) Benefit of averting accident at railway grade crossings<br>(4) Land use benefit | (1) Benefit from promotion of more productive use of land around railway stations<br>(2) Dissolution of areal division<br>(3) Relief of road congestion based on modal shift from bus to railway<br>(4) Job generation |

## 3. Evaluation

### (1) EIRR

| Case | Case-I-3 | Case-I-2 | Case-II-3 | Case-II-2 |
|---|---|---|---|---|
| EIRR | 16.2% | 20.4% | 16.3% | 20.1% |

(i) It can be concluded that the implementation of the Project is reasonable and viable from the viewpoint of the national economy, since the EIRR of each case surpasses the internationally acceptable level of 12 or 13 percent.

(ii) The relatively high level of EIRR in Case-I-2 and Case-II-2 indicates that each "net flow" from the Mae Nam Line in Case-I-3 and Case-II-3 is relatively lower than that of the other 2 lines (Northern, Eastern Lines).

(iii) There is little difference between the EIRR of Case-I and Case-II. However, taking into consideration unquantified benefits in Case-II, the EIRR of Case-II is superior.

(Case of no flyovers constructed in "Without the Project")

| Case | Case-I-3 | Case-I-2 | Case-II-3 | Case-II-2 |
|---|---|---|---|---|
| EIRR | 17.7% | 19.3% | 18.6% | 20.4% |

Even in this case, the EIRR also indicates that the Project is feasible.

(2) Sensitivity analysis

The sensitivity analysis was conducted for Case-I-2 as follows.

| No. | Base Case | 20.4% |
|---|---|---|
| 1 | Construction cost: +10% | 19.5% |
| 2 | Road traffic volume: -10% | 20.9% (Note) |
| 3 | 1 + 2 | 20.0% |

Note: Sensitivity Analysis No. 2

Despite a 10% decrease of road traffic volume, the EIRR increases by 0.5% due to the difference in when the time saving benefit occurs in the "With/Without" case.

# CHAPTER 12 FINANCIAL ANALYSIS

## 1. Financial Analysis Method and Study Cases

The marginal analysis method was adopted, for the financial analysis conducted on the following two cases considering the scale of the capital investment:

| | |
|---|---|
| Case-I-2 | Case of the lowest investment amount among four cases |
| Case-II-3 | Case of the highest investment amount among four cases |

## 2. Cash Flow Analysis

Assuming that SRT obtains subsidies according to the assumed finance plans, the results of the cumulative net cash flow are shown as follows:

(Unit: Million Baht)

| Finance plan / Case | Base | Plan No. 1 | Plan No.2 | Plan No. 3 |
|---|---|---|---|---|
| Case-I-2 | -6,496.4 | -3,634.1<br>(2,862.3) | -771.7<br>(5,724.6) | +582.3<br>(7,078.7) |
| Case-II-3 | -8,075.9 | -4,581.7<br>(3,494.2) | -1,087.4<br>(6,988.5) | +435.8<br>(8,561.7) |

*Notes:* 1. *Figures in ( ) show subsidies*

2. Finance Plan

(i) Base Plan: No subsidies for SRT

(ii) No. 1: Governmental subsidies will be made for 50% of domestic currency portion

(iii) No. 2: Governmental subsidies will be made for 100% of domestic currency portion

(iv) No. 3: In addition to No. 2, subsidies will be made for 100% of interest on foreign currency portion

In plan No. 3, the cumulative net cash flow changes from minus to plus for the first time.

## 3. Evaluation

Both cases produce operating income sufficient to cover working costs; however, they cannot become profitable at the level of operating profit through the whole project life due to the heavy burden of interest and depreciation.

Considering the national economic benefits of the Project, it may be desirable to implement some form of government financial support such as subsidies for SRT.

## CHAPTER 13 CONCLUSION

(1) The Project is feasible from a national economic standpoint.

National or municipal government support and special consideration may be indispensable in promoting the Project.

(2) The proposed track elevation section consists of the Eastern and the Northern Lines, a total length of approximately 10 km. The Mae Nam Line will be considered for elevation depending on the future circumstances.

With this improvement, railway transport system shall contribute to the whole urban transportation picture. Service improvements will include additional train operation, construction of new stations and shortening of the access/egress to the railway stations.

Moreover, the following improvements should be made in addition to the track elevation:

° Improvement of railway facilities to meet the increasing railway traffic demand (e.g. Bangkok Station Yard, Bang Sue Yard and Makkasan Workshop).

° Improvement of other transportation facilities such as railway station access roads, station plazas and bus networks.

° Security devices at grade crossings outside the elevated section.

° Effective land utilization alongside the elevated track.

(3) To make the Project more effective, it is essential to establish an urban transport Master Plan for the Greater Bangkok Area, with its population of over 6 million, as soon as possible. This will enable the railway transport system to function as one of the major urban transportation modes.

# CONTENTS

## CHAPTER 4 DEMAND FORECAST

## CHAPTER 5 TRANSPORTATION PLANNING

## CHAPTER 6 SOILS AND ENVIRONMENTAL IMPACT STUDY

## CHAPTER 7 RAILWAY FACILITIES PLAN

## CHAPTER 8 INVESTMENT SCALE AND SCHEDULE

## CHAPTER 9 UTILIZATION PLANNING UNDER ELEVATED TRACKS

## CHAPTER 10 GRADE SEPARATION AS ALTERNATIVE TO RAILWAY TRACK ELEVATION

## CHAPTER 11 ECONOMIC ANALYSIS

## CHAPTER 12 FINANCIAL ANALYSIS

## CHAPTER 13 CONCLUSION

## TABLE LIST

# FIGURE LIST

# CHAPTER 1 INTRODUCTION

# CHAPTER 1 INTRODUCTION

## 1.1 Background of the Study

Bangkok is well known not only as a center of politics, economy and culture in the Kingdom of Thailand, but also as an economic and transportation center in Southeast Asia.

Bangkok originally developed owing to an extensive canal transport system. With the advent of motorization, the canals were replaced by roads, shifting the major mode of urban transportation to the automobile. Nevertheless, improvement of roads has not kept pace with the increase of automobiles and this has created chronic traffic congestion.

Railway transportation has had drawbacks in having poor access to railway stations as a result of the city development pattern along canals (roads at present). Also, railways have grade crossings with major roads in the central part of the city which aggravate traffic congestion, increase the risk of accident and obstruct efficient and normal train operation. As a result, the railway fails to sufficiently achieve its major functions of mass transportation, scheduled operation and safety.

Moreover, the population is expected to further concentrate in the Bangkok Metropolitan Area (hereinafter referred to as "the Study Area") in line with the economic development of the country. This will increase traffic volume in the Study Area, and thereby further aggravate traffic congestion.

Under these circumstances, the Government of Japan decided, upon request by the Government of the Kingdom of Thailand, to carry out a feasibility study on "Track Elevation Project of Existing Railway Lines in the Bangkok Metropolitan Area" (hereinafter referred to as "the Project").

Prior to commencement of this study, the preliminary study team (Contact Mission) visited Thailand in November 1982 and had discussions with the concerned parties. Based on these discussions, another preliminary study team (Scope of Work Mission) visited the country again in June 1983, at which time the Scope of Work of this study was concluded.

This study was carried out on the basis of this Scope of Work.

## 1.2 Objective of the Study

The objective of this study is to carry out "A Feasibility Study on the Track Elevation Project of the Existing Railway Lines in the Bangkok Metropolitan Area" (hereinafter referred to as "the Study"). Under the Project, sections between Bangkok Station and Bang Sue Station (Nothern Line), Yoma Rat, Chit-La-Da Junction and Makkasan Station (Eastern Line), and Makkassan Station and Mae Nam Station (Mae Nam Line), with a total length of approximately 13 km, will be elevated to eliminate grade crossings. The proposed elevated section is shown in Fig. 1.2.1. The aim is to help the normal development of the Study Area and to increase train operation efficiency in order to shift the major mode of transportation from automobiles to railway by improving railway transport service.

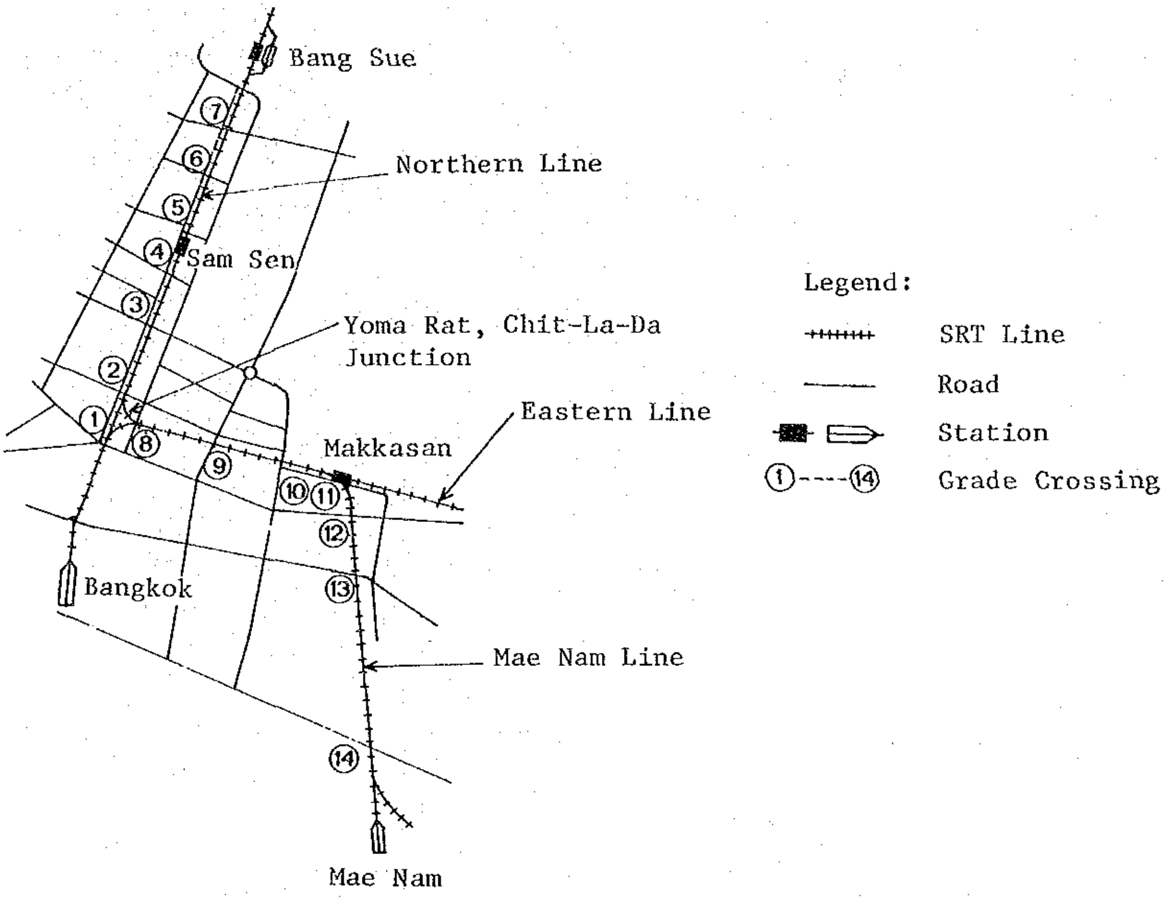


Fig. 1.2.1 Proposed Elevated Section

## 1.3 Outline of the Study

The Study is made up of roughly seven phases as shown in Fig. 1.3.1.

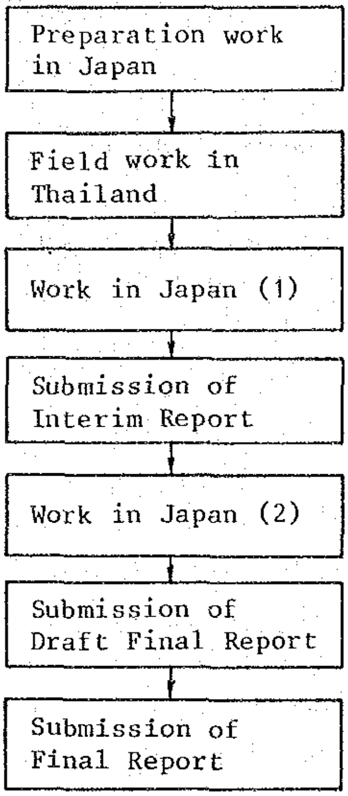


Fig. 1.3.1 Flow of the Study

Major items of work at each phase are listed as follows:

First Phase: Preparation work in Japan

(1) Examination of collected data and information

(2) Examination of general policy of the Study

(3) Preparation of Inception Report

Second Phase: Field work in Thailand

Field work was carried out for 70 days between August 29 and November 6, 1983. The following work was carried out in this phase:

(1) Submission, presentation and discussion of Inception Report and request on assistance from SRT in connection with the Study

(2) Hearing of opinions from related organizations and discussion

(3) Data and information collection and analysis

(4) Land use survey, traffic volume survey at grade crossings and stations, and interviewing survey at stations and bus terminals

(5) Soil survey, noise survey, vibration survey and land surveying around grade crossings

(6) Establishment of basic scheme

(7) Preparation and presentation of Progress Report

At the end of field work period, a joint meeting of Thai and Japanese government officials was held and Progress Report was submitted and explained.

Third Phase: Work in Japan to prepare Interim Report

Work to prepare Interim Report was carried out in Japan between the beginning of November 1983 and the end of January 1984, with the following items:

(1) Reconsideration of basic scheme of the Study

(2) Demand forecast on the basis of traffic volume and transport analysis

(3) Transportation planning on the basis of demand forecast

(4) Establishment of design standards for the Project on the basis of transport plan

(5) Examination of individual grade separation of roads which is an alternative to the track elevation

Fourth Phase: Submission and explanation of Interim Report

The study team stayed in Thailand for 9 days between January 26 and February 3, 1984, submitted and explained Interim Report to the joint meeting of Thai and Japanese government officials. After discussion, policy on preparing Draft Final Report was approved.

Fifth Phase: Work in Japan to prepare Draft Final Report

After submission of Interim Report, work to prepare Draft Final Report was carried out between the beginning of February and the middle of April 1984, with the following items:

(1) Reconsideration of transport plan by each case of demand forecast

(2) Design and cost estimation of railway facilities in connection with transport plan

(3) Examination of individual road grade separation which is an alternative to the track elevation

(4) Planning of land use under elevated tracks

(5) Economic analysis

(6) Financial analysis

(7) Examination items to be carried out along with the Project

Sixth Phase: Submission and explanation of Draft Final Report

The Draft Final Report was submitted and explained to the joint meeting of Thai and Japanese government officials, held in the end of April 1984, and was approved.

Seventh Phase: Submission of Final Report

The Final Report was submitted to the Government of Thailand at the end of July 1984.

## 1.4 Basic Policy of the Study

As most urban transportation in the Study Area depends on automobiles, traffic congestion occurs throughout the city all day long, especially during morning and evening rush hours. Furthermore, the existing railway transportation makes a minimum contribution to the Study Area and is not efficiently utilized. This is mainly because normal operation of trains is disturbed by obstructions and accidents with automobiles at grade crossings as well as frequent train delays.

In general, construction of the elevated railway, as a way to eliminate grade crossings, is planned and carried out to develop urban areas from the city planning point of view. Major considerations include integration of urban areas, effective land use and harmony with existing built-up areas.

In the Study Area, where further population increases are expected with economic growth, it is very difficult to continue to depend on automobiles due to inadequate road improvement in the area.

Thus, the Project is considered to be rather useful not only in helping to solve the ever-worsening traffic problem but also in making train operation by SRT more efficient.

Under such policies, the work proceeded in the following sequence.

### 1.4.1 Sequence of the Work

Sequence of the work is described in Fig. 1.4.1. Main items are as follows;

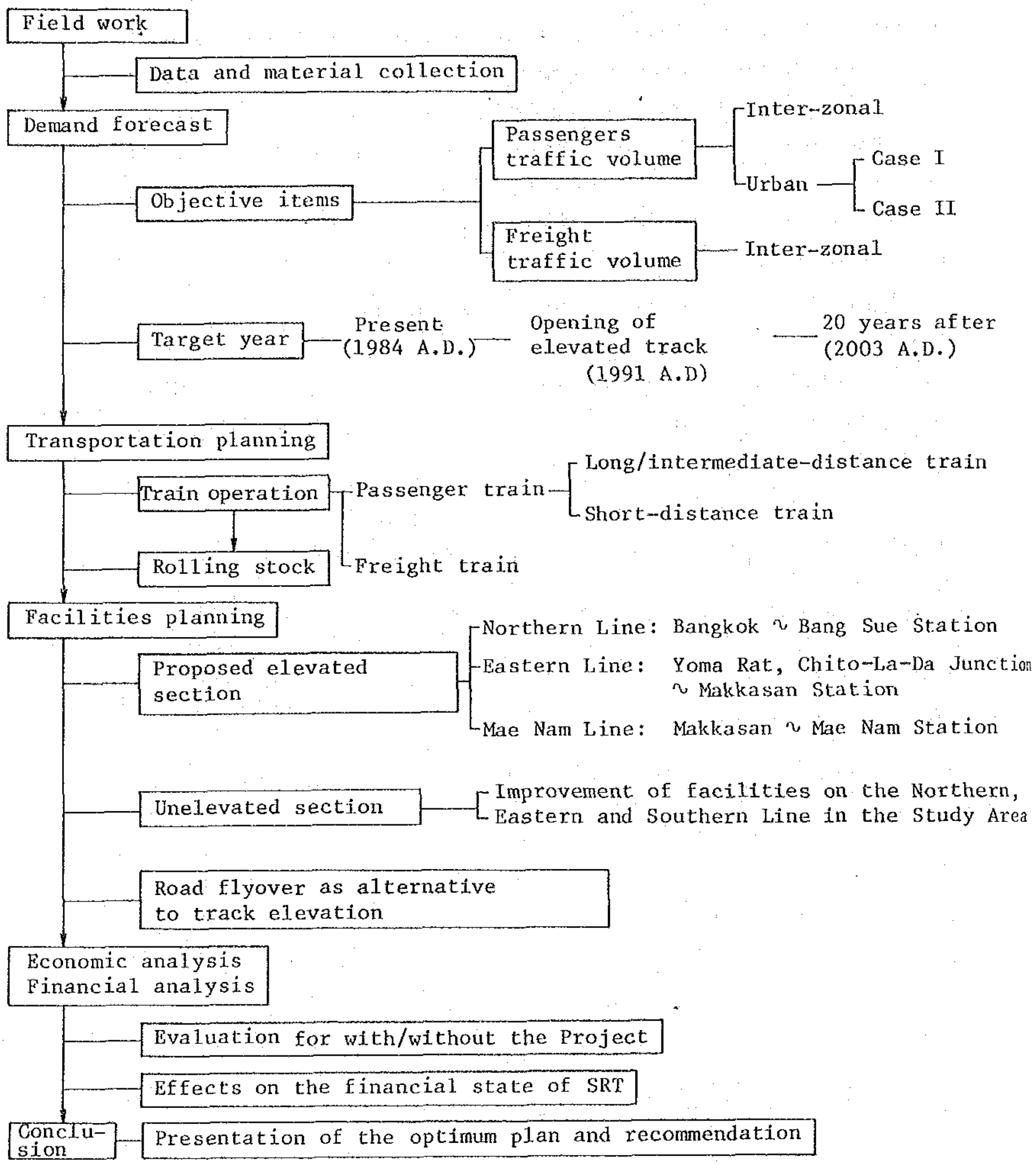


Fig. 1.4.1 Sequence of the Work

(1) Demand forecast

(i) Forecast of passenger traffic in the Greater Bangkok Area is studied for two cases:

Case I: Natural trend type which follows changes on the demand side deriving from the changes in future socio-economic conditions.

Case II: High-level service type which means that railway offers relatively high level of service to passengers.

Passenger flow among zones, in addition to intra-urban flow, is calculated separately.

(ii) Forecast of freight traffic demand assumes that a new line from Klong Sip Khao to Ban Pachi or Kaeng Khoi will be completed in 1991, upon request by Thai authorities.

(2) Scope of track elevation

Scope of track elevation will be studied for each case in the following two alternatives.

Alternative I: Track elevation in three lines of which length is about 13 km: Northern Line (Bangkok St. to Bang Sue St.), Eastern Line (Yoma Rat, Chito-La-Da Junction to Makkasan St.), and Mae Nam Line (Makkasan St. to Mae Nam St.).

Alternative II: Track elevation in two lines of which length is about 10 km: Northern Line and Eastern Line.
This is because the Mae Nam Line operates only freight trains and thus has different characteristics from the other two lines.

### (3) Establishment of with/without cases for the Project

In the Study, track elevation is considered to be "with the project" and flyover by roads "without the project".

### 1.4.2 Traffic Demand Cases to be Considered

First, two cases of intra-urban passenger flow, differing by service level, are assumed. Second, two cases of proposed elevated section are assumed, for a total of four possible cases. Then these four cases are compared with corresponding cases of individual road grade separation projects.

Thus, relatively many cases are examined in the Study, as shown in the table below:

Table 1.4.1 Cases to be Considered

| | | Proposed Elevated Section | |
|---|---|---|---|
| | | Alternative I (three lines) | Alternative II (two lines) |
| Demand Forecast | Case I (Natural Trend Type) | Case-I-3 | Case-I-2 |
| | Case II (High-level Service Type) | Case-II-3 | Case-II-2 |

In addition, for unelevated section, traffic demand in the Greater Bangkok Area and studies for corresponding rolling stock and facilities are conducted in parallel with the main work.

## 1.5 Organization for the Study

The JICA Advisory Committee and the Study Team as well as the Thai Coordination Committee and the Counterpart Personnel are as follows;

## (1) JICA Advisory Committee

| | |
|---|---|
| Ryosuke Hirota<br>Chairman: | Director<br>Facilities Division<br>National Railway Department<br>Secretariat to the Minister<br>Ministry of Transport |
| Hisao Uchiyama<br>Member: | Associate Professor<br>Faculty of Science and Technology<br>Science University of Tokyo |
| Kazuyoshi Matsumoto<br>Member: | International Cooperation Officer<br>International Cooperation Division<br>International Transport and Tourism Bureau<br>Ministry of Transport |
| Kunihiko Harada<br>Member: | Deputy Director<br>Street Division<br>City Bureau<br>Ministry of Construction |
| Norio Fukushiro<br>Coordinator: | Social Development Cooperation Department<br>JICA |

## (2) JICA Study Team

| | |
|---|---|
| Masashi Hatori: | Leader |
| Kimiaki Ijuin: | (Traffic Demand Forecast) |
| Tanehiko Aibara: | Traffic Demand Forecast |
| Kenji Maeda: | Traffic Planning |
| Kazunaga Kurauchi: | Train Operation & Rolling Stock Planning |
| Norishige Ohtaka: | Elevated Structure Planning |
| Iwao Tsuruda: | Elevated Structure Planning |
| Torao Tokozumi: | Elevated Structure Plannig (Road) |
| Akihiko Hayashi: | Construction Execution Planning |
| Keiichi Egawa: | Development Planning |
| Masanori Arita: | Electrification, Signalling and Telecommunication Planning |
| Masami Shigematsu: | Economic and Financial Analysis |
| Hiroo Yanai: | Economic and Financial Analysis |

## (3) Thai Coordination Committee

| | |
|---|---|
| Manus Corvanich<br>Chairman: | Deputy Permanent Secretary of Communications |
| Chomsin Dhabbhasuta<br>Vice Chairman: | Chief Civil Engineer<br>State Railway of Thailand |
| Kamrob Warachat<br>Member: | Ministry of Communication |
| Vichai Pornsiriponge<br>Member: | Ministry of Communication |
| Ura Sunthonsaratool<br>Member: | Ministry of Interior |
| Prapon Vongvichien<br>Member: | Ministry of Interior |
| Phanlop Ongchareon<br>Member: | Department of Town and Country Planning |
| Pisanuroj Plubrukarn<br>Member: | Department of Town and Country Planning |
| Sansern Wongcha-um<br>Member: | National Economic and Social Development Board |
| Chomsak Saradatta<br>Member: | National Economic and Social Development Board |
| Somjate Archaviboonyobone<br>Member: | National Economic and Social Development Board |
| Pichai Pananickabud<br>Member: | National Environment Board |
| Somjai Vatanavanichkul<br>Member: | National Environment Board |
| Vichitr Vatcharindr<br>Member: | Expressway and Rapid Transit Authority of Thailand |
| Damri Ratanawong<br>Member: | Bangkok Metropolitan Administration |
| Voravit Lohthong<br>Member: | Bangkok Metropolitan Administration |
| Thawee Dhammaraksa<br>Member and Secretary: | State Railway of Thailand |
| Vanich Pansuwan<br>Member and Assistant Secretary: | State Railway of Thailand |

(4) Thai Counterpart Personnel

| | |
|---|---|
| Thawee Dhammaraksa: | Deputy Chief Civil Engineer |
| Wayupol Chaisiri: | Chief, Passenger Marketing Division |
| Vichit Chanarakao: | Chief, Transportation Division |
| Prasert Netrapukana: | Mechanical Engineer I/C Locomotive Technical Section |
| Ukrit Sirisalee: | Engineer I/C Telecommunication Section |
| Suthee Ploysook: | Project Analysis Development Co-ordinating Bureau |
| Sompong Bunnag: | Superintending Engineer |
| Saravudh Dhamasiri: | District Engineer, Bangkok |
| Aphai Phadermchit: | Architect Attached to Civil Engineering Department |
| Vanich Pansuwan: | Civil Engineer I/C Planning Section |
| Prasert Attanand: | Assistant Engineer |
| Jain Boonsue: | Assistant Engineer |
| Chatchai Koomsup: | Assistant Engineer |
| Somkiat Piriyakakul: | Assistant Engineer |
| Thavee Thongpan: | Assistant Engineer |

# CHAPTER 2 SOCIO-ECONOMIC FRAMEWORK

# CHAPTER 2 SOCIO-ECONOMIC FRAMEWORK

## 2.1 Nature and Socio-economy

### 2.1.1 Nature and Geography

The Kingdom of Thailand is situated in the central part of the Indo-China Peninsula, from 5° to 21° of north latitude and from 97° to 106° of east longitude. The Bangkok Metropolitan Area (hereinafter referred to as "the Study Area") is near the country's center, nearly 13.7° of north latitude and about 100.6° of east longitude.

The country has a total area of 514,000 $km^2$. The Study Area is 1,549 $km^2$ which is only 0.3% of the whole country.

The climate is divided into the rainy season (May thru October) and the dry season (November thru April). During the rainy period, there are often heavy squalls lasting 1 or 2 hours. Average annual precipitation is about 1,600 mm. In some areas of the country's southern region, annual precipitation reaches more than 3,000 mm.

The Chao Phraya River, flowing through the central part from north to south, forms a large delta zone in the plain, which is noted as a rich granary region. In this region, rice is produced in large quantities as the major agricultural product in this country. Other main products in the agricultural sector are represented by tapioca, sugar cane, maize, rubber and pineapple.

Marine products are also in abundance there, recently with particular emphasis on lobster culture. Teak wood is the main forest product and tin is so in mineral products.

### 2.1.2 Socio-economic Background

Thailand had a population of approximately 48,600,000 at the end of 1982, with a population density of 95 persons per $km^2$. The birth rate has been gradually decreased, becoming less than 2% on the average in the last 5 years. Approximately 30% of Thailand's population is distributed in the Central region, 34% in the Northeastern region, 24% in the Northern region and 12% in the Southern region.

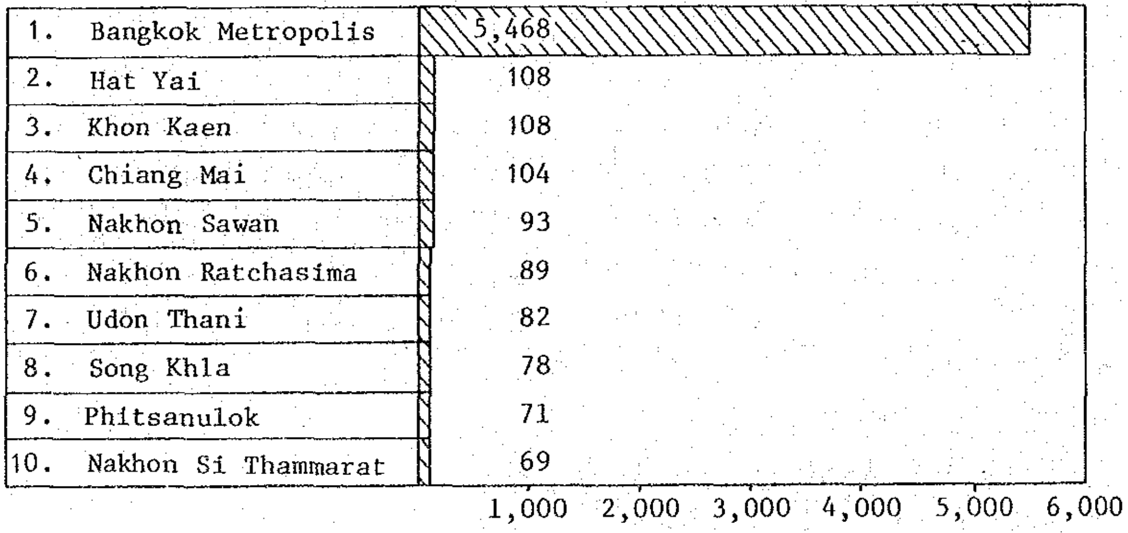
As shown in Table 2.1.1, city population is highly concentrated in the Study Area; Bangkok Metropolis has a population of over 5 million, while other major cities below the second rank have populations of around 100,000.

The population in the Study Area has been growing at an average annual rate of more than 3.3% in the past 10 years, to further widen the difference between small cities.

The population density in the Study Area exceeds 3,400 persons per km$^2$, being 36 times as high as the national average.

Table 2.1.1 City Population (as of the End of December 1982)

(Unit: 1,000 persons)



| | |
|---|---|
| 1. Bangkok Metropolis | 5,468 |
| 2. Hat Yai | 108 |
| 3. Khon Kaen | 108 |
| 4. Chiang Mai | 104 |
| 5. Nakhon Sawan | 93 |
| 6. Nakhon Ratchasima | 89 |
| 7. Udon Thani | 82 |
| 8. Song Khla | 78 |
| 9. Phitsanulok | 71 |
| 10. Nakhon Si Thammarat | 69 |

Thailand's economy has been achieving a steady growth since the start of a series of Five-year plan, beginning under the First Economic Development Plan in 1961.

This steady growth may be attributed to the relatively stable political situation over a long time, an agricultural diversification and increased industrial production resulting from industrial development as an import substitution.

The average annual GDP growth rates were 7.3% for the period of the First Plan (January 1961 to September 1966), 7.2% for the Second Plan (October 1966 to September 1971), 6.2% for the Third Plan (October 1971 to September 1976) and 7.3% for the Fourth Plan (October 1976 to September 1981), as shown in Table 2.1.2. This development growth compares well to that in other countries, as shown in Table 2.1.3.

Table 2.1.2 Per-capita National Income (Nominal)

| Year | Per-capita National Income |
|---|---|
| 1960 | 1,989 Baht |
| 1965 | 2,633 " |
| 1970 | 3,600 " |
| 1979 | 11,843 " |
| 1980 | 14,475 " |
| 1981 | 16,096 " |
| 1982 | 17,212 " |

Table 2.1.3 Per-capita National Income in Asian Countries (1982)

| ASEAN countries | Per-capita National Income |
|---|---|
| Singapore | US$5,743 |
| Malaysia | 1,862 |
| Philippines | 809 |
| Thailand | 749 |
| Indonesia | 578 |
| (Japan) | (8,970) |
| (U.S.A.) | (13,242) |

Note: Relevant data as available from countries.
Conversion rate is based upon annual average rate taken from IMF's "International Financial Statistics."

However, in the process of such economic growth, the problem of regional gaps in economic development occurred.

The Government has established regional development and agricultural promotion as one of the major policies with a view to reducing the income gap. In reality, however, the gap still remains as shown in Table 2.1.4 and actually tends to grow larger.

Table 2.1.4 National Income by Region (Nominal in 1982)

| Area | Total (Million Baht) | Per-capita National Income (Baht) |
|---|---|---|
| Bangkok Metropolis | 281,317 | 50,779 (2,208) |
| East | 121,372 | 33,518 (1,457) |
| West | 84,391 | 25,847 (1,124) |
| Central | 61,046 | 20,999 (913) |
| South | 87,275 | 14,376 (625) |
| North | 114,366 | 11,434 (497) |
| Northeast | 109,603 | 6,390 (278) |

Notes: 1. Data: NESDB "Gross Regional and Provincial Product 1982"
2. ( ) is US$.

In the distribution pattern of 1982's GDP by region, the GDP in the Study Area takes a large share (33%) of the nation's total. From this fact, it is believed that the centralized trend of population and industry in Bangkok would further continue in the future as well as at present, unless effective measures are taken by giving priorities to implement the regional development program.

## 2.2 National Economic and Social Development Plan

### 2.2.1 Achievement in the First to Fourth Plans

The Thai economy has been developing in a relatively stable manner from World War II to the present. This post 1960 development has been achieved by agricultural diversification and industrial development which have been integrally linked to a traditional agricultural base depending on rice production.

Fundamental factors to achieve this economic development are considered to be introduction of the Development Plan, improvement and expansion of the infrastructure, diversification of agricultural production and development of import substitute industries.

The Thai Government introduced a comprehensive Economic and Social Development Plan in 1961, accepting the recommendation from the World Bank. This has established a foundation that makes aid and assistance from international organizations smoother and more effective.

At the same time, improvement of the road network and expansion of the electric power generating capacity, which are the main components of the infrastructure, have provided not only the foundation for industrial development in later years but also a great increase in agricultural production.

In agriculture, Thailand has successfully diversified from heavy dependence on rice and rubber to new crops such as maize, tapioca and sugar, which have become major export items, as shown in Table 2.2.1.

Table 2.2.1 Export Value by Major Commodity

(Unit: Million baht)

| | 1960 | 1970 | 1980 | 1981 |
|---|---|---|---|---|
| Rice | 2,570<br>(29.8) | 2,516<br>(17.0) | 19,508<br>(14.6) | 26,353<br>(17.2) |
| Tapioca | 288<br>(3.3) | 1,223<br>(3.8) | 14,887<br>(11.2) | 16,434<br>(10.7) |
| Rubber | 2,579<br>(29.9) | 2,232<br>(15.1) | 12,351<br>(9.3) | 10,839<br>(7.1) |
| Sugar | 8<br>(0.1) | 94<br>(0.6) | 2,975<br>(2.2) | 9,571<br>(6.3) |
| Tin | 537<br>(6.2) | 1,618<br>(11.0) | 11,347<br>(8.5) | 9,099<br>(5.9) |
| Maize | 551<br>(6.4) | 1,969<br>(13.3) | 7,299<br>(5.5) | 8,328<br>(5.4) |
| Others | 2,087<br>(24.2) | 5,120<br>(34.7) | 64,830<br>(48.7) | 72,406<br>(47.3) |
| Total | 8,612<br>(100.0) | 14,772<br>(100.0) | 133,197<br>(100.0) | 153,030<br>(100.0) |

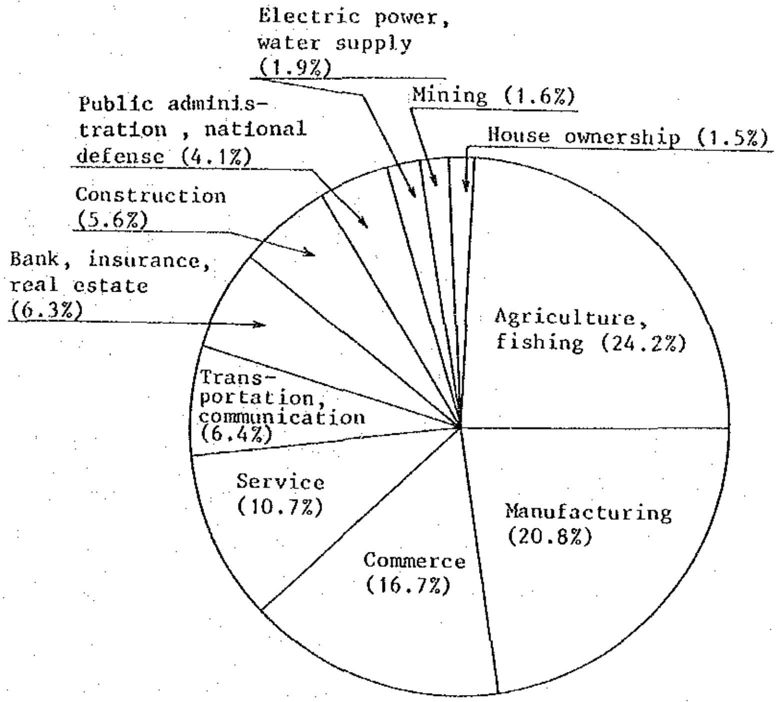
Note: ( ) is percentage of total value.

Industrial development has greatly advanced on account of the policy change in the First Development Plan from public leading type to private leading one. Export manufacturing industries are emphasized at the present.

It is an undeniable fact that the economic development owes much to political stablity in the 1960s.

However, in 1970s the country encountered international economic fluctuations, political instability and drought. Under these circumstances, the Third Plan failed to achieve sufficient results and was succeeded by the Fourth Plan.

During the Fourth Plan, the Thai economy has grown at an average annual rate of 7.3%, a remarkable achievement considering the large fluctuations of the global economy. Gross domestic product by sector (as of 1981) is shown in Fig. 2.2.1. Various problems, however, such as high inflation rate, worsening of trade balance and widening of income differences are left unsolved as shown in Tables 2.2.2 and 2.2.3.



Source: NESDB

Fig. 2.2.1 Gross Domestic Product by Sector in 1981

Table 2.2.2 Consumer Price Increase Rate

| Area | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|
| Bangkok Metropolitan area | 8.8% | 10.3% | 19.9% | 13.4% |
| National average | 7.9% | 9.9% | 19.7% | 12.7% |

Table 2.2.3 External Trade Trend

| Year | Export (FOB) | | Import (CIF) | | Balance (Mil. baht) |
|---|---|---|---|---|---|
| | (Mil. baht) | GDP Ratio (%) | (Mil. baht) | GDP Ratio (%) | |
| 1960 | 8,614 | 16 | 9,622 | 18 | Δ1,008 |
| 1965 | 12,941 | 15 | 15,433 | 18 | Δ2,492 |
| 1970 | 14,772 | 11 | 27,009 | 20 | Δ12,237 |
| 1975 | 45,007 | 15 | 66,835 | 22 | Δ21,828 |
| 1976 | 60,797 | 18 | 72,877 | 22 | Δ12,080 |
| 1977 | 71,198 | 18 | 94,177 | 24 | Δ22,979 |
| 1978 | 83,065 | 18 | 108,839 | 23 | Δ25,834 |
| 1979 | 108,179 | 19 | 146,161 | 26 | Δ37,982 |
| 1980 | 133,197 | 19 | 188,686 | 28 | Δ55,489 |
| 1981 | 153,001 | 19 | 216,746 | 27 | Δ63,745 |

Data: The Bank of Thailand
Note: "Δ" means deficit

In summary, during the 20-year period between the First Plan and the Fourth Plan, the Thai economy has achieved a remarkable 7% average annual growth accompanied by structural change in the field of production, trade and income distribution. At the same time, however, economic development has brought about rapid deterioration of forest, land, water and fishing resources. Economic development has not been evenly distributed among regions and sectors, further widening income inequities. The Thai economy has become increasingly affected by international economic conditions.

## 2.3 Fifth National Economic and Social Development Plan

The future socio-economic framework of the Kingdom of Thailand is inferred in the Fifth National Economic and Social Development Plan (1981 to 1986) published by NESDB in October 1981. The Fifth Plan is a policy plan that should be broken down into operational plans.

In the Fifth Plan, the Government stresses the following six main points:

(1) The adjustment of the economic structure rather than economic growth

(2) Equality in national economic and social development efforts

(3) The alleviation of poverty for people in backward rural areas

(4) Closer coordination between economic and social development efforts and national security management

(5) The advancement of the Fifth Plan into operational plans

(6) The role and cooperation of the private sector

### 2.3.1 Summary of the Overall Development Targets

To accomplish the above main themes, the Government has formulated the following overall development targets.

(1) Targets for restoring the country's stability

- Increase the export of goods by 22.3% per annum
- Limit the growth rate of import to no more than 18.1% per annum
- Reduce the oil import volume by an average of 3% per annum

(2) Economic production targets

- GDP growth of 6.6% per annum
- Agricultural growth of 4.5% per annum
- Manufacturing industry growth of 7.6% per annum
- Mining output increase of 16.4% per annum
- Natural gas production of 525 million cubic feet per day in 1986

(3) Reduction of oil import volume by 3% per year

(4) The Government's fiscal targets

- ·Increase Government revenues by 22.3% per annum (or an average of 16.7% of the GDP)
- ·Increase Government expenditures by 20.2% per annum (or an average of 18.2% of the GDP)
- ·Limit the Government budget deficit to no more than 22,000 million baht per year

(5) Social development and service target

- ·Reduce the population growth rate to 1.5% by 1986

### 2.3.2 Transportation

During the past 20 years, the so-called "inexpensive oil era", the Government has emphasized the development of the road transportation system. Overburdening of the road transportation system caused many problems, especially traffic congestion in the Study Area.

In the so-called "expensive oil era" at present, a more balanced transportation system should be established not only to save energy but also to facilitate the sound development of socio-economic activities.

*Targets for the development of land transportation which is re*lated to the Track Elevation Project are as follows:

(1) Increase rail transportation capability by improving tracks, bridges and station capacity, and by building double tracks and elevated tracks

(2) Construct another expressway and, at most, two kinds of mass transit systems in order to alleviate traffic congestion in the Study Area.

### 2.3.3 Eastern Seaboard

In accordance with the policy of decentralizing economic and industrial activities, the Eastern Seaboad sub-region will be established as a new center to alleviate congestion in the Bangkok Metropolitan Area.

The necessary infrastructure for this new center includes the following:

(1) Deep-sea port

(2) Water

(3) Road network

(4) Railway lines

(5) Electricity

# CHAPTER 3 TRANSPORTATION

# CHAPTER 3 TRANSPORTATION

## 3.1 Transportation Outline

Representative inland transportation in Thailand is road transportation, which carries 85 percent of the freight and 93 percent of the passengers. Transport share by mode is shown in Table 3.1.1.

Table 3.1.1 Transport Share by Mode (1978)

| Transport mode | Freight | | Passenger | |
|---|---|---|---|---|
| | Million tons | % | Million passenger-km | % |
| Road | 79.0 | 85 | 83,700 | 93 |
| Railway | 8.4 | 9 | 6,030 | 6.7 |
| Water | 5.6 | 6 | - | - |
| Air | - | - | 270 | 0.3 |
| Total | 93.0 | 100 | 90,000 | 100.0 |

Data: NESDB "The Fifth National Economic and Social Development Plan"

### (1) Road transportation

The existing road network throughout the country consists of national freeways and highways, provincial roads, rural, municipal roads, and town roads. Main roads are maintained in good conditions.

The road improvement is performed on the Fifth Plan. The highway network has been nearly completed all over the country by the Fourth Plan. The future improvement program stresses the necessity of construction of feeder roads to contribute to agricultural development, improve road sections where the increase of traffic volume is noticeable, and upgrade road maintenance level. The road maintenance conditions as of 1980 are shown in Table 3.1.2.

Table 3.1.2 Road Maintenance Conditions Current State of Road (1980)

|  | No. of provinces | Area (1000 sq. Kms) | Population (million) | In service (Kms) |  |  | Under planning or construction (Kms) |  |  | Grand total (Kms) |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  | Paved | Unpaved | Total | National highway | Provincial highway | Total |  |
| Northern | 17 | 170 | 9 | 5,608 | 1,025 | 6,633 | 442 | 5,187 | 5,629 | 12,262 |
| North-eastern | 16 | 170 | 16 | 6,221 | 2,389 | 8,610 | 163 | 3,565 | 3,728 | 12,338 |
| Central | 25 | 104 | 15 | 5,628 | 1,486 | 7,114 | 340 | 2,485 | 2,825 | 9,939 |
| Southern | 14 | 70 | 6 | 4,875 | 847 | 5,722 | 35 | 2,842 | 2,877 | 8,599 |
| Total | 72 | 514 | 46 | 22,332 | 5,747 | 28,079 | 980 | 14,079 | 15,059 | 43,138 |

Note: According to data of the Highway Department.

### (2) Railway transportation

The railway network radiates from Bangkok. The trunk lines comprise the Northern Line to Chiang Mai, Northeastern Line to Nong Khai near the Loas border and to Ubon Ratcha Thani near the Cambodian border, Eastern Line to Aranya Prathet near the Cambodian border, and Southern Line to Sungai Kolok near the Malaysian border.

Total route length in service is 3,735 km, transporting mainly intermediate/long distance traffic.

Passengers carried by rail increased 1.52 times in number and 2.15 times in passenger-km during these ten years as shown in Table 3.1.3. Freight traffic increased only 1.13 times in tonnage and 1.16 times in ton-km during the same period.

Table 3.1.3 Passenger and Freight Traffic

| | No. of passengers ($\times 10^3$) | Passenger-Km ($\times 10^6$) | Tonnage ($\times 10^3$) | Ton-Km ($\times 10^6$) |
|---|---|---|---|---|
| 1972 | 51,952 (100) | 4,412 (100) | 5,354 (100) | 2,242 (100) |
| 1973 | 55,507 (107) | 4,694 (106) | 5,020 ( 94) | 2,070 ( 92) |
| 1974 | 61,409 (118) | 5,376 (122) | 5,117 ( 96) | 2,296 (102) |
| 1975 | 61,567 (119) | 5,640 (128) | 5,052 (106) | 2,353 (105) |
| 1976 | 55,759 (107) | 5,628 (128) | 5,351 (100) | 2,505 (112) |
| 1977 | 57,974 (116) | 5,649 (128) | 6,310 (118) | 2,912 (130) |
| 1978 | 59,035 (114) | 6,039 (137) | 6,096 (114) | 2,651 (118) |
| 1979 | 64,398 (124) | 7,029 (159) | 6,366 (119) | 2,747 (122) |
| 1980 | 74,286 (143) | 8,861 (201) | 6,230 (116) | 2,805 (125) |
| 1981 | 78,824 (152) | 9,483 (215) | 6,041 (113) | 2,601 (116) |

Note: ( ) indicates indices when the traffic in 1972 is 100.

(3) Other transportation

The inland waterway has been developed principally along the Chao Phraya River and played a major role in domestic inland transportation. Since the transportation is required to be rapid and reliable, the river transportation with extremely slow speed may be said to be rather outdated.

There are three international airports, Bangkok, Chiang Mai and Hat Yai, and 27 local airports. The Bangkok airport facilities are now being expanded in order to cope with air transport demand for 15 years in the future. Meanwhile, in anticipation of further increases in air traffic demand, construction of a new airport is under planning. The location is about 25 km east of Bangkok.

## 3.2 Urban Transportation

### 3.2.1 Outline of Urban Transportation

#### (1) Transport situation

Bangkok began to take an urban form as the nation's capital with the establishment of the present Dynasty in 1782. Since the city was formed basically with the traffic network consisting of rivers and waterways, it still remains somewhat unsuitable for the prevailing trend of motorization as is seen today.

According to the result of person trip survey conducted in 1982 throughout the Greater Bangkok Area, the typical pattern of transport means is represented by buses and private cars, as shown in Table 3.2.1, which takes a greater share of 88% in the total number of trips. In contrast with that, the railway traffic shows a very minor utilization rate of 0.3%, the lowest urban transport contribution rate.

Table 3.2.1 Result of Person Trip Survey

| Item | No. of trips | Composition (%) | Composition (%) |
|---|---|---|---|
| 1. Private means | persons | | |
| (1) Car | 1,853 | 65.8 | 21.7 |
| (2) Motorcycle | 553 | 19.6 | 6.4 |
| (3) Samlor | 76 | 2.7 | 0.9 |
| (4) Taxi | 71 | 2.5 | 0.8 |
| (5) School bus | 207 | 7.1 | 2.3 |
| (6) Truck | 59 | 2.3 | 0.8 |
| Subtotal | 2,819 | 100.0 | 32.9 |
| 2. Public means | | | |
| (1) Small bus | 532 | 9.3 | 6.2 |
| (2) Heavy bus | 5,142 | 89.6 | 60.1 |
| (3) Train | 25 | 0.4 | 0.3 |
| (4) Boat | 42 | 0.7 | 0.5 |
| Subtotal | 5,741 | 100.0 | 67.1 |
| Total | 8,560 | - | 100.0 |

Data: Feasibility Study of the Second Stage Expressway System in The Greater Bangkok Area, 1983.

Notwithstanding the fact that the greater majority of the existing urban traffic depends solely upon road traffic, the total length of roads existing within the Study Area is no more than about 1,150 km, and the road area is less than 10% of the urban area. This causes traffic congestion all day long throughout the whole urban area.

To measure the extent of influence from traffic congestion, car travel time survey was conducted in September 1983.

As shown in Fig. 3.2.1, while speed from the suburban area up to the outskirt of Bangkok City is relatively high, 56 to 70 km per hour, it is acutely slowed down to 5 to 25 km per hour inside the city.

| Survey Section | Survey Time | Length | Average Speed |
|---|---|---|---|
| ① Sukhumvit Soi 5 → Bangkok Station | 7°15' - 7°37' | 2.7km | 7.4km/h |
| ② Sukhumvit Soi 5 → Wong Wien Yai | 8°08' - 8°33' | 6.0km | 14.4km/h |
| ③ Mahachai → Bangkok Station | 13°47'- 14°56' | 53.4km | 46.4km/h |
| ④ Ayutthaya → Sukhumvit Soi 5 | 12°50'- 14°03' | 77.8km | 63.9km/h |
| ⑤ Chachoeng Sao → Sukhumvit Soi 5 | 13°23'- 14°59' | 82.9km | 51.8km/h |

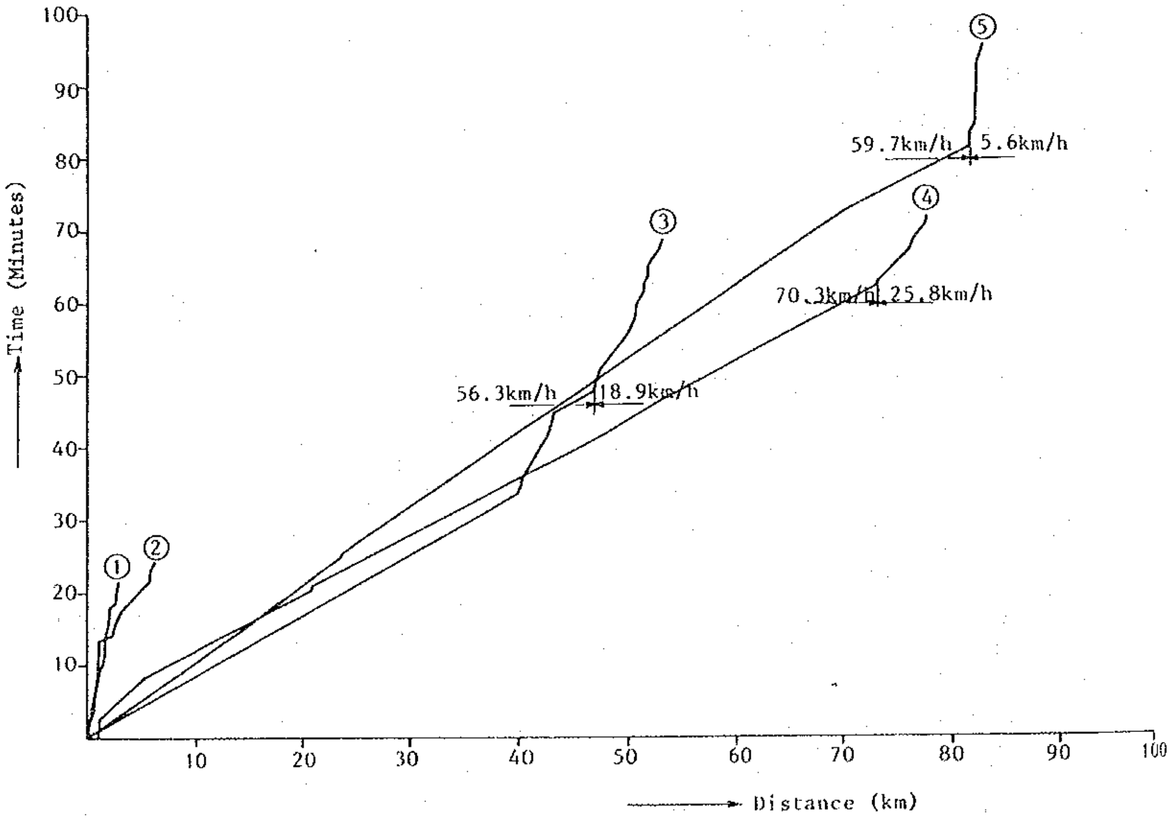


Fig. 3.2.1 Travel Time Survey

### (2) Railway transportation in the urban area

#### (i) Railway transportation

Trains available for the genuine purpose of commuter transportation within the Study Area are limited solely to between Don Muang and Hua Takhe. As indicated in Fig. 3.2.2, temporary platforms made of sleepers are provided alongside each main road for the sake of passengers' convenience.

Train operation in that section features such railway benefits as high efficiency, energy saving and transportability throughout all weather conditions. In full recognition of those benefits, the railway initiated its operation on November 5, 1979 to comply with the governmental request.

In the said section, trains are operated with a very low frequency of three round trips per day. The loading efficiency is shown in Table 3.2.2. Passengers utilize the railway at a loading efficiency of 134% (at Khlong Tan Station) during the morning rush hours and 218% (at Khlong Tan Station) during the evening rush hours. During the day time, off-peak loading efficiency is as low as 40% or so.

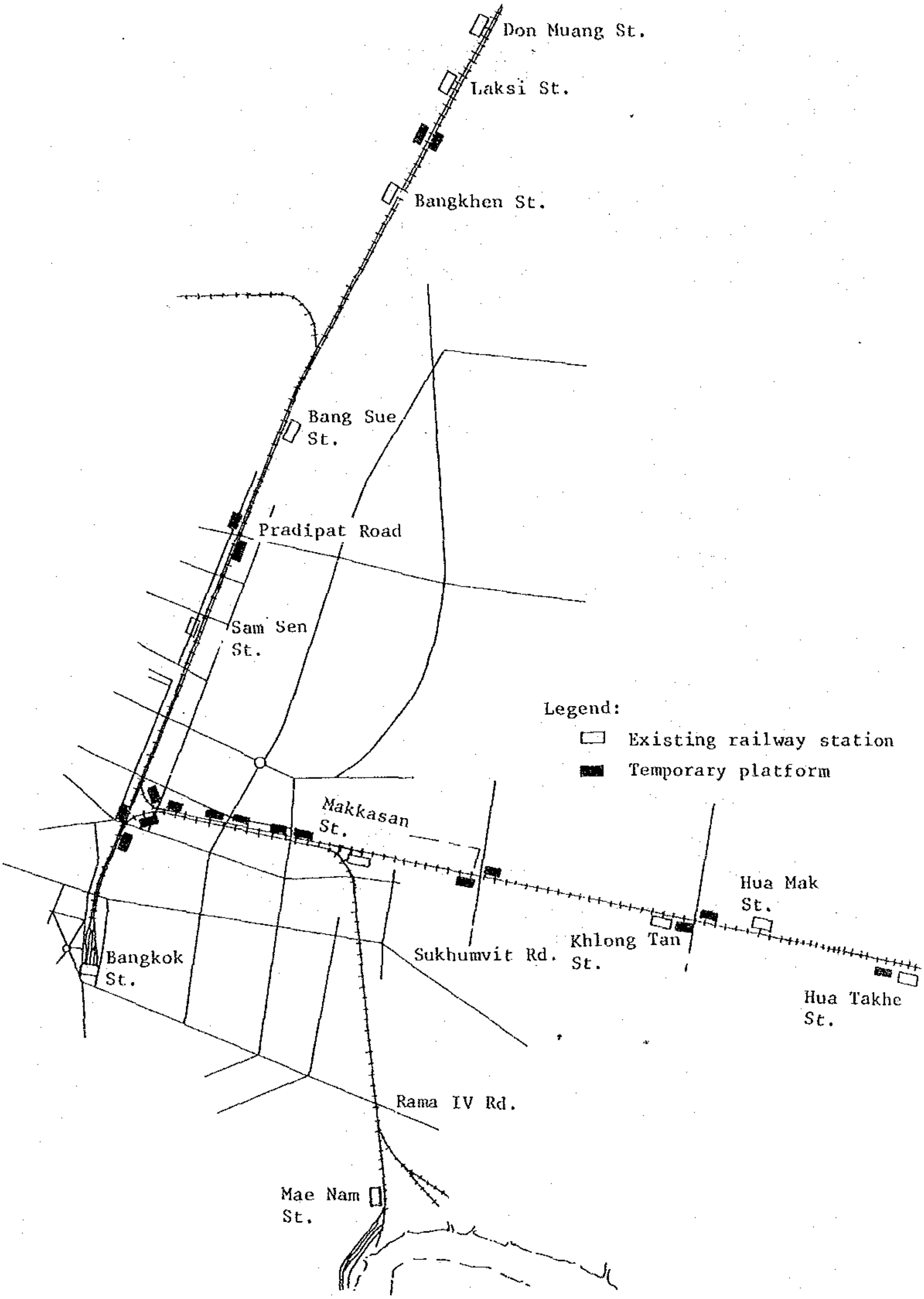


Fig. 3.2.2 Location of Temporary Platform

Table 3.2.2 Number of Passengers

(Unit: person)

| Station | | Year / Train | 1981 | | 1982 | |
|---|---|---|---|---|---|---|
| | | | On week day | On holiday | On week day | On holiday |
| From Don Muang to Hua Takhe | Don Muang | Train No. 192 ( 6:00) | 48 ( 32) | 26 ( 17) | 46 ( 30) | 27 ( 18) |
| | | Train No. 194 (10:15) | 15 ( 10) | 13 ( 9) | 26 ( 17) | 13 ( 9) |
| | | Train No. 196 (15:00) | 20 ( 13) | 13 ( 9) | 24 ( 16) | 32 ( 21) |
| | Khlong Tan | Train No. 192 ( 6:53) | 200 (132) | 94 ( 62) | 204 (134) | 103 ( 68) |
| | | Train No. 194 (11:20) | 74 ( 49) | 51 ( 33) | 93 ( 61) | 117 ( 77) |
| | | Train No. 196 (15:58) | 145 ( 95) | 102 ( 67) | 177 (116) | 97 ( 64) |
| From Hua Takhe to Don Muang | Hua Takhe | Train No. 191 ( 8:05) | 83 ( 56) | 92 ( 60) | 82 ( 54) | 104 ( 68) |
| | | Train No. 193 (12:40) | 43 ( 28) | 81 ( 53) | 149 ( 98) | 141 ( 93) |
| | | Train No. 195 (16:50) | 176 (116) | 49 ( 32) | 277 (182) | 95 ( 63) |
| | Khlong Tan | Train No. 191 ( 8:38) | 110 ( 72) | 163 (107) | 189 (124) | 129 ( 85) |
| | | Train No. 193 (13:13) | 134 ( 88) | 141 ( 93) | 223 (147) | 97 ( 64) |
| | | Train No. 195 (17:23) | 281 (185) | 140 ( 92) | 331 (218) | 132 ( 87) |

Notes:
1. Survey was provided by the State Railway of Thiland in June of each year.
2. Commuter train operated by 1 set of diesel railcar.
3. ( ) shows the loading factor by %.
   Fixed number is 152 persons per diesel railcar set.

(ii) Train operations in urban areas

(a) Safety

There are 14 grade crossings in the proposed elevated section, and the average distance between grade crossings is about 1.0 km. On the other hand, 1,490 grade crossings are located in the whole country, with an average interval of 2.5 km.

On average, 7 accidents happened annually at these 14 grade crossings (0.49 cases per crossing) during the past 6 years (1977 to 1982). This figure is 7 times higher than that of the country's average (0.07 cases per grade crossing). There are certain problems as to the safety at these grade crossings.

(b) Train operating speed

Road traffic congestion obstructs the normal train operation at the grade crossings in the proposed elevated section, so that, the scheduled speed (23.5 to 28.0 km per hour) is set lower than that in the outside area (40.3 to 54.3 km per hour). (Appendix 3.3.5)

However, it is difficult to maintain the present scheduled train speed because of frequent train stoppage and slow-down due to road traffic congestion.

(c) Train operating capacity

A double-track line on the proposed elevated section is restricted in track capacity because of grade crossing disturbance and present operation system. Also, dead-end terminal of Bangkok Station greatly restricts the number of trains because its departure track yard and arrival track yard are located separately.

It will be difficult to increase train operation on the proposed elevated section and in Bangkok Station.

### 3.2.2 Traffic Survey

#### (1) Passenger survey at stations

The survey was conducted to obtain information such as the number of trains and that of passengers utilizing each train. It was conducted on October 7 at two selected stations, Bangkok and Thon Buri.

The period of survey coincided with the rainy season, during which several areas in Bangkok were flooded and some schools were already closed for vacation. It seems, therefore, that the result of survey may differ, to some extent, from that during the dry season. Figs. 3.2.3 and 4 compare the survey results with those taken in December 1978.

The present number of passengers at Bangkok Station amounts to 47,422 persons per day, 2.10 times those in 1978. Peak load during the morning rush hours may be divided into two time zones: 05:00 to 06:00 and 07:00 to 08:00. All the trains scheduled for arrival during the time zone of 05:00 to 06:00 travel all night over long distances, while the trains for arrival between 07:00 and 08:00 are operated within a medium distance of 100 km for commuting services. A total of 3,651 passengers arrived between 07:00 and 08:00 with an increase of 1.30 times as compared with the total in 1978.

Meanwhile, the number of passengers at Thon Buri Station totals 5,821 a day, only a negligible increase as compared with the total of 5,788 in 1978. This is apparently due to road expansion in the west of Thon Buri.

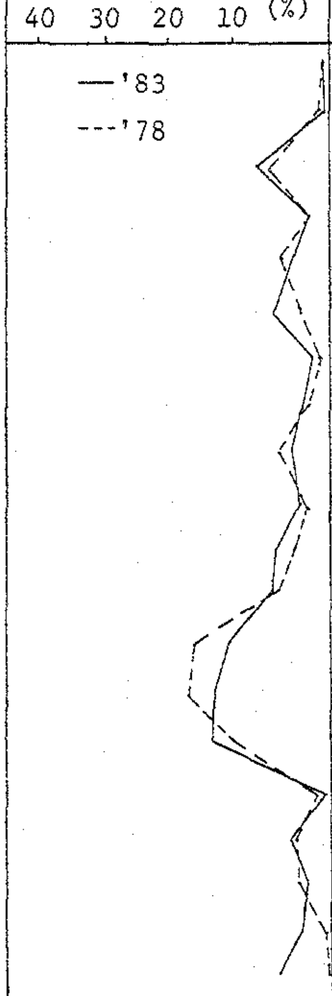
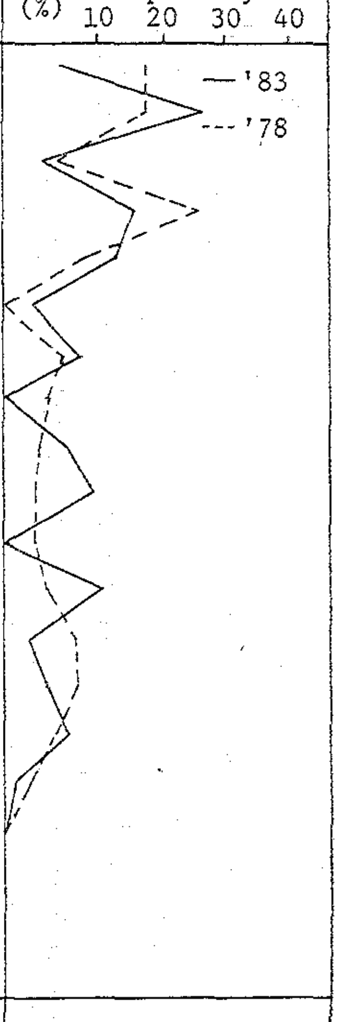
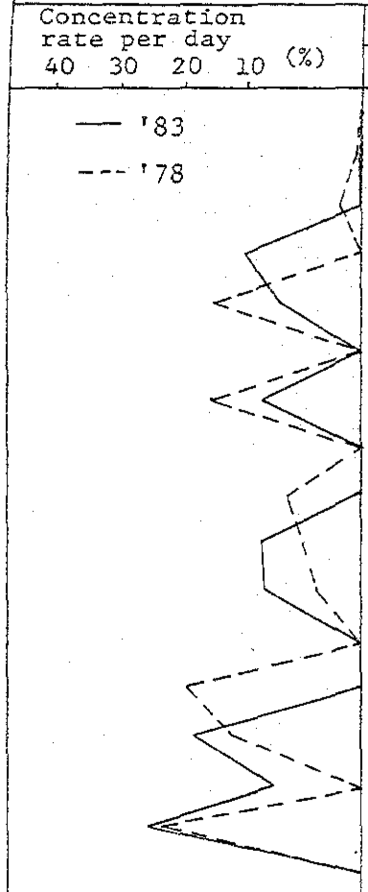
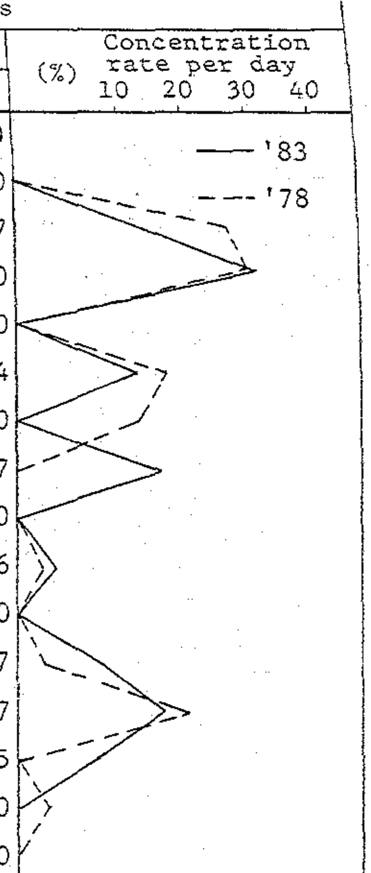
| Departures | | | | | Time | Arrivals | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Concentration rate per day | No. of passengers | | No. of trains | | | No. of trains | | No. of passengers | | Concentration rate per day |
| 40 30 20 10 (%) | '78 | '83 | '78 | '83 | | '78 | '83 | '78 | '83 | (%) 10 20 30 40 |
|  | 9 | 14 | 1 | 1 | 4:00∿ 5:00 | 5 | 2 | 2,078 | 1,682 |  |
| | 93 | 102 | 1 | 3 | 5:00∿ 6:00 | 3 | 6 | 1,986 | 5,805 | |
| | 684 | 1,777 | 4 | 4 | 6:00∿ 7:00 | 4 | 4 | 801 | 1,185 | |
| | 213 | 427 | 1 | 2 | 7:00∿ 8:00 | 5 | 5 | 2,732 | 3,651 | |
| | 670 | 796 | 3 | 2 | 8:00∿ 9:00 | 2 | 4 | 845 | 2,621 | |
| | 373 | 1,335 | 3 | 4 | 9:00∿10:00 | 0 | 2 | 0 | 737 | |
| | 129 | 527 | 1 | 2 | 10:00∿11:00 | 6 | 7 | 563 | 1,627 | |
| | 283 | 762 | 2 | 2 | 11:00∿12:00 | 2 | 0 | 230 | 0 | |
| | 748 | 932 | 2 | 2 | 12:00∿13:00 | 1 | 3 | 147 | 1,065 | |
| | 321 | 874 | 3 | 3 | 13:00∿14:00 | 1 | 0 | 97 | 0 | |
| | 459 | 1,375 | 2 | 4 | 14:00∿15:00 | 2 | 3 | 160 | 1,291 | |
| | 737 | 1,553 | 2 | 2 | 15:00∿16:00 | 2 | 0 | 287 | 0 | |
| | 1,648 | 2,621 | 4 | 5 | 16:00∿17:00 | 3 | 4 | 598 | 1,711 | |
| | 1,808 | 2,904 | 3 | 4 | 17:00∿18:00 | 3 | 2 | 623 | 689 | |
| | 1,373 | 3,928 | 4 | 5 | 18:00∿19:00 | 2 | 5 | 245 | 895 | |
| | 198 | 0 | 1 | 0 | 19:00∿20:00 | 2 | 3 | 65 | 843 | |
| | 381 | 977 | 2 | 2 | 20:00∿21:00 | 0 | 1 | 0 | 169 | |
| | 402 | 565 | 2 | 1 | 21:00∿22:00 | 0 | 0 | 0 | 0 | |
| | 149 | 739 | 1 | 1 | 22:00∿23:00 | 0 | 0 | 0 | 0 | |
| | 0 | 1,243 | 0 | 1 | 23:00∿24:00 | 0 | 0 | 0 | 0 | |
| | 10,678 | 23,451 | 42 | 50 | Total | 43 | 51 | 11,457 | 23,971 | |

Fig. 3.2.3 Result of Survey at Bangkok Station





| Departures |  |  |  | Time | Arrivals |  |  |  |
|---|---|---|---|---|---|---|---|---|
| No. of passengers |  | No. of trains |  |  | No. of trains |  | No. of passengers |  |
| '78 | '83 | '78 | '83 |  | '78 | '83 | '78 | '83 |
| 0 | 0 | 0 | 0 | 4:00∿ 5:00 | 0 | 0 | 0 | 0 |
| 15 | 32 | 1 | 1 | 5:00∿ 6:00 | 0 | 0 | 0 | 0 |
| 32 | 24 | 1 | 1 | 6:00∿ 7:00 | 1 | 1 | 750 | 437 |
| 0 | 365 | 0 | 1 | 7:00∿ 8:00 | 1 | 1 | 815 | 790 |
| 418 | 276 | 2 | 1 | 8:00∿ 9:00 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 9:00∿10:00 | 1 | 1 | 419 | 324 |
| 432 | 326 | 1 | 1 | 10:00∿11:00 | 2 | 0 | 289 | 0 |
| 0 | 0 | 0 | 0 | 11:00∿12:00 | 0 | 2 | 0 | 297 |
| 191 | 0 | 1 | 0 | 12:00∿13:00 | 0 | 0 | 0 | 0 |
| 128 | 248 | 1 | 1 | 13:00∿14:00 | 1 | 1 | 85 | 96 |
| 104 | 218 | 1 | 1 | 14:00∿15:00 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 15:00∿16:00 | 1 | 1 | 33 | 167 |
| 514 | 0 | 1 | 0 | 16:00∿17:00 | 3 | 1 | 518 | 387 |
| 420 | 532 | 1 | 0 | 17:00∿18:00 | 0 | 2 | 0 | 185 |
| 0 | 352 | 0 | 1 | 18:00∿19:00 | 1 | 0 | 28 | 0 |
| 597 | 765 | 1 | 1 | 19:00∿20:00 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 20:00∿21:00 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 21:00∿22:00 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 22:00∿23:00 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 23:00∿24:00 | 0 | 0 | 0 | 0 |
| 2,851 | 3,138 | 11 | 10 | Total | 11 | 10 | 2,937 | 2,683 |

Fig. 3.2.4 Result of Survey at Thon Buri Station

### (2) Traffic volume at grade crossings

Traffic volume at the grade crossings was surveyed to monitor how and to what extent the vehicle traffic flow is impeded at each grade crossing. Thus, the traffic volume at the grade crossing and the barrier time during train passage were surveyed at 14 grade crossings in the proposed elevated section.

Total volume measured in the surveyed section amounted to 401,707 vehicles per 12 hours. The blocked traffic volume was calculated on a basis of the suspension probability sought from barrier time at the grade crossing. It accounts for 12% in the total traffic volume. This means that 47,826 vehicles per 12 hours have been blocked by passage of trains at the grade crossings. The result of traffic survey is shown in Table 3.2.3 (Appendixes 3.2.1 and 2).

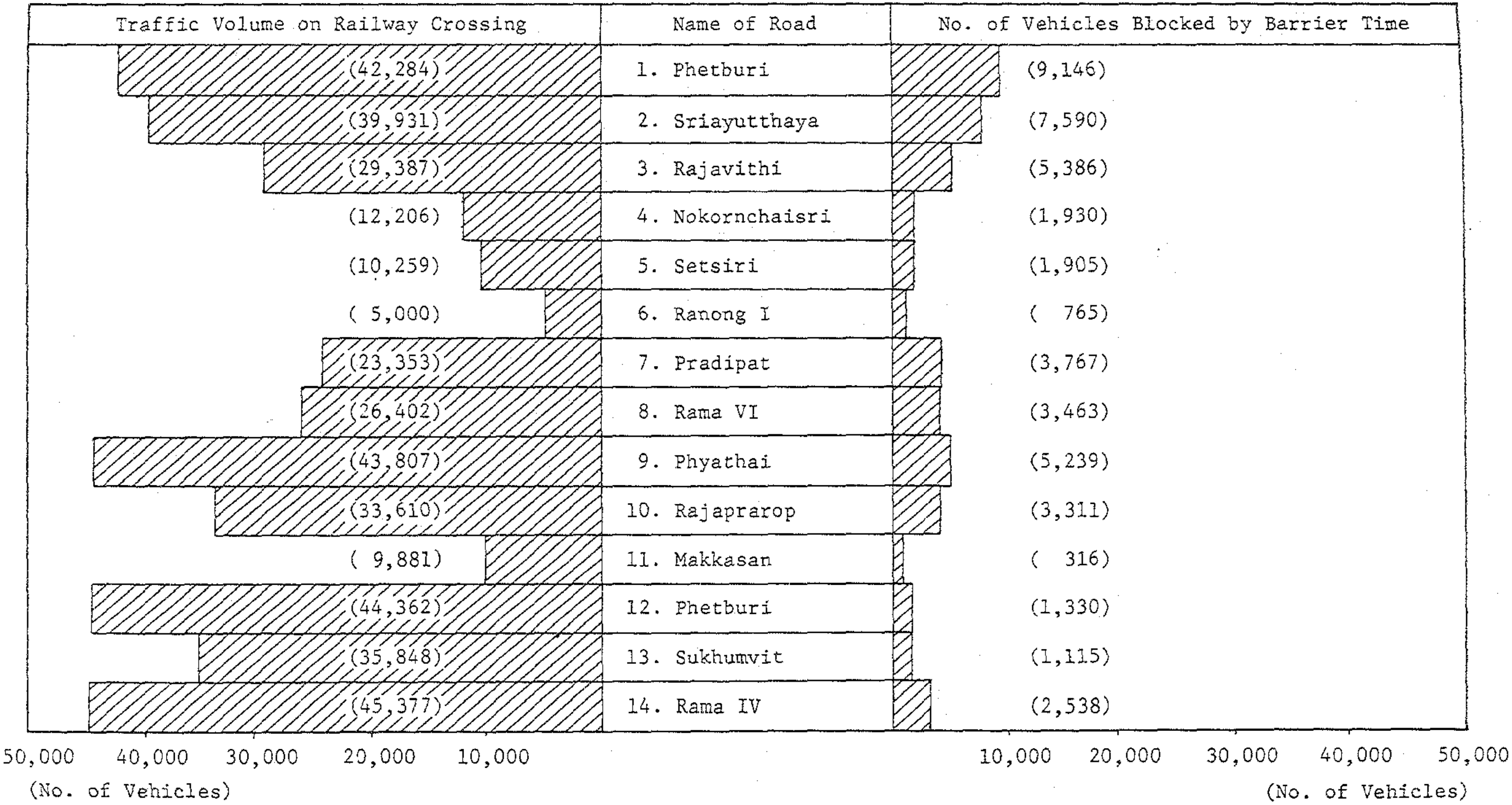
The grade crossings with a large volume of blocked traffic are Phetburi, Sriayutthaya, Rajavithi and Phayathai. In particular, the blocked traffic adversely affects road congestion during the morning and evening rush hours. Furthermore, it tends to hamper train operation because such traffic jams frequently occur on the grade crossing itself.

The Mae Nam freight line crosses Phetburi, Sukhumvit and Rama IV Roads with a heavy traffic volume at each grade crossing. However, because train operation is restrained during the morning and the evening rush hours, the road traffic is not affected in the least.

Hourly traffic fluctuation on the main roads is shown in Fig. 3.2.5. At peak hours both in the morning and evening, private cars with a small number of passengers constitute a large percentage of the total vehicle traffic. This is deemed as a big factor causing the traffic congestion in many instances.

Table 3.2.3  Result of Traffic Volume Survey (6:00 to 18:00)

(Unit: Vehicles per 12 hours)



| Traffic Volume on Railway Crossing | Name of Road | No. of Vehicles Blocked by Barrier Time |
|---|---|---|
| (42,284) | 1. Phetburi | (9,146) |
| (39,931) | 2. Sriayutthaya | (7,590) |
| (29,387) | 3. Rajavithi | (5,386) |
| (12,206) | 4. Nokornchaisri | (1,930) |
| (10,259) | 5. Setsiri | (1,905) |
| ( 5,000) | 6. Ranong I | ( 765) |
| (23,353) | 7. Pradipat | (3,767) |
| (26,402) | 8. Rama VI | (3,463) |
| (43,807) | 9. Phyathai | (5,239) |
| (33,610) | 10. Rajaprarop | (3,311) |
| ( 9,881) | 11. Makkasan | ( 316) |
| (44,362) | 12. Phetburi | (1,330) |
| (35,848) | 13. Sukhumvit | (1,115) |
| (45,377) | 14. Rama IV | (2,538) |

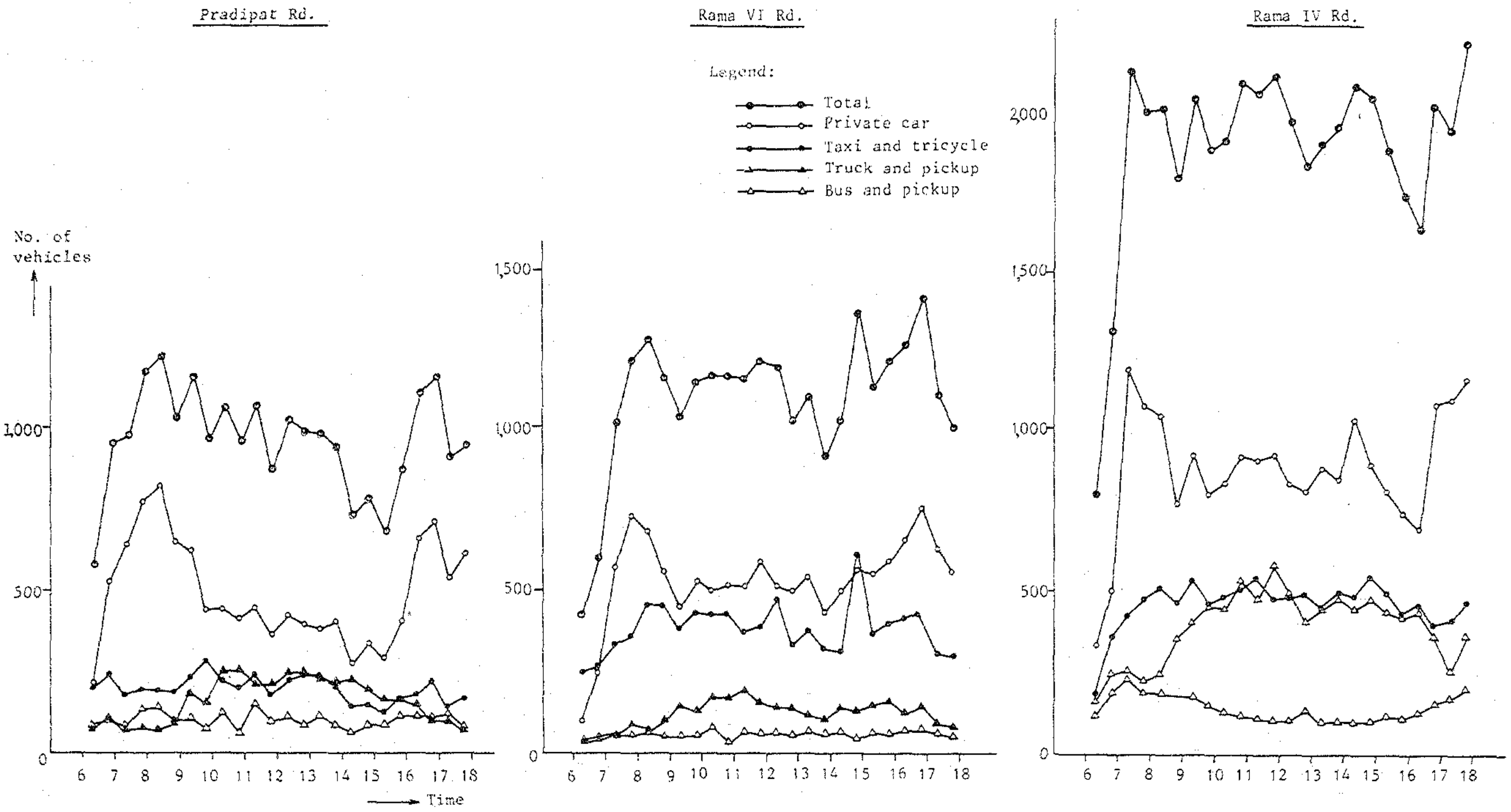


Fig. 3.2.5 Hourly Traffic Volume

### (3) Interview survey

Interview surveys for railway and bus passengers were made to obtain the information on railway improvement. Major interview questions include trip purpose, access traffic means available and desire for railway transportation.

The time zone for this interview survey was set from 06:00 to 18:00 with a concentrated effort for enquiry during the rush hours for those passengers utilizing trains and buses alike. Bus passengers were selected for this survey from the service lines interconnecting Bangkok with Nakhon Pathon, Ayutthaya and Chachoeng Sao.

The survey continued from October 3 to 18 (Appendix 3.2.3). During the full period, roads were covered with water and schools were closed for vacation. Because of this, it seems that the pattern of utilization for that survey period may differ somewhat from the dry period pattern.

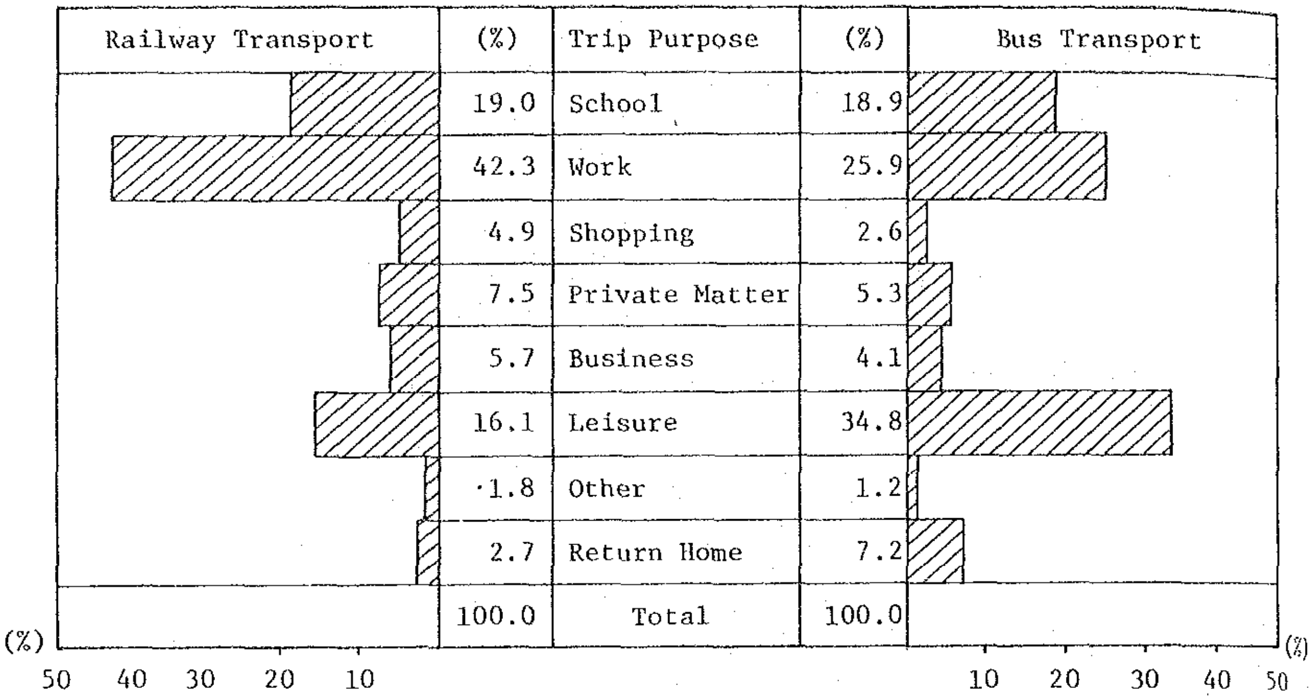
#### (i) Purpose of journey

Except for commuting and leisure travel, as shown in Table 3.2.4, the results of trip purpose surveys for bus passengers and train passengers turned out to be almost the same ratio.

This is due to the fact that passengers were selected for the survey from railway and bus routes available within the traffic radius of 20 to 30 km for railway and of 60 to 70 km for bus. The survey of the BMTA's service routes in urban and suburban Bangkok will indicate that a utilization rate by bus passengers for commuting purpose is as high as that of the railway traffic.

By trip purposes of railway passengers, the survey result reveals that the commuters going to work and school during the morning and the evening rush hours account for 61.3% of the total, thus signifying the pattern of urban traffic. (Appendix. 3.2.4)

Table 3.2.4 Purpose of Journey by Origin Station



| Railway Transport | (%) | Trip Purpose | (%) | Bus Transport |
|---|---|---|---|---|
| | 19.0 | School | 18.9 | |
| | 42.3 | Work | 25.9 | |
| | 4.9 | Shopping | 2.6 | |
| | 7.5 | Private Matter | 5.3 | |
| | 5.7 | Business | 4.1 | |
| | 16.1 | Leisure | 34.8 | |
| | ·1.8 | Other | 1.2 | |
| | 2.7 | Return Home | 7.2 | |
| | 100.0 | Total | 100.0 | |

(ii) Access transport means

The typical access means of traffic to railway stations or the bus stops is mainly by bus or on foot, as shown in Table 3.2.5, for both railway and bus passengers alike. Those access means are utilized at a high rate of 83% of the total.

Table 3.2.5 Access Mobility by Transport Means

(Unit: person)

| | Railway passenger | | Bus passenger | |
|---|---|---|---|---|
| 1. On foot | 1,990 | (31.9) | 845 | (23.1) |
| 2. Bicycle | 52 | (0.8) | 37 | (1.0) |
| 3. Motorcycle | 93 | (1.5) | 106 | (2.9) |
| 4. Tricycle | 222 | (3.6) | 101 | (2.8) |
| 5. Car | 149 | (2.4) | 84 | (2.3) |
| 6. Taxi | 201 | (3.2) | 175 | (4.8) |
| 7. Bus (pick-up) | 544 | (8.7) | 428 | (11.7) |
| 8. Bus | 2,693 | (43.1) | 1,785 | (48.9) |
| 9. Truck | 3 | (0.0) | 2 | (0.0) |
| 10. Train | 89 | (1.4) | 11 | (0.3) |
| 11. Boat | 210 | (3.4) | 79 | (2.2) |
| Sampling total | 6,246 | (100.0) | 3,653 | (100.0) |

Note: ( ) indicates % of total volume.

By distances within the accessible range, the number of passengers moving on foot reach, as shown in Fig. 3.2.6, a maximum within the range of 1 km; 78% accounted for by railway passengers and 64% by bus passengers. The number of passengers utilizing buses for access reaches a maximum within the range of 5 to 10 km; 62% accounted for by railway passengers and 64% by bus passengers. (Appendixes 3.2.5 and 6)

The accessible range by the required time length is shown in Fig. 3.2.7; the maximum number of walkers within a distance of 10 minutes reached 66% for railway passengers and 62% for bus passengers.

As for the access by bus, the maximum number of passengers is reached within a range of 10 to 30 minutes; 43% for railway passengers and 35% for bus passengers. (Appendixes 3.2.7 and 8)

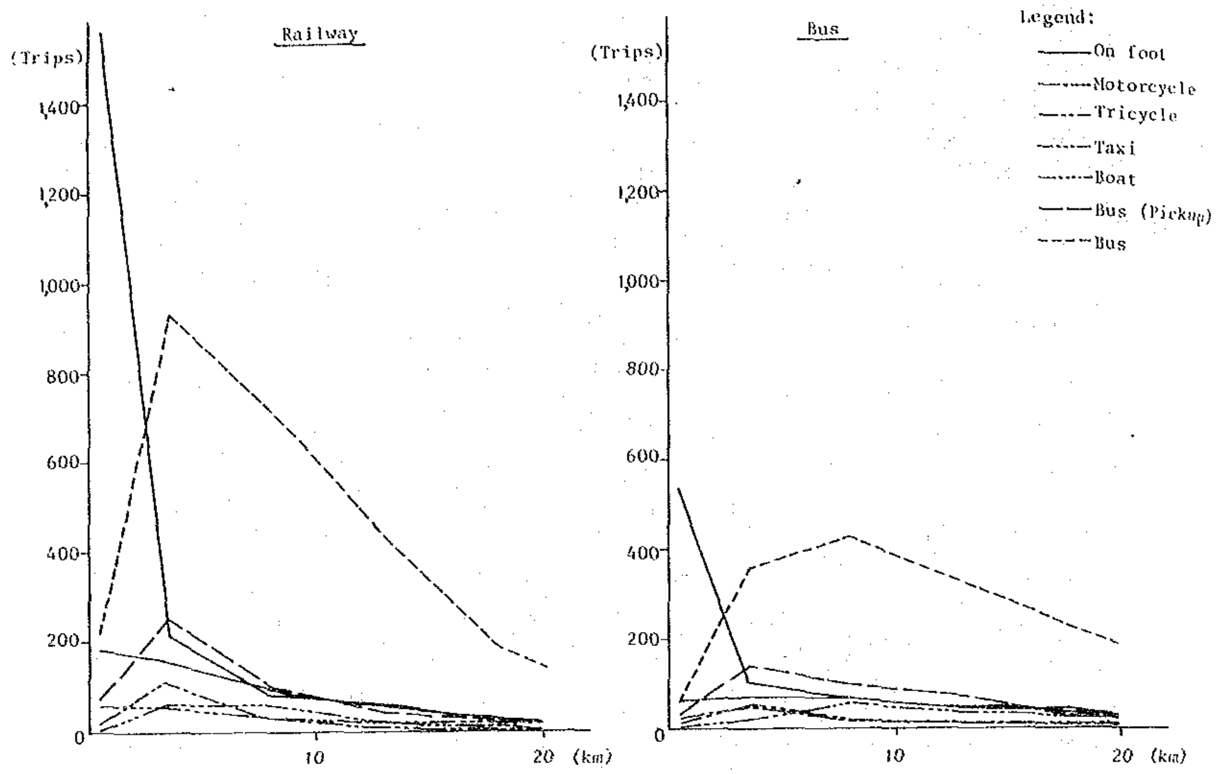


Fig. 3.2.6 Access Distance

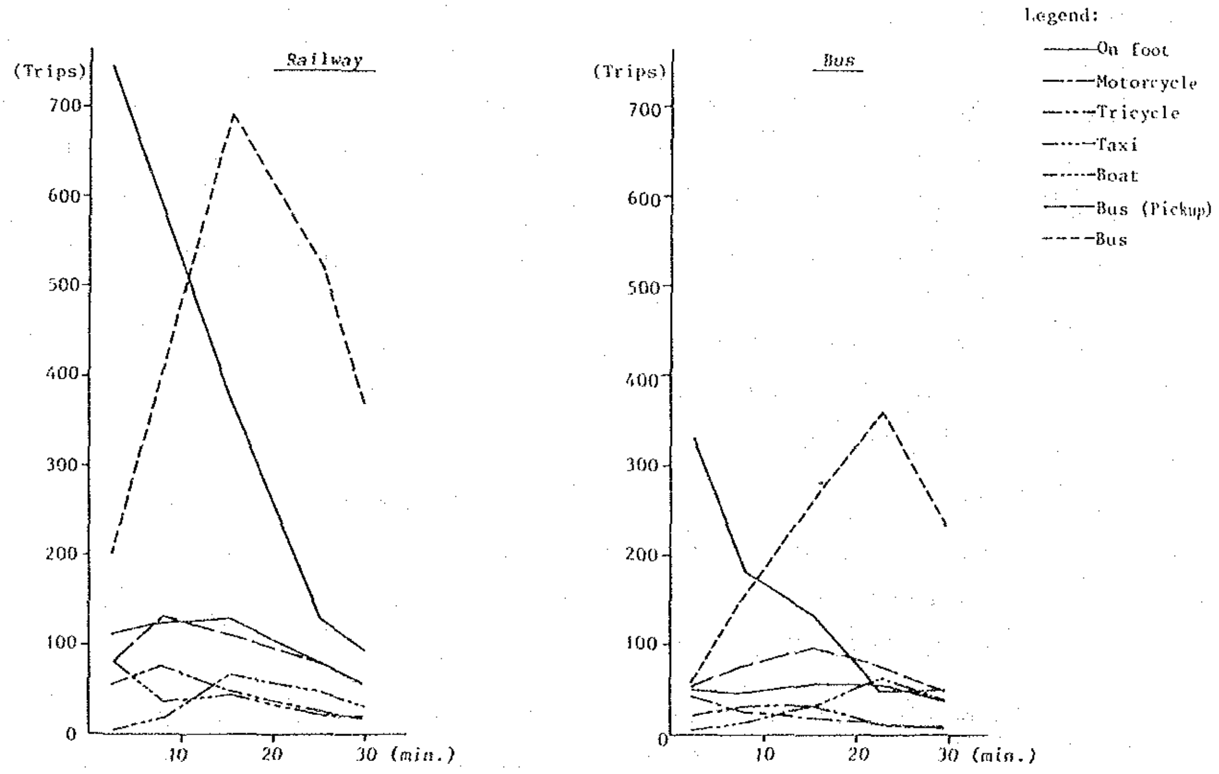


Fig. 3.2.7 Access Time

(iii) Comments to the railway transport system

Railway passengers were asked to what extent they desired improvement of the present railway transport system and bus passengers were asked why they are reluctant to utilize the railway service.

Table 3.2.6 summarizes the result of survey. It is particularly noteworthy that the main reasons for reluctancy to utilize the railway transportation by those bus passengers are time consuming travel by train (31.5%), uncomfortable riding quality (16.7%), and unavailability of train operation when they wish to travel (14.5%).

With regard to the desires for railway improvement by the passengers, the request for increased number of cars for each train formation ranks at the top (22.9%), followed by the request for an increase in the total number of trains in operation (21.0%). (Appendixes 3.2.9 and 10)

Table 3.2.6 Result of Interview for Railway Transportation

(Unit: person)

| Reason for not using railway transportation | | Requirement for improvement of railway transportation | |
|---|---|---|---|
| Item | No. of samples | Item | No. of samples |
| 1. Time consuming | 1,132 (31.5) | 1. Increase passenger cars | 1,373 (22.9) |
| 2. No train* | 773 (21.4) | 2. Increase number of trains | 1,264 (21.0) |
| 3. Not comfortable | 603 (16.7) | 3. Cleanliness | 1,109 (18.5) |
| 4. No train during trip | 521 (14.5) | 4. On time operation | 944 (16.2) |
| 5. Another alternative* | 464 (12.9) | 5. Increase speed | 741 (12.3) |
| 6. Crowded | 58 (1.6) | 6. Safety | 190 (3.2) |
| 7. Expensive | 23 (0.6) | 7. Improve ticket price | 150 (2.5) |
| 8. Dangerous | 19 (0.5) | 8. No need of improvement | 120 (1.5) |
| 9. Other | 12 (0.3) | 9. Other | 88 (2.0) |
| Sampling total | 3,605 (100.0) | Sampling total | 6,009 (100.0) |

Notes: * mark is outside of railway influence area.
( ) indicates percentage of total volume.