2-4 Related Development Plans

The outline of socio-economic-related development plans, which are deemed to relate particularly to future railway traffic demand forecast, is described below.

2-4-1 The Fifth National Economic and Social Development Plan (1982/Oct. - 1986/Sept.)

(1) Main economic indicators

	Target	Estimate by NESDB
1) Economic growth (annual rate, %)		
a. Real GDP	6.6	5.3
b. Agriculture production	4.5	2.9
c. Industrial production	7.6	6.1
d. Mining production	16.4	4.8
2) International trade (annual rate, %)		
a. Increase in export amount	22.3	7.6
b. Increase in import amount	18.1	7.1
3) Balance of payments		
a. Deficits in trade balance		
- Annual deficit (Bil. Baht)	78.4	70.0
- Annual deficit/GDP (%)	5.9	6.6
b. Deficits in current account		
- Annual deficit (Bil. Baht)	53.0	48.7
- Annual deficit/GDP (%)	4.1	4.5
4) Government finance (%)		
a. Gov't expenditure/GDP	18.2	16.9
b. Gov't revenue/GDP	16.0	14.1
c. Gov't deficit (annual, Bil. Baht)	22.0	31.0
5) Energy sector		
a. Increase in energy consumption (annual, %)	4.8	Not available (N.A.)
b. Decrease in imported oil (annual, %)	3.0	N.A.
c. Imported oil/total energy	46.0	N.A.

consumption (%)

d.	Production of Natural Petroleum Gas (MMCF/D) * Year 1986	525.0*	360.0 (as of July 1985)

6) Other major targets

a.	Control of population growth (1986)	1.5	N.A.
b.	Unemployment rate	2.0	N.A.

(Note) Estimate of items (1) - 1) - a, b, c was released in October 1985, the others in July 1984.

(2) Target of transportation and communication service sector

1) To control investment for roads, which were given relatively high priority for the past 20 years despite inferiority in energy efficiency.
2) To promote increases in railway transportation efficiency, and also to encourage inland waterway and coastal shipping.
3) To expand the domestic air network and telecommunications service system.

2-4-2 The Sixth National Economic and Social Development Plan (1986/Oct. - 1991/Sept.)

(1) Background

The Sixth Plan has commenced from October 1986.
The guideline for the Sixth Plan (The Direction of the Sixth Plan) was made public in October 1985, after Cabinet approval.

(2) Direction of development under the Sixth Plan

The Sixth Plan has a direction for development that includes 2 overall targets; 4 main strategies, and 10 working programs.

1) 2 Targets

a. To set the economic growth target to be at an average of more than 5 percent per annum.
b. To develop the human resources to enable progress in social development and to create peace and fairness in society.

2) 4 Strategies

a. To continue to proceed with the development and adjustment of the economic and social framework of important policies carried over from the Fifth Plan.
b. To increase efficiency and improve quality in production costs to be able to better compete with other countries.
c. To promote the development of human resources to possess the knowledge and capabilities that are beneficial in the development of life, career, and society, through mainly emphasizing the principle of self-reliance. Social development must be consistent with career development and economic development especially in creating discipline and respect for law and order; and in developing of virtue, ethics, and unity among the population. This, in a way, will reduce the responsibilities of the government and encourage frugality and savings.
d. To adjust the role and the management organizations of the government sector through regulations, orders, and laws; to be suitable to development directions. Consideration must be given to the limitations in the capabilities and the fiscal status of the government. There will be an appropriate sharing of the development burden between the government sector, state enterprises, and the private sector under the principle of integration.

3) 10 Working Programs

a. Economic and Financial Stabilization Program
b. Natural Resources Development and Environmental Management Program
c. Rural Development Program

d. Urban and Specific Zones Development Program
e. Program to Develop Society, Human Quality, Human Resources, and Labor
f. Program to Develop Production, Marketing, Technological, and Employment Generation Systems
g. Basic Services Development Program
h. Science and Technology Development Program
i. State Enterprises Development Program
j. Program to Improve Management and Review the Government's Role in the Development Process

2-4-3 Overview of the Eastern Seaboard Development Program

(1) Objectives of the program

1) To make full utilization of domestic resources, especially using natural gas from offshore fields.
2) Relief of the excessive concentration of population in Bangkok Metropolitan Area.
3) To aim at growing to a Newly Industrialized Country through bringing up capital intensive chemical industries as well as export-oriented, labor-intensive light industries.

Fig. 2.4.1 shows the program area and location of projects.

(2) Outline

1) Map Ta Phut area development

a. Industrial project

Natural gas separation plant, chemical fertilizer plant and petro-chemical complex are major projects, of which details are shown in Table 2.4.1.

b. Infrastructure development

- Map Ta Phut industrial deep-sea port

  The port, scheduled for completion in 1987 and currently at the design stage, will be available for handling 60,000 DWT ore carriers and 120,000 DWT dry bulk carriers bringing industrial raw materials and carrying away the finished products from heavy industries.

- Industrial Complex and Urban Areas

- Railway

The 140 km long railway line from Chachoengsao down the western fringe of the eastern seaboard to Sattahip is under construction and will be opened to traffic in 1986. A spur of some 20 kms to connect this line with the industrial area is in the design stage.

2) Laem Chabang area development

a. Planned industries

The planned industries in Laem Chabang will be mainly small scale, labor-intensive, export-oriented and non-polluting industries such as agro-industries, electronics, auto parts and manufacture of toys and sporting goods.

b. Infrastructure development

- Laem Chabang Commercial Deep-Sea Port

  The commercial port, currently in the design stage, will be a primary gateway of containerized and break-bulk cargo to and from Thailand and will handle 4 million tons of containerized cargo, 2 million tons of agricultural bulk cargo and 0.3 million tons of break-bulk cargo per year by 1995.

  It will handle up to 2,000 TEU container vessels and 120,000 DWT dry bulk carriers. Operation is scheduled to commence during the year 1987 - 1990.

- General Industrial Estate/Export Processing Zone
- Water supply
- Railway

  Railway spurs from the new Chachoengsao - Sattahip line will be constructed into the port and industrial estate area.

(3) Implementation program and financial sources

Refer to Tables 2.4.2 and 2.4.3.

It should be noted, however, that these two tables are subject to be revised as necessary.

(4) Current status of ESB program

In mid-November 1985, the Cabinet decided to set up a three-man committee to review the ESB due to government's fiscal problems and the country's current account situation.

The committee had 45 days to review the entire program, during which time it was reported that the ESB was likely to be scaled down in size. After reviewing it, however, the Cabinet announced on the 24th of December 1985 that the entire program would proceed as planned.

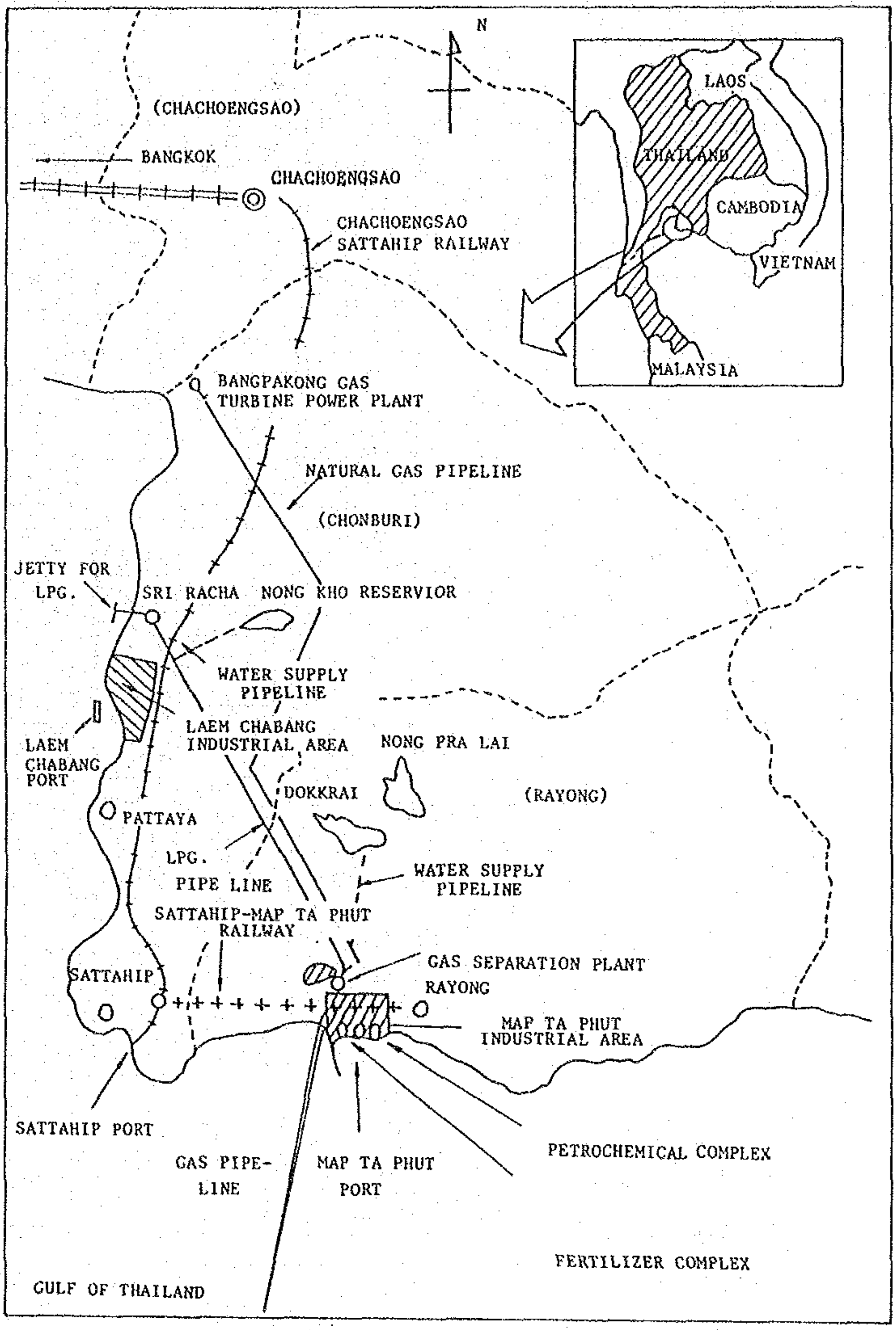


Fig. 2.4.1 Program Area and Location of Project

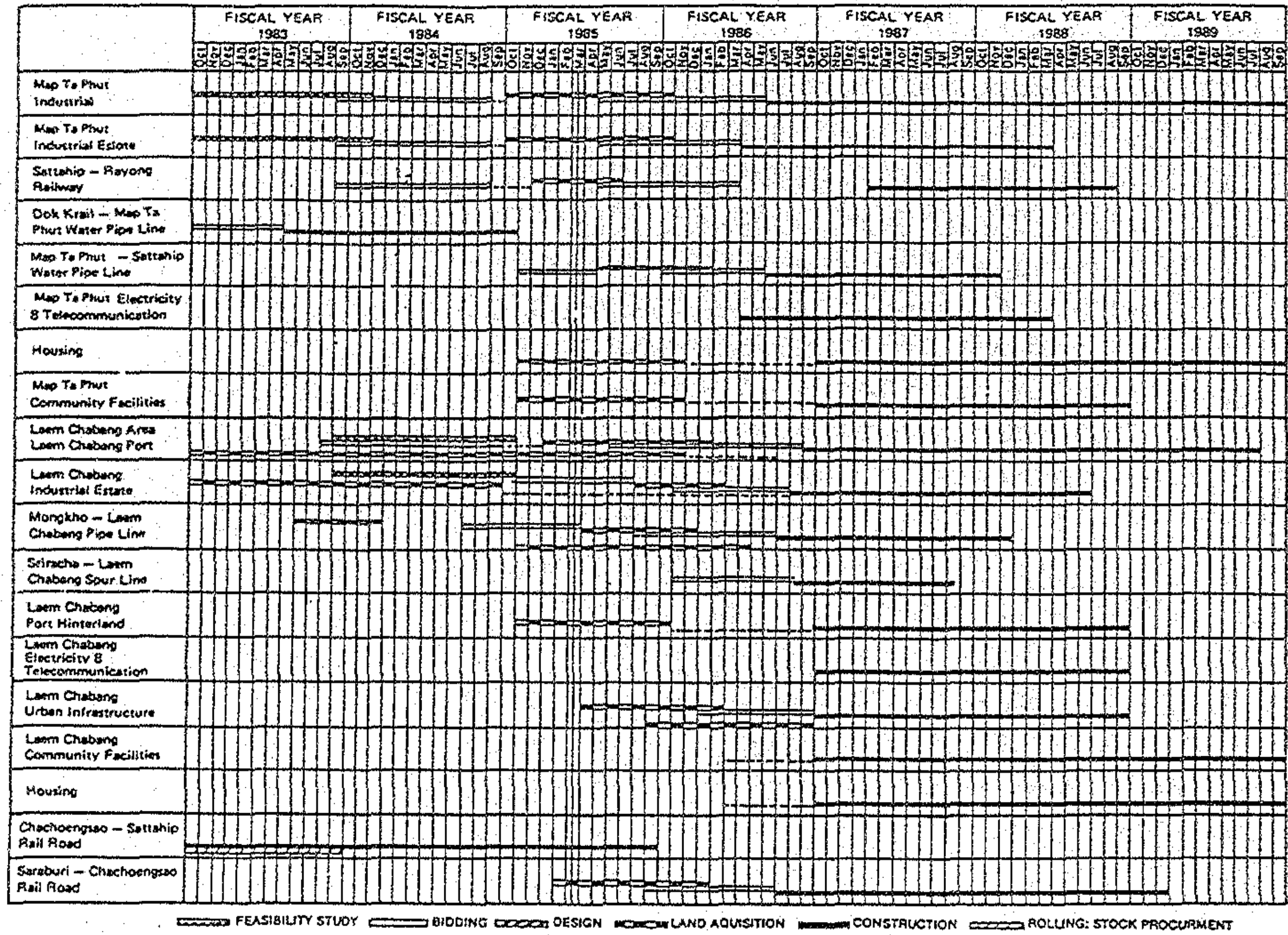
Table 2.4.1 Large Scale Industrial Projects -- Map Ta Phut Area

Project	Ownership	Current Status	Plant Capacity	Cost* (US $ million)	Production Date
Gas Separation Plant	Petroleum Authority of Thailand (PTT) - 100%	Plant completed and operating since Jan., 1985	350 MMSCFD	$ 178	Jan, 1985
Petrochemicals					
1. Upstream Olefins Plant + Central Utilities	PTT - 49% Bureau of Crown- 2% Properties Downstream - 49% Industries	National Petrochemical Corporation formed with ฿ 70 million registered Capital. Now tendering for construction of upstream and downstream plants	300,000 TPA Ethylene 73,000 TPA Propylene	$ 475	
2. Downstream					Nov, 1988
a) HDPE	Siam Cement Co., Ltd.		110,000 TPA	$ 106	
b) LDPE	Thai Petrochemical Industry Co., Ltd.	Expansion from 65,000 to 100,000 TPA	100,000 TPA	$ 42	
c) Polypropylene	Srikrung Wattana Co., Ltd.		70,000 TPA	$ 55	
d) VCM	Thai Plastic and Chemical Co., Ltd.		80,000 TPA	$ 130	
Fertilizer Complex	PTT/MOF/BAAC/MOF - 33% (State enterprise/ gov't) Commercial Banks/- 28% Domestic Financial Inst. Int'l Development- 18% Banks Operator - 15% Fertilizer Distributors - 3% Others - 3%	National Fertilizer Corporation formed in Oct., 1982. Registered capital of ฿ 200 million to be increased in stages to ฿ 2,500 million. Tendering for plant construction completed. Contract to be signed in Oct, 1985. Foster wheeler has been contracted as PMC	670,000 TPA NPK 142,000 TPA Urea 122,800 TPA MAP 125,600 TPA DAP 11,300 TPA Phosphoric Acid 28,830 TPA Ammonia	$ 430	Dec, 1987

Note : *Current prices for construction, working capital, start-up and construction financing.

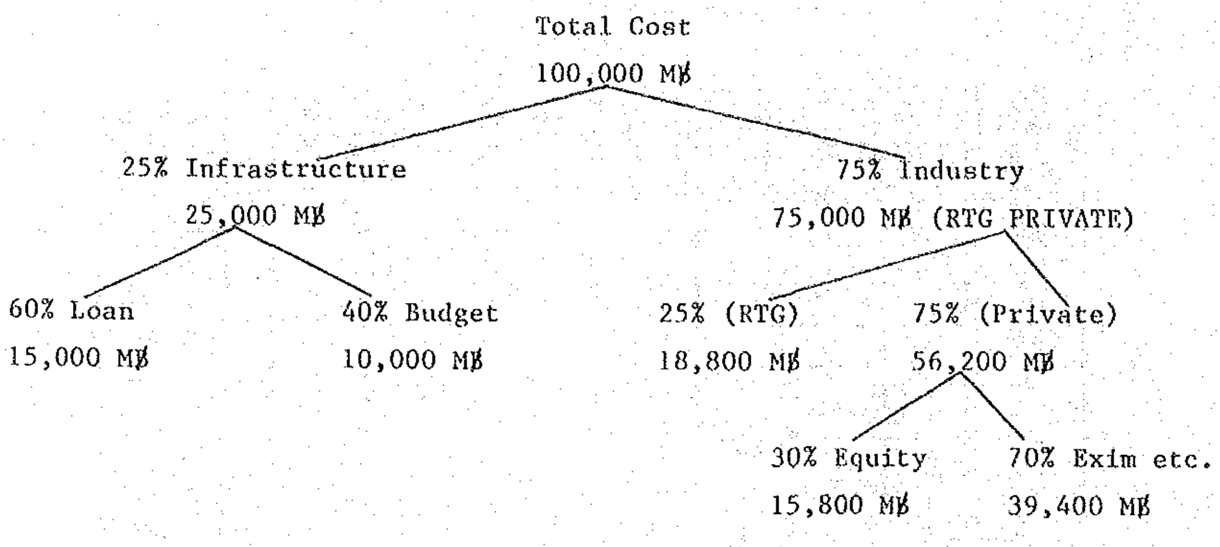
Source: NESDB

Table 2.4.2 Implementation Program of ESB



Source: NESDB

Table 2.4.3 Financial Sources for the Program



Remarks: (1) RTG means the Royal Thai Government

(2) The anticipated proportion of the financial burden by sector is as follows:

Private sector 56%

Government sector 44%

CHAPTER 3 DEMAND FORECAST

CHAPTER 3 Demand Forecast

3-1 Basic Concept

The aim of a demand forecast is to determine the railway traffic demand for a project evaluation.

Methodologically, this study will be carried out by the "four-step-estimate" method based on the best possible understanding of the current situation and future outlook for the socioeconomy and transportation, while reviewing the major railway improvement plan already being studied by the Thai Government and SRT.

Passenger

Case I There is no particular improvement in the railways concerning traffic congestion in the Bangkok Metropolitan Area.

Case II Railways carry out positive demand stimulation measures in the traffic congested Bangkok Metropolitan Area.[1)]

1) This assumes the same positive measures of Case II (High Level Service Type) that were proposed in the "Report for the Feasibility Study on the Track Elevation Project in the Bangkok Metropolitan Area, 1984 JICA."

Freight

Case I Railways promote modernization and rationalization of freight transportation facilities, services and rolling stock.
Accordingly, the competitiveness of railways and the railway traffic share do not decrease further than what they are at present.

Case II Envisaging the recent severe competitive conditions for railways continuing (due to such factors as the priority put on investments for roads and progress of motorization thereby), the competitiveness of road transportation is assumed to be stronger than that of Case I (See 3-3-5).

3-2 Preconditions

3-2-1 Socio-economic Framework

(1) Population

The estimated population is as shown in Table 3.2.1, and uses past trends, population growth targets in the Fifth Five-Year Plan, NESDB population forecast values, etc.

(2) GDP

The estimated GDP is as shown in Table 3.2.2 and takes into consideration past trends, the actual results of the Fifth Five-Year Plan (1982-1986), and NESDB data on the Sixth Five-Year Plan.

(3) Population and GRP by Zone

The future population and GRP by zone are estimated by region (see Table 3.2.3) and based on data from concerned government agencies, with future values obtained by applying the growth rates of the respective regions. Population and GRP by zone are shown in Appendix 3.2.1.

3-2-2 Zoning

Thailand is divided into 19 zones by combining its provinces into larger units. The Bangkok Metropolitan Area zone (Bangkok, Nontaburi, and Samut Prakan) is divided into six further zones. (See Table 3.2.4 and Figure 3.2.1)

3-2-3 Transportation Network

(1) The status of the networks of the other transportation modes (excluding railways) are assumed, in principle, to remain unchanged, except for the establishment of a new network with the construction of a new deep-sea port and container pier on the Eastern Seaboard.

(2) The following construction or modernization plans are considered completed for the railway transportation network and facilities.

1) Plans to be realized by 1996:

The Chachoengsao - Sattahib New railway line

The Kaeng Koi - Khlong Sip Kao new railway line

2) Plans to be realized by 2006:

Track elevation plan in Bangkok

Northern line electrification and realignment

Signalling and telecommunication modernization plan

3-2-4 Extent of Traffic Demand in the Study

Traffic demand forecasting covers the respective passenger and freight traffic volumes of highways, railways, shipping, and aviation, with freight classified into the following five commodities. (See Appendix 3.2.2)

(1) Rice
(2) Other agricultural products
(3) Cement
(4) Petroleum
(5) Others

3-2-5 Transportation Conditions by Mode

The forecasting of each mode's share is made by applying of the "Least Sacrificed Volume Model" described later on. The transportation conditions used are door-to-door travel time and the cost (fares and charges) of each zonal OD, which were estimated from data collected in Thailand. Cost is assumed to remain unchanged in the future.

Table 3.2.1 Actual Value and Forecasting of the Population

Unit: Thousand persons

	Actual value			Forecast	
	1976	1980	1984	1996	2006
Population	43,213.7	46,961.3	50,583.1	60,478.1	68,140.2
	(2.1%)	(1.9%)	(1.5%)	(1.2%)	

Note: Figures in parentheses are the average yearly growth rates.
Source: NESDB

Table 3.2.2 Actual Value and Forecasting of the GDP

1972 price, Mil. Baht

	Actual value			Forecast	
	1978	1980	1983	1996	2006
GDP	261,098.7	292,853.3	342,878.7	657,717.5	1,021,415.2
	(5.9%)	(5.4%)	(5.1%)	(4.5%)	

Note: Figures in parentheses are the average yearly growth rates.
Source: NESDB

Table 3.2.3 Population and GRP by Region

Population: Thousand persons
GRP : Mil. Baht

	Population			G.R.P.		
	1984	1996	2006	1983	1996	2006
BANGKOK	6,293.2	8,527.4	9,791.8	133,469.2	250,787.7	355,656.8
	(2.6)	(1.4)		(5.4)	(3.6)	
NORTHERN	10,281.2	11,666.2	12,749.0	45,812.0	82,148.9	127,064.1
	(1.1)	(0.9)		(5.0)	(4.5)	
NORTH EASTERN	17,638.0	20,865.0	23,487.9	48,838.3	97,408.0	163,222.1
	(1.4)	(1.2)		(5.9)	(5.3)	
CENTRAL	10,070.8	11,980.7	13,696.2	81,172.6	165,284.4	275,782.1
	(1.5)	(1.3)		(6.1)	(5.3)	
Intra, EASTERN ZONES (15, 16 zones)	3,185.1	4,497.3	5,784.9	26,381.0	62,590.4	119,152.8
	(2.9)	(2.5)		(7.5)	(6.6)	
SOUTHERN	6,299.9	7,438.8	8,415.3	33,586.6	62,088.5	99,690.1
	(1.4)	(1.2)		(5.3)	(4.8)	
ALL REGION	50,583.0	60,478.1	68,140.2	342,878.7	657,717.5	1,021,415.1
	(1.5)	(1.2)		(5.1)	(4.5)	

Note: Figures in parentheses are the average yearly growth rates.
Source: NESDB

Table 3.2.4 Zoning

Zone Number	Provinces
1-6	Bangkok, Nontaburi, Samut Prakan
7	Mae Hongson, Chiang Mai, Lamphun
8	Chiangrai, Payao, Lampang
9	Phrae, Nan, Uttaradit
10	Tak, Kampaengphet, Nakhon Sawan, Uthai Thani
11	Sukhothai, Phitsanulok, Phichit, Phetchabun
12	Loei, Nongkhai, Udon Thani, Khon Kaen
13	Sakon Nakhon, Kalasin, Nakhon Phanom, Mahasarakham, Roi Et
14	Chaiyapum, Nakhon Ratchasima
15	Buriram, Surin, Yasothon, Sisaket, Ubon Ratchathani
16	Kanchanaburi, Ratchaburi, Suphanburi
17	Chainat, Singburi, Angthong, Lopburi
18	Ayuthaya, Pathum Thani, Saraburi
19	Nakhon Pathom, Samut Sakhon, Samut Songkhram
20	Nakhon Nayok, Prachinburi, Chachoengsao, Chanthaburi, Trat
21	Chonburi, Rayong
22	Phetchaburi, Prachuap Khirikhan
23	Ranong, Phangnga, Surat Thani, Phuket, Krabi, Nakhon Srithammarat, Trang, Chumphon
24	Phattalung, Satun, Songkhla, Pattani, Yala, Narathiwat

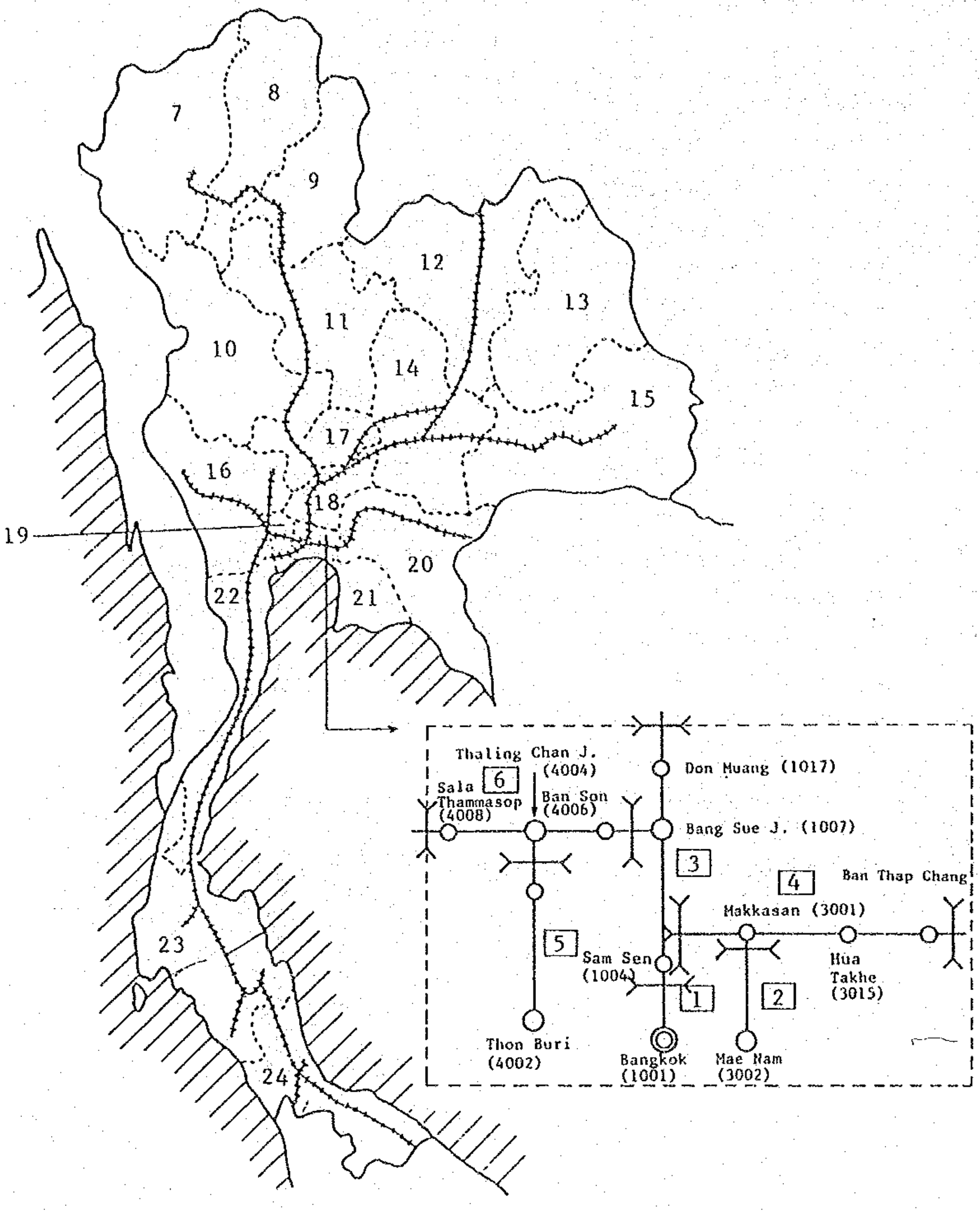


Fig. 3.2.1 Zone Map

3-2-6 Others

The future capacity of roads, ports, airports, bus terminals, ships and other facilities are assumed to impose no restrictions on satisfying demand.

3-3 Traffic Demand Forecast

3-3-1 Process of Demand Forecast

A demand forecast is implemented according to the four-step estimate method under the above-mentioned conditions in the following step-by-step process:

(1) Forecast of generated and attracted volumes (freight only)
(2) Forecast of the traffic distribution (total volume of flow between zones)
(3) Forecast of modal shares and of railway traffic demand
(4) Forecast of other traffic demand volumes required for the project evaluation

An outline of demand forecast work based on the four-step estimate method is shown in Figure 3.3.1.

3-3-2 Forecast of Generated/Attracted Volumes by Commodity and Zone

Generated and attracted freight volumes are defined as follows:

- o (Zonal Volume Generated) = (Volume of Zone's Production) + (Volume of Imports Arriving Directly in Zone from Areas Not Covered by the Study)
- o (Zonal Volume Attracted) = (Volume of Zone's Consumption) + (Volume of Exports Going Out Directly from the Zone into Areas Not Covered by the Study)
- o (Total National Volume Generated) = (Total National Volume Attracted)

The total volumes generated (attracted) by year and commodity were estimated on the basis of data and materials presented by the Thai Government and agencies concerned during the field survey (See Table 3.3.1). The zonal volumes generated and attracted by year and commodity are shown in Appendices 3.3.1-(1), 3.3.1-(2), and 3.3.1-(3).

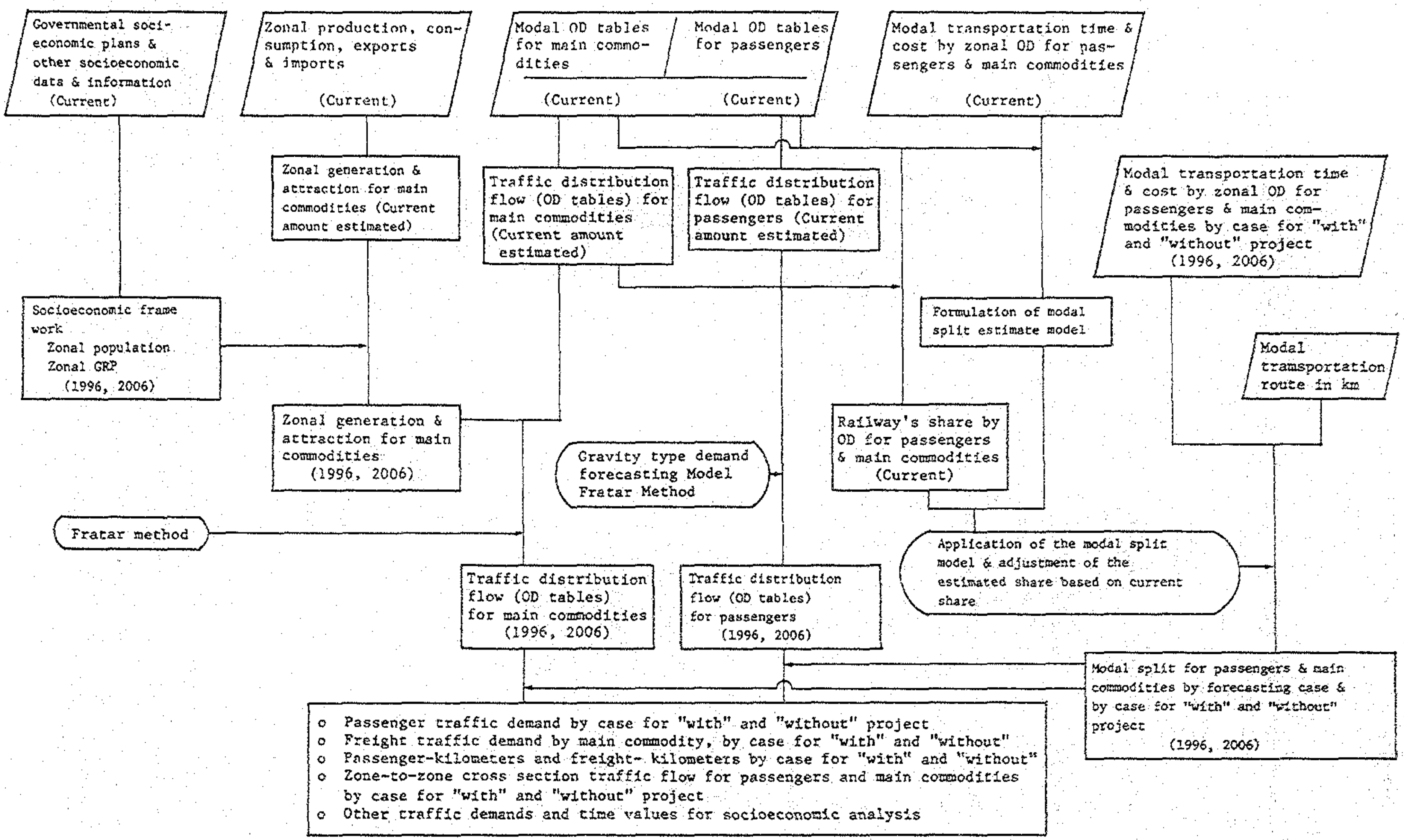


Fig. 3.3.1 Concept of Demand Forecast

Table 3.3.1 Total Zonal Freight Generation (Attraction)

Unit: Thousand tons

Items \ Year	1983	1996	2006
Rice	18,580	25,613	31,222
Other agricultural products	12,997	19,087	24,432
Cement	7,320	13,803	18,550
Petroleum	9,691	14,232	18,218
Miscellaneous	18,353	23,741	27,553
Total	66,941	96,475	119,974

3-3-3 Forecast of Traffic Distribution Volumes for Passengers and Freight (by Commodity)

Traffic distribution means the zonal OD table for all modes for passengers and freight (by commodity).

The concept for this method of estimate is the same for passengers and freight. Namely, the future traffic demand is first estimated by applying the "demand forecast model," which is constructed on the basis of the current OD table, then the future traffic distribution is obtained through the revision of the results of this estimate using the Fratar Method.

The following is a detailed explanation of passenger and freight traffic volumes.

(1) Passengers

Since there is no complete current OD table on passenger traffic except for railway data, the current traffic distribution is estimated first, then the future traffic distribution is estimated using this as its base.

1) Estimate of the current traffic distribution

After the zonal OD table is estimated for each mode as stated below, the current traffic distribution is obtained by adding the results of these estimates.

a. The zonal OD table for railway passengers presented by SRT is used as it is.

b. The zonal OD table for bus service is obtained by applying a gravity type formula (formula (1) and formula (2)) obtained through regression analysis based on statistical information received in Thailand on bus passengers departing Bangkok and arriving in other provinces.

$$\log Tij = 0.317605 + 0.226224 \log(GRPi \cdot GRPj) - 1.03191 \cdot \log Dij + \log(Pi + Pj)$$

$$(R = 0.75) \quad \ldots\ldots\ldots\ldots \quad (1)$$

Where,

Tij : Number of passengers transported by bus per day between Zone i and Zone j (thousands)

GRPi, GRPj: Total output of Zone i and Zone j (million Bahts)

Pi, Pj : Population of Zone i and Zone j (thousands)

Dij : Road distance between Zone i and Zone j (km)

$$Tii = \alpha \cdot (Pi)^{\beta} \cdot (Dii)^{\gamma} \quad \ldots\ldots\ldots\ldots \quad (2)$$

Where,

Tii : Number of Intrazonal passengers transported by bus in Zone i

Dii : Average Intrazonal road distance in Zone i

α, β, γ : Parameters (α=1.0, β=2.0, γ=2.0)

c. The air passenger zonal OD table is obtained by applying model formulas (3) and (4) from the Ministry of Communications' zonal OD table for zones where an airport exists.

$$TAiK,jL = TAij \cdot Wik \cdot WjL \quad \ldots\ldots\ldots\ldots \quad (3)$$

$$\left.\begin{aligned} Wik &= \alpha \cdot \frac{Pik/(Dik)^{\beta}}{\sum_{ik=1}^{m} Pik/(Dik)^{\beta}} \\ Wjk &= \alpha \cdot \frac{PjL/(DjL)^{\beta}}{\sum_{jL=1}^{n} PjL/(DjL)^{\beta}} \end{aligned}\right] \quad \ldots\ldots\ldots\ldots \quad (4)$$

Where

TAik, jL	:	Number of airline passengers from Zone K's departure airport sphere i to Zone L's arrival airport sphere j
TAij	:	Number of passengers from departure airport sphere i to arrival airport sphere j
Wik, WjL	:	Proportions of airline passengers in Zones iK and jL to total airline passengers in departure and arrival airport spheres i and j
Dik, DjL	:	Access and egress distances of Zones ik and jL to and from airport (km)
Pik, PjL	:	Populations of Zones iK and JL (thousand persons)
α, β	:	Parameter

2) Estimate of the future traffic distribution

The future traffic distribution is estimated by applying a gravity type formula constructed from the traffic distribution obtained in 1) mentioned above and its revision using the Fratar Method.

The gravity models obtained through regression analysis concerning the current traffic distribution is shown in formulas (5) and (6). The future traffic distribution is estimated when future population by zone, GRP, and other descriptive variables are assigned to these models. The flow pattern of the estimated traffic distribution does not necessarily conform well with that of the current traffic distribution. Consequently, the final future traffic distribution is obtained through the additional revision of the above-mentioned estimate by the Frafar Method. The current traffic distribution is used as a flow pattern when applying the Fratar Method.

$$\log Tij = -1.99437 + 0.308917 \cdot \log(GRPi \cdot GRPj) - 1.06214 \cdot \log Dij + \log(Pi + Pj) \quad (R = 0.985) \quad \ldots\ldots\ldots\ldots\ldots (5)$$

$$\log Tii = 0.067586 + 0.315206 \log GRPi^2 - 1.25671 \cdot \log DII + \log 2Pi \quad (R = 0.933) \quad \ldots\ldots\ldots\ldots\ldots (6)$$

(2) Freight

1) Current traffic distribution volume

The current traffic distribution is obtained through additional revision of using the Fratar Method, which uses the earlier obtained general/attracted volumes by zone as a control total, the results by applying the following gravity type model formulas (7) and (8), which were estimated on the basis of SRT's railway OD traffic volume by commodity and MOC's OD table for each transportation mode by commodity.

$$T^K_{ij} = \alpha \cdot (T^K_i \cdot T^K_j)/D_{ij}{}^{\beta} \quad \text{.................... (7)}$$

Where,

T^K_i : Generated traffic volume by commodity K in Zone i

T^K_j : Attracted traffic volume by commodity K in Zone j

Dij : Road distance between Zone i and Zone i

α, β : Parameters (α= 1.0, β= 2.0)

K : Commodity K includes the following 4 commodity items

1 Rice

2 Other agricultural products

3 Cement

4 Petroleum

$$\log T^K_{ij} = -5.93512 + 1.048412 \cdot \log(T^K_i \cdot T^K_j) - 0.8186111 \cdot \log Dij$$

$$(R = 0.7905) \quad \text{...................... (8)}$$

Where,
K : "other" commodities

2) Future traffic distribution

The future traffic distribution is obtained by the Fratar Method using the current traffic distribution as the future flow pattern and, at the same time, the future generated/attracted volumes by zone as the control total.

3-3-4 Modal Split Estimate Model and Forecasting the Railway Share

The future share of railways is obtained by the application of the modal split estimate model and the revision of the actual measurement value base. The model used here is "the least sacrificed volume model" described below, and it is applied by giving the transportation conditions (door-to-door transportation time and cost) of competing modes for each OD pair.

(1) Least sacrificed volume model

The least sacrificed volume model is illustrated by formulas (9) - (11). The basic concept of this model is the choice of the least costly and most rational mode by carefully comparing the transportation time and cost offered by each mode at the time of the passenger's trip or the shipper's shipping of freight (see Appendix 3.3.2). Parameters μ and σ in formula (9) are obtained by regression analysis from the current transportation conditions of the OD and mode and from the actual measurement values for each mode's share. The results are as follows:

(i) Passengers (R = 0.8244) $\log(\mu) = 3.3395$

$\log(\alpha) = 1.2967$

(ii) Freight (R = 0.7080) $\log(\mu) = 2.1663$

$\log(\alpha) = 1.9899$

(iii) The values for μ in (i) and (ii) above are assumed to fluctuate in proportion to the annual growth of the GDP.

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \cdot \mathrm{EXP} \cdot \left(-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)\right)^2 \quad \ldots\ldots\ldots\ldots \quad (9)$$

Where,

F(x): Probability density function

x : Alternative ratios of transportation time and cost among mode options

μ, σ: Parameter

$$SH_B = \int_{X_{A \cdot B}}^{X_{B \cdot C}} f(x) \cdot dx \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (10)$$

$$\left.\begin{aligned} X_{A \cdot B} &= \text{Log}\left(\frac{C_A - C_B}{T_A - T_B}\right) \\ X_{B \cdot C} &= \text{Log}\left(\frac{C_B - C_C}{T_C - T_B}\right) \end{aligned}\right\} \qquad (11)$$

Where, in the formulae (10), (11)

SH_B : Share of mode B

X_{AB} : Alternative ratios of transportation time and cost by mode A and mode B

X_{BC} : Alternative ratios of transportation time and cost by mode B and mode C

T_A, T_B, T_C: Transportation time when mode A, B, and C are used respectively

C_A, C_B, C_C: Transportation cost when mode A, B, and C are used respectively

(2) Revision of the railway share on the basis of the actual measurement value

The share measured by the above-mentioned model is an average value, and if we look at this for each OD, there is a considerable gap between the estimated value and the actual measurement value. That is why the final railway share in this study is forecasted by revising the estimated value based on the actual measurement value according to the method shown in Appendix 3.3.3. As for zones in which a new railway network is being formed, such as the Eastern Seabord zone, the estimated value, which is the output of the model, is taken as the final railway share.

(3) Transportation time and cost by mode

Transportation conditions by OD and mode for the application of the "least sacrificed volume model" are the so-called door-to-door transportation time and cost, which included the access/egress time for each OD for passenger and freight transportation. These transportation times and costs are calculated by computer using various generation rates such as the average running speed by transportation modes, time required for interconnections between transportation modes, and freight handling times and handling charges by commodity. At the same time, the linear and nonlinear transportation time and cost formulas, whose descriptive variable is transportation distance, are used.

The generation rates and formulae for calculating the above-mentioned transportation times and costs are obtained through regression analysis and other analyses of current data collected during the field survey.

Transportation conditions for railway freight by commodity are established for the appropriate form of transportation for each commodity. These transportation forms are specialized freight cars, container transportation, and carload transportation.

The railway transportation conditions in the case of this project's implementation ("with project") are considered, putting together the study results for each specialized area, to include a shorter door-to-door railway transportation time and keeping transportation costs as they are.

3-3-5 Demand Forecast for Case II

Case II passenger traffic demand is forecasted by applying the demand raising effect upon the implementation of the "High Level Service Type", which is envisaged in the afore-mentioned "Railway Track Elevation Project Study Report."

On the other hand, Case II freight traffic demand is forecasted on the assumption that the competitiveness of road transportation will be further strengthened and its time shortened uniformly by a total of 27% by 1996. However, road transportation time is assumed to remain unchanged after 1996.

3-3-6 Demand Forecast & other Estimates for the F/S

The following items have been studied for the Feasibility Study.

(1) Rough estimate of passenger and freight (by commodity) traffic volume in 1991

(2) Estimate of traffic volume diverted from other modes to the railway upon the implementation of the concerned project

(3) Rough estimate of railway traffic demand upon the improvement of the F/S yards.

(4) Estimate of the amount of time saved per passenger-km and freight ton-km as well as the evaluation of the time value per passenger- and freight-hour.

The rough estimate of the 1991 traffic volume mentioned in (1) above is applied fundamentally by interpolation.

Of the above-mentioned (2) and (4), the traffic demand diverted to the railway from the other modes, the time saved and its value upon improvement of the railway services by implementation of the project, are calculated by application of the "least sacrificed volume model" as shown in Appendix 3.3.4. In (3) above, the traffic demand, upon the improvement of the yards covered by the F/S, is estimated from the aspect of yard function, that is, the weight of the yards in the F/S to that of the ten yards originally studied, then this weight and the traffic demand estimated for the case of ten yards being improved are used. The weight of the F/S yards to the ten yards is obtained by formula (12).

$$WFS = \frac{\sum_{L=1}^{m} TRF(L) \cdot PRS(L)}{\sum_{k=1}^{n} TRF(k) \cdot (PRS(k)} \quad \cdots\cdots\cdots\cdots (12)$$

Where,

WFS : Weight of F/S yards to the ten yards

TRF(L): Traffic activity indicator of the L-th yard, which is selected from the yards of M in the F/S.

(The passenger indicator shows the number of arriving and departing passengers per year, and the freight indicator number of cars handled per day.)

TRF(K): Traffic activity indicator of the K-th yard among the ten yards.

PRS(L): PRS(K) Any improvement plan for the L-th or K-th yards ("Yes" = 1, "No" = 0), refer to Appendix 3.3.5.

3-4 Railway Traffic Demand Forecast Results

The railway traffic demand is obtained by multiplying the traffic demand distribution by passenger and freight (by commodity), as stated above by the respective railway shares obtained from the sacrifice volume model, Also, these traffic demands are estimated by case and for "with" and "without" according to the methods described in the preceding section. These results and the results of the approximate estimation, which used methods other than the foregoing, are as follows:

(1) Railway passenger traffic tonnage by case and for "with" and "without" (refer to Figure 3.4.1)

(2) Railway freight (by commodity) traffic tonnage by case and for "with" and "without" (refer to Figures 3.4.2-3.4.3)

(3) Railway passenger and freight (by commodity) traffic ton-kilometerage by case and for "with" and "without" (refer to Table 3.4.1)

(4) Railway passenger OD tables. Case II, "with" project (1984, 1996, 2006) (refer to Appendix 3.4.1-(1), (2) and (3))

(5) Railway freight OD tables, Case II, "with" and "without" project (1984, 1996, 2006) (refer to Appendix 3.4.2-(1), (2) and (3))

(6) Railway passenger zone-to-zone cross-sectional traffic volumes, Case II, "with" and "without" (1984, 1996, 2006) (refer to Figures 3.4.4, 3.4.5, and 3.4.6)

(7) Railway freight zone-to-zone cross-sectional traffic volumes, Case II, "with" and "without" (1984, 1996, 2006) (refer to Figures 3.4.7, 3.4.8, and 3.4.9)

(8) Traffic demand diverted from other modes to the railway upon project implementation (refer to Table 3.4.2)

(9) Railway passenger traffic demand upon improvement of the four F/S yards (refer to Figure 3.4.10)

(10) Estimates of time saved and evaluation of the times value by type of diverted traffic demand (refer to Table 3.4.3) ,

(11) Railway freight traffic demand upon improvement of the four F/S yards (rough estimate) (refer to Figure 3.4.11)

3-5 Some Remarks

(1) Change in the railway traffic demand with a raise in railway fare and freightage

To what extend would the railway traffic demand change if railway fare and freightage were raised? This is influenced greatly by the general consumer prices, service levels of the other modes of traffic, fares and charges of the other modes of transportation and trends in the tastes of the general consumer. If it is assumed that the other conditions do not vary and that the time lag in the changes of the traffic demand due to an increase in the fare and freightage can be neglected, changing railway traffic demand, in the case of only the railway fare and freightage being raised, is estimated by application of the above-mentioned "sacrifice volume model" (see Appendix 3.5.1). In short, the elasticity of railway traffic demand in relation to increases in the railway fare and freightage is great for both passengers and freight, with freight being particularly sensitive.

(2) Railway traffic demand resulting from the Eastern Seaboard Development Program

In this study, population, GRP and railway traffic demand in the area of development under the Eastern Seaboard Development Program, that is, Zone No. 21, were forecasted, assuming that the development program would be implemented as scheduled, as shown in Appendix 3.5.2. The traffic demands of railway passengers and freight in Zone 21 and their percentage of national traffic demand are, in 1996 and Case II, 2,420 thousand passengers (2.5%) and 1,313 thousand tons (21.6%), respectively. Of these railway traffic demands, the percentages induced by the implementation of the development plan are roughly estimated as shown in Appendix 3.5.2, that is, 67% for passengers and 100% for freight.

(3) The major reasons for having taken up Case II for both passengers and freight are that the former was regarded as the most promising for SRT and latter as the most favorable for the SRT from the viewpoint of keeping the security of the railway investment.

Unit: Thousand persons per year

		1984*	1991**		1996		2006	
		-	"without" project	"with" project	"without" project	"with" project	"without" project	"with" project
Intra - zone***	Case I	(100) 52,793.0	(103) 54,332.8	(107) 56,346.1	(105) 55,432.7	(109) 57,486.8	(109) 57,650.0	(115) 60,664.3
	Case II	-	-		(116) 61,434.0	(125) 65,809.7	(127) 67,121.0	(135) 71,249.8
Inter - zone***	-	(100) 28,705.0	(112) 32,012.3	(141) 40,479.0	(120) 34,374.7	(151) 43,466.2	(136) 39,101.1	(179) 51,393.7
Total	Case I	(100) 81,498.0	(106) 86,345.1	(119) 96,825.1	(110) 89,807.4	(124) 100,953.0	(119) 96,751.1	(137) 112,058.0
	Case II	-	-	(118)	(134) 95,808.7	(130) 109,275.9	(150) 106,222.1	122,643.5

* Figures for 1984 are based on the O.D. tables provided by the SRT.

** 1991 figures are rough estimates obtained by the extrapolation method and application of the "without"/"with" ratio.

*** Zones 1 - 6 are regarded as one zone.

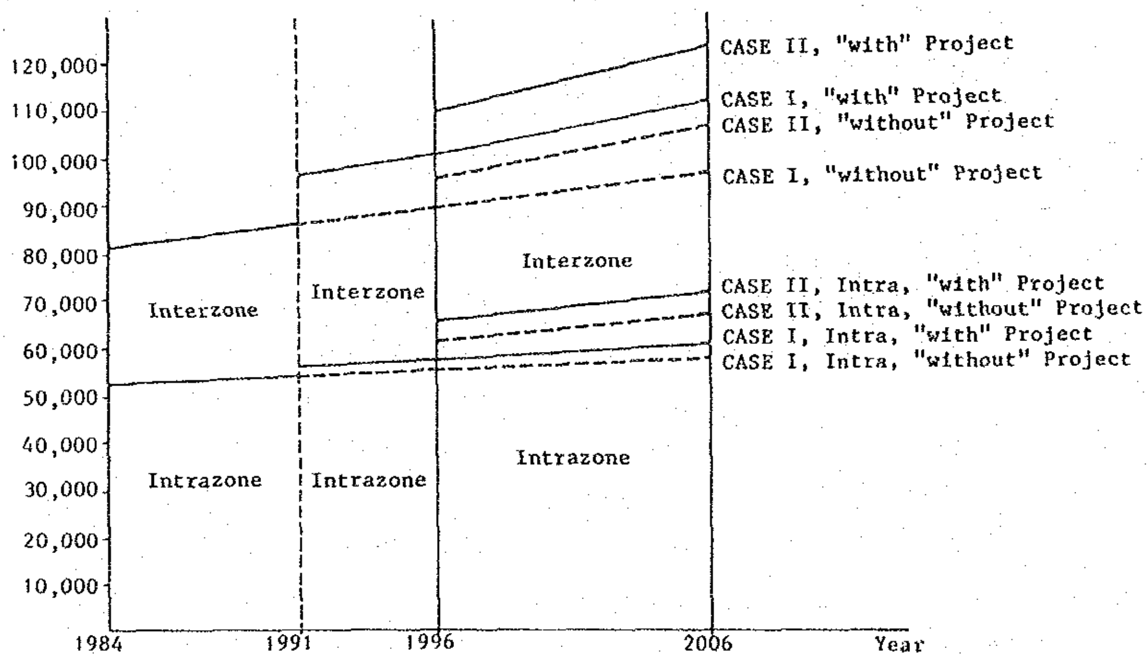


Fig. 3.5.1 Passenger Demand by Case for "with" and "without" Projects

Case I

Unit: Thousand tons per year

	Total traffic volume				Railway traffic volume						
	1984	1991	1996	2006	1984*	1991**		1996		2006	
	-	-	-	-	-	without	with	without	with	without	with
Rice	(100) 18,580	(122) 22,682	(138) 25,612	(168) 31,221	(100) 475.6	(110) 521.9	(121) 575.6	(117) 554.9	(128) 612.0	(124) 591.8	(138) 656.7
Other agricultural products	(100) 12,997	(127) 16,549	(147) 19,086	(188) 24,432	(100) 289.3	(193) 558.4	(215) 623.4	(259) 750.6	(289) 838.0	(320) 927.6	(360) 1,041.5
Cement	(100) 7,319	(152) 11,101	(188) 13,802	(253) 18,549	(100) 1,480.7	(125) 1,858.1	(150) 2,225.2	(144) 2,127.7	(172) 2,548.1	(160) 2,376.5	(192) 2,853.9
Petroleum including crude oil	(100) 9,691	(127) 12,339	(147) 14,231	(189) 18,217	(100) 2,121.1	(118) 2,510.0	(133) 2,826.5	(131) 2,787.7	(148) 3,139.2	(144) 3,047.4	(163) 3,450.1
Others	(100) 18,352	(117) 21,496	(129) 23,741	(150) 27,552	(100) 1,139.7	(146) 1,667.4	(190) 2,164.1	(179) 2,044.3	(232) 2,653.3	(205) 2,340.2	(267) 3,049.6
Total	(100) 66,940	(126) 84,167	(144) 96,474	(179) 119,974	(100) 5,506.3	(129) 7,115.8	(153) 8,414.8	(150) 8,265.2	(178) 9,790.6	(169) 9,283.5	(201) 11,051.8

* Figures for 1984 are based on the O.D. tables provided by the SRT.

** 1991 figures are rough estimates obtained by extrapolation and application of the "without"/"with" ratio.

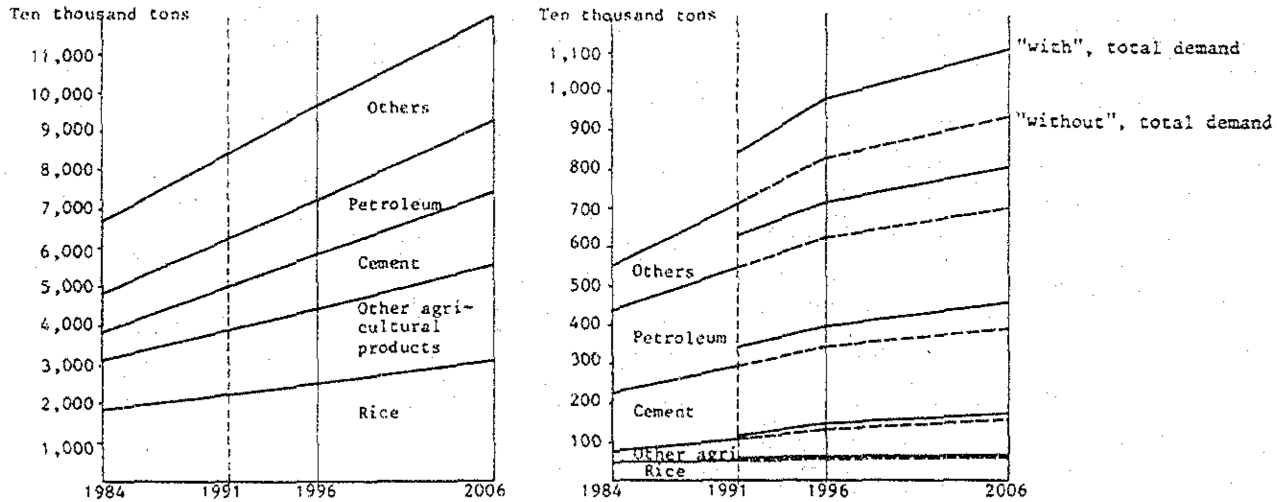


Fig. 3.5.2 Case I Freight Traffic Demand by Item for "with" and "without" Projects

Case II

Unit: Thousand tons per year

	Total traffic volume				Railway traffic volume						
	1984	1991	1996	2006	1984*	1991**		1996		2006	
	-	-	-	-	-	without	with	without	with	without	with
Rice	(100) 18,580	(122) 22,682	(138) 25,612	(168) 31,221	(100) 475.6	(92) 436.8	(101) 481.8	(86) 409.0	(95) 451.1	(92) 436.2	(102) 484.2
Other agricultural products	(100) 12,997	(127) 16,549	(147) 19,086	(188) 24,432	(100) 289.3	(153) 443.1	(171) 494.7	(191) 552.9	(213) 617.3	(236) 683.6	(265) 767.5
Cement	(100) 7,319	(152) 11,101	(188) 13,802	(253) 18,549	(100) 1,480.7	(103) 1,531.0	(124) 1,833.5	(106) 1,567.0	(127) 1,876.6	(118) 1,750.4	(142) 2,102.1
Petroleum including crude oil	(100) 9,691	(127) 12,339	(147) 14,231	(189) 18,217	(100) 2,121.1	(98) 2,081.3	(110) 2,343.8	(97) 2,052.8	(198) 2,311.7	(106) 2,243.6	(120) 2,540.0
Others	(100) 18,352	(117) 21,496	(129) 23,741	(150) 27,552	(100) 1,139.7	(119) 1,353.4	(154) 1,756.6	(132) 1,506.0	(172) 1,954.7	(151) 1,723.9	(197) 2,246.4
Total	(100) 66,940	(126) 84,167	(144) 96,474	(179) 119,974	(100) 5,506.3	(106) 5,845.6	(125) 6,910.4	(111) 6,087.7	(131) 7,211.4	(124) 6,837.7	(148) 8,140.2

* Figures for 1984 are based on the O.D. tables provided by the SRT.

** 1991 figures are rough estimates obtained by extrapolation and application of the "without"/"with" ratio.

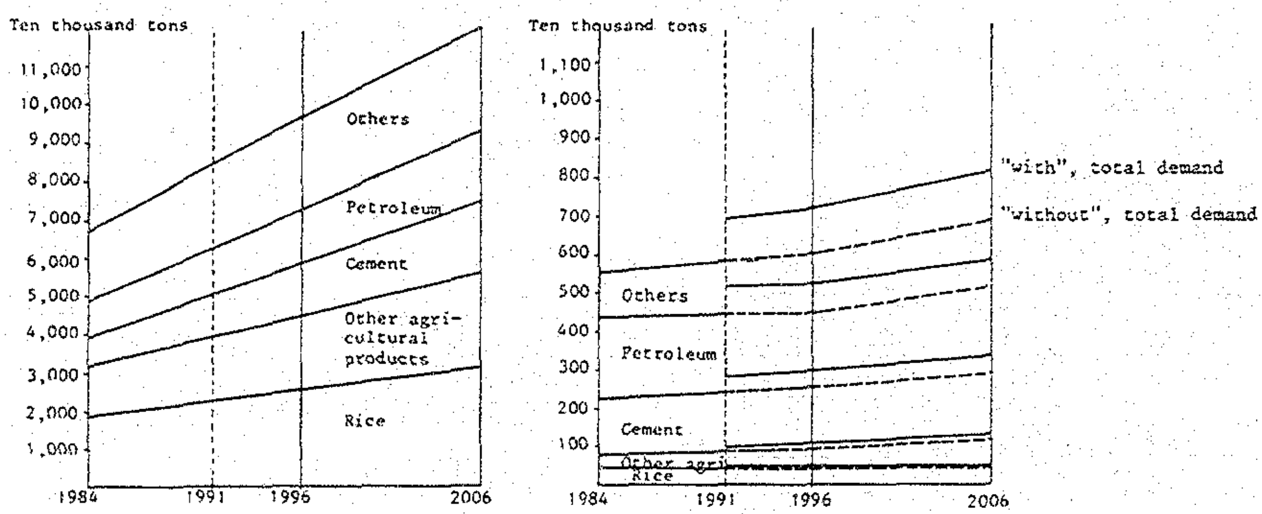


Fig. 3.5.3 Case II Freight Traffic Demand by Item for "with" and "without" Projects

Table 3.5.1 Traffic Volume by Case for "with" and "without" Projects

Unit: Millions

		1984	1996		2006	
			"without"	"with"	"without"	"with"
Passenger (passenger -km)	Case I	9,643	11,681.8	14,916.6	13,382.6	17,943.5
	Case II		11,740.7	15,054.4	13,518.8	18,119.7
Freight Case I (ton-km)	Rice	429	474.6	517.5	492.6	538.8
	Other agricul- tural products	282	532.1	584.5	634.4	701.5
	Cement	267	397.4	463.5	461.9	539.9
	Petroleum	988	1,431.9	1,605.0	1,590.7	1,793.2
	Others	652	977.1	1,191.0	1,109.2	1,360.8
	Total	2,618	3,813.1	4,361.5	4,288.8	4,934.2
Freight Case II (ton-km)	Rice	429	349.8	381.4	363.1	397.1
	Other agricul- tural products	282	391.9	430.5	467.3	516.7
	Cement	267	292.7	341.4	340.2	397.6
	Petroleum	988	1,054.5	1,181.9	1,171.4	1,320.5
	Others	652	719.8	877.4	817.1	1,002.4
	Total	2,618	2,808.7	3,212.6	3,159.1	3,634.3

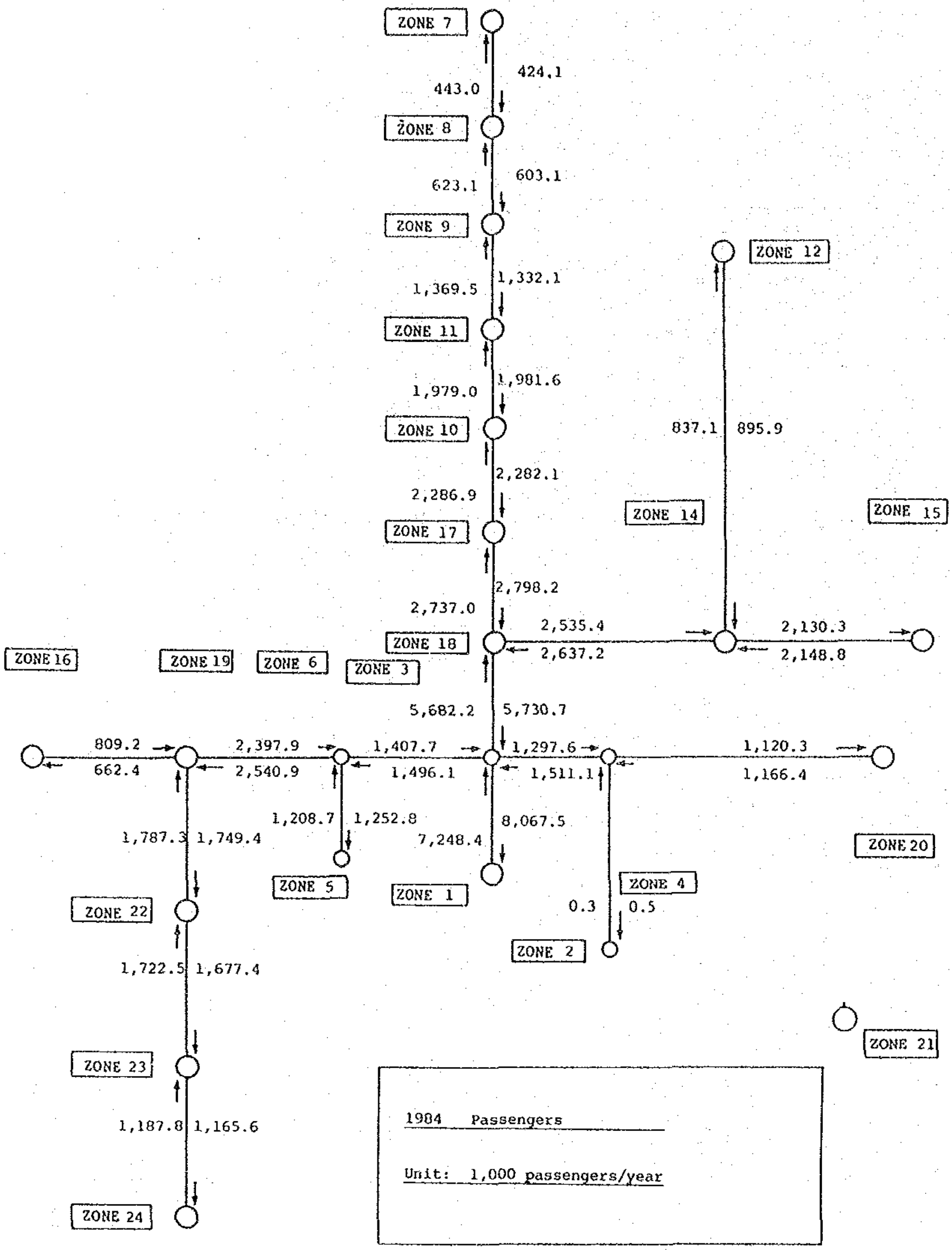


Fig. 3.5.4 Zone-to-zone Cross-sectional Traffic Flow

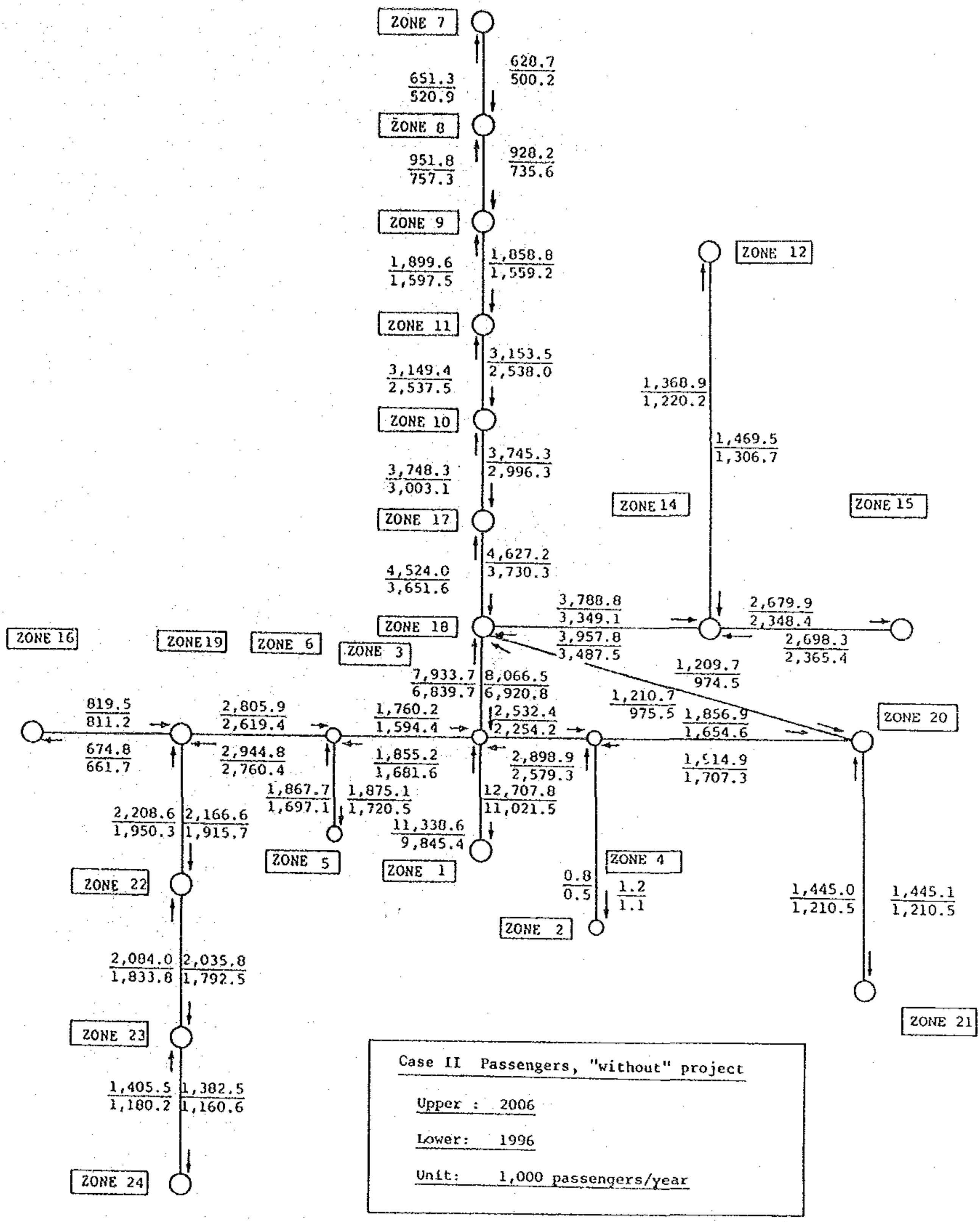


Fig. 3.5.5 Zone-to-zone Cross-sectional Traffic Flow

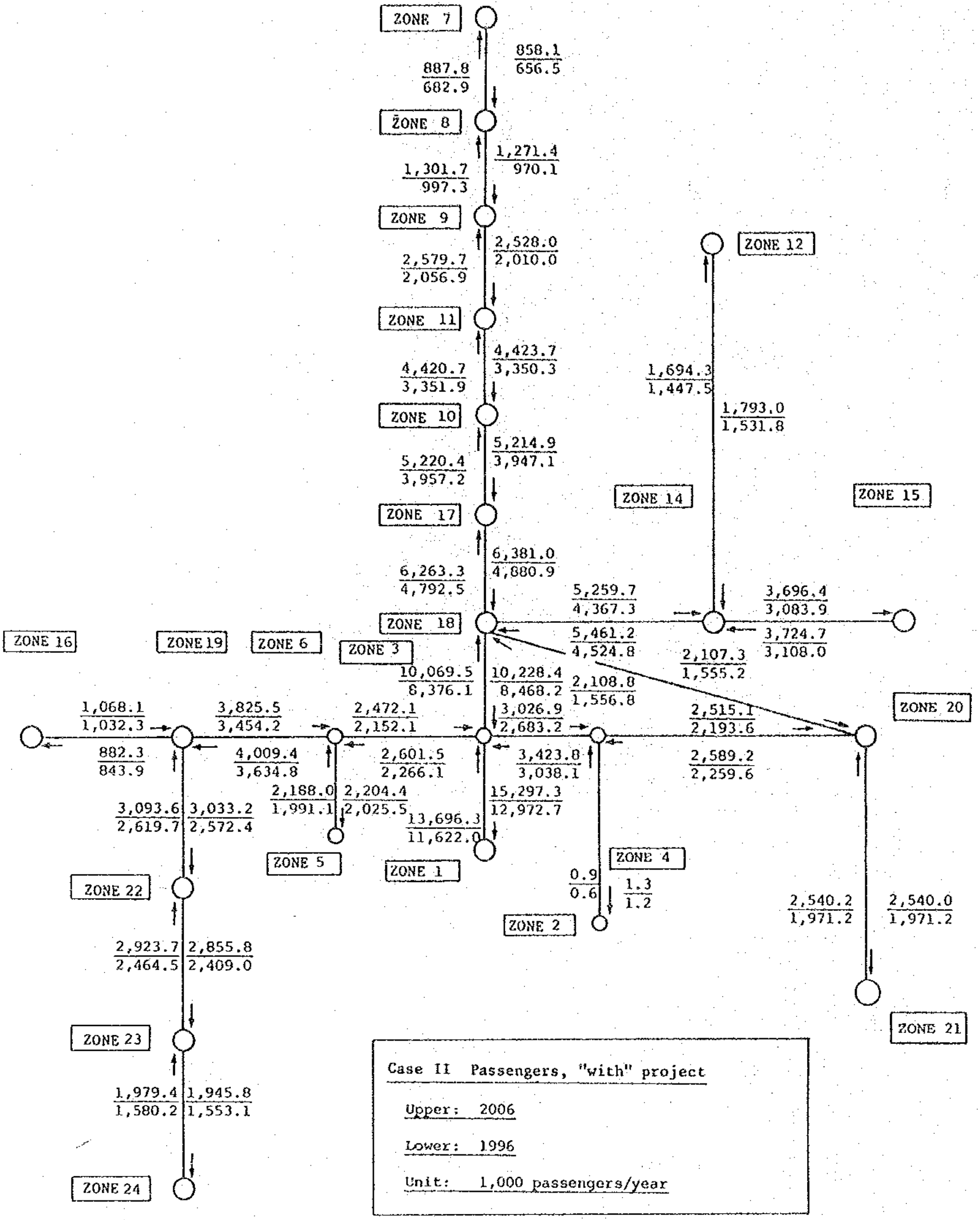


Fig. 3.5.6 Zone-to-zone Cross-sectional Traffic Flow

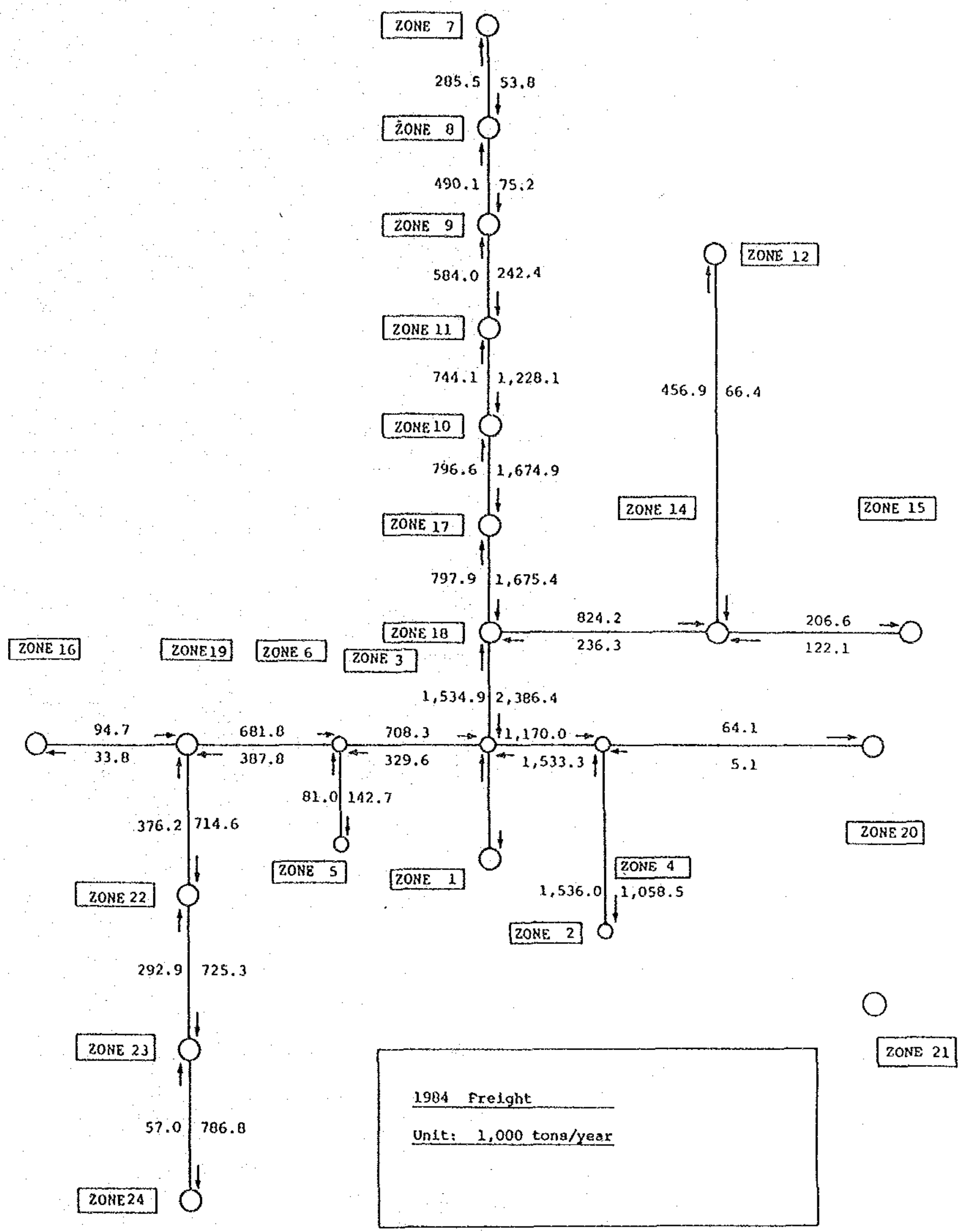


Fig. 3.5.7 Zone-to-zone Cross-sectional Traffic Flow

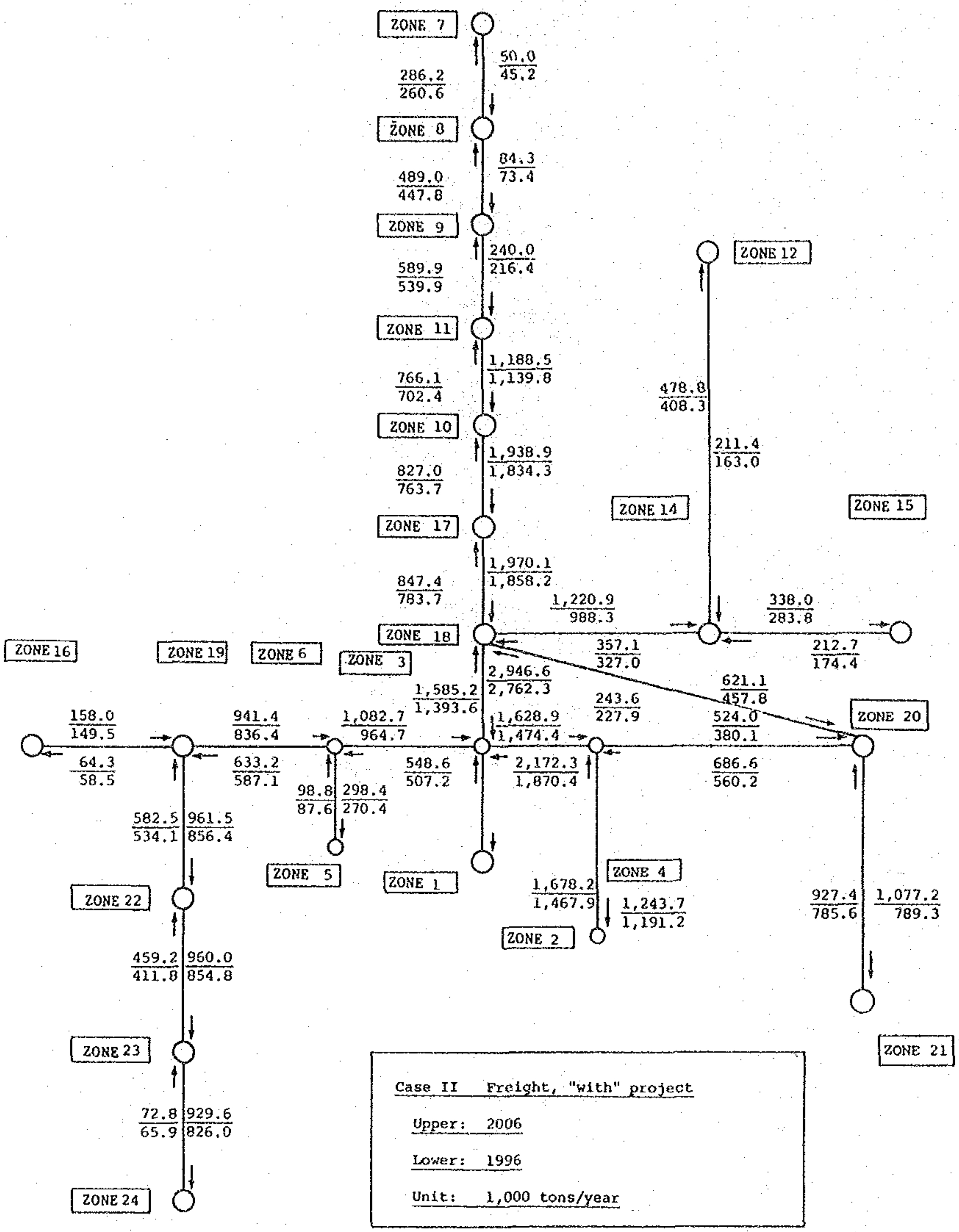


Fig. 3.5.8 Zone-to-zone Cross-sectional Traffic Flow

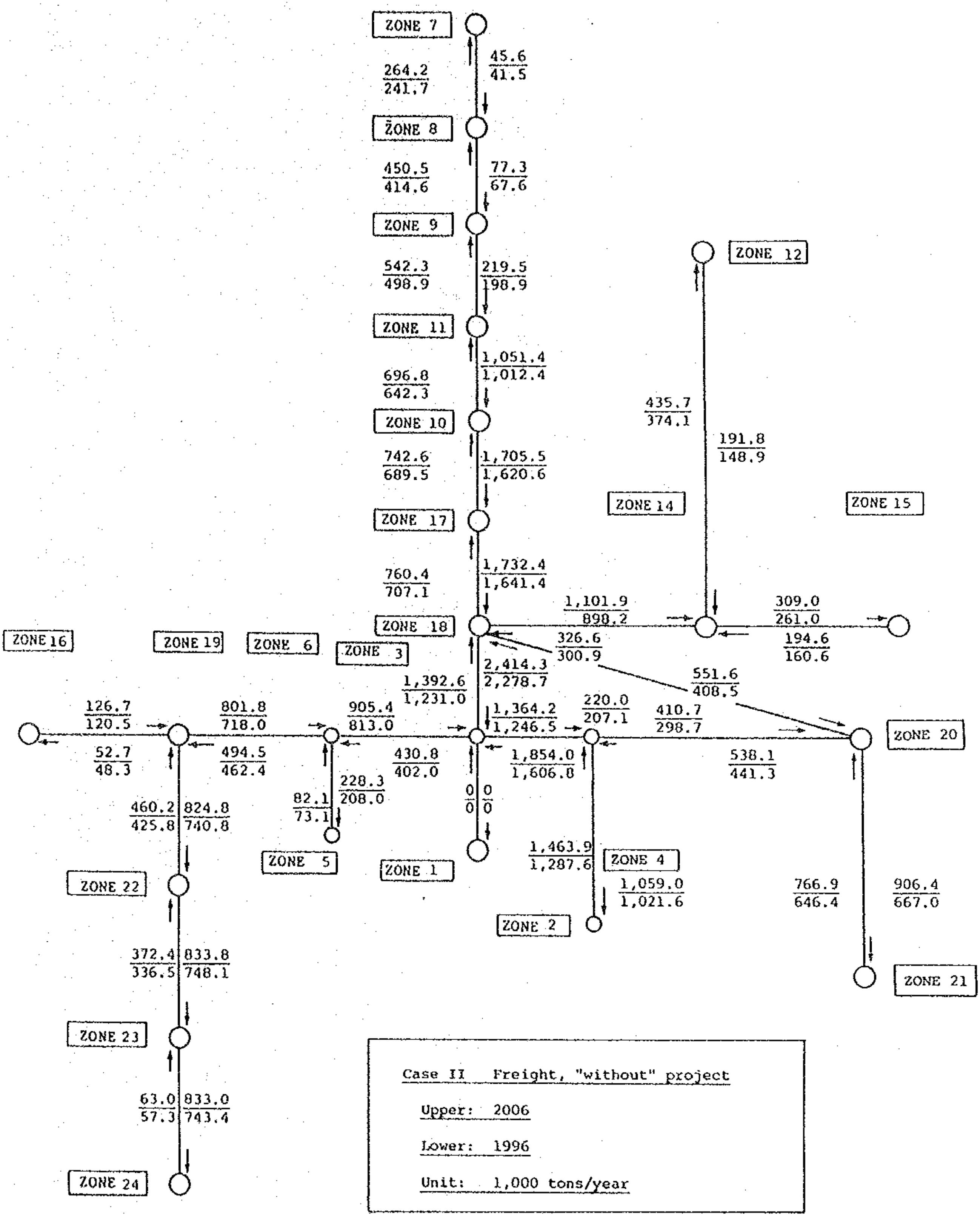


Fig. 3.5.9 Zone-to zone Cross-sectional Traffic Flow

Table 3.5.2 Traffic Volume Diverted to the Railway from Other Modes upon Project Implementation

Unit: Million

		1996			2006		
		Increased railway traffic	Traffic diverted from other modes		Increased railway traffic	Traffic diverted from other modes	
			From the road	From airways & waterways		From the road	From airways & waterway
Passenger (passenger-km)		3,313.7	3,267.6	46.1	4,600.9	4,524.1	76.8
Freight (ton-km)	Rice	31.7	29.0	2.7	34.0	31.6	2.4
	Other agricultural products	38.6	37.4	1.2	49.5	48.2	1.3
	Cement	48.6	44.1	4.5	57.4	52.5	4.9
	Petroleum	127.5	119.8	7.7	149.0	140.3	8.7
	Others	157.6	143.1	14.5	185.4	169.2	16.2
	Total	404.0	373.4	30.6	475.3	441.8	33.5

CASE I, CASE II

Unit: Thousand persons per year

		1984	1991	1996	2006
INTRAZONE	CASE I	52,793	56,084	57,220	60,272
	CASE II		-	65,241	70,713
INTERZONE	CASE I	28,705	39,379	42,284	49,796
	CASE II		-	42,284	49,796
TOTAL	CASE I	81,498	95,463	99,504	110,068
	CASE II		-	107,525	120,509

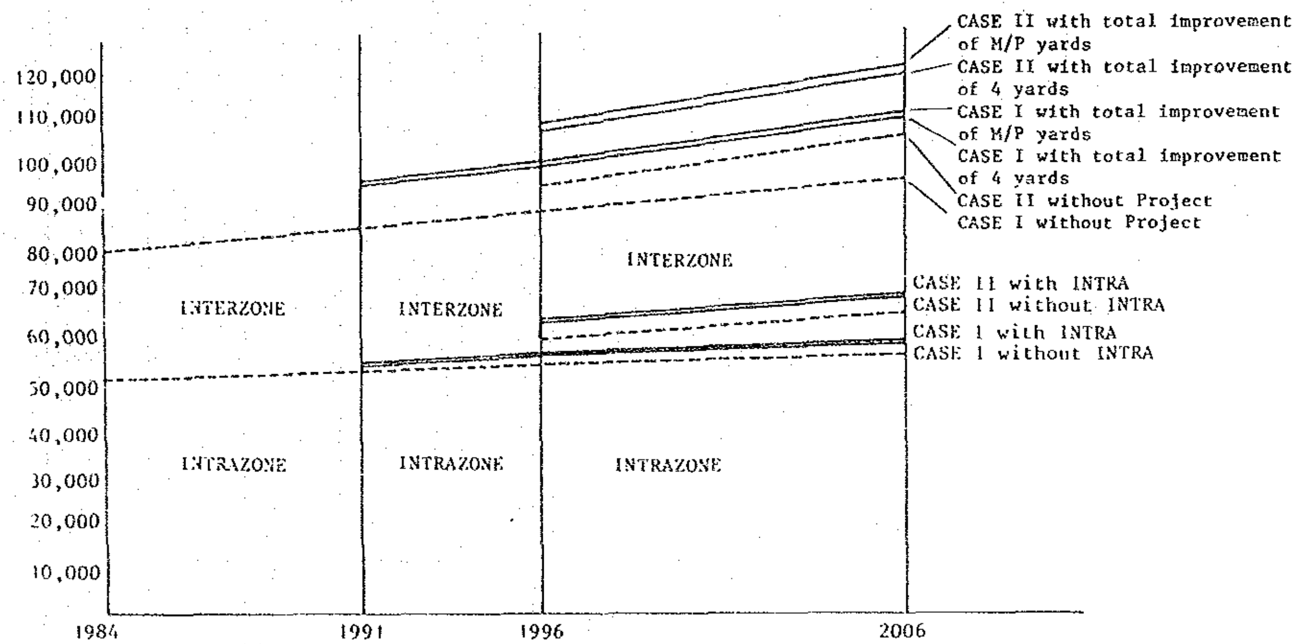


Fig. 3.5.10 Estimate of Passenger Traffic Volume

Table 3.5.3 Traffic Volume Diverted and Value of the Time Saved

Year / Mode / Items	1996			2006		
	Railway	Road	Other mode	Railway	Road	Other mode
Passenger-kilometers diverted (Millions)	11,740.7	3,267.6	46.1	13,518.8	4,524.1	76.8
Number of passengers diverted (Thousands)	95,808.7	13,386.8	80.4	106,222.1	16,295.6	125.8
Time saved per passenger-kilometer (Hour)	0.00653	-0.0086	-0.0087	0.00628	-0.0072	-0.00803
Time saved per passenger (Hour)	0.8	-2.1	-5.0	0.8	-2.0	-4.9
Value of a passenger-hour (Bahts)	13.6	21.8	116.0	28.0	40.9	184.4
Freight ton-kilometers diverted (Millions)	2,808.7	373.3	30.6	3,159.1	441.8	33.5
Freight tons diverted (Thousands)	6,087.7	1,063.8	59.9	6,837.7	1,237.9	64.8
Time saved per freight ton-kilometer (Hour)	0.00629	-0.0390	0.0579	0.0061	-0.0378	0.0567
Time saved per freight ton (Hour)	2.9	-13.7	29.6	2.8	-13.5	29.3
Value of a freight ton-hour (Bahts)	7.1	13.6	2.1	7.8	15.0	2.2

CASE II

Unit: Thousand tons per year

	1984	1991	1996	2006
Rice	475.6	477.1	446.7	479.2
Other agricultural products	289.3	489.3	610.5	758.7
Cement	1,480.7	1,801.7	1,844.1	2,065.2
Petroleum including crude oil	2,121.1	2,316.2	2,284.5	2,508.9
Others	1,139.7	1,714.3	1,907.6	2,191.5
Total	5,506.3	6,798.6	7,093.4	8,003.4

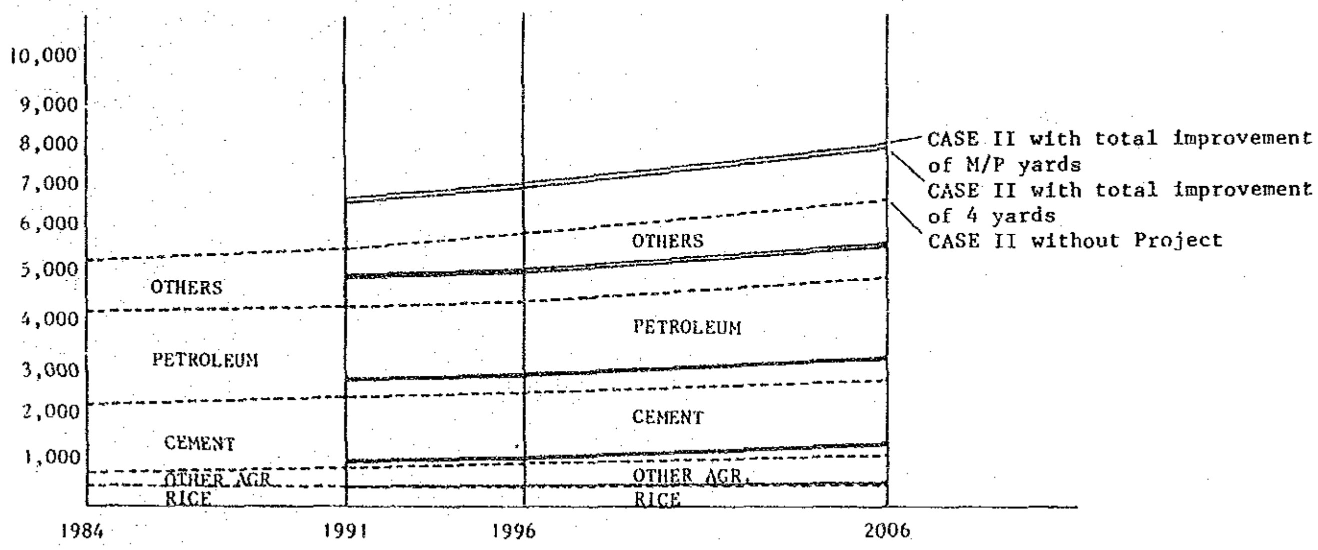


Fig. 3.5.11 Estimate of Freight Traffic Volume

CHAPTER 4 RAILWAY TRANSPOTATION AND TRAIN OPERATION PLAN

CHAPTER 4 Railway Transportation and Train Operation Plan

4-1 Present Condition of Transportation and Its Themes of Improvement

4-1-1 Passenger Transportation

(1) Change in traffic volume

The traffic volume of SRT in 1985 was 78,013,000 persons, a decrease of 3,485,000 persons (4.3%) from the previous year. Changes during the past ten years are as shown in Table 4.1.1. As can be seen, the trend of increases in passenger transportation has slowed down and become stagnant.

The record of passenger fluctuation by month for 1975, 1980 and 1985 is shown in Appendix 4.1.1. It is noted that the peak load in each year occurred during March and May.

To study the fluctuation by hour, the observation of numbers of passengers destinating at Bangkok station has been done on January 12 (Sunday) and January 13 (Monday), 1986. The result is shown in Appendix 4.1.2. On Sunday, in the morning there was a peak occurring from the arriving of long distance trains and there was also a broad peak in the evening. On the weekday there was a sharp peak occurring from the arriving of long distance trains in the early morning and 2 - 3 hours after that with another peak due to the commuter trains.

In the evening there was a short-period peak occurring due to commuter trains.

(2) Transportation forms

The flow of passengers on SRT lines between the Bangkok metropolitan area and the local cities along the respective line is quite large.

The transportation capacity is generally set according to such flows, and the trains, for the greater part, have Bangkok station set as their starting point.

The number of trains and train kilometers per day are 198 and 53,489 km respectively.

Table 4.1.1 Change in Transportation Volume

Fiscal Year	Number of Passengers '000	Growth Rate (%)	By Class			Passenger kms (Million)	Growth rate	Average distance per passenger (kms)
			1st class '000	2nd class '000	3rd class '000			
1975	61,567	0.3	128	923	(5,961) 60,516	5,640	4.9	91.6
1976	55,759	△9.4	112	971	(7,071) 54,676	5,352	△ 5.1	96.0
1977	57,974	4.0	91	1,026	(8,097) 56,857	5,649	5.5	97.4
1978	59,035	1.8	65	1,141	(8,309) 57,809	6,039	6.9	102.3
1979	64,398	9.1	71	1,272	(9,533) 63,055	7,029	16.4	109.1
1980	74,286	15.4	78	1,605	(10,439) 72,603	8,861	26.1	119.3
1981	78,824	6.1	78	1,642	(10,177) 77,104	9,483	7.0	120.3
1982	80,306	1.9	80	1,653	(10,866) 78,573	9,231	△ 2.7	114.9
1983	81,404	1.4	81	1,698	(10,418) 79,625	9,699	5.1	119.2
1984	81,498	0.1	77	1,766	(7,229) 79,645	9,643	△ 0.6	118.3
1985	78,013	△4.3	69	1,757	76,187	9,140	△ 5.2	117.2

Note: Parenthesized figures represent commuters.

Source: SRT Information Booklet

Passenger transportation is to be made available for long- and medium-distance passengers and for short-distance passengers.

For long- and medium-distance passengers, long- and medium-distance passenger trains starting from or terminating at Bangkok station will leave and arrive from various directions. There are express, rapid, and ordinary trains available. On the other hand, commuter trains are operated for short-distance passengers.

The roles and features of these trains are as follows:

1) Express trains

Express trains have been designated for long-distance passengers and are operated between Bangkok and the terminal stations of the respective lines (Chiang Mai, Nong Khai, Ubon Ratchathani, Sungai Kolok, etc.). They are composed of 14-16 coaches including sleeping cars and are hauled by a diesel locomotive (DL)

2) Rapid trains

Rapid trains are long-distance trains that complement the express trains, and are operated between Bangkok and the terminal stations of the respective lines. Rapid trains are hauled by a DL and are generally composed of 8-18 seating cars, although some of the night trains have sleeping cars.

3) Ordinary trains

Ordinary trains have been designated mainly for transportation over intermediate distances and for connecting local cities, although some are operated over long distances. This type of train makes up the greatest number of trains and train kilometers constituting about 50% and 45% respectively of all passenger trains. They are composed of seating cars only, and about 60% of the trains are DRC.

4) Commuter trains are operated for short-distance passengers in or about the Bangkok metropolitan area. The operating section is about 100 km and almost all trains are DRCs.

In addition to the foregoing, mixed trains are operated on the branch lines. Also, recently, operation of air-conditioned special high-speed trains (DRC) has begun from Bangkok - Phitsanulok, Surin and Khon Kaen. The scheduled speed is high (77.86 km/h on the Northern Line), and improvement of services to passengers is being promoted.

(3) Transportation routes and forms

The transportation routes are generally comprised of those established on each line. Routes extending over multiple lines are meager, except for those over the Northern and Northeastern Lines. Transportation routes of the passenger trains are as shown in Appendix 4.1.3.

(4) Themes of improvement

1) Long- and medium-distance transportation are fields of fierce competition with airlines and long-distance bus services. In Appendix 4.1.4, the fares and travel time by railway between Bangkok and major cities as against those by airplane and bus are shown. As can be seen, airplanes and buses are obviously superior to trains. The railway must, therefore, try to reduce the traffic cost and travel time, improve accommodations, and offer good services to comply with the needs of passengers.

2) In short-distance transportation, the train is also vulnerable to competition with the bus and car.
However, commuter transportation is a field in which the features of the railway are exhibited, and it should be given primary importance. Thus, increasing the opportunities to use the commuter and securing regularity are prerequisite conditions.

4-1-2 Freight Transportation

(1) Traffic volume

Although total domestic traffic has increased these past ten years, the railway traffic volume has been basically stagnant. In tonnage, railway traffic volume was 5.05 million tons for 1975, increased to 6.36 million tons in 1979, then decreased to 5.26 million tons in 1983. Then, in 1985, there was a small increase to 5.65 million tons. In ton-kilometers, the 1975 volume was 2.4 billion, then increased to 2.9 billion in 1979, but decreased back to 2.4 billion ton-kilometers in 1983. In 1985, however, it went up to 2.7 billion ton-kilometers.
Such a traffic volume trend is shown by commodity in Table 4.1.2.

Table 4.1.2 Traffic Volume by Commodity

(Unit: 10^3 tons, 10^6 ton kilometers)

Items / Fiscal Years	Petroleum		Cement			Sub-Total	Agricultural Products			Sub-Total	Others	Total Tonnage		Ton Kilometers	
	Crude Oil	Petroleum Products	Cement	Clinker	Gypsum		Rice	Maize	Rubber						
1975		968	852	582	119	2521	473	136	52	661	1870	(100)	5052	(100)	2353
1976		942	1026	447	94	2509	470	190	63	723	2119	(106)	5351	(106)	2505
1977		1110	1460		150		570	190	80	840		(124)	6310	(124)	2912
1978		1250	1610	610	270	3740	350	120	80	550	1779	(120)	6096	(113)	2651
1979		1467	1827	560	310	4167	397	132	61	590	1609	(126)	6366	(117)	2747
1980		1353	1611	568	350	3879	505	269	56	830	1521	(123)	6230	(120)	2805
1981		1419	1590	534	363	3906	450	265	63	778	1357	(120)	6041	(110)	2601
1982		1540	1550		330		430	330	90	850		(111)	5614	(103)	2421
1983		1440	1460	40	270	3210	370	210	140	720	1329	(104)	5259	(103)	2413
1984	700	1396	1479		244	3819	476	200	155	831	923	(110)	5573	(110)	2618
1985	1213	1347	1265	20	242	4087	435	215	174	824	737	(112)	5648	(112)	2718

Source: SRT Information Booklet

Looking at railway transportation as a whole, we see that it carried 2.52 million tons of bulky cargo such as petroleum, cement, clinker, and gypsum (or 50% of total domestic transportation) in 1975, and 4.16 million tons (or 65%) in 1979, a peak year for total domestic transportation. In 1985, the railway transported 4.12 million tons of bulky cargo (or 75%). These figures indicate that the railway has an important role in the bulky cargo.

The flow for main cargo in 1985 is as follows:

(Minerals)

o Petroleum

The petroleum supply of Thailand was about 10 million tons in 1983. In 1985, the railways transported 1.21 million tons of crude oil and 1.36 million tons of petroleum products, or a total of 2.75 million tons.

Crude oil is transported from Bung Phra, near the Sirikit oil field, to the Bang Chak oil refinery in Mae Nam. Petroleum products are then transported from Mae Nam to major stations along the Northern and Northeastern Lines, mainly by unit freight trains.

Petroleum products are generally transported to the southern part of Thailand by ships directly from the refinery, while the proportion transported by trains is very small.

Crude oil:

Bung Phra, Northern Line (1.21 million tons) → Mae Nam (1.21 million tons)

Petroleum products:

Mae Nam (1.34 million tons) → Northern Line (Phitsanulok, Den Chai, Chiang Mai, etc.) (650,000 tons)

Mae Nam (1.34 million tons) → Northeastern Line (Nakhon Ratchasima, Nong Khai, Ubon Ratchathani, Udon Thani) (650,000 tons)

Mae Nam (1.34 million tons) → Southern Line, etc. (40,000 tons)

- Cement

As of 1983, the cement production of Thailand was about 7.30 million tons, with production mainly in the central and southern parts of Thailand where gypsum is abundant. In 1985, the railway was responsible for the transportation of 1.28 million tons, with unit freight trains used from Ban Mo and Map Kabao to Bang Sue. Regular transportation was employed from Thi Wang to Hat Yai, etc.

Northern Line

Phon Thong (100,000 tons) —80,000→ Bang Sue (780,000 tons)

Ban Mo (380,000 tons) —310,000→ Bang Sue

Northeastern Line

Map Kabao (530,000 tons) —370,000→ Bang Sue

Southern Line

Ban Cha-am (30,000 tons) —20,000→ Bang Sue

Thi Wang (150,000 tons) → Chumphon (50,000 tons)

→ Surat Thani (40,000 tons)

→ Hat Yai (60,000 tons)

o <u>Gypsum</u>

As of 1983, the production of gypsum was about 9 million tons. The greater part of the production was consumed at the cement plants at the site, but some was transported from the mines to other cement plants by railway.

Northern Line

Taphan Hin (120,000 tons) → Ban Mo (80,000 tons)

→ Ban Chong Tai (40,000 tons)

Southern Line

Ban Song (110,000 tons) → Malaysia via Padang Besar (110,000 tons)

(Agricultural Products)

Agriculture is a basic industry in Thailand, accounting for 22% of domestic production. In 1983, the yield was 18 million tons of rice, 3.6 million tons of maize, 20 million tons of tapioca, 24 million tons of sugarcane, and 0.6 million tons of natural rubber. However, since the transportation is of the wide area dispersion type, and tapioca and sugarcane are processed at their respective sites into products, the volume of railway transportation is very small.

o <u>Rice</u>

The amount of rice transported was 420,000 tons in 1985. Producing districts are located in the northern, northeastern, and central areas. Short-distance transportation is by truck or boat, while the railway handles long-distance transportation: Sila-At (Northern Line) to Mae Nam; Ubon Ratchathani, Khon Kaen, and Udon Thani (Northeastern Line) to Mae Nam; Taphan Hin and Sila-At (Northern Line), Nakhon Ratchasima and Khon Kaen (Northeastern Line), and Nakhon Pathom (Southern Line) to the southern part of Thailand.

Northern Line (120,000 tons) → Mae Nam (40,000 tons); → Southern Thailand (80,000 tons)
- Taphan Hin
- Phitsanulok
- Sila-At

Northeastern Line (170,000 tons) → Mae Nam (40,000 tons); → Southern Thailand (130,000 tons)
- Nakhon Ratchasima
- Ubon Ratchathani
- Khon Kaen
- Udon Thani

Southern Line (50,000 tons) → Southern Thailand (100,000 tons)
- Nakhon Pathom

Mae Nam (50,000 tons) → Southern Thailand (100,000 tons)

o <u>Maize</u>

The amount of maize transported was 210,000 tons in 1985, originating mainly from Den Chai, Sila-At, and Sawankhalok along the Northern Line. The maize was bound, for the greater part, for Malaysia via Padang Besar.

Northern Line (140,000 tons) → (120,000) Malaysia via Padang Besar (140,000 tons); → (10,000) Hat Yai (30,000 tons)
- Ban Mo
- Sawankhalok
- Sila-At
- Den Chai

Southern Line (50,000 tons) → (20,000) Malaysia via Padang Besar; → (20,000) Hat Yai
- Tha Ruanoi
- Ban Cha-am

o Rubber

Natural rubber is produced mainly in the southern part of Thailand. The amount transported by the railway was 170,000 tons in 1985, headed mainly for Mae Nam for exporting.

Southern Line (170,000 tons) ——→ Mae Nam

Surat Thani (150,000 tons)

Thung Song

Trang

Hat Yai

(2) Transportation form

An inclination to transportation with stress placed on bulky cargo may result in economic growth and intensive competition with other means of transportation; namely, trucks. This tends to make railway transportation stay in the field of mass and long- and medium-distance transportation, which are the strong points of railways.

1) Direct station-to-station transportation by commodity

SRT has been promoting a direct station-to-station transportation service for petroleum, cement, and gypsum, with stations handling these commodities in large quantities designated as key stations. Presently, of the total 132 trains, 62 are used for direct station-to-station transportation by commodity. The proportion of such trains is particularly high on the Northern and Northeastern Lines, since petroleum and cement are a large part of the commodities transported.

Table 4.1.3 Proportion of Station-to-Station Train by Line

Number of Freight	Northern	Northeastern	Southern	Eastern	Total
Trains	36	42	40	14	132
(Unit transportation trains)	(28)	(30)	(4)	(-)	(62)

Note: The number of trains includes temporarily operated trains.

The extension of such a service is being considered for the agricultural products of rice, sugar, and maize, so the conversion to the direct station-to-station transport will be accelerated.

2) Ordinary transportation

For cargo other than bulky cargo transportation is by local train with Bang Sue, a distribution center acting as a pivot, while the local stations of Nakhon Ratchasima, Phitsanulok, Thung Song, and Hat Yai act as sub-yards. However, as the direct station-to-station transportation of bulky cargo increases, the proportion of ordinary transportation falls sharply. In particular, the proportion of ordinary transportation is lower in the districts along the Northern and Northeastern Lines where the railway's dependency on petroleum and cement transport is high, and the density of roads is higher than that of the railway. However, on the Southern Line where petroleum and cement transportation occupies a smaller proportion, ordinary transportation is higher.

3) Container transportation

For domestic container transport, a small number of container wagons (3-4 trains per week) start from Mae Nam and Bang Sue. Although local stations such as Chiang Mai, Thung Song, and Hat Yai are also planned to handle container trains, it should be noted that the container train is only in the trial stage; volume will be increased in the future because of the policy to foster the growth of container traffic.

(3) Freight handling stations

Presently, SRT has 432 stations in operation. These stations will handle cargo, except some passenger stations such as Bangkok. In 1985, the number of the stations that actually handled cargo was 359 (Appendix 4.1.5). However, as the proportion of bulky cargo such as petroleum and cement in the total traffic volume increases, as previously stated, there will be a trend towards concentrating the handling of such cargo at a few stations. These main stations are Mae Nam (petroleum departure and arrival), Bang Sue (cement arrival), Bang Mo (cement departure), and Bung Phra (crude oil departure). The top 20 stations, in terms of departure and arrival tonnage, accounted for 8.30 million tons or 73% of the total 11.23 million departure and arrival tonnage in 1982. However, in 1985, the cargo they handled amounted to 9.21 million tons or 82% of the total 11.30 million departure and arrival tons. Consequently, the other stations had their handling reduced. So a number of stations only handle a few tons of cargo a year (reference Table 4.1.4).

Now, from the equipment handling aspect, a considerable volume of transportation is maintained at those stations which have a stock point, etc. developed at the sites of departure and arrival for petroleum, cement, etc. However, in the other stations, which constitute the majority, the equipment is worn and obsolete, and the cargo handling is dependent on manpower. Thus, the lack of efficiency is considerable, resulting in handling capacity being greatly decreased.

(4) Role of freight car yard

Transportation by ordinary freight cars goes in various directions from the Bang Sue yard, which is located at a pivotal point of transport. However, with increasing direct station-to-station transportation about the key stations, the yard relay rate is decreasing. With respect to the Bang Sue yard, conventional yard transportation is decreasing greatly, so the handling plan has been set at 600 cars using the hump, as compared to the handling capacity of 2500 cars. Also, it should be noted that there are tracks not in operation at Thung Song and Nakhon Ratchasima.

Table 4.1.4 Classification of Freight Stations by Handling Scale

Handling Scale	Number of Stations	Handling Tonnage (Departure & Arrival)	Handling Tonnage per Station	Remarks
1,000,000 tons or more	2	4,240,000 tons	2,120,000 tons	Mae Nam 303 (ten thousand tons) Bung Phra 121
990,000-500,000 tons	2	1,530,000 tons	765,000 tons	Bang Sue 99, Map Kabao 54
490,000-300,000 tons	2	900,000 tons	450,000 tons	Ban Mo 49, Padang Besar 40.7
290,000-200,000 tons	4	970,000 tons	242,500 tons	Chiang Mai 24.5, Khon Kaen 23.8 Ubon Rachathani 21.3, Hat Yai 27.6
190,000-100,000 tons	14	2,000,000 tons	142,800 tons	Phon Thong 14, Taphan Hin 16, Phitsanulok 15, Den Chai 14.7, Nakhon Lampang 18.5, Ban Chong Tai 10.4, Nakhon Ratchasima 12.4, Udon Thani 17.2, Thon Buri 18.2, Surat Thani 10.8, Thi Wang 19, Ban Song 11.3, Yala 11.7, Sungaikolok 10.5
99,000-50,000 tons	5	370,000 tons	74,000 tons	Sila-At 8.4, Nakhon Pathom 5.9, Chumphon 8.8, Trang 8.5 Nakhon Si Thammarat 5.1
49,000-30,000 tons	10	410,000 tons	41,000 tons	Nakhon Sawan 4.4, Sawankhalok 3.5, Thanon Chira 3.9, Nong Khon Kwanq 4.9, Surin 4.1, Nong Khai 3.7, Khlong Tan 4, Ban Cha-am 4.4, Thung Song 4, Tanyong Mat 3.5
29,000-10,000 tons	26	440,000 tons	16,900 tons	
9,900-5,000 tons	25	180,000 tons	7,200 tons	
4,990-1,000 tons	50	120,000 tons	4,000 tons	
Subtotal	140	11,160,000 tons	79,000 tons	(99.7%)
990-100 tons	61	25,000 tons	400 tons	
99 tons or less	158	4,400 tons	28 tons	
Subtotal	219	29,300 tons	134 tons	(0.3%)
Total	359	11,190,000 tons	31,170 tons	

Source: Annual Report of Freight Train Arrivals and Departures by Station

(5) Themes of improvement

1) Taking the traffic volume as a whole, the importance of bulky cargo such as petroleum, cement, and gypsum is increasing. However, looking at the details, this increase is due mainly to the new development of crude oil, while petroleum products, cement, rice, and maize are stagnant, and other cargos are considerably decreasing except for rubber which is still increasing. Therefore, it is extremely necessary to maintain and secure an adequate volume of railway transportation.

2) The transportation of cargo is done in two ways, via direct station-to-station transportation and ordinary transportation. For petroleum, cement etc., the transportation of these contain the strong points of railway transportation, or large unit and station-to-station transportation incorporated fully, enabling an appreciable volume to be secured. However, as the range of truck movement has gradually expanded, due to the use of larger trucks and an easier availability of fuel oil, railway transportation has tended to decrease, and its future is by no means bright. It is, therefore, important to review the needs of the consignors and, at the same time, improve and strengthen the goods collection and distribution base and transportation system.

   For other cargo, transportation is by yard. With every train fully loaded to the traction efficiency, the transportation itself is being conducted effectively. However, a considerably long time is required for relaying at the yards, and freight trains are also often delayed. Therefore, the transportation system ranks fairly low as a service for quick delivery and punctuality, resulting in a consequent decrease in the traffic volume. Therefore, for agricultural products dispersed over a wide area, a concentrative base should be maintained at a collection center and distributed for each district, and the agricultural products, thus collected, guided to a direct station-to-station transportation system. For container transport in the trial stage, its merits are proved by door-to-door transportation, quick delivery, and punctuality. These services have to be promoted along with improvement of the transportation system in general. Drastic improvements such as these are required for transportation as a whole.

3) Arrangement of freight stations and freight handling stations (or fronts) that serve as the base of business have an important role to secure and cultivate traffic volume. It is imperative to install such fronts at important points and to develop business activities. Also, since SRT assumes such an important public role, it is desirable that it maintains a system answerable to the transportation demands of the consignors. Railway transportation basically has the feature of carrying large units of cargo. However, if it has a number of small stations handling very small amounts of cargo, the following demerits may occur and result in the railway being unable to exhibit its strong points.

a. Decoupling and coupling work of long trains causes delays in the arrival of other freight trains and thus weakens its competitive power with truck transportation.

b. In smaller stations, the time required for decoupling and coupling work is not included in the diagram, thus causing delays for the train concerned as well as for other trains, and making the arrival time vague.

c. The work of arranging freight cars according to a station sequence at the yard becomes complex.

d. Too many personnel result in losses.

e. Other difficulties (loss of fuel cost, etc.)

Therefore, the freight handling by smaller stations should be abolished as far as practicable, while stations serving as a center for the respective districts should be set up so as to offer good services (improvement in transportation services, improvement in handling equipment, etc.). This will help improve transportation services as a whole. When the freight handling of a smaller station is less than 1,000 tons of cargo a year (218 stations), it should be abolished: the decrease in transportation tonnage will be 58,000 tons (1%). When the freight handling of a smaller station is less than 100 tons a year (158 stations), it should also be abolished: the decrease will be 8,743 tons (0.15%).

4) For freight car yards, inefficient equipment along with the decrease of cars relayed at the yard at the time of expansion of direct station-to-station transportation was noted.

The Bang Sue yard has a hump of scale capable of handling 2500 cars, but actually the hump is designated to handle 600 cars. Also, as a base for cement arrival, it has a number of direct station-to-station trains arriving and departing. Nevertheless, the entry and exit routes are not sufficiently maintained and as a whole, the equipment and its use are imbalanced.

Hat Yai is a transportation base for trade with Malaysia and is a pivot for transportation in southern Thailand, so the yard is overcrowded.

Furthermore, each yard has a number of empty cars impeding yard work.

4-1-3 Transportation Facilities

(1) Rolling stock

The rolling stock possessed by SRT is comprised of diesel locomotives (DL), diesel railcars (DRC), passenger cars (PC) and freight cars (FC), and the number of these locomotives and cars as of the end of September 1985 is shown in Table 4.1.5.

Table 4.1.5 Number of Rolling Stocks

(As of September 30, 1985)

	On book			In service
DL	Electric	212	277	194
	Hydraulic	65		
DRC	Power-car		204	190
	Trailer-car			
PC	Ordinary PC	801	1,111	822
	Other	310		
FC	Covered goods wagon	4,702	8,904	7,915
	Other	4,202		

Source: SRT Information Booklet

But, as shown in Table 4.1.6, the locomotives and cars are generally obsolete, and the obsoleteness is particularly high in the passenger and freight cars.

Table 4.1.6 Age of Rolling Stock on Books

(As of September 30, 1985)

Type	Group of age	Number	Percent	Average age
DL	1-10 years	75	27.1	
	11-20 years	70	25.3	
	Over 20 years	132	47.6	
	Total	277	100.0	17.2
DRC	1-10 years	116	56.9	
	Over 10 years	88	43.1	
	Total	204	100.0	6.4
PC	1-10 years	311	28.0	
	11-20 years	369	33.2	
	21-30 years	204	18.4	
	31-40 years	217	19.5	
	Over 40 years	10	0.9	
	Total	1,111	100.0	19.0
FC	1-10 years	1,481	16.6	
	11-20 years	2,431	27.3	
	21-30 years	1,864	20.9	
	31-40 years	1,379	15.5	
	Over 40 years	1,749	19.7	
	Total	8,904	100.0	26.5

Source: SRT Information Booklet

The operating conditions of locomotives and cars, for example, as of October 1, 1985, are shown in Table 4.1.7, with the percentage of usable cars at a low of 71% for DLs and 74% for PCs.

Table 4.1.7 Operating Condition of Locomotives and Cars

(As of October 1, 1985)

Description	Diesel Locomotive	Diesel Railcar		Passenger car	Freight car	
		Power car	Trailer car		4 wheeled	8 wheeled
Number on books	277	159	45	1,107	5,899	3,005
Number intended to be scrapped	3	2	4	1	268	
Number in service	274	157	41	1,106	5,631	3,005
Available	194	152	38	818	5,090	2,825
Number under repair						
Number under repair at running shed	26	4		82	424	55
Number under repair at workshop	54	1	3	206	117	125
Availability (%)	71	97	93	74	90	94
Under repair (%)	29	3	7	26	10	6

The occurrence of car failures is not only a cause of train delay but a factor impeding proper operation of trains, so it is important to prevent such failures. Table 4.1.8 shows DL and DRC failures.

Table 4.1.8 Statistics of Rolling Stock Failure

Type	Number of failures		Total kilometer		Rate of failure/1000 km	
	1984	1985	1984	1985	1984	1985
DL	1,549	1,554	28,757,010	24,680,387	0.05386	0.06296
DRC	233	361	10,024,962	18,242,244	0.02324	0.01979

Noting the failures of DLs and DRCs by year by rate of failure per 1000 kilometers, DLs have increasing failures due apparently to obsoleteness, while DRC failures are decreasing on account of the introduction of new cars.

The number of freight cars is 8,904 (survey of 1985), and the number of operable freight cars is 7,915.

The operation efficiency (number of utilized cars/number of operable cars) is 12.3%. As a whole, there are too many freight cars, and the operation efficiency is not good.

Also, owing to the increase in unit freight trains (one-way empty) and one-way loaded transportation from north to south, the empty-car rate is high at 40% (empty-car kilometers/all freight car kilometers).

Of the total number of retained freight cars, about 20% are 40 years or older.

Generally there are too many freight cars, but with the expansion of the unit freight train by commodity, it will be necessary to check the cars for retention and adaptability.

(2) Car shed

Except FC, the cars are assigned to the car shed where they are appropriated to specified trains and have inspection and repairs done.

In Appendix 4.1.6 are shown the car shed and types and number by type of the cars assigned.

But, they have major repair and overhaul inspection made at the railway factory.

Appendix 4.1.7 shows the record of maintenance.

The cars are generally of foreign make and so it is often difficult to procure the parts or convert them to one another, resulting in difficulty of repair and generation of unusable cars, leading to decrease of the operating rate.

(3) Tracks

1) Gradient

Appendix 4.1.8 shows the maximum gradient that affects train speed and tractive capacity.

On the Northern Line, there are gradients of 20 - 26 o/oo between Sila-At (488 km from Bangkok) and Chiang Mai (751 km from Bangkok).

On the Northeastern Line, the maximum gradient is 24 o/oo, and is between Map Kabao (134 km from Bangkok) and Pak Chong (180 km from Bangkok).

On the Eastern Line, there is no gradient exceeding 10 o/oo because of the flat geography.

On the Southern Line, the maximum gradient is 18 o/oo and is between Thung Song (773 km from Bangkok) and Phatthalung (862 km from Bangkok).

2) Curvature radius

Appendix 4.1.8 shows the minimum curvature radius that affects train operating speed.

On the Northern Line, between Phitsanulok (389 km from Bangkok) and Chiang Mai (751 km from Bangkok), there are some curves with radii from 300 m to 180 m, which is considered to be very small. On the Northeastern Line, the minimum curve between Map Kabao (134 km from Bangkok) and Pak Chong (180 km from Bangkok) is 180 m in radius.

On the Eastern Line, the minimum curve between Bangkok and Hua Mak (15 km from Bangkok) is 400 m in radius.

On the Southern Line, the minimum curve between Thung Song (773 km from Bangkok) and Phatthalung (862 km from Bangkok) is 250 m in radius.

3) Problems in track facility

a. Appendix 4.1.8 also shows comparisons of line capacity and the number of trains. Shortage in line capacity could be found between Lop Buri - Ban Mi, and the following sections have no room in their line capacity due to inbound trains from the other lines:

Bangkok - Bang Sue - Ban Phachi

b. The Northern Line and Southern Lines branch at Bang Sue, and Northern Line and Northeastern Lines branch at Ban Phachi respectively. These junctions are level crossings, so they hinder smooth train operation.

c. Inbound and outbound tracks can be used for up and down trains at major stations. However, due to lack of safe sidings, both up and down trains cannot proceed simultaneously, thus one of them must wait outside of the station.

d. As shown in Appendix 4.4.4 nominal hauling capacity is compelled to be small due to the slope, so there are some sections in which a train operates dividing into two parts.

e. There are a lot of places with slow-speed operation due to bridge rehabilitation work or to alternation work for track beds and sleepers. This is one of the causes of train delay.

(4) Signalling and telecommunication systems

1) Signalling system

a. For the blocking system the following equipment is used.

- o Tablet
- o Ticket
- o Tokenless
- o Token

Appendix 4.1.9 shows a map of the existing instruments in the block system.

b. For signalling the following instruments are used.

- o Mechanical and color light types
- o The 2 aspects system (Go, Careful, Stop); (Y, GG, G, R)
- o The indication system is for route indication
- o The meanings of displays are

  R: Stop

  G: Go to the main track

  GG: Go to the side track

  Y: Stop at home

- o The aspects of a starter signal are R and G.
- o The aspects of a home signal are R, G, and GG.
- o The aspects of a warning signal are Y and G. The Y is on when the home signal is R, and the G is on when the home signal is G and means passing without stopping.

c. The types of signals are as follows:

o Home signal

o Starter signal

o Warning signal

o Shunting signal

o Shunting limit post

o Calling-on signal

d. The interlocking equipment is as follows:

o All relay interlocking

o Electromechanical interlocking

o Mechanical interlocking

e. The types of interlocking are:

A1, A2, A3, A4, B, C, D

f. The location of installation for each signal instrument and piece of interlocking equipment is shown in Appendices 4.1.6 - 4.1.9.

g. The railway-road level crossing protection instruments are:

A1, A2, A3, A4, B1, B2, B3

h. The train detecting systems are the track circuit and detector bar.

2) Signalling equipment (new signalling system)

a. The sections that had new signalling devices installed are Ban Phachi - Lop Buri, Thonburi - Ratchaburi.

b. The ongoing project is introducing a new signalling system, "The Installation of Color Light Signalling Project," which received on OECF loan. Under this project, the mechanical signals will be replaced with color light signals, and all relay interlocking equipment will be introduced to a number of sections.

3) Telecommunication system

a. The telecommunication systems in use are as follows:

o PABX (Private Automatic Branch Exchange)

o Open-wire carrier system

o Train dispatching telephone

o Teleprinter

o Carrier telegraph

o Fixed radio

o Mobile radio

o Talk back

o Intercom

o Public address and electric clock

o Party line telephone

b. The telecommunication network is shown in Appendix 4.1.10.

c. Carrier telephone network (whole line) is shown in Appendix 4.1.11.

d. Outline of train dispatcher telephone network (whole line) is shown in Appendix 4.1.12.

e. Teleprinter network (auto line) is shown in Appendix 4.1.13.

4) Themes of improvement in signalling and telecommunication systems

a. Signalling system

a) Failure occurs frequently due to old equipment.

b) The braking distance and signal visibility do not match each other. The operator usually brakes early due to insufficient signal visibility.

c) Trains often have to wait at the station because they cannot enter the station simultaneously.

d) There is loss of time due to the handling of blocking instruments.

e) There is loss of time due to the handling of mechanical interlocking equipment.

b. Telecommunications system

a) The PABX in Bang Sue is of the old type and has become timeworn.

b) The use of open-wire transmission lines for dispatching telephones has caused a significant number of failures and affected reliability.

c) The number of open-wire lines is not enough and telephones are not sufficiently connected.

d) Some of the telephones are of low quality and some are inconvenient to use.

e) Some freight handling stations are not equipped with the talk-back system. Also, troubles in this system are observed in many stations.

4-2 Passenger Transportation Plan

4-2-1 Principles for Future Passenger Transportation

The demand of railway passenger transportation in Thailand will increase to 109,276,000 passengers/year in 1996, and 122,644,000 passengers/year in 2006, increases over 1985 of 31,263,000 passengers (40%) and 44,631,000 passengers (57%) respectively.
That is to say, there is a need to improve the quality of the railway in terms of safety, accuracy and comfortability by utilizing the railway's features of rapid mass transportation. To do this, they have to change the transportation facilities to meet the needs of the times by increasing the investment of the railway and promoting the improvement of the transportation services and the modernization of various facilities.

(1) Long-distance and medium-distance transportation

In the field of long-distance and medium-distance transportation, there is severe competition with airline and bus services. Railway service has to cope with the needs of passengers by making use of its strong points.

In the near future, the railway needs to promote a selection of established time zones, shortening of arrival time and the improvement of comfort. Night trains will have to be composed chiefly of sleeping cars. Therefore, such factors as the modification of departure/arrival times, improvement of accommodations, and the providing of quality service are indispensable. In connection with day trains, the railway will have to increase people's chances to use them, shorten arrival time, and improve accommodations. At the same time, they will have to improve operation efficiency by trying DRCs and unifying train composition.

The number of passengers using sleeping cars is shown in Table 4.2.1.

Table 4.2.1 Number of Passengers Using Sleeping Cars

Year	Numbers
1980	796,450
1981	816,012
1982	770,325
1983	901,060
1984	944,451
1985	916,689

(2) Short-distance transportation

Short-distance trains are in severe competition with buses and privately owned cars. However, in the commuter traffic field railways have strong points, so more emphasis must be placed on commuter traffic in the near future. The increasing of chances to use the railway and securing of punctuality are very important factors that will lay the foundations for making it reliable.

In general, commuter trains should be run at distances between 30 to 50 km. But in Thailand, the distance has been expanded to 100 to 120 km, as shown in Table 4.2.2. This is because commuter trains are also regarded as short-distance trains. If in the future they are made into actual commuter trains, frequency can be raised by shortening the section.

Table 4.2.2 Section for Short-distance Trains to be set up

Line	Operating Section	Distance (km)
Northern	Bangkok-Lop Buri	132.8
Northeastern	Bangkok-Kaeng Khoi	125.1
Eastern	Bangkok-Prachin Buri	121.8
Southern	Bangkok-Ratchaburi	117.3

(3) Number of cars to be made up

Presently, the number of cars composing a passenger train and the train composition is varying from train to train, as shown in Appendix 4.4.2. Here, the number of cars and the composition are fixed for each type of train, as shown in Table 4.2.3.

Table 4.2.3 Number of Cars to be Made Up

(1996, 2006)

Trains	Composition	No. of Cars
Express	BFP, BFV, BRC, 12ANS, 2ANF	17
Rapid	BFP, BBT, 8BTC, 2BSC, 3BNS	15
Ordinary	DRC	8
Commuter	DRC	6

The ordinary and commuter trains are formed by DRCs.

(4) Number of seats

The number of seats (beds) within a car depends on the type of car. The number of seats per train is shown in connection with (3) by consolidating with the standard form as shown in Table 4.2.4.

Table 4.2.4 Number of Seats in Each Car

Type	No. of Seats	Remarks
ANS	32	Day and Night Coach
ANF	15	Day and Night Coach
BTC	76	
BSC	48	
BNS	32	Day and Night Coach
DRC	76	

(5) Passenger load factor

The passenger load factor will have to be planned reasonably. We have made the passenger load factor for the long-distance train flexible and the one for the short-distance train rather inflexible, using a fixed number. The passenger load factors are assumed as shown in Table 4.2.5.

Table 4.2.5 Passenger Load Factor of Each Train

Load Factor / Trains	Present	Future
Express	75 ~ 80	80 (%)
Rapid	70 ~ 75	75
Ordinary	60 ~ 65	65
Commuter	100 ~ 120	100

(6) Transportation routes

The trains are made up in principle by using the railway lines as units. As mentioned in 4-1-1, lots of trains use Bangkok Station as a terminal and starting station. Therefore, the Northern and North-eastern Lines will use the section between Bangkok and Ban Phachi, while the Southern Line will use it together with the section between Bangkok and Bang Sue.

In addition, the trains running on the Northeastern Line will all go by way of Ban Phachi, and not by way of the newly-built short-circuit line connecting Chachoengsao and Kaeng Khoi.

4-3 Freight Transportation Plan

4-3-1 Principles for Future Freight Transportation

(1) Summary of themes of improvement

As pointed out in the 4-1-2 the themes of improvment with SRT's freight transportation may be summed up in the following four items.

1) The traffic volume increased 110% during the past ten years. However, if the transportation of crude oil that started in 1983 is excluded, it shows a decrease of 14%. Therefore, some measures for expanding the volume quantitatively are required.

2) The weight of bulky cargo, such as petroleum and cement, increased greatly from 2.52 million tons in 1975 to 4.12 million tons in 1985. This increase owes much to the transportation of crude oil, which has just begun, and when crude oil is excluded, the increase is only from 2.52 million tons to 2.91 million tons, or 15%. When this value (2.91 million tons) is compared with that of the peak value of 4.16 million tons in 1979, it accounts for 70% of the peak, and the future is by no means promising.

3) Agriculture is the basic industry of Thailand and yields a great amount of products; yet, rice and maize are not transported by railway, except for those going long distances, and tapioca and sugarcane are scarcely transported by rail at all. Therefore, regaining these products for the railway in one way or another is sought.

4) Transport of general goods such as groceries and textiles is largely dependent on trucks, while the railway's transport share is meager. To recover these lost shares, transportation service that promises quick delivery and strict punctuality is necessary.

If it continues as at present, the volume of freight transportation in the future will remain stagnant. However, with the construction of the Laem Chabang Port, development of related new railway lines, and improvement of yards, freight volume is estimated to reach 7.21 million tons (131%) in 1996 and 8.14 million tons (148%) in 2006. Thus, these measures should be promoted for the improvement of freight transportation.

(2) Improvement of transportation services

SRT is offering two systems of transportation service, direct transportation between strategic points by unit freight trains, and ordinary transportation in which the Bang Sue yard is used as the main yard and the local central stations as auxiliary yards. However, in the future, the flow characteristics of the objective cargo should be taken into consideration and the direct transportation services between the strategic points expanded for cargo that could be collected en masse, while rapid transportation services should be promoted for general commodities through containerization to ensure rapid delivery and punctual arrival. For other cargo, rationalization of transportation should be promoted as much as practicable.

The present condition and future direction of the specific transportation systems by commodity are as follows:

o Crude oil, gypsum	
Uni-product freight transportation →	Same as the left
o Petroleum products, cement	
Uni-product freight transportation →	Uni-product freight transportation is to be expanded.
o Rice, maize, etc.	
Ordinary transportation →	With an intensive handling base provided for each district of departure or arrival, standardized or uni-product transportation is to be promoted.
o Rubber and other general cargo	
Ordinary transportation →	Containerization is to be promoted to ensure rapid delivery and punctual arrival.
o Others	
Ordinary transportation →	Same as before, but rationalization is to be promoted.

(See Appendices 4.3.1 and 4.3.2)

For the time being, the following should be implemented, improvements designed for transportation geared toward 1996, in order to improve transportation services and labour economy.

1) The punctuality of freight transportation has to be taken into consideration. Punctual and high-speed transportation for general cargos between strategic stations have to be promoted.
   Securing the regularity of all trains may be realized upon implementation of the various measures to be taken hereafter (such

as, for example, integration of small freight handling stations). However, for the time being, some trains should be chosen from among the existing trains, about one shuttle for each line, to connect the central stations in the areas where the commodities concentrate to offer rapid services of high regularity - that is, if the cargo is brought to C station until B o'clock of A day, it will arrive at the objective D station until some time of some day.

2) Regarding unit freight trains, transportation from station to station will have to be strengthened, transportation standardized, and the work in yards improved.
Taking the cement trains arriving at Bang Sue (13 trains a day: annual transport, 910,000 tons), for example, 87% of them terminate at Bang Sue, and the remaining 13% go to Thon Buri, Khlong Tan and other stations. Of these trains, those composed of freight cars wholly destined for Bang Sue are only about two, and the other trains undergo sorting at Bang Sue. By converting these trains to piston trains between the departure sites and Bang Sue so far as practicable, transportation will be standardized, and the yard work improved, to serve for reduction of the transportation cost.

3) Transportation during effective time zones will have to be taken into consideration, so as to cope with the improvement of yard work in freight stations as well as with the needs of shippers.
Freight trains to and from a freight station such as Mae Nam should be set to suit the loading/unloading time zones to help economize on labour at the freight station. The empty oil cars that are returned arrive from 14:00 to 21:00 hours. This competes with the composition of dispatched cars, resulting in the yard work becoming disordered. Therefore, it is desirable to have some of the empty cars arrive after the departure of the dispatched cars and thus alleviate the yard work.

4) Regarding bulky cargos being transported between sections, the needs of shippers will have to be met by making use of rapid freight trains from Bang Sue.

For agricultural products going from the Northern Line to the Southern Line; general commoditites going from Mae Nam to various sites; and import and export cargos, the transportation of which between the New Port and various sites is expected to increase; the freight relay cars promising quick delivery should be used at Bang Sue for volumes too small to form a unit train but large enough to require several cars to ensure effective use of Bang Sue in the new transportation system.

(3) Arrangement of freight stations

Stations serving as centers of local distribution for commodities should have their container yards and stock points for oil, cement, rice and/or maize developed and improved, in accordance with the commodities to be handled for the modernization of cargo handling and cultivation and acquisition of new regular consignors.

Furthermore, small freight stations (handling less than 1000 tons of cargo a year) causing hazards to rapid and punctual delivery should be integrated as much as possible (see Appendices 4.3.3-(1), 4.3.3-(2)).

Also, the development of stock points should be carried out jointly with the industries concerned.

(4) Freight car yards

Although traffic volume is expected to increase, the number of freight cars handled in the respective freight shunting yards will tend to decrease because of the expansion of uni-product direct transportation and promotion of container transportation. The allocated space in the compound should therefore be reduced, or the facilities rearranged, to ensure efficiency and permit rationalization of staff and reduction of yard expenses.

Particularly, for the Bang Sue yard, handling volume has already decreased so much that it is necessary to reduce the area of use to match the actual conditions, and to improve the route by having it run straight into the loading and unloading tracks to meet the increasing volume of container handling. It will also be necessary to decide on a layout to promote good work efficiency, including how to use the hump in accordance with the change in the number of cars to be handled in the future.

(5) Routes for Freight Transportation

Concerning the routes for freight transportation, which will be used for Laem Chanbang's New Port and the opening of the new Northeastern Line, the arrival time of freights, number of arriving and departing freight cars and personnel allocation at junctions will have to be taken into consideration. Transportation by way of the following routes would be convenient and beneficial:

1) Between the Northeastern Line and the New Port

Freight train unit: by way of a new line

Others : as served so far

2) Between the Northern Line and the New Port

All freight : as served so far

(See Appendix 4.3.4.)

4-4 Train Operation Plan

4-4-1 Present Train Operation

(1) Number of trains

The number of trains set up presently is 336, and these trains are shown by line and by type in Table 4.4.1.

Table 4.4.1 Number of Trains by Line (1985)

(Unit: Train/day)

Types \ Lines		Northern	North-eastern	Eastern	Southern	Total
Passenger	Express	2	4	-	6	12
	Rapid	6	8	-	10	24
	Ordinary	28	43	10	30	111
	Commuter	19	8	16	8	51
	Total	55	63	26	54	198
Mixed		6	2	2	16	26
Freight		36	42	-	34	112
Total		97	107	28	104	336

Note: (1) "Ordinary" passenger trains include special air-condition DRC and Tour Train.

(2) "Freight" trains include temporary operated trains.

(3) "Freight" trains do not include short distance trains.

(4) No work train is included.

As stated above, the greater part of passenger trains are set up with Bangkok Station as the starting or terminating station, and they number 119 a day, including both arrivals and departures. They are shown in Table 4.4.2 by line and type.

Table 4.4.2 Number of Trains Departing from and Arriving at Bangkok Station (1985)

(Unit: Train/day)

Type \ Line	Northern	North-eastern	Eastern	Southern	Total
Express	2	4	—	4	10
Rapid	6	8	—	8	22
Ordinary	20	16	8	7	51
Commuter	16	6	12	—	34
Mixed	—	—	2	—	2
Total	44	34	22	19	119

In Appendix 4.4.1 the operation section of these trains is shown.

(2) Train kilometerage

Train kilometerage is 79,059 km/day and is classified by line and type of train in Table 4.4.3.

Table 4.4.3 Number of Train Kilometers by Line (1985)

(Unit: Train-km/day)

Types \ Lines		Northern	North-eastern	Eastern	Southern	Total
Passenger	Express	1,502	2,410	-	4,281	8,193
	Rapid	3,638	4,856	-	7,574	16,068
	Ordinary	8,991	7,501	1,730	6,995	25,217
	Commuter	1,088	621	1,196	1,106	4,011
	Total	15,219	15,388	2,926	19,956	53,489
Mixed		374	372	322	1,290	2,358
Freight		9,344	5,706	151	8,011	23,212
Total		24,937	21,466	3,399	29,257	79,059

From such a situation, the following problems are considerable.

1) As almost all trains depart from or arrive at Bangkok Station, the Bangkok-Ban Phachi section has as many as 142 inbound and outbound trains, including a concentration of freight trains in the day; therefore, track capacity is limited.

2) The Eastern and Southern Lines branch from the Northern Line at a level crossing; thus, there is a problem of crossing both main tracks. Therefore, a speed limit is provided, resulting in difficulties in both transportation and operation. Also, to ensure safety, care is required.

3) Bangkok station, because it is a dead-end station, has presented the passenger trains with the following problems.
   - o In the absence of an engine running track, a shunting locomotive has to be used to remove arriving trains and replace them with starting trains.
   - o Arrival and departure tracks are classified, but the removal of trains from the arrival to the departure track is restricted to two tracks.
   - o The passenger car yard is located close by, but due to a shortage of capacity, trains are apt to stay at the platform for a considerably long time.

4) As shown in Appendix 4.4.2, train composition varies from train to train. Thus, car operation is limited, and when a car is used for another train, the work of changing the train composition must be done.

4-4-2 Train Setup Plan

(1) Prior conditions

In setting up an operation plan, we would like to assume the following conditions.

1) Type of train

At the present time, passenger trains consist of express, rapid, ordinary and commuter trains. In the future, passenger trains will be classified into these four types.

Regarding freight trains, they will be classified into three types, such as the direct unit freight train, rapid freight train and ordinary freight train. The mixed train will be abolished. The type of trains schedueled by line is shown in Table 4.4.4.

Table 4.4.4 Type of Trains Scheduled by Line (1996, 2006)

Train \ Line		Northern	North-eastern	Eastern	Southern
Passenger	Express	○	○		○
	Rapid	○	○		○
	Ordinary	○	○	○	○
	Commuter	○	○	○	○
Freight	Unit	○	○	○	○
	Rapid	○			○
	Ordinary	○	○	○	○

2) Type of motive capacity

The passenger, express, rapid, and ordinary trains hauled by DLs with their present capacity will pull trains composed of passenger coaches. Other trains will be operated by DRCs. All freight trains will be pulled by DLs. Main DL specifications and capacities are shown in Appendix 4.4.3.

3) Hauling capacity

The hauling capacities are shown by line and section in Appendix 4.4.4.

4) Standard operation time

The operating hours between the stations are to be determined by type of the hauling capacity, and in assessing the capacity, the car performance, train composition, maximum speed, track condition and other conditions must be considered. However, in this report, the operating hours between the main stations are obtained from the current train schedule and are applied.

(2) Number of trains

The number of trains needed was calculated by dividing the sectional traffic volume between zones with the transportation capacity per train. Such a traffic volume was obtained from the traffic demand (OD Table), which was forecasted in Chapter 3. Furthermore, we decided to adopt types of trains, sections, time zones, etc. on the basis of the present situations of train setup and the prior conditions.

1) Passengers

The number of trains by railway line and the number of trains that departed and arrived in Bangkok are shown in Table 4.4.5 and 4.4.6 respectively.

Table 4.4.5 Number of Passenger Trains by Railway Line

Line / Train	Northern	Northeastern	Eastern	Southern	New line	Total
Express	2	4	-	6	-	12
	4	6	-	6	-	16
Rapid	8	10	-	10	-	28
	10	12	-	12	-	34
Ordinary	48	46	18	56	24	192
	52	48	18	64	30	212
Commuter	30	12	18	12	-	72
	34	16	22	16	-	88
Total	88	72	36	84	24	304
	100	82	40	98	30	350

Note: Upper column 1996, Lower column 2006

Table 4.4.6 Number of Passenger Trains Departing from and Arriving at Bangkok Station

Line / Train	Northern	Northeastern	Eastern	Southern	Total
Express	2 4	4 6	- -	4 4	10 14
Rapid	8 10	10 12	- -	8 10	26 832
Ordinary	24 26	18 18	18 18	4 6	64 68
Commuter	22 26	8 12	14 18	6 8	50 64
Total	56 66	40 48	32 36	22 28	150 178

Note: Upper columm 1996, Lower columm 2006

2) Freight trains

The number of freight trains by railway line is shown in Table 4.4.7.

Table 4.4.7 Number of Freight Trains by Railway Line

Line / Type	Northern	North-eastern	Eastern	Southern	Klong Sip Kao-Kaengkhoi	New Port	Total
Unit	26 28	18 20	2 2		(2) (2)	(4) (4)	46 50
Rapid	4 4	4 4		6 8			14 16
Ordinary	4 4	8 8	8 12	22 24	2 2	(10) (12)	44 50
Total	34 36	30 32	10 14	28 32	2(2) 2(2)	(14) (16)	104 116

Note: Upper column 1996, Lower column 2006

(3) Train-kilometer

Train-kilometers by railway line are shown in Table 4.4.8.

Table 4.4.8 Train-kilometers

(Unit: kms/day)

Line / Type	Northern	North-eastern	Eastern	Southern	Klong Sip Kao-Kaengkhoi	New Port	Total
Passenger	21,055 26,127	24,249 28,706	3,334 3,518	27,133 33,058	832 1,040	2,144 2,680	78,747 95,129
Freight	14,956 15,745	10,394 11,175	752 1,135	12,061 14,364	416 416	1,876 2,144	40,455 44,980
Total	36,011 41,873	34,643 39,881	4,086 4,653	39,194 47,422	1,248 1,456	4,020 4,824	119,202 140,109

Note: Upper column 1996, Lower column 2006

Of these trains, the number of trains by section, systematic chart and train diagram are illustrated in Appendices 4.4.5 through 4.4.7

4-4-3 Carriage Plan

(1) Number of cars to be needed

The following formulas are used in order to calculate the number of cars needed for operating the trains planned in 4-4-1.

1) DL

Number of DLs

$$= \text{Number of DLs for PC trains} + \text{Number of DLs for FC trains}$$

$$= \frac{\text{Kilometer/day of PC trains (kilometer/day of PC locomotives)}}{\text{Daily car-kilometers of DLs}}$$

$$+ \frac{\text{Kilometer/day of FC trains (kilometer/day of FC locomotives)}}{\text{Daily car-kilometers of DLs}}$$

2) DRC

$$\text{Number of DRCs} = \frac{\text{Kilometer/day of DRCs}}{\text{Daily car-kilometers of DRCs}}$$

3) PC

$$\text{Number of PCs} = \frac{\text{Kilometer/day of PCs}}{\text{Daily car-kilometers of PCs}}$$

4) FC

$$\text{Number of FCs} = \frac{\text{Number of freight cars to be used per day}}{\text{Operation efficiency}}$$

Car-kilometers and daily car-kilometers in 1996 and 2006 are shown in Table 4.4.9. For the daily car-kilometers, the actual values in 1984 were used, as shown in Table 4.4.10 FC was obtained by dividing the number of freight cars used per day with operation efficiency. In 1984, the operation efficiency of SRT was equal to 12.3 per cent, while it was equal to 15.6 per cent, the highest ratio in the past, in 1980. Therefore, we have adopted 15.6 per cent and consider it as possible.

The number of cars to be needed is shown in Table 4.4.11.

Table 4.4.9 Total Car-kilometers

(Unit: kms/day)

Type	1996	2006
DL	69,409	81,686
DRC	380,245	446,420
PC	451,148	572,724
FC	970,102	1,105,150

Table 4.4.10 Daily Car-kilometers per car

(1984)

Type	Car-kilometers
DL	379
DRC	490
PC	658
FC	82

Table 4.4.11 Number of Cars to be Needed

Type	1996	2006
DL	183	216
DRC	776	911
PC	686	870
FC	8,396	9,281

(2) Car allocation plan

If we compare the number of cars calculated in (1) with the number of existing cars, it is understood that DRCs will drastically increase. This will occur because the number of trains will increase as the traffic volume increases, and because ordinary and commuter trains will be replaced by DRCs.

Accordingly, it will be possible for DLs and PCs to be assigned to the existing car base. A new car base for DRCs will be needed even if they make full use of the existing base facilities.

1) Car allocation

Each car will be allocated to the car bases shown in Table 4.4.12. For DRCs, Ban Phachi was selected as a newly-built base. The scale, work allotment and reasons for such a choice are indicated in Appendix 4.4.8.

Table 4.4.12 Car Allocation

Type	Car Bases
DL	Bang Sue, Sila-At, Nakhon Ratchasima, Thon Buri, Thung Song, Hat Yai
DRC	Bangkok, Uttaradit, Nakhon Ratchasima, Thon Buri, Thung Song (or Chumphon), New Depot
PC	Bangkok, Uttaradit, Thon Buri, Thung Song, Hat Yai

2) Inspection and repair plan

In each car base they will have to establish a regular inspection plan in connection with the allocated cars, make arrangements for the security of workers and the materials/equipment and maintain the cars. At the same time, they will have to set up a control system for making repairs whenever necessary.

The inspections by type are shown in Table 4.4.13.

Table 4.4.13 Inspections by Type

Type	Periods
DL	1 month, 3 months, 6 months, 12 months, 24 months
DRC	1 month, 3 months, 6 months, 12 months, 18 months
PC	4 months, 20 months

Inspection criteria specifying the locations and method of inspection are provided in SRT, and the maintenance of cars is made according to such criteria, but review of the criteria must be made for obsoletion of cars and introduction of new cars.

3) Work allotment

As a principle, inspection and repair works will be performed at the car bases. However, employees will sometimes do work at other places if their ability merits it or if integration of car operation requires it.

In addition, it would be more effective for employees to conduct the above-mentioned inspection after they collect the cars at the large-scaled bases, because such inspections will need more time and replacement parts. That is to say, DLs will be inspected at Bang Sue and Hat Yai, and DRCs at Bangkok and Ban Phachi (to be built).

4) Facilities to be needed

In order to conduct the inspection and repair of cars, such facilities as shown in Appendix 4.4.9 will be needed.

Furthermore, there will be a need to set up more storage sidings due to the increase of cars and integrated car operation. As this will require plenty of investment and time, making full use of the idle lines of the freight storage sidings located at the stations will be tried.

4-4-4 Operation Control

(1) Performance of regular time operation

The trains are to be operated according to the diagram. But operation may be obstructed by an accident or disaster, resulting in the failure of proper train operation. Securing scheduled operation of trains is an important duty for transportation and is the basis for reliability. But in SRT, delays occur everyday and have not yet been improved. Punctual performance ratio for all trains from 1982 to 1985 is shown in Table 4.4.14.

Table 4.4.14 On-time Performance Record

(%)

Line \ Year	1982 9/12 - 10/2	1983 9/11 - 10/1	1984 10/21 - 11/10	1985 10/20 - 11/9
Northern	62	49	64	44
Southern	43	39	46	64
Eastern & Northeastern	36	30	55	69

Note: $\text{On-time Performance} = \frac{\text{On-time trains (0 - 4 min)}}{\text{All trains}} \times 100$

Delay times by line and by type of train from October 20 to November 9, 1985, are shown in Table 4.4.15. On each line, delays of freight trains are far greater than those of passenger trains. Particularly, for the Southern Line, delays of freight trains are all too common. It is thought that this is due to required adjustments in train operation, since freight trains have to bear this strain.

Table 4.4.15 Train Delay Time (Oct. 20 - Nov. 9, 1985)

(min.)

Type / Line	Express	Rapid	Ordinary	Commuter	Mixed	Freight
Northern	2,319 13.2	3,181 25.2	5,742 12.4	1,440 4.2	142 1.3	59,819 133.4
Eastern & Northeastern	1,971 7.8	1,745 10.3	10,611 8.9	1,364 2.9	1,697 10.1	59,894 148.9
Southern	621 5.7	1,300 8.3	4,506 9.3	1,146 4.4	3,636 10.8	75,083 248.6

Note: The lower figure is the average per train.

Nowadays, the solution of delay problems is a matter of importance. As shown in Appendix 4.4.10, the major causes are as follows:

1) Waiting to cross and for clearance
2) Shunting waiting for yard clearance
3) Waiting for locomotives
4) Delays due to arrival trains
5) Waiting due to loading and unloading

It seems that most of these are regarded as secondary factors while the primary causes are unclear. It is necessary to investigate and study the primary factors in detail. For the time being, the following countermeasures can be taken:

1) All staff members are to be educated so as to understand the philosophy that regular operation is the most important factor.
2) Concerned staff members and top management are to have discussions on the countermeasures for and causes of delays.
3) Various equipment and cars are to be maintained and inspected strictly, in order to prevent troubles with facilities before they happen.
4) In making up the train plan, secure stoppage time and leave enough time left open so as to absorb delays.
5) In planning the work, take adequate time so as to finish it within the fixed time.

(2) Improvement of operation safety

It is most important for the operation safety standards of the transportation facilities to be raised and for safe transportation to be provided. Operation accidents may not only cause some delay but also have a bad effect on management. For this reason accidents have to be prevented by all means.

The number of operation accidents that occurred amounted to approximately 3,000 per year, as shown in Appendix 4.4.11. The following items are the major causes:

1) Damaged locomotives
2) Cars crashing into crossing protectors
3) Objects thrown at locomotive
4) Hitting animals
5) Trains crashing into autos

Damaged locomotives accounted for approximately 60 per cent of all operation accidents. The following countermeasures will have to be taken to get rid of this problem.

1) Maintain and inspect the cars (especially locomotives) strictly and do the best in parts management to control potentially troublesome situations.
2) Make efforts to raise their level of technology and make full use of existing facilities.
3) Obsolete equipment and facilities have to be renovated.
4) Introduce new safety equipment such as automatic signals, relayed arrangements, and ATS.
5) Disseminate the importance of safety to the public.

(3) Improvement of dispatching system

The operation of trains is controlled by the Railway Dispatching Offices located at 13 places all over the country as shown in Appendix 4.4.12. Each dispatcher understands the operating conditions of trains within the section he is in charge of dispatching.

The following problematic points are pointed out concerning the dispatching system:

1) The dispatcher has difficulty in understanding the condition of the entire railway line because he is occupied with grasping the situation of the section he is in charge of.
2) The operating conditions of trains are recorded on paper in which only the station and time lines are printed.
3) Dispatching equipment consists only of an outdated telephone.
4) It is very difficult to make arrangements for positive operation when there is a disorder in the diagram due to an accident.
5) In the case of operation arrangements, it is necessary to change car operation and labor conditions, and communicate with passengers. However, it is not easy to get in touch with all the related places quickly.

In order to solve such problems the following countermeasures will have to be taken.

1) Study the conditions of operation throughout the railway line and set up a central dispatching office or railway line instructions office that can be reached easily.
2) Use recording paper on which the train plan is printed. Describe delayed trains on the paper or introduce a facility that can record it automatically, so that dispatchers can concentrate on dispatching work.
3) Introduce a CTC and wireless set and modernize the dispatching equipment.
4) Conduct positive operation arrangements.
5) Improve and strengthen the dispatching system including sales (passengers and freight), trains, and equipment. In addition, make communication with related departments.

CHAPTER 5 YARD FUNCTION ASSIGNMENT

CHAPTER 5 Yard Function Assignment

5-1 Future Railway Freight Transportation and Policies for Yard Function Assignments

In this chapter, based on the network of the freight yards, yard function assignment will be described.

SRT's future freight transportation demand will continue to gradually decline unless the competitive force of SRT in the transportation market is strengthened.

However, once the Eastern Seaboard Development Program takes effect, development demands are expected, and a movement in the development of freight demand should, therefore, be noted.

Generally, freight transportation facilities (terminal, yard, and main track) have been increased, improved or abolished repeatedly depending on the demand trend. However, the freight transportation capacity (freight transportation facilities, cars, and personnel) has not always been in alignment with demand, and it will be necessary to review the capacity for the next several years (or 5 years at the most) and to create a balanced transportation system.

Here, the railway freight transportation is classified into (1) unit transportation by commodity, (2) collective transportation through yards and (3) container transportation. The basic principles for these are shown in the following.

(1) Direct transportation should be employed as much as possible in consideration of the economic transportation unit (minimum value of train composition), and the yards bypassed.

(2) The collective transportation, except for direct transportation, should be built up into an efficient and reasonable transportation system. Based on the OD table of collective transportation, an optimum transportation system should be examined in consideration of the capacity of the respective yards and the yard network.

(3) The container transportation designed for high class miscellaneous cargos is expected to be a competitive force in the transportation market on account of its door-to-door quick delivery and punctuality in arrival time. Here, it is desirable to form a network after test runs and by utilizing sufficient data.

5-2 Work Flowchart for Yard Function Assignment and Units Used

As a whole, the work flowchart is comprised of five blocks as shown in Figure 5.2.1.

(1) Preparation of all-cargo OD in 25 yard blocks.

(2) Preparation of OD for direct transportation by commodity items.

(3) Extracting from (1) a collective transportation OD (loaded car) by yards except for (2), and through optimization (freight car kilometer-minimization) of empty car control upon such OD, preparation of an empty car OD.

(4) Preparation of a loaded/empty OD as a yard relay OD.

(5) Based on (4), assignment of yard capacities and yard positioning is optimized (minimization of total relay time) by the yard handling capacity table, relay table by OD, and network table.
Meanwhile, optimization was done with linear programming applied to the parts calculated for the empty car control and yard capacity assignment. Then, using the capacity of the respective yards for the

given OD, the method of use of the yards according to which the relay time of all freight cars in all yards would be minimized, that is, optimized functional assignment, is obtained.

Also, the basic units used in the foregoing work are as follows:

(1) Mean load per SRT freight car

14.65 tons/car (1984) (Information Booklet 1985)

(2) Minimum number of units of freight trains by commodity

Table 5.2.1 Minimum Number of Units of Train Compositions

Unit: Car/day

Rice	Other agricultural products	Oil	Cement	Miscellaneous cargos
10	20	30	30	30

Rice and agricultural products are fluctuating and are thus taken to be 1/1.5 to 1/3 of the oil, cement and miscellaneous cargos.

(3) Yard block and OD conversion

The yard blocks, including the 10 yards being studied, were divided as shown in Appendix 5.2.1. Also, OD conversion from the administrative zones to these blocks was made, since the OD of the administrative zones is not sufficient for grasping the flow between the yards.

The number of cars per OD after conversion is shown in Appendices 5.2.2 and 5.2.3.

Table 5.2.2 Distances between Yards

		1	2	3	4	5	6	7	8	9	10
1	Phitsanulok		299	473	382	388	394	859	1,025	1,147	1,318
2	Ban Phachi			174	82	90	96	559	726	848	1,020
3	Nakhon Ratchasima				256	264	270	733	900	1,022	1,194
4	Bang Sue					8	13	477	644	766	937
5	Bangkok						10	469	635	757	929
6	Mae Nam							490	657	779	950
7	Chumphon								167	289	460
8	Surat Thani									122	294
9	Thung Song										172
10	Hat Yai										

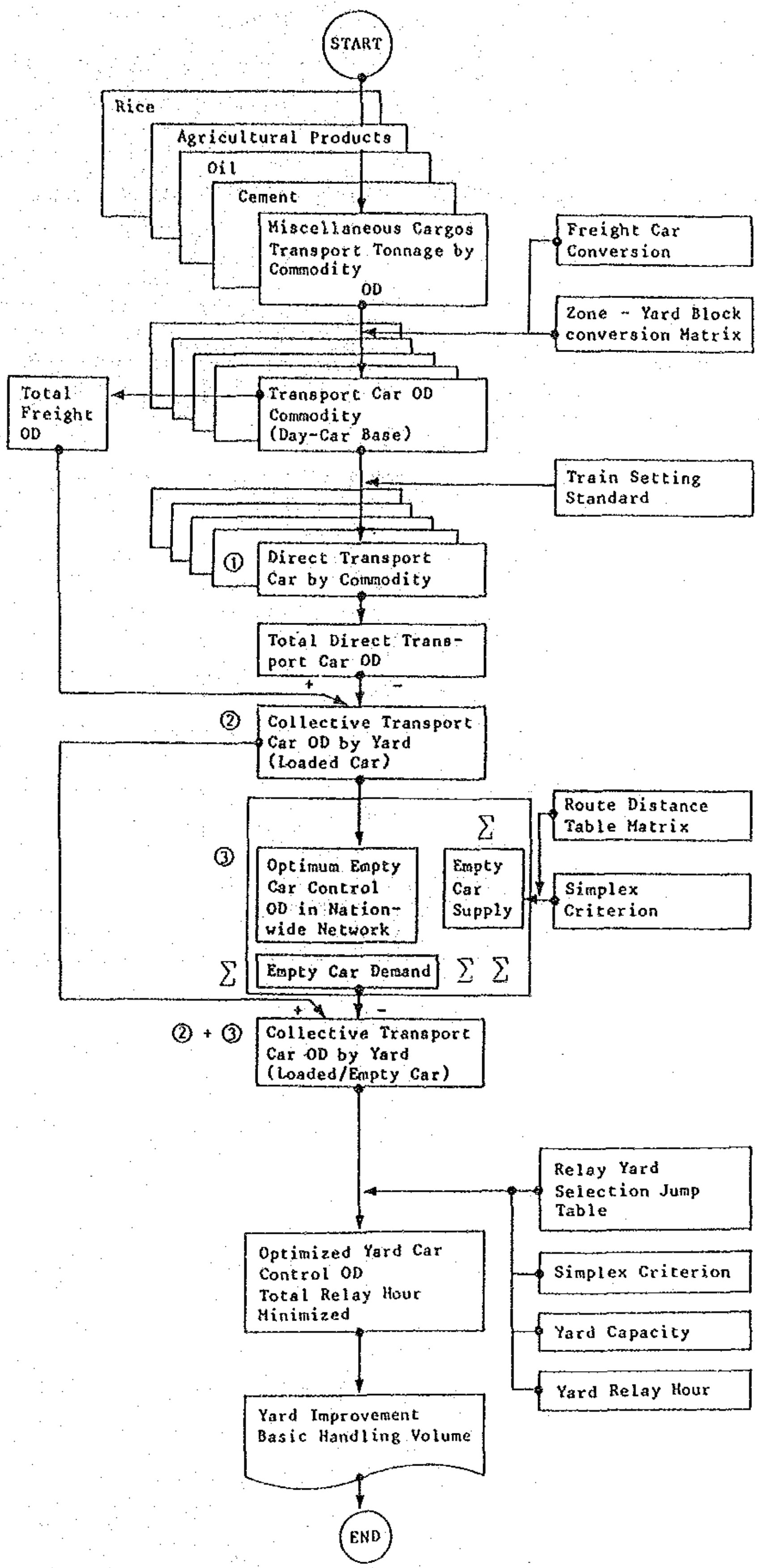


Fig. 5.2.1 Work Flowchart of Functional Assignment

(4) Capacities of main yards and yard relay times

The yard capacities and relay times were determined from the results of the primary field survey as shown in Table 5.2.3.

Table 5.2.3 Capacities of Main Yards and Relay Times

(As of 1984)

District	Yard	Capacity	Relay time
N	Phitsanulok	472 cars/day	6 hours
	Ban Phachi	186	12
NE	Nakhon Ratchasima	268	11
C	Bang Sue	2680	9
	Mae Nam	450	10
E	New Port		10
S	Chumphon	156	12.3
	Surat Thani	118	7.6
	Thung Song	310	10
	Hat Yai	440	15.4