No.57

THE REPUBLIC OF INDONESIA

REPORT
OF
THE FEASIBILITY STUDY
ON
THE ELECTRIFICATION PROJECT OF MAIN LINE IN JAVA

FEBRUARY 1986

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

THE REPUBLIC OF INDONESIA

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(JICA)

PREFACE

In response to the request of the Government of the Republic of Indonesia, the Government of Japan decided to conduct a feasibility study on the Electrification Project of Main Line in Java and entrusted the study to the Japan International Cooperation Agency (JICA).

The JICA sent to Indonesia a study team headed by Mr. Tatsuya Ishihara of the Japan Railway Technical Service from December, 1984 to March, 1985.

The team had discussions on the Project with the officials concerned of the Government of Indonesia including those of the Indonesian State Railways and conducted a field survey.

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

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

I wish to express my deep appreciation to all the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the team.

February, 1986

Keisuke Arita
President
Japan International
Cooperation Agency

JAPAN RAILWAY TECHNICAL SERVICE

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TELEX
J25254
TELEGRAMS
RAILWAYTECHS TOKYO

February, 1986

Mr. Keisuke Arita
President
Japan International Cooperation
Agency
Tokyo, Japan

Dear Sir,

LETTER OF TRANSMITTAL

We have the pleasure of submitting to you herewith the final report of the Feasibility Study on the Electrification Project of Main Lines in Java in the Republic of Indonesia.

The Study was conducted during the period from December 1984 to March 1985, including the field surveys carried out twice, firstly from December 1984 to January 1985 and secondly from February to March 1985.

The study formulated the AC electrification system for the main line, including the railway traction system between the present DC-system in JABOTABEK area and the main line AC-system, and examined the effects of the Project on the nation's economy and PJKA's finance.

We hope that the Study will serve as the base for future implementation of the Project, and accordingly, contribute to further development of Indonesia.

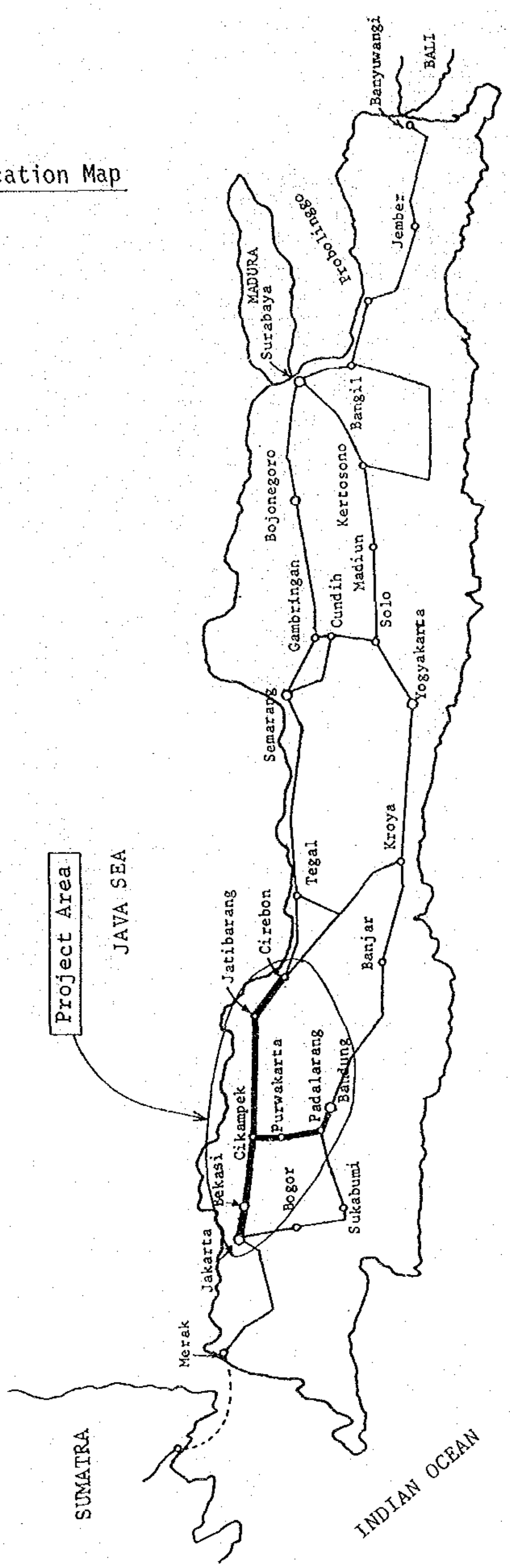
We wish to express our sincere gratitude to the officials of your Agency, Advisory Committee, the Embassy of Japan in Indonesia and those concerned of the Government of the Republic of Indonesia for their kind assistance and cooperation extended to the Study Team.

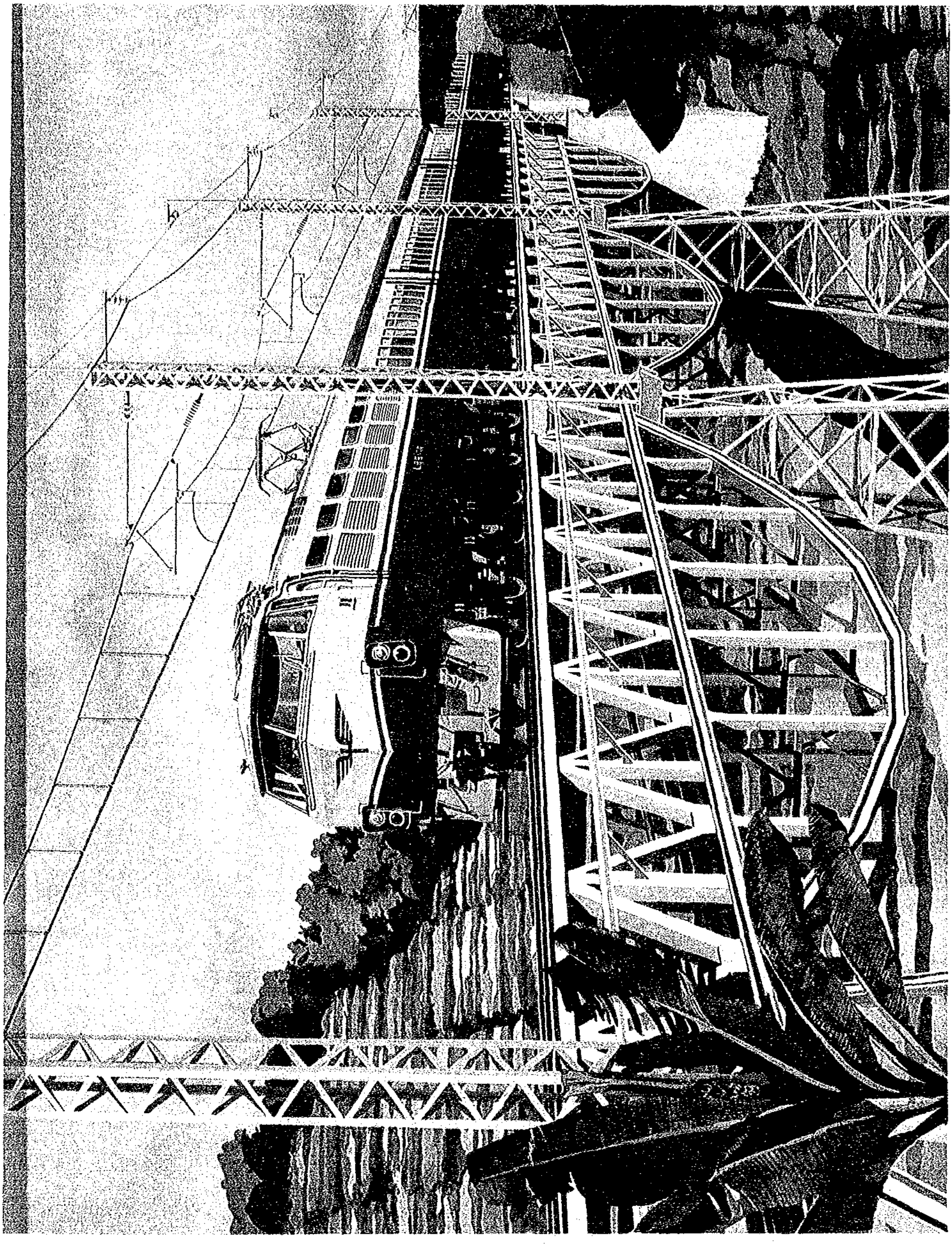
Very truly yours,

M. Takiyama

Mamoru Takiyama
President
Japan Railway Technical Service

Project Location Map





CONTENT

TABLE LIST

Page

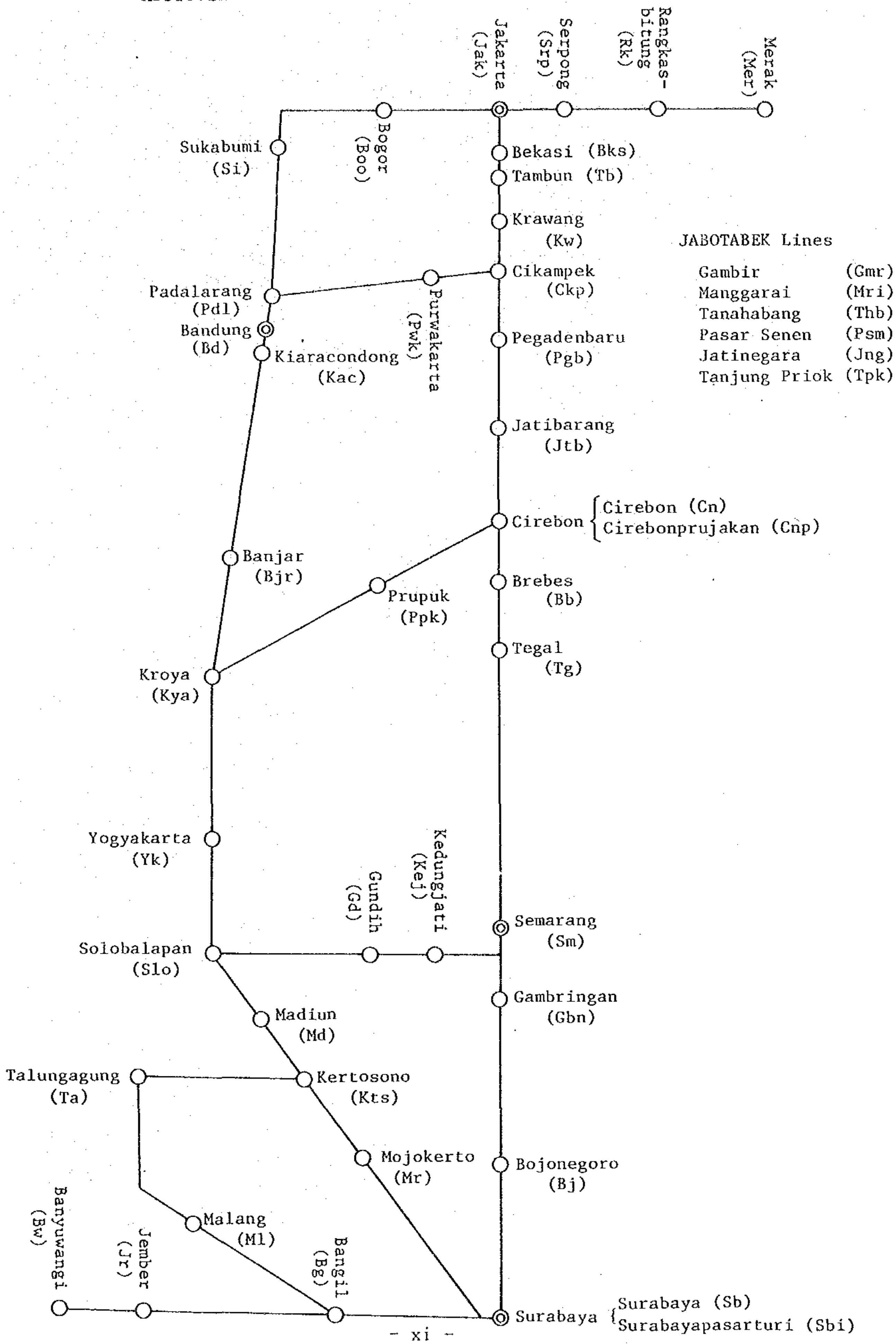
Page

Page

FIGURE LIST

Page

Abbreviations of Station Name of the Main Line in Java



CHAPTER 1 INTRODUCTION

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1-1 Study Background

Since 1969 when the government started the First five-year Development Plan (REPELITA), the Republic of Indonesia has achieved a stable economic growth making use of its abundant petroleum resources as a source of both energy and funds. However, the worldwide recession in recent years has retarded the petroleum export, leading to insufficient government development funds. At the same time, the recent economic growth has accelerated domestic petroleum consumption.

To cope with this situation, the government has been pursuing the policies to reform its excessive dependency on petroleum, developing alternative energy resources and conserving energy.

Regarding land transportation, the government has emphasized the development of road transportation as a key infrastructure to support the economic activities of the country. However, the rapid increase in motor vehicles (15% annually) has outpaced road construction, particularly in the major cities and intercity links in Java.

Java has 61% (98.7 million) of the total population and produces some 80% of the country's GDP, while its land represents only 7% of the total. As a result, significant traffic-related problems, such as traffic jams, road accidents, and air pollution (caused by exhaust gas) have recently been observed. Furthermore, since the transportation sector consumes relatively large share of petroleum, road transport is considered as a major bottleneck in petroleum savings.

Realizing this situation, the government has planned to improve and augment the existing railway transport. In this context, the government has approved the Master Plan, prepared in 1983 by the Japan International Cooperation Agency (JICA), on upgrading the railway main lines by modernization and electrification which will take advantage of the power networks rapidly strengthened in recent years.

Consequently, the government of Indonesia requested the government of Japan to conduct a feasibility study, based on the Master Plan, on electrification of the Jakarta - Bandung and Cikampek - Cirebon sections. In response to the request, JICA sent a preliminary survey team to Indonesian in July 1984, reaching an agreement with the Indonesian government on the scope of the study. Based on the agreement, the Study was started in December 1984.

1-2 Objective of the Study

This Study is designed to examine the feasibility of a railway electrification project in the Jakarta - Bandung and the Cikampek - Cirebon sections (hereinafter referred as "the Section") to improve transport capacity, services, railway management, and promote more efficient use of petroleum resources.

The railway sections to be electrified under the project are shown in Fig. 1.2.1.

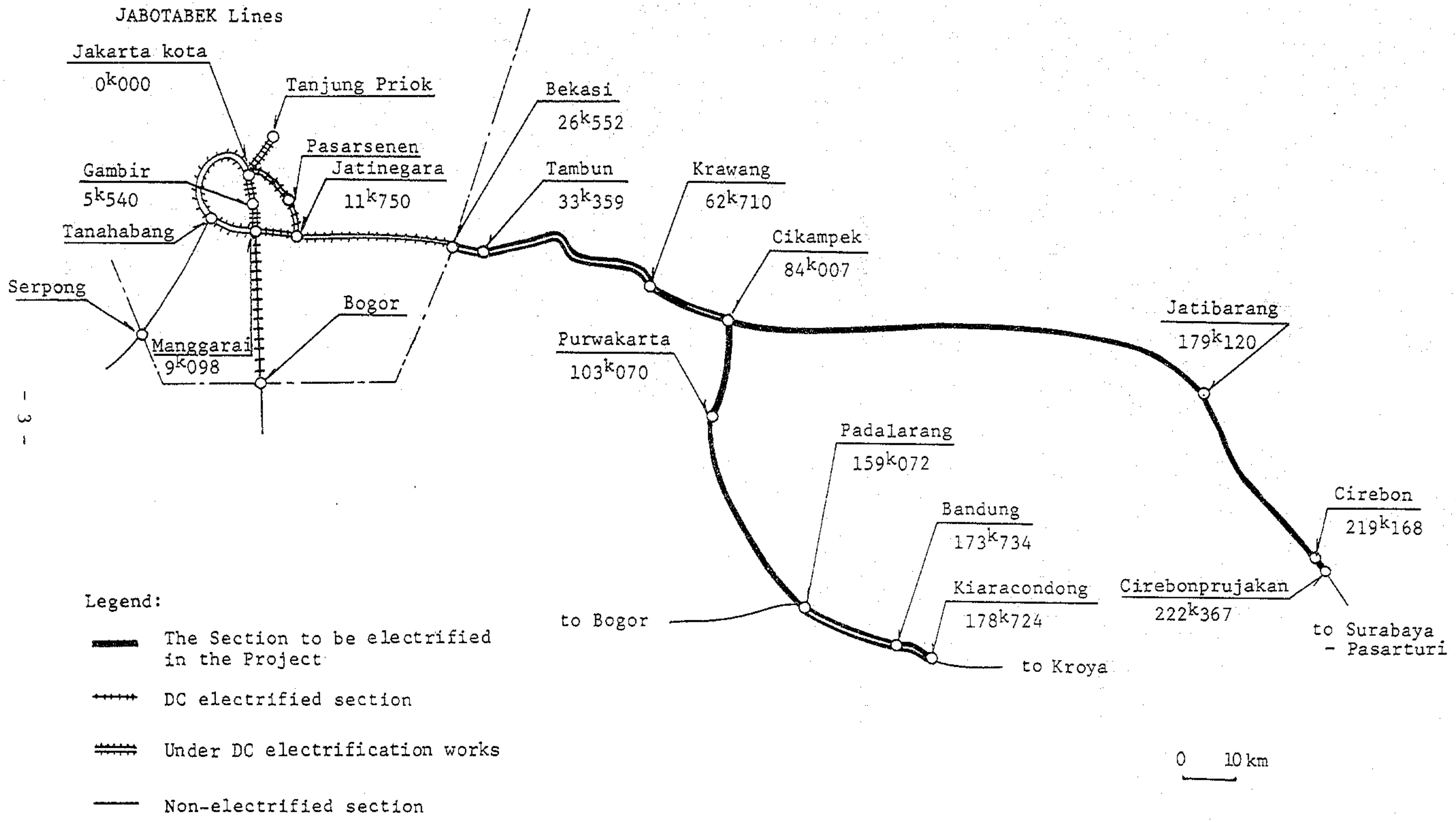


Fig. 1.2.1 Railway Map of Electrification Project Area

1-3 Basic Policy of the Study

This Study was conducted based on the following principles.

(1) Existing rolling stock and facilities will be utilized as far as possible to minimize the investment.

(2) The project will be designed considering the future expansion of electrification.

(3) Coordination with related transportation improvement plans will be fully considered.

(4) Local labor force and resources will be used as much as possible in order to stimulate domestic industries.

(5) Technology transfer in the areas of railway construction, management, train operation, and maintenance will be fully considered.

1-4 Study Schedule

The study schedule is shown in Table 1.4.1.

Table 1.4.1 Study Schedule

Work \ Year	1984/85				1985/86										
	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2
Preparatory Work in Japan	□														
Work in Indonesia (I)	■	■													
Work in Indonesia (II)			■	■											
Work in Japan (I)		□	□												
Work in Japan (II)						□	□	□							
Presentation and discussion of the Interim Report									■	■					
Work in Japan (III)										□	□	□			
Presentation and discussion of the Draft Final Report													■		
Work in Japan (IV)														□	
Submission of the Final Report														▽	

■ : Work in Indonesia　　□ : Work in Japan

1-5 Organization for the Study

1-5-1 Advisory Committee

Hiroyuki KOBAYASHI - Chairman
Director of Safety Division,
National Railway Department,
Minister's Secretariat, Ministry of Transport

Makoto TAKAHARA - Traffic demand forecast
Deputy Director of General Affairs Division,
Regional Transport Bureau, Ministry of Transport

Yoshio SHIRATO - Electrification planning
Chief of Ojima Rolling Stock Maintenance Shop/
Engineering Advisor of Transportation Bureau,
Tokyo Metropolitan Government

Masayasu KOKUBO - Economic and financial analysis
Chief of Cooperation Section, International
Cooperation Division, International Transport and
Tourism Bureau, Ministry of Transport

1-5-2 Study Team

Tatsuya ISHIHARA - Team leader

Heiichi SHINKAI - Deputy leader/System engineering

Kiminari TACHIYAMA - Traffic demand forecast (Passenger)

Tadashi ISHIKAWA - Traffic demand forecast (Freight)

Tei KOJIN - Train operation

Noboru FUNAKOSHI - Electrification and overhead contact system

Motoo SAKAI - Power supply system and substation

Akira YAMAGUCHI - Signalling and telecommunications

Yoshiichi YOSHIKAWA - Signalling and telecommunications

Takatoshi YAMADA	- Track and station
Mitsuo FUKUDA	- Track and station
Seisuke YOSHIDA	- Structure
Akio ISHIGURO	- Rolling stock and workshop
Hideo DENDA	- Economic and financial analysis

1-5-3 Indonesian Counterparts

Ir. DJAUHARI P.	- Project officer	(PHBD)
Drs. BOEDI SOEHARNO	- Project officer	(PMG)
Ir. EDDY RUSLANI	- Project officer	(PJKA)
Ir. MULYADI H	- Administrator	(PHBD)
Drs. SRIYOTO	- Administrator	(PMG)
Ir. P. TARIGAN	- Passenger traffic demand	(PHBD)
Dr. BADAR ZAENIE	- Passenger traffic demand	(PMG)
SOENARDJO	- Freight traffic demand	(PJKA)
TOHIR KARTA BRATA	- Freight traffic demand	(PMG)
Drs. SOEDARMADJI	- Economist	(PJKA)
Drs. RAIS BAKAR	- Economist	(PHBD)
S. SOEHARTO	- Train operation	(PJKA)
Ir. HERU SASONGKO	- Train operation	(PMG)
SOEGANPARI	- Rolling stock and workshop	(PJKA)
Dipl. Ing. MURDIAWAN	- Rolling stock and workshop	(PMG)
SOEKISWO	- Electrification and power supply	(PJKA)
Ir. SYAHRIAR BACHTIAR	- Electrification and power supply	(PMG)

SOETOJO	- Signalling and telecommunications	(PJKA)
Ir. MANURIYANTO	- Signalling and telecommunications	(PMG)
Ir. SYAIFUL SAID	- Signalling and telecommunications	(PMG)
Ir. PY. SOEYATNO	- Track and structure	(PJKA)
Ir. NICHO DH. DJAJASINGA	- Track and structure	(PMG)
Ir. WAHYUDI	- City planner	(PJKA)
Ir. MARNALOM	- City planner	(PHBD)

JICA Export

Akira TAMURA	- Special Advisor to PHBD	
Kazunaga KURAUCHI	- Special Advisor to PHBD	(The predecessor)
Hiroshi NISHIZIMA	- Special Advisor to PHBD	(The successor)
Masahiro YOSHIDA	- Special Advisor to PHBD	
Nobuo FUKUI	- Special Advisor to PHBD	

CHAPTER 2 SOCIAL AND ECONOMIC FRAMEWORK

CHAPTER 2 SOCIAL AND ECONOMIC FRAMEWORK

2-1 Basic Concept

In establishing the social and economic framework for this study, the Five-Year Development Plan (REPELITA), regional plans and the electrification master plan of the main railway lines in Java were examined, taking into consideration the economic situation of the country and the trend of world economy.

2-2 Economy

2-2-1 Economic Development and Industrial Structure

During the past ten years (1974 - 1983), the GDP grew at an average annual rate of 6.3%, mainly due to high oil prices. It should be noted, however, that the growth rate dropped to 2% in 1982 and 1983 due to the worldwide recession and a sluggish oil market (see Table 2.2.1).

Table 2.2.1 GDP Growth Rate (Actual)

	1969-1973 (REPELITA I)	1974-1978 (REPELITA II)	1979	1980	1981	1982	1983	1979-1983 (REPELITA III)	1974-1983
Average annual growth rate	7.7%	6.9	6.3	9.9	7.9	2.25	* 2.15	5.7	6.3

Note : * Estimated from the average annual growth rate (5.7%) between 1979 - 1983 and the actual growth rate between 1979 - 1982.

Source: Statistical Year Book of Indonesia (1983)

The GDP in 1983 amounted to 73,692 billion rupiahs, resulting in a per capita GDP of 466,158 rupiahs. In the past ten years between 1972 and 1982, the share of the agriculture sector declined while those of manufacturing, construction, electric-power, and water/gas-supply sectors increased. GDP composition is shown in Table 2.2.2

Table 2.2.2 Sectoral Composition of GDP

(Unit: billion Rp.)

Sector	1972		1977		1982	
	Amount	%	Amount	%	Amount	%
(Constant prices of 1978)						
Agriculture	2,479.0	40.8	2,981.3	33.6	3,669.8	29.8
Mining	674.0	11.1	1,070.0	12.0	939.8	7.6
Manufacturing	564.0	9.3	1,057.7	11.9	1,900.7	15.4
Electricity, gas, water	26.2	0.4	49.0	0.6	105.5	0.9
Construction	222.0	3.7	463.8	5.2	757.8	6.1
Transportation, communication	229.0	3.8	438.7	4.9	716.6	5.8
Commerce, finance, service	1,873.0	30.9	2,821.5	31.8	4,235.2	34.4
GDP	6,067.2	100.0	8,882.0	100.0	12,325.4	100.0
(Nominal market prices)						
Agriculture	1,837.0	40.3	5,905.7	31.0	15,668.3	26.3
Mining	491.0	10.8	3,599.7	18.9	11,707.8	19.6
Manufacturing	448.0	9.8	1,816.9	9.5	7,680.7	12.9
Electricity, gas, water	20.0	0.4	105.6	0.6	380.3	0.6
Construction	174.0	3.8	1,023.3	5.4	3,507.2	5.9
Transportation, communication	182.0	4.0	842.9	4.4	2,795.2	4.7
Commerce, finance, service	1,412.0	30.9	5,738.9	30.2	17,893.1	30.0
GDP	4,564.0	100.0	19,033.0	100.0	59,632.6	100.0

Source: NOTA KEUANGAN 1984/85

(1) Agriculture

The agriculture sector is labor intensive; with 113.9 million people, or 78% of the total population, residing in rural areas (1980 Census) and about 55% of the working population engaged in it.

The government has given priority to paddy production, and has implemented various programs for this purpose. As a result, paddy production almost doubled during the period between 1969 and 1982, from 12.25 million tons to 23.19 million tons, almost attaining self-sufficiency in terms of rice.

(2) Mining

Major mining products are petroleum and natural gas. Petroleum production increased dramatically after 1967, and reached 615 million barrels in 1977. Although it slightly declined thereafter due to the worldwide recession and production curtailment among OPEC countries, it is expected to resurge with the recovery of the world economy (see Table 2.2.3).

Indonesia has large natural gas reserves, and natural gas production has been growing rapidly owing to successful LNG projects. Production reached 1,112 million Mcf in 1982; approximately 50% of which was exported as LNG with the remaining used locally as industrial raw material and fuel. Indonesia also produces a large amount of tin (35 thousand tons in 1983), the second in the world, which is expected to increase for exports.

Table 2.2.3 Crude Oil/Natural Gas Production

Year	Crude oil (10^6 Barrel)	Natural gas (10^6 Mcf)
1975	476.8	
1976	550.3 (100)	312.1 (100)
1977	615.1 (112)	542.6 (174)
1978	596.7 (108)	820.1 (263)
1979	580.4 (105)	988.5 (317)
1980	577.0 (105)	1,045.7 (335)
1981	584.8 (106)	1,123.7 (360)
1982	488.2 (89)	1,119.3 (359)
1983	564.7 (103)	1,766.0 (566)

Source: Statistical Year Book of Indonesia (1983)

(3) Manufacturing

The manufacturing sector has grown at a rapid rate with the guidance of the government since the REPELITA I. As a result, such industries as plywood, cement, textiles, garments, chemical fertilizer and plate glass have become competitive in the world market.

2-2-2 Government Finance

Since the REPELITA I, the government has maintained sound finance by which the amount of foreign loans has been controlled within the government's reimbursement capability, while the budget grew with the increase in revenues, which in 1983 became twice that of 1979 (see Table 2.2.4).

A major portion of government revenue has come from petroleum/gas related taxes, representing 64.2% of the total in 1983. Although foreign loans have increased steadily, their share in total revenues declined from 17.1% in 1979 to 16.6% in 1983. Expenditures include ordinary disbursements and development outlays, the latter including foreign loans allocated for development investment.

Table 2.2.4 Government Finance

(Unit: billion Rp.)

Item \ Year	1979	1980	1981	1982	1983
Revenue (A)	6,696.8	10,227.0	12,212.6	12,418.3	13,823.6
	(100)	(100)	(100)	(100)	(100)
Oil/gas revenue	4,259.6	7,019.6	8,627.8	8,170.4	8,869.1
	(63.6)	(68.6)	(70.6)	(65.8)	(64.2)
Oil	4,096.3	6,403.7	7,942.7	7,449.8	7,902.6
	(61.2)	(62.6)	(65.0)	(60.0)	(57.2)
Gas	163.3	615.9	685.1	720.6	966.5
	(24.4)	(6.0)	(5.6)	(5.8)	(7.0)
Non-oil revenue sources	2,437.2	3,207.4	3,584.8	4,247.9	4,954.5
	(36.4)	(31.4)	(29.4)	(34.2)	(35.8)
Taxes	2,249.9	2,891.7	3,248.4	3,812.3	4,452.5
	(33.6)	(28.3)	(26.6)	(30.7)	(32.2)
Other	187.3	315.7	336.4	435.6	502.0
	(2.8)	(3.1)	(2.8)	(3.5)	(3.6)
General expenditures (B)	4,061.8	5,800.0	6,977.6	6,996.3	7,275.1
	(50.3)	(49.5)	(50.1)	(48.7)	(43.9)
Government savings (C)	2,635.0	4,427.0	5,235.0	5,422.0	6,548.0
(A - B)	(32.6)	(37.8)	(37.6)	(37.8)	(39.5)
Foreign aid (D)	1,381.1	1,493.8	1,709.0	1,940.0	2,741.8
	(17.1)	(12.7)	(12.3)	(13.5)	(16.6)
Development expenditures (E)	4,016.1	5,920.8	6,944.0	7,362.0	9,290.3
(C + D)	(49.7)	(50.5)	(49.9)	(51.3)	(56.1)
Total expenditures (F)	8,077.9	11,720.8	13,921.6	14,358.3	16,565.4
(B + E)	(100)	(100)	(100)	(100)	(100)
Total expenditures/GDP (%)	25.2	25.8	25.8	24.1	22.8

Source: REPELITA IV.

The government aims to reform its financial position from over-dependency on petroleum, by means of export promotion of non-petroleum products, revenue increases through tax reform, subsidy cuts and expenditure cuts utilizing the private sector resources.

2-2-3 Trade

Indonesia exports petroleum, LNG and other primary commodities, and imports raw materials, intermediate products and capital goods.

In 1982, petroleum and gas represented nearly 80% of total exports, with primary commodities as a whole representing 95%. On the other hand, foods/raw materials represented some 10% of total imports, petroleum and petroleum products 21%, chemical and steel products 16%, and machinery and transportation equipment 37%. The balance of payments in 1982 recorded a large deficit due to sluggish export, but improved in 1983 as a result of the devaluation of the rupiah, export recovery due to better market conditions for primary commodities, import control, and scaling down of development projects.

2-2-4 Population

The population of Indonesia, increasing at an average annual rate of 2.2% since 1961, totaled to 158.1 million as of 1983 (the fifth in the world). More than 60% of the total population concentrates on Java which occupies only 7% of the total land area, and its population density of 733 persons/km^2 is the highest in the world for an island.

Indonesia had a working population (10 years of age and over) of 52.4 million in 1980, which increased at an average annual rate of 2.7% from 1971. Employment did not catch up with the increase, causing an unemployment rate of 27% in rural areas and 17% in urban areas (see Tables 2.2.5 - 2.2.6).

Table 2.2.5 Population Trends

Item	Year	Java	Other island	Indonesia
Growth rate	1961 - 1971	1.91%	2.40%	2.07%
	1971 - 1981	2.04	3.00	2.15
	1981 - 1983	1.89	2.74	2.21
	1961 - 1983	2.00	3.00	2.24
Population (million)	1983	96.9	61.2	158.1
Population density (persons/km^2)	1983	733	34	82

Source: Statistical Year Book of Indonesia (1983)

Table 2.2.6 Working Population

(Unit: thousand)

Population \ Year	1971	1980	Growth Rate
Working (10-year-old or older)	41,261	52,421	2.7% per year
Non-working	39,246	51,931	
Total	80,507	104,352	

Source: Statistical Year Book of Indonesia (1983)

2-3 Energy Situation

2-3-1 General

Energy consumption per capita in Indonesia is 157 kg (in terms of petroleum), which is 1/8 of the world average of 1,255 kg (see Table 2.3.1). Energy consumption has increased at a rate twice that of the GDP after 1970, and is expected to grow at a higher rate along with the economic growth. Industry, transportation and households each represents 30% of total energy consumption. Energy for commercial use in 1983 is as shown in Table 2.3.2.

Table 2.3.1 Energy Consumption per Capita

(Unit: kg of oil equivalent)

Year / Place	1975	1981	1982
Indonesia	112	154	157
World	1,255	1,279	1,255

Source: Annual Statistics of World Energy (1982)

Table 2.3.2 Energy Consumption by Sources

(Unit: million barrels)

Energy source	Consumption	Composition rate (%)
Petroleum	163.661	77.9
Natural gas (including LPG)	37.164	17.7
Coal	1.109	0.5
Hydropower	7.761	3.7
Geothermal power	0.367	0.2
Total	210.062	100.0

Source: REPELITA IV

2-3-2 Petroleum and Natural Gas

In 1982, Indonesia exported 75% of the total petroleum production, and income from it accounted for more than 60% of government revenues. However, exports as well as government revenues have declined in recent years due to declines in world market prices, production cuts and increased domestic consumption. To cope with this tendency, the government is trying to develop non-petroleum energy resources, and energy saving technologies.

Production of natural gas as a petroleum by-product increased with the growth of petroleum production, and its consumption has increased rapidly during the REPELITA III, from 24,495 to 37,164 million barrels in terms of petroleum.

2-3-3 Coal

390 thousand tons of coal was produced in 1983 and consumed at power stations, and cement, carbide and coke plants. Proven reserves of coal exceed 10 billion tons, and its production will be increased during the REPELITA IV to provide a substitute energy source to petroleum; 9.4 million tons being produced in 1988.

2-3-4 Electric Power

Electric power supply represented only 6.5% of the total energy supply in 1981. As of March 1982, State Electric Public Corporation (PLN) recorded an output of 4,653 MW, while 3,300 MW was generated at private power plants. The latter will be incorporated in the PLN system as its network expands. Households consumed 56% of the total power supply in 1978, industries 34% and the commercial sector 10%. Power consumption increased at an average annual rate of 20%, and 5,255 MW power stations, 70/150/500 kV transmission lines totaling 9,329 km in length, and related substations (total capacity of 11,070 MVA) will be constructed during the REPELITA IV period.

2-4 Forecast

In this study, the social and economic forecast for the period between 1984 and 1988 uses development indices adopted in REPELITA IV. For further forecasts, basic development policies are assumed to follow those of REPELITA IV.

2-4-1 REPELITA IV Period (1984 - 1988)

(1) Major economic indices

Major economic indices are shown in Table 2.4.1. Basic policies during the period aim at concentration of public investment on labor intensive sectors, to achieve an annual growth rate of 5% as well as to create more than 9.3 million employments.

The total investment is expected to increase at an average annual rate of 19%, representing 26.7% of GDP of REPELITA IV, while the development expenditures, including foreign aid, are expected to increase at an annual rate of 17.2%.

Table 2.4.1 Major Social and Economic Indices

Indices	Average annual growth rate between 1983 - 1988 (%)	Remarks
Total population	2	1988: 175.6 million persons
Java	1.8	1988: 106.0 "
Other islands	2.6	1988: 69.6 "
Working population	2.8	Increased by 9.32 million persons
Investment	19.1	
Consumption	16.3	
Export	10.0	
Import	7.9	
GDP	5	Real growth rate
GDP per capita	2.9	

Source: REPELITA IV

(2) GDP growth rate by sector

Major sectors in GDP are expected to grow as shown in Table 2.4.2. The manufacturing sector is expected to grow at the rate of 9.5% per year, the highest of all sectors, increasing its share from 15.8% in 1983 to 19.4% in 1988.

Table 2.4.2 GPD Growth Rate by Sector

Period / Sector	1983/1984 (%)	Growth rate planned in PELITA IV (%)	1988/1989 (%)
Agriculture	29.2	3.0	26.4
Mining	7.4	2.4	6.6
Manufacturing	15.8	9.5	19.4
Construction	6.3	5.0	6.3
Transportation, communication	6.0	5.2	6.0
Other	35.3	5.0	35.3
Total	100.0	5.0	100.0

Source: REPELITA IV

(3) Trade and balance of payments

Exports are expected to grow at an average annual rate of 10% (see Table 2.4.3), with industrial products assuming a larger share in total exports.

Table 2.4.3 Export

(Unit: million US dollars)

Item \ Year	83/84	84/85	85/86	86/87	87/88	88/89	Average annual growth rate (%)
Petroleum/gas	14,140	13,825	15,424	17,317	19,008	20,363	7.6
• Crude oil, petroleum products	11,861	10,644	11,873	13,463	14,664	15,766	5.9
• Liquefied natural gas	2,279	3,181	3,551	3,854	4,344	4,597	15.1
Non-petroleum products	5,170	6,050	7,009	8,015	9,215	10,753	15.8
• Agricultural products	2,597	2,859	3,123	3,395	3,717	4,160	9.9
• Mineral products	652	740	841	963	1,066	1,166	12.3
• Industrial products	1,921	2,451	3,045	3,657	4,432	5,427	23.1
Total	19,310	19,875	22,433	25,332	28,223	31,136	10.0

Source: REPELITA IV

As to imports, food is expected to decrease remarkably, while raw materials, semi-finished products and capital goods will increase at an average annual rate of 9.4% as a whole (see Table 2.4.4).

Table 2.4.4 Import

(Unit: million US dollars)

Item \ Year	83/84	84/85	85/86	86/87	87/88	88/89	Average annual growth rate (%)
Petroleum	4,114	3,885	4,260	4,573	4,979	5,504	6.0
Liquefied natural gas	155	212	237	260	291	301	14.2
Non-petroleum products	12,804	13,190	14,482	16,011	17,636	19,194	8.4
· Consumer products	1,767	1,780	1,825	1,921	1,976	1,904	1.5
· Food	615	601	569	534	480	381	-9.1
· Non-food products	1,152	1,179	1,256	1,387	1,496	1,523	5.7
· Raw material, semi-finished products	5,608	5,771	6,256	6,661	7,195	7,812	6.9
· Capital goods	5,429	5,619	6,401	7,429	8,465	9,478	11.8
Total	17,073	17,287	18,979	20,844	22,906	24,999	7.9

Source: REPELITA IV

(4) Development investment

Development budget allocation plan by sector is as shown in Table 2.4.5.

Table 2.4.5 Development Expenditures Plan

Sector	Investment in billion Rp.	Share in %
Agriculture	10,014	12.7
Manufacturing	4,281	5.4
Mining, energy	12,126	15.4
(1) Mining	2,497	3.2
(2) Energy	9,629	12.2
Transportation, communication, tourism	9,923	12.6
(1) Road	4,220	5.4
(2) Land transport	1,593	2.0
(3) Sea transport	1,964	2.5
(4) Air transport	1,324	1.7
(5) Other	822	1.0
Business, cooperatives	969	1.2
Labor, emigration	4,552	5.8
Urban and regional development	5,379	6.8
Religion	507	0.6
Education, culture, youth	11,540	14.7
Public health, social welfare, family planning	3,517	4.5
Housing	2,980	3.8
Other	12,821	16.5
Total	78,609	100.0

Source: REPELITA IV

(5) Population

Both birth and death rates are expected to decline, and the population growth rate is expected to decline to less than 2% per year.

2-4-2 Post-REPELITA IV Period (1989 - 2007)

(1) Economic growth rate

After REPELITA IV period, the world economy is expected to enter a restrained growth period with a medium inflation due to protectionism, currency control and high interest rates of the developed countries. Based on these assumptions, the GDP growth rate is estimated to be lower than that in REPELITA IV, as follows:

1989 - 1992 4.5%
1993 - 2007 3.5%

(2) Population

Population growth rate in Java is estimated on the basis of projections made by the government and DKI Jakarta as shown in Table 2.4.6.

Table 2.4.6 Population Growth Rate Forecast of Java

Year \ Area	Java	JABOTABEK		Other areas
		DKI Jakarta	Botabek	
1983 - 1988 (REPELITA IV)	1.8%	1983 - 1985 3.8%	3.0%	1983 - 1992 1.4%
1988 - 2002	1.7	1985 - 1990 3.1 1990 - 1995 2.3 1995 - 2000 2.0	3.5 2.6 2.3	1992 - 1997 1.6 1997 - 2002 1.6
2002 - 2007	1.7*	2000 - 2005 1.8 2005 - 2007 1.7*	2.0 2.0*	2002 - 2007 1.7*

Note : * Estimated value in the study

Source: Statistical Year Book of Indonesia (1983)

CHAPTER 3 CURRENT STATE OF TRANSPORTATION

CHAPTER 3 CURRENT STATE OF TRANSPORTATION

3-1 General Background

3-1-1 General

The government of Indonesia has invested 14 - 16% of its annual budget on transportation improvement projects, following the directions of REPELITA which started in 1969.

In REPELITA III, 2,998.2 billion Rp. were invested in the transportation sector. Of the total, 1,666.5 billion Rp. were spent on road facilities while 338.8 billion Rp. were spent on other modes including railways (proportion of 5:1). Despite emphasis on road facilities (mainly road improvement), its capacity is not sufficient for the ever-increasing road traffic volume, causing traffic congestion in metropolitan areas.

In the railway sector, investment was made by REPELITA III for introduction of the diesel locomotives, electric cars, passenger and freight cars, and railway rehabilitation and improvement, yet the railways represent only 7 - 8% of all land transport.

On the other hand, 524.4 billion Rp. were invested on ports during the REPELITA III.

Nevertheless, coastal transport does not represent a significant share in domestic transport due to the shortage of port facilities, small shipping tonnage and excessive competition among small shipping companies.

In REPELITA IV, which started in 1984, the transport investment plan was made giving priority to road. In 1984, 1,401.4 billion Rp. were allocated to road, 6 times more than the 224.6 billion Rp. allocated to railway.

During the REPELITA IV, approximately 310,000 km of road will be either improved, or constructed. Particularly, the Jakarta - Cikampek and Jakarta inter-urban highways are being constructed, extending existing Jakarta - Tangerang and the JAGORAWI (Jakarta - Bogor - Ciawi) highways.

In the railway sector, since an annual average growth rate of 14% for passenger traffic and 21% for freight traffic are forecast, 4,000 km of track, 2,000 passenger cars and 15,599 freight cars are planned to be repaired.

In the coastal shipping sector, construction of wharfs (total of 19 km), warehouses and container yards as well as channel dredging are planned.

3-1-2 Passenger Traffic

According to an OD survey conducted by BINA MARGA in 1982, passenger traffic volume in Java was estimated at 1,160 million persons/year, most of which was carried by bus. On the other hand, railways carried 43 million passengers in 1983, only 1/27 of the road traffic volume.

Domestic air traffic increased by 31% between 1979 and 1982, reaching 5,550,000 passengers/year, but its share of the total is still small.

The number of registered buses is shown in the Table 3.1.1, according to which, the number of registered buses increased 2.5 times between 1979 and 1983.

Table 3.1.1 Number of Buses by Province

Year / Province	1979	1980	1981	1982	1983
DKI Jakarta	(1.000) 21,655	(1.364) 29,546	(1.777) 38,478	(2.301) 49,827	(2.889) 62,515
Java Barat	(1.000) 8,540	(1.288) 10,997	(1.796) 15,339	(1.989) 16,983	(2.316) 19,775
Java Tengah	(1.000) 5,211	(1.126) 5,865	(1.266) 6,597	(1.806) 9,412	(2.306) 12,015
Java Timur	(1.000) 4,676	(1.055) 4,931	(1.186) 5,544	(1.335) 6,243	(1.409) 6,590
Java	(1.000) 40,082	(1.281) 51,339	(1.646) 65,958	(2.057) 82,465	(2.517) 100,895

Note : Figures within parentheses ( ) indicate the ratio to the number in 1979.

Source: Vehicles and Length of Road Statistics (BPS).

3-1-3 Freight Traffic

Like passenger traffic, freight traffic in Java Island is mostly carried by motor vehicles. According to the OD survey, trucks carried approximately 67.8 million tons/year while railways carried only 2.7 million tons/year in 1983. While truck services cover most of Java, major rail freight flows are limited to such OD pairs as Jakarta - Surabaya, Cilacap - Yogyakarta, and Surabaya - Madium.

Coastal shipping of Java carries cargo, mainly between Jakarta and Surabaya.

The growth of freight traffic by truck was estimated by the number of trucks registered, for the annual freight traffic data by truck were not available (see Table 3.1.2).

Table 3.1.2 Number of Trucks by Province

Year / Province	1979	1980	1981	1982	1983
DKI Jakarta	(1.000) 64,713	(1.162) 75,219	(1.481) 95,858	(1.738) 112,494	(1.960) 126,859
Java Barat	(1.000) 73,554	(1.249) 91,864	(1.501) 110,426	(1.579) 116,113	(1.592) 117,087
Java Tengah	(1.000) 57,006	(1.264) 72,059	(1.431) 81,571	(1.600) 91,200	(1.655) 94,350
Java Timur	(1.000) 53,565	(1.109) 59,380	(1.402) 75,119	(1.740) 93,188	(1.992) 106,689
Java	(1.000) 248,838	(1.200) 298,522	(1.459) 362,974	(1.660) 412,995	(1.788) 444,985

Note : Figures within parentheses ( ) indicate the ratio to the number in 1979.

Source: Vehicles and Length of Road Statistics (BPS).

According to this, the number of registered trucks increased 1.79 times between 1979 and 1983.

3-2 Railway

3-2-1 PJKA

Railways in Indonesia started service in 1864, managed by a private company. After World War II, railway ownership was transferred to the government of the newly independent country. Currently, the railway is operated as a public organization under the Ministry of Communication.

Indonesian State Railways (PJKA) operates approximately 6,700 km of railway in total, 70% of which is in Java Island. In Java Island, the railway networks are formed connecting two metropolises: Jakarta on the west and Surabaya on the east (826 km apart). The railway network of main lines are shown in Fig. 3.2.1.

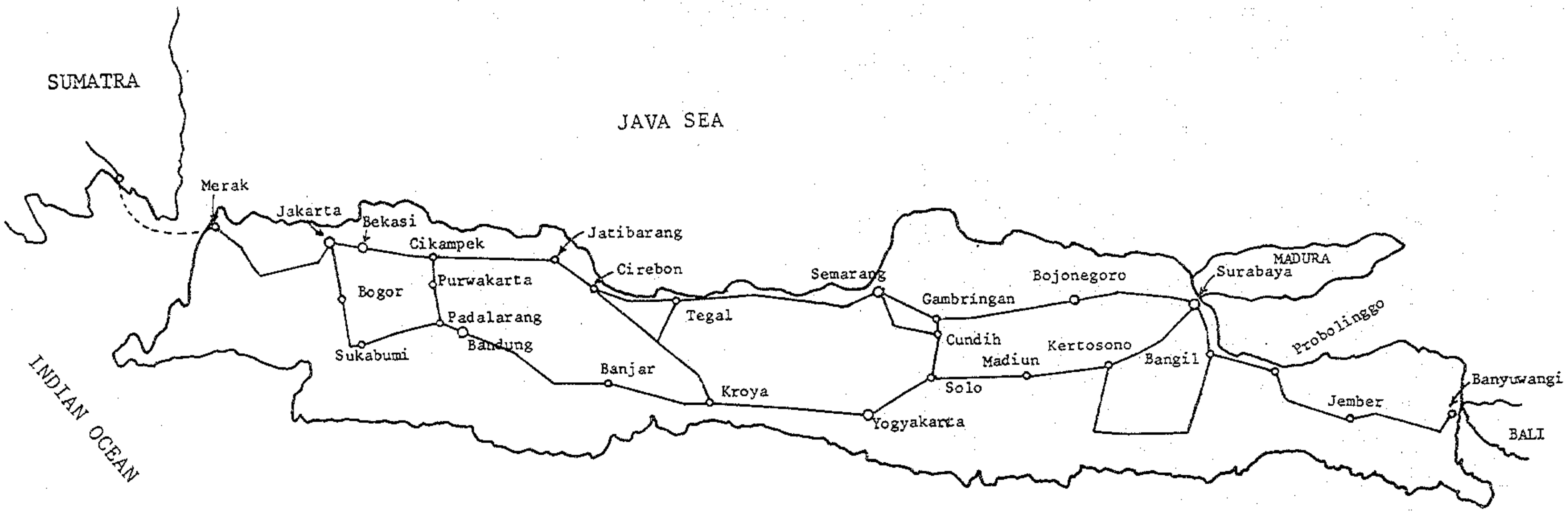


Fig. 3.2.1 Railway Network of Main Lines

PJKA has approximately 50,000 employees, and served 5,573 million passenger-kilometers and 553 million ton-kilometers in 1983. In the same year, it earned 85.6 billion Rp., with expenses of 122.9 billion Rp.

3-2-2 Passenger Traffic

As shown in Table 3.2.1, rail passenger traffic in Java has increased in terms of the number of passengers carried. However, passenger-kilometers, as a basis of revenue, decreased between 1982 and 1983.

Table 3.2.1 Number of Passengers, Passenger-km, and Average Travel Distance

Year	Passenger (million)	Passenger-km (million)	Average travel distance (km)
1977	21	3,460	165
1978	29	4,306	149
1979	37	5,142	139
1980	38	5,410	142
1981	40	5,537	138
1982	41	5,705	139
1983	43	5,573	130

Source: Railways Statistics 1983 (BPS)

Major passenger traffic flows between DKI Jakarta and the state capitals of Bandung, Cirebon, Semarang, Yogyakarta and Surabaya. Within the Jakarta region, passenger flow is concentrated in the terminal stations of Jakarta Kota, Gambir, and Pasarsenen. In terms of class, third class coach service is predominant.

3-2-3 Freight Traffic

As shown in Fig. 3.2.2 rail freight traffic in Java has decreased in terms of freight tons carried. But in 1983, PJKA carried 2.7 million tons/year in Java, a 6.3% increase over the previous year. This tendency is partially attributed to the enforcement of the Government Regulation in 1982, named "Operasi Tertib", which limits the truck traffic by axle load capacity of each road.

Major commodities carried by the railway were mining products, petroleum, cement and fertilizer, amounting to 1.8 million tons/year or 67.9% of the total tonnage carried. Agricultural products such as rice, corn and cassava have been carried less and less by the railway partly because of decreasing production in Java and the extra transport time required for freight car classification, and loading and unloading at stations.

The government plans to use the railway to transport steel and coal which are now carried by other modes.

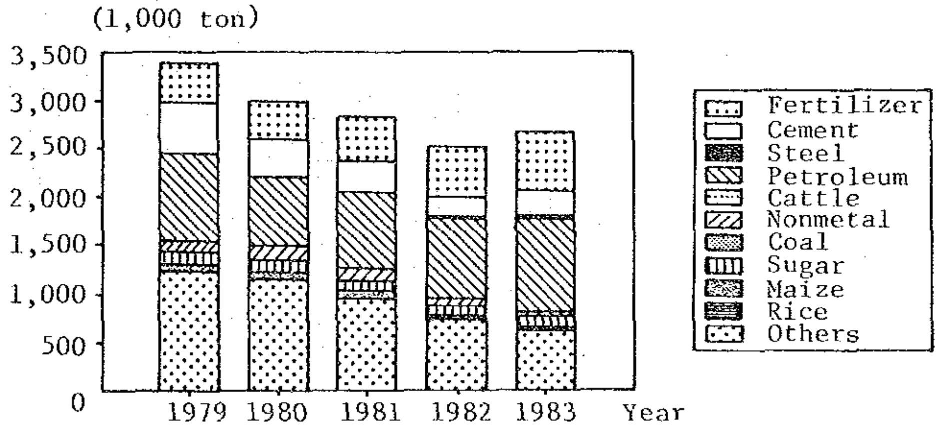


Fig. 3.2.2 Railway Freight

3-2-4 Train Operation

(1) Train routes

Major train operation routes are shown in Fig. 3.2.3.

Passenger trains are operated linking major cities in Java, serving as intermediate and long distance transport. Commuter trains are operated in and around Jakarta, Bandung and Surabaya.

Between Jakarta and Surabaya, passenger trains are mainly operated on the southern line, while freight trains on the northern line.

(2) Number of trains

The number of trains operated are classified by section and train type as shown in Fig. 3.2.4.

On single track sections, 50 trains (both directions) are operated between Cikampek and Cirebon, making it the busiest single track section, while 22 trains are operated between Cikampek and Padalarang.

Express and fast passenger trains have a major share in the total number, with a small share held by local trains. Only 16 express freight trains are operated on trunk lines in Java.

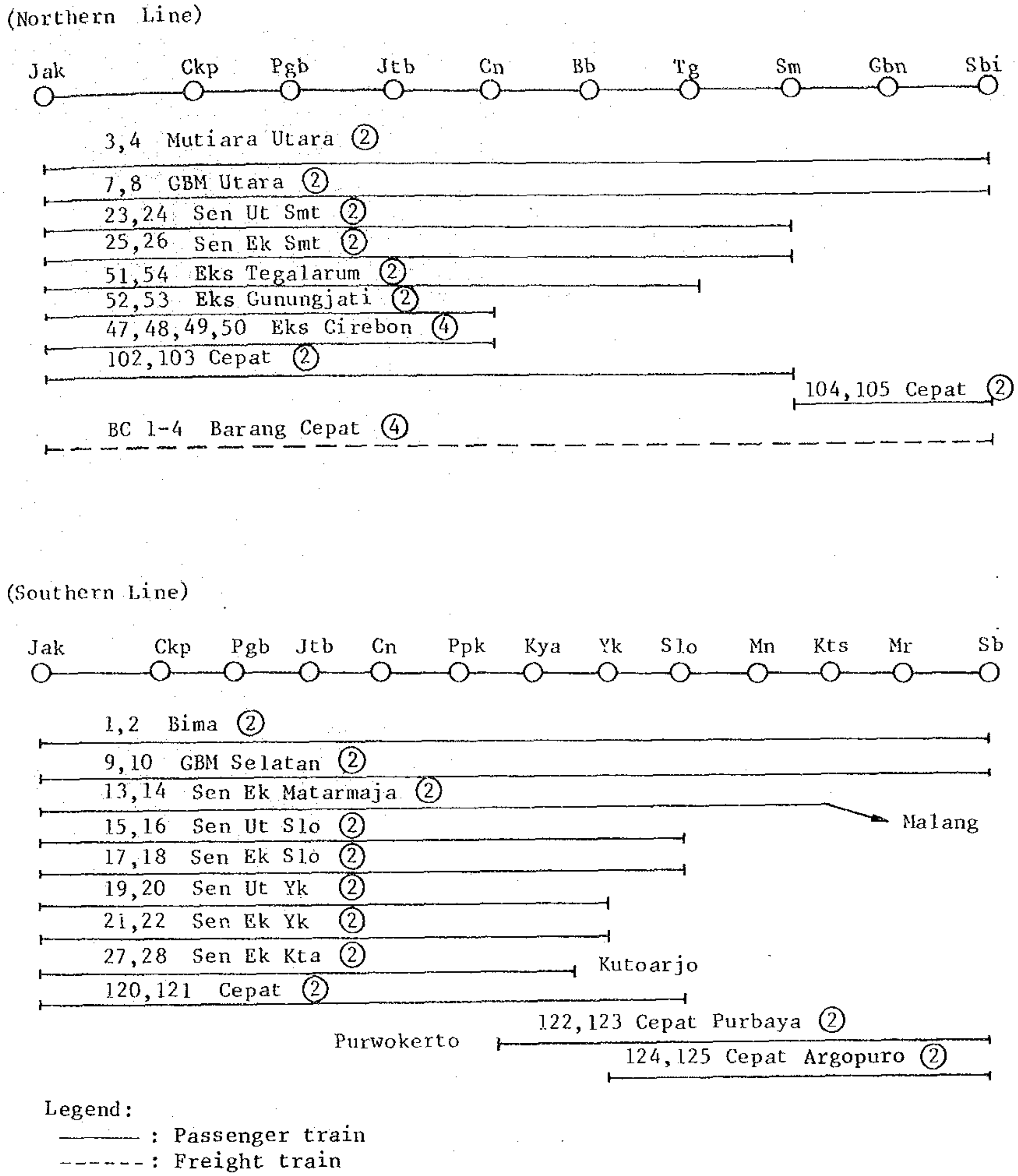


Fig. 3.2.3 (1) Train Operation Route (Apr. 1984)

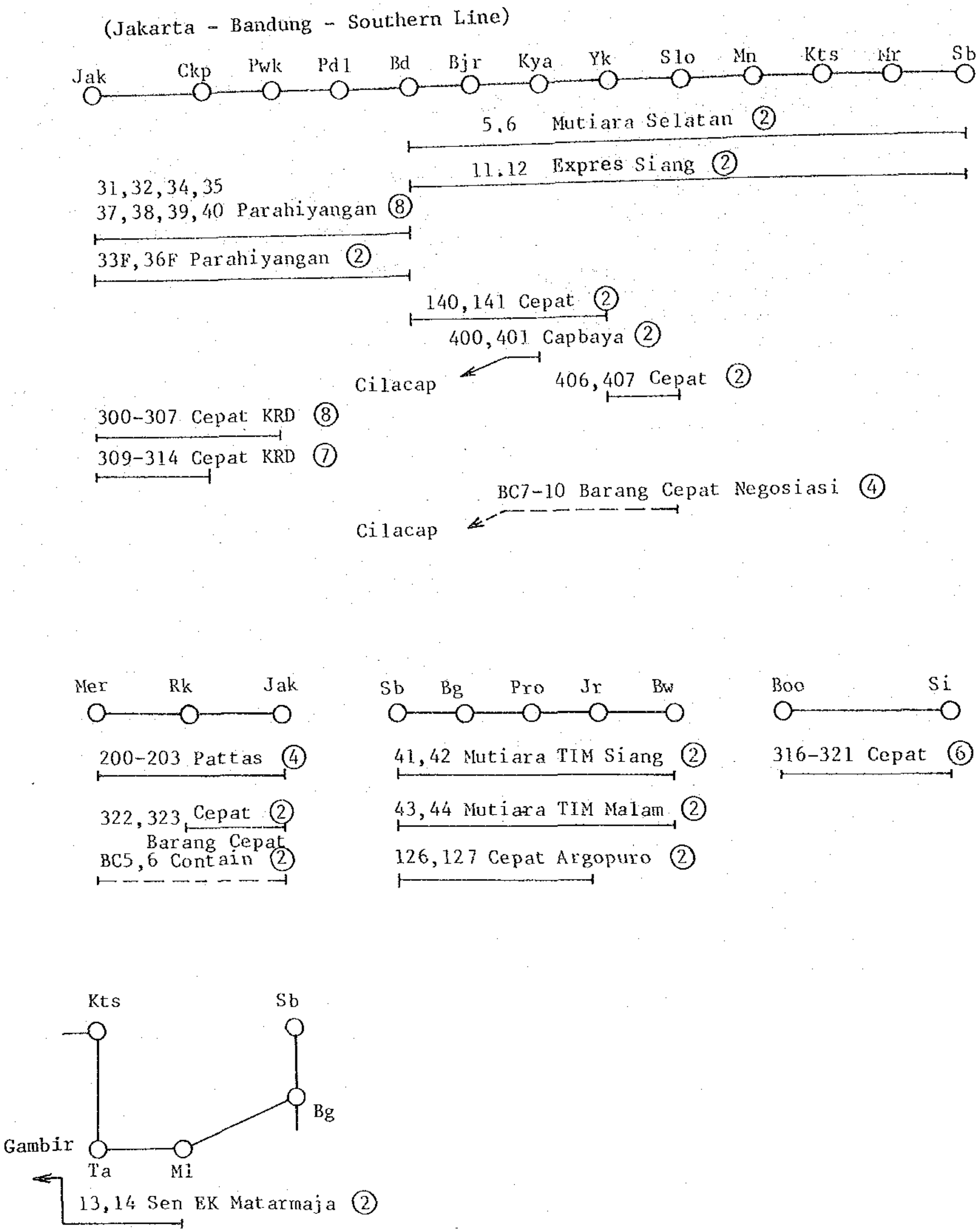
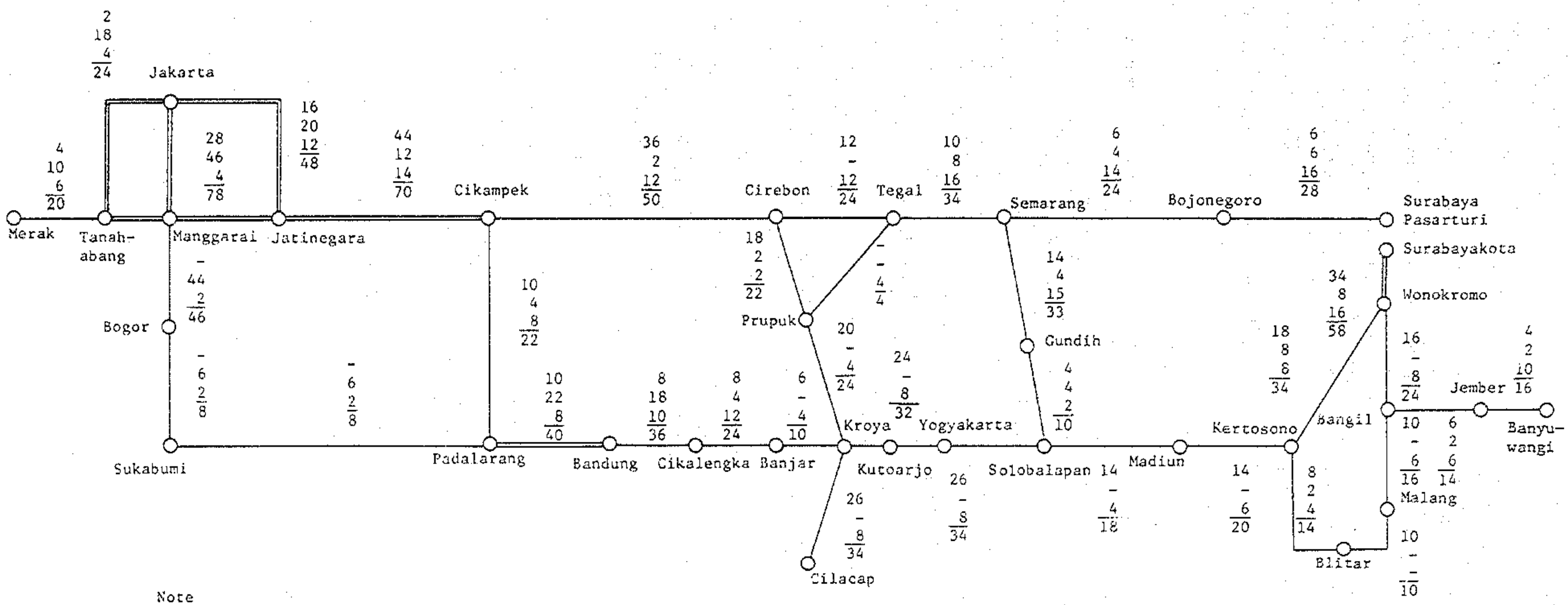


Fig. 3.2.3 (2) Train Operation Route (Apr. 1984)



Note

(1) ——— : Single track
═══ : Double track

(2) 44 .. Express/fast passenger train
12 .. Local/electric MU car/diesel railcar train
14 .. Freight/mixed train
70 .. Total No. of trains (both ways)

Fig. 3.2.4 Number and Types of Trains by Section

(3) Travelling time and scheduled speed

Travelling time and scheduled speed between major stations are shown in Table 3.2.2. The scheduled speed is 55 km/h for the Bima train operated between Jakarta and Surabaya. As to travelling time, PJKA revised the timetable in April 1984 to reduce travelling time considerably. For instance, the Bima train speeded up its travelling time by 75 minutes (8%) and the Cirebon express train between Jakarta and Cirebon by 50 minutes (19%).

Table 3.2.2 Travelling Time and Scheduled Speed of Passenger Trains

Line	Train		Train section	Distance (km)	Travelling time (hr:min.)	Scheduled speed (km/h)
	No.	Name				
Northern Line	3, 4	Mutiara Utara	Jakarta - Surabaya	725.6	14:05	51.5
	23, 24	Sen Ut Smt	Jakarta - Semarang	443.9	7:45	57.3
	47, 48, 49, 50	EKs Cirebon	Jakarta-Cirebon	219.9	3:30	61.1
	BC1 - BC4	Barang Cepat	Jakarta-Surabaya	725.6	20:30	35.4
	DGGW1 - DGGW4	Barang Hanter Kilat	Jakarta-Surabaya	725.6	16:30	44.0
Southern Line	1, 2	Bima	Jakarta-Surabaya	829.8	15:05	55.0
	15, 16	Sen Ut Slo	Jakarta-Solobalapan	576.8	12:10	47.3
	19, 20	Sen Ut Yk	Jakarta - Yogyakarta	517.6	10:10	50.7
	122, 123	Cepat Purbaya	Purwokerto - Surabaya	479.1	11:45	40.8
Bandung Line	31 - 40	Parahiyangan	Jakarta - Bandung	174.5	3:15	53.7
	300 - 307	Cepat KRD	Jakarta - Purwakarta	103.8	2:30	41.5
Other Lines	5, 6	Mutiara Selatan	Bandung - Surabaya	699.5	14:35	48.4
	200 - 203	Pattas	Merak - Tanahabang	151.7	4:00	37.9
	41, 42	Mutiara TIM Siang	Surabaya - Banyuwangi	300.1	7:10	41.7

As to freight trains, freight cars used for local freight trains are not equipped with an air brake system, so their maximum speed is limited to 45 km/h to use hand brakes.

(4) Train make-up and trailing load

The number of cars and trailing load per major passenger train are shown in Table 3.2.3, the maximum being 11 cars and 420 tons. Local passenger trains are operated mainly for distances of less than 150 km and their make-up is 2 - 4 cars.

Freight trains range between 300 - 1,000 tons, mostly 500 tons.

Table 3.2.3. Number of Cars by Passenger Train

Train		Section	No. of cars	Hauling load (t)
No.	Name			
1, 2	Biru Malam	Jakarta - Surabaya	9	358
3, 4	Mitiara Utara	Jakarta - Surabaya	10	385
52, 53	Gunung Juti	Jakarta - Cirebon	8	285
5, 6	Mutiara Selatan	Bandung - Surabaya	9	331
32, 35, 38	Parahiyangan	Jakarta - Bandung	9	330
31, 36, 39	Parahiyangan	Jakarta - Bandung	8	295
27, 28	Sen Ek	Jakarta - Kutoarjo	11	420
23, 24	Sen Ut Smt	Jakarta - Semarang	7	257
102, 103	Cepat Smt	Jakarta - Semarang	6	246

(5) Train operating conditions

Many long distance passenger trains arrive at Jakarta in the early morning and depart from Jakarta in the evening, passing Cirebon at approximately 20 minute headway during the night.

Local freight trains are often canceled due to a shortage of diesel locomotives.

Long distance trains are subject to chronic long delays. Average delays for major trains are shown in Table 3.2.4.

Table 3.2.4 Average Delay Time of Long Distance Passenger Train (Nov. 1984)

Train		Section	Delay time (min.)
No.	Name		
1	Biru Malam	Surabaya - Jakarta	79
3	Mutiara Utara	Surabaya - Jakarta	97
5	Mutiara Selatan	Surabaya - Bandung	30
7	GBM Utara	Surabaya - Pasarsenen	99
9	GBM Selatan	Surabaya - Gambir	97
23	Senja Utara	Semarang - Pasarsenen	93
31	Parahiyangan	Bandung - Jakarta	17
53	EKs Gunungjati	Cirebon - Jakarta	32

Passenger traffic does not show significant seasonal fluctuation, except a peak during the period one week before and after Lebaran when train delays increase considerably.

(6) Rolling stock

The rolling stock owned by PJKA is summarized in Table 3.2.5. Due to a shortage of spare parts, many locomotives are held up in workshops, resulting in a non-service ratio of 30% or more for both diesel locomotives and diesel cars.

Approximately half of freight cars are not equipped with an air brake system, so many freight trains have brake-men on board for braking.

Table 3.2.5 Number of Rolling Stock

DL		EC	DC	PC	FC	
For main line operation	For shunting				With air brake	Without air brake
226	143	80	136	719	4,584	4,724

(7) Workshop

Locations of workshops and types of rolling stock inspected and repaired there are shown in Table 3.2.6.

The machinery and facilities at all of the workshops are superannuated, resulting in low work efficiency and productivity.

Table 3.2.6 Types of Rolling Stock Inspected and Repaired in Workshops

	Manggarai	Semarang	Yogyakarta	Tegal	Surabaya
Types of rolling stock inspected/repaired	EC DC PC	PC	DL	FC	FC

3-3 Present Status of the Project Section

3-3-1 General Situation

The Jakarta - Cikampek - Cirebon and Cikampek - Bandung sections are located in the western part of Java. The area has a large population representing 38.1% of the population of Java and 23.4% of that of Indonesia as a whole, and has the highest population density in the country. DKI Jakarta, the capital of Indonesia, is the center of political, economic and cultural activities. As of 1983, its population and density recorded 7.3 million and 12,370 persons/km^2, respectively.

Bandung is the provincial capital of West Java, and has a long history as the political and cultural center of the country. As of 1983, Bandung had a population of 1,930,000, and the total population of Bandung and Kab. Bandung exceeded 4 million.

Cirebon is a city of medium scale, with a population of 210,000, but it is expected to grow into an industrial city centered around the Cirebon port and will serve as a junction point to Central and East Java.

3-3-2 Railway Transport

(1) Passenger

Currently, PJKA operates 8 express trains (both ways) and 2 fast trains (both ways) between Jakarta and Bandung, carrying a total of 830,000 passengers/year. The railway had a 9.4% share in the total passenger traffic between the two cities, compared to 90.6% for buses in 1983.

Between Jakarta and Cirebon, PJKA operates 32 express trains and 4 fast trains (both ways), carrying 667,000 passengers/year. The railway has an 8.7% share against 91.3% for buses. Characteristics of rail and bus services are compared in Table 3.3.1.

Table 3.3.1 Rail and Bus Services in the Section

Service / Section	Rail			Bus			Share (%)	
	Time (hr:min.)	Charge (Rp.)	Frequency	Time (hr:min.)	Charge (Rp.)	Frequency	Rail	Bus
From Jakarta to Cirebon	3:20 ∫ 4:37	1st 7800 2nd 4500 3rd 2900	18	7:35	2000 ∫ 2400	432	9.4	90.6
From Jakarta to Bandung	4:16 ∫ 3:15	1st 6000 2nd 4500 3rd 1800	5	6:15	1500 ∫ 1750	428	8.7	91.3

(2) Freight

According to the rail freight OD table, freight traffic between Jakarta and Bandung/Cirebon is relatively small; only 3,500 tons of petroleum and 800 tons of fertilizer were carried in 1983 from Jakarta to Bandung. In terms of the cross sectional traffic volume, 120,000 tons of freight passed between Cikampek and Padalarang, while 305,000 tons of freight passed between Cikampek and Pegadenbaru. This freight traffic was originated at or destined for Jakarta and Surabaya.

3-3-3 Railway Facilities

(1) Car depot

a. Diesel locomotive

Depots for diesel locomotives used in the Section are shown in Table 3.3.2.

Table 3.3.2 Number of Diesel Locomotives by Depot

(Feb. 1985)

Type of loco / Depot	CC201	CC200	BB301	BB303	BB306	C300	D300	Total
	1950HP	1600	1500	1000	950	350	340	
Jatinegara	19							19
Cirebon	10	12				2	3	27
Bandung	24		7				12	43
Tanahabang				9	8	20		37

Average running kilometer of CC201 type locomotive is approximately 450 km/day, and its average operating time is 13 - 14 hours.

Each depot conducts daily, monthly, three month, six month and annual checks. Mechanical diesel locomotives are inspected at intervals determined on the basis of engine driving time.

b. Passenger car

Locations of depots for passenger cars used in the Section and their number are shown in Table 3.3.3.

Table 3.3.3 Number of Passenger Cars by Depot

Depot	No. of cars assigned	Name of main trains
Jakarta	94	Biru Malam, Mutiara Utara
Cirebon	24	Tegal Arum, Gunung Jati
Bandung	106	Mutiara Selatan, Parahiyangan

c. Diesel MU car

Diesel MU cars used in the Section are assigned to the Bukitduri, Cirebon and Bandung depots.

(2) Tracks

a. Track structure

Track structure in the Section is of R14/R14A rail, wood ties and 20 cm deep ballast (permitting a maximum speed of 100 km/h), except for the Bekasi - Cikampek section which is being renewed with R54 rail and concrete ties.

Table 3.3.4 Track Structure by Section

Particulars / Section	Section length (km)	Track length (km)	Rail	Tie	Maximum allowable speed (km/h)	Remarks
Jatinegara-Bekasi	14.1	28.2	R14/R14A (R54)	Wood (PC concrete)	100 (120)	Detailed structure is designed under the JABOTABEK project.
Bekasi - Cikampek	57.5	115.0	R54	Wood (PC concrete)	100 (120)	Track renewal is underway as planned in REPELITA III and IV.
Cikampek - Cirebon	135.2	135.0	R14/R14A (R54)	Wood (PC concrete)	100 (120)	Track renewal is scheduled in REPELITA IV.
Cikampek - Bandung	89.8	104.5	R14/R14A	Wood	100	Ballast and ties are scheduled for replacement under REPELITA IV.
Total	296.6	382.7	-	-	-	-

b. Track maintenance

Track maintenance for main lines in Java is carried out in accordance with data obtained with a track measurement car. The maximum allowable speed in the Section is 80 km/h.

c. Turnout

Most of the turnouts are #10 and placed on steel ties. Most of them have exceeded their service life and are superannuated, with fastenings to steel ties damaged.

(3) Stations

a. Number of stations

There are 57 stations in the Section; 6 junction stations and 51 way stations.

b. Effective track length

Effective track lengths of major stations are shown in Table 3.3.5; Krawang station has the shortest length of 170 m, while at other stations the length exceeds 220 m.

Table 3.3.5 Effective Track Length and Track Spacing at Major Stations

Main track / Station	I	II	III	IV	V	VI	Minimum track spacing
	m	m	m	m	m	m	m
Manggarai	340	340	340	340	350	350	4.0
Jatinegara	300	230	200	250	180	110	4.0
Krawang	170	170	170	100			4.54
Cikampek	320	350	420	310	310	260	4.18
Jatibarang	450	520	470	380	330	290	5.0
Cirebon	360	430	300	250	240	200	5.3
Purwakarta	420	420	360	330	330		4.0
Padalarang	220	220	460	550	440		4.0
Bandung	340	250	300	300	250	300	4.0

c. Track spacing

Main and side tracks at each station are spaced at least 4 m apart.

d. Passenger platform

Platforms at each station are of a low type, around 180 mm above the rail level. Movable steps are used at some stations for passengers to get on/off.

e. Freight handling facilities

Though most stations have freight loading/unloading tracks, their handling volume is limited due to the narrow platform.

f. Water supply facilities

Water supply facilities for passenger trains are installed at the Bandung and Cirebon stations. Because of their fly-over structure, they will constitute an obstacle to electrification facilities.

g. Freight yards

Freight yards are located at Jakartagudang, Tanjungpriokgudang, Cipinang, Bandunggudang and Kiaracondong, all of which are of a flat type.

(4) Railway structure

a. Tunnel

There is a 949 m long Sasaksaat tunnel between Cikampek and Bandung. The major features of the tunnel are shown in Table 3.3.6.

Table 3.3.6 Major Features of the Sasaksaat Tunnel

Location	Bandung - Cikampek
Section	km 142 m 939 - km 143 m 888
Year constructed	1902 - 1903
Dimensions (m)	H = 4.20 - 4.30, W = 4.40
Length (m)	949
Speed limit	50 km/h
Water-leakage	Some
Invert	10 m from both portals

b. Bridges

Bridges to be reconstructed in the project are shown in Table 3.3.7. Their clearance above the rail level ranges from 3.97 m to 4.54 m.

Table 3.3.7 Bridges to be Reconstructed

Section \ Type	Aqueduct	Road overpass	Railway bridge
Manggarai - Cirebon	-	-	3
Cikampek - Kiaracondong	9	2	-

(5) Electrification

83 km of the JABOTABEK lines is electrified (1.5 kV DC), and another 15.5 km of the Western Line is under electrification.

Major electrification facilities in the JABOTABEK lines are shown in Table 3.3.8.

Table 3.3.8 Major Electrification Facilities in the JABOTABEK Lines

		Existing facilities	Under construction (Western Line)
Substation	Number	7	3
	Capacity	1,000 - 3,000 kW	1,500 - 3,000 kW
	Receiving voltage	6 - 70 kV	20 kV
Overhead line equipment	Catenary system	Simple catenary system with double contact wires	Simple catenary system
	Support	Steel mast	Steel pipe mast

(6) Signalling

Signalling system is mostly comprised of mechanical interlocking device, semaphores and mechanical switches. These facilities are generally superannuated, require extra time and manpower for operation and do not warrant safe train operation.

Existing signalling facilities are shown in Fig. 3.3.1.

a. Block instrument

All stations employ S & H type electro-mechanical tokenless block instrument with hand generators. Although rail contactors and other devices to detect trains are installed, 77% of them do not work due to breakdown.

In addition, local blocks to connect two or more signal cabins are provided at large stations.

b. Interlocking device

Mechanical interlocking devices, semaphores and mechanical switches are provided at all stations except Bandung. Semaphores and switches are operated by a central lever, with mechanical interlocking between them. They are controlled by double wire system, but remote semaphores at some stations are out of use due to damaged wires (3%).

Bandung station is equipped with relay interlocking device, color light signals, electric switches and commercial frequency track circuits.

The mechanical interlocking devices at Cikampek and Cirebon stations are being replaced by relay interlocking devices.

c. Level crossing protection device

Manually operated crossing gates are installed at 72 level crossings.

The watchman at inter-station level crossing is notified of the train departure by means of a hand generator.

The number of level crossings by type is shown in Table 3.3.9.

Table 3.3.9 Level Crossing

	Bks - Ckp	Ckp - Cn	Ckp - Kac
Manned	20	22	30
Unmanned (more than 4 m wide)	6	14	2
Unmanned (less than 4 m wide)	2	65	154
Total	28	101	186

(7) Communication

As for the communication system, UHF, VHF radio and overhead open wire are widely used. Communication equipment used at every station include Morse telegraphs and a dispatcher telephone, with automatic exchange telephones and teleprinters at major stations.

The communication facilities are shown in Fig. 3.3.2.

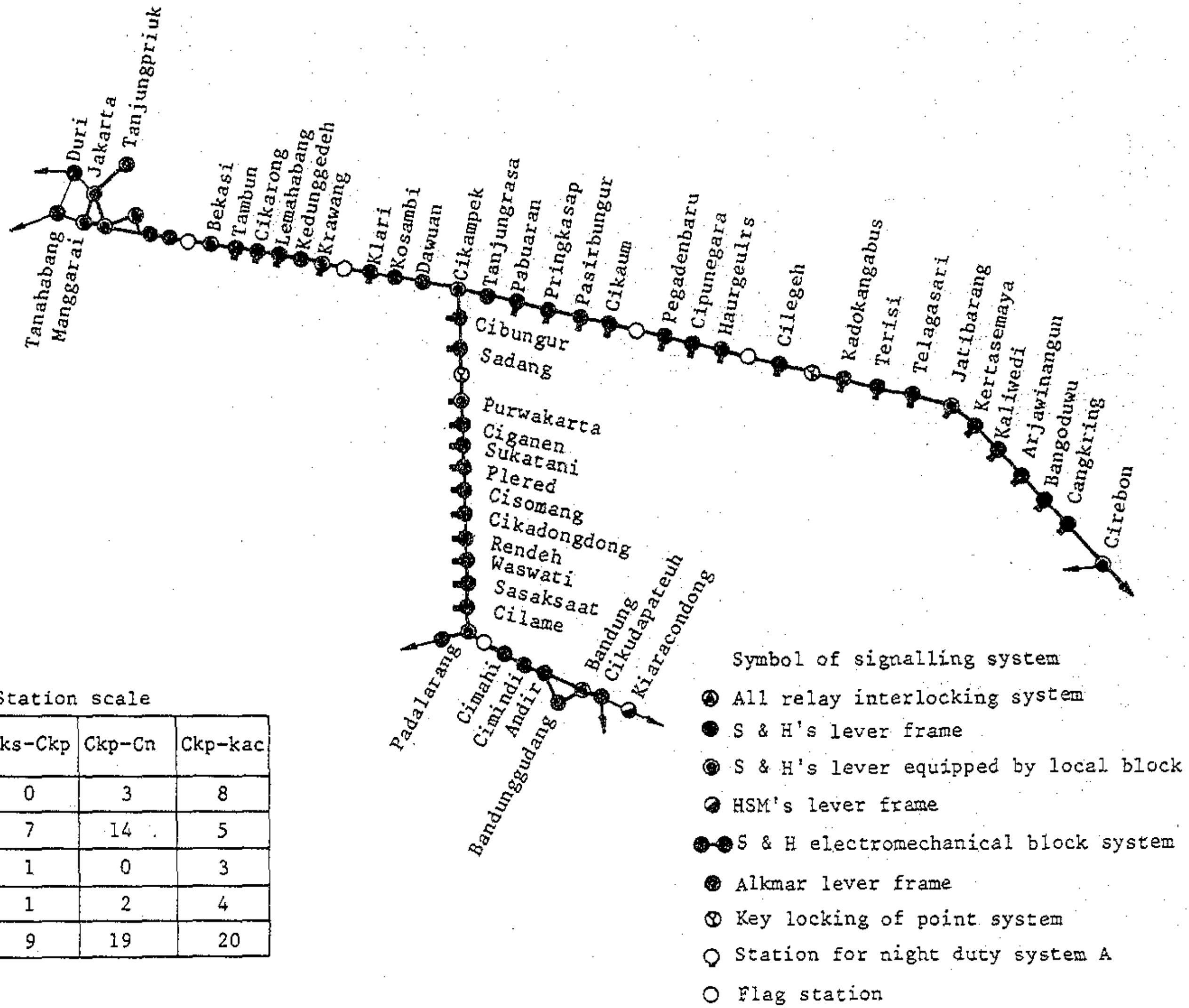
a. UHF microwave network

For long distance communication, a UHF radio system is provided for the Jakarta - Krawang - Cikampek - Cirebon route and the Jakarta - Krawang - Padalarang - Bandung route. The UHF multiplex radio has a 72 channel capacity with actual usage of 36 channels at the maximum. The number of channels actually used in the Section is shown in Fig. 3.3.2.

Channels for dispatcher, direct, automatic-exchange telephone and telex are accommodated in the UHF system.

b. Overhead open wire

For short distance communication, overhead open wire (mainly of copper weld steel wire) are provided. 8 to 14 wires are installed along the entire Section. PERUMTEL's overhead open wires (2 to 18 wires) are also installed along the railway.



Station scale

Number of main tracks	Bks-Ckp	Ckp-Cn	Ckp-kac
2	0	3	8
3	7	14	5
4	1	0	3
More than 4	1	2	4
Total	9	19	20

Fig. 3.3.1 Existing Signalling System

c. Telegraphic facilities

Three types of Morse telegraph are used; type T for block setting (can be switched to telephone when the telegraph does not work), type A to communicate among major stations and type B to communicate within several stations in a party.

Teleprinters are installed at the Bandung, Cikampek, Cirebon and Purwakarta stations, used mainly for reporting and instruction to/from the head office. Exchanges are provided at Jakarta, Cirebon and Bandung.

d. Automatic exchange telephone system

Automatic exchanges with a maximum capacity of 200 lines are provided at Bandung, Cikampek and Cirebon, with automatic telephones installed in their service areas. Repeating exchanges are provided at Jakarta and Bandung to relay long distance telephone calls.

e. Dispatcher telephone system

Three inspection dispatchers are stationed at Jakarta, Cirebon and Bandung. The above dispatcher offices and stations are connected through dispatcher telephones using UHF/VHF radio.

Communication among inspection dispatcher offices and dispatcher center at the head office are mainly made by automatic telephones and teleprinters.

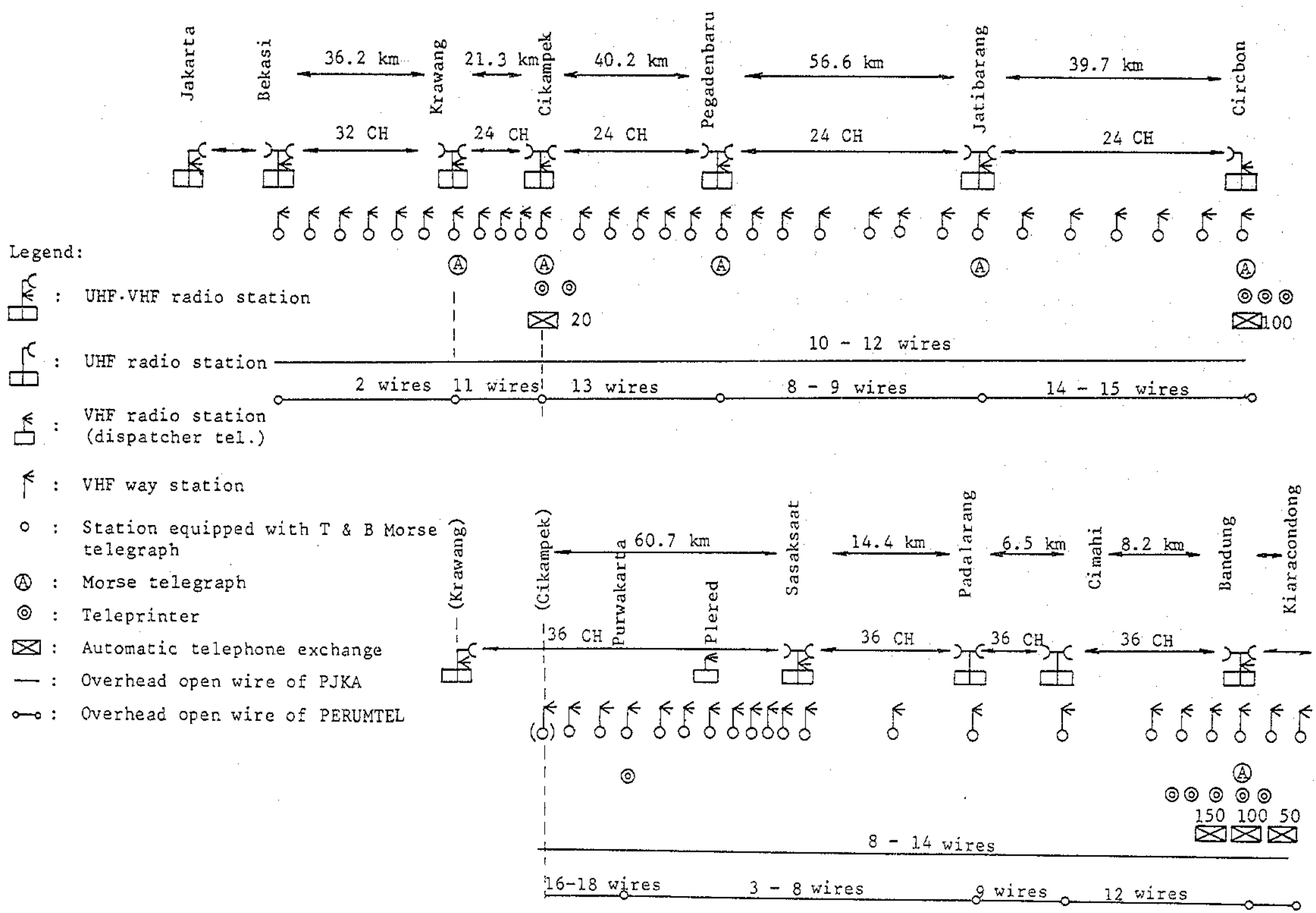


Fig. 3.3.2 Present Communication System

CHAPTER 4 TRAFFIC DEMAND FORECAST

CHAPTER 4 TRAFFIC DEMAND FORECAST

4-1 Premises

4-1-1 Term of Forecast Period

The traffic demand forecast covers a 30-year period starting from the year 1988 (when the electrification works will begin), with 1983 as the base year. Traffic volume is estimated for 1992 (the year when electrified railway will be completed), 1997, 2002, and 2007. Traffic demand after 2007 is estimated taking that between 2002 and 2007 into consideration.

4-1-2 Geographical Extent of Forecast

Java island

4-1-3 Transportation Modes Analyzed

As for passenger transport, demand forecasts are made for both railway (local and express trains) and road (bus). Demand forecasts for passengers by private car and airplane are not made, because they are not competitive with bus and railway.

Coastal shipping around Java is not included in the analysis because of the insignificant volume of traffic.

As for freight transport, railway, road (truck), and coastal shipping are analyzed by major commodities carried.

4-1-4 Social and Economic Framework

The annual growth rates of GDP and population, adopted in Chapter 2, are used as the basis of traffic demand forecast.

4-1-5 "With the Project" and "Without the Project"

Traffic demand will be forecasted on "With the Project" and "Without the Project".

"With the Project" means that the project will be implemented. In this case, it is expected that the relative competitiveness of the railway will increase owing to the improvement in transport conditions, thereby, drawing passengers/freights from the road and coastal shipping transportation.

"Without the Project" means that the project will not be implemented.

4-1-6 Basic Assumptions on Transport Conditions

(1) Transport time

a. Railway

In the case of "With the Project", it is assumed that railway transport time will be reduced after 1992, due to higher train speed. In "Without the Project", current transport time is assumed to remain the same.

b. Road

Reduction in road transport time, due to the completion of highways which are under construction or planning, is taken into consideration. It is assumed that most of the highways will be completed by 1992.

c. Coastal shipping

Transport time for both "With the Project" and "Without the Project" is assumed to be the same.

(2) Transport cost

a. Railway

Fares/tariffs and terminal transport costs are assumed to remain unchanged over the forecast years, both in "With the Project" and "Without the Project".

b. Road

Fares/tariffs and terminal transport costs are assumed to remain unchanged over the forecast years. In addition, highway tolls are taken into account.

c. Coastal shipping

Tariffs and terminal transport costs are assumed to remain unchanged over the forecast years.

4-2 Methodology of Traffic Demand Forecast

The general flow chart of the traffic demand forecast methodology is shown in Fig. 4.2.1.

Detailed flow chart is shown in Appendix 4-2-1.

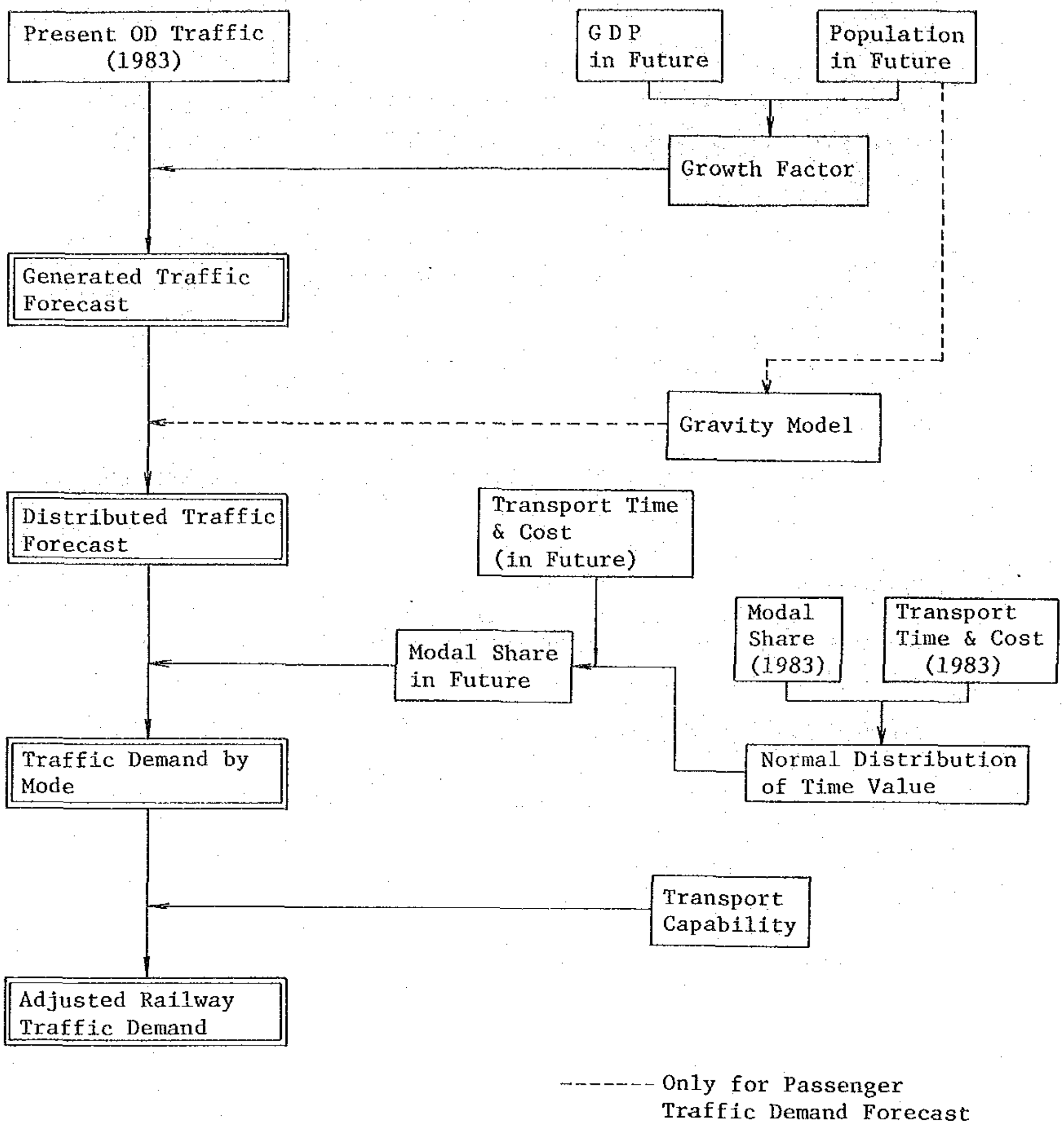


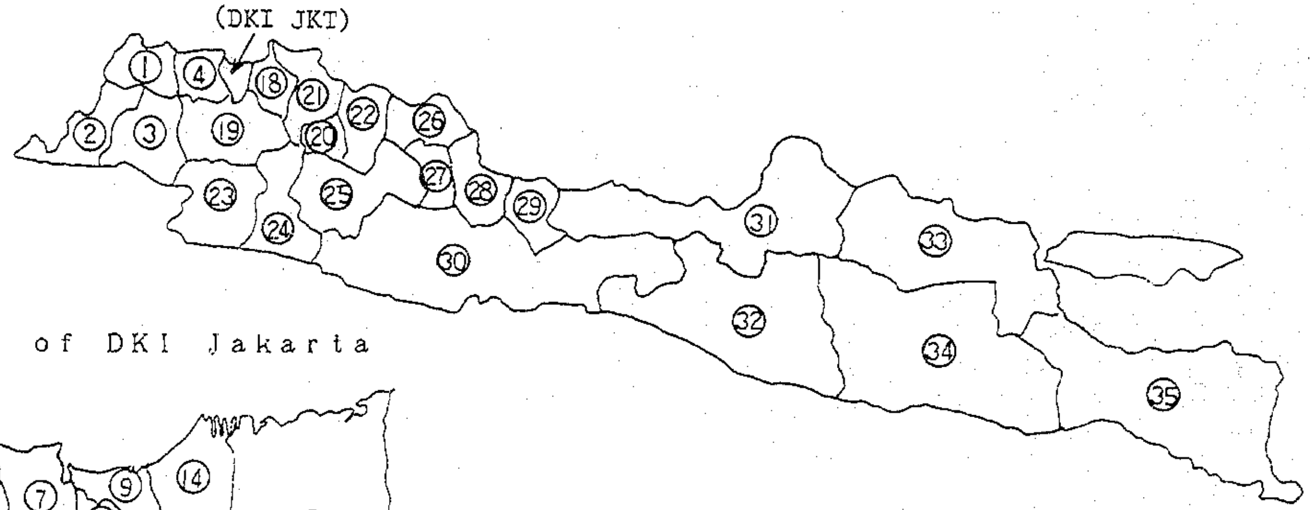
Fig. 4.2.1 General Flow Chart of Traffic Demand Forecast

4-3 Zoning and Link Network

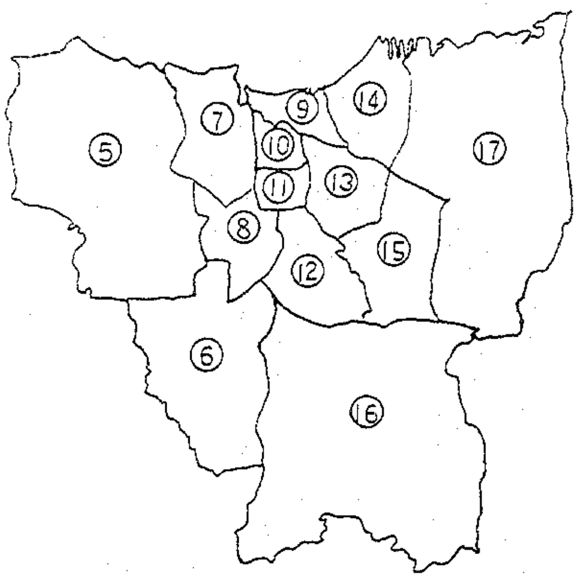
4-3-1 Zoning

For the purposes of this analysis, Java was divided into 35 zones. The area along the electrification project was divided using Kabupaten as the base unit; the DKI Jakarta area was divided into smaller zones by Kecamatan; the rest of the areas were divided into bigger zones.

Zone names are shown in Fig. 4.3.1 (see Appendix 4-3-1).



Detail of DKI Jakarta



No	Zone	NO	Zone	No	Zone
1	Merak	13	Pasar Senen	25	Bandung
2	Pandegelang	14	Tanjung Priok	26	Jatibarang
3	Rankasbitung	15	Jatinegara	27	Jatiwangi
4	Tanggerang	16	Pasarminggu	28	Cirebon
5	Rawabuaya	17	Kelender	29	Brebes
6	Kebayoran	18	Bekasi	30	Banjar
7	Duri	19	Bogor	31	Semarang
8	Tanahabang	20	Purwakarta	32	Yogyakarta
9	Kampung Bandan	21	Cikampek	33	Surabaya
10	Jakarta	22	Pegadenbaru	34	Madiun
11	Gambir	23	Sukabumi	35	Jember
12	Manggarai	24	Cianjur		

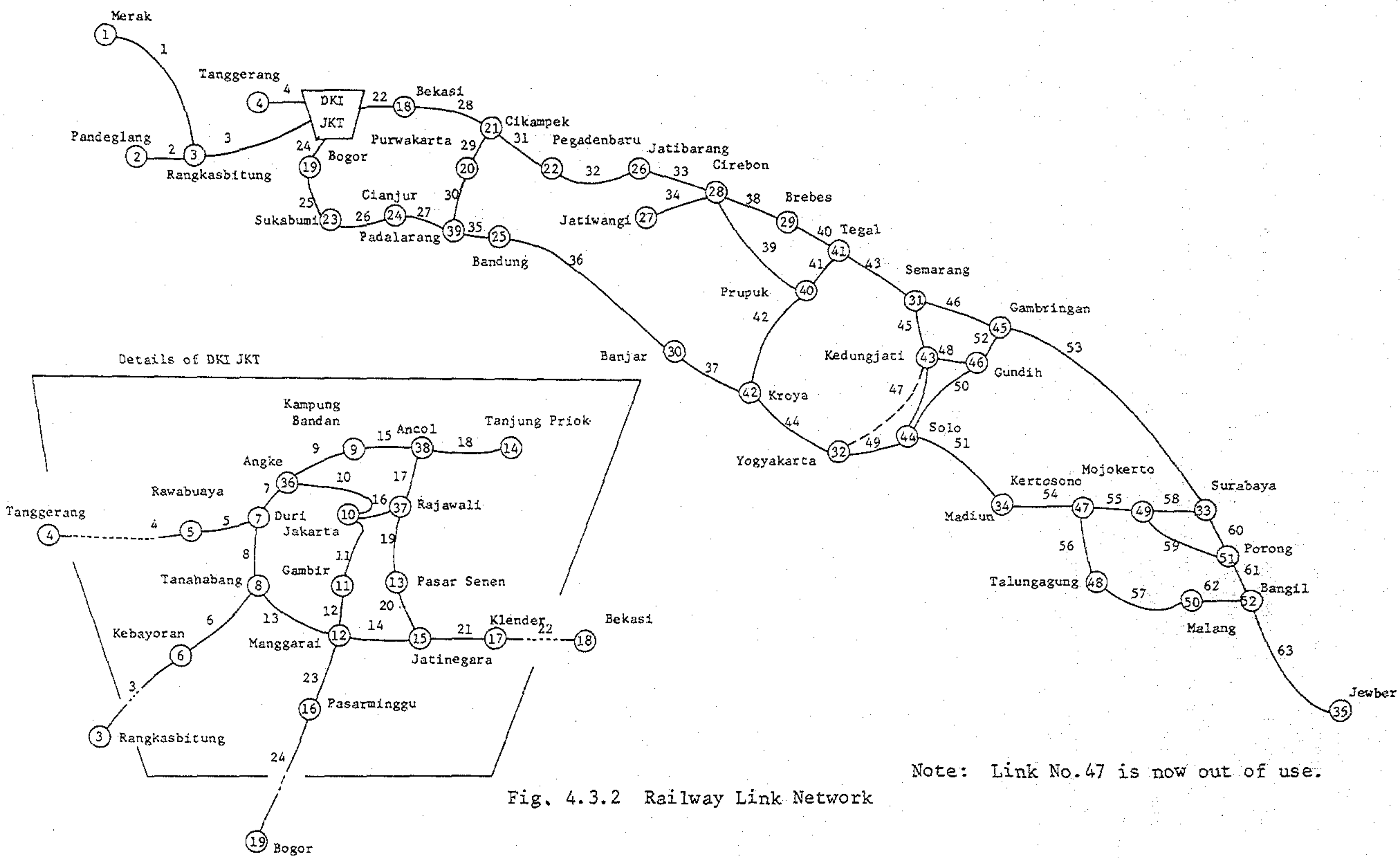
Fig. 4.3.1 Zoning Map

4-3-2 Link Network

For the railway network, 52 nodes (including 17 dummy nodes) were established around major stations, with 63 links connecting them.

For the road network running along the railway, 62 nodes (including 27 dummy nodes) were established for roads, with 99 links connecting them.

Link network maps for the railway, roads and sea line are shown in Figs. 4.3.2 and 4.3.3.



Note: Link No.47 is now out of use.

Fig. 4.3.2 Railway Link Network

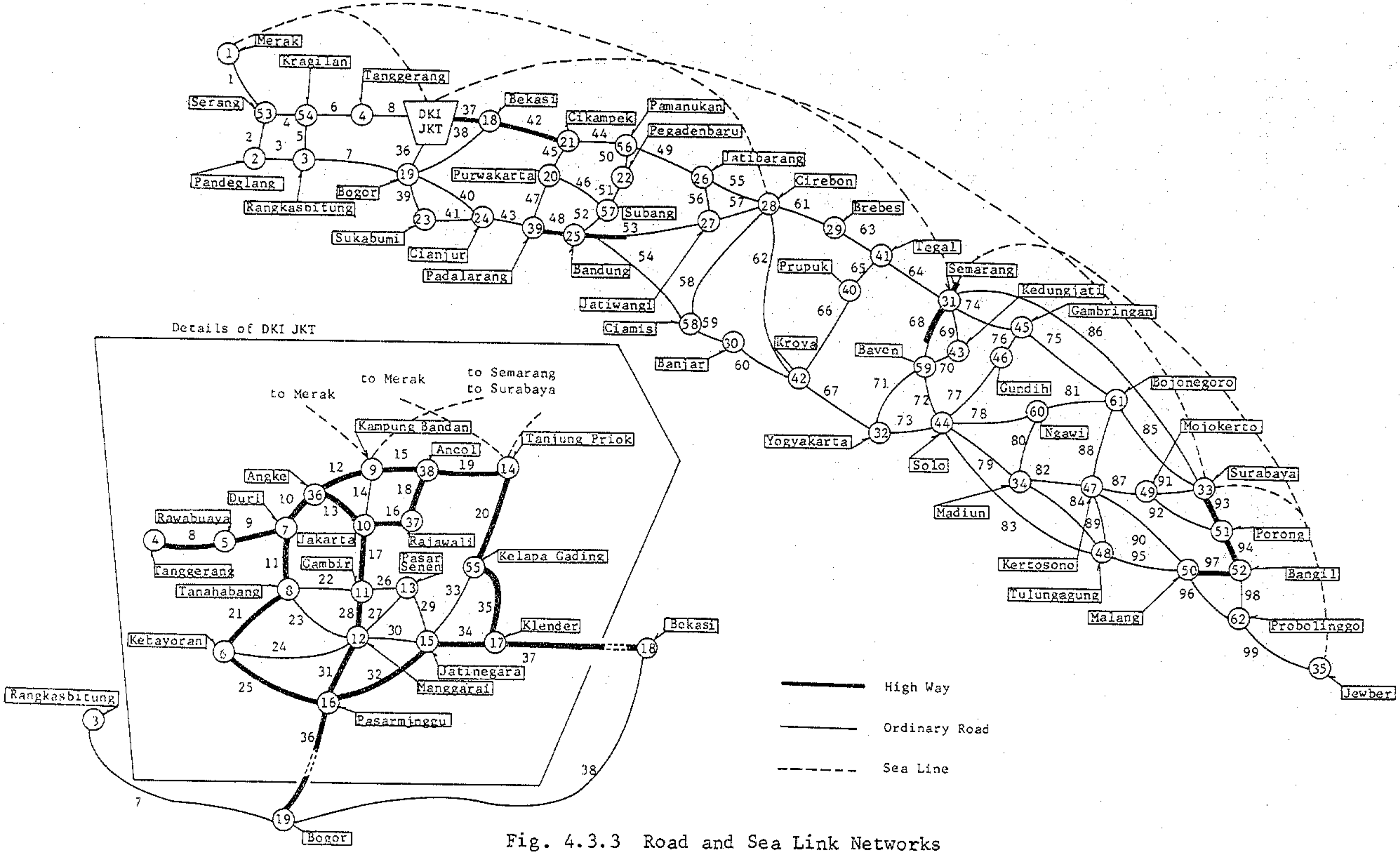


Fig. 4.3.3 Road and Sea Link Networks

4-3-3 Routing

Based on the actual distances between nodes, the shortest routes among zone pairs were determined for the railway and road links by using the "Minimum Path Method".

4-4 Present OD Traffic

4-4-1 Passenger Traffic

(1) Railway

Based on the OD table in 1983 (between stations), rail passenger traffic was classified into 35 zones by train type (express and local) and class.

One type of passenger traffic (express type) was formed by combining the number of express and fast train passengers. Another type of passenger traffic (local type) was formed by combining the number of local and mixed train passengers (see Appendix 4-4-2).

(2) Road

a. Bus passenger traffic was estimated using the regression model from the results of the nationwide OD survey conducted in 1982 (see Appendix 4-4-1).

b. The 88 zones used in the OD study were regrouped into 23 zones.

c. The DKI Jakarta zone was divided again into 13 zones.

d. The regrouped OD traffic for 1982 was multiplied by the 1983's annual population growth rate in Java (see Appendix 4-4-2).

4-4-2 Freight Traffic

(1) Railway

Based on the 1983 OD tables for each commodity and station, the freight OD traffic was classified into 35 zones. The following 12 commodities were selected for the analysis. The 11 commodities except coal accounted for more than 90% of the total freight traffic.

(1) Rice (2) Maize (3) Sugar (4) Coal (5) Non-metal mining products (6) Cattle (7) Petroleum products (8) Steel (9) Cement (10) Fertilizer (11) Paper (12) General cargo (see Appendix 4-4-3)

(2) Road

a. OD tables on the 12 commodities were regrouped into 35 zones using the same method used in the railway.

b. The regrouped 1982 OD traffic was multiplied by the annual production increase rate of 1983 for each commodity to obtain the 1983 OD traffic (see Appendix 4-4-3).

(3) Coastal shipping

Based on the 1982 OD table, the OD traffic among major ports on Java was extracted on the following commodity.

(1) Rice (5) Non-metal mining products (7) Petroleum products (9) Cement (10) Fertilizer (see Appendix 4-4-3)

The production increase rate for each commodity, which was used for road/coastal shipping estimation, is shown in Appendix 4-4-4.

4-5 Transport Distance, Time, and Cost

4-5-1 Inter-zonal Distance

(1) Link distance

The link distances for railway, road, and coastal shipping were determined on the basis of the materials provided by PJKA, BINA MARGA, and PHBL respectively (see Appendix 4-5-1 - 3).

(2) Inter-zonal distance

The link distance along the shortest routes (determined by the "Minimum Path Method") were totaled for each zone-pair, as well as for each mode (see Appendix 4-5-4).

4-5-2 Inter-zonal Transport Time

(1) Link running-time

a. "Without the Project"

(a) Railway

Passenger (express and local) and freight train running-times for each link were calculated from the link distances and current commercial speeds (see Appendix 4-5-1).

(b) Road

Road running-times were calculated for each link based on the link distance and the average speed of buses and trucks (see Appendix 4-5-2).

(c) Coastal shipping

Cruising times among major ports were calculated from the distances and average cruising speed (37 km/hour) (see Appendix 4-5-3).

b. "With the Project"

(a) Railway

Passenger and freight train running-times for each link were determined from the link distances and the commercial speeds after electrification (see Appendix 4-5-1).

(b) Road

Same as "Without the Project".

(c) Coastal shipping

Same as "Without the Project".

(2) Terminal transport time

Identical times were adopted, both for "With the Project" and "Without the Project" cases (see Appendix 4-5-5).

(3) Inter-zonal transport time

Modal inter-zonal transport times for each link were calculated as the sum of the link running-time and the terminal transport time. For railway passenger transport time, transfer time required for changing trains was added to the above time.

4-5-3 Modal Inter-zonal Transport Cost

(1) Inter-zonal transport fare/tariff

Linear formulas for fare/tariff estimation were employed, whose parameters for the fixed and distance-proportional terms were estimated based on the actual fare/tariff structures. The fare/tariff estimation formulas are given in Appendix 4-5-6.

(2) Terminal transport cost

Terminal transport cost was estimated for passenger and each freight commodity, as shown in Appendix 4-5-5.

(3) Inter-zonal transport cost

Inter-zonal transport cost was calculated on the basis of the inter-zonal fare/tariff and the terminal transport cost, obtained in (1) and (2).

4-6 Forecasting of Generated Traffic

4-6-1 Generated Passenger Traffic (TDP)

Generated passenger traffic represents the total of all OD traffic. Control total was estimated using the procedure as shown in Fig. 4.6.1. The result of the calculation is shown in Table 4.6.1.

Since the number of bus passengers was not available, the number of buses per person was used as a substitute variable, for the number of bus passengers is assumed in proportion to the number of buses.

The forecasting procedure is described in Appendix 4-6-1.

The TDP increase ratio of each forecast year to the TDP traffic in 1983 was defined as the passenger growth factor of generated traffic (G_p) (see Table 4.6.1).

4-6-2 Generated Freight Traffic

Generated freight traffic was calculated by multiplying the generated freight traffic in 1983 by the freight growth factor of each commodity.

The method of estimating the growth factor is explained in Appendix 4-6-2.

The freight growth factor (G_f), as well as the estimated generated freight traffic of each commodity, is shown in Table 4.6.2.

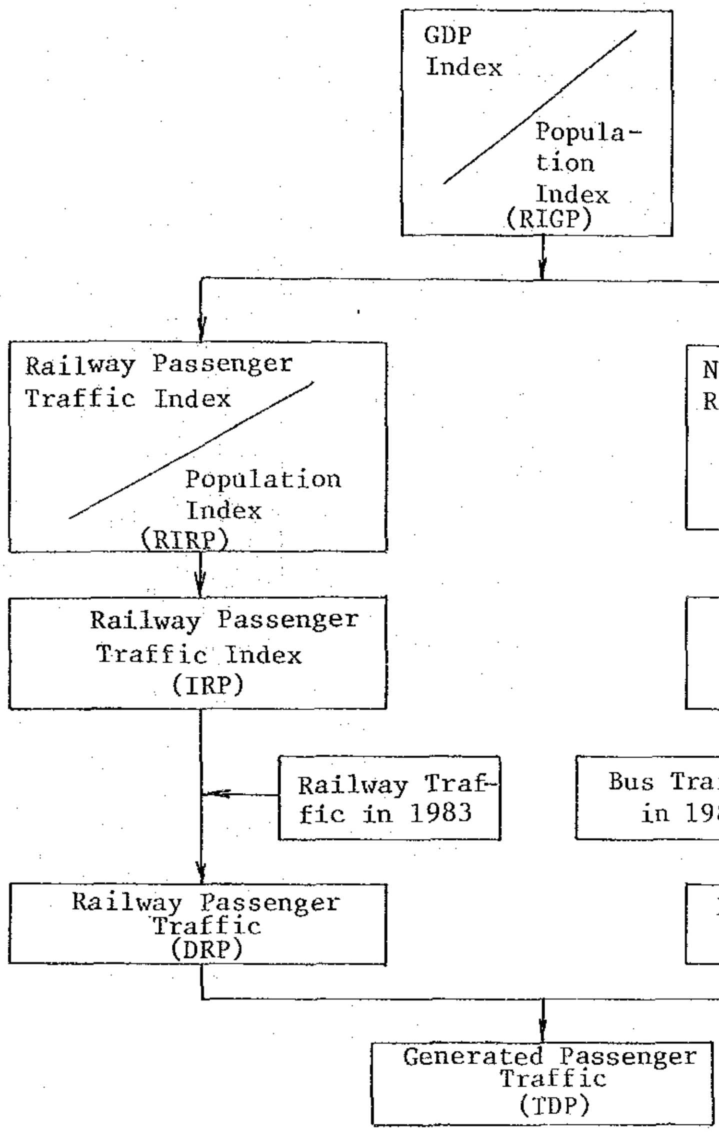


Fig. 4.6.1 Flow Chart of Generated Passenger Traffic Forecast

Table 4.6.1 Forecast of Generated Passenger Traffic

Year	Population index (IP)	GDP index (IGDP)	RIGP $\left(=\frac{IGDP}{IP}\right)$	Railway			Bus			Generated passenger traffic (TDP) (thousand)	Growth factor (Gp)
				RIRP $\left(=\frac{IRP}{IP}\right)$	Passenger index (IRP)	Generated railway traffic (DRP) (thousand)	RIBOP $\left(=\frac{IBO}{IP}\right)$	Index for No. of bus registered (IBO)	Generated bus traffic (DBP) (thousand)		
1983	100.0	100.0	1.000	1.000	100.0	16,422	1.000	100.0	220,711	237,133	1.000
1992	117.2	152.2	1.299	1.373	160.9	26,423	1.308	153.3	338,350	364,773	1.538
1997	127.5	182.5	1.431	1.499	191.1	31,382	1.540	196.4	433,476	464,858	1.960
2002	138.7	216.8	1.563	1.685	233.7	38,378	1.772	245.8	542,508	580,886	2.450
2007	150.9	257.5	1.706	1.890	285.2	46,836	2.023	305.3	673,831	720,667	3.039

Table 4.6.2 Forecast of Generated Freight Traffic

(Unit: 1,000 ton)

Code	Commodity \ Year	1983	1992	1997	2002	2007
1	Rice	8,323 (1.000)	11,003 (1.322)	11,968 (1.438)	13,025 (1.565)	14,166 (1.702)
2	Maize	1,407 (1.000)	1,659 (1.179)	1,829 (1.300)	2,267 (1.611)	2,814 (2.000)
3	Sugar	2,528 (1.000)	3,044 (1.204)	3,395 (1.343)	4,214 (1.667)	5,266 (2.083)
4	Coal	27 (1.000)	741 (27.436)	865 (32.051)	1,025 (37.949)	1,218 (45.128)
5	Non Metallic Mining	9,580 (1.000)	19,955 (2.083)	24,448 (2.552)	30,436 (3.177)	37,419 (3.906)
6	Cattle	1,137 (1.000)	1,416 (1.245)	1,557 (1.369)	1,887 (1.660)	2,265 (1.992)
7	Petroleum	6,324 (1.000)	6,982 (1.104)	6,982 (1.104)	6,982 (1.104)	6,982 (1.104)
8	Steel	1,898 (1.000)	4,722 (2.488)	6,774 (3.569)	8,287 (4.366)	10,069 (5.305)
9	Cement	2,881 (1.000)	5,468 (1.898)	6,678 (2.318)	8,222 (2.854)	10,055 (3.490)
10	Fertilizer	3,153 (1.000)	8,056 (2.555)	8,611 (2.731)	10,279 (3.260)	12,224 (3.877)
11	Paper	671 (1.000)	1,864 (2.778)	2,485 (3.704)	3,231 (4.815)	3,728 (5.556)
12	General Cargo	8,858 (1.000)	13,482 (1.522)	16,166 (1.825)	19,204 (2.168)	22,809 (2.575)

Note. ( ) denotes freight growth factor (G_f) against 1983 figure

4-7 Forecasting of Distributed Traffic

4-7-1 Passenger Traffic

(1) Gravity model

The "Gravity Model" was used to calculate the distributed traffic. The model is expressed as follows:

$$T_{ij} = \alpha (P_i \cdot P_j)^{\beta}/D_{ij}{}^{\gamma} \quad \text{..................} \quad (1)$$

P_i, (P_j): Population in zone i, (j) (thousand)

D_{ij} : Distance between i and j (km; average distance of road and railway)

T_{ij} : Distributed traffic between i and j

Parameters (α, β, γ) are estimated by the least-square method using 1983 data of zone population, inter-zonal distance and inter-zonal distributed traffic.

The three parameters were estimated as follows:

α = 5.5686, β = 0.5664, γ = 1,0432
(10.802) (8.818)

R^2 = 0.460 (coefficient of determination)

R = 0.680 (correlation coefficient)

t value in ( ) (to indicate reliability of the parameter)

(2) Deviation ratio (Q_{ij}) between theoretical and actual values

The deviation ratio (Q_{ij}) between theoretical distributed traffic ($\hat{T}_{ij(83)}$) and actual distributed traffic ($T_{ij(83)}$) in 1983 was calculated using the following formula:

$$Q_{ij} = \frac{T_{ij(83)}}{\hat{T}_{ij(83)}} \quad \text{............................} \quad (2)$$

(3) Modifying coefficient MT_n for generated traffic

By substituting the parameters α, β, γ as well as future zonal population (Appendix 4-7-1) and each inter-zonal distance for each zone into equation (1), the total distributed traffic in the forecast year (n) ($\Sigma\hat{T}_{ij(n)}$) was calculated. Then the ratio (MT_n) of future generated traffic ($TDP_{(n)} = G_{p(n)} \times \Sigma T_{ij(83)}$) to future total distributed traffic ($\Sigma\hat{T}_{ij(n)}$) was calculated as follows:

$$MT_n = \frac{G_{p(n)} \times \Sigma T_{ij(83)}}{\Sigma T_{ij(n)}} \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (3)$$

MT_n : Modifying coefficient of nth year

$\Sigma T_{ij(83)}$: Total traffic in 1983

(4) Distributed traffic

Distributed traffic ($\tilde{T}_{ij(n)}$) in each forecast year (n) was obtained by multiplying the theoretical distributed traffic ($\hat{T}_{ij(n)}$) by Q_{ij} and MT_n, as follows:

$$\tilde{T}_{ij(n)} = \hat{T}_{ij(n)} \times Q_{ij} \times MT_n \quad \cdots\cdots\cdots\cdots\cdots \quad (4)$$

4-7-2 Freight Traffic

Assuming that the current traffic distribution pattern will not change in the future, future distributed traffic for freight transport ($\hat{T}_{ij(n)}$) was calculated by multiplying the distributed traffic for each commodity in 1983 ($T_{ij(83)}$) by the growth factor ($G_{f(n)}$) for each commodity:

$$\hat{T}_{ij(n)} = T_{ij(83)} \times G_{f(n)} \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (5)$$

4-8 Traffic Demand Forecast by Mode

4-8-1 Determining Distribution Form of Time Value

(1) Modal share

Modal share for inter-zonal traffic in 1983 was calculated based on the actual data.

(2) Boundary of modal choice

It is assumed that a user of inter-zonal transport service will select a mode in which they could minimize the amount of sacrifice required.

The boundary of modal choice is determined at the point where the amount of the sacrifice in using the two competing modes becomes equal, and this can be calculated by the following equation:

$$Sr = Cr + Tr\omega$$

$$Sb = Cb + Tb\omega$$

$$Sr = Sb, \text{ or}$$

$$Cr + Tr\omega_0 = Cb + Tb\omega_0$$

$$\omega_0 = \frac{Cr - Cb}{Tb - Tr} \quad \dots\dots\dots\dots\dots\dots\dots\dots \quad (6)$$

Sr: Amount of sacrifice incurred by railway user

Cr: Transport cost for railway

Tr: Railway transport time

ω_0: Time value at the boundary point

Sb: Amount of sacrifice incurred by user of the competing mode

Cb: Competing modes' transport cost

Tb: Competing modes' transport time

The above equation can be expressed graphically as shown in Fig. 4.8.1.

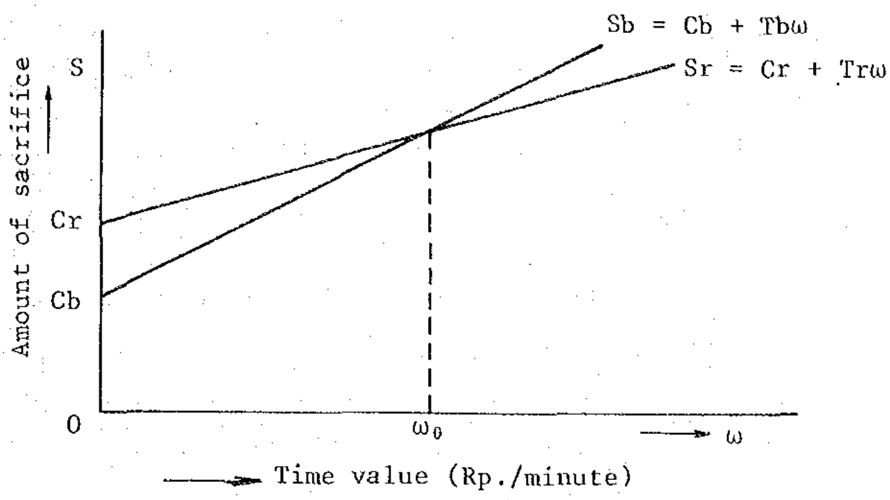


Fig. 4.8.1 The Boundary of Modal Choice between Two Competing Modes

According to the above graph, a user who has a time value greater than that at the boundary point (ω_O) will select the railway which requires less sacrifice, while a user who has less time value will select another mode (e.g., bus).

(3) Mean value (μ) and standard deviation (σ) of time value at the boundary point.

The time value ω_O for each inter-zonal traffic forms a probability distribution. Assuming that ω_O is normally distributed, its distribution pattern can be determined by the mean value (μ) and the standard deviation (σ). μ and σ are calculated by the least-square method using the following formula:

$$\omega_O = \mu + \sigma p \quad \text{.................................} \quad (7)$$

In the above formula, p denotes a percentile in the normal distribution table. From this point, the modal share can be calculated in terms of probability (percentage) under normal distribution. This can be explained graphically (see Fig. 4.8.2).

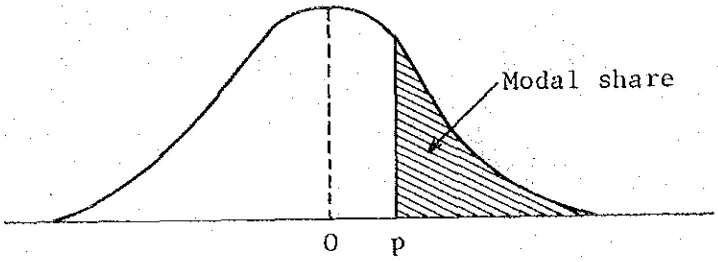


Fig. 4.8.2 Normal Distribution Curve

μ and σ for passenger and freight traffic by commodity are shown in Appendix 4-8-1.

From empirical evidence, it should be noted, time values for passenger traffic form a logarithmic normal distribution, so that ω_0 for the passenger traffic is converted to logarithmic value ($\log \omega_0$).

4-8-2 Calculation of the Deviation Ratio between Theoretical and Actual Modal Shares ($Q_{s(ij)}$)

From formula (7), the following formula is obtained.

$$\hat{p} = \frac{\omega_0 - \mu}{\sigma} \quad \cdots\cdots (8)$$

ω_0, which was calculated from present traffic conditions, along with μ and σ, which were obtained by the least square method based on formula (7), was used in equation (8) to calculate a theoretical percentile ($\hat{p}$) for 1983.

By taking the probability value under $\hat{p}$ from the normal distribution table, a theoretical modal share in 1983 ($\hat{S}_{b(ij)(83)}$) was obtained.

The deviation ratio ($Q_{s(ij)}$) between the theoretical modal share ($\hat{S}_{b(ij)(83)}$) and the actual modal share ($S_{b(ij)(83)}$) was determined by the following equation:

$$Q_{s(ij)} = S_{b(ij)(83)} / \hat{S}_{b(ij)(83)} \quad \cdots\cdots\cdots\cdots\cdots \quad (9)$$

4-8-3 Estimating the Future Modal Share

(1) Future theoretical modal share

Future time value (ω_0) at the boundary point of competing modes for each pair of zones was calculated from future traffic conditions (time and cost). The values of ω_0, μ, and σ were then substituted into equation (8) to obtain the percentile ($\hat{p}$). Finally, a theoretical modal share for each pair of zones in the forecast years ($\hat{S}_{b(ij)(n)}$) was obtained using the normal distribution table.

(2) Future modal share

The future modal share ($\tilde{S}_{b(ij)(n)}$) was determined by multiplying the theoretical modal share for each pair of zones ($\hat{S}_{b(ij)(n)}$) obtained in (1) by the deviation ratio ($Q_{s(ij)}$).

$$\tilde{S}_{b(ij)(n)} = \hat{S}_{b(ij)(n)} \times Q_{s(ij)} \quad \cdots\cdots\cdots\cdots\cdots \quad (10)$$

4-8-4 Traffic Demand Forecast by Mode

Inter-zonal future traffic demand for each mode was determined by multiplying the distributed traffic for each zone pair ($\tilde{T}_{ij(n)}$) by the future modal share ($\tilde{S}_{b(ij)(n)}$) obtained in 4-8-3.

In addition, railway passenger traffic demand was forecast for first, second, and third classes, where shares in each of the three classes in 1983 was maintained.

4-9 Result of Traffic Demand Forecast

4-9-1 Passenger Traffic

(1) Demand forecast for inter-zonal traffic

Inter-zonal passenger traffic demand was forecast for each mode for "With the Project" and "Without the Project" (see Appendix 4-9-1).

The result was summarized as the total traffic demand in Table 4.9.1. According to this table, the railway share is expected to increase from 5.9% for express trains and 1.9% for local trains in 1983 to 7.7% and 2.9% respectively in 1992, in the case of "With the Project" case.

Diverted traffic from bus to railway amounts to 6,482,400 passengers for express trains and 3,407,400 passengers for local trains in 1992, and 10,462,200 passengers and 5,578,900 passengers respectively in 2002.

(2) Link traffic before adjustment

Link traffic was calculated as shown in the column of "Traffic Demand" in Table 4.9.2, Figs. 4.10.2 - 4 and Appendix 4-9-2.

Link traffic in 1992 (one way, annually) will be the highest in link No. 28 (Bekasi - Cikampek) in the electrified section; 12,555,700 passengers for "With the Project", and 8,782,400 passengers for "Without the Project". In both cases, the link traffics remain within the track capacity.

Table 4.9.1 Passenger Traffic Demand and Volume by Mode

(Unit: 1,000 pass.)

Mode \ Item \ Year		1983	1992						1997					
			Traffic demand			Traffic volume			Traffic demand			Traffic volume		
			WITHOUT	WITH	Diverted traffic	WITHOUT	WITH	Diverted traffic	WITHOUT	WITH	Diverted traffic	WITHOUT	WITH	Diverted traffic
Rail	Ex-press	14,182.2 (5.9)	21,854.2 (5.9)	28,336.6 (7.7)	6,482.4	21,854.2 (5.9)	28,336.6 (7.7)	6,482.4	27,524.5 (5.9)	35,869.2 (7.6)	8,344.7	25,634.2 (5.5)	33,234.8 (7.1)	7,600.6
	Local	4,515.0 (1.9)	7,153.8 (1.9)	10,561.2 (2.9)	3,407.4	7,153.8 (1.9)	10,561.2 (2.9)	3,407.4	91,121.0 (1.9)	13,502.1 (2.9)	4,390.0	9,088.8 (1.9)	13,271.1 (2.8)	4,182.3
	Sub-total	18,697.2 (7.8)	29,008.0 (7.8)	38,897.8 (10.6)	9,889.8	29,008.0 (7.9)	38,897.8 (10.6)	9,889.8	36,636.6 (7.8)	49,371.3 (10.5)	12,734.7	34,723.0 (7.4)	46,505.9 (9.9)	11,782.9
Bus		220,713.0 (92.2)	339,266.4 (92.2)	329,377.4 (89.4)	-9,889.0	339,266.4 (92.1)	329,377.4 (89.4)	-9,889.0	432,683.6 (92.2)	419,948.6 (89.5)	-12,735.0	434,597.1 (92.6)	422,814.1 (90.1)	-11,783.0
Total		239,410.2 (100.0)	368,274.4 (100.0)	368,275.2 (100.0)		368,274.4 (100.0)	368,274.2 (100.0)		469,320.2 (100.0)	469,319.9 (100.0)		469,320.1 (100.0)	469,320.0 (100.0)	
Rail (overflow traffic)		-	-	-	-	0	0	-	-	-	-	1,890.3	2,634.4	744.1

Mode \ Item \ Year		2002						2007					
		Traffic demand			Traffic volume			Traffic demand			Traffic volume		
		WITHOUT	WITH	Diverted traffic	WITHOUT	WITH	Diverted traffic	WITHOUT	WITH	Diverted traffic	WITHOUT	WITH	Diverted traffic
Rail	Ex-press	33,771.3 (5.8)	44,233.5 (7.5)	10,462.2	28,427.6 (4.9)	36,605.1 (6.3)	8,177.5	41,398.5 (5.7)	54,229.7 (7.5)	12,831.2	30,204.5 (4.2)	38.695.9 (5.3)	8,491.4
	Local	11,397.8 (1.9)	16,976.7 (2.9)	5,578.9	11,322.1 (1.9)	16,013.1 (2.7)	4,691.0	14,158.1 (1.9)	21,101.0 (2.9)	6,942.9	13,153.4 (1.8)	18,360.4 (2.5)	5,207.0
	Sub-total	45,169.1 (7.7)	61,210.2 (10.4)	16,041.1	39,749.7 (6.8)	52,618.2 (9.0)	12,868.5	55,556.6 (7.6)	75,330.7 (10.4)	19,774.1	43,357.9 (6.0)	57,056.3 (7.8)	13,698.4
Bus		541,295.1 (92.3)	525,253.6 (89.6)	-16,041.5	546,714.2 (93.8)	533,845.6 (91.0)	-12,868.6	672,028.6 (92.4)	652,254.6 (89.6)	-19,774.0	684,227.4 (94.0)	670,528.9 (92.2)	-13,698.5
Total		586,464.2 (100.0)	586,463.8 (100.0)		586,463.9 (100.0)	586,463.8 (100.0)		727,585.2 (100.0)	727,585.3 (100.0)		727,585.3 (100.0)	727,585.2 (100.0)	
Rail (overflow traffic)		-	-	-	5,343.7	7,628.4	2,284.7	-	-	-	11,194.0	15,533.8	4,339.8

Note (1) The value inside ( ) means "modal share" (%).

(2) The "Traffic Volume" means the actual traffic volume determined while taking the track capacity of each link into consideration.

Table 4.9.2 Link Traffic of Railway Passengers (1992)

(One way; Per Year; Unit: 1,000 pass.)

Link No.	Track Capacity		1992			
			Traffic Demand		Traffic Volume	
	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH
1	3551.5	3551.5	18.3	57.1	18.4	57.2
2	1588.8	1588.8	26.3	247.8	26.3	247.8
3	5233.8	5233.8	57.9	319.0	57.9	319.0
4	8411.4	8411.4	50.0	391.3	50.0	391.3
5	8411.4	8411.4	54.6	559.6	54.6	559.6
6	8037.6	8037.6	74.7	550.2	74.7	550.2
7	22430.4	22430.4	0	0	.0	.0
8	18878.9	18878.9	65.8	696.2	65.8	696.2
9	16075.1	16075.1	0	0	1.6	1.6
10	10841.4	10841.4	0	0	.0	.0
11	12897.5	12897.5	24.0	24.0	24.0	24.0
12	16075.1	16075.1	2491.0	2541.8	2491.0	2541.8
13	12336.7	12336.7	144.0	1430.6	144.0	1430.6
14	21495.8	21495.8	2866.9	4812.5	2866.9	4812.5
15	5233.8	5233.8	4.4	28.2	6.0	29.8
16	18878.9	18878.9	1610.1	1751.2	1610.1	1751.2
17	22430.4	22430.4	220.9	343.5	220.9	343.5
18	14579.8	14579.8	216.5	315.3	216.5	315.3
19	22430.4	22430.4	1827.7	2091.5	1827.7	2091.5
20	11962.9	11962.9	4214.9	4725.6	4214.9	4725.6
21	22430.4	22430.4	7780.2	10585.2	7780.2	10585.2
22	22430.4	22430.4	8160.9	11383.5	8160.9	11383.5
23	22430.4	22430.4	62.4	482.3	62.4	482.3
24	7663.7	7663.7	55.3	69.6	55.3	69.6
25	3364.6	3364.6	89.7	89.7	89.7	89.7
26	3738.4	3738.4	336.9	336.9	336.9	336.9
27	3925.3	3925.3	269.2	269.2	269.2	269.2
28	15327.4	22430.4	8782.4	12555.7	8782.4	12555.7
29	6168.4	7103.0	1968.6	3605.6	1968.9	3605.9
30	6168.4	7103.0	1536.2	2659.0	1536.2	2659.0
31	6729.1	10467.5	5474.7	8913.7	5474.7	8913.7
32	5794.5	10467.5	5242.0	8273.9	5242.0	8273.9
33	7009.5	10467.5	5176.4	7757.1	5176.4	7757.1
34	3551.5	3551.5	.2	3.2	.2	3.2
35	21495.8	22430.4	1804.7	2927.1	1804.7	2927.6
36	3644.9	3644.9	1472.7	1534.0	1472.7	1534.0
37	2990.7	2990.7	1006.2	1006.2	1006.2	1006.2
38	3551.5	3551.5	2541.7	2967.3	2541.7	2967.3
39	5233.8	5233.8	2293.5	2558.8	2293.5	2558.8
40	3738.4	3738.4	2388.3	2727.6	2388.3	2727.6
41	4673.0	4673.0	19.1	19.1	19.1	19.1
42	4859.9	4859.9	2312.6	2577.9	2312.6	2577.9
43	3644.9	3644.9	2369.4	2708.7	2369.4	2708.7
44	3644.9	3644.9	3290.8	3556.2	3290.8	3556.2
45	2990.7	2990.7	855.9	868.9	855.9	868.9
46	2897.3	2897.3	1026.6	1062.7	1026.6	1062.7
47	3738.4	3738.4	310.8	310.8	310.8	310.8
48	3551.5	3551.5	545.1	558.1	545.1	558.1
49	5420.7	5420.7	818.7	818.7	818.7	818.7
50	3364.6	3364.6	545.1	558.1	545.1	558.1
51	3925.3	3925.3	1363.8	1376.7	1363.8	1376.7
52	3738.4	3738.4	0	0	.0	.0
53	2803.8	2803.8	1026.6	1062.7	1026.6	1062.7
54	4486.1	4486.1	2690.2	2690.2	2690.2	2690.2
55	6448.7	6448.7	2690.2	2690.2	2690.2	2690.2
56	4112.2	4112.2	0	0	.0	.0
57	2803.8	2803.8	0	0	.0	.0
58	5794.5	5794.5	2348.5	2348.5	2348.5	2348.5
59	2803.8	2803.8	341.8	341.8	341.8	341.8
60	7009.5	7009.5	95.4	102.0	95.4	102.0
61	8411.4	8411.4	437.2	443.8	437.2	443.8
62	5233.8	5233.8	0	0	.0	.0
63	3738.4	3738.4	437.2	443.8	437.2	443.8

Note:

Link No.

4 - 19 JABOTABEK Line

28 Bks - Ckp

29 Ckp - Pwk

30 Pwk - Pdl

31 Ckp - Pgb

32 Pgb - Jtb

33 Jtb - Cn

35 Pdl - Bd

4-9-2 Freight Traffic

(1) Demand forecast for inter-zonal traffic

Inter-zonal freight demand was forecast for "With the Project" and "Without the Project" (see Appendix 4-9-3).

The result is summarized as the total traffic demand in Table 4.9.3.

According to the table in the case of "With the Project", the railway share is expected to increase from 4.4% in 1983 to 5.5% in 1992, and to 5.3% after 1997.

Diverted traffic from truck to rail amounts to 866,100 tons in 1992, and to 1,639,300 tons in 2007.

Railway freight traffic for fertilizer is expected to increase from 584,900 tons in 1983 to 1,496,600 tons in 1992 (about 2.6 times), and eventually amount to 2,271,000 tons in 2007 (about 3.9 times of the 1983 figures) in the case of "Without the Project". In the case of "With the Project", traffic is expected to increase to 1,691,700 tons in 1992 and 2,567,000 tons in 2007, 2.9 and 4.4 times above the 1983 figures, respectively.

Traffic diverted from truck is expected to reach 195,100 tons in 1992 and 296,100 tons in 2007.

Railway traffic for other major articles such as petroleum products and cement is expected to increase steadily.

Overall, the railway share for freight traffic will be 4% in the case of "Without the Project" and 5.3% in the case of "With the Project" case; due to the project, 1.3% increase will be realized.

(2) Link traffic before adjustment

The link traffic is shown in 1992 in the column of "Traffic Demand" in Table 4.9.4.

This table shows that link traffic is the highest in link No. 31 (420,000 tons, east-bound) and link No. 28 (256,000 tons, west-bound) in the electrified section in the case of "Without the Project".

In the case of "With the Project", the highest east-bound link traffic is observed on link No. 31 (1,076,700 tons) and west-bound link traffic No. 28 (429,200 tons) in the electrified section.

Table 4.9.3 Freight Traffic Demand and Volume by Mode

(Unit: 1,000 tons)

Year / Item / Mode	1983	1992						1997					
		Traffic demand			Traffic volume			Traffic demand			Traffic volume		
		WITHOUT	WITH	Diverted traffic	WITHOUT	WITH	Diverted traffic	WITHOUT	WITH	Diverted traffic	WITHOUT	WITH	Diverted traffic
Rail	2,069.3 (4.4)	3,448.7 (4.4)	4,314.8 (5.5)	866.1	2,664.9 (3.4)	3,356.0 (4.3)	691.1	3,775.1 (4.1)	4,889.4 (5.3)	1,114.3	2,853.6 (3.1)	3,556.5 (3.9)	702.9
Truck	44,538.0 (95.2)	74,390.3 (95.3)	73,525.6 (94.2)	-864.7	75,176.0 (96.3)	74,480.6 (95.4)	-695.4	87,294.0 (95.6)	86,179.5 (94.4)	-1,114.5	88,215.5 (96.6)	87,500.2 (95.8)	-715.3
Ship	179.1 (0.4)	213.2 (0.3)	213.2 (0.3)		212.9 (0.3)	215.8 (0.3)	2.9	236.4 (0.3)	236.4 (0.3)		236.5 (0.3)	248.8 (0.3)	12.3
Total	46,786.4 (100.0)	78.052.2 (100.0)	78,053.6 (100.0)		78,053.8 (100.0)	78,052.4 (100.0)		91,305.5 (100.0)	91,305.3 (100.0)		91,305.6 (100.0)	91,305.5 (100.0)	
Rail (overflow traffic)	-	-	-	-	783.8	958.8	175.0	-	-	-	921.5	1,332.9	411.4

Year / Item / Mode	2002						2007					
	Traffic demand			Traffic volume			Traffic demand			Traffic volume		
	WITHOUT	WITH	Diverted traffic	WITHOUT	WITH	Diverted traffic	WITHOUT	WITH	Diverted traffic	WITHOUT	WITH	Diverted traffic
Rail	4,386.8 (4.0)	5,742.5 (5.3)	1,355.7	3,224.9 (3.0)	3,909.6 (3.6)	684.7	5,107.7 (4.0)	6,746.5 (5.3)	1,638.8	3,663.3 (2.9)	4,326.9 (3.4)	663.6
Truck	103,840.6 (95.7)	102,484.4 (94.4)	-1,356.0	105,002.3 (96.8)	104,296.6 (96.1)	-705.7	122,909.6 (95.8)	121,270.6 (94.5)	-1,639.3	124,353.8 (96.9)	123,661.0 (96.4)	-692.6
Ship	275.6 (0.3)	275.6 (0.3)		275.5 (0.3)	296.5 (0.3)	21.0	320.8 (0.2)	320.8 (0.2)		320.9 (0.3)	350.1 (0.3)	30.0
Total	108,503.0 (100.0)	108,502.5 (100.0)		108,502.7 (100.0)	108,502.7 (100.0)		128,338.1 (100.0)	128,337.9 (100.0)		128,338.0 (100.0)	128,338.0 (100.0)	
Rail (overflow traffic)	-	-	-	1,161.9	1,832.9	671.0	-	-	-	1,444.4	2,419.6	975.2

Note (1) The value inside ( ) means "modal share" (%).

(2) The "Traffic Volume" means the actual traffic volume determined while taking the track capacity of each link into consideration.

Table 4.9.4 Link Traffic of Railway Freight (1992)

(Per Year; Unit: 1,000 tons

Link No.	Track Capacity		East Bound				West Bound			
			Traffic Demand		Traffic Volume		Traffic Demand		Traffic Volume	
	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH
1	346.8	346.8	.8	1.4	.8	1.3	6.1	6.5	6.1	6.5
2	155.1	155.1	.0	1.4	.0	1.4	.2	.2	.2	.2
3	511.0	511.0	.8	2.8	.8	2.8	7.2	7.7	7.2	7.7
4	821.3	821.3	.0	1.5	.0	1.0	.0	3.6	.0	3.6
5	821.3	821.3	.0	75.2	.0	61.3	.0	37.1	.0	37.1
6	784.8	784.8	.8	25.2	.8	21.2	7.7	18.4	7.7	18.4
7	2190.0	2190.0	7.1	7.2	7.1	7.2	.0	.0	.0	.0
8	1843.3	1843.3	7.3	122.6	7.3	101.6	.0	57.5	.0	57.5
9	1569.5	1569.5	.0	.0	.0	.0	7.1	7.2	7.1	7.2
10	1058.5	1058.5	.0	.0	.0	.0	.0	.0	.0	.0
11	1259.3	1259.3	.0	.0	.0	.0	.0	.0	.0	.0
12	1569.5	1569.5	.0	.0	.0	.0	.0	.0	.0	.0
13	1204.5	1204.5	9.4	248.1	9.4	213.1	7.8	95.2	7.8	95.2
14	2098.8	2098.8	1.2	337.6	1.2	291.4	12.0	127.5	12.0	127.5
15	511.0	511.0	.0	21.5	.0	17.5	9.7	18.4	9.7	18.4
16	1843.3	1843.3	86.6	108.9	85.9	99.9	142.5	149.4	142.5	149.4
17	2190.0	2190.0	145.1	236.0	144.7	221.5	56.2	67.2	56.2	67.2
18	1423.5	1423.5	152.2	221.6	151.8	211.1	53.5	56.0	53.5	56.0
19	2190.0	2190.0	231.7	345.0	230.6	321.4	198.7	216.7	198.7	216.7
20	1168.0	1168.0	231.7	346.2	230.6	322.5	198.7	217.9	198.7	217.9
21	2190.0	2190.0	235.1	717.8	234.0	641.9	230.9	383.4	230.9	383.4
22	2190.0	2190.0	235.2	757.7	234.1	674.6	239.6	411.3	239.6	411.3
23	2190.0	2190.0	12.0	28.5	12.0	28.5	.2	68.2	.2	62.7
24	748.3	748.3	10.5	12.7	10.5	12.7	.1	51.8	.1	49.1
25	197.1	197.1	8.5	10.5	8.5	10.5	1.9	1.9	1.9	1.9
26	219.0	219.0	.2	.3	.2	.3	2.2	2.2	2.2	2.2
27	230.0	230.0	.1	.2	.1	.2	2.2	2.2	2.2	2.2
28	1496.5	2190.0	236.7	761.1	235.7	677.3	256.7	429.2	256.7	429.2
29	602.3	693.5	168.5	180.1	168.5	180.1	35.9	181.3	35.9	174.1
30	361.4	416.1	115.8	128.7	115.8	128.7	34.3	40.5	34.3	40.5
31	657.0	1022.0	420.3	1076.7	419.2	973.2	229.8	399.7	229.8	399.7
32	565.8	1022.0	362.3	961.7	361.2	864.0	232.4	402.2	232.4	402.2
33	684.4	1022.0	288.8	891.5	287.7	797.6	242.9	426.2	242.9	426.2
34	346.8	346.8	.0	.0	.0	.0	.0	15.7	.0	15.7
35	2098.8	2190.0	116.0	128.9	116.0	128.9	36.5	42.6	36.5	42.6
36	213.5	213.5	82.8	87.1	82.8	87.1	58.0	56.7	46.1	46.7
37	292.0	292.0	672.7	672.7	555.7	485.5	128.7	128.7	58.1	58.1
38	346.8	346.8	172.6	449.8	172.6	427.2	221.6	347.9	221.6	347.9
39	306.6	306.6	4.6	129.1	3.4	73.6	8.7	25.6	8.7	25.6
40	365.0	365.0	172.6	449.8	172.6	427.1	266.8	393.0	266.8	393.0
41	456.3	456.3	.3	.3	.3	.3	198.0	198.0	198.0	198.0
42	284.7	284.7	4.9	129.4	3.8	74.0	206.8	223.7	206.8	223.7
43	355.9	355.9	328.5	605.7	328.5	583.0	224.9	351.2	224.9	351.2
44	355.9	355.9	474.0	598.5	355.8	355.8	131.9	148.8	61.3	78.2
45	175.2	175.2	.9	12.6	.9	12.0	9.2	15.0	9.2	15.0
46	282.9	282.9	199.8	369.7	199.8	353.6	283.7	368.4	283.7	368.4
47	219.0	219.0	.0	.0	.0	.0	.1	.1	.1	.1
48	208.1	208.1	.9	12.6	.9	12.0	9.0	14.8	9.0	14.8
49	529.3	529.3	121.0	121.0	108.4	100.8	204.9	204.9	88.1	88.1
50	197.1	197.1	.9	12.6	.9	12.0	9.0	14.8	9.0	14.8
51	383.3	383.3	122.0	133.6	109.4	112.9	213.9	219.8	97.2	103.0
52	219.0	219.0	.0	.0	.0	.0	.0	.0	.0	.0
53	273.8	273.8	199.8	369.7	199.8	353.6	283.7	368.4	283.7	368.4
54	438.0	438.0	124.5	124.5	113.0	106.2	1105.2	1105.2	438.0	438.0
55	629.6	629.6	124.5	124.5	113.0	106.2	1105.2	1105.2	438.0	438.0
56	401.5	401.5	.0	.0	.0	.0	.0	.0	.0	.0
57	273.8	273.8	.0	.0	.0	.0	.0	.0	.0	.0
58	565.8	565.8	123.9	123.9	112.4	105.5	1097.8	1097.8	435.0	435.0
59	273.8	273.8	.6	.6	.6	.6	7.4	7.4	2.9	2.9
60	684.4	684.4	477.2	477.7	477.2	477.6	28.5	29.2	28.5	29.2
61	821.3	821.3	477.8	478.4	477.8	478.2	35.9	36.6	31.5	32.2
62	511.0	511.0	.0	.0	.0	.0	.0	.0	.0	.0
63	365.0	365.0	477.8	478.4	477.8	478.2	35.9	36.6	31.5	32.2

Note:

Link No.

4 - 19 JABOTABEK Line

28 Bks - Ckp

29 Ckp - Pwk

30 Pwk - Pdl

31 Ckp - Pgb

32 Pgb - Jtb

33 Jtb - Cn

35 Pdl - Bd