NO. 8

THE STUDY ON ELECTRIFICATION PROJECT OF MAIN RAILWAY LINES IN JAVA IN THE REPUBLIC OF INDONESIA (MASTER PLAN)

FINAL REPORT

MARCH 1983

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

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PREFACE

In response to the request of the Government of the Republic of Indonesia, the Government of Japan decided to conduct a study on the Electrification Project of Main Railway Lines in Java and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to Indonesia a study team headed by Mr. Kazuo Hiramatsu, Director of the Japan Railway Technical Service in June, 1982 under the guidance of the Supervisory Committee chaired by Dr. Naohei Yamada, Professor of Science University of Tokyo.

The team held discussions with the officials concerned of the Government of Indonesia over the Project and conducted a field survey in Indonesia. Subsequently, further studies were made in Japan and the present report has been prepared.

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

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

March, 1983

Keisuke Arita

Keisuke Arita
President
Japan International Cooperation Agency

SUMMARY

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1. The Basic Electrification Concept and Execution Thereof

In this study, the following three basic matters are made clear. They are:

(1) The main railway line to be electrified is about 2,500km and the project itself is generally feasible with a total amount of investments of 1,463 billion Rp (annual average 49 billion Rp) with an IRR exceeding 20%. The amount of oil conservation would reach 84 million gallons per year.

(2) The highest priority sections are the Jakarta~Cirebon and the Cikampek~Bandung.

(3) As a result of a comparison of various feeding systems, AC electrification system with the commercial frequency of 25kV is optimal as a feeding system for this project.

The amount of transport which is a prerequisite for this electrification project was calculated on the assumption that double track lines (between Manggarai and Cikampek) are used exclusively for medium and long distance electrically operated trains at a maximum speed of 100 km/h. As a result of this, the total amount of transport by railway and road shows an average annual increase of 7%, but this amount is restricted by the capacity of the railway lines and the amount of transport by railway becomes half of the calculated value and the share of railway is 20% for passenger and 10% for freight.

It is planned that electrification and the opening to operation of electrified sections will be carried out at the pace of 100km section per year and that the first stage electrified sections of Jakarta~Cirebon and Cikampek~Bandung will be put into operation in 1989, and from then electrification will extend sequentially to the south line.

The subjects for investment considered under this electrification project are those facilities such as the ground electrification facilities, rolling stocks, workshops, depot facilities, vehicle bases, large scale improvement of train turning stations, extension of the

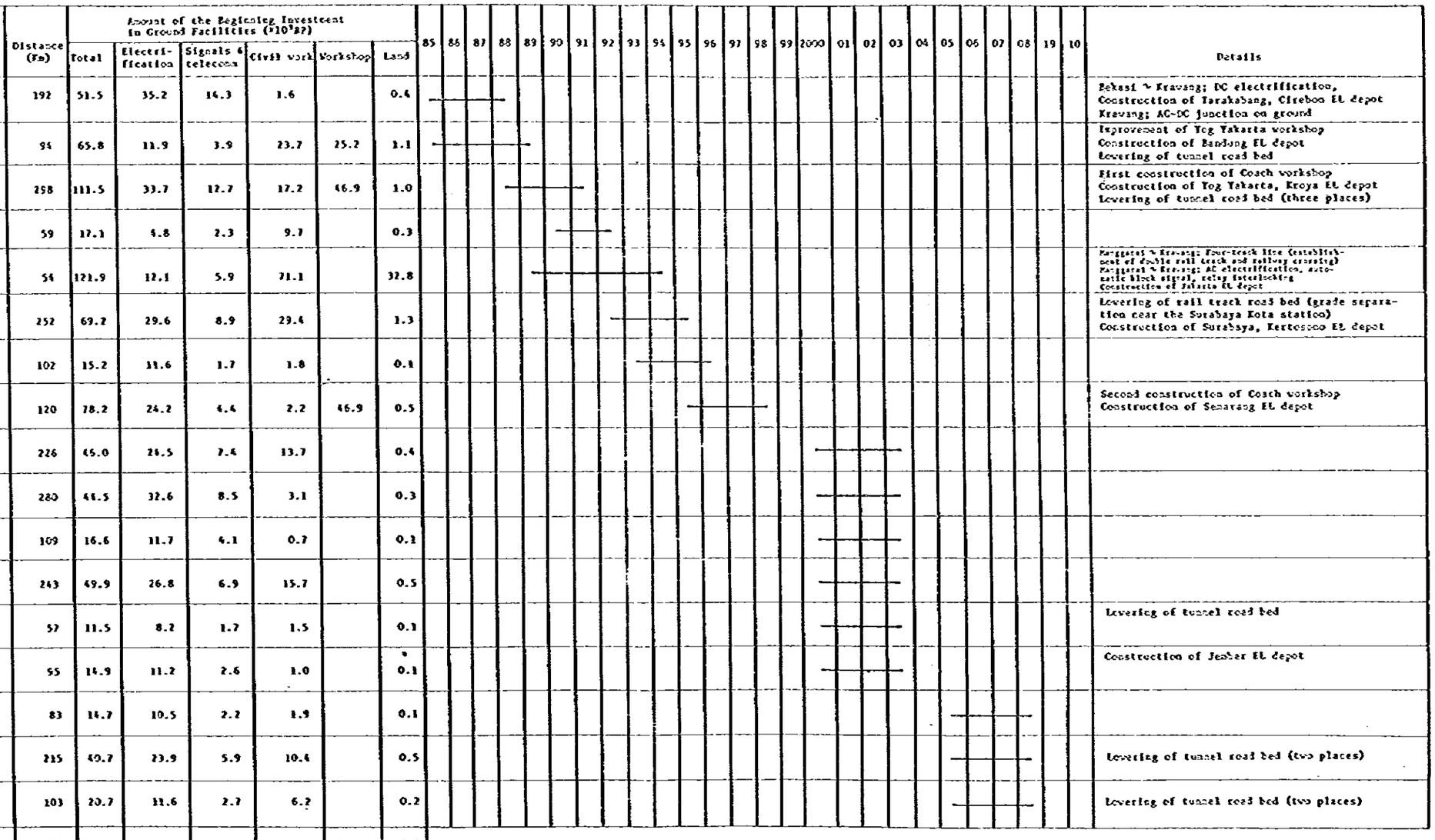
effective length of stations for the passing of freight trains, signalling automatization of double track sections, conversion of single track sections into tokenless block systems, color signalling systems, conversion of communication lines to cable systems, etc. Inicial investment of each year are shown in Table 1.1. In addition, there are additional problems which are to be investigated for the improvement of transport such as the maintenance of terminals including the concentration of freight stations, the improvement of train controlling functions, etc.

As for the relationship with the JABOTABEK project, we made clear our basic policies including the review of AC/DC connecting points. In other words, it is decided that consideration should be given to the section covering Krawang from Jakarta as a transport section for commuters in the JABOTABEK area, the starting station of medium and long distance trains shall be Manggarai Station, for the first electrification stage the existing double tracks between Manggarai and Cikampec are used for commuters and medium-long distance service and for the second electrification stage a double track line will be additionally constructed at the existing line up to Krawang from Manggarai and the new section will be electrified by an AC system. Regarding the relationship with the JABOTABEK project, the further study is required.

As for the conversion of passenger trains into electric trains, a review is given macroscopically and concluded that the amount of rolling stock investment would become larger, but that effects of such investment could be expected.

Table 1.1 The Work Schedule of Electrification Project

Electric Section	Distance (Km)	Amount of the Beginning Investment in Ground Facilities (10^9RP)						Details
		Total	Electrification	Signals & telecom	Civil work	Workshop	Land	
Bekasi ~ Cirebon	192	51.5	35.2	14.3	1.6		0.4	Bekasi ~ Kravang; DC electrification, Construction of Tarakabang, Cirebon EL depot Kravang; AC-DC junction on ground
Cikampek ~ Kiaracondong	94	65.8	11.9	3.9	23.7	25.2	1.1	Improvement of Yog Yakarta workshop Construction of Bandung EL depot Lowering of tunnel road bed
Cirebon ~ Yog Yakarta	258	111.5	33.7	12.7	17.2	46.9	1.0	First construction of Coach workshop Construction of Yog Yakarta, Kroya EL depot Lowering of tunnel road bed (three places)
Yog Yakarta ~ Solo	59	17.1	4.8	2.3	9.7		0.3	
Manggarai ~ Kravang	54	121.9	12.1	5.9	71.1		32.8	Manggarai ~ Kravang; Four-track line (establishment of double rail track and railway crossing) Manggarai ~ Kravang; AC electrification, automatic block signal, relay Interlocking Construction of Jakarta EL depot
Solo ~ Surabaya	252	69.2	29.6	8.9	29.4		1.3	Lowering of rail track road bed (grade separation near the Surabaya Kota station) Construction of Surabaya, Kertosono EL depot
Surabaya ~ Probolinggo	102	15.2	11.6	1.7	1.8		0.1	
Serpong ~ Merak	120	78.2	24.2	4.4	2.2	46.9	0.5	Second construction of Coach workshop Construction of Semarang EL depot
Cirebon ~ Semarang	226	65.0	26.5	7.4	13.7		0.4	
Semarang ~ Surabaya	280	44.5	32.6	8.5	3.1		0.3	
Brumbung ~ Solo	109	16.6	11.7	4.1	0.7		0.1	
Kiaracondong ~ Kroya	243	49.9	26.8	6.9	15.7		0.5	
Bogor ~ Sukabumi	57	11.5	8.2	1.7	1.5		0.1	Lowering of tunnel road bed
Probolinggo ~ Jember	55	14.9	11.2	2.6	1.0		0.1	Construction of Jember EL depot
Sukabumi ~ Padalarang	83	14.7	10.5	2.2	1.9		0.1	
Kertosono ~ Bangil	215	40.7	23.9	5.9	10.4		0.5	Lowering of tunnel road bed (two places)
Jember ~ Banyuwangi	103	20.7	11.6	2.7	6.2		0.2	Lowering of tunnel road bed (two places)
Total	2,582	789.9	328.1	55.1	210.9	119.0	39.8	



Rolling Stock (10^9RP)

First Stage (1987~1993)	Second Stage (1993~1997)	Third Stage (1998~2016)
79.0	453.4	141.1

2. Traffic Demand Forecasting

In the interim report, the traffic demand forecast was premised on a maximum speed of 120 km/h but in this report, the traffic demand forecast is premised on one of 100 km/h.

- Zoning and Link Network

The entire Java Island is divided into 25 zones in accordance with the railway transportation forming a link network of 32 railways and 53 roads as the outlined on the OD chart provided by PJKA. Then, the shortest railway and road distances were searched by the minimum path method for each zone pair, using these links as a basis and taking the link resistance into consideration, and routes were decided accordingly.

- Traffic Demand Forecast Years and Sections to be Electrified

In consideration of the present conditions of sections and their importance the electrification of lines will be carried out in three periods; by 1989, by 1994 and by 2002.

- Traffic Demand Forecasting Model

Fig. 2.1 shows the flow chart of the traffic demand forecasting model.

The results of forecasting of the frequency of all passenger and freight trains are shown in Figs. 2.2 ∿ 2.4.

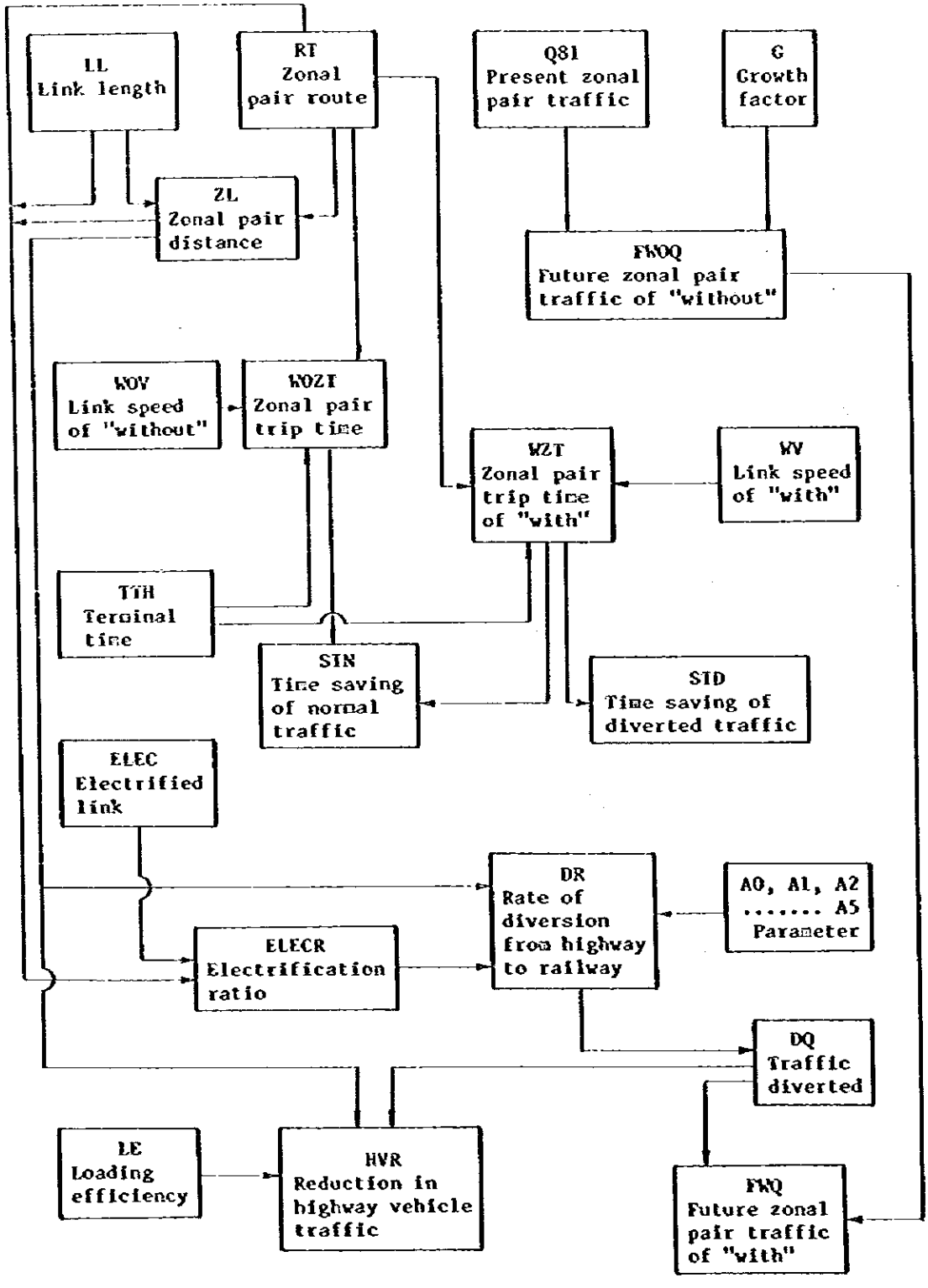
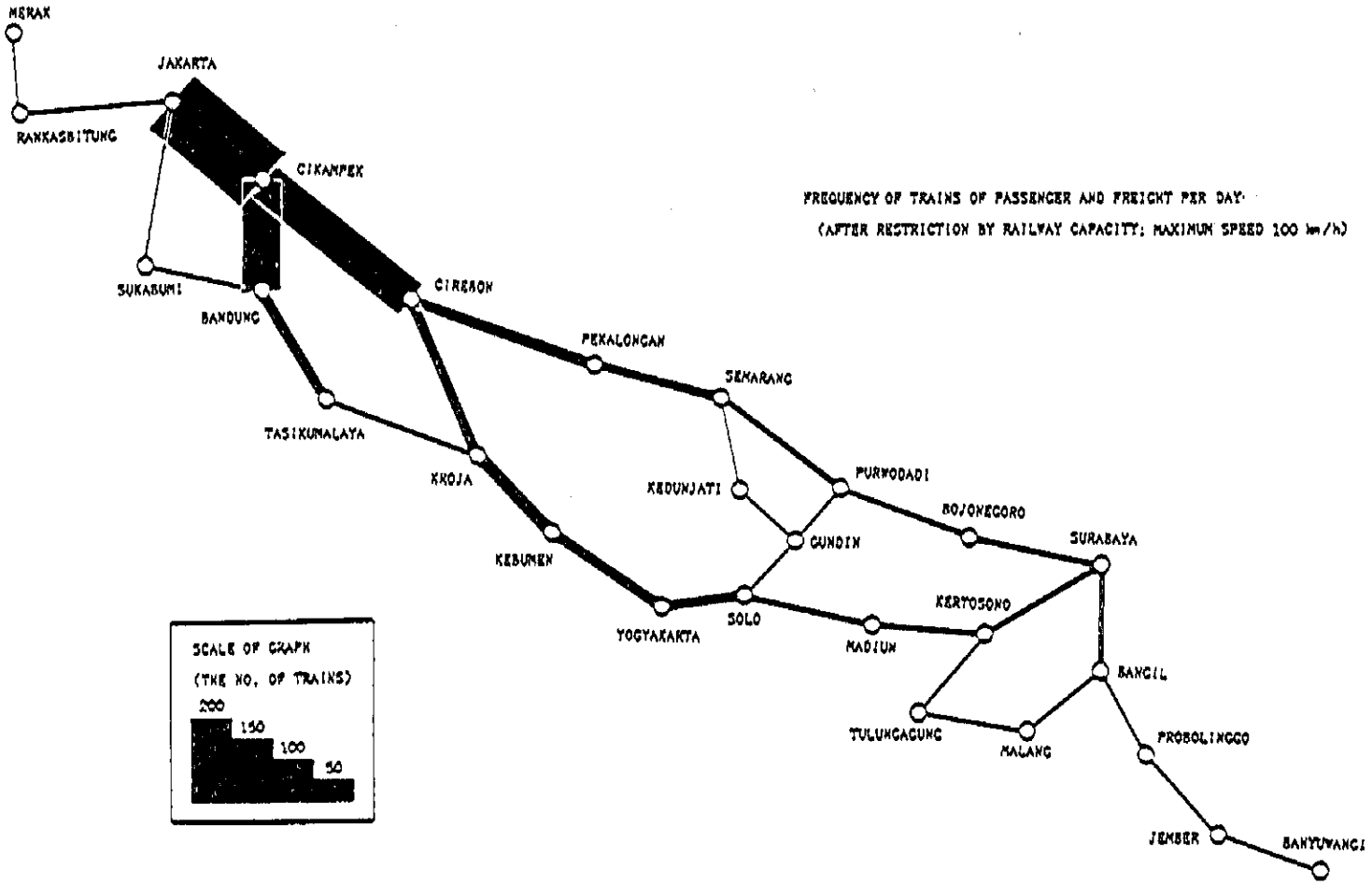
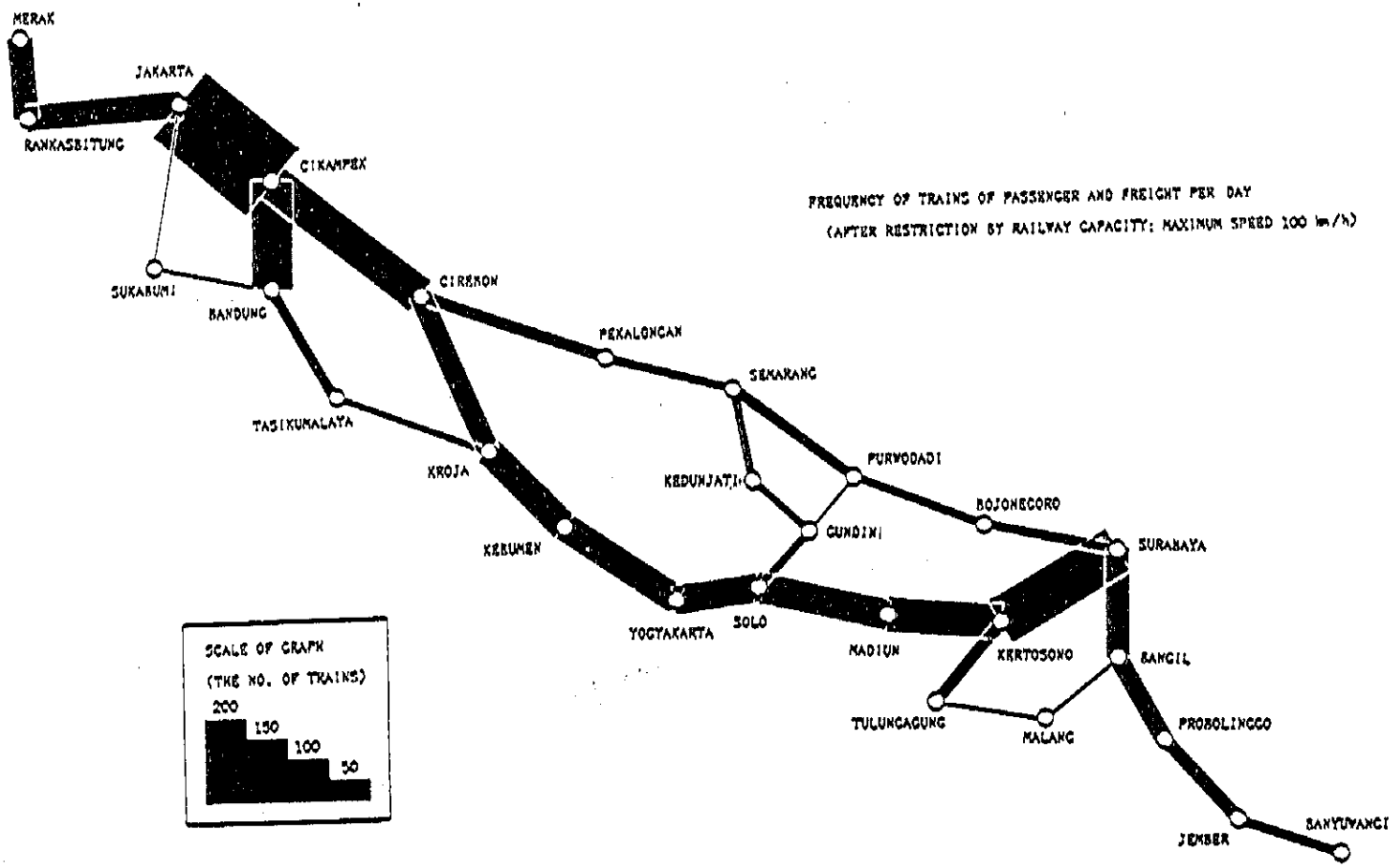


Fig. 2.1 The Model Used for Traffic Demand Estimation



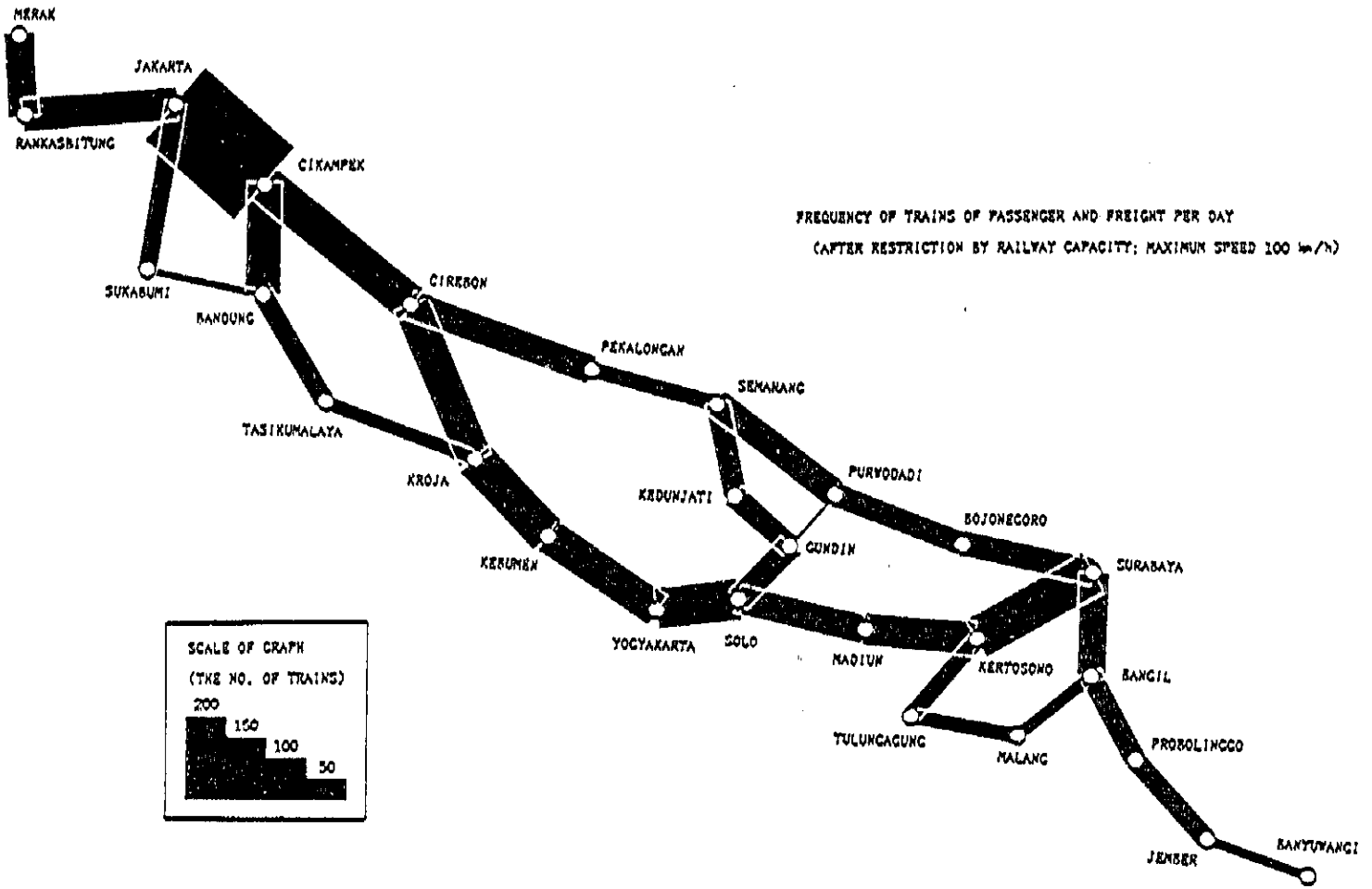
Note: Railway sections to be electrified are "JAKARTA-CIKAMPEK-CIREBON." and "CIKAMPEK-BANDUNG."

Fig. 2.2 Railway Link Trafic (Year : 1989)



Note: Railway sections to be electrified are "MERAK-RANKASBITUNG-JAKARTA," and "CIREBON-KROJA-YOGYAKARTA-SOLO-MADIUN-KERTOSONO-SURABAYA-BANGIL-PROBOLINGGO."

Fig. 2.3 Railway Link Traffic (Year : 1994)



Note: Railway sections to be electrified are "JAKARTA-SUKABUMI-BANDUNG-TASIKMALAYA-KROJA," "CIREBON-SEMARANG-PURWODADI-BOJONEGORO-SURABAYA," "SEMARANG-KEDUNJATI-GUNDIH-SOLO," "PURWODADI-GUNDIH," and "KERTOSONO-TULUNGAGUNG-MALANG-BANGIL-PROBOLINGGO-JEMBER-BANYUWANGI."

Fig. 2.4 Railway Link Traffic (Year : 2002)

3. Train Operation Plan

- Flow Chart of Operation Plan

The procedure of the planning of train operation after electrification is briefly classified as three items as follows.

(1) Preparation of operation-related data necessary for traffic demand forecasting (Operating time according to the section and track capacity both at present and after electrification)

(2) Preparation of train operation plans by stage of electrification (Train operation route and number of trains)

(3) Determination of the number of vehicles and the number of personnel and depot planning (Number of electric locomotives by DC/AC, engine driver and assistant, etc., and electric locomotive depots and stabling sidings by stage of electrification)

- Train Operation Plan

(1) Conditions of Planning

1) Until 1993, DC will be used in the JABOTABEK area for long distance trains and commuter trains and long-distance trains will be AC/DC connected at Krawang Station.

2) A new double-track line (AC electrification) will be provided between Manggarai and Krawang in 1994 and long-distance passenger trains will be AC operated up to Manggarai. AC/DC connection at Krawang Station will terminate. Beginning from 1994, trains will be operated up to Tanjungpriuk via a new AC freight line from Bekasi.

3) The entire Merak Line will be DC electrified and will be opened for electric operation in 1994, the year of the start of AC operation between Manggarai and Krawang, for the purpose of effectively use of DC locomotives.

4) The entire line except for the Jakarta-Cikampek section will be single-track electrified.

5) The block system will be of the tokenless type.

(2) Operating Time and Train Running Speed

The following is the average speed calculated by determining the operating time for the entire line and dividing it under the track conditions of grade and curvature:

Track condition	Average speed of passenger trains after electrification (km/h)	
	Express trains	Local trains
(1) Small grade and large curvature radius	83 ∿ 90	62 ∿ 76
(2) Small grade and small curvature radius	71 ∿ 90	60 ∿ 74
(3) Large grade	55 ∿ 88	50 ∿ 69

The average speed of the BIMA train (express train operating between Jakarta and Surabaya) is 54.2 km/h and its scheduled speed is 50.3 km/h. So, the proposed speed-up is possible.

(3) Train Operation Plans, by Stage of Electrification

A train operation route and train operation sections were decided in accordance with the OD chart for each year for completion of electrification, and the respective numbers of trains was decided from traffic demand.

From this train operation plan, train kilometers were determined separately by year of electrification, by passenger/freight type and by DC/AC/diesel locomotive type. The train kilometers in 2008, the year all the lines will be electrified, is 177,700 km. The train kilometers by electric locomotive traction in 1988, the year the Jakarta-Cirebon section will be electrified, is 24,700 km.

(4) Arriving Time After Electrification

The following table is the comparison between arrival time after electrification and the present arrival time. They indicate that the arrival time will be drastically shortened through electrification.

Operating section	Arrival time after electrification (A)	At present		Difference (B - A)	Reduction rate $\frac{(B-A)}{B} \times 100\%$
		Name of train	Arrival time(B)		
Jakarta ~ Surabaya Gubeng	10hr. 34min.	Bima	16°30'	5°56'	36.0
Bandung ~ Surabaya Kota	9hr. 28min.	Mutiara Selatan	16°20'	6°52'	42.0

(5) Line Capacity

Line capacity for the case with a maximum speed of 100 km/h and 120 km/h and the present case were calculated. Though line capacity determined by calculation is merely a general standard, it is about double after electrification (100 km/h), when compared to the present level.

(6) Number of Electric Locomotives

The number of locomotives required was roughly calculated on the assumption that in an electrified section, all trains will be tracted by electric locomotives. Nineteen DC electric locomotives and 256 AC electric locomotives will be necessary in 2008. The number of diesel locomotives will peak at 82 in 1989 but will then gradually decrease to 0 in 2008.

(7) Number of Passenger Cars and Freight Cars

Approximately 2,500 passenger cars and 3,900 freight cars will be necessary. Since freight cars must have air brakes, most will have to be newly provided.

(8) Number of Personnel

The approximate number of electric locomotive drivers and assistant and depot inspection/repair personnel are calculated. In 2008, the number of engine crew (engine driver and assistant) is about 2,220 and the number of depot inspection/repair personnel is about 550. As many as 310 engine crew will be necessary in 1988, the first year, and their training - including the training of instructors from the previous 1 1/2 years - must begin in 1986.

· Train Dispatcher

The present three-stage operation center organization is consid-

ered to be excellent but, with a view to the smooth progress of high-density train operation after electrification, it is necessary to increase related personnel and to modernize the related facilities.

4. Electrification Plan

- Selection of Electrification Systems

The commercial frequency of (50 Hz) single-phase AC 25 kvAT feeding system is selected for electrification of the main railway lines in Java Island, and after taking all factors including economic merits as a system, location of the power supply network, technical universality, and maintainability after the start of business as an electrified line into consideration.

However depending on the district, it will be necessary to compare the system for with this simple feeding system with respect to the amount of equipment investment necessary and to study the adoption of the latter system.

- Power Supply Network

The power supply network of PLN (State Electric Public Corporation) on Java Island is still inadequate, particularly in Central Java. However, extensive power supply network improvement is now in progress throughout Java Island and it seems that by 2000, a further system buildup will be necessary. It is considered, therefore, that in the long term, the power necessary for the electrification of main railway lines in Java will be secured.

- Feeder System

(1) Voltage and Frequency

1) Voltage

Standard voltage	25 kv
Range of variation	27.5 ∿ 19 kv
Short-time drop	17.5 kv

2) Frequency

Standard	50 Hz
Range of variation	51 ∿ 48 Hz

(2) AT Feeding System

The AT feeding system for the electrification of main railway lines in Java is outlined in Fig. 4.2.1 and Fig. 4.3.4. Positions considered to permit drawing from PLN substation bus bars with as large a fault level as possible were selected for traction substations.

- Selection of Overhead Contact System

The heavy simple catenary system is simplest, economically excellent and capable of coping with future 120 km/h operation, was selected as the overhead contact system.

The iron system (St 135 mm^2) which is economical and can be domestically produced is recommended for the messenger wires.

- Selection of Structure

Indonesia is getting ready to domestically produce prestressed-concrete poles and it is necessary to use inexpensive and semipermanent concrete poles and use steel masts according to the circumstances wherever possible.

The use of hinged cantilever, which are durable and capable of maintaining satisfactory overhead contact characteristics, is recommended.

5. Signalling and Telecommunication Plan

- Signalling System

The basic consideration for signalling system relative to AC electrification is track circuit and inductive interference. The track circuit in an AC electrified section must be able to cope with such interference currents as harmonic current or rush current caused by an AC electric locomotives or by electric cars or stray currents generated near AC/DC connecting points. Furthermore, countermeasures against inductive interference by screening or grounding are necessary for block circuits, signal control cables, signal wires and switch levers.

As improvement of signalling system, automatic block signal and relay interlocking system will be employed for the Jakarta-Cikampek section and at the same time automatic safety equipment will be introduced at railway level crossings. For other sections, the tokenless block system will be introduced to increase safety. Also, color light will be adopted for signals.

- Telecommunication System

The basic consideration for telecommunication system is communication circuit composition and inductive interference. The communication circuit must be systematically composed of long-distance communication circuits, medium-distance communication circuits and short-distance communication circuits so as to maintain ties between different work organizations. Care must also be exercised so that the dispatching systems for electric power, signal and telecommunication, facilities and train operation can be established as electrification progresses.

The inductive interference countermeasures for aerial open-wires must consist of replacing all aerial open-wires now existing along related railway lines with underground shielded cables having satisfactory balance degree.

As improvement of the communication system, replacement with cables, modernization of dispatching system, radio system, exchange, telegraph/telephone and passenger guide facilities will be carried

out for the Jakarta-Cikampek section. For other sections, replacing the cables will be carried out in connection with inductive interference countermeasures.

The improvement of signalling and telecommunication system presupposes the basic improvement of external environmental conditions, such as tracks and bridges. In future track renewal under PELITA and others, therefore, it is desirable to execute track insulation in advance.

6. Structure Plan

• Tracks

As the design maximum speed after electrification, train speed of 100 km/h is assumed taking into account the track structures presently being renewed.

Reinforcement of the track by the employment of 50N/UIC54 rails and concrete sleepers is proposed for some section under the PELITA programme. If maintenance of the track is satisfactorily performed, those sections will be serviceable for 120 km/h operations because locomotive speed capacity has been designed to meet the requirements of 120 km/h.

Since improvement of the track would require tremendous cost it is advisable to determine the implementation of the programme after cautious study has been made on the propensity of future road transport.

Track renewal is not considered in this master plan to avoid duplication of investment under the PELITA.

Improvement to curvature on the track will contribute to the increase in the train speed, however this particular problem will be discussed in a practical manner at a later stage.

Matters related to the present improvement plan are as follows:

- Provision of new tracks and railway level crossing due to the construction of double track between the Manggarai and Krawang Stations.
- Lowering of the southern line roadbed to obtain sufficient overhead clearance at the Southern line and Northern line level crossings adjacent to Surabaya Kota Station.

• Bridges

Railway bridges are being improved under the present PELITA programme so as to be able to withstand an axle load of 15 to 20 tons. Shearing stress and bending moment were calculated and compared for the purpose of determination how the proposed electric locomotive will affect the existing structures. As a result, it has been confirmed

that the design strength of the bridges is sufficient for the load of the locomotive.

The major subject for improvement in this master plan is to increase the overhead clearance sufficient to rolling stock gauge for the future electrification. Various items subject to investment for respective sections are summarized in Table 6.1.

- Tunnels

Seven of the nine tunnels on the main railway lines are 80 through 100 years old and are considerably deteriorated. Although, the enlargement of inner dimensions of tunnel is only proposed under this project, it is desirable to study the possibility of driving new tunnels with view to the degree and extent of deterioration of the existing tunnels and restricted train speeds due to the location of the tunnels on the curve in a small radius.

Various methods are recommendable to enlarge the inner dimensions of tunnels, however the method to lower the track which is relatively inexpensive and safe in the work is tentatively proposed. For remodeling, live-line work method is proposed taking into account local topographical conditions under which substitution by bus transportation is unfeasible.

Table 6.1 Bridge to be Improvement

Type / Electrification section	Siphon Type Aqueaduct	Roadway Bridge		Railway Bridge	
		Reconstruction	Girder Elevating	Extending of Upper Chord Member	Improvement of Portal Bracing
	(Place)	(Place)	(Place)	(m)	(Bridges)
Bekasi ∿ Cirebon	0	0	0	40	1
Cikampek ∿ Kiarakondong	11	0	2	30	0
Cirebon ∿ Yogyakarta	4	0	9	300	0
Yogyakarta ∿ Solo	0	0	0	50	0
Manggarai ∿ Krawang	Note 1.	No. of improvement due to double track line.			
Solo ∿ Surabaya	2	0	1	66	0
Wonokromo ∿ Probolinggo	1	0	0	72	0
Merak ∿ Serpong	1	3	1	105	0
Bogor ∿ Sukabumi	7	2	3	0	0
Kiarakondong ∿ Kroya	10	0	2	0	0
Cirebon ∿ Semarang	0	0	0	450	11
Semarang ∿ Surabaya	0	0	0	291	0
Brumbung ∿ Solo	0	0	1	164	0
Probolinggo ∿ Jember	1	0	1	0	0
Sukabumi ∿ Padalarang	5	0	0	0	0
Bangil ∿ Kertosono	3	1	5	0	0
Jember ∿ Banyuwangi	0	0	1	0	0

Note 1.

Type / Section	Truss bridge	Girder bridge	R.C. bridge	Abutment	Pier
Manggarai ∿ Krawang	277 (m)	176 (m)	128 (m)	26 (Place)	86 (Place)

7. Station and Yard Program

• Passenger Service Facilities

The number of passengers on long and medium distance trains after completion of electrification of the trunk lines in the year 2002 is estimated to be 1,163,000/day which is 14.1 times the year 1981.

Particularly, a large number of passengers boarding and descent are envisaged at the Jakarta Area (228,000/day), the Surabaya Area (118,000/day), the Semarang Area (79,000/day), the Bandung Area (74,000/day), the Yogyakarta Area (59,000/day) and the Solo Area (53,000/day).

The number of incoming and outgoing long and medium distance trains are forecasted to be 350 at the Jakarta Area and 236 at the Surabaya Area respectively.

The improvement of the station facilities to cope with the growth of train operations is being planned under the following policies:

1) Although consistency is required with the transportation plan for JABOTABEK Area, the Manggarai Station shall be the starting station temporarily on the North Line for long and medium distance trains and the Jatinegara Station shall be the transfer station to/from the East Line.

2) A.C./D.C. convertor facilities shall be installed at Krawang station.

3) Bekasi station shall be the connecting station for the Cibinang freight line (under separate planning) and the north line.

4) Expansion of the passenger service facilities shall be made at five (5) stations, i.e., Bandung, Yogyakarta, Solo, Surabaya and Semarang where limited express trains to start.

5) Extension of the effective track lengths shall be made at 34 junction stations and 52 intermediate station for the freight trains (1,000-ton traction).

- Freight Depot Facilities

1) Improvement of Freight Depots

The volume of freight handled in 1982 was 25,000/day. It is envisaged to reach 84,000 ton/day in 2002 after completion of electrification of the trunk lines of the State Railways.

The areas where the large volume of freight handled are the Jakarta Area (11,000 ton/day), the Kroya Area (10,000 ton/day) and the Surabaya Area (18,000 ton/day). Areas other than those handled less than 4,000 ton/day.

Expansion and improvement of the freight depot facilities at the above three major areas will be required.

Ever-increasing goods at these three areas are of petroleum products, fertilizer and cement, and loading/unloading have been carried out on the exclusive tracks.

In connection with the increasing of goods, the installation of additional tracks of the exclusive use would be required, followed by the expansion of loading/unloading facilities.

Also, extension of the effective track lengths of arrival/departure line will be ingegral due to the traction of 1,000-ton freight trains.

However, it is anticipated that the improvement of the freight depot facilities will be carried out at the expense of consignors to cope with gradually increased volume of the freight in line with the development of the economy, the separate survey and study therefore will be required.

2) Consolidation of Freight Depots

In order to expedite the delivery of the goods, it is preferable to operate the through freight trains between the key bases as the distribution of a few freight trains to the freight depots spotted in various localities to handle the small consignments is extravagant and inappropriate.

For the solution of the problem, it is advisable to concentrate these small freight depots at a suitable area and to install a modernized consolidated freight terminal.

It is prerequisite for the consolidated freight terminal to

cater for the large volume of freight for which through freight trains would be required.

The four areas, e.g., Cikampek, Semarang, Sukabumi and Solo are assumed to be suitable for the above conditions.

Upon concentration, the detailed survey will be necessary to the particular circumstances at the respective depots and it is recommendable to make a separate planning taking into account the propensity of future railroad freight transport.

- Freight Car Yards

1) Future Concept for the Jakarta Area

According to the future planning of freight transport route at the Jakarta Area, Cibinang freight line from the vicinity of Beaksi station is to be extended to north and south, and reached Tanjung Priok Budang at northern area and Cibinang area at southern area respectively.

In this plan, the operation of freight trains on the east line will be discontinued and the present location of the yard will become inconvenient in terms of yard function.

On the other hand, Tanjung Priok Gudang yard, though it was provided to cater for the freight to be handled at port, the volume of freight is less and its operation ratio is considerably low.

However, it is envisaged through the study on the size and extent of the yard that it is able to cope with the growth of freight in 2002, it is therefore preferable to utilize effectively the existing facilities as the major yard at the Jakarta Area.

In addition, the Cibinang Yard is located adjacent to Manggarai station which is the starting station for A.C. electrification, it is recommended to alter to the base to accommodate long and medium distance coaches as it has a suitable location.

2) Tanjung Priok Gudang Yard

If the growth of bulk freight traffic by through trains at the Jakarta Area takes place in the future, the number of freight cars to be handled at the yard will amount to 650.

Since this figure is less than the capacity of approximately 700 cars, it is quite feasible to meet the requirements. However, a separate survey will be required for the solution of various problems such as handling of marine containers, installation of level crossings on the lead track, and linkage with the Cibinang freight line.

3) Perspective to the Surabaya Area

At the Surabaya Area, the Sodotopo Yard capable of handling 100 freight cars for the south line and the Kalimas Yard capable of handling 500 freight cars for the north line are located.

Even though the through freight trains are operated in conjunction with the expansive growth in the freight traffic in the near future, the existing facilities will be capable of catering for the demands.

8. Vehicle Program

- Basic Conditions

(1)	Maximum traction load weight	PC-400 ton	FC-1000 ton
(2)	Maximum operating speed	PC-120 km/h	FC-75 km/h
(3)	Maximum weight of axle load	15 ton/axle	
(4)	Rolling stock gauge	Tentative recommended limits	
(5)	Environmental condition		

- Specifications for Locomotives

Data on the conditions of 3 representative lines (south, north and Bandung line) and running conditions were fed into a computer and such conditions were optimized by running simulation. Five type of locomotive were examined by trial and error and in consideration of the running performance, RMS current, arrival time, energy consumption, etc., D3 type gave the optimal results. The specifications for the locomotive are as follows:

Electric system	25kV 50Hz
Arrangement of axle	B_o-B_o
Dead load	60 ton (Axle load: 15 tons)
Continuous rating	1800kW
Traction force	13,200kg
Rated speed	49 km/h
Control system	Thyrister continuous phase control, field control (Minimum field 50%)
Drive motor	Continuous rating 450kW-900V-540A-1070rpm
Diameter of drive wheel	1120mm (1080mm for calculation)
Gear ratio	1:4.44 (16:71)
Motive power transmission system	Nose suspension with axle roller system

To obtain the performance of AC locomotive (D3 type described above), DC locomotives should have 6 axles drive.

The maximum speed of 120 km/h is provided to meet to the future requirement when the tracks are improved to allow a specified maximum speed.

The rolling stock gauge given presently is a tentative one. Also, the rolling stock gauge to be applied when the structures are improved, in the future, is proposed.

9. Rolling Stock Workshop and Rolling Stock Depot

・Workshop

It is estimated that the number of DC locomotives will be about 19 and that of AC locomotive will be about 256 in 2008 and big diesel locomotives for main lines will all be replaced by electric locomotives and only small type diesel locomotives for branch lines and shunting will remain. Consequently, the amount of work at the Yogyakarta workshop which exclusively repairs diesel locomotives at present will be considerably decreased and its facilities and personnel will become redundant.

The present locomotive repairing system will have to be changed greatly. Thus, in this study, the basic specifications for repair of the electric locomotives and the resulting workshop capacity were determined at first, and for such conditions, the possibility of converting the existing five workshops was studied. As the result, it was found to be best to convert the Yogyakarta workshop after suitable improvements.

The reasons being that the Yogyakarta workshop has many experienced technicians and skilled workers and its basic facilities including its area, arrangement of rails within the compound and buildings are suitably well arranged for the repair of locomotives and its capacity is also large. Consequently, it is considered best to convert the workshop into an electric locomotive workshop in consideration of the effective utilization the accumulated repairing techniques for diesel locomotive which is common in many respects to that for electric locomotives. Another reason is the econonic utilization of facilities and personnel which would other wise become redundant.

In connection with this concept, we have devised an improvement program for the same workshop. In the manner outlined below, this program deals with the construction of the necessary buildings and the maintenance of facilities for the repair of electric locomotives.

(1) Construction of a new locomotive body shop and related warehouse and administrative office.

(2) Movement of shops of bogie, wheel and axle sets, machine processing and improvement of work flow.

(3) Movement of shops of traction motor, electric equipment and air brake valve and improvement of work flow.

(4) Construction of a new servicing room

(5) Improvement and construction of equipments for the above works.

- Depot

(1) Inspection at Depot

The description concerns matters that must be considered regarding the position of depots and their functions. Depot inspection on electric locomotives comprises daily checks, monthly checks and bogie truck checks.

Regarding other vehicle types (diesel locomotives, passenger cars and freight cars: DL, PC, FC), the present methods will continue to be used but it is desirable for the monthly check of freight cars to be executed at freight car depots just as the monthly check of passenger cars is executed at passenger car depots.

(2) Facilities at Depots

The typical layouts of electric locomotive, passenger car, electric car, and freight car depots are shown. Furthermore, facilities necessary for the inspection and repair of electric locomotives is indicated.

(3) Depots, by Stage of Electrification

By electrification stage, depots and stabling sidings of electric locomotive are necessary. Monthly checks and bogie truck checks execute to be concentrated.

In 2008, there must be a DC electric locomotive depot at Tanah Abang and AC electric locomotive depots at Jakarta, Cirebon, Bandung, Yogyakarta, Jember, Surabaya and Semarang. Of these, the depots at Tanah Abang, Jakarta, Bandung, Yogyakarta, Surabaya and Semarang will handle bogie truck check as well as daily and monthly checks.

10. Economic Analysis, Financial Evaluation, Effects of Electrification and Education

- Economic Analysis

(1) In accordance with the principles of With the project/Without the project and increment analysis, we calculated the costs of investment, maintenance and operation, benefits, and obtained the internal rates of return.

(2) Forecast of traffic volume

1) With the project: Normal traffic volume (natural increase of railway traffic) + Converted traffic volume (conversion from road traffic)

2) Without the project: Railway - Normal traffic volume
Road - Converted traffic volume

(3) Concept of With/Without

	Investment item	Maintenance and operating cost item	Calculation of Internal rate of return	
			Cost	Benefit
With	Ground facilities (power source, electrification, signal and communications, civil engineering, workshop) Vehicles (DL, DC, passenger car, freight car)	Maintenance cost Labor cost Energy cost	Difference between amounts of investment	Benefit of time saving Benefit of cost saving
Without	Ground facilities (signal and communications, civil engineering, workshop) Vehicles (DL, passenger car, freight car/bus truck)	Maintenance cost Labor cost Energy cost		

(4) Evaluation

1) The internal rate of return for the base case obtained by the aforementioned method is 24.3%, which exceeds the 13% level regarded as the standard for evaluation of Indonesian railway projects hence showing that this project is fully feasible. The following savings can be obtained over the life of the project if executed:

1,122.7 billion RP, as time saving benefits

2,093.2 billion RP, as cost saving benefits
(Including a saving of 611.9 billion RP as a result of fuel conservation)

Especially regarding the conservation of fuel, it can be said that this project will fully conform to the energy conservation policy of the Indonesian Government.

2) Sensitivity analysis

The internal rates of return the following 3 cases were obtained:

	Case 1	Case 2	Case 3
Traffic volume Investment	-20% +10%	-30% +20%	- +30%
IRR Analysis table	20.6% Appendix. 10.1.2	17.9% Appendix. 10.1.3	17.4% Appendix. 10.1.4

The internal rates of return for all cases exceed the evaluation standards for Indonesian railway projects and all cases are feasible.

· Financial Evaluation

(1) Method and purpose of evaluation

In consideration of the returns and operating expenses belonging to the portion of increment (investment) and the procurement of necessary funds, we prepared a cash flow projection using the increment method and carried out evaluation from the following viewpoints:

1) Presence or absence of necessity for governmental subsidies for PJKA

2) Bearing of liabilities in conjunction with the procurement of funds and reimbursement margin on the cash flow

Assuming the following 3 types of fund procurement plans, we prepared cash flow tables.

	Foreign currency	Local currency	Remarks	Analysis table
Base case	6.0% p.a. 27yrs incl. 7rs grace	PELITA (Government budget)	Average ODA loan from overseas is assumed.	Appendix. 10.2.1
Case 1	3.0% p.a. 30yrs incl. 10yrs grace	PELITA (Government budget)	ODA base concessional loan from overseas is assumed.	Appendix. 10.2.2
Case 2	6.0% p.a. 27yrs incl. 7yrs grace	13.5% p.a. 10yrs incl. 4yrs grace	Condition wherein the bearing of liabilities is the greatest.	Appendix. 10.2.3

(2) Earnings and expenses program of PJKA

Since a large increase of demand in the future is forecast, an annual average operation profit of RP 118 billion/year can be forecast throughout the period and it is considered that the execution of the master plan will make a great contribution to the betterment of PJKA's records.

(3) Cash Flow Analysis

The net cash flows of the Base Case, Case 1 and Case 2 were in the black throughout the period and there were no possibilities that the reimbursement of liabilities related to the project would result in an increase in the financial burden of the Government or the burden to be borne by users.

(4) Evaluation

If the execution of the master plan is reviewed based on the data of the above evaluation, its FIRR is viable at 16.3% and it is considered possible to repay part of the investment by the net profit of the project. In view of the fact that this project adopts the "increment method" and the profit of the project will be absorbed into the actual record of the overall operation of PJKA, it would be practical to devise a procurement program such that all of the investment funds are procured from outside and that a portion of domestic funding (25%) should be obtained from the Government budget and a portion of foreign currencies (75%) should be obtained from long-term low interest funds.

·Effect of Electrification

(1) Energy Conservation by Electrification

When electrification is completed, trains which were so far operated by diesel locomotives will be hauled by electric locomotives and it is expected that a considerable number of passengers and freight will turn to railway services instead of conventional bus and truck services due to rail's convenience and comfort.

For the forecast of transport demand estimated in Chapter 2, the amount of energy conservation was calculated in terms of light oil due to the change in motive power source and the change from automobile to electric operation. According to the estimate, it is forecast that about 230,000 gallons of light oil will be saved per day.

(2) Comparison of Transport Cost

To change the motive power of train operation to electricity requires converting the key points of the transport program such as the transport system, setting of trains, etc. and there are many items related to such changes in operating railway services. As for the amount of transport in the "With" case in 1990, the transport costs for electric operation and that for diesel operation were calculated and also for the amount of transport converted to railway, the transport cost of passengers and that of freight were calculated and compared assuming that such amounts of transport were performed by automobile. As a result of this comparison, when the cost of electric operation is assumed as 1, the cost of diesel operation in terms of passenger-kilometer is 1.64 and that of bus is 5.80 and the cost of diesel operation in terms of ton-kilometer is 1.18 and that of truck is 9.35 so illustrating that electric operation will make a great contribution to the operation of railway services.

(3) Influence of Electrification Investment on Industries

A large amount of money is used for electrification, and such a large investment, if interpreted by "Input-Output Analysis", will give an impact not only to those industries which are directly related with the electrification project, but

also to those industries which are indirectly related. The influence of this investment on industries was numerically understood by using the inverse matrix of the Republic of Indonesia. It is considered that about 41% of the amount of money to be invested in domestically produced goods would instigate indirectly related industries to promote their production owing to the complexity of the nation's industrial composition.

·Education and Training of Employee

(1) Present Condition of Education of PJKA Employees

PJKA is making efforts to educate its employees by providing Railway Engineering College as well as training centers. However, it seems that the shortage of education and training facilities for practice degrades the intensity of the contents of the education.

(2) Reinforcement and Improvement of Education and Training

The purpose of employee education is to make them fully understand the mission of the state railways and to promote their consciousness as railway employees, and to diffuse the necessary knowledge and techniques so they can work with confidence as professional railway workers. Therefore, it is desirable that the contents of education be reinforced in both quality and quantity. As for methods of education, on the job training, class room training, education by external facilities, etc. they can be considered and it is desirable that an effective education program combining those kinds of training be properly compiled in response to the advancement of techniques.

(3) Education and Training of Employees in Connection with Electrification

In conjunction with the introduction of electric operation, it becomes necessary to educate employees in the various fields of operation, electricity, facilities, vehicles, etc. This project has a long distance of electrification of 2,500km and its construction period of 20 years is also long. Consequently, the early stage of electrification work would be an unequalled

practical training aid for the latter stages of electrification. It is necessary to devise precise training programs with close liaison maintained between all systems for the purposes of utilizing the early stages of electrification.

For this purpose, it is desired that a training center be reinforced. Here, we show a plan for such a training center where not only the education of electrical divisions but also the education of operation, facilities, rolling stocks and other divisions can be conducted as guidelines for the enlargement of education facilities.

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INTRODUCTION

INTRODUCTION

1. Background of the Survey

The Republic of Indonesia has undergone a favorable economic growth at the average rate of 7.5% per a year increase in GNP since the First Five-year Plan starting in 1969.

In the field of transportation, the Government has adopted the policy stressing road transport in achieving rapid economic growth.

However, the road transportation seems close to saturation point with marked congestion due to the drastic increase in the number of automobiles at an annual rate of 15%. Serious problems have caused such as increasing traffic accidents in many places, chronic traffic congestion, and air pollution by exhaust gas.

As oil deposits, the backbone of the country's economic growth, are limited, the Government of the Republic of Indonesia believes that an energy-saving policy is important to maintain steady economic growth in the future, thereby consolidating the foundation of the infrastructure while oil resources are still abundant and saving on domestic oil consumption which has reached a third of total oil exports and is still increasing at an annual rate of 14% so that the country can maintain its oil exporting capacity.

In the field of power generation, for instance, efforts are being made to convert oil-fired thermal power generators to coal or natural gas or even to geothermal plants.

From the same point of view, emphasis in the transport policy is also being shifted from road to railways.

Moreover, though the country's economy has steadily developed, the standard of living is still low for most of the population. Expansion of a low-price means of public transportation is thus in increasing need. With the operation of electric railways in the Jakarta area achieving satisfactory results under the Suburban Railway Transport Expansion Plan (the so-called Intermediate Plan), the people place great expectations on railways.

In view of the above conditions and the rapid progress made with the improvement of power networks under its economic development plan, the Government of the Republic of Indonesia has revealed its intention to carry out the electrification of main lines in Java. The government is planning to drastically increase the railway transport capacity by not only increasing the transport capacity through electrification but by improving tracks, signallings, telecommunications and platform facilities, centering around electrification.

2. Purpose of the Survey

This survey is intended to formulate a master plan for the electrification of main lines in Java, bearing in mind the conditions in Indonesia outlined above, on the basis of the Scope of Work concluded between the Government of the Republic of Indonesia and the JICA Contact Mission. The master plan aims at the implementation of the improvements outlined below.

- Effective use of oil resources

  The railways' oil consumption for diesel operation can be reduced through electrification. The resulting increased transport capacity is expected to check the marked increase in domestic oil consumption due to road transportation. With a positive shift from road to railway transportation thus a saving on domestic consumption of valuable oil resources can be made.

- Increase and improvement in transport capacity

  Powerful electric locomotives will be introduced with electrification to increase the hauling power and the operating speed, while improving ground facilities such as tracks, signallings, telecommunications, stations, etc., thereby increasing and improving the transport capacity of main lines in Java.

- Improvement of railway finances

  While increasing the passenger and goods demand and earnings with improved transportation through electrification, power costs and maintenance costs such as engine repair costs will be reduced to improve the financial condition of railways.

3. Circumstances of the Survey

This survey was conducted on the basis of the Scope of Work for the electrification of main lines in Java concluded on April 6, 1982, between the Directorate General of Land Transport and Inland Waterways (PHBD) and the Department of Transport Communication and Tourism for the Government of the Republic of Indonesia and the Japan International Cooperation Agency (JICA) for the Government of Japan.

In order to formulate the Master Plan, a survey team organized by the JICA conducted a field survey of main lines in Java from June 16 through to September 14, 1982 under the guidance of the JICA Supervisory Committee in accordance with the contents of the Inception Report agreed upon on June 21, 1982.

On completing the field survey, a Progress Report, containing the salient results of the survey and the basic policy for formulating the Master Plan, was compiled and submitted to the Indonesian authorities on September 13, 1982.

Thereafter, work was carried out in Japan and, as a result, an Interim Report, consisting mainly of transport demand forecast and EL performances, was submitted on October 28, 1982 and approved by the Government of the Republic of Indonesia.

Further domestic work was carried out in Japan and an overall plan for the electrification of main lines in Java, covering train operation, ground facilities, rolling stock factories, economic analysis and financial evaluation, etc. was formulated. This was submitted on January 19, 1983, as a Draft Final Report and was duly approved.

This Final Report is intended to give are principal Plan on the Electrification of Railway Trunk Lines on Java, on the Basis discrived above.

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Soekiswo	Electric Power Engineer
Kenang	Signalling and Telecommunication Engineer
Ir. Darmawan Danu	Civil Engineer
Sidharto	Rolling Stock and Traction Engineer
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CHAPTER 1 THE BASIC ELECTRIFICATION CONCEPT AND EXECUTION THEREOF

CHAPTER 1 THE BASIC ELECTRIFICATION CONCEPT AND EXECUTION THEREOF

1.1 Purpose of the Study

The purpose of the study is to clarify the following items:

1) Whether this project - Electrification of approximately 2,500 kilometres of main line - is feasible as a whole; and what it will the investment and energy saving effects of this project be estimated.

2) Assuming the project to be feasible, in which order electrification should be carried out, or which lines should be electrified first.

3) What the most suitable system for electrification of the main lines of Java island is.

1.2 The Fundamental Conditions for Traffic Demand Forecast and General Aspects of Traffic Demand

The assumptions made in estimating traffic demand are the following:

1) Present economic development trends will continue.

2) Qualitative, not quantitative, improvement in road transport will not be taken into consideration. (i.e.,new construction of expressways will not occur.)

3) The government will not give railways priority.(Some countries have imposed legal restrictions on road transportation exceeding a certain distance, or tax policies that give priority to rail transportation.)

4) Modernizing the railway by electrification and, a complete double truck between Manggarai and Cikampec (the others are single) will be layed, operating of the electric trains with maximum speed of 100km/hr.

With regard to the renewal of track, 70% of main line track renewal has already been carried out. We assume that electrification will come with the completion of track renewal. To achieve maximum

speed of 120km/hr., considerable investment would be required in track strengthening; thus the investment effect of a 120km/hr. train operation would increase traffic volume and the cost of track maintenance, which should be studied before a 120km/hr. train operation would be carried out.

Total traffic volume (including rail and road) is expected to increase 7% a year to the year 2002, and this figure is matched by the present growth rate of the Indonesian economy. This is the same record as Japan experienced at the time of rapid economic growth. Rail transport's share of total transport is 20% for passenger, and 10% for freight - these being lower shares than those in Japan in the past, probably because of restriction of traffic volume by track capacity and the single track rail network.

Rail freight in Java consists mainly of cement, fertilizer and oil, and the areas of production and consumption of them are limited respectively to the west, central and eastern parts of the country. Terminals for these goods are well arranged for rail transport, so the railway's transport share for long distance runs is large, but road vehicles account for a large part of the freight traffic over short distances.

Generally, Java has gently sloping coasts, coastal industrial sites have thus not developed much. Roads are completely paved but are only wide enough to allow nine-ton trucks to pass each other. The study of the transport demand forecast are made only for nine goods, which make up 90% of present rail freight, and raw materials for industrial production, sand and rubble have not been included. We can say from the facts mentioned above that the share of rail freight transport might be increased over what we have forecast.

Java has an area of 130,000km^2, and a population of approximately 90,000,000. Cities with a population exceeding 1,000,000 are Jakarta (6.5 million), Surabaya (2 million), Bandung (1.5 million), Yogjakarta, and Solo (2.8 million), and Semarang (1 million). Depending on future economic growth, development of secondary and tertiary industries and a corresponding expansion of passenger traffic can be expected.

1.3 Stages in Establishing Electrification

1.3.1 Items to be Considered.

With regard to the implementation of electrification, sections where the investment in electrification will have the greatest effect are generally started first. This effect is in proportion to the number of trains in the section, so in most cases electrification starts where the train frequency is highest.

The following factors, in addition to train frequency, should be given consideration in determining the priority sequence of electrification.

(1) Track condition

Electrification will increase track capacity where the lines have not yet been electrified and there is no further track capacity, and it will increase the shuttle capacity of terminal stations where there is no more track layout space, through the high speed and high acceleration and deceleration characteristics of electrification.

(2) The existence of other competitive transport modes

The effect of investment in electrification depends to a great extent on whether passengers and clients can be attracted away from buses and trucks to the faster rail services provided by electrification. Therefore, it is desirable to start electrification in a district where such a transfer can be expected.

(3) Power source situation

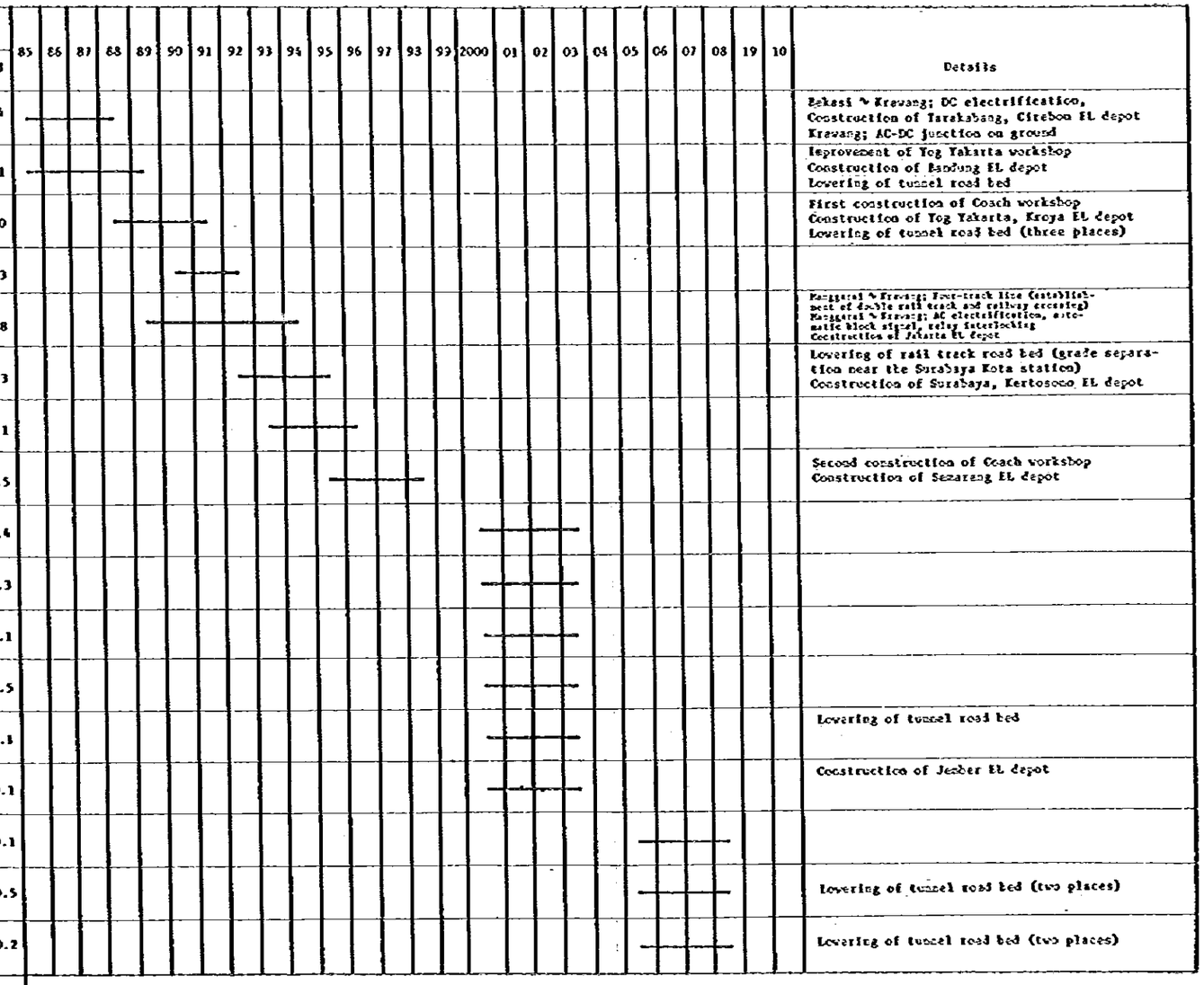
Where new power supply projects are planned, it is necessary to co-ordinate electrification with these projects. However, with the development of the auto transformer feeding system, sub-station intervals can be extended two times more than other feeding system, and conditions imposed by the power supply situation are thus becoming less restrictive.

(4) Operating considerations

In selecting sections for electrification, junctions between electrified and non-electrified sections should be chosen which are found a drop in traffic demand, in order to minimize the effects

Table 1.3.1 The Work Schedule of Electrification Project

Electric Section	Distance (Km)	Amount of the Beginning Investment in Ground Facilities ($\times 10^9$ Rp)						Details
		Total	Electrification	Signals & telecom	Civil work	Workshop	Land	
Bekasi ~ Cirebon	192	51.5	35.2	14.3	1.6		0.4	Bekasi ~ Krewang; DC electrification, Construction of Tarakabang, Cirebon EL depot Krewang; AC-DC junction on ground
Cikampek ~ Kiaracondong	94	65.8	11.9	3.9	23.7	25.2	1.1	Improvement of Yog Yakarta workshop Construction of Bandung EL depot Lowering of tunnel road bed
Cirebon ~ Yog Yakarta	293	111.5	33.7	12.7	37.2	46.9	1.0	First construction of Coach workshop Construction of Yog Yakarta, Kroya EL depot Lowering of tunnel road bed (three places)
Yog Yakarta ~ Solo	59	17.1	4.8	2.3	9.7		0.3	
Manggarai ~ Krewang	54	121.9	12.1	5.9	71.1		32.8	Manggarai ~ Krewang; Four-track line (establishment of double rail track and railway crossing) Manggarai ~ Krewang; AC electrification, automatic block signal, relay interlocking Construction of Jakarta EL depot
Solo ~ Surabaya	252	69.2	29.6	8.9	29.4		1.3	Lowering of rail track road bed (grade separation near the Surabaya Kota station) Construction of Surabaya, Kertosoco EL depot
Surabaya ~ Probolinggo	102	15.2	11.6	1.7	1.8		0.1	
Serpong ~ Merak	120	78.2	24.2	4.4	2.2	46.9	0.5	Second construction of Coach workshop Construction of Semarang EL depot
Cirebon ~ Semarang	226	45.0	25.5	7.4	13.7		0.4	
Semarang ~ Surabaya	280	44.5	32.6	8.5	3.1		0.3	
Brumbung ~ Solo	109	16.6	11.7	4.1	0.7		0.1	
Kiaracondong ~ Kroya	243	49.9	26.8	6.9	15.7		0.5	
Bogor ~ Sukabumi	57	11.5	8.2	1.7	1.5		0.1	Lowering of tunnel road bed
Probolinggo ~ Jember	55	14.9	11.2	2.6	1.0		0.1	Construction of Jember EL depot
Sukabumi ~ Padalarang	83	14.7	10.5	2.2	1.9		0.1	
Kertosono ~ Bangil	215	40.7	23.9	5.9	10.4		0.5	Lowering of tunnel road bed (two places)
Jember ~ Banyuwangi	103	20.7	11.6	2.7	6.2		0.2	Lowering of tunnel road bed (two places)
Total	2,582	789.9	324.1	95.1	210.9	119.0	39.8	



Rolling Stock ($\times 10^9$ Rp)

First Stage (1987~1988)	Second Stage (1989~1997)	Third Stage (1998~2016)
29.0	453.4	141.1

of changes in the operation system.

(5) Length of electrified sections

It is desirable for electrified sections to run up to points where the traffic volume drops, but if the electrified section is too long, the investment required is large then becomes excessive and at the opening of the electrified section the costs and staffing requirements are temporarily high. For this reason, sections are usually limited to about 300km in length.

1.3.2 Order of Electrification

When the priority sections for electrification are chosen, the internal rate of return (I.R.R.) of each section is calculated, taking the factors mentioned above into consideration and the priority is determined.

In the case of this project, electrification of main railway lines in Java, Jakarta-Cirebon has now more than 50 frequencies in train operation, which is considerably larger than other sections, which have 30 ∿ 40 frequencies at most. And the rate of increase in train operation frequencies by electrification is extremely large. (see fig. 2.4). Therefore, Jakarta-Cirebon is a section which may be expected the highest I.R.R.

Cikampec-Bandung is a section which has following characteristics.

① This section branches off at Cikampec, located between Jakarta and Cirebon, so electrification will result in improvement of rolling stock operation efficiency.

② This section is a grade line connecting two large cities, Jakarta with 6.5 million inhabitants and Bandung with 1.5 million, and therefore transfer of passengers from roads to the railway is expected by electrification.

Taking these factors into consideration, Jakarta-Cirebon and Cikampec-Bandung are the top priority sections for electrification.

Following the first stage, the second stage can consist of an extension of the line either to the north or the south. From estimates of traffic volumes after electrification, the southern extension should

be given priority, in which case, there would be a choice between extending east from Cirebon to Yogjakarta and Solo, or west from Surabaya. Traffic volume (train frequency) after electrification would be greatest between Surabaya-Kertosono and Surabaya-Bangil, but judging from a) the train operations flow around Surabaya, which shows a few train frequency drop at Kertosono and Bangil, b) if electrification starts from near Jakarta, a workshop for electric rolling stocks will be coordinated with the first stage of electrification, and c) the almost same traffic volume can be expected on the southern line west from Cirebon as near Surabaya, the Yogjakarta-Solo-Cirebon section is preferred.

Therefore the order of electrification is following:

Cirebon-Yogjakarta(91) - Solo(92)

Solo-Surabaya(95), Surabaya - Probolingo(96)

Jakarta - Merak

the numbers in ( ) show the opening year of electrified train operation.

The time of electrification of the Merak section will be determined by its relationship with the JABOTABEK project.

In the third stage the following sections are to be electrified, around the year 2003:

Cirebon-Semaran.

Semaran-Surabaya.

Semaran-Solo.

Bandung-Kroya.

Probolingo-Tember.

The following sections will make up the last stage because they are assumed to have train frequencies under 50 in the year 2002, which will not result in good investment effect:

Jakarta-Sukaburni-Bandung.

Kertosono-Tulungugang-Malay-Bangil.

Tember-Banyuwangi.

However, the order of electrification may be changed by the future change of economic activities in Java, for example, the production of a fertilizer factory, which is under construction near Banyuwangi, will be increased in the future, order of electrification between Tember-Banywagi will be re-studied.

1.3.3 Program of Electrification Construction and Investment

Electrification of the top priority section will begin in 1985 at earliest, considering that the feasibility study, detail design and bid preparation will follow this study. Each electrification section is considered to be between 200km and 300km long. In the first year of the electrification work in a section, equipment manufacture will be concentrated on, and construction work in the site will start later. Before the electrification opening, tests of equipment and trial runs of rolling stock will be carried out for about six months.

The construction period is therefore estimated to be 3 years for a 200km section and 4 years for a 300km section. Given the continuity of work on a site, a one year overlap is allowed between electrification of one section and the next.

The average rate of electrification advance is estimated to be about 100km per year (the actual rate in Japan has been over 300km/h).

The program of the whole investment of this project, which amounts to 1,463 billion rp. (annual average 49 billion rp.), is shown in Table 1.3.1.

The purpose of this report is to determine the top priority section. The work sequence in each section after the second stage, and the work rate, should be discussed again during the first construction period, taking into account of any changes in the Indonesian economy, oil consumption, and construction capabilities.

1.4 Fundamental Plan for Electrification and Related Work

1.4.1 Fundamental Plan for Electrification

When DC and AC electrification are compared, AC electrification is more economical since DC locomotives with 6 axles cost about the same as AC locomotive with 4 axles which has excellent adhesive characteristic. Regarding multiple unit trains, the AC type is approximately 15% more expensive but AC ground facilities are 50∿70% less than the DC type. Thus nowadays AC is applied even on urban commuter sections.

The items to study for electrification are the choice of ATS

system and the track circuit and telecommunication system, which are described in detail in a later chapter. At present, the problems of PJKA in Java generally fall into three areas: track maintenance, locomotive maintenance and terminal services. Future problems will be the modernization of train operation control and the development of data processing for railway management. The present maintenance problems of diesel locomotives are a major management problem, but the introduction of electric rolling stock will provide a solution.

1.4.2 Fundamental Plan for the Work Related to Electrification

(1) Terminal improvements

Terminal improvement is one of the problems of PJKA. With regard to passenger terminals, at the shuttle stations of express trains (Manggarai, Bandung, Yogjakarta, Solo, Semarang and Surabaya) platform construction, improvement of track layout, and construction of overbridges will be required.

Improvement of other stations is recommended to study at the time of double tracking.

Electric rolling stock should be equipped with steps.

Designs of station plazas should be chosen independently according to passenger increase and in consideration of connections with bus service.

The extension of effective length of tracks in the stations for freight trains, is to be carried out in every fifth station.

Terminals are well arranged for transport of cement, fertilizer, oil, molasses, etc., which have a large share of railway transportation. The improvement of terminals should be carried out, therefore, only after careful consideration of investment effects. Freight services should concentrate on goods suitable for the railway, establishing a direct transport system and goods which are not suitable for the railway should be left for the roads.

(2) Track and bridges

Track maintenance is one of PJKA's problems. Regarding the renewal of track, completion of the present project is expected by the start of electrification, making 100km/hr. speeds possible. As

for track improvement, in order to cope with the adoption of automatic signal systems in the future, iron sleepers should be replaced by concrete (or wooden) ones, and old trough girders should be replaced. Assuming the locomotive axle weight to be 15 tons, the bridges which cannot support it should be improved.

(3) Signalling and communication facilities

To prevent serious accidents (head-on collisions between stations), the concept of blocking is being introduced. At present, signals are difficult to see at night and thus the colouring of signals is to be adopted. Automatic signals are to be used between Manggarai and Cikampec as train frequency exceeds 200.

1.5 Co-ordination with JABOTABEK Project

1.5.1 Electrification System

In the JAPOTABEK district there is an existing DC section, and future rail service in this district can obtain up to 50% of the railway transport share. Transport intervals of 2 1/2 or 3 minutes by high acceleration and deceleration trains would be adopted. DC electrification operation is more economical in the JAPOTABEK district because a DC multiple unit train is about 15% cheaper than the AC multiple unit train.

Judging from the power source situation and also from future transport demand, AC electrification is more economical for the main line electrification.

1.5.2 A Terminal in Jakarta for Medium and Long Distance Trains

Regarding the location of terminals for medium and long distance trains in Jakarta, the following two plans are to be discussed.

(1) If the present Jakarta-Kota (or Gambil) terminal is used for medium and long distance trains, one double track of the central lines, of two double tracks can be used for long distance, and the other double track line for urban traffic.

(2) If both double tracks of the central lines are used for urban traffic, Manggarai is an important traffic center can be used as the long distance terminal.

At present, elevation work at Manggarai station is under study in JAPOTABEK project and if the medium and long distance terminal can be constructed under an elevated Manggarai station, passengers can easily change trains. Therefore, we have chosen Mangarai station as the medium and long distance terminal. However, it would be convenient for passengers to be able to take some medium and long distance trains from Jakarta Kota or Gambil, so adoption of AC/DC dual service trains would be reasonable. The station track layout and train operation plan in Manggarai and Jakarta-Kota, should be co-ordinated with the Manggarai elevation plan which will be studied next year in JAPOTABEK project.

1.5.3 How to use the Track Located West of Manggarai Station

The results of the traffic demand forecast indicate that at the first stage of electrification in 1989, it will be possible for long distance trains to share the present double tracks between Jakarta and Cikampec with commuter trains for Bekasi or Krawang. The operational limit of commuter trains depends on the Indonesian government's future housing policies but, based on the Japanese experience, it should be enough to extend commuter service up to Krawang, about 60km from Jakarta.

In the second stage of electrification, in 1994, it will be necessary to use at least one double track only for medium and long distance trains. At this time, about 100 commuter trains will be operating on the Bekasi line. Therefore, one double track will be required solely for commuter services. The double track is likely to be constructed on the coastal side of the present double track line, judging from the difficulties in obtaining land. The best use of these four tracks is studied below.

(1) Assuming the new double track line is used for long distance trains

This new line is to cross the eastern line in Jakarta between Manggarai and Jatinegara, and, judging from the train density of long distance trains and the eastern line, it needs to be a grade separated crossing. On the other hand, as a new freight line project between Cibinang and Tanjungpruk, it will be necessary for freight trains to run on the new line to Tanjungpriuk, because the JAPOTABEK district will be occupied by commuter train operations. Chipinang yard is the most suitable place to a depot for medium and long distance trains.

(2) Assuming the new double track line is used for commuter services:

The above-mentioned grade separated crossing of the long distance and eastern line would not be necessary, but the movement of trains from a Chipinang base, crossing the new double tracks, would be carried on a grade separated crossing. Therefore in either case, 1) or 2), one grade separated crossing is required.

In the following year, the detail design for the Bekasi electrification is to be started; thus in this project, the new double track line is to be used for long distance services.

1.5.4 AC-DC Junction

On completion of the two double track lines to Krawang in the future, the following three possibilities for AC-DC junctions are compared: (See Figure 1.5.1)

(1) AC-DC junction at Krawang, which is the terminal for the commuter line.

(2) Jakarta-Cikampec-Bandung to be DC, with the AC-DC junction near Cikampec and Bandung.

(3) All lines up to Manggarai, and the new Cibinang-Tanjungpriuk freight line, to be AC.

Items which differ in costs are listed below, and the overall costs differences are estimated.

① Krawang station

In (2) and (3) above, Krawang station's function is only to connect the two double track lines toward Jakarta and the double track lines toward Cikampec. In the case of (1) above, extra storage tracks for locomotives would be required in the Krawang station. In the first stage of electrification, Krawang station's track layout would have to be changed for the future double track arrangement with extra storage tracks for locomotives. This will require an additional approximately 0.4 billion RP.

② AC-DC junctions near Cikampec and Bandung

In (2) above, AC-DC junctions are required at Cikampec and Bandung, at a cost of 1∿2 billion RP at each station.

③ Cost of electrification (difference between AC and DC)

- Cost difference in ground facilities of electrification

  Manggarai∿Krawang
  (including Cibinang-Tanjungpriuk line) 14.7 billion RP

Krawan-Cikampec-Bandung 11.3 billion RP

- Cost difference in signalling and telecommunication facilities

  Manggarai ∿ Krawan 2.6 billion RP

  Krawan ∿ Cikampec ∿ Bandung 1.9 "

- Cost difference in rolling stock

  For 30 EC trains (10 cars × 7) 3.5 ∿ 4.4 "

  1 EL carriage for AC-DC connection 0.8 "

(See Fig. 1.5.2 An example EC operation diagram between Manggarai and Bandung.) Comparisons of the above are shown in Table 1.5.1 and from the point of view of the investment involved, (3) is the most economical, and is also the most suitable choice from the operational point of view.

At the time of the first stage of electrification, an AC-DC junction should be provided at Krawang and if future improvements are made to the Krawang station track layout to provide a junction between the two double tracks line and the one double track line, only a small additional investment would be required for locomotive storage.

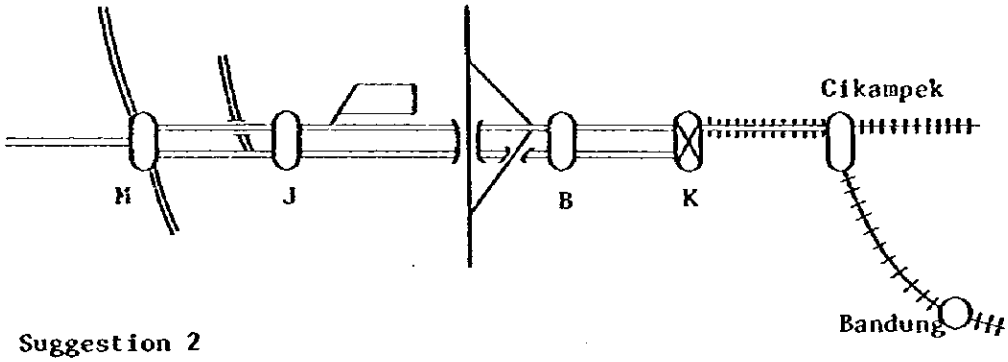
Table 1.5.1 Construction Cost Comparison of AC-DC Junctions

	Krawang station	AC and DC junctions at Cikampec and Bandung	Electrification ground facilities cost difference	Signaling and telecommunications cost difference	Rolling stock cost difference	Total
Case 1	0.4	0	11.3	0	5.2	16.9
Case 2	0	3	26	0	1.6	30.6
Case 3	0	0	0	4.5	3.5	8.0

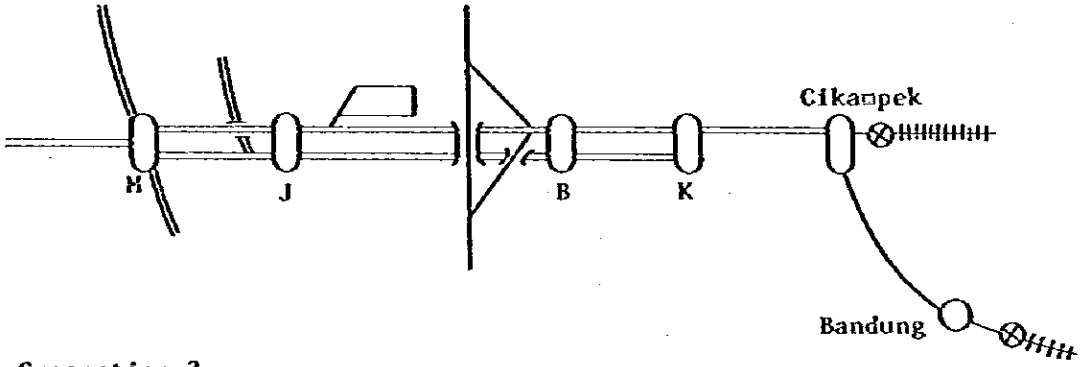
1.5.5 Merak Line

With regard to the Merak line, in the JAPOTABEK project DC electrification is planned to Serpong. Assuming 60km from Jakarta to be the commuter train operation section, the other section is then 100km. Train operation for passengers is to be multiple unit

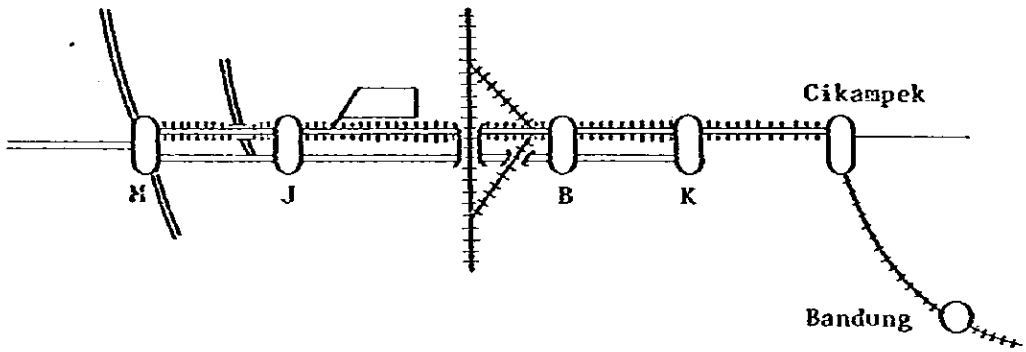
Suggestion 1



Suggestion 2



Suggestion 3



M: Manggarai B: Bekasi ⊗: AC-DC Junction
J: Jatinegara K: Krawang —: DC
⁓: AC

Note: First stage

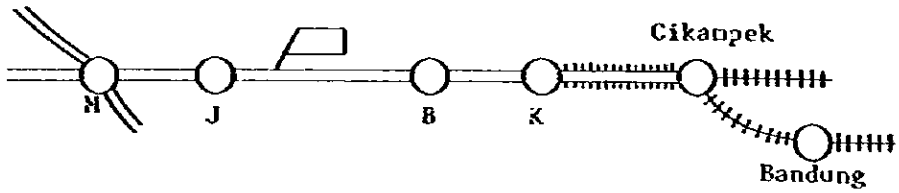


Fig. 1.5.1 Comparison Figure of AC-DC Junctions

trains in the future. The cost difference for EC amounts to 6 billion rp.; the cost difference for overall facilities amounts to 8.8 billion rp.; and the cost of the DC-AC junction amounts to 1∿2 billion rp. The cost difference between DC and AC is not great and thus the Merak line is to be electrified with the DC system.

And at the time of four tracks to Krawang, AC electrification will be realized for medium and long distance train. So the DC locomotives, which will have operated in the Manggarai-Krawang line, will be converted to the Merak line.

1.6 Adoption of Multiple Unit Train (EC)

1.6.1 Comparison with EL Train

EL and EC both have advantages and disadvantages. The difference are as follows:

(1) Effect on tracks

① The maximum axle weight for EL is 15 tons, in EC 12 tons. EL is larger.

② Regarding non-suspended load, EC is smaller (less than 1/2 of EL).

If tracks are well maintained, long distance trains, which make few stops, show little difference of travel time between EL and EC trains. Travelling speed on curves is $V=4.3\sqrt{R}$ according to PJKA regulation and this is the same regulation as in European countries where ground is solid. However, PJKA adopts a lower value in maximum speed and curve travelling speed than PJKA regulation value, in view of present rail conditions. (In Japan, EC trains are allowed to run faster than EL train and an extra 5 k/h in curve travelling speed over EL trains. Pendulum EC trains are allowed to run an extra 20∿25 Kph over EL trains.)

The effects of axle weight and non-suspended load on track maintenance depends largely on rail conditions; thus, general comments can not be given, but with regard to axle weight, the effect is said to be proportional or squarely proportional while non-suspended load also considerably influences track maintenance.

At present, the track is maintained by track renewal, carried out approximately every 25 years, but if this cycle can be extended by 20% by EC train operation, the approximately 1∿2 billion rp. saving will be realized.

(2) Influence on rolling stock maintenance

EC train have more 1∿2 motive units than EL train, that is, EC train in Bandung line have 3 motive units and 2 motive units in other lines. The maintenance cost increase of these motive units of one EC train is assumed about 30% more than one EL train, which result in the maintenance cost increase of 1∿2 billion rp. per year in 240 trains.

(3) The energy consumption

In general, EC train has a little greater energy consumption comparing of EL train, which is caused by high acceleration and a large number of motive units. But it is assumed that the weight of one train is 460 ton for EL train and 480 ton for EC train, so if the running condition of both trains is equal, the difference of energy consumption between EC train and EL train is found little.

(4) Traffic volume

At present, the effective length of ordinary stations in Java is about 220m and the EL maximum number of passenger carriages per train is nine, whereas in the case of electric multiple unit trains, the introduction of 10 carriage trains is possible. The potential traffic demand in Java is largely controlled by track capacity, and thus a difference in traffic volume of 10% may be considered a difference in passenger income of 10%.

The number of passenger-km for the year 2002 is estimated to be 42.6 billion, and the income per kilometer per person averages 5.4 RP; an income increase of 23 billion RP, which may be max. value, can thus be expected.

(5) Improvement of train running reliability

One of the disadvantages of railways transportation is the particular characteristic that a train can only travel on rails.

Therefore, one train in trouble can bring all the following trains to a halt. For this reason, the running reliability of the rolling stock should be well established. Electric multiple unit train (EC train) has more than 2 motive units, and in case one motive unit breaks down travel can be continued using another unit without any trouble. EL has only 1 motive unit, and the running reliability of the EC train, in comparison with EL, is said to be very high.

(6) Increase of terminal capacity

Generally, the exchange of locomotives is required at terminals and this considerably affects the departure and arrival capacities at terminals. As a solution, push-pull operation of a train may be applied, but in this case a small repair to the passenger carriages are required and trains are used in fixed sets.

Generally, in comparison with EL, the electric multiple unit train has good acceleration and deceleration characteristics, two to four times those of EL. These characteristics, determine the capacity of the station. Almost all passenger terminals are located in large cities and there is no room for expansion, thus even with sufficient track capacity between stations, it is possible in some cases that terminal capacity will hinder increasing train frequency.

(7) Ease in train make-up

It is easy to make-up one train by coupling two trains and to make two trains by discoupling one.

(8) Power supply for air conditioning etc., is readily available.

(9) The above-mentioned characteristics are all advantages, but there is a disadvantage: compared with EL trains, the cost of EC trains is high.

If EL-9PC is assumed to be 100, 10EC is approximately, 160. By the year 2002, 260 ELs are required for passenger and freight, and assuming 240 ELs are required for passengers. 240 EC trains are also required when all passengers are transported by EC trains, and the investment difference will be 370 billion RP over EL trains. On the other hand, track maintenance and maintenance of train are offset

each other, and income increases of 23 billion RP/year are expected. So it is generally said that the introduction of EC for passenger transport is feasible.

1.6.2 An Example of Electric Railcar Rostering Diagram

Fig. 1.5.2 is an example of an operation diagram based on the assumption that the operating time between Manggarai and Bandung is two hours and that electric railcar trains are operated for this section at the rate of one per hour.

The total number of trains in both directions is 30 and seven train sets, (i.e., six train sets plus one train set in reserve) are necessary. The daily check can be carried out everyday. The reason why trains leaving Manggarai at noon and leaving Bandung at 2 PM are missing is that these hours are put aside for daily check. It is possible to increase the total number of trains to 32 by operating trains at these hours but, in this case, daily check can be carried out only every other day.

The daily average running kilometers of electric cars is 826.9km for the use of six-train sets.

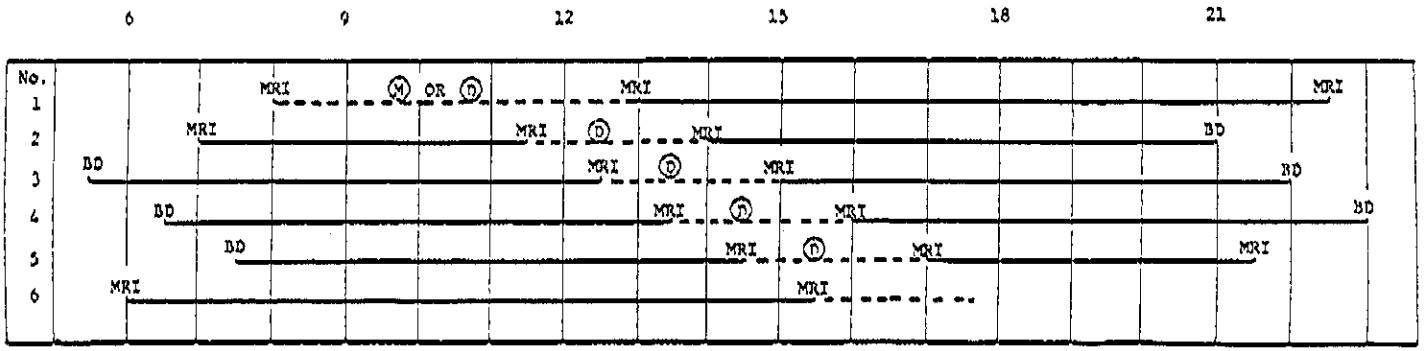


Fig. 1.5.2 Circuratory Diagram of Bandung Express Trains (Electric Railcars)

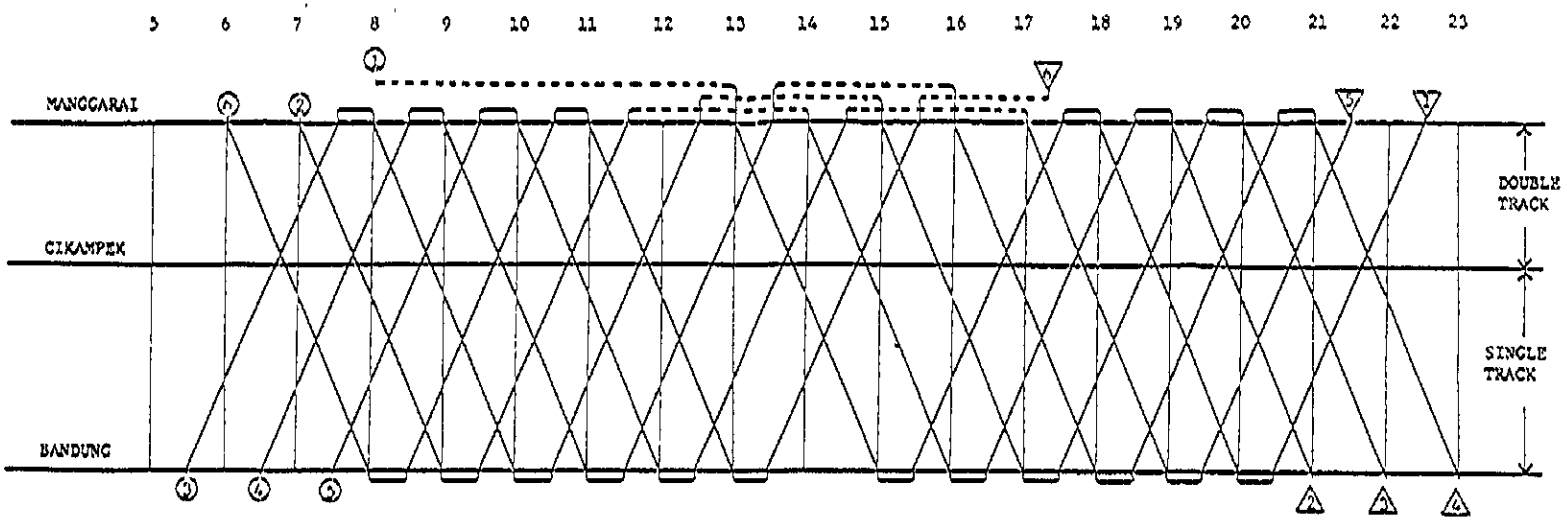


Fig. 1.5.3 An Example of EC Operation Diagram between Manggarai and Bandung

CHAPTER 2 FORECAST OF TRAFFIC DEMAND

CHAPTER 2 FORECAST OF TRAFFIC DEMAND

In the interim report, the traffic demand forecast was conducted on the premise that passenger train maximum velocity was 120 km/h, whereas that of a freight train was 80 km/h. This time, however, the traffic demand forecast is made on the premise that the maximum velocity of a passenger train is 100 km/h and that of a freight train the same as before, i.e., 80 km/h.

2.1 Zoning and Link Network

2.1.1 Zoning

Upon considering the main lines of railway which are the sections of electrification based on the O.D. Table (Actual results of 1981) of railway passengers and freight traffic volume of Java Island (including Madura Island) and 98 zones (Kabupaten 82 zones, Kodya 9 zones, Kotamadya 2 zones and Jakarta 5 zones) provided by P.J.K.A., the zone names are integrated into 25 zones. The classification of Kabupaten, etc., falling under these zone names and the zoning map are as shown in Fig. 2.1.1 and Table 2.1.1.

2.1.2 Link Network

First of all, the link network connecting the 25 railway nodes was prepared and it became 32 links. Since the transportation network of roads was originally complicated in comparison with that of the railway, the link network of roads was prepared centered around the roads running parallel to the railway and as a result, it became 53 links. The above-mentioned link network diagrams of the railway and roads are as shown in Figs.2.1.2 and 2.1.3.

2.1.3 Route Search

(1) Route search of railways

In searching for routes of railways, the minimum distance of routes was considered. Since severe grades exist in some links, when performing route search for a zonal pair of railways, the link

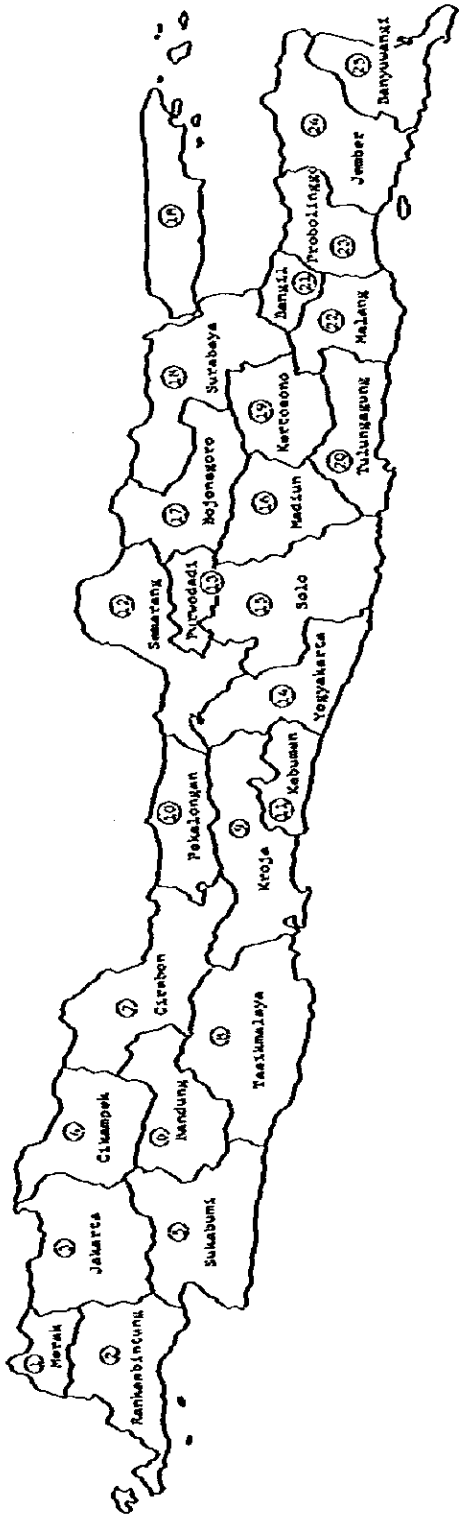
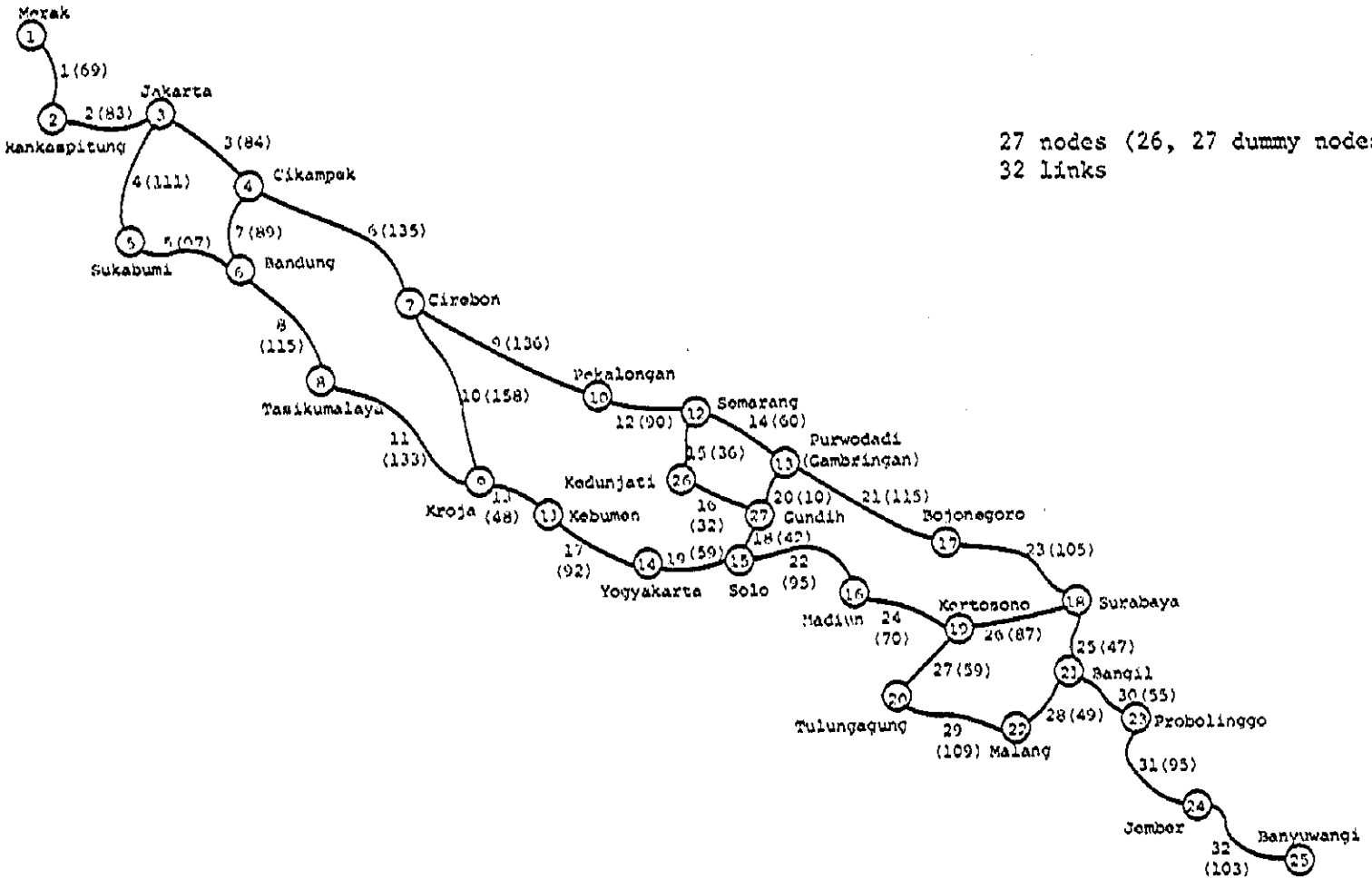


Fig. 2.1.1 Zoning Map

Table 2.1.1 Zoning

Zone and zone code	Kabupaten
① Merak	Serang
② Rankasbitung	Panderang, Lebak
③ Jakarta	Tangerang, DKI Jakarta, Bekasi, Bogor, Kodya Bogor
④ Cikampek	Purwakarta, Karawang, Subang
⑤ Sukabumi	Sukabumi, Cianjur
⑥ Bandung	Kotamadya Bandung, Bandung, Sumedang
⑦ Cirebon	Indramayu, Majalengka, Kuningan, Cirebon, Bredes, Kotamadya Cirebon
⑧ Tasikumaalaya	Garut, Tasikumalaya, Ciamis
⑨ Kroja	Cilacap, Banjarnegara, Banyumas, Wonosobo, Purbulinggu
⑩ Pekalongan	Kodya Tegal, Tegal, Pemalang, Pekalongan, Batang, Kodya Pekalongan
⑪ Kebumen	Kebumen, Purworejo
⑫ Semarang	Kodya Semarang, Kendal, Demak, Jepara, Kudus, Semarang, Pati
⑬ Purwodadi (Gambringan)	Purwodadi (Grobogan)
⑭ Yogyakarta	Kodya Yogyakarta, Temanggung, Magelang, Kulon Progo, Sleman, Bantul, Gunung Kidul
⑮ Solo	Kodya Surakarta, Klaten, Boyolali, Sukoharjo, Pacitan, Sragen, Karanganyar, Wonojiri

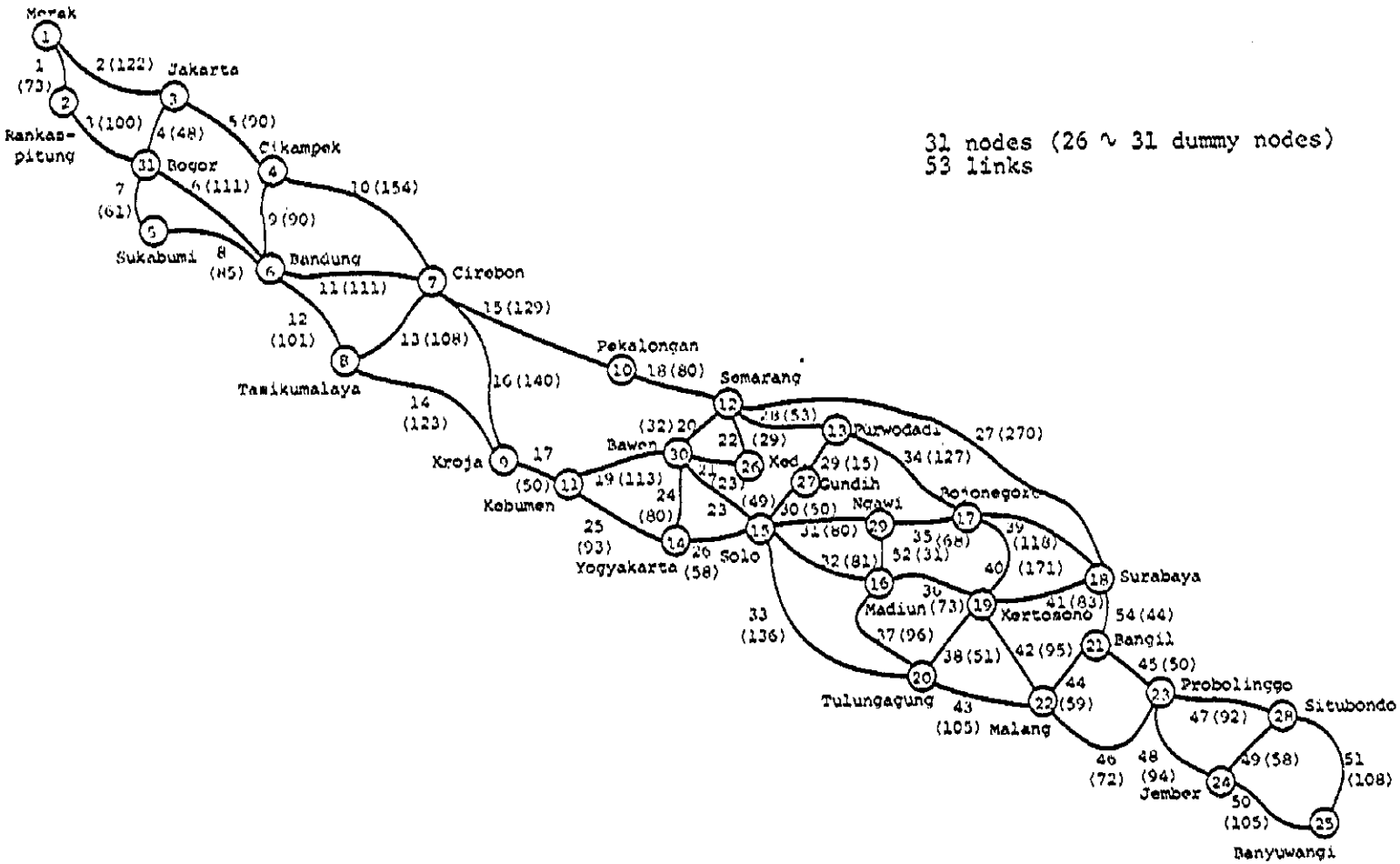
Zone and zone code	Kabupaten
⑯ Madiun	Ponorgo, Magetan, Ngawi, Madiun, Kodya Madiun
⑰ Bojonegoro	Rombang, Bojonegoro
⑱ Surabaya	Tuban, Sumenep, Kodya Surabaya, Lamongan, Mojokerto, Bangkaran, Kodya Mojokerto, Surabaya, Sidoarjo, Sumpang, Pamekasang
⑲ Kertosono	Jombang, Nganjuk, Kediri
⑳ Tulungagung	Trenggalek, Tulungagung, Blitar
㉑ Bangil	Pasuruan
㉒ Malang	Malang
㉓ Probolinggo	Lumajang, Probolinggo
㉔ Jember	Jember, Bondowoso, Situbondo
㉕ Banyuwangi	Banyuwangi
㉖ Kedunjati	Dummy node
㉗ Gundih	Dummy node



27 nodes (26, 27 dummy nodes)
32 links

Note: The figures of parenthesis are actual railway distance.

Fig. 2.1.2 Railway Links



Note: The figures of parenthesis are actual road distance.

Fig. 2.1.3 Highway Links

resistance is determined by multiplying the some coefficient to the link distance. Route search has been performed on this basis. Moreover, the minimum path method was used in the route search, for finding the shortest route.

(2) Route search of roads

The route search of the zonal pair on the 53 links of roads was performed similarly as the railway by the actual distance but without considering the resistance coefficient.

2.2 Present Situation of Transport

2.2.1 Traffic Volume between Zones

(1) Passenger

① Railway

Based on the O.D. Table of 98 zonal pairs by classes (Class 1 to Class 3) for the year of 1981 provided by P.J.K.A., the whole passenger traffic volume was summed up for each 25 zonal pairs as aforementioned and an O.D. Table (see Table 2.2.1) was prepared.

② Road

This has been prepared based on the O.D. survey results of 1977 performed on a nationwide basis in Indonesia (1977 ORIGIN DESTINATION SURVEYS dated September, 1980).

Since the O.D. survey of 1977 had been zoned according to each Kabupaten and Kodya, first of all, zone changing was performed similarly as for the railway. Then, the increase rate of the number of buses in the Java Island during 1977 to 1981 was considered as the growth factor and the total passenger traffic volume was obtained by multiplying this growth factor (2.144) to each zonal pair traffic volume of 1977. (See Table 2.2.1)

(2) Freight

① Railway

Based on the O.D. Table of 98 zonal pairs classified by article (22 articles) for the year of 1981 provided by P.J.K.A., it was changed over to 25 zones similarly as for passenger and an O.D. Table was prepared for each article. In this survey, however, O.D.

Table 2.2.1 Passenger Traffic (Year 1981)

(UNIT 100PASSENGER/YEAR)

RAILWAY (Based on Summing Up by P.J.K.A)

RAILWAY	1 MERAK	2 RANGKAS BITUNG	3 JAKARTA	4 CIKAMPEK	5 SUKABUMI	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROJA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 MERAK		1920	2550	0	0	0	20	0	40	40	40	100	0	50	40	40	20	120	60	10	0	0	0	0	0	5050
2 RANGKASBITUNG			5220	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5270
3 JAKARTA				14760	7350	2590	8310	1690	2270	3180	4710	2820	10	2510	4150	2260	910	5180	1680	850	10	180	30	50	140	65680
4 CIKAMPEK					0	650	1740	270	90	70	120	40	0	120	30	10	0	30	10	0	0	0	0	0	0	3140
5 SUKABUMI						2420	0	70	0	0	10	0	0	10	0	0	0	0	0	0	0	0	0	0	0	2510
6 BANDUNG							40	4750	1330	0	1840	0	0	2420	630	350	0	1730	380	10	0	20	0	20	130	13170
7 CIREBON								0	190	120	210	340	0	610	200	60	50	450	110	20	0	0	0	0	0	2360
8 TASIKMALAYA									2420	0	790	0	0	820	260	90	0	650	160	10	0	10	10	30	30	5280
9 KROJA										0	610	0	0	750	400	120	0	710	200	30	10	10	10	30	10	2890
10 PEKALONGAN											0	290	0	0	0	0	30	220	0	0	0	0	0	0	0	610
11 KEBUMEN												0	0	100	170	60	0	630	90	10	0	10	20	50	10	1150
12 SEMARANG													3720	0	1150	0	630	1140	0	0	0	10	0	0	0	6970
13 PURWODADI														0	870	0	610	360	0	0	0	0	0	0	0	1840
14 YOGYAKARTA															150	250	0	1930	380	50	30	20	100	150	70	3130
15 SOLO																440	0	1470	170	10	70	30	70	90	10	2360
16 MADIUN																	0	830	30	10	20	10	40	80	10	1030
17 BOJONEGORO																		2110	0	0	0	0	0	0	0	2110
18 SURABAYA																			6150	2750	1160	3470	420	1770	2180	17750
19 KERTOSONO																				560	20	170	30	60	20	860
20 TULUNGAGUNG																					230	2030	0	20	30	2310
21 BANGIL																						590	30	80	270	970
22 MALANG																							10	20	40	70
23 PROBOLINGGO																								60	150	210
24 JEMBER																									670	670
25 BANYUWANGI																										0
TOTAL		1920	7770	14530	7350	5660	10370	6720	5700	3410	8330	3620	3790	6970	7360	3680	2540	17840	9370	4550	1550	6180	770	2530	3770	147340

HIGHWAY (Multiplied the Results of Origin and Destination in 1977 by Growth Factor)

HIGHWAY	1 MERAK	2 RANGKAS BITUNG	3 JAKARTA	4 CIKAMPEK	5 SUKABUMI	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROJA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 MERAK		62662	139232	0	64	3692	0	64	0	557	0	628	0	322	943	0	0	1541	0	0	0	0	0	0	0	209775
2 RANGKASBITUNG			27336	64	150	472	64	129	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26215
3 JAKARTA				200271	92345	190720	74654	104541	11024	15274	814	17624	21	12692	21576	4179	0	21	193	0	0	819	150	0	107	743155
4 CIKAMPEK					65	6137	28177	665	107	1587	0	21	0	0	21	65	0	64	0	0	0	0	0	0	0	36975
5 SUKABUMI						41722	64	493	0	64	0	21	0	21	0	0	0	0	0	0	0	0	0	0	0	42385
6 BANDUNG							55724	117610	5457	5574	4475	8362	64	6495	4553	172	0	3557	64	0	0	1935	0	0	193	213428
7 CIREBON								621	35617	5922	21	2251	0	21	0	0	0	672	0	0	745	21	0	0	107	46201
8 TASIKMALAYA									12821	1329	1427	3130	0	557	0	0	0	85	64	0	0	1800	0	0	0	20816
9 KROJA										25484	1722	5103	0	31024	1415	64	0	21	0	0	0	129	43	0	0	65105
10 PEKALONGAN											15157	13143	0	643	395	0	343	557	0	193	0	64	0	0	0	30155
11 KEBUMEN												9224	0	43845	2873	43	21	64	0	0	0	0	0	0	0	56730
12 SEMARANG													63454	54841	41653	2144	21140	14193	1244	643	129	7933	0	256	257	207681
13 PURWODADI														107	13228	0	0	0	0	0	0	0	0	0	0	13335
14 YOGYAKARTA															117942	2873	407	13124	172	0	64	3838	321	107	0	138843
15 SOLO																26435	203	53236	5574	43	43	1458	150	0	2551	89693
16 MADIUN																	6282	52141	4781	1329	0	536	43	600	407	66119
17 BOJONEGORO																		23627	515	343	279	1887	0	214	0	26865
18 SURABAYA																			71011	69575	167460	214	37797	57451	67990	471261
19 KERTOSONO																				5145	565	12655	300	43	43	19352
20 TULUNGAGUNG																					193	54651	952	43	1050	56919
21 BANGIL																						143377	17596	1544	10164	135241
22 MALANG																							24870	9217	178	34267
23 PROBOLINGGO																								17173	343	17516
24 JEMBER																									178	178
25 BANYUWANGI																										0
TOTAL		62662	166568	200335	91145	242615	161685	220123	65348	55951	22338	64167	63569	145767	245452	32996	28401	163116	83643	77459	169461	192424	84254	86669	83493	2761721

TOTAL (Railway + Highway)

TOTAL	1 MERAK	2 RANGKAS BITUNG	3 JAKARTA	4 CIKAMPEK	5 SUKABUMI	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROJA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 MERAK		64782	141782	0	64	3692	20	64	40	597	40	728	0	372	983	40	20	1621	60	10	0	0	0	0	0	214825
2 RANGKASBITUNG			32556	114	150	472	64	129	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31495
3 JAKARTA				215451	98195	193320	82964	106231	13354	18954	5524	20454	31	15202	25726	3439	910	5201	1873	859	10	999	150	50	247	828795
4 CIKAMPEK					65	6737	29879	935	197	1657	120	61	0	120	51	95	0	94	10	0	0	0	0	0	0	40145
5 SUKABUMI						44142	64	563	0	64	10	21	0	31	0	0	0	0	0	0	0	0	0	0	0	44895
6 BANDUNG							58764	118369	6519	5574	5735	8362	64	8515	5518	522	0	5567	364	10	0	1928	0	20	323	226568
7 CIREBON								621	36037	6102	231	2591	0	631	200	60	50	1072	110	20	703	21	0	0	107	48561
8 TASIKMALAYA									14541	1329	1819	3930	0	1377	260	90	0	935	224	10	0	1514	10	30	30	26096
9 KROJA										25484	1832	5103	0	31774	1815	184	0	731	200	30	10	139	53	30	10	66995
10 PEKALONGAN											15157	13433	0	643	355	0	373	837	0	193	0	64	0	0	0	31056
11 KEBUMEN												9834	0	43945	3043	103	21	694	90	10	0	10	20	50	10	57880
12 SEMARANG													67254	54841	42800	2144	22020	15333	1244	643	129	7943	0	235	257	214651
13 PURWODADI														107	14093	0	610	360	0	0	0	0	0	0	0	15175
14 YOGYAKARTA															118092	3123	407	15054	552	50	94	3858	421	257	70	141978
15 SOLO																26875	203	54726	5744	53	113	1458	220	90	2561	92073
16 MADIUN																	6282	52971	4510	1339	20	545	63	650	417	67149
17 BOJONEGORO																		25737	515	343	279	1587	0	214	0	28975
18 SURABAYA																			77181	72756	169220	3284	38219	59221	72039	489511
19 KERTOSONO																				5706	995	13075	330	103	63	20262
20 TULUNGAGUNG																					423	56651	962	63	1080	59227
21 BANGIL																						144457	15626	1624	10154	136171
22 MALANG																							24539	9233	218	34337
23 PROBOLINGGO																								17233	493	17726
24 JEMBER																									1049	1049
25 BANYUWANGI																										0
TOTAL		64782	174356	215165	98175	248275	171755	226993	71283	59361	30668	63767	67359	152759	213412	36676	30981	180756	92978	82010	170771	198244	85024	89190	87469	2912321

Note: Source; INDONESIAN STATE RAILWAYS RESEARCH AND DEVELOPMENT CENTRE
(The following Tables 2.2.2~2.2.11 are from the same source)

Tables were prepared on 9 main articles which occupy a large share of more than 90% of the entire railway freight. (See Tables 2.2.2∿2.2.10.) The 9 articles are as follows:

(a) Rice, (b) Maize, (c) Salt, (d) Sugar, (e) Paper, (f) Steel, (g) Petroleum products, (h) Fertilizer, (i) Cement

② Road

Since the O.D. traffic survey results of road freight could not be obtained according to articles, the total freight O.D. Table including the railway freight was estimated and, by deducting the railway freight traffic volume from this, the O.D. Table of the road freight transport volume classified by article was prepared.

a. Estimate of total arrival and departure traffic volume by article

First of all, the arrival and departure traffic volume of 1980 to each zone by article was estimated by this method under the following formulas.

(i) $TO_{mi} = P_{mi} + IMPF_{mi} + IMPD_{mi}$

Whereas, TO_{mi}: Sending volume (100 tons/year) of article m from zone i (See Tables 2.2.11∿2.2.19.)

P_{mi}: Production volume (100 tons/year) of article m in zone i

$IMPF_{mi}$: Import volume (100 tons/year) of article m to zone i from foreign countries

$IMPD_{mi}$: Import volume (100 tons/year) of article m to zone i from other islands in Indonesia

(ii) $TD_{mi} = C_{mi} + EXPF_{mi} + EXPD_{mi}$

Whereas, TD_{mi}: Arrival volume (100 tons/year) of article m to zone i (See Tables 2.2.11∿2.2.19)

C_{mi}: Consumption volume (100 tons/year) of article m in zone i

$EXPF_{mi}$: Export volume (100 tons/year) of article m from zone i to foreign countries

Table 2.2.2 Freight Traffic (Year 1981)

ARTICLE : RICE

(UNIT 100TON/YEAR)

RAILWAY

	1 JAKARTA	2 BANDAR BETUNG	3 JAKARTA	4 CIANJUR PEC	5 SURA BAYA	6 BANYU WANGI	7 CIREBON	8 TASIKMALAYA	9 KROJA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 JAKARTA		0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
2 BANDARBETUNG			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 JAKARTA				0	0	0	0	0	0	0	0	0	0	0	2	34	0	35	16	47	0	0	0	0	0	95
4 CIANJUR PEC					0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	18
5 SURABAYA						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 BANDUNG							0	0	45	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	45
7 CIREBON								0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 TASIKMALAYA									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 KROJA										0	0	0	0	0	51	0	0	0	0	0	0	0	0	0	0	51
10 PEKALONGAN											0	47	0	0	0	0	0	0	0	0	0	0	0	0	0	47
11 KEBUMEN												0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 SEMARANG													0	0	0	0	2	0	0	0	0	0	0	0	0	2
13 PURWODADI														0	0	0	0	0	0	0	0	0	0	0	0	0
14 YOGYAKARTA															0	0	0	17	0	0	0	0	24	5	0	46
15 SOLO																0	0	1	0	0	0	0	0	0	0	1
16 MADIUN																	0	1	0	0	0	0	0	1	3	5
17 BOJONEGORO																		0	0	0	0	0	0	0	0	0
18 SURABAYA																			0	0	0	0	0	2	2	4
19 KERTOSONO																				0	0	0	0	0	0	0
20 TULUNGAGUNG		(Based on Sensing Up by P.J.K.A)																			0	0	0	0	0	0
21 BANGIL																						0	0	0	0	0
22 MALANG																							0	0	0	0
23 PROBOLINGGO																								0	0	0
24 JEMBER																									0	0
25 BANYUWANGI																										0
TOTAL	0	0	0	0	0	0	0	0	45	0	0	47	0	1	56	34	2	74	16	47	0	0	24	8	5	329

HIGHWAY

	1 JAKARTA	2 BANDAR BETUNG	3 JAKARTA	4 CIANJUR PEC	5 SURA BAYA	6 BANYU WANGI	7 CIREBON	8 TASIKMALAYA	9 KROJA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 JAKARTA		513	992	99	188	95	54	55	22	22	9	19	5	15	14	8	6	18	8	8	2	6	4	4	5	2981
2 BANDARBETUNG			847	88	254	218	78	187	35	34	14	27	6	23	23	11	8	25	12	11	3	8	5	5	6	1358
3 JAKARTA				3924	1145	595	523	249	129	97	66	148	36	58	54	5	47	8	14	6	8	12	15	28	66	6344
4 CIANJUR PEC					354	1861	424	447	187	133	39	77	18	56	59	29	19	39	29	31	7	21	13	19	12	3786
5 SURABAYA						822	432	183	91	51	41	61	18	37	32	13	23	23	11	11	4	8	7	13	26	1924
6 BANDUNG							1875	654	164	185	94	126	32	69	55	34	44	31	15	15	5	11	14	23	47	3421
7 CIREBON								1229	743	995	193	337	72	196	281	87	58	136	61	91	19	55	22	24	29	4243
8 TASIKMALAYA									811	69	254	148	49	142	95	45	56	49	24	22	7	16	13	27	55	1578
9 KROJA										119	2128	278	61	459	192	48	65	91	64	74	12	49	22	24	49	3742
10 PEKALONGAN											182	1426	210	284	291	95	115	86	47	47	12	27	24	34	53	2849
11 KEBUMEN												282	50	652	266	78	46	77	53	59	9	28	16	65	20	1652
12 SEMARANG													1587	826	1644	347	258	248	166	197	32	87	54	49	74	5474
13 PURWODADI														217	746	117	169	179	66	76	17	53	24	19	21	1627
14 YOGYAKARTA															2656	351	224	154	158	174	23	74	14	42	79	3937
15 SOLO																1266	452	259	251	252	34	116	55	57	112	3829
16 MADIUN																	615	455	956	528	47	173	68	66	79	2993
17 BOJONEGORO																		2498	258	196	135	187	142	73	65	3866
18 SURABAYA																			1256	458	1272	823	928	632	723	6654
19 KERTOSONO																				1316	183	415	127	159	127	2247
20 TULUNGAGUNG		(Total - Railway)																			53	275	143	127	149	791
21 BANGIL																						452	552	154	127	1235
22 MALANG																							644	321	343	1767
23 PROBOLINGGO																								687	762	1459
24 JEMBER																									978	978
25 BANYUWANGI																										0
TOTAL	0	513	1839	3210	1866	3591	3443	2924	2479	1644	2938	2935	2462	2953	6256	2333	2229	3872	3493	3664	2418	2945	2064	2543	3654	63245

TOTAL

	1 JAKARTA	2 BANDAR BETUNG	3 JAKARTA	4 CIANJUR PEC	5 SURA BAYA	6 BANYU WANGI	7 CIREBON	8 TASIKMALAYA	9 KROJA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 JAKARTA	1314	222	841	33	87	87	21	59	14	19	5	63	3	11	12	6	3	15	7	7	2	5	3	2	0	3519
2 BANDARBETUNG	291	2539	749	49	233	235	36	188	25	34	9	19	4	19	19	9	4	24	11	11	3	8	4	3	0	4378
3 JAKARTA	152	99	26859	262	654	429	51	176	32	54	17	23	6	22	23	13	6	25	15	18	4	12	7	3	1	27955
4 CIANJUR PEC	61	48	2762	5395	326	1765	219	428	83	123	27	59	12	45	52	24	11	53	27	34	7	29	11	6	1	11526
5 SURABAYA	83	27	497	28	4254	524	24	121	19	25	6	12	3	12	11	5	3	12	6	7	2	5	3	0	0	5637
6 BANDUNG	7	12	165	76	238	4788	76	317	27	35	8	14	3	13	12	6	3	12	7	7	2	5	3	1	0	5589
7 CIREBON	33	42	522	224	484	1849	11255	1176	526	914	324	254	47	866	975	213	33	832	376	87	17	57	29	63	2	17676
8 TASIKMALAYA	4	6	72	19	68	331	53	5867	183	31	24	17	3	29	28	9	3	15	10	11	2	7	3	2	0	6712
9 KROJA	2	10	97	25	72	197	167	787	7478	93	851	131	23	291	166	56	29	25	53	61	9	33	15	7	1	10643
10 PEKALONGAN	3	4	43	11	26	69	81	58	26	4326	17	328	32	66	185	31	13	47	27	32	5	16	8	4	0	5369
11 KEBUMEN	4	5	54	12	36	85	64	231	1759	86	2248	165	23	459	298	55	18	67	47	53	7	26	12	5	1	5276
12 SEMARANG	7	8	76	18	49	162	83	123	137	1223	117	8744	582	5338	8335	175	78	287	168	174	24	73	36	14	2	16458
13 PURWODADI	2	3	38	6	15	34	25	37	38	179	26	925	8765	161	545	85	63	158	59	78	16	29	19	8	1	3616
14 YOGYAKARTA	3	4	37	8	25	55	34	114	168	137	183	287	56	7819	1443	173	44	124	112	141	16	54	22	9	1	10255
15 SOLO	5	4	33	7	21	44	26	73	29	165	66	589	160	1216	7439	478	86	177	248	275	28	88	38	11	1	10923
16 MADIUN	2	2	22	4	12	24	14	37	34	65	22	118	31	179	568	4197	829	332	715	426	29	128	48	13	1	7659
17 BOJONEGORO	3	4	41	8	21	41	25	52	45	102	27	173	92	176	484	455	3324	1836	238	154	116	171	119	35	3	8227
18 SURABAYA	2	2	16	3	11	28	9	25	15	37	10	42	28	97	81	124	172	13468	673	292	219	435	328	58	4	16799
19 KERTOSONO	1	1	9	2	5	9	5	14	11	28	7	26	7	38	81	241	21	583	3101	727	37	295	42	11	1	5253
20 TULUNGAGUNG	1	1	7	1	4	7	4	11	9	16	5	23	6	34	77	192	12	868	537	2348	16	129	27	7	1	5548
21 BANGIL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1858	67	47	523	275	259	29	1	2459
22 MALANG	1	1	7	1	4	7	3	9	7	12	4	14	5	15	25	28	23	618	65	77	273	429	2142	183	4	4882
23 PROBOLINGGO	1	1	8	1	4	7	4	9	7	12	4	14	5	15	25	28	23	618	65	77	273	429	2142	183	4	4882
24 JEMBER	2	2	25	4	12	21	11	26	17	30	9	34	11	38	56	54	38	554	428	428	134	295	584	5548	58	7769
25 BANYUWANGI	5	5	66	11	28	47	27	55	39	59	19	72	21	78	111	91	61	721	185	167	125	241	556	928	3115	6687
TOTAL	2453	3452	27843	6078	6553	10743	12826	9825	10229	7819	3835	12168	2242	10710	12580	6547	4787	21141	6739	5533	2283	5645	4619	6782	3242	245237

(Multiplied Freight Traffic Generation (Table 2.2.11) by growth factor and calculated by Gravity Model)

Table 2.2.3 Freight Traffic (Year 1981)

(UNIT 100TON/YEAR)

ARTICLE : MAIZE

RAILWAY

	1 PERAK	2 PAKAS BITUNG	3 JAKARTA	4 CIKAMPEK	5 SUKABUMI	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROYA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 PERAK		0	9	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
2 PAKASBITUNG			1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3 JAKARTA				0	0	0	0	0	0	0	0	12	0	0	3	4	18	219	56	16	1	24	64	81	47	541
4 CIKAMPEK					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 SUKABUMI						0	0	0	0	0	0	0	0	0	1	0	0	2	1	0	0	0	0	1	0	5
6 BANDUNG							0	0	0	0	0	1	0	0	0	0	2	54	41	1	5	21	44	23	2	194
7 CIREBON								0	0	0	0	0	0	0	0	0	0	9	0	1	0	1	0	0	0	11
8 TASIKMALAYA									0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	3	0	6
9 KROYA										0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 PEKALONGAN											0	0	0	0	0	0	0	0	0	0	0	6	1	0	4	11
11 KEBUMEN												0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 SEMARANG													0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 PURWODADI														0	0	0	0	0	0	0	0	0	0	0	0	0
14 YOGYAKARTA															0	0	0	0	0	0	0	0	0	0	0	0
15 SOLO																0	0	0	0	0	0	0	0	0	0	0
16 MADIUN																	0	0	0	0	0	0	0	0	0	0
17 BOJONEGORO																		0	0	0	0	0	0	0	0	0
18 SURABAYA																			0	0	0	0	34	2	0	36
19 KERTOSONO																				0	0	0	0	0	0	0
20 TULUNGAGUNG		(Based on Summing Up by P.J.K.A)																			0	0	0	0	0	0
21 BANGIL																						0	0	0	0	0
22 MALANG																							0	0	0	0
23 PROBOLINGGO																								0	0	0
24 JEMBER																									0	0
25 BANYUWANGI																										0
TOTAL	0	0	10	0	1	0	0	0	0	0	0	13	0	0	4	4	20	284	97	18	6	45	145	114	54	816

HIGHWAY

	1 PERAK	2 PAKAS BITUNG	3 JAKARTA	4 CIKAMPEK	5 SUKABUMI	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROYA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 PERAK		11	23	1	1	1	0	1	51	4	7	13	2	7	1	1	5	6	4	9	5	15	19	66	99	351
2 PAKASBITUNG			34	2	6	3	1	2	68	4	9	15	2	9	1	2	5	6	5	11	5	16	21	72	112	484
3 JAKARTA				75	76	32	8	13	323	26	47	58	11	37	2	4	11	0	4	27	22	69	45	268	744	1713
4 CIKAMPEK					5	12	3	6	188	14	22	44	5	24	3	4	12	12	14	22	10	32	41	135	213	814
5 SUKABUMI						25	3	8	186	12	22	55	4	28	2	3	11	9	8	21	10	31	49	133	219	645
6 BANDUNG							7	31	452	27	49	73	8	39	5	6	15	9	4	36	12	32	22	178	326	1341
7 CIREBON								19	785	61	69	112	11	43	6	7	22	18	16	39	17	51	65	214	227	1665
8 TASIKMALAYA									685	18	58	33	4	33	4	4	11	10	8	23	9	32	34	119	243	1278
9 KROYA										59	339	73	14	142	115	26	18	13	9	9	2	7	7	23	52	899
10 PEKALONGAN											16	227	15	29	17	7	15	14	9	24	8	21	32	141	168	748
11 KEBUMEN												32	5	25	37	7	6	4	3	6	1	5	6	18	37	249
12 SEMARANG													141	143	223	29	26	16	14	32	8	28	35	144	183	944
13 PURWODADI														18	43	6	15	7	4	18	4	9	14	36	56	220
14 YOGYAKARTA															314	31	23	13	17	41	9	34	35	144	182	778
15 SOLO																53	61	24	42	126	19	64	26	248	312	978
16 MADIUN																	52	27	98	112	16	75	55	138	179	735
17 BOJONEGORO																		98	14	16	17	28	45	91	121	434
18 SURABAYA																			92	76	368	244	414	520	583	2295
19 KERTOSONO																				224	29	123	69	114	152	744
20 TULUNGAGUNG		(Total - Railway)																			9	75	37	21	131	353
21 BANGIL																						69	114	69	56	299
22 MALANG																							125	75	143	343
23 PROBOLINGGO																								124	93	217
24 JEMBER																									168	168
25 BANYUWANGI																										0
TOTAL	0	11	53	78	83	69	23	72	2748	218	637	788	221	575	774	179	592	256	353	879	573	1868	1348	3421	4795	19745

TOTAL

	1 PERAK	2 PAKAS BITUNG	3 JAKARTA	4 CIKAMPEK	5 SUKABUMI	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROYA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 PERAK	29	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29
2 PAKASBITUNG	9	75	13	1	3	2	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	116
3 JAKARTA	27	18	1655	58	43	26	6	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	97
4 CIKAMPEK	1	1	27	67	2	7	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	236
5 SUKABUMI	1	3	23	3	178	19	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	145
6 BANDUNG	4	1	4	5	6	64	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	64
7 CIREBON	1	0	2	2	1	5	53	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	262
8 TASIKMALAYA	1	2	9	6	7	27	9	197	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4795
9 KROYA	51	68	323	188	186	452	784	685	1325	59	272	67	14	135	115	25	8	12	8	5	1	1	1	0	0	641
10 PEKALONGAN	6	6	25	14	12	27	69	9	1	455	1	26	3	5	12	2	1	1	1	0	0	0	0	0	0	745
11 KEBUMEN	7	9	47	22	22	49	69	59	67	15	244	23	4	69	36	6	2	3	2	1	0	0	0	0	0	2164
12 SEMARANG	13	15	78	48	35	74	112	32	5	281	9	1142	89	63	212	23	8	8	5	4	2	1	0	0	0	2784
13 PURWODADI	2	2	11	4	4	8	11	4	1	12	1	52	69	8	39	4	3	2	1	1	0	0	0	0	0	1527
14 YOGYAKARTA	7	9	37	28	28	39	43	32	7	25	15	48	9	821	292	22	5	5	4	3	2	1	1	0	0	1529
15 SOLO	1	1	5	3	3	5	6	3	1	5	1	10	4	25	225	9	1	1	1	1	0	0	0	0	0	329
16 MADIUN	1	2	8	4	3	6	7	4	1	4	1	6	2	9	43	159	6	5	11	4	2	3	4	0	0	321
17 BOJONEGORO	5	5	29	12	11	28	22	11	2	14	2	29	12	13	59	47	249	65	8	4	2	2	1	0	0	719
18 SURABAYA	6	6	24	12	11	28	19	9	1	9	1	7	6	8	23	22	27	810	33	7	15	5	2	1	0	1877
19 KERTOSONO	4	5	20	10	9	16	16	9	1	9	1	9	3	13	41	29	7	67	316	97	2	6	1	0	0	692
20 TULUNGAGUNG	9	11	53	22	21	37	48	23	4	24	4	28	9	38	125	148	12	63	187	497	3	13	2	0	0	1336
21 BANGIL	5	5	23	10	10	17	17	9	1	8	1	8	4	8	19	15	15	353	18	7	66	24	13	1	0	657
22 MALANG	15	16	68	32	31	53	52	32	5	27	5	28	9	34	84	75	26	235	107	62	45	515	25	2	0	1634
23 PROBOLINGGO	19	21	118	41	40	66	65	36	6	33	6	35	14	35	76	55	45	445	59	35	101	121	338	19	0	1739
24 JEMBER	66	72	369	136	134	221	214	122	22	101	18	148	36	102	241	130	91	521	114	71	53	94	123	844	8	3958
25 BANYUWANGI	99	110	771	213	219	338	327	203	52	122	37	188	56	182	314	178	121	583	652	381	56	193	83	169	4224	9321
TOTAL	372	442	3954	926	1018	1629	1939	1468	1543	1173	578	1789	341	1628	1917	997	722	3191	1936	651	359	656	588	1018	458	38248

(Multiplied Freight Traffic Generation (Table 2.2.12) by growth factor and calculated by Gravity Model)

Table 2.2.4 Freight Traffic (Year 1981)

(UNIT 100TON/YEAR)

ARTICLE : SUGAR

RAILWAY

	1 PERAK	2 PARAS BITUNG	3 JAKARTA	4 CIKAH PEK	5 SURA BUHI	6 BAN DUNG	7 CIRE BON	8 TASIKU MALAYA	9 KROJA	10 PEKA LONGAN	11 KEBUMEN	12 SEMA RANG	13 PURWO DADI	14 YOGYA KARTA	15 SOLO	16 MADIUN	17 BOJO NEGORO	18 SURA BAYA	19 KERTO SONO	20 TULUN GAGUNG	21 BANGIL	22 MALANG	23 PROBO LINGGO	24 JEMBER	25 BANYU WANGI	TOTAL
1 PERAK		0	34	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	37
2 PARASBITUNG			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 JAKARTA				0	0	0	1	0	9	18	0	5	0	0	26	3	0	12	0	0	0	2	0	0	0	76
4 CIKAREK					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 SURABAYA						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 BANDUNG							9	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	4
7 CIREBON								0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 TASIKMALAYA									0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2
9 KROJA									1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 PEKALONGAN										0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	13
11 KEBUMEN											0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 SEMARANG												0	0	0	0	7	0	4	10	0	0	0	0	0	0	21
13 PURWODADI													0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 YOGYAKARTA														0	0	0	0	0	0	0	0	0	0	0	0	0
15 SOLO															0	0	0	1	0	0	0	0	0	0	0	1
16 MADIUN																0	0	2	0	0	0	0	0	0	0	2
17 BOJONEGORO																	0	0	0	0	0	0	0	0	0	0
18 SURABAYA																		0	0	0	0	0	0	0	0	0
19 KERTOSONO																			0	0	0	0	0	0	0	0
20 TULUNGAGUNG		(Based on Sumaing Up by P.J.K.A)																		0	0	0	0	0	0	0
21 BANGIL																					0	0	0	0	0	0
22 MALANG																						0	0	0	0	0
23 PROBOLINGGO																							0	0	0	0
24 JEMBER																								0	0	0
25 BANYUWANGI																									0	0
TOTAL		1	34	0	0	0	1	0	9	18	0	21	0	0	26	11	0	24	10	0	0	2	0	0	0	156

HIGHWAY

	1 PERAK	2 PARAS BITUNG	3 JAKARTA	4 CIKAH PEK	5 SURA BUHI	6 BAN DUNG	7 CIRE BON	8 TASIKU MALAYA	9 KROJA	10 PEKA LONGAN	11 KEBUMEN	12 SEMA RANG	13 PURWO DADI	14 YOGYA KARTA	15 SOLO	16 MADIUN	17 BOJO NEGORO	18 SURA BAYA	19 KERTO SONO	20 TULUN GAGUNG	21 BANGIL	22 MALANG	23 PROBO LINGGO	24 JEMBER	25 BANYU WANGI	TOTAL
1 PERAK		65	63	5	14	3	9	8	59	1	5	8	1	4	1	1	2	1	0	4	1	4	4	29	44	343
2 PARASBITUNG			39	4	12	7	3	4	17	2	2	3	0	2	1	0	1	2	0	1	0	1	1	6	13	121
3 JAKARTA				142	102	42	15	22	87	0	12	14	2	7	0	0	3	0	2	6	1	3	6	35	82	527
4 CIKAREK					14	29	8	16	78	4	7	12	1	4	1	1	1	1	1	3	0	3	3	16	35	233
5 SURABAYA						82	14	14	28	6	6	6	1	3	1	1	1	4	1	2	0	2	2	9	21	212
6 BANDUNG							17	83	181	6	67	29	2	9	1	4	3	2	2	6	1	5	5	27	58	445
7 CIREBON								39	447	17	33	55	3	15	2	2	4	2	3	9	1	7	7	35	72	752
8 TASIKMALAYA									295	12	15	9	1	8	4	2	2	7	1	3	4	2	2	11	25	318
9 KROJA										127	165	93	13	118	114	24	14	152	14	9	2	4	2	3	6	878
10 PEKALONGAN											25	355	14	34	14	6	14	2	6	29	2	13	13	53	115	695
11 KEBUMEN												29	3	65	29	7	3	29	3	3	0	1	1	3	6	184
12 SEMARANG													98	72	174	22	18	92	9	17	2	9	7	35	79	684
13 PURWODADI														9	21	3	6	16	2	4	0	2	2	9	17	89
14 YOGYAKARTA															195	21	9	44	7	14	1	7	5	22	43	351
15 SOLO																27	13	9	12	45	2	18	12	52	55	291
16 MADIUN																	23	33	37	55	2	22	12	44	73	383
17 BOJONEGORO																		224	7	9	4	11	13	38	58	363
18 SURABAYA																			227	231	327	618	654	1531	1829	5734
19 KERTOSONO																				126	6	45	17	69	72	373
20 TULUNGAGUNG		(Total - Railway)																			3	38	18	26	41	118
21 BANGIL																						29	43	38	23	142
22 MALANG																							47	53	69	159
23 PROBOLINGGO																								81	55	136
24 JEMBER																									87	87
25 BANYUWANGI																										0
TOTAL		63	192	111	142	163	58	186	1975	174	349	688	139	332	545	127	116	619	326	637	423	829	1167	2241	3224	13559

TOTAL

	1 PERAK	2 PARAS BITUNG	3 JAKARTA	4 CIKAH PEK	5 SURA BUHI	6 BAN DUNG	7 CIRE BON	8 TASIKU MALAYA	9 KROJA	10 PEKA LONGAN	11 KEBUMEN	12 SEMA RANG	13 PURWO DADI	14 YOGYA KARTA	15 SOLO	16 MADIUN	17 BOJO NEGORO	18 SURA BAYA	19 KERTO SONO	20 TULUN GAGUNG	21 BANGIL	22 MALANG	23 PROBO LINGGO	24 JEMBER	25 BANYU WANGI	TOTAL
1 PERAK	65	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74
2 PARASBITUNG	61	141	25	3	4	6	2	1	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	248
3 JAKARTA	96	14	1685	22	25	35	14	4	0	6	2	1	0	1	1	1	0	4	0	0	0	0	0	0	0	1878
4 CIKAREK	5	1	34	161	2	19	6	1	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	234
5 SURABAYA	18	7	77	82	242	76	13	5	0	5	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	561
6 BANDUNG	2	1	7	14	6	283	18	4	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	249
7 CIREBON	1	0	2	2	1	7	136	41	0	5	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	155
8 TASIKMALAYA	8	3	18	15	9	84	38	616	2	11	1	3	0	3	4	1	1	8	1	2	0	0	0	0	0	619
9 KROJA	59	17	96	79	38	181	447	293	672	127	159	93	13	116	114	24	14	152	14	8	2	4	1	0	0	2623
10 PEKALONGAN	1	0	2	2	1	8	12	1	0	319	0	9	1	1	1	4	1	0	5	0	0	0	0	0	0	362
11 KEBUMEN	5	2	12	7	4	17	33	15	26	26	94	26	3	41	29	7	3	29	3	2	0	1	1	0	0	365
12 SEMARANG	11	3	14	12	5	23	33	7	2	356	4	1454	66	44	167	25	12	85	7	4	1	1	0	0	0	1952
13 PURWODADI	1	0	1	1	0	2	3	1	0	13	0	32	32	3	19	3	2	15	1	1	0	0	0	0	0	128
14 YOGYAKARTA	4	1	6	4	2	9	15	5	2	33	5	32	5	459	176	18	5	44	5	3	0	1	0	0	0	832
15 SOLO	6	0	1	1	0	1	2	0	0	6	0	7	2	10	128	7	1	9	1	1	0	0	0	0	0	174
16 MADIUN	1	0	1	1	0	1	2	1	0	5	0	4	1	3	24	122	5	31	9	3	0	1	0	0	0	212
17 BOJONEGORO	2	0	2	1	1	2	4	1	0	9	0	6	3	4	17	16	165	221	4	2	1	1	1	0	0	466
18 SURABAYA	4	0	4	0	0	0	8	1	0	0	1	0	0	0	1	2	3	685	3	0	2	1	0	0	0	722
19 KERTOSONO	1	0	2	1	0	2	3	1	0	5	0	3	1	3	11	29	5	224	144	18	0	4	1	0	0	456
20 TULUNGAGUNG	4	1	6	3	2	6	9	3	1	13	1	13	3	11	45	53	8	298	118	267	3	11	2	0	0	878
21 BANGIL	1	0	1	0	0	1	1	0	0	2	0	1	0	1	2	2	2	358	3	1	14	4	2	0	0	433
22 MALANG	4	1	5	3	2	5	7	2	0	13	1	7	2	6	18	22	18	689	42	17	25	239	13	1	0	1054
23 PROBOLINGGO	4	1	5	3	2	5	7	2	0	13	0	7	2	4	12	12	12	654	15	8	49	24	129	3	0	1177
24 JEMBER	29	6	35	16	9	27	35	11	3	59	3	35	9	22	52	44	33	1531	49	25	33	52	29	429	5	2684
25 BANYUWANGI	45	13	82	35	21	58	72	25	6	115	6	74	17	43	95	73	58	1828	72	41	38	60	55	60	487	3448
TOTAL	492	217	2458	497	676	778	919	746	715	1155	275	1443	162	773	989	473	343	6745	491	484	165	418	281	454	495	21552

(Multiplied Freight Traffic Generation (Table 2.2.13) by growth factor and calculated by Gravity Model)

Table 2.2.5 Freight Traffic (Year 1981)

(UNIT 100TON/YEAR)

ARTICLE : SALT

RAILWAY

	1 CIREBON	2 TASIKMALAYA	3 PURWOKERTO	4 YOGYAKARTA	5 SOLO	6 PEKALONGAN	7 SEMARANG	8 KUDUS	9 REMBANG	10 PATI	11 PURWODADI	12 BLORA	13 CEPU	14 KEDUNGBANTENG	15 TEGAL	16 PEMALANG	17 BUMIAYU	18 PURWOKERTO	19 KUTOARJO	20 GOMBONG	21 CILACAP	22 KEBUMEN	23 PURWOREJO	24 WONOSOBO	25 MAGELANG	TOTAL
1 CIREBON												1														1
2 TASIKMALAYA												11						1								22
3 PURWOKERTO												22						24								116
4 YOGYAKARTA												4						1								5
5 SOLO												1						8								9
6 PEKALONGAN												12						2								28
7 SEMARANG																										
8 TASIKMALAYA												2						1								7
9 KUDUS												1						3								5
10 PEKALONGAN												4														4
11 REMBANG												4														4
12 SEMARANG																										
13 PURWODADI																										
14 YOGYAKARTA																										
15 SOLO																										
16 PEMALANG																										
17 BUMIAYU																										
18 PURWOKERTO																										
19 KUTOARJO																										
20 GOMBONG																										
21 CILACAP																										
22 KEBUMEN																										
23 PURWOREJO																										
24 WONOSOBO																										
25 MAGELANG																										
TOTAL												104						49								195

(Based on Soraing Up by P.J.K.A)

HIGHWAY

	1 CIREBON	2 TASIKMALAYA	3 PURWOKERTO	4 YOGYAKARTA	5 SOLO	6 PEKALONGAN	7 SEMARANG	8 KUDUS	9 REMBANG	10 PATI	11 PURWODADI	12 BLORA	13 CEPU	14 KEDUNGBANTENG	15 TEGAL	16 PEMALANG	17 BUMIAYU	18 PURWOKERTO	19 KUTOARJO	20 GOMBONG	21 CILACAP	22 KEBUMEN	23 PURWOREJO	24 WONOSOBO	25 MAGELANG	TOTAL
1 CIREBON							19											65					1			97
2 TASIKMALAYA							15											182					1			115
3 PURWOKERTO							134											225					3			927
4 YOGYAKARTA							67											166					2			237
5 SOLO							57											193					2			255
6 PEKALONGAN							171											236								443
7 CIREBON								99	68	43	12	18	1	8	6	1		47								345
8 TASIKMALAYA																		285								263
9 KUDUS																		312					2			322
10 PEKALONGAN																		258					3			261
11 REMBANG																		137					1			139
12 SEMARANG																		435					4			539
13 PURWODADI																		86					1			87
14 YOGYAKARTA																		418					4			418
15 SOLO																		426					4			430
16 PEMALANG																		295					2			297
17 BUMIAYU																		185					1			186
18 PURWOKERTO																			265	216	83	214	116	211	125	1235
19 KUTOARJO																							2			2
20 GOMBONG																							2			2
21 CILACAP																							2			2
22 KEBUMEN																							2			2
23 PURWOREJO																							2			2
24 WONOSOBO																								15		15
25 MAGELANG																									3	3
TOTAL		9	1	1	1	9	515	99	68	43	12	18	1	9	6	1	9	4457	265	217	83	214	153	233	132	6557

(Total - Railway)

TOTAL

	1 CIREBON	2 TASIKMALAYA	3 PURWOKERTO	4 YOGYAKARTA	5 SOLO	6 PEKALONGAN	7 SEMARANG	8 KUDUS	9 REMBANG	10 PATI	11 PURWODADI	12 BLORA	13 CEPU	14 KEDUNGBANTENG	15 TEGAL	16 PEMALANG	17 BUMIAYU	18 PURWOKERTO	19 KUTOARJO	20 GOMBONG	21 CILACAP	22 KEBUMEN	23 PURWOREJO	24 WONOSOBO	25 MAGELANG	TOTAL
1 CIREBON																										
2 TASIKMALAYA																										
3 PURWOKERTO			145	1	1																					148
4 YOGYAKARTA																										
5 SOLO																										
6 PEKALONGAN																										
7 CIREBON	19	15	191	69	57	171	449	99	68	43	12	18	1	8	6	1										1222
8 TASIKMALAYA																										
9 KUDUS																										
10 PEKALONGAN																										
11 REMBANG																										
12 SEMARANG																										5
13 PURWODADI																										
14 YOGYAKARTA																										
15 SOLO																										
16 PEMALANG																										
17 BUMIAYU																										
18 PURWOKERTO	85	183	756	187	241	245	47	283	319	258	137	495	86	414	456	255	165	783	265	216	83	214	114	211	125	6519
19 KUTOARJO																										
20 GOMBONG																										
21 CILACAP																										
22 KEBUMEN																										
23 PURWOREJO	1	1	19	2	2	3	1	3	3	1	1	4	1	1	1	1	1	2	2	2	2	9	27	15	4	124
24 WONOSOBO			2																					38	3	43
25 MAGELANG																										
TOTAL	97	119	1497	259	252	428	496	386	392	344	150	521	88	423	476	258	185	785	267	219	98	223	152	263	132	8415

(Multiplied Freight Traffic Generation (Table 2.2.14) by growth factor and calculated by Gravity Model)

Table 2.2.6 Freight Traffic (Year 1981)

ARTICLE : PAPER

(UNIT 100TON/YEAR)

RAILWAY

	1 PEKAL	2 PAPAS BITUNG	3 JAKARTA	4 CIKAMPEK	5 SURABAYA	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROJA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 PEKAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 PAPASBITUNG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 JAKARTA			0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	9
4 CIKAMPEK				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 SURABAYA					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 BANDUNG						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 CIREBON							0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 TASIKMALAYA								0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 KROJA									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 PEKALONGAN										0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 KEBUMEN											0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 SEMARANG												0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 PURWODADI													0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 YOGYAKARTA														0	0	0	0	0	0	0	0	0	0	0	0	0
15 SOLO															0	0	0	0	0	0	0	0	0	0	0	0
16 MADIUN																0	0	0	0	0	0	0	0	0	0	0
17 BOJONEGORO																	0	0	0	0	0	0	0	0	0	0
18 SURABAYA																		1	0	0	0	0	2	0	0	3
19 KERTOSONO		(Based on Straing Up by P.J.K.A)																	0	0	0	0	0	0	0	0
20 TULUNGAGUNG																				0	0	0	0	0	0	0
21 BANGIL																					0	0	0	0	0	0
22 MALANG																						0	0	0	0	0
23 PROBOLINGGO																							0	0	0	0
24 JEMBER																								0	0	0
25 BANYUWANGI																									0	0
TOTAL	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	9

HIGHWAY

	1 PEKAL	2 PAPAS BITUNG	3 JAKARTA	4 CIKAMPEK	5 SURABAYA	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROJA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 PEKAL	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
2 PAPASBITUNG	0	0	77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78
3 JAKARTA				142	163	237	203	236	256	158	73	114	27	125	153	47	15	4	15	28	1	10	0	18	1	2127
4 CIKAMPEK					1	5	4	2	3	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	23
5 SURABAYA						2	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	8
6 BANDUNG							3	3	2	1	0	1	0	1	1	0	0	2	0	0	0	0	1	0	0	15
7 CIREBON								0	1	0	0	1	0	0	1	0	0	10	0	0	0	0	2	0	1	14
8 TASIKMALAYA									1	0	0	0	0	0	0	0	0	6	0	0	0	0	1	0	1	9
9 KROJA										0	4	3	0	3	1	0	0	28	0	0	0	0	5	0	2	69
10 PEKALONGAN											0	8	0	0	0	0	0	23	0	0	0	0	4	0	1	36
11 KEBUMEN												2	0	1	0	0	0	18	0	0	0	0	2	0	1	18
12 SEMARANG													6	19	17	2	0	45	0	1	0	0	9	0	4	94
13 PURWODADI														0	0	0	0	2	0	0	0	0	1	0	0	23
14 YOGYAKARTA															11	1	0	69	0	0	0	0	18	0	4	86
15 SOLO																0	0	112	0	0	0	0	15	0	5	132
16 MADIUN																	0	73	0	0	0	0	11	0	3	111
17 BOJONEGORO																		93	0	0	0	0	7	0	2	142
18 SURABAYA																			139	92	49	28	42	56	6	452
19 KERTOSONO		(Total - Railway)																		0	0	0	11	0	2	13
20 TULUNGAGUNG																					0	0	14	0	3	17
21 BANGIL																						0	15	0	1	16
22 MALANG																							48	0	3	52
23 PROBOLINGGO																								56	3	59
24 JEMBER																									37	37
25 BANYUWANGI																										0
TOTAL		0	149	143	153	245	318	242	262	159	77	133	34	143	184	52	15	516	155	122	41	69	197	129	79	3641

TOTAL

	1 PEKAL	2 PAPAS BITUNG	3 JAKARTA	4 CIKAMPEK	5 SURABAYA	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROJA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 PEKAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 PAPASBITUNG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 JAKARTA	22	77	1291	141	162	243	203	236	256	158	73	114	27	125	153	47	15	5	15	28	1	10	1	18	1	3573
4 CIKAMPEK	0	0	1	14	0	5	4	2	3	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	32
5 SURABAYA	0	0	0	0	1	2	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	15
6 BANDUNG	0	0	0	0	1	21	3	3	2	1	0	1	0	1	1	0	0	2	0	0	0	0	1	0	0	34
7 CIREBON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 TASIKMALAYA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 KROJA	0	0	0	0	0	0	1	1	55	0	4	1	0	2	1	0	0	0	0	0	0	0	0	0	0	64
10 PEKALONGAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 KEBUMEN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 SEMARANG	0	0	0	0	0	0	1	0	3	0	2	129	6	8	17	2	0	0	0	1	0	0	0	0	0	168
13 PURWODADI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 YOGYAKARTA	0	0	0	0	0	0	0	0	2	0	1	2	0	57	11	1	0	0	0	0	0	0	0	0	0	73
15 SOLO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 MADIUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 BOJONEGORO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 SURABAYA	0	0	0	0	1	2	10	6	28	23	13	45	19	68	112	93	93	654	137	92	49	28	73	13	2	1553
19 KERTOSONO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 TULUNGAGUNG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 BANGIL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 MALANG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 PROBOLINGGO	0	0	0	0	0	1	2	1	5	4	2	9	2	10	15	11	7	29	11	14	15	48	68	56	1	323
24 JEMBER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 BANYUWANGI	0	0	0	0	0	0	1	1	2	1	1	4	1	4	5	3	2	4	2	3	1	3	8	37	74	142
TOTAL	72	78	1293	156	171	274	324	251	357	196	97	277	57	278	316	163	117	692	168	132	57	149	96	166	78	6424

(Multiplied Freight Traffic Generation (Table 2.2.15) by growth factor and calculated by Gravity Model)

Table 2.2.7 Freight Traffic (Year 1981)

ARTICLE : STEEL

(UNIT 100TON/YEAR)

RAILWAY

	1 JAKARTA	2 BANDUNG	3 CIREBON	4 PEKALONGAN	5 SEMARANG	6 PURWOKERTO	7 YOGYAKARTA	8 SOLO	9 MADIUN	10 SURABAYA	11 BONDOWOSO	12 JEMBER	13 BANYUWANGI	TOTAL
1 JAKARTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 BANDUNG	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 CIREBON	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 PEKALONGAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 SEMARANG	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 PURWOKERTO	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 YOGYAKARTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 SOLO	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 MADIUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 SURABAYA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 BONDOWOSO	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 JEMBER	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 BANYUWANGI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(Based on Scaling Up by P.J.K.A)

HIGHWAY

	1 JAKARTA	2 BANDUNG	3 CIREBON	4 PEKALONGAN	5 SEMARANG	6 PURWOKERTO	7 YOGYAKARTA	8 SOLO	9 MADIUN	10 SURABAYA	11 BONDOWOSO	12 JEMBER	13 BANYUWANGI	TOTAL
1 JAKARTA	0	517	437	122	149	269	376	276	213	235	121	185	43	4225
2 BANDUNG	0	0	359	0	0	0	0	0	0	0	0	0	0	351
3 CIREBON	0	0	0	1614	1751	2674	3459	2421	1539	1457	754	586	225	22187
4 PEKALONGAN	0	0	0	0	0	1	0	0	0	0	0	1	0	6
5 SEMARANG	0	0	0	0	0	0	0	0	0	0	0	0	0	3
6 PURWOKERTO	0	0	0	0	0	0	15	14	7	4	2	7	0	77
7 YOGYAKARTA	0	0	0	0	0	0	0	2	10	4	0	35	0	156
8 SOLO	0	0	0	0	0	0	0	0	6	0	0	12	0	71
9 MADIUN	0	0	0	0	0	0	0	0	0	2	39	77	1	321
10 SURABAYA	0	0	0	0	0	0	0	0	0	0	0	229	0	481
11 BONDOWOSO	0	0	0	0	0	0	0	0	0	0	0	62	0	178
12 JEMBER	0	0	0	0	0	0	0	0	0	0	0	0	216	354
13 BANYUWANGI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	517	797	1736	1895	2944	3441	2733	2225	1721	918	1261	494	28352

(Total - Railway)

TOTAL

	1 JAKARTA	2 BANDUNG	3 CIREBON	4 PEKALONGAN	5 SEMARANG	6 PURWOKERTO	7 YOGYAKARTA	8 SOLO	9 MADIUN	10 SURABAYA	11 BONDOWOSO	12 JEMBER	13 BANYUWANGI	TOTAL
1 JAKARTA	8294	517	353	122	149	269	376	276	313	235	121	185	43	5442
2 BANDUNG	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 CIREBON	85	358	8648	1614	1751	2674	3459	2421	1910	1457	754	586	225	31367
4 PEKALONGAN	0	0	0	0	0	1	0	0	0	0	0	1	0	2
5 SEMARANG	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 PURWOKERTO	0	0	0	0	3	97	15	14	6	4	2	1	0	152
7 YOGYAKARTA	0	0	0	0	0	1	75	2	5	4	1	1	0	91
8 SOLO	0	0	0	0	0	0	0	0	8	0	0	4	0	8
9 MADIUN	0	0	0	0	0	1	5	6	355	2	39	3	1	444
10 SURABAYA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 BONDOWOSO	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 JEMBER	0	0	0	1	1	5	34	12	74	299	62	2327	215	3541
13 BANYUWANGI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 YOGYAKARTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 SOLO	0	0	0	0	0	0	0	0	3	3	2	0	0	386
16 MADIUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 BOJONEGORO	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 SURABAYA	0	1	1	3	4	19	79	53	169	179	185	198	137	17327
19 BERTOSONO	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 TULUNGAGUNG	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 BANGIL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 MALANG	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 PROBOLINGGO	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 JEMBER	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 BANYUWANGI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1379	859	8998	1742	1908	3454	3632	2834	2835	2192	1887	3192	631	3029

(Multiplied Freight Traffic Generation (Table 2.2.16) by growth factor and calculated by Gravity Model)

Table 2.2.8 Freight Traffic (Year 1981)

(UNIT 100TON/YEAR)

ARTICLE: PETROLEUM PRODUCTS

RAILWAY

	1 PEKAL	2 KAIMAS BITUNG	3 JAKARTA	4 CIKAMPEK	5 SURABAYA	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROYA	10 PEKALONGAN	11 REMBANG	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 BLIMBING	21 BANGIL	22 PALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 PEKAL			1															1							1
2 KAIMAS BITUNG			1															1374							1374
3 JAKARTA				728		287	7		19	18		126		6				3								3
4 CIKAMPEK						2	1																			2
5 SURABAYA																		1								1
6 BANDUNG																										0
7 CIREBON									22																	22
8 TASIKMALAYA												8		73	637			718								718
9 KROYA											1275							1276								1276
10 PEKALONGAN																										0
11 REMBANG														1			211	2								214
12 SEMARANG																		5								5
13 PURWODADI																										0
14 YOGYAKARTA																										0
15 SOLO																		1228								1228
16 MADIUN																		54								54
17 BOJONEGORO																			1167		2	1457	133	394	159	2773
18 SURABAYA																										0
19 KERTOSONO																										0
20 BLIMBING																										0
21 BANGIL																										0
22 PALANG																										0
23 PROBOLINGGO																										0
24 JEMBER																										0
25 BANYUWANGI																									2	2
TOTAL		0	2	728	0	289	8	4	32	18	9	1407	0	84	637	0	211	1417	1167	0	2	1857	133	394	161	7249

(Based on Suraing Up by P.J.K.A)

HIGHWAY

	1 PEKAL	2 KAIMAS BITUNG	3 JAKARTA	4 CIKAMPEK	5 SURABAYA	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROYA	10 PEKALONGAN	11 REMBANG	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 BLIMBING	21 BANGIL	22 PALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 PEKAL			1248						14									5								1268
2 KAIMAS BITUNG			1553						35									11								1599
3 JAKARTA				2352	2495	4757	3688	2583	978	2488	139	2857	376	1177	1729	617	198	13	293	388	67	245	148	518	398	23879
4 CIKAMPEK									53									18								66
5 SURABAYA									29																	93
6 BANDUNG							1	1	544									76								621
7 CIREBON									2443									222								2671
8 TASIKMALAYA									2398									128								2455
9 KROYA										998	1777	2583	339	3559	2888	628	142	297	152	326	7	129	56	254	177	13729
10 PEKALONGAN																		591								591
11 REMBANG																		43								43
12 SEMARANG																		1332								1332
13 PURWODADI																		448								448
14 YOGYAKARTA																		875								875
15 SOLO																		2118								2118
16 MADIUN																		878								878
17 BOJONEGORO																		2329								2329
18 SURABAYA																			1941	2136	1149	1243	1673	2263	684	11533
19 KERTOSONO																										0
20 BLIMBING																										0
21 BANGIL																										0
22 PALANG																										0
23 PROBOLINGGO																										0
24 JEMBER																										0
25 BANYUWANGI																										0
TOTAL		0	2802	2352	2495	4757	3689	2586	6453	3488	1917	4592	716	4528	3732	1245	341	8997	2275	2651	1169	1837	1936	3435	1452	54219

(Total - Railway)

TOTAL

	1 PEKAL	2 KAIMAS BITUNG	3 JAKARTA	4 CIKAMPEK	5 SURABAYA	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROYA	10 PEKALONGAN	11 REMBANG	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 BLIMBING	21 BANGIL	22 PALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 PEKAL																										
2 KAIMAS BITUNG																										
3 JAKARTA	1269	1554	14138	2141	3445	5461	3875	2587	982	2418	139	2181	376	1185	1729	617	198	55	293	388	67	245	148	518	398	46754
4 CIKAMPEK																										
5 SURABAYA																										
6 BANDUNG						1	41	1		2		1			1											47
7 CIREBON																										
8 TASIKMALAYA												16	1	1	2											21
9 KROYA	14	35	6	53	77	541	2442	2384	28458	998	1777	3541	339	3423	2637	628	142	19	152	325	7	129	56	254	177	47519
10 PEKALONGAN																										
11 REMBANG																										
12 SEMARANG																										
13 PURWODADI																										
14 YOGYAKARTA																										
15 SOLO																										
16 MADIUN																										
17 BOJONEGORO																										
18 SURABAYA	5	11	3	13	18	77	222	128	188	592	43	1332	448	988	2118	2185	2464	18139	3183	2136	1145	2568	1876	2653	1837	34554
19 KERTOSONO																										
20 BLIMBING																										
21 BANGIL																										
22 PALANG																										
23 PROBOLINGGO																										
24 JEMBER																										
25 BANYUWANGI																										
TOTAL	1289	1591	14148	3206	3545	5616	6592	5436	29629	4011	1961	6871	1156	5547	6472	3552	2421	18213	3453	2851	1170	2874	1969	3425	1615	129253

(Multiplied Freight Traffic Generation (Table 2.2.17) by growth factor and calculated by Gravity Model)

Table 2.2.9 Freight Traffic (Year 1981)

ARTICLE : FERTILIZER

(UNIT 100TON/YEAR)

RAILWAY

	1 MERAK	2 RANGKASBITUNG	3 JAKARTA	4 CIKAMPEK	5 SURABAYA	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROYA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 MERAK	*	*	0	38	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39
2 RANGKASBITUNG			1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	4
3 JAKARTA				33	5	11	0	10	0	0	2	0	0	2	0	0	0	2	0	0	0	0	0	0	0	33
4 CIKAMPEK					0	154	718	139	0	7	8	9	54	0	0	0	15	6	0	0	0	0	0	0	0	1498
5 SURABAYA						0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	4
6 BANDUNG							0	9	0	0	0	2	1	0	0	0	0	35	0	0	0	0	0	0	0	47
7 CIREBON								9	1	0	0	0	0	0	0	0	0	47	0	0	0	0	0	0	0	48
8 TASIKMALAYA									0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	13
9 KROYA										0	146	60	147	228	372	0	78	10	0	0	0	0	0	0	0	1062
10 PEKALONGAN											0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	34
11 KEBUMEN												0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 SEMARANG													0	0	0	0	1	2	0	0	0	0	0	0	0	7
13 PURWODADI														0	0	0	1	7	0	0	0	0	0	0	0	7
14 YOGYAKARTA															0	0	0	2	0	0	0	0	0	0	0	2
15 SOLO																0	0	1	0	0	0	0	0	0	0	1
16 MADIUN																	0	270	0	0	0	0	0	0	0	279
17 BOJONEGORO																		101	0	0	0	0	0	0	0	101
18 SURABAYA																			342	149	134	343	282	273	144	1567
19 KERTOSONO																				0	0	0	0	0	0	0
20 TULUNGAGUNG																					0	0	0	0	0	0
21 BANGIL																						0	0	0	0	0
22 MALANG																							0	0	0	0
23 PROBOLINGGO																								0	0	0
24 JEMBER																									0	0
25 BANYUWANGI																										0
TOTAL	0	1	41	5	165	281	149	1	7	148	91	197	234	379	0	85	535	342	149	134	343	282	273	144	4335

(Based on Scaling Up by P.J.K.A)

HIGHWAY

	1 MERAK	2 RANGKASBITUNG	3 JAKARTA	4 CIKAMPEK	5 SURABAYA	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROYA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 MERAK	*	116	224	0	0	0	0	0	3	0	0	0	0	0	0	0	0	51	0	0	0	0	0	0	0	493
2 RANGKASBITUNG		149	543	0	0	0	0	0	15	0	0	0	0	0	0	0	0	245	0	0	0	0	0	0	0	912
3 JAKARTA			655	292	0	6	0	0	1	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	957
4 CIKAMPEK				1993	818	875	414	0	0	13	1	0	0	3	1	0	0	4	0	0	0	0	0	0	0	2518
5 SURABAYA					0	0	0	0	24	0	0	0	0	0	0	0	0	238	0	0	0	0	0	0	0	222
6 BANDUNG						0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
7 CIREBON							0	0	399	0	0	0	0	0	0	0	0	438	0	0	0	0	0	0	0	836
8 TASIKMALAYA								0	963	0	0	0	0	0	0	0	0	418	0	0	0	0	0	0	0	1363
9 KROYA										0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	366
10 PEKALONGAN											0	0	0	0	0	0	0	428	0	0	0	0	0	0	0	428
11 KEBUMEN												0	0	0	0	0	0	15	0	0	0	0	0	0	0	15
12 SEMARANG													0	0	0	0	0	1355	0	0	0	0	0	0	0	1355
13 PURWODADI														0	0	0	0	355	0	0	0	0	0	0	0	355
14 YOGYAKARTA															0	0	0	998	0	0	0	0	0	0	0	998
15 SOLO																0	0	1824	0	0	0	0	0	0	0	1824
16 MADIUN																	0	679	0	0	0	0	0	0	0	679
17 BOJONEGORO																		1816	0	0	0	0	0	0	0	1816
18 SURABAYA																			452	418	257	367	335	1876	1164	4154
19 KERTOSONO																				0	0	0	0	0	0	0
20 TULUNGAGUNG																					0	0	0	0	0	0
21 BANGIL																						0	0	0	0	0
22 MALANG																							0	0	0	0
23 PROBOLINGGO																								0	0	0
24 JEMBER																									0	0
25 BANYUWANGI																										0
TOTAL	0	265	1422	1385	818	881	414	1421	21	358	0	0	3	1	1	0	7265	452	418	257	367	335	1876	1165	17237

(Total - Railway)

TOTAL

	1 MERAK	2 RANGKASBITUNG	3 JAKARTA	4 CIKAMPEK	5 SURABAYA	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROYA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 MERAK	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
2 RANGKASBITUNG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
3 JAKARTA	116	159	2692	0	297	3	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3259
4 CIKAMPEK	272	543	658	1421	1693	972	855	553	0	24	1	7	0	3	1	0	0	0	0	0	0	0	0	0	0	6434
5 SURABAYA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 BANDUNG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 CIREBON	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
8 TASIKMALAYA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 KROYA	3	15	1	0	24	7	422	963	1238	7	581	24	1	81	8	0	0	0	0	0	0	0	0	0	0	2855
10 PEKALONGAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 KEBUMEN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 SEMARANG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 PURWODADI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 YOGYAKARTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 SOLO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 MADIUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 BOJONEGORO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 SURABAYA	51	283	6	0	242	27	455	413	2	528	25	1337	362	1082	1825	943	1817	2243	794	567	391	674	614	1369	1228	15767
19 KERTOSONO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 TULUNGAGUNG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 BANGIL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 MALANG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 PROBOLINGGO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 JEMBER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 BANYUWANGI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	445	915	3356	1422	1665	1010	1748	1936	1249	556	529	1368	363	1186	1834	959	1817	2243	794	567	391	674	614	1369	1329	28763

(Multiplied Freight Traffic Generation (Table 2.2.18) by growth factor and calculated by Gravity Model)

Table 2.2.10 Freight Traffic (Year 1981)

ARTICLE : CEMENT

(UNIT 100TON/YEAR)

RAILWAY

	1 PEMAK	2 PAKASBITUNG	3 JAKARTA	4 CIKAMPEK	5 SURABAYA	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROYA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 PEMAK	0	129	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	129
2 PAKASBITUNG		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 JAKARTA			0	0	0	0	0	0	3	0	1	54	0	2	0	0	0	71	0	0	0	0	0	0	0	132
4 CIKAMPEK				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 SURABAYA					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 BANDUNG						0	0	0	615	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	116
7 CIREBON							0	0	69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	69
8 TASIKMALAYA								0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
9 KROYA									0	1	0	219	0	237	257	43	0	118	0	7	0	2	5	18	12	911
10 PEKALONGAN										0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 KEBUMEN											0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 SEMARANG												0	0	0	8	0	0	539	0	0	0	0	0	0	0	547
13 PURWODADI													0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 YOGYAKARTA														0	3	0	0	245	0	0	0	0	0	0	4	249
15 SOLO															0	36	0	447	0	0	0	0	0	0	0	483
16 MADIUN																0	0	192	0	0	0	0	0	0	0	192
17 BOJONEGORO																	0	0	0	0	0	0	0	0	0	0
18 SURABAYA																		0	3	0	0	0	0	11	87	101
19 KERTOSONO																			0	0	0	0	0	0	0	0
20 TULUNGAGUNG	(Based on Scaling Up by P.J.K.A)																			0	0	0	0	0	0	0
21 BANGIL																					0	0	0	0	0	0
22 MALANG																						0	0	0	0	0
23 PROBOLINGGO																							0	0	0	0
24 JEMBER																								0	0	0
25 BANYUWANGI																									0	0
TOTAL	0	129	0	0	0	0	0	0	699	1	1	273	0	237	268	84	0	1695	3	7	0	2	5	29	99	2932

HIGHWAY

	1 PEMAK	2 PAKASBITUNG	3 JAKARTA	4 CIKAMPEK	5 SURABAYA	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROYA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 PEMAK	0	1176	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1176
2 PAKASBITUNG		678	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	678
3 JAKARTA			1176	1397	1527	2453	2721	1938	2	1728	14	2123	392	832	1775	566	73	0	52	264	1	63	25	351	675	13773
4 CIKAMPEK				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 SURABAYA					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 BANDUNG						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 CIREBON							0	0	138	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	139
8 TASIKMALAYA								0	343	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	324
9 KROYA									0	45	851	328	69	1258	542	78	9	0	7	22	0	4	0	0	14	3228
10 PEKALONGAN										0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 KEBUMEN											0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 SEMARANG												0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 PURWODADI													0	0	0	0	0	55	0	0	0	0	0	0	0	55
14 YOGYAKARTA														0	0	0	0	0	0	0	0	0	0	0	0	0
15 SOLO															0	0	0	0	0	0	0	0	0	0	0	0
16 MADIUN																0	0	568	0	0	0	0	0	0	0	568
17 BOJONEGORO																	0	935	0	0	0	0	0	0	0	935
18 SURABAYA																			1331	918	434	1142	799	1473	443	6249
19 KERTOSONO																				0	0	0	0	0	0	0
20 TULUNGAGUNG	(Total - Railway)																				0	0	0	0	0	0
21 BANGIL																						0	0	0	0	0
22 MALANG																							0	0	0	0
23 PROBOLINGGO																								0	0	0
24 JEMBER																									0	0
25 BANYUWANGI																										0
TOTAL	0	1854	1397	1527	2453	2726	1938	444	1766	645	2451	452	2138	2317	644	82	1569	1458	1241	431	1213	824	1424	3127	32358

TOTAL

	1 PEMAK	2 PAKASBITUNG	3 JAKARTA	4 CIKAMPEK	5 SURABAYA	6 BANDUNG	7 CIREBON	8 TASIKMALAYA	9 KROYA	10 PEKALONGAN	11 KEBUMEN	12 SEMARANG	13 PURWODADI	14 YOGYAKARTA	15 SOLO	16 MADIUN	17 BOJONEGORO	18 SURABAYA	19 KERTOSONO	20 TULUNGAGUNG	21 BANGIL	22 MALANG	23 PROBOLINGGO	24 JEMBER	25 BANYUWANGI	TOTAL
1 PEMAK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 PAKASBITUNG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 JAKARTA	1245	698	15713	1397	1527	2453	2721	1938	5	1728	15	2177	392	832	1775	567	73	1	52	264	1	63	25	351	675	26778
4 CIKAMPEK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 SURABAYA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 BANDUNG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 CIREBON	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
8 TASIKMALAYA	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
9 KROYA	0	0	0	0	0	4	198	315	4326	47	851	547	69	1495	799	121	9	0	7	33	0	6	2	12	26	8566
10 PEKALONGAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 KEBUMEN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 SEMARANG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 PURWODADI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 YOGYAKARTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 SOLO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 MADIUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 BOJONEGORO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 SURABAYA	0	0	0	0	0	0	1	0	0	2	0	83	55	53	272	752	935	7425	1396	918	438	1147	799	1484	527	15333
19 KERTOSONO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 TULUNGAGUNG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 BANGIL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 MALANG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 PROBOLINGGO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 JEMBER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 BANYUWANGI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1245	698	15713	1397	1527	2457	2922	2245	4329	1775	866	2811	516	2438	2851	1439	1017	7427	1453	1248	474	1215	826	1852	1268	61569

(Multiplied Freight Traffic Generation (Table 2.2.19) by growth factor and calculated by Gravity Model)

Table 2.2.11 Freight Traffic Generation

ARTICLE : RICE (YEAR 1980)

ZONE CODE AND ZONE NAME \ ITEM	DEPARTURE				ARRIVAL			
	PRODUCTION	IMPORT		TOTAL	CONSUMPTION	EXPORT		TOTAL
		FOREIGN	DOMESTIC			FOREIGN	DOMESTIC	
1 MERAK	3227			3227	2336			2386
2 RANGKASBITUNG	4281			4281	2965			2965
3 JAKARTA	12778	8360	901	22039	25639	341	427	26407
4 CIKAMPEK	11197			11197	5939			5939
5 SUKABUMI	5467			5467	6489			6489
6 BANDUNG	5730			5730	10444			10444
7 CIREBONG	16664	1598		18262	12353		45	12397
8 TASIKMALAYA	6521			6521	9562			9562
9 KEDUA	9702	685		10387	9685		225	9910
10 PEKALONGAN	5220	15		5235	7509		79	7588
11 KEBUMEN	5106			5106	3720			3720
12 SEMARANG	12539	1150		13689	11443		380	11822
13 PURWODADI	3518			3518	2180			2180
14 YOGYAKARTA	9985			9985	10416			10416
15 SOLO	10666			10666	12243			12243
16 MADIUN	6842			6842	6350			6350
17 BOJONEGORO	7972			7972	4598			4598
18 SURABAYA	14876	1332	38	16246	19333		1335	20668
19 KERTOSONO	5084			5084	6584			6584
20 TULUNGAGUNG	3389			3389	5407			5407
21 BANGIL	2385			2385	2227			2227
22 MALANG	4080			4080	5502			5502
23 PROBOLINGO	3892			3892	3744		547	4291
24 JEMBER	7658			7658	6494		1	6494
25 BANYUWANGI	6591		1	6592	3058		1	3058
TOTAL	185369	13139	939	199447	196268	341	2839	199447

(UNIT 1000TON/YEAR)

Table 2.2.12 Freight Traffic Generation

ARTICLE : MAIZE (YEAR 1980)

ZONE CODE AND ZONE NAME \ ITEM	DEPARTURE				ARRIVAL			
	PRODUCTION	IMPORT		TOTAL	CONSUMPTION	EXPORT		TOTAL
		FOREIGN	DOMESTIC			FOREIGN	DOMESTIC	
1 MERAK	29			29	371			371
2 RANGASBITUNG	103			103	461			461
3 JAKARTA	162	1332		1994	3987			3987
4 CIKAMPEC	96			96	924			924
5 SUKABUMI	234			234	1009			1009
6 BANDUNG	104			104	1624			1624
7 CIREBONG	64			64	1921	14		1935
8 TASIKMALAYA	260			260	1487			1487
9 KROJA	4751			4751	1506			1506
10 PEKALONGAN	658			658	1168			1168
11 KEBUMEN	699			699	579			579
12 SEMARANG	2108	46		2154	1779	3		1782
13 PURWODADI	237			237	339			339
14 YOGYAKARTA	1522			1522	1620			1620
15 SOLO	309			309	1904			1904
16 MADIUN	322			322	987			987
17 BOJONEGORO	711			711	715			715
18 SURABAYA	542	508	33	1093	3006	83	53	3142
19 KERTOSONO	694			694	1024			1024
20 TULUNGAGUNG	1337			1337	841			841
21 BANGIL	660			660	346			346
22 MALANG	1608			1608	856			856
23 PROBOLINGO	1794			1794	582			582
24 JEMBER	3961			3961	1010			1010
25 BANYUWANGI	5298		1	5299	475		10	486
TOTAL	28264	2387	34	30685	30522	100	63	30685

(UNIT 1000TON/YEAR)

Table 2.2.13 Freight Traffic Generation

ARTICLE : SUGAR (YEAR 1980)

ZONE CODE AND ZONE NAME \ ITEM	DEPARTURE				ARRIVAL			
	PRODUCTION	EXPORT		TOTAL	CONSUMPTION	EXPORT		TOTAL
		FOREIGN	DOMESTIC			FOREIGN	DOMESTIC	
1 MERAK	67			67	171		221	391
2 RANGKASBITUNG	236			236	212			212
3 JAKARTA	370	1406		1776	1833		168	2001
4 CIKAMPEK	219			219	425			425
5 SUKABUMI	534			534	464			464
6 BANDUNG	238			238	747			747
7 CIREBON	147			147	983		5	988
8 TASIKMALAYA	594			594	684			684
9 KROJA	2522			2522	692			692
10 PEKALONGAN	349			349	537	575	2	1113
11 REMBANG	371			371	266			266
12 SEMARANG	1119	765		1884	818		533	1351
13 PURWODADI	126			126	156			156
14 YOGYAKARTA	808			808	745			745
15 SOLO	164			164	875			875
16 MADIUN	205			205	454			454
17 BOJONEGORO	452			452	329			329
18 SURABAYA	345	245	14	604	1382	1789	3487	6658
19 KERTOSONO	442			442	471			471
20 TULUNGAGUNG	851			851	387			387
21 BANGIL	420			420	159			159
22 MALANG	1023			1023	393			393
23 PROBOLINGO	1142			1142	268		4	272
24 JEMBER	2520		4	2524	464			464
25 BANYUWANGI	3371		2	3373	219		256	475
TOTAL	18634	2416	20	21071	14031	2363	4677	21071

(UNIT 100TON/YEAR)

Table 2.2.14 Freight Traffic Generation

ARTICLE : SALT (YEAR 1980)

ZONE CODE AND ZONE NAME \ ITEM	DEPARTURE				ARRIVAL			
	PRODUCTION	EXPORT		TOTAL	CONSUMPTION	EXPORT		TOTAL
		FOREIGN	DOMESTIC			FOREIGN	DOMESTIC	
1 MERAK					95			95
2 RANKASBITUNG					117			117
3 JAKARTA			105	105	1016		13	1029
4 CIKAMPEK					235			235
5 SUKABUMI					257			257
6 BANDUNG					414			414
7 CIREBON	1159		26	1185	490		6	495
8 TASIKMALAYA					379			379
9 KROJA					384			384
10 PEKALONGAN					298			298
11 KEBUMEN					147			147
12 SEMARANG			5	5	453		56	509
13 PURWODADI					86			86
14 YOGYAKARTA					413			413
15 SOLO					485			485
16 MADIUN					252			252
17 BOJONEGORO					182			182
18 SURABAYA	6041	360		6401	766		1	767
19 KERTOSONO					261			261
20 TULUNGAGUNG					214			214
21 BANGIL					88			88
22 MALANG					218			218
23 PROBOLINGO			113	118	148			148
24 JEMBER			47	47	257			257
25 BANYUWANGI					121		8	129
TOTAL	7200	360	302	7862	7778	0	84	7862

(UNIT 100TON/YEAR)

Table 2.2.15 Freight Traffic Generation

ARTICLE : PAPER (YEAR 1980)

ZONE CODE AND ZONE NAME \ ITEM	DEPARTURE				ARRIVAL			
	PRODUCTION	EXPORT		TOTAL	CONSUMPTION	EXPORT		TOTAL
		FOREIGN	DOMESTIC			FOREIGN	DOMESTIC	
1 MERAK					55		9	63
2 RANGKASBITUNG					68			68
3 JAKARTA	946	2184	40	3130	1007		120	1127
4 CIKAMPEK	33			33	136			136
5 SUKABUMI	12			12	149			149
6 BANDUNG	30			30	239			239
7 CIREBON					283			283
8 TASIKMALAYA					219			219
9 KROJA		57		57	312			312
10 PEKALONGAN					172			172
11 KEBUMEN					85			85
12 SEMARANG	60	88		148	262			262
13 PURWODADI					50			50
14 YOGYAKARTA	69			69	238			238
15 SOLO					280			280
16 MADIUN					145			145
17 BOJONEGORO					105			105
18 SURABAYA	494	819	60	1373	573	43	6	622
19 KERTOSONO					151			151
20 TULUNGAGUNG					124			124
21 BANGIL					51			51
22 MALANG					126			126
23 PROBOLINGO	280			280	86			86
24 JEMBER					149			149
25 BANYUWANGI	129			129	70			70
TOTAL	2053	3158	99	5310	5133	43	134	5310

(UNIT 100TON/YEAR)

TAble 2.2.16 Freight Traffic Generation

ARTICLE : STEEL (YEAR 1980)

ZONE CODE AND ZONE NAME \ ITEM	DEPARTURE				ARRIVAL			
	PRODUCTION	IMPORT		TOTAL	CONSUMPTION	EXPORT		TOTAL
		FOREIGN	DOMESTIC			FOREIGN	DOMESTIC	
1 MERAK	3560			3560	450		438	888
2 RANKASBITUNG					559			559
3 JAKARTA	9520	10795	172	20457	4837	10	938	5785
4 CIKAMPEK					1120			1120
5 SUKABUMI					1224			1224
6 BANDUNG	100			100	1970			1970
7 CIREBON		60		60	2330	3	4	2337
8 TASIKMALAYA					1804			1804
9 KROJA		291		291	1827			1827
10 PEKALONGAN					1417			1417
11 KEBUMEN					702			702
12 SEMARANG	1440	1309		2749	2159			2159
13 PURWODADI					411			411
14 YOGYAKARTA					1965			1965
15 SOLO	250			250	2310			2310
16 MADIUN					1198			1198
17 BOJONEGORO					867			867
18 SURABAYA	4400	6673		11073	3647	8	152	3807
19 KERTOSONO					1242			1242
20 TULUNGAGUNG					1020			1020
21 BANGIL					420			420
22 MALANG					1038			1038
23 PROBOLINGO					706			706
24 JEMBER					1225			1225
25 BANYUWANGI			9	9	577			577
TOTAL	19270	19129	181	38580	37028	20	1532	38580

(UNIT 1000TON/YEAR)

Table 2.2.17 Freight Traffic Generation

ARTICLE : PETROLEUM PRODUCTS (YEAR 1980)

ZONE CODE AND ZONE NAME \ ITEM	DEPARTURE				ARRIVAL			
	PRODUCTION	IMPORT		TOTAL	CONSUMPTION	EXPORT		TOTAL
		FOREIGN	DOMESTIC			FOREIGN	DOMESTIC	
1 MERAK					1204			1204
2 RANGKASBITUNG					1496			1496
3 JAKARTA		242	44800	45041	12934		278	13212
4 CIKAMPEK					2956			2956
5 SUKABUMI					3274			3274
6 BANDUNG					5269			5269
7 CIREBON			47	47	6231		1	6233
8 TASIKMALAYA					4824			4824
9 KROYA		2905	42007	44913	4885		23517	28402
10 PEKALONGAN					3788			3788
11 KEBUMEN					1877			1877
12 SEMARANG		20		20	5772			5772
13 PURWODADI					1100			1100
14 YOGYAKARTA					5255			5255
15 SOLO					6176			6176
16 MADIUN					3203			3203
17 BOJONEGORO					2320			2320
18 SURABAYA		332	32509	32841	9753	5	51	9809
19 KERTOSONO					3321			3321
20 TULUNGAGUNG					2728			2728
21 BANGIL					1123			1123
22 MALANG					2775			2775
23 PROBOLINGO					1889			1889
24 JEMBER					3276			3276
25 BANYUWANGI					1542			1542
TOTAL		3500	119363	122561	99009	5	23848	122861

(UNIT 1000TON/YEAR)

Table 2.2.18 Freight Traffic Generation

ARTICLE : FERTILIZER (YEAR 1980)

ZONE CODE AND ZONE NAME \ ITEM	DEPARTURE				ARRIVAL			
	PRODUCTION	EXPORT		TOTAL	CONSUMPTIOS	EXPORT		TOTAL
		FOREIGN	DOMESTIC			FOREIGN	DOMESTIC	
1 MERAK			6	6	393		30	428
2 RANKASBITUNG					870			870
3 JAKARTA		472	2361	2833	1839	480	963	3283
4 CIKAMPEC	5700			5700	1367			1367
5 SUKABUMI					1591			1591
6 BANDUNG					969			969
7 CIREBONG			5	5	1665		6	1671
8 TASIKMALAYA					1814			1814
9 KROJA			2973	2973	1168			1168
10 PEKALONGAN					497			497
11 REMBANG					497			497
12 SEMARANG					1218		1	1219
13 PURWODADI					323			323
14 YOGYAKARTA					969			969
15 SOLO					920			920
16 MADIUN					845			845
17 BOJONEGORO					994			994
18 SURABAYA	5500	3757	5761	15018	1814	1	186	2001
19 KERTOSONO					671			671
20 TULUNGAGUNG					497			497
21 BANGIL					348			348
22 MALANG					596			596
23 PROBOLINGO					596			596
24 JEMBER					1218			1218
25 BANYUWANGI					1168		14	1182
TOTAL	11200	4230	11105	26534	24853	481	1201	26534

(UNIT 100TON/YEAR)

Table 2.2.19 Freight Traffic Generation

ARTICLE : CEMENT (YEAR 1980)

ITEM / ZONE CODE AND ZONE NAME	DEPARTURE				ARRIVAL			
	PRO DUCTION	IMPORT FOREIGN	IMPORT DOMESTIC	TOTAL	CONSUM PTION	EXPORT FOREIGN	EXPORT DOMESTIC	TOTAL
1 MERAK					481		637	1118
2 RANGASBITUNG					598			598
3 JAKARTA	32000	453	221	32673	5167	3395	4899	13461
4 CIKAMPEC					1197			1197
5 SUKABUMI					1308			1308
6 BANDUNG					2105			2105
7 CIREBON			2	2	2489		16	2505
8 TASIKMALAYA					1927			1927
9 KROJA	7500	312		7812	1952	95	1703	3749
10 PEKALONGAN					1513		9	1522
11 KEBUMEN					750			750
12 SEMARANG					2306		106	2412
13 PURWODADI					439			439
14 YOGYAKARTA					2099			2099
15 SOLO					2467			2467
16 MADIUN					1280			1280
17 BOJONEGORO					927			927
18 SURABAYA	13000	298		13298	3896	702	2201	6799
19 KERTOSONO					1327			1327
20 TULUNGAGUNG					1090			1090
21 BANGIL					449			449
22 MALANG					1109			1109
23 PROBOLINGO			1	1	755			755
24 JEMBER					1309			1309
25 BANYUWANGI					616		469	1085
TOTAL	52500	1063		53736	39555	4192	10039	53786

(UNIT 100TON/YEAR)

$EXPD_{mi}$: Export volume (100 tons/year) of article m from zone i to other islands in Indonesia

The production volume by zone, P_{mi}, used in formula (i) has been obtained in the following ways.

A. Rice: The rice production volume of Java Island in 1980 listed in the statistical yearbook was apportioned to each zone in proportion to the paddy field area.

B. Maize: The maize production volume of Java Island in 1980 listed in the statistical yearbook was apportioned according to the dry field farming area. The apportioning calculation was performed by classifying into 3 regions of West, Central and East.

C. Sugar: The sugar production volume of Java Island in 1980 according to the BULOG's data was apportioned to each zone in proportion to the dry field farming area. Apportionment was performed by classifying into 3 regions of West, Central and East.

D. Salt: The salt production volume of 1980 based on the Multi-various Manufacturing Industries' data was apportioned to each zone according to the salt farm area.

E. Paper: The paper production volume of 1980 by zone is in accordance with the data of the Indonesian Pulps and Paper Association.

F. Steel: The steel production volume of 1980 by zone is in accordance with the data of the Ministry of Industry.

G. Fertilizer: The fertilizer production volume of 1980 by zone is in accordance with the PUSRI's data.

H. Cement: The cement production volume of 1980 by zone is in accordance with the Cement Association's data.

The export and import volumes of 1980 which have been classified by article and zone, and used in formulas (i) and (ii), i.e., $IMPF_{mi}$, $IMPD_{mi}$, $EXPF_{mi}$ and $EXPD_{mi}$, have been obtained from the Export and Import Statistics. Next, the consumption volume of 1980 classified by article for the whole Java Island has been estimated by the following formula.

$$(iii) \quad \Sigma C_m = \Sigma P_m + \Sigma IMPF_m + \Sigma IMPD_m - (\Sigma EXPF_m + \Sigma EXPD_m)$$

Whereas, ΣC_m: Consumption volume of article m in the whole Java Island

ΣP_m: Production volume of article m in the whole Java Island

$\Sigma IMPF_m$: Import volume of article m from foreign countries to the whole Java Island

$\Sigma IMPD_m$: Import volume of article m to the whole Java Island from other Indonesian islands

$\Sigma EXPF_m$: Export volume of article m from the whole Java Island to foreign countries

$\Sigma EXPD_m$: Export volume of article m from the whole Java Island to other Indonesian islands.

Then, the consumption volume of 1980 classified by article and zone (C_{mi}) and used in formula (ii) was apportioned to each zone by proportioning the consumption volume of the whole Java Island obtained as above-mentioned by the population ratio of each zone. For fertilizer, however, the apportionment was made by the total area ratio of the paddy field area and the dry field farming area of each zone. The paper consumption volume was apportioned by the population ratio of each zone for common use papers (mainly newspapers), whereas it was based on actual consumption results of cement companies on craft papers used for cement.

b. Estimate of traffic volume between zones

First of all, the total arrival and departure traffic

volume classified by article and zone of 1981, which is the basic year, was obtained by multiplying the total arrival and departure traffic volume of 1980 classified by article and zone obtained in subsection a. by the growth factor on Table 2.2.20.

Table 2.2.20 Growth Factor of Total Arrival and Departure Traffic Volume Classified by Article and Zone (1981/1980)

Article	Growth factor	Article	Growth factor
Rice	1.028	Steel	1.539
Maize	1.004	Petroleum products	1.052
Sugar	1.037	Fertilizer	1.084
Salt	1.020	Cement	1.145
Paper	1.134		

Next, the total primary traffic volume (railway + road) between zones is estimated by the so-called "Gravity Model."

The total arrival and departure traffic volume classified by zone and article which is obtained by totalling the primary traffic volume by each zone pair, does not correspond with that of 1981 which was obtained by the above-mentioned formula. Then, by "Fratar Method," the convergent calculation was made, and the total arrival and departure traffic volume classified by article and zone, which was obtained by totalling each zone pair, was made nearly to correspond with that of 1981 (with an error ratio of 5%).

The calculation formula by Gravity Model and by Fratar Method is as follows:

$$\text{(iv)}\quad TQ_{mij} = TO_{mi} \cdot TD_{mj} \cdot \frac{1}{L_{ij}^{2}}$$

Whereas, TQ_{mij}: Traffic volume of article m from i to j (100 t/year)

L_{ij}: Railway distance between i and j (actual distance) (Table 2.2.21)

TO_{mi}: Departing volume of article m from zone i

TD_{mj}: Arriving volume of article m to zone j

(Note: Q_{mii} - Intra-zonal traffic volume of article m was calculated assuming a constant fixed (L_{ii}), but this is not shown in Tables 2.2.2∿10.)

When utilizing the Fratar Method for forecasting the traffic volume, which was established by Thomas J. Fratar, for the purpose of forecasting distributed traffic volume (the traffic volume between zones), iteration of the following is necessary for obtaining the forecasted traffic volume. That is, the first revised distributed traffic volume, $\widehat{TQ}_{mij}^{(1)}$, would be obtained by the following:

$$\text{(v)}\quad \widehat{TQ}_{mij}^{(1)} = TQ_{mij} \cdot \frac{\widehat{TO}_{mi}}{TO_{mi}} \cdot \frac{\widehat{TD}_{mj}}{TD_{mj}} \cdot \frac{\sum_{j=1}^{n} TQ_{mij}}{\sum_{j=1}^{n} \left(\frac{\widehat{TD}_{mj}}{TD_{mj}}\right) TQ_{mij}},$$

$$TO_{mi} = \sum_{j=1}^{n} TQ_{mij}, \quad TD_{mj} = \sum_{j=1}^{n} TQ_{mij}$$

$$(n = 25)$$

In general, the revised distributed traffic volume $\widehat{TQ}_{mij}^{(s)}$ for the "Sth" time is gained by the following:

$$\text{(vi)}\quad \widehat{TQ}_{mij}^{(s)} = \widehat{TQ}_{mij}^{(s-1)} \cdot \frac{\widehat{TO}_{mi}}{\widehat{TO}_{mi}^{(s-1)}} \cdot \frac{\widehat{TD}_{mj}}{\widehat{TD}_{mj}^{(s-1)}} \cdot \frac{\sum_{j=1}^{n} \widehat{TQ}_{mij}}{\sum_{j=1}^{n} \left(\frac{\widehat{TD}_{mj}}{\widehat{TD}_{mj}^{(s-1)}}\right) \cdot \widehat{TQ}_{mij}^{(s-1)}}$$

whereas the result of the above is to be

$$\widehat{TO}_{mi}^{(s-1)} = \sum_{j=1}^{n} \widehat{TQ}_{mij}^{(s-1)}, \quad \widehat{TD}_{mi}^{(s-1)} = \sum_{j=1}^{n} \widehat{TQ}_{mij}^{(s-1)}$$

which means that if the outcome was

$$\text{(vii)}\quad \sum_{j=1}^{n} \widehat{TQ}_{mij}^{(s)} \fallingdotseq \widehat{TO}_{mi}$$

Table 2.2.21 Link Distance by Mode

End node		Link No. L=	Distance	
Railway	Highway		Railway	Highway
① Merak - ② Parkasptung	① Merak - ② Parkasptung	1	69	73
② Parkasptung - ③ Jakarta	① Merak - ③ Jakarta	2	83	122
③ Jakarta - ④ Citarget	② Parkasptung - ① Bogor	3	84	100
③ Jakarta - ⑤ Sukabumi	③ Jakarta - ① Bogor	4	141	43
⑤ Sukabumi - ⑥ Bandung	③ Jakarta - ④ Citarget	5	97	90
④ Citarget - ⑦ Cirebon	⑥ Bandung - ① Bogor	6	135	111
④ Citarget - ⑥ Bandung	⑤ Sukabumi - ① Bogor	7	89	61
⑥ Bandung - ⑤ Tasikmalaya	⑤ Sukabumi - ⑥ Bandung	8	115	85
⑦ Cirebon - ⑪ Pekalongan	④ Citarget - ⑥ Bandung	9	136	90
⑦ Cirebon - ⑨ Kroja	④ Citarget - ⑦ Cirebon	10	158	154
⑧ Tasikmalaya - ⑨ Kroja	⑥ Bandung - ⑦ Cirebon	11	133	111
⑪ Pekalongan - ⑫ Semarang	⑥ Bandung - ⑧ Tasikmalaya	12	90	101
⑨ Kroja - ⑬ Rembang	⑦ Cirebon - ⑧ Tasikmalaya	13	43	108
⑫ Semarang - ⑬ Purwodadi	⑧ Tasikmalaya - ⑨ Kroja	14	60	123
⑫ Semarang - ⑭ Bedonjati	⑦ Cirebon - ⑪ Pekalongan	15	36	129
⑭ Bedonjati - ⑱ Gundih	⑦ Cirebon - ⑨ Kroja	16	32	140
⑬ Rembang - ⑯ Yogyakarta	⑨ Kroja - ⑬ Rembang	17	92	50
⑮ Solo - ⑱ Gundih	⑪ Pekalongan - ⑫ Semarang	18	42	80
⑯ Yogyakarta - ⑮ Solo	⑬ Rembang - ⑰ Bawean	19	59	113
⑬ Purwodadi - ⑱ Gundih	⑫ Semarang - ⑰ Bawean	20	10	32
⑬ Purwodadi - ⑬ Bojonegoro	⑭ Bedonjati - ⑰ Bawean	21	115	23
⑮ Solo - ⑯ Madiun	⑫ Semarang - ⑭ Bedonjati	22	95	29
⑬ Bojonegoro - ⑮ Surabaya	⑮ Solo - ⑰ Bawean	23	105	43
⑯ Madiun - ⑬ Kertosono	⑯ Yogyakarta - ⑰ Bawean	24	70	80
⑮ Surabaya - ⑳ Bangil	⑬ Rembang - ⑯ Yogyakarta	25	47	93
⑮ Surabaya - ⑮ Kertosono	⑯ Yogyakarta - ⑮ Solo	26	87	58
⑮ Kertosono - ㉗ Talunggagung	⑫ Semarang - ⑮ Surabaya	27	59	270
⑳ Bangil - ㉒ Malang	⑫ Semarang - ⑬ Purwodadi	28	43	53
㉔ Talunggagung - ㉒ Malang	⑬ Purwodadi - ⑱ Gundih	29	103	15
㉓ Bangil - ㉒ Probolinggo	⑮ Solo - ⑱ Gundih	30	55	50
㉓ Probolinggo - ㉕ Jember	⑮ Solo - ㉕ Ngawi	31	95	80
㉕ Jember - ㉖ Banyuwangi	⑮ Solo - ⑯ Madiun	32	103	61
-	⑮ Solo - ㉗ Talunggagung	33	-	136
-	⑬ Purwodadi - ⑬ Bojonegoro	34	-	127
-	⑬ Bojonegoro - ㉕ Ngawi	35	-	68
-	⑯ Madiun - ⑬ Kertosono	36	-	73
-	⑯ Madiun - ㉔ Talunggagung	37	-	96
-	⑬ Kertosono - ㉔ Talunggagung	38	-	51
-	⑰ Bojonegoro - ⑮ Surabaya	39	-	118
-	⑰ Bojonegoro - ⑮ Kertosono	40	-	171
-	⑮ Surabaya - ⑬ Kertosono	41	-	83
-	⑬ Kertosono - ㉒ Malang	42	-	95
-	㉔ Talunggagung - ㉒ Malang	43	-	105
-	⑳ Bangil - ㉒ Malang	44	-	53
-	㉓ Bangil - ㉓ Probolinggo	45	-	59
-	㉒ Malang - ㉓ Probolinggo	46	-	72
-	㉓ Probolinggo - ㉙ Situbondo	47	-	92
-	㉓ Probolinggo - ㉕ Jember	48	-	94
-	㉕ Jember - ㉙ Situbondo	49	-	58
-	㉕ Jember - ㉖ Banyuwangi	50	-	105
-	㉖ Banyuwangi - ㉙ Situbondo	51	-	108
-	㉖ Malang - ㉕ Ngawi	52	-	31
-	⑮ Surabaya - ⑳ Bangil	53	-	44

(viii) $\sum_{j=1}^{n} \widehat{TQ}_{mij}^{(s)} \fallingdotseq \widehat{TD}_{mj}$

The revised calculation has to be stopped, thus making the $\widehat{TQ}_{mij}^{(s)}$, the forecasted TQ_{mij} of distributed traffic volume (traffic volume between zones).

Furthermore, TQ_{mij} is the primary traffic volume between zones as determined by the Gravity Model, and $\widehat{TO}_{mi}$ and $\widehat{TD}_{mj}$ are respectively the estimated total arrival and departure traffic volume of 1981.

The total both-way road traffic volume between the zones classified by article (1981 as base year) can be obtained by deducting the total both-way railway traffic volume from the total both-way railway and road traffic volume derived from formulas (iv) ~ (viii).

2.2.2 Distance between Zones

(1) Link distance by transportation mode

① Railway

The distance by kilometer for every 32 links was calculated from the P.J.K.A.'s data. (See Table 2.2.21)

② Road

The distance by kilometer on the 53 links was calculated from the BINA MARGA's data. (See Table 2.2.21)

(2) Distance between zones according to transportation modes

The passing link of train differs from each zonal pair so the distance between zones was obtained by totalling the distance of each link belonging to the route of zonal pair selected by the minimum path method.

2.2.3 Transportation Time between Zones

(1) Link time by transportation mode

① "Without project"

a. Railway

The transportation time by link for passenger and freight

was obtained by dividing the distance of each link by the presnet speed (km/hour) classified by passenger and freight.

b. Road

The transportation time by link for bus and truck was obtained by dividing the distance of each link by the present speed (km/hour) classified by bus and truck. (See Table 2.2.22)

② With project

a. Railway

The transportation time by link for passenger and freight was obtained by dividing the distance of each link by the speed (km/hour) classified by passenger and freight at the time of electrification. In addition, the stopping time, passing and waiting time have also been considered. (See Table 2.2.23)

b. Road

It is the same as without project, for the present condition has been considered to be preserved. (See Table 2.2.22.)

We represented the link time by the railway passengers by local train. The reason why we represented the link time by the road passengers by bus is because we considered that the ratio occupied by the users of passenger cars and motorcycles was extremely small especially in the transport between zones. Furthermore, it can be considered that passenger cars in particular seem to be used only by extremely limited people in the upper brackets of income and the diversion from passenger cars to railway due to electrification is small. Therefore, it has been represented with bus having the greatest diversion effect.

(2) Terminal time by transportation mode

A difference was not provided in the terminal time according to 'with or without' project.

① Passenger

a. Railway

The terminal time was assumed to be about 1 hour including the access time, egress and passenger's waiting time for train. (See Table 2.2.24.)

Table 2.2.22 Link Speed for "Without"

End Node		Link No.	Link Speed for "Without" (Km/h) Without			
			Railway (N=1)		Highway (N=2)	
Railway	Highway	L=	Passenger (N=1)	Freight (N=2)	Passenger (N=1)	Freight (N=2)
① Merak - ② Ranksbitung	① Merak - ② Ranksbitung	1	33	26	27	30
② Ranksbitung - ③ Jakarta	① Merak - ③ Jakarta	2	33	28	35	33
③ Jakarta - ④ Cikarget	② Ranksbitung - ⑪ Bogor	3	42	31	27	30
③ Jakarta - ⑤ Sukabumi	③ Jakarta - ⑪ Bogor	4	31	32	42	42
⑤ Sukabumi - ⑥ Bandung	③ Jakarta - ④ Cikarget	5	26	17	42	42
④ Cikarget - ⑦ Cirebon	⑥ Bandung - ⑪ Bogor	6	18	20	27	30
④ Cikarget - ⑥ Bandung	⑤ Sukabumi - ⑪ Bogor	7	20	23	27	30
⑥ Bandung - ⑧ Tasikmalaya	⑤ Sukabumi - ⑥ Bandung	8	23	19	27	30
⑦ Cirebon - ⑬ Pekalongan	④ Cikarget - ⑥ Bandung	9	18	23	40	45
⑦ Cirebon - ⑨ Kroja	④ Cikarget - ⑦ Cirebon	10	43	25	42	47
⑧ Tasikmalaya - ⑨ Kroja	⑥ Bandung - ⑦ Cirebon	11	20	23	33	36
⑬ Pekalongan - ⑫ Semarang	⑥ Bandung - ⑧ Tasikmalaya	12	19	42	33	36
⑨ Kroja - ⑪ Kebumen	⑦ Cirebon - ⑧ Tasikmalaya	13	13	34	33	36
⑫ Semarang - ⑬ Purwodadi	⑧ Tasikmalaya - ⑨ Kroja	14	20	36	33	36
⑫ Semarang - ㉒ Kedinjati	⑦ Cirebon - ⑬ Pekalongan	15	23	35	42	47
㉒ Kedinjati - ㉑ Gundih	⑦ Cirebon - ⑨ Kroja	16	23	35	46	51
⑪ Kebumen - ⑯ Yogyakarta	⑨ Kroja - ⑪ Kebumen	17	15	27	32	36
⑮ Solo - ㉑ Gundih	⑬ Pekalongan - ⑫ Semarang	18	26	34	42	47
⑯ Yogyakarta - ⑮ Solo	⑪ Kebumen - ㉘ Bawean	19	20	29	32	36
⑬ Purwodadi - ㉑ Gundih	㉒ Semarang - ㉘ Bawean	20	30	30	38	43
⑬ Purwodadi - ⑰ Bojonegoro	㉖ Kedinjati - ㉘ Bawean	21	21	29	38	42
⑮ Solo - ⑲ Malang	㉒ Semarang - ㉖ Kedinjati	22	19	29	38	22
⑰ Bojonegoro - ⑱ Surabaya	⑮ Solo - ㉘ Bawean	23	26	22	38	43
⑲ Malang - ⑱ Pertosoco	⑯ Yogyakarta - ㉘ Bawean	24	18	26	33	43
⑱ Surabaya - ㉑ Bangil	⑪ Kebumen - ⑯ Yogyakarta	25	43	43	32	36
⑱ Surabaya - ⑱ Pertosoco	⑯ Yogyakarta - ⑮ Solo	26	50	26	37	41
⑱ Pertosoco - ㉔ Tulungagung	⑫ Semarang - ⑱ Surabaya	27	23	30	47	52
㉑ Bangil - ㉔ Malang	⑫ Semarang - ⑬ Purwodadi	28	17	17	47	52
㉔ Tulungagung - ㉔ Malang	⑬ Purwodadi - ㉑ Gundih	29	31	34	33	42
㉑ Bangil - ㉓ Probolinggo	⑮ Solo - ㉑ Gundih	30	51	35	33	42
㉓ Probolinggo - ㉗ Jember	⑮ Solo - ㉓ Ngawi	31	31	26	37	41
㉗ Jember - ㉘ Banyuwangi	⑮ Solo - ⑲ Malang	32	24	26	37	41
-	⑮ Solo - ㉔ Tulungagung	33	-	-	41	45
-	⑬ Purwodadi - ⑰ Bojonegoro	34	-	-	47	52
-	⑰ Bojonegoro - ㉓ Ngawi	35	-	-	37	41
-	⑲ Malang - ⑱ Pertosoco	36	-	-	37	41
-	⑲ Malang - ㉔ Tulungagung	37	-	-	41	45
-	⑱ Pertosoco - ㉔ Tulungagung	38	-	-	41	45
-	⑰ Bojonegoro - ⑱ Surabaya	39	-	-	37	41
-	⑰ Bojonegoro - ⑱ Pertosoco	40	-	-	37	41
-	⑱ Surabaya - ⑱ Pertosoco	41	-	-	37	41
-	⑱ Pertosoco - ㉓ Malang	42	-	-	37	41
-	㉔ Tulungagung - ㉔ Malang	43	-	-	41	45
-	㉑ Bangil - ㉓ Malang	44	-	-	41	45
-	㉑ Bangil - ㉓ Probolinggo	45	-	-	41	45
-	㉓ Malang - ㉓ Probolinggo	46	-	-	41	45
-	㉓ Probolinggo - ㉖ Situbondo	47	-	-	41	45
-	㉓ Probolinggo - ㉗ Jember	48	-	-	41	45
-	㉗ Jember - ㉖ Situbondo	49	-	-	41	45
-	㉗ Jember - ㉘ Banyuwangi	50	-	-	41	45
-	㉘ Banyuwangi - ㉖ Situbondo	51	-	-	41	45
-	⑲ Malang - ㉓ Ngawi	52	-	-	37	41
-	⑱ Surabaya - ㉑ Bangil	53	-	-	41	45

Table 2.2.23 Railway Link Speed for "With"

(Maximum speed 100 km/h)

End Node / Railway	Link No. / L=	Railway Link Speed for "with" Km/h XRV (T,N,L)							
		1982 (T=1)		1983 (T=2)		1994 (T=3)		2002 (T=4)	
		Passenger (N=1)	Freight (N=2)	Passenger (N=1)	Freight (N=2)	Passenger (N=1)	Freight (N=2)	Passenger (N=1)	Freight (N=2)
① Merak ~ ② Rankasbitung	1	33	26	33	26	58	69	58	69
② Rankasbitung ~ 3 Jakarta	2	33	28	33	28	46	44	46	44
③ Jakarta ~ ④ Cikarçek	3	42	31	42	35	42	35	42	35
③ Jakarta ~ ⑤ Sukabumi	4	31	32	31	32	31	32	40	38
⑤ Sukabumi ~ ⑥ Bandung	5	26	17	26	17	26	17	40	46
④ Cikarçek ~ ⑦ Cirebon	6	17	19	54	68	54	68	54	68
④ Cikarçek ~ ⑥ Bandung	7	20	23	42	56	42	56	42	56
⑥ Bandung ~ ⑧ Tasikmalaya	8	23	19	23	19	23	19	46	40
⑦ Cirebon ~ ⑩ Pekalongan	9	18	29	18	29	18	29	58	54
⑦ Cirebon ~ ⑨ Kroja	10	43	24	43	24	53	47	53	47
⑧ Tasikmalaya ~ ⑨ Kroja	11	20	23	20	23	20	23	54	53
⑩ Pekalongan ~ ⑫ Semarang	12	19	42	19	42	19	42	59	69
⑨ Kroja ~ ⑪ Kebumen	13	19	34	19	34	47	65	47	65
⑬ Semarang ~ ⑬ Purwodadi	14	20	36	20	36	20	36	56	67
⑫ Semarang ~ ㉒ Kedunjati	15	23	35	23	35	23	35	47	45
㉒ Kedunjati ~ ㉑ Gundih	16	23	35	23	35	23	35	60	64
⑪ Kebumen ~ ⑫ Yogyakarta	17	15	27	15	27	52	43	52	43
⑮ Solo ~ ㉑ Gundih	18	26	34	26	34	26	34	67	70
⑭ Yogyakarta ~ ⑮ Solo	19	20	23	20	23	44	59	44	59
⑬ Purwodadi ~ ㉑ Gundih	20	30	30	30	30	30	30	88	100
⑬ Purwodadi ~ ⑰ Bojonegoro	21	21	23	21	23	21	23	59	52
⑮ Solo ~ ⑱ Madiun	22	19	29	19	29	54	63	54	63
⑰ Bojonegoro ~ ⑲ Surabaya	23	26	22	26	22	26	22	51	48
⑱ Madiun ~ ⑬ Kertosono	24	18	26	18	26	58	70	58	70
⑲ Surabaya ~ ㉓ Bangil	25	43	43	43	43	45	59	45	59
⑲ Surabaya ~ ⑬ Kertosono	26	50	26	50	26	51	67	51	67
⑬ Kertosono ~ ㉗ Tulungagung	27	23	33	23	33	23	33	50	66
㉓ Bangil ~ ㉘ Malang	28	17	17	17	17	17	17	48	51
㉗ Tulungagung ~ ㉘ Malang	29	31	34	31	34	31	34	50	47
㉓ Bangil ~ ㉙ Probolinggo	30	51	35	51	35	69	69	69	69
㉙ Probolinggo ~ ㉔ Jember	31	34	26	31	26	34	26	50	45
㉔ Jember ~ ㉜ Banyuwangi	32	23	26	23	26	23	26	48	43

Note) The above will be determined in accordance with the number of stop stations.

b. Road

The terminal time was considered to be about 30 minutes including the access, egress and passenger's waiting time for bus.

② Freight

a. Railway

The handling time at both ends, freight car's waiting time and marshaling time at the route midway have been obtained by surveying the present situation. (See Table 2.2.24.)

b. Road

Similarly as the railway, it has been obtained by surveying the present situation.

(3) Transportation time between zones by transportation mode

Based on the link time which has been obtained as above-mentioned, the time for the link belonging to each zonal pair is totalled by transportation mode and then value which was added the terminal transportation time to this has been made the transportation time between zones.

It becomes as follows when the transportation time between zones is represented by a formula.

$$PH_{mnij} = \sum_{\ell}(L_{m\ell} \div V_{mn\ell} \cdot RT_{mij\ell}) + HT_{mn}$$

Whereas, PH_{mnij}: Time in status quo when article n is transported between i and j by transportation mode m.

$V_{mn\ell}$: Time when article n passes link ℓ of transportation mode m.

$L_{m\ell}$: Distance of link ℓ of transportation mode m.

$RT_{mij\ell}$: The dummy variable (1 or 0) indicating the passing link when transport is made between i and j by transportation mode m.

HT_{mn}: The terminal transport time when article n uses the transportation mode m.

Table 2.2.24 Terminal Time to and from Stations by Transportation Mode (1982)

(Unit: hour)

Article		Railway	Road
Passenger		1.03	0.47
Freight	Rice	72	4
	Maize	72	4
	Sugar	72	4
	Salt	72	4
	Paper	72	4
	Steel	72	4
	Petroleum products	72	1
	Fertilizer	48	4
	Cement	48	4

(Notes): 1. The time for access and egress and the waiting time for train have been considered in case of passenger.
2. The handling time at both ends, freight car waiting time and marshaling time at the route midway are included in case of freight.

2.2.4 Transportation Costs between Zones

(1) Fare or tariff between zones by transportation mode

① Passenger

The linear formula was applied to the actual results of fares classified by distance zone, and the marginal costs and the constant costs were estimated. The linear formulas are as shown below. (See Table 2.2.25.)

a. Railway fares (Rp./pass.): $R_r = 236.4 + 5.1d$
(d is distance, km.)

b. Bus fares (Rp./pass.): $R_b = 4.05d$

Table 2.2.25 Marginal Cost and Terminal Cost

Article No. N =	Item / Article	Marginal Transportation Charge (Rp./km) MCmn		Terminal Cost (Rp./ton) CTmn	
		Railway M = 1	Highway M = 2	Railway M = 1	Highway M = 2
1	Passenger	5.1	4.05	336.4	100
2	Rice	9.3	12.4	3000	4300
3	Maize	9.3	12.4	3000	4300
4	Sugar	8.4	12.4	3000	4300
5	Salt	9.3	12.4	3000	4300
6	Paper	10.2	12.4	3000	4300
7	Steel	10.2	20.4	3000	2500
8	Pet-Products	21.5	20.4	1100	2500
9	Fertilizer	13.3	13.0	1300	2500
10	Cement	13.3	13.0	1300	2500

② Freight

The parameters of the marginal costs and the constant costs were estimated by the same method as for passenger. The following are the linear formulas by article.

a. Railway tariffs (Rp./ton)

(i)	Rice, maize and salt:	$R_r = 1{,}000 + 9.3d$
(ii)	Sugar:	$R_r = 950 + 8.4d$
(iii)	Paper:	$R_r = 1{,}000 + 10.2d$
(iv)	Steel:	$R_r = 1{,}000 + 10.2d$
(v)	Petroleum products:	$R_r = 1{,}100 + 21.5d$
(vi)	Fertilizer, cement:	$R_r = 500 + 13.3d$

b. Truck tariffs (Rp./ton)

(i)	Rice, maize, sugar, salt and paper:	$R_t = 1{,}500 + 12.4d$
(ii)	Steel, petroleum products:	$R_t = 1{,}000 + 20.4d$
(iii)	Fertilizer, cement:	$R_t = 1{,}000 + 13.0d$

(2) Terminal transportation costs by transportation mode

① Passenger

Terminal transportation costs of both the railway and road passenger were made the bus fares of 100 Rp. at both ends. Calculation-wise, however, the constant costs of the aforementioned fares between zones added to this has been made the terminal transportation costs.

② Freight

a. Railway

By surveying the present situation of consignors, terminal transportation costs of rice, maize, sugar, salt, paper and steel were estimated at about 2,000 Rp. Those of petroleum products were not especially considered as they did not necessitate handling costs. Those of fertilizer and cement were estimated at about 300 Rp.

b. Road

By surveying the present situations of consignors, the terminal transportation costs of 5 articles which are rice, maize,

sugar, salt and paper were estimated at about 2,800 Rp. Those of steel, petroleum products, fertilizer and cement were estimated at about 1,000 Rp.

Similarly as for the passenger in actual calculation, the constant costs of the tariffs between zones as the terminal transportation costs has been added to this. It becomes as shown in Table 2.2.25 when arranging the above-mentioned terminal transportation costs.

(3) Transportation costs between zones by transportation mode

The transportation costs between zones by transportation mode were obtained by totalling the fares or tariffs between zones and terminal costs by transportation mode obtained from (1) and (2) above. It becomes as follows when expressing the transportation costs between zones by transportation mode with a formula.

$$F_{mnij} = MC_{mn} \times L_{mij} + CT_{mn}$$

Whereas, F_{mnij}: Fares or tariffs when article n is transported between i and j by the transportation mode m.

MC_{mn}: The marginal costs per kilometer when article n uses the transportation mode m.

L_{mij}: Distance between i and j of transportation mode m.

CT_{mn}: Terminal costs when article n uses transportation mode m.

2.3 Forecast of Traffic Demand

2.3.1 Years for Demand Forecast and Sections for Electrification

The years for demand forecast are the 3 fiscal years of 1989, 1994 and 2002. Although the sections for electrification will be of electrification of railway line units in principle, electrification of regional units will also be considered and upon taking into consideration the present transport situations and future importance of the railway lines, the electrifying sections have been established for each 3 years for demand forecast as follows. (See Table 2.3.1.)

Table 2.3.1 Sections for Electrification by Year

Year	Electrified section	Distance
1989	Jakarta - Cikampek - Cirebon Cikampek - Bandung	308km
1994	Merak - Rankasbitung - Jakarta Cirebon - Kroja - Yogyakarta - Solo - Madiun - Kertosono - Surabaya - Bangil - Probolinggo	863km
2002	Jakarta - Sukabumi - Bandung - Tasikumalaya - Kroja Cirebon - Semarang - Purwodadi - Bojonegoro - Surabaya Semarang - Kedunjati - Gundin - Solo Purwodadi - Gundih Kertosono - Tulungagung - Malang - Bangil Probolinggo - Jember - Banyuwangi	1,507km

(Notes): 1. It has been assumed that the respective electrified sections will start operation in the above-mentioned years.
2. The actual construction for electrification shall be carried out with the above-mentioned years as the central year.

2.3.2 Forecasting Model for Traffic Demand

Detailed explanation on the demand forecasting method of passengers and freights will be made after Section 2.3.3 and the structure of the demand forecast model will be explained here.

First of all, the meanings of the following suffixes of the structural formula of model will be explained.

t: Year
i, j: Zone
ℓ: Link
m: Transportation mode (m = 1 : railway, m = 2 : road)
n: Article
k: Kind of vehicle

Then, the structural formulas of model are as follows:

(i) $ZL_{mij} = \sum_{\ell}(LL_{m\ell} \cdot RT_{m\ell ij})$

ZL: Zonal pair distance

LL: Link length (exogeneous)

RT: Route dummy (exogeneous)

(ii) $FWOQ_{tmnij} = Q_{81mnij} \cdot G_{tn}$

FWOQ: Future zonal pair traffic of "without"

Q_{81}: Present zonal pair traffic in 1981 (exogeneous)

G: Traffic growth factor (1981 = 1.00) (exogeneous)

(iii) $WOZT_{tmnij} = \sum_{\ell}(WOV_{tmn\ell} \cdot RT_{m\ell ij}) + TTH_{mn}$

WOZT: Zonal pair trip time (hour) of "without"

WOV: Link time of "without" (exogeneous)

TTH: Terminal time (exogeneous)

(iv) $WZT_{tmnij} = \sum_{\ell}(WV_{tmn\ell} \cdot RT_{m\ell ij}) + TTH_{mn}$

WZT: Zonal pair trip time "with"

WV: Link time of "with" (exogeneous)

(v) $STD_{tmnij} = WOZT_{tm(=2)nij} - WZT_{tm(=1)nij}$

STD: Time saving of diverted traffic

(vi) $STN_{tmnij} = WOZT_{tm(=1)nij} - WZT_{tm(=1)nij}$

STN: Time saving of normal traffic

(vii) $ELECR_{tij} = \{\sum_{\ell}(LL_{m(=1)\ell} \cdot RT_{m(=1)\ell ij} \cdot ELEC_{t\ell})\} \div ZL_{m(=1)ij}$

ELECR: Electrification ratio

ELEC: Designation of electrified railway link (exogeneous)

(viii) $DR_{tnij} = (A0_n + A1_n \cdot ZL_{m(=1)ij} + A2_n \cdot ZL^2_{m(=1)ij} + A3_n \cdot ZL^3_{m(=1)ij} + A4_n \cdot ZL^4 + A5_n \cdot ZL^5_{m(=1)ij}) \cdot ELECR_{tij}$

DR: Rate of traffic diversion from highway to railway

$A0_n$, $A1_n$ ... $A5_n$: Parameter (exogeneous)

(ix) $DQ_{tnij} = DR_{tnij} \cdot FWOQ_{tm(=2)nij}$

DQ: Traffic diverted from highway to railway

(x) $FWQ_{tm(=1)nij} = FWOQ_{tm(=1)nij} + DQ_{tnij}$

FWQ: Future zonal pair traffic of "with"

(xi) $FWQ_{tm(=2)nij} = FWOQ_{tm(=2)nij} - DQ_{tnij}$

(xii) $HVR_{tk} = \sum_{n} \sum_{ij} (DQ_{tnij} \cdot LE_{m(=2)kn} \cdot ZL_{m(=2)ij})$

HVR: Reduction in highway vehicle traffic

LE: Loading efficiency (exogeneous)

Fig. 2.3.1 shows flow chart of Forecast Model for Traffic Demand.

2.3.3 Forecast of Passenger Traffic Demand

(1) Forecast of total traffic demand

Total traffic demand means the total number of railway and bus passengers by each zonal pair. For forecasting this total traffic demand, the actual results of past total traffic demand and the relation with the economic indicators having a deep correlation with the total traffic demand are analyzed, and the method of forecasting the future traffic demand from the regression formula to be explained by this economic indicator is normally adopted. However, since the actual result values of bus traffic volume sufficient for analyzing was not obtainable in this occasion, the number of buses registered was selected in its substitute. The reason why we selected the number of buses registered is because we considered that this figure reflected most sensitively the whole traffic demand

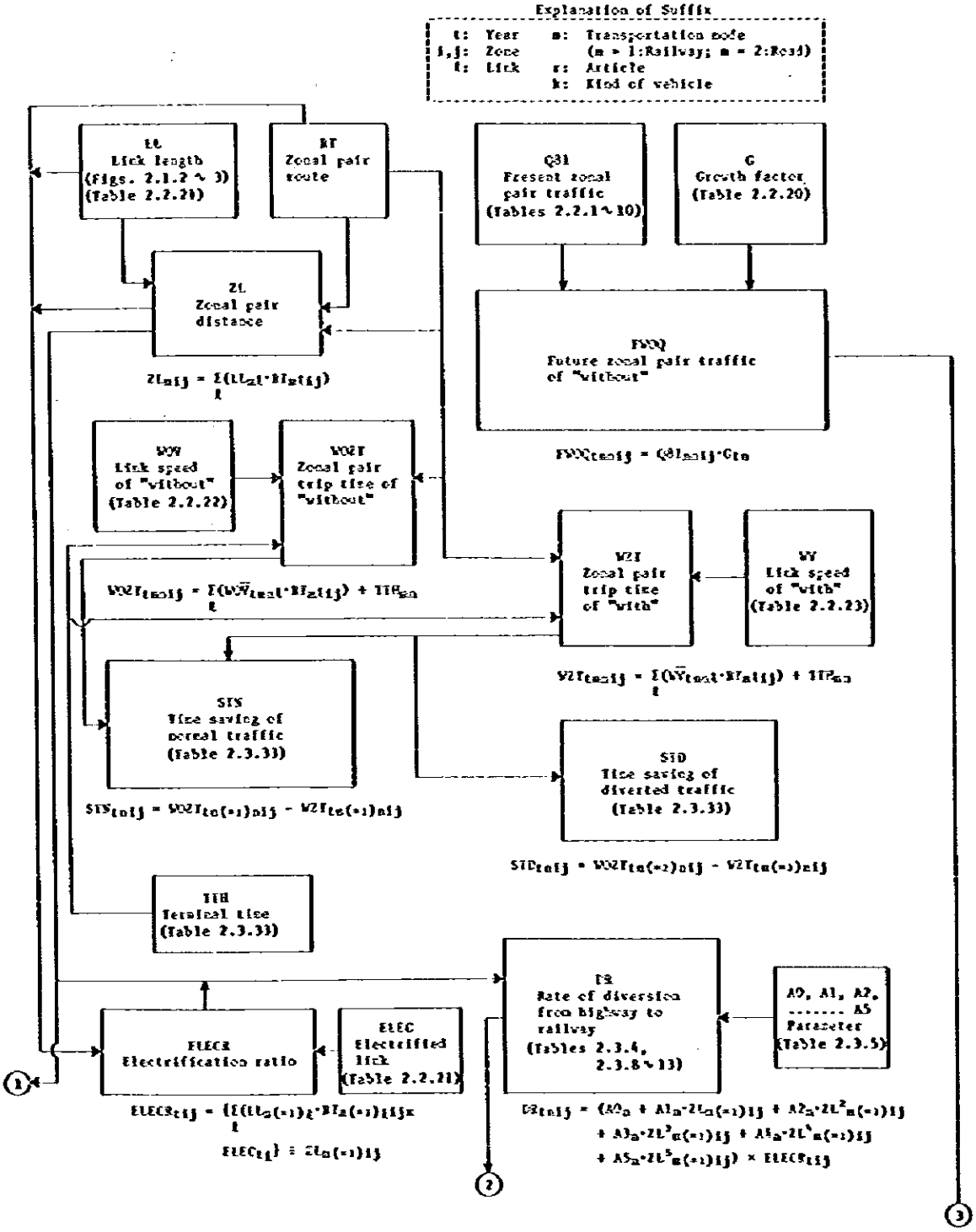
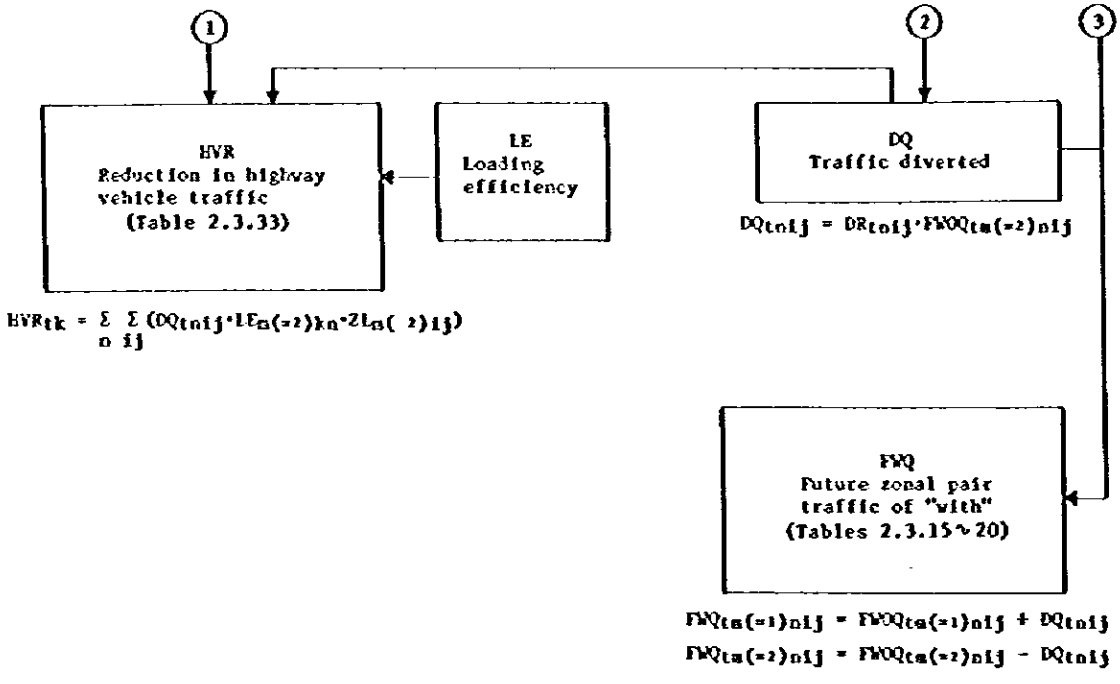


Fig. 2.3.1 The Model Used for Traffic Demand Estimation


1
2
3
HVR
Reduction in highway vehicle traffic
(Table 2.3.33)
LE
Loading efficiency
DQ
Traffic diverted
DQtnij = DRtnij·FWOQtn(=2)nij
HVRtk = Σn Σij (DQtnij·LEn(=2)kn·Ltn(=2)ij)
FWQ
Future zonal pair traffic of "with"
(Tables 2.3.15~20)
FWQtn(=1)nij = FWOQtn(=1)nij + DQtnij
FWQtn(=2)nij = FWOQtn(=2)nij - DQtnij

trend of the Java Island. However, the estimated value of the number of buses registered, itself, is not the total traffic demand but its rate of increase can be used as the growth factor of the total traffic demand. Therefore, the rate of increase of the number of buses registered was estimated here for estimating the growth factor.

The estimation method of rate of increase of the number of buses registered is as follows:

(i) Estimation of the regression formula which makes the GDP per capita (1973 price) the explanatory variable and the number of buses possessed per capita the explained variable.

$$Y = -1.41752 \times 10^{-3} + 2.265322 \times 10^{-8}X$$

The data used for estimating this formula are as follows:

Table 2.3.2 GDP per Capita and Number of Buses Possessed per Capita

Year	GDP per capita (1973 price)	Number of buses possessed per capita
1976	61,004 Rp.	0.000258 Bus/capita
1977	64,846	0.000305
1978	67,738	0.000378
1979	69,761	0.000455
1980	74,720	0.000554

Note: GDP means Gross Domestic Products.

(ii) Estimation of GDP per capita

(i) Estimation of regression formula making the year (t) its explanatory variable

$$y = 57,909.7 + 3,234.7t$$

Whereas, t = 1 to 5 (1 : 1976 year)

(ii) Estimation of GDP per capita for the 3 years of 1989, 1994 and 2002

This estimation was obtained by inserting the values of t = 14, 19 and 27 into the above-mentioned formula.