6 - 4 - 3 Outline of System to be Introduced

(1) Collecting and conveying information

1) With CTC and train numbering equipment as the base, now the system will be able to offer running information concerning any kind of conventional train in the Delhi area.

2) From terminals connected to the seat reservation system, information on vacant seats will be automatically conveyed to the respective indicators at the exits of the station's wickets.

3) The system will enable the passenger dispatcher to directly announce information to passengers.

4) As to conveying information, the system will not be solely automatic, but will rely on personel announcing information as well when so needed.

5) The automatic conveyance of information will be done by a passenger information control system (PIC) in which tape-recorded announcement or visual indicators are activated directly from an information source.

6) The system will provide train operation indicators (VDUs) as well as apparatus for the passenger dispatcher to make simultaneous announcement to any or all station staff and all inquiry clerks at general inquiry office. The conventional telephone system is also incorporated in the system.

7) The system will also provide a means of visually broadcasting certain kinds of information to all the passengers in the station.

Examples of such kinds of informations are:

— Natural disasters and the countermeasures being taken.
— Sudden changes in the schedules for important trains.
— Local events related to train service.

The medium to be used will be a large screen or CCTV (Closed Circuit T.V), and the text for it will be easy for station staff to edit.

8) An information control center will be organized incorporating

the existing Inquiry Centre. All the above-mentioned information equipment will be under the unified control of this center.

(2) Kind of equipment and their functions

1) Passenger Information Control System (PIC)

a) The functions of the PIC can be roughly classified into that for automatic broadcasting and automatic indicating of information. The flow of information is as shown in Fig. 6.4.3-1. PIC collects the required information from the train operation information system and from the train's position/number detection system, and controls the broadcasting and indication of said information in a timely manner.

b) As to the system for tape-recorded announcements, it will be connected either to the train operation information system or to the operation of the track circuit.

c) In abnormal cases PIC, along with outputting information on train delays, has the function of outputting all kinds of information at a station in a concentrated style. Furthermore, local information of a particular station can be easily drawn up by selecting a basic sample and editing item registered in the said station's multi-item-input equipment.

d) The system prepares for two methods of activating the indicators and TV screens. By the first method, the system works under the control of the Centre, instructions given directly from CTC & PIC, and patternized indications are output. By the other method, the system will be activated manually to output the particular texts which are unavailable among the prepared indications. The difference in the system-configurations for these two methods is shown in the Fig.6.4.3-2 and Fig.6.4.3-3.

Basically for the New Delhi Station, the Centralized Control Method will be adopted. But the software will be prepared to accommodate it to the Independent Method too. This is in order to enable the

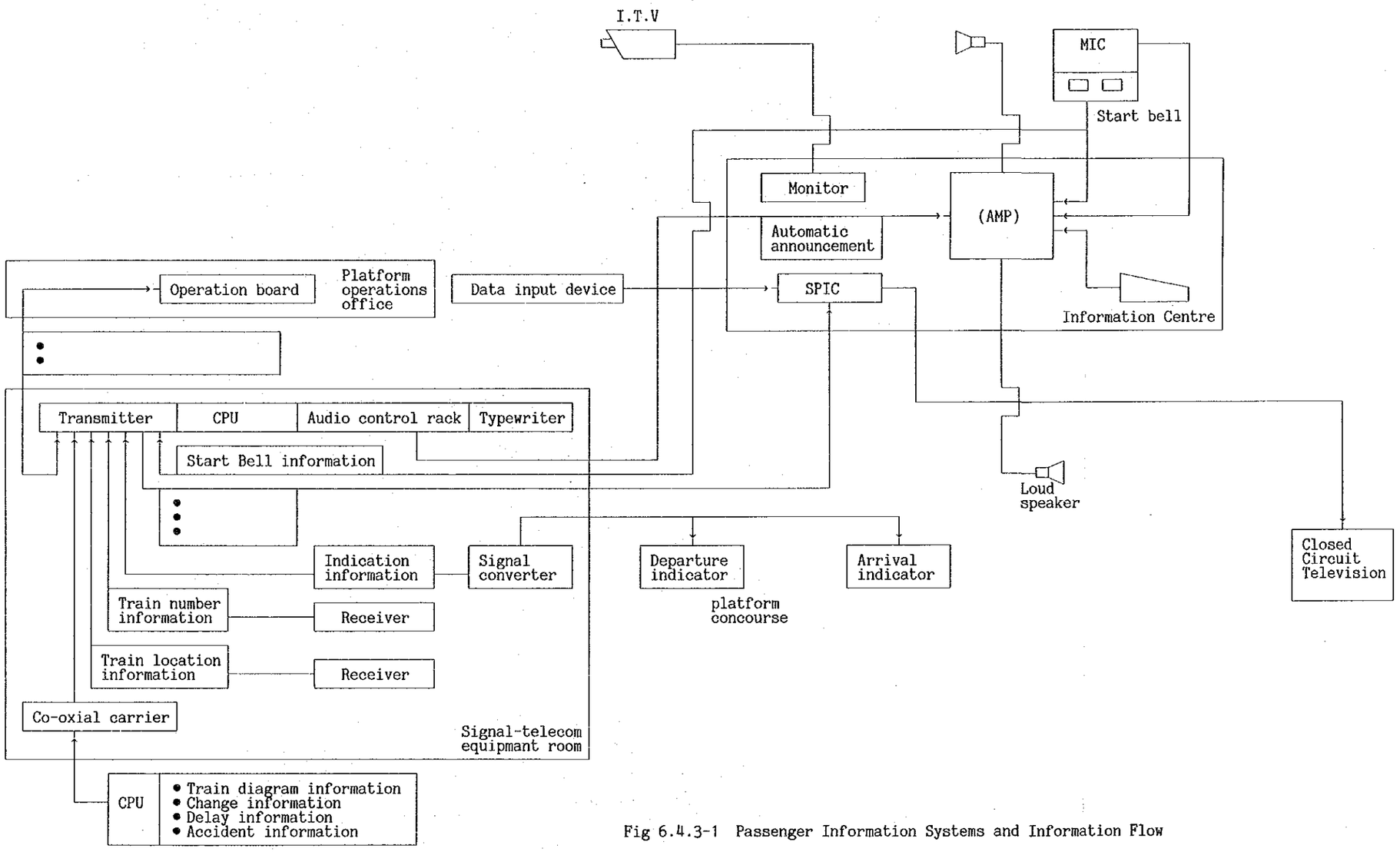


Fig 6.4.3-1 Passenger Information Systems and Information Flow

Table 6.4.3-1 Input Method of Guidance Information for Passengers

I t e m s	Input Method
Operational conditions	A
Status of accidents	A P・M
Local changes in information on operational conditions	P・M
Transport disruption, train cancellation, slowdown, operation suspension	A
Schedule changes, replacement of transport	P・M
Other patterned local information	P・M
Others	S

Note) A : Automatic input
P・M : Patterned input
S : Handwritten input

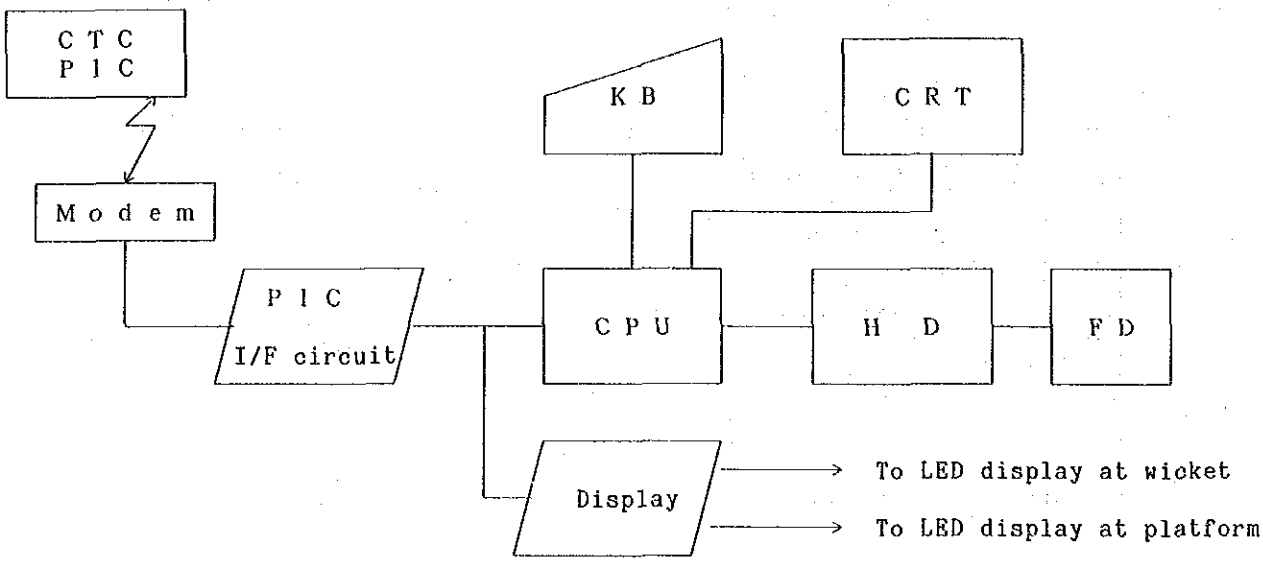


Fig. 6.4.3-2 Concentrated Control Method

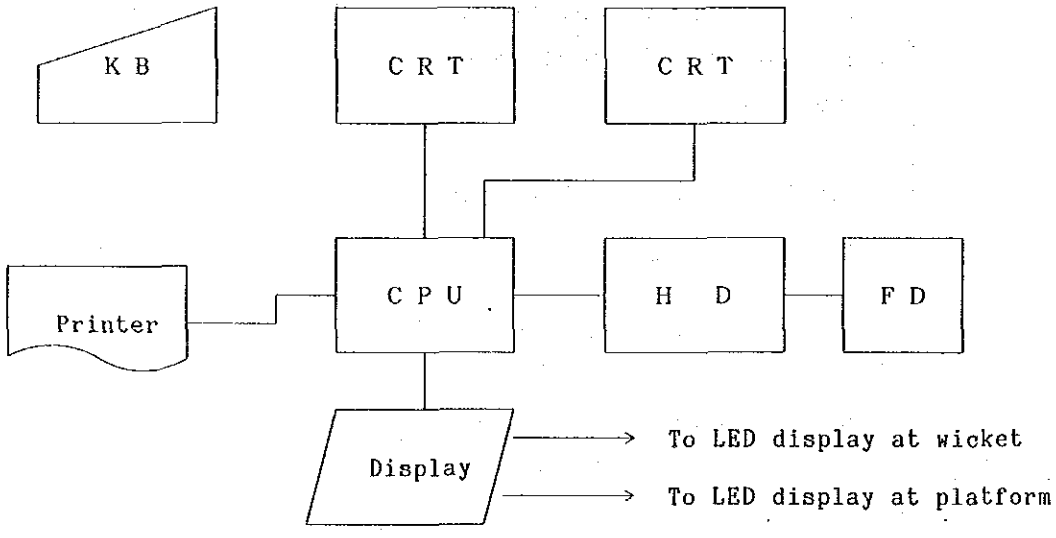


Fig. 6.4.3-3 Independent Manual Method

station staff to make the text which are unavailable among the patternized outputs prepared by the Centralized Method. The method of input is shown in Table 6.4.3-1, and the examples of output are shown in Fig.6.4.3-4 (a) ～(c). (See Appendix 6-2)

2) Automatic indicators (departure train signs, etc.)

a) Automatic indicators widely in use in passenger stations are classified into: movable indicators, such as revolving-sheet-and overturning-plate-type indicators; and static indicators. Since the former have movable sections, they are liable to go out of order and require maintenence. On the other hand, the latter need much less maintenance since they have no movable sections.

Accordingly, it is recommended that the static indicators be introduced in the future. The departure train sign scheduled to be introduced to New Delhi Station is a movable indicator.

b) The static indicators include a light emitting diode (LED), liquid crystal display (LCD), plasma display panel (PD), and cathode ray tube (CRT).

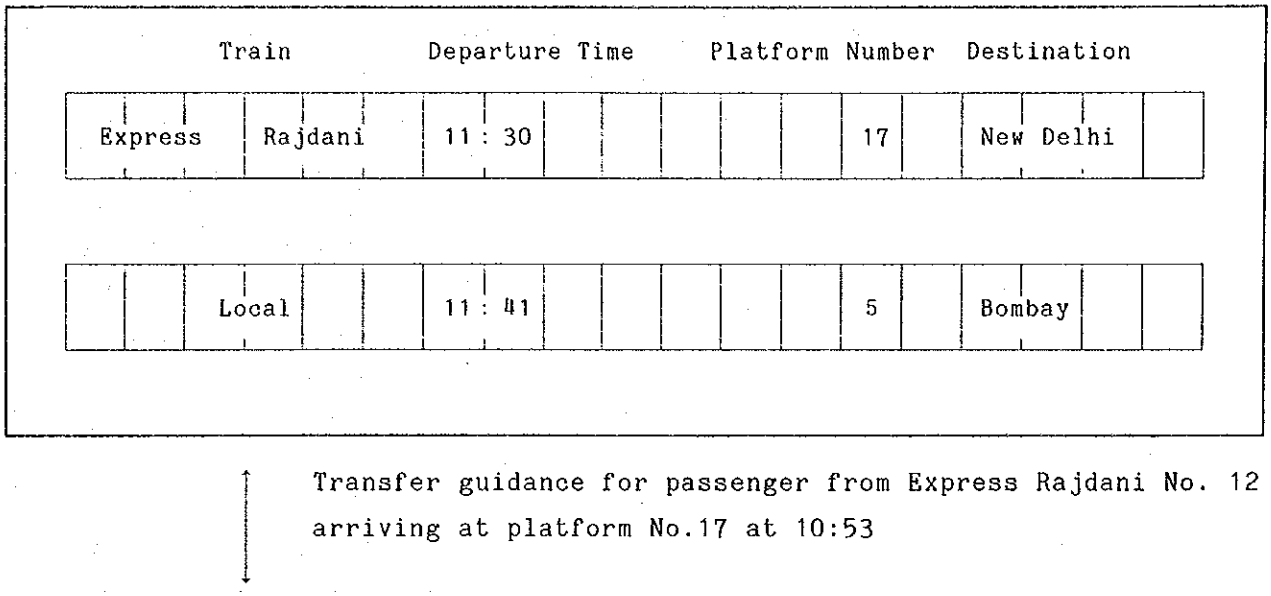
By comparison the present functions of the various types of indicators, the LCD-type indicators are to be introduced for departure train signs and guiding indicators that mainly relay on the characters of the alphabet, in view of train technical advantages such as:

—Characters can be shown at any place on the indicators.
—Character flows are easy to see.
—The size of indicators can be made small.
—The indicators are easy to read from a distance.
—Power consumption can be reduced.
—Internal lighting is not necessary.

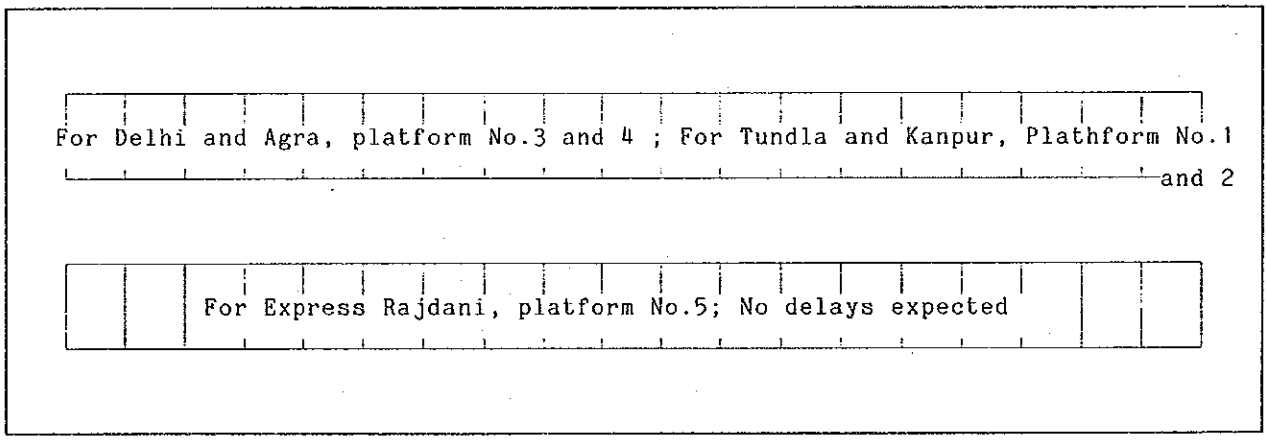
(Refer to Appendix 6-2).

In this project, a centralized control system is to be introduced. At the same time, software is to be designed that will allow individual manual input through a CRT keyboard that

enables the compilation of sentences for emergency information and guidance that can not be automatically indicated. The method of inputting information is as shown in Table 6.4.6-2. Examples of the indications are as shown in Figs.6.4.3-4 (a) and (b).



Transfer guidance for passenger from Express Rajdani No. 12 arriving at platform No.17 at 10:53



Note : Hindi expression is available as well as English one.

Fig. 6.4.3-4(a) Example for Transfer, Guidance Indication

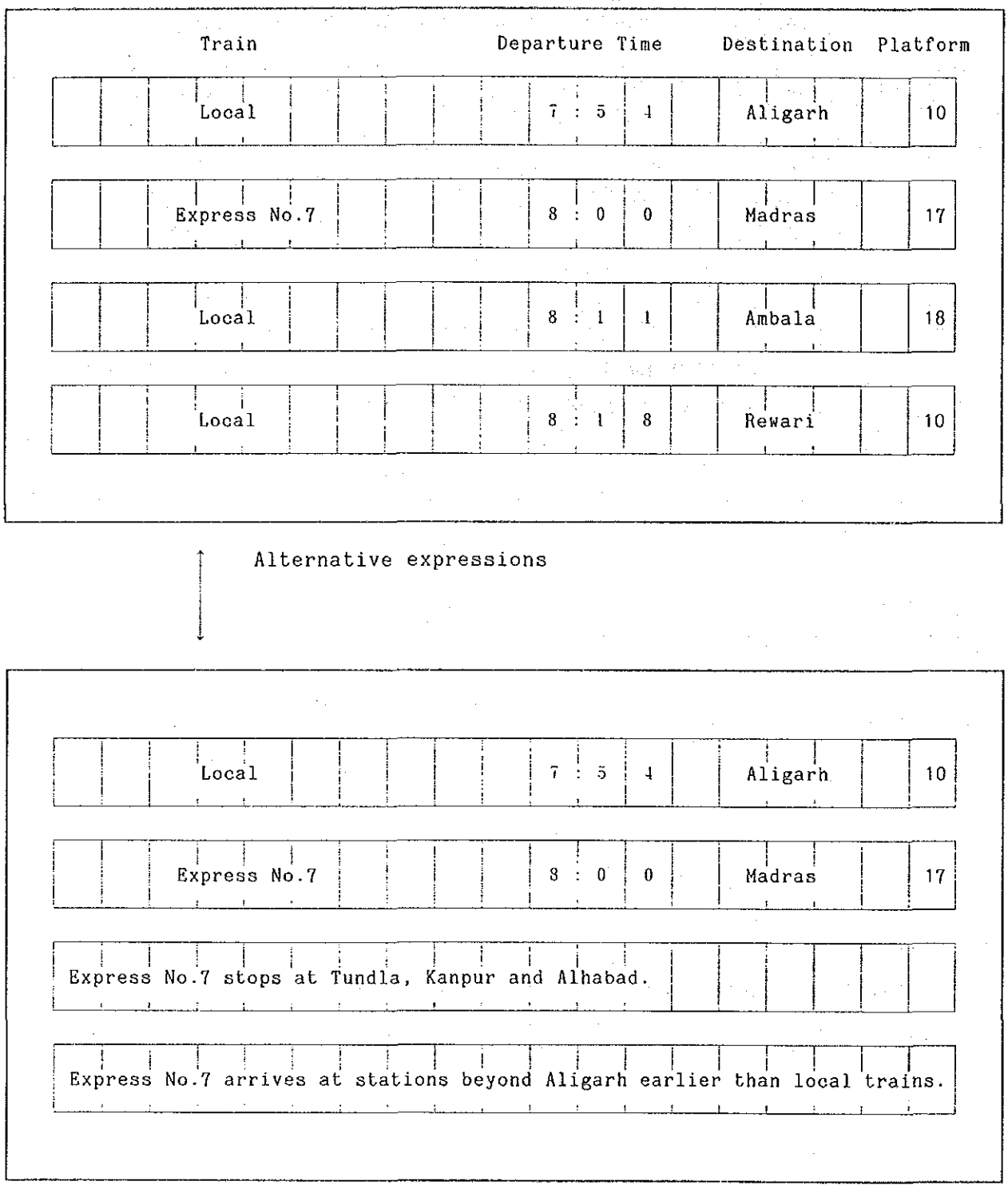
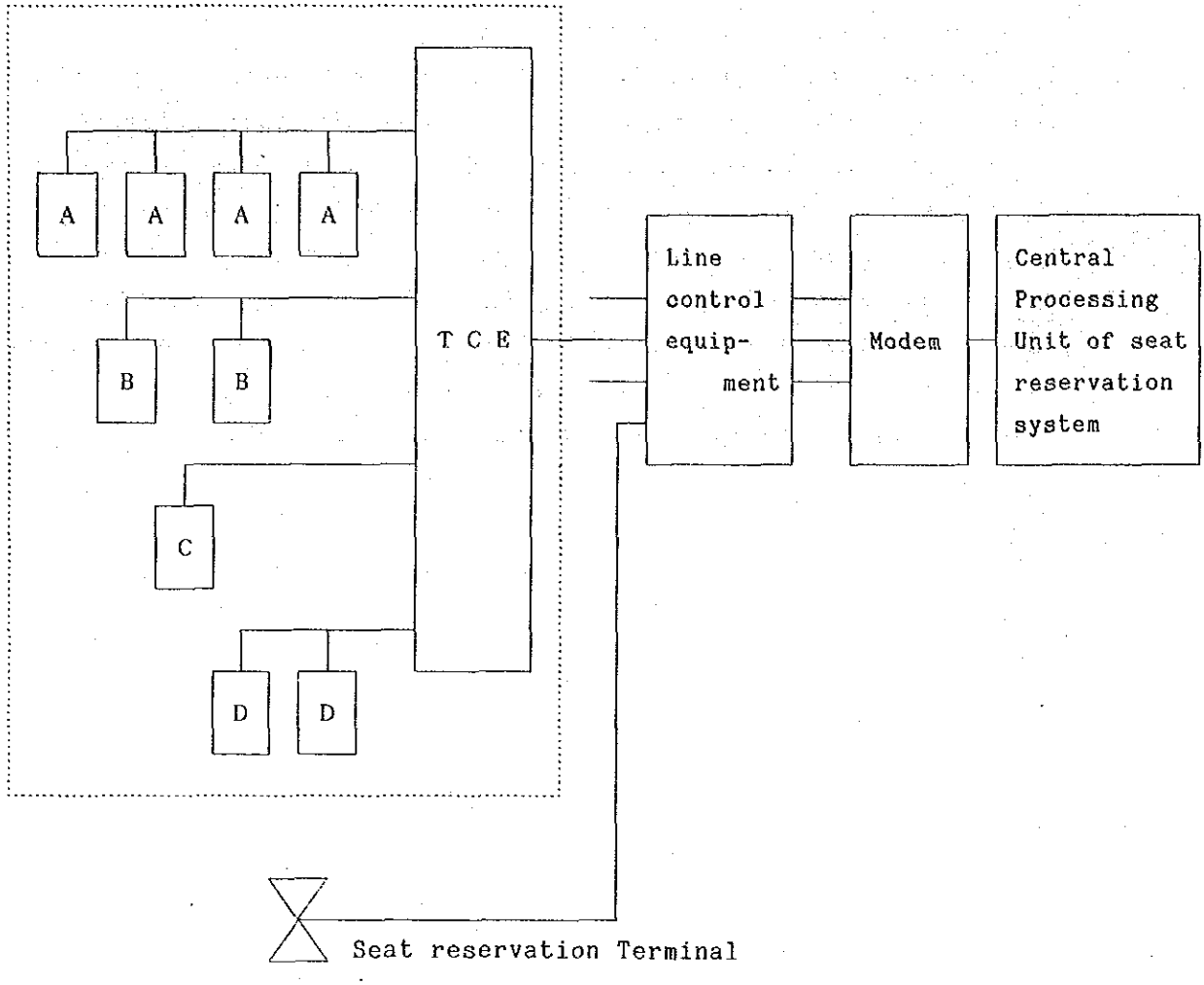


Fig. 6.4.3-4(b) Earlier Arrival Indication

3) Available Seat Indication System

By connecting these indicators with the central equipment for the seat reservation system, the status of seat reservations for specified trains is indicated near ticket windows. The indicators for trips on a particular day show whether there are vacancies on trains that start that day in the order of departure. Indicators for advanced reservations (i.e., the following day and often). show the status of reservations. For trains one month beforehand, including information for the day. The system configuration for seat vacancy indications is as shown in Fig. 6.4.3-5.



T C E : Terminal control Equipment

A : Up-Display for the day

B : Down-Display for the day

C : Up-Display for the day in advance sale

D : Down-Display for the day in advance sale

Fig. 6.4.3-5 Configuration of Available Seat System Indication

4) Simultaneous notification equipment

Instant notification equipment is to be introduced to provide stations with passenger dispatching information, such as that on train delays.

5) Train operation information indicators

Train operation information indicators will be installed in the dispatcher's office and certain stations' operation staff rooms. Inputting actual train operation status (represented by the confirmation/modification/cancellation of train code numbers) is done there.

The main functions of the system are:

— Indication of train positions

The position and code number of a train will be indicated on a CRT. The screen shows three stations and the relevant four sections.

— Train delay indicator

Certain stations are assigned to recorded the actual arrival/departure time of trains. By comparing the actual arrival/departure time and the fixed schedules, the system will indicate on request how many minutes a train is behind schedule.

— Train detection

When the code number of a train in question is inputted, the system will indicate the station name where the train is located and the delay time.

— Indication of the causes of delay

The cause of a delay and the time required for its recovery,when their data are identified and inputted by the center, can be outputted on the screen.

— Train diagram processing

The basic diagram and temporary diagram (defined by train indicator departure order, turnaround train number, departure scheduling data, and Five-character train number) can be

changed by exogenous factors, which are recorded by the input memory monitor indicator.

— Train diagram editing

The actual operating diagram of a particular day is drawn up by incorporating the temporary diagram into the basic diagram.

The entire train operation information system configuration is shown in the Fig.6.4.3-6. (Refer to Appendix 6-4 and 6-5)

(3) Performance Evalution

Performance analysis is shown in Appendix 6-7.

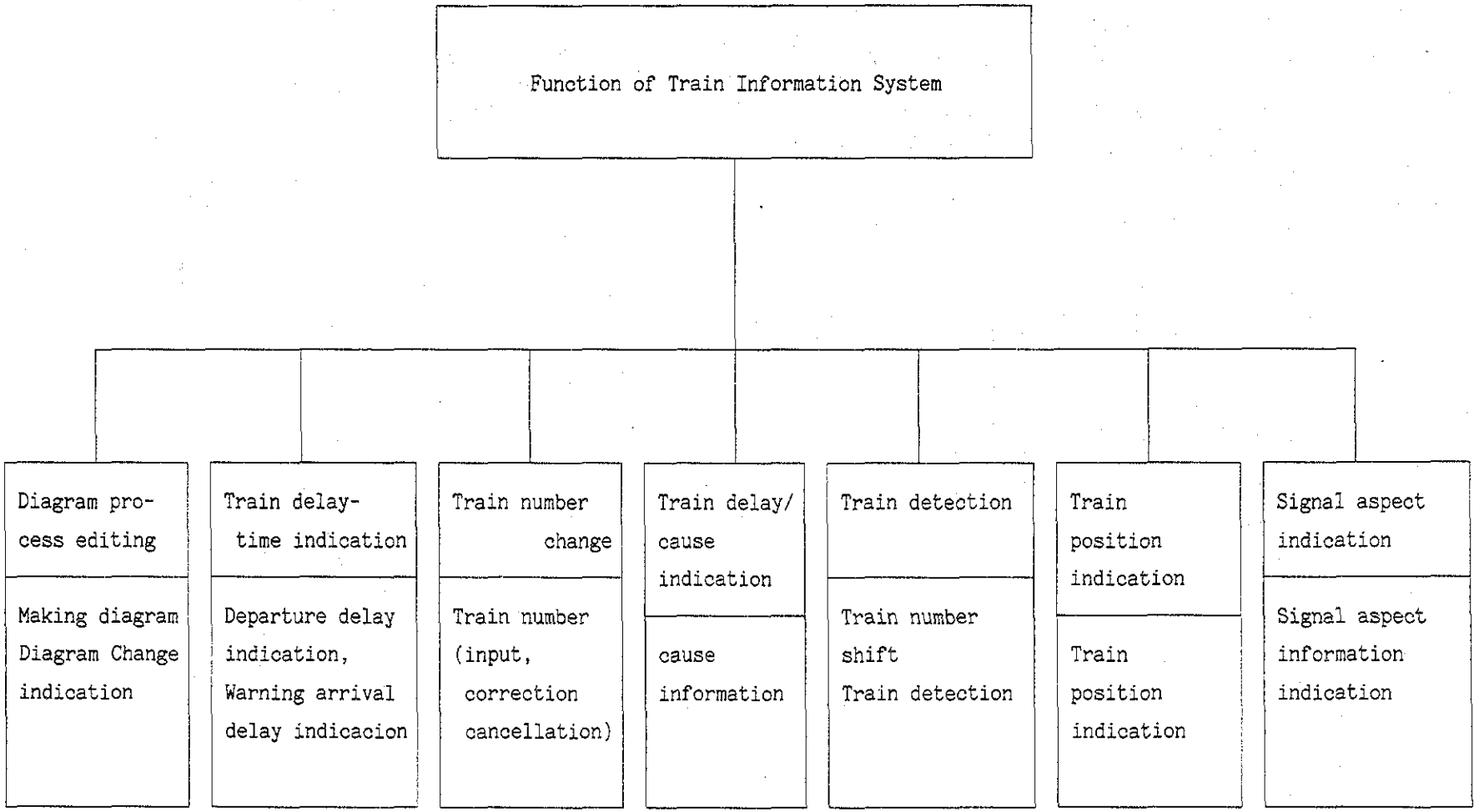


Fig.6.4.3-6 Contiguration of Train Information System

6 - 5 Communication Facilities

6 - 5 - 1 Wireless Telephones for Yard and for Maintenance

(1) Necessity

Communication in the New Delhi Station yard among the yardmen, signalmen and drivers is now achieved with flags and signs. However, with the predicted increase in the trains that are to be dealt with, which will create more shunting work at washing/storage lines and more locomotive coupling/recoupling work, yard work must be conducted in a surer, safer and more efficient manner. To do this, the introduction of wireless telephones in the yard will become necessary.

At present, communication between wayside-facilitiy maintenance gangs, accident cleanup teams and management is accomplished with portable control telephones that connect to on-site jacks. To meet the demands for even swifter accident cleanup and efficient maintenance, which will accompany the rise in the number of trains, train speed increases, and growing interstation upkeep, wireless telephones will be all that more necessary.

(2) Plan for Introduction

1) Yard wireless telephones (Duplex communication)

Engine drivers and yardmen, as a team that carries outroute formation, work supervision, and coupling/uncoupling of freight cars, require an exclusive wireless channel for their use, in order that they can work safely and efficiently. Accordingly, several channels must be secured for a yard that are allotable area-wise and team-wise.

In the Japanese Railway Group, a handy 300 MHz portable wireless telephone is being used that can receive 12 channels (max.). It is employed not only as a means of communication but also as an alarm. (See Appendix 6-8)

2) Maintenance wireless telephones (Simplex communication)

Wireless telephones are needed to ensure the efficiency and safety of maintenance crews, as they are highly mobile and work in the vicinities of operating trains. In the JR Group, a maintenance gang consisting of 5 ～6 men, assigned to a ten-kilometer double-tracked section, is equipped with a set of maintenance wireless telephones to guarantee communication within the section. (See Appendix 6-8)

3) Car wireless telephones

Car wireless telephones are useful for workers at the scene of a train accident, in that they can report back to management and devise appropriate countermeasures together. In the JR Group, a maintenance depot has a car equipped with a 150 MHz wireless telephone that can receive signals within a ten-kilometer radius.

6 - 6 Investment Planning

Technical concepts of the modernization of New Delhi have been clarified in the preceding paragraphs. Next issue is its investment planning.

6 - 6 - 1 Investment Timing

(1) From the viewpoint of transportation planning, when the number of platforms is compared with the number of trains planned to be treated at New Delhi, the investment timing can be rather long-ranged. It would do building platforms and washing/stabling lines, step by step, as the number of trains increases.
- Contruction of 2 more platforms by 1992-93 (total 11)
- Construction of 4 more platforms by 1999-2000 (total 15)

(2) From the viewpoint of minimizing the construction cost and the impacts of the construction works troubling the normal train operation, however, the investment timing had better be short-ranged. A work may have to be done in the same step concurrently with another, whether or not the transportation plan needs it at the timing.

(3) From the viewpoint of improving the passenger service facilities, the investment timing cannot be too early in New Delhi, even if it is made today. In some of the facilities, limit has been already reached. Considering the rapid growth in GDP and in living standards, their drastic renovation must be prepared in the Capital's railway station right now.
Approximately four years will be required to complete this large scaled work for the modernizaiton.
The steps after Nizamuddin must be prepared. The preparations started today, it will be well into 1995 that the work will be completed.

(4) In order for the works to least disturb the normal train operation and to minimize the number of switch-over steps, it must be performed concurrently with the improvement work of the platforms. arrival/departure lines and washing/stabling lines. The works will be performed in the following manner; Build a new platform - Shift the passenger handling at the existing platform to the new platform - Perform the modernization work at the vacated existing platform.

(5) It is planned in this study that the work steps will be completed by March 1995 for the overbridge passage, the platforms and the arrival/departure/washing/stabling lines that will be required by 2000.

6 - 6 - 2 Investment Cost and Implementation Schedule

(1) Investment Cost

The required reconstruction cost of New Delhi Station itself is as is shown in Tables 6.6.1 and 6.6.2.

(2) Implementation Schedule

The work schedule and the year-wise investment cost of the improvement are as shown in Table 6.6.3.

Table 6.6.1 Investment Cost for Modernizing New Delhi Station

Up to 2000 (Rs million)

Item	Classification	Total	Breakdown		
			Personal expenses in local Currency	Material expenses in local Currency	Foreign Currency
Track and Structure	Roadbed	2.7	0.5	2.2	-
	Platform	119.2	25.7	93.5	-
	Station Building	906.8	369.3	537.5	-
	Track	66.0	8.0	58.0	-
Machine and equipment	Car Washing Machine and Repairing equipment	25.4	0.7	2.7	22.0
	Escalator and Lift	24.2	2.4	21.8	-
	Air Conditioner	26.2	5.5	20.7	-
	Electric Power equipment	50.0	15.5	34.5	
Signalling and telecommunication	Signalling	120.0	72.0	48.0	-
	Telecommunication	73.4	8.3	13.6	51.5
Electrification	Electrification	17.5	7.8	9.7	-
Ground Facilities Total		1431.4	515.7	842.2	73.5

Note: (1) Prices are as of July 1989. No escalation is taken into account.

(2) Prices of imported equipment are cost, insurance and freight (C.I.F.) plus vaious duties (See 8-2-1(2)).
The Passenger information equipment and Car washing machines are considered as imported instruments (All others, goods and services, are considered as local currency items), exchange rate between Rs and Yen being set at 1Rs = 8.42 Yen.

(3) Construction cost includes contingency, supervision charges and general charges.

Table 6.6.2 Investment Cost for Modernizing New Delhi Station

After 2001 (Rs million)

Item	Local Currency	Foreign Currency	Total
Track and Structure	105	-	105
Signalling and telecommunication	10	-	10
Electrification	10	-	10
Total	125	-	125

Table 6.6.3 Implementation Schedule for Modernizing New Delhi Station

(Schedule of investment up to 2000)

Rs million

	1989~1990	1990~91	1991~92	1992~93	1993~94	1994~95
Ongoing improvement						
Designing						
Track and structure						
Building						
Machine and equipment						
Signalling						
Telecommunication						
Electrification						
Local currency			115.5	231.1	458.2	553.1
Foreign currency			0	0	2.2	71.3
Total			115.5	231.1	460.4	624.4

6 - 7 Station Improvement and Environmental Impacts

When this project is completed, the environment of the station and its surrounding area will be cleaned and the improved station plaza will make the traffic around the station less disordered.

6 - 7 - 1 Station Improvement and Road Congestion

(1) Around the New Delhi Station are Kutab Road, Minto Road, Thompson Road and Ajmeri Gate Road which crosses the station at its middle.Ajemeri Road is a busiest of them. During the peak three hours in the morning (7:30 AM ~ 10:00 AM), and in the evening (5 PM ~ 8 PM), it has the traffic of 6,000 cars and 8,400 cars, respectively. During the peak one hour, it is 1,550 cars each in the morning and in the evening.

(2) The number of users of New Delhi Station will be doubled by 2010. As far as the station itself and the plaza are concerned, the problems arising from the increase of users will be solved by the implementation of the project. But as to the roads around the station, problems will become serious.

(3) The countermeasures to be taken are

1) Widening of Ajmeri Road, Thompson Road connecting with East Gate of the station and other roads connecting with Ring Road.
2) Construction of guided urban mass transit system such as LRT and underground, which should be linked with New Delhi Station.
3) Road traffic regulations for dividing the use of lanes for higher speed road vehicles and lower speed vehicles after having widened the roads. Characterizing the traffic around New Delhi Station is its low speed. Buses, trucks, taxis account for only 10% of the traffic. Horse/ox drawn carriages and rickshaws 25 ~ 40%. The rest is two or three wheelers.

6 - 7 - 2 Night-soil Problems

With the increase in number of trains originating from New Delhi, the night-soil problem will get more serious, not only for the station users but for track maintenance staff and for the inhabitants new to the track.

The countermeasures to be taken are:

(1) Increase the water closets near the platforms of the Station.

(2) Build more washing aprons, improve draining/sewerage facilities of the station.

(3) Increase, step by step, the number of passenger cars equipped with soil tank or soil treatment apparatus and the relevant ground treatment facilities of foul water.

CHAPTER 7 ECONOMIC ANALYSIS

CHAPTER 7 ECONOMIC ANALYSIS

7 - 1 Objective and Method of Economic Analysis

7 - 1 - 1 Objective

The objective of the economic analysis is to analyze and evaluate the viability of the project from standpoint of the national economy.

7 - 1 - 2 Method of Economic Analysis

(1) The costs and economic benefits of the case implementing the project ("With the Project") and the case not implementing the project ("Without the Project") are analyzed and compared, and the Economic Internal Rate of Return (EIRR) is calculated as an index for evaluating the viability of the project.
The EIRR is the discount rate which would make the net present value of the costs equal to the net present value of the benefits. It is obtained using the following equation. There, the difference of investment and operating costs between "With the Project" and "Without the Project," plus the resultant benefits each over the project life are calculated.

$$O = \sum_{i=1}^{n} A_i / (1 + EIRR)^{i-1}$$

n : Project life (31 years, 1990-2020)
Ai: Differences of investment and operating costs between the cases "With the Project" and "Without the Project", plus the resultant benefits, each calculated on yearly basis

(2) Sensitivity analysis is made for the deviation of investment cost and divereted traffic volume.

(3) Indirect benefits, such as promotion of employment and development of local economy, brought about by this project, are also described.

7 - 2 Premises

The following premises are taken for the analysis:

(1) Economic Price

The prices of the materials, equipments, commodities and manpower to be used in this analysis are calculated as follows.

1) When locally procured, the prices are subtracted of excise tariff and sales tax from the market prices (Taxes are regarded as transfer items within the national economy). Weighted average excise tariff, and sales tax rates are 20% and 7% respectively.
Incidentally, buses and trucks are considered as local products. Therefore, excise tariff (25%), sales tax (7%) and vehicle registration fee for V.R.A. (Rs. 300/unit) are subtracted from the market prices.

2) When imported, the prices are CIF prices plus inland transport and handling costs.

3) Labour Cost
The cost is the standard annual wage of the average workers. Incidentally, it is below the taxable income level, which is, for reference, over Rs.18,000 per year at present.

4) Foreign Exchange Rate
The mean value as of August 1989 (Rs.1.00=Japanese Yen 8.42) is used.

(2) Inflation
The prices are assumed to remain fixed for all the project life. Inflation is not considered in the analysis, since it tends to be capricious to determine an inflation rate for the 31 years period.

(3) Project Life

The period of 31 years from 1990 to 2020.

(4) Reinvestment and Maintenance

All the depreciable assets are considered to be reinvested upon expiration of their respective useful life. Maintenance cost is calculated at a rate of the value of the depreciable assets. The maintenance rate and useful life of railway assets are shown in Table 7.2.1 determined upon the standard data of the Indian Railways.

(5) Residual Value

The residual value is assumed as the unamortized portion of the depreciable assets. It is counted as negative investments in the final year of the project life.

(6) Economic Growth

Annual economic growth rate is assumed at 5% up to 2010, and thereafter, 4%, in accordance with the forecast given in the Socio-Economic Framework in Chapter 2.

Table 7.2.1 Maintenance Rate and Useful Life of Railway Assets

Items	Assets Description	Maintenance Rate %	Useful Life (Years)
Civil Work	Roadbed	3	57*
	Steel bridge work	3	60
	Platform	3	65
	Concrete structures	3	65
	Overbridge	3	60
	Station building	3	60
	Building (workshop depot etc.)	3	60
	Track	3	60
	Asphalt	3	5*
	Mechanical facilities	5	20
	Water supply pipe	3	20
Signalling & Telecom-munication	Signalling facilities	3	25
	Telecommunication facilities	3	15
Electrifi-cation & Power Supply	Substation facilities	5	25
	Substation building	5	25
	Overhead equipment	5	42
	Power distribution line	5	30
	Internal wiring	5	10
Rolling Stock	Diesel locomotive	Included in Working Expense	36
	Electric locomotive		35
	EMU		25
	Coach		30
	Wagon		35

Source : IR Data. As to Roadbed and Asphalt (*) based on the standard data of JR.

7 - 3 Cases for Analysis

The case "With the Project" and the case "Without the Project" are compared in investment cost and operating cost, and the difference obtained is added with the benefits brought about by the Project.
The case "With the Project" is the case where the New Delhi Station is modernized and the related sections are improved within 200 km radius circle connected with the Delhi Area.
The case "Without the Project" is the case where no such railway improvement would be made, and buses and trucks would transport the increasing traffic.

7 - 3 - 1 Investment Cost

(1) Case "With the Project"

The investment costs are those for the modernization of New Delhi Station, and for the improvement of terminal functions and facilities in Delhi Area as well as in the related sections. It is to be noted that the investment cost includes the amount for procurement of the rolling stock which will be necessary to cope with the increase in traffic.

The investment corresponds, in items, with those given in the Column "Total" of Table 5.5.1(5), but, in amount, it is different from the figures given there, because it is calculated based on economic price (the figures in the Table are given in market price). Category-wise, i.e., civil work, signalling & telecommunication, etc., it is as listed in Table 7.3.1 below.

Table 7.3.1 Estimated Economic Investment Cost of "With the Project"

(In Thousand Rs.)

Department	New Delhi Station	Delhi Area	Relevant Sections	Within the Boundary of the Study	Total
Civil Work	1,001,407 (163,324)	852,863 (131,293)	370,011 (369,114)		2,224,281 (663,731)
Signalling & Telecommunication	149,781 (32,475)	124,930 (26,444)	1,002,199 (120,345)		1,276,910 (179,264)
Electrification & Power Supply	56,508 (29,982)	123,203 (26,471)	111,571 (0)		291,282 (56,453)
Sub Total	1,207,696	1,100,996	1,483,781		3,792,473
Rolling Stock				9,090,820	9,090,820
Total	1,207,696 (225,781)	1,100,996 (184,208)	1,483,781 (489,459)	9,090,820 (-)	12,883,293 (899,448)
Grand Total	1,433,477	1,285,204	1,973,240	9,090,820	13,782,741

Note: The costs in brackets show the costs planned in the Action Plan (on-going) below.

(1) New Delhi Station (Phase I) : washing/stabling lines at Nizamuddin and 2 additional platforms

(2) Sahibabad ~ Ghaziabad 4th line

(3) Ghaziabad: Remodelling of yard

(4) Track Doubling between Rohtak ~ Jakhal

(5) Track Doubling between Garhi-Harsaru and Khalilpur

The costs of reinvestment are excluded from the sums in the above Table.

(2) Case "Without the Project"

The investment cost is identified with the cost procuring such number of buses and trucks as may be required for transporting the traffic, which would have been diverted to the improved railways, had the Project been implemented.

This "diverted traffic," or the traffic volume which is incremental to the railway mode, had the project been implemented,

is assessed as follows:

1) The traffic volume in 1990 is considered as the basic traffic volume.

2) The traffic increase after 1995, the year of completion of the new station building and related railway facilities is counted. The increase in a period 1990 ~ 1994 is not counted. (See Graphic given below.)

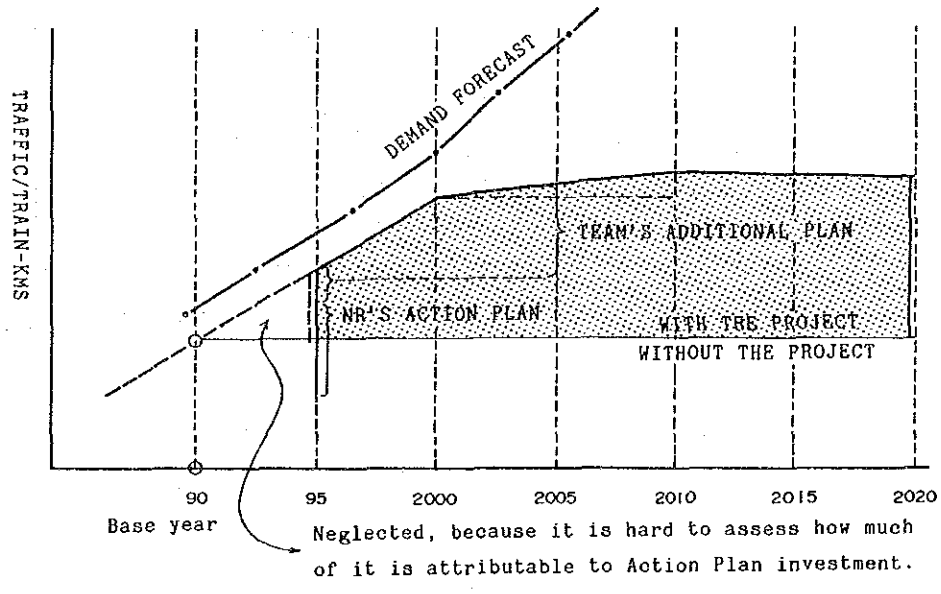
3) All of the incremental transport capacity, after 1995, planned in Chapter 3 "Basic Transportation Planning," is assumed to contribute, in full, to the growth of traffic volume.

4) The induced traffic volume, which is expected for the three lines (Delhi/New Delhi-Tundla, Delhi/New Delhi-Ambala and Delhi/New Delhi-Mathura) by the improved scheduled speed, is estimated in Chapter 2 "Demand Forecast" and also included in the diverted traffic volume.

5) The diverted traffic consist of the traffic volume terminating/originating and passing through the Study Area.

The results is as shown in Table 7.3.3.

Graphic



The resultant investment amount for buses and trucks is as shown in Table 7.3.2.

It is to be noted that the investment which may be required for the road improvement, incremental due to the increase in traffic, is not considered in this study. This serves as a fail-safe factor in calculating the EIRR.

In estimating the required number of vehicles, the following formula is used:

Required number of vehicles = Annual diverted traffic volume (passenger-kms or tonne-kms) ÷ Average annual transport volume per vehicle (passenger-kms or tonne-kms)

The diverted traffic volume and the average annual transport volume per vehicle mentioned in the above formula are as shown in Tables 7.3.3 and 7.3.4 respectively. The relevant data are as given in Table 7.3.5.

Table 7.3.2 Estimated Economic Investment of "Without the Project"

(In Thousand Rs.)

Item	Within the Boundary of the Study
Bus	629,322
Truck	3,477,502
Total	4,106,824

Note: The cost of reinvestment is not included.

Table 7.3.3 Diverted Traffic Volume

(In Million Passenger-kms or In Million Tonne-kms)

Year	Bus	Truck
1995	2,748	2,366
2000	6,262	9,124
2005	7,895	10,669
2010	8,266	12,121

(See Appendix Tables 2.7 through 2.11)

Table 7.3.4 Average Annual Transport Volume per Vehicle

Bus	Truck
4,176,000 passenger-kms	969,000 tonne-kms

Note: The average annual transport volume has been calculated from the operational statistics of Delhi Transport Corporation (D.T.C.) and private public carriers.

Table 7.3.5 Operational Statistics of Bus and Truck

	Bus	Truck
Capacity	60 persons	9.5 tonne
Average Occupancy Ratio or Average Load Factor	87 %	85 %
Useful Life	8 years	10 years
Travelling Distance	80,000 km/year	120,000 km/year
Price	Rs. 318,000/unit	Rs. 278,000/unit

7 - 3 - 2 Operating Cost

(1) Case "With the Project"

The railway operating costs are calculated based on working expense and maintenance cost. (Depreciation is excluded in economic analysis.) The economic working expense per train-km is estimated using the unit cost of the "Working Expense per Train-km" obtained from Railway Board and Indian Railways. The unit cost includes fuel cost, personnel cost, maintenance cost of the rolling stock and terminal cost.

The maintenance cost of depreciable assets is calculated using the maintenance rate shown in Table 7.3.1.

In calculating the sum total, the following formulas are used:

Working expense = Working expense per train-km
× Incremental annual train-km (*)

Maintenance cost = Annual investment cost
× Maintenance rate

* incremental due to the project.

Working expense per train-km and incremental annual train-kms are shown in Table 7.3.6 and Table 7.3.7 respectively.

Table 7.3.6 Working Expense per Train-km

Type of Train	Working Expense (Rs./train-km)
Passenger Train	
Diesel	56.07
Electric	59.81
Goods Train	
Diesel	67.19
Electric	77.34

Table 7.3.7 Incremental Annual Train-km by Types of Traction

(In thousand train-kms)

Year	Passenger		Goods	
	Diesel	Electric	Diesel	Electric
1995	699	1,126	1,217	2,155
2000	2,362	2,177	3,079	5,900
2005	3,180	2,177	4,580	5,941
2010	530	5,317	1,895	9,543

The figures are based on Chapter 3 "Basic Transportation Planning".

(2) Case "Without the Project"

The operating costs of buses and trucks are calculated based on the maintenance and fuel costs per kilometer and personnel cost per unit of bus/truck operation. The following formulas are used:

Maintenance cost

= Annual number of vehicles ×
Average annual travelling distance per vehicle ×
Unit maintenance cost (Rs./km)

Fuel cost = Annual number of vehicles ×
Average annual travelling distance per vehicle ×
Unit fuel cost (Rs./km)

Personnel cost

= Annual number of vehicles ×
Annual personnel cost per unit (Rs./Unit)

The maintenance and fuel costs per kilometre and the personnel cost per unit are shown in Table 7.3.8.

Table 7.3.8 Unit Operating Cost of Bus and Truck

Item	Bus	Truck
Maintenance Cost	Rs. 0.51/km	Rs. 1.09/km
Fuel Cost	Rs. 0.72/km	Rs. 0.74/km
Annual Personnel Cost	Rs.199,000/unit	Rs.44,000/unit

Note: In the above Table the "Maintenance Cost" represents those for lubricants, tyres & tubes, stores & spare parts and retreading materials. But in the column "Truck", it includes the personnel cost of maintenance and repair arising in the companies to which the work is contracted out.

The "Personnel Cost" for buses is calculated from the average working expenditure of D.T.C. subtracting all taxes and related costs. The number of staffs for operation is nine per bus.

The "Personnel Cost" for trucks is calculated from the annual wages of two truck drivers and an assistant.

These data are obtained from the operational statistics and hearings from D.T.C. and private public carriers.

7 - 4 Benefits of Case "With the Project"

7 - 4 - 1 Passenger Time Saving Benefit

With the project, it is expected that a remarkable passengers traffic volume will be diverted from buses, because the railway mode would attract passengers, qualitatively through the improvements of station facilities and other passenger services, and quantitatively through the

improvement of line capacity by track doubling, electrification, signalling modernization, etc.

Without the project, on the other hand, the passengers who would have been diverted to the railway must be transported by buses.
The transport time of buses are longer than that of railway. Hence, the passenger's time-saving-benefit can be expected. This is estimated from the difference of transport time as below given:

Assumed transport time of each mode is shown in Table 7.4.1.

Table 7.4.1 Transport Time of Each Mode

Transport Mode	Section	Transport Time (Hour/km)
Railways	TKD-MTJ	0.015
	GZB-TDL	0.014
	GZB-MB	0.021
	GZB-MTC-SRE	0.040
	DSA-SMQL-SRE	0.031
	NDAZ-UMB	0.025
	SSB-JHL	0.017
	DEE-RE	0.027
Bus	Average of all routes	0.033

(1) Estimation of Passenger Time Value

The average annual wages of passengers using railways and buses are assumed as nearly equal to those of the workers employed in manufacturing industries. Several labour statistics support this assumption.

They were Rs. 9,594 in 1984 and are estimated to be Rs. 12,900 annually (Rs. 1,075/month) in 1988, adjustment being made by the growth rate of the consumer price indices. (Source: Pocket Book of Lobour Statistics, 1989)

The following formula is applied in estimating the time-value:

Passenger time value = Monthly wages per passenger
÷ Average working time per month
× Non-working time adjustment factor

Average monthly wages per passenger: Rs. 1,075/ month
Average monthly working hours: 182 Hours
Note: Normal working hours of industrial workers are assumed to be 2,184 hours per year.
Non-working hours adjustment factor: 0.75
Note: Non-working hours are assumed to be one fourth of the activity hours per day at 12 hours.

Based on the above assumptions, the passenger time value is estimated at Rs. 4.42/hour. The time value will increase with the growth of GDP per capita. Passenger time value per hour in each year is shown in Table 7.4.2.

Table 7.4.2 Passenger Time Value in Each Year

Year	Passenger Time Value (Rs./hour)	Growth Rate of GDP per capita(%)
1988	4.42	-
1990	4.63	2.39
1995	5.25	2.56
2000	6.03	2.81
2005	6.97	2.94
2010	8.15	3.18
2020	10.51	2.58

(2) Result

Passenger time saving benefit is calculated by the following formula:

Passenger time saving benefit
= Passenger time value × Saving in passenger-hours
(number of passengers × travel hours saved)

Saving in passenger-hours and passenger time saving benefit are shown in Table 7.4.3.

Table 7.4.3 Passenger Time Saving Benefit

Year	Saving in Passenger-hours (In 1,000 passenger-hours)	Passenger Time Saving Benefit (In 1,000 Rs.)
1995	36,000	189,000
2000	88,000	530,640
2005	107,000	745,790
2010	109,000	888,350

(See Appendix Table 2.12)

7 - 4 - 2 Other Benefits of Case "With the Project"

Besides the above mentioned passenger time saving benefit, some indirect benefits can be expected from this project. Their quantitative evaluation was not made in this analysis, but they will become important factors in decision making for the implementation of the project. They are:

(1) Improvement of Road Traffic Conditions

By implementing this project, it can be expected that a large traffic volume would be diverted from highways to railways. As a consequence, there will be a reduction in road congestion and accidents. The alleviation of air pollution caused by car exhaust gas in Delhi Area is also an important factor.

(2) Promotion of Related Industries

Local industries will be encouraged to expand their manufacturing and sales of the materials and equipments through the orders related to the railway construction/improvement for this project. Furthermore, in some cases, new local industries can be created with the new industrial demands (e.g. electronics products).

(3) Promotion of Employment Opportunity

Job opportunities will be increased by the promotion of the related industries above-mentioned.

(4) Promotion of Inland Trips

New inland trips will be induced by the attractive railway passenger service attributed to this Project. Increment of workers annual wages and reduction in working hours will also encourage these trips.

(5) Development of Local Areas

With the improved railway service, the economic development of local areas will be accelerated filling the existing gap between Delhi Area and related local areas in living standards.

(6) Technology Transfer

With the project, high technologies in the field of railways and architecture will be introduced. Applications of these technologies to other industries in India can be also expected.

7 - 5 Calculation of EIRR

Comparing the cases "With the Project" and "Without the Project", EIRR was computed according to the formula in 7-1-2(1) applying the investment/operating costs and the benefits described in 7-3 and 7-4. The EIRR is calculated as 19.5% by computer model.

7 - 6 Sensitivity Analysis

The above-mentioned EIRR was verified of its sensitivity to the factors: reduction in diverted traffic volume, in time value and cost overrun. The result is shown in Table 7.6.1 and in Fig. 7.6.1.

Table 7.6.1 Economic Sensitivity Analysis

	Case	EIRR(%)
a	Base Case	19.5
b	10% reduction in diverted traffic	17.4
c	20% reduction in diverted traffic	15.1
d	10% cost overrun	17.6
e	20% cost overrun	15.9
f	50% cost overrun	11.7
g	b + d	15.5
h	50% reduction in passenger time value	18.0
i	b + d + h	14.1

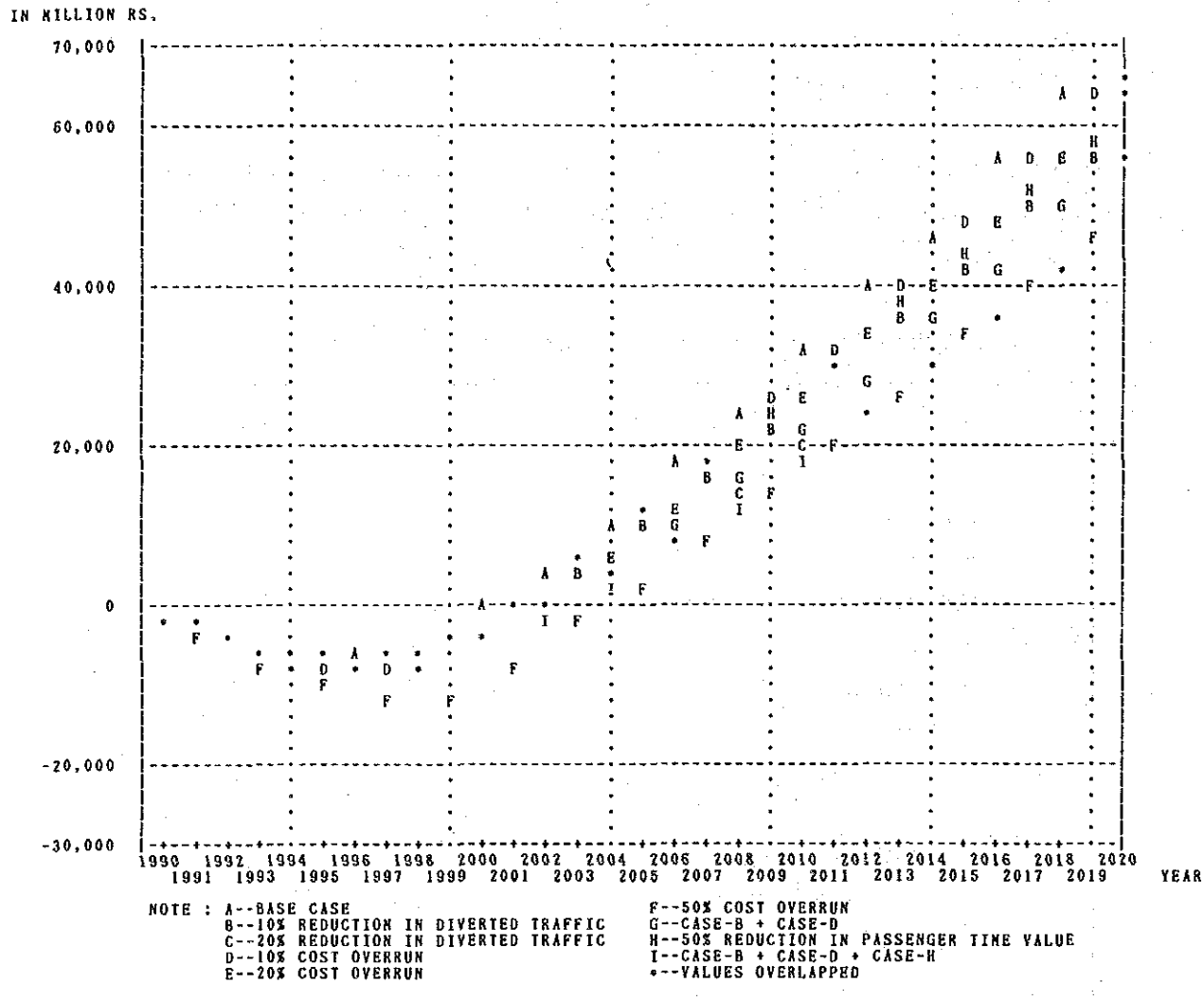


Fig. 7.6.1 Results of Sensitivity Analysis (Cash Flow)

7 – 7 Evaluation

The EIRR for the base case is 19.5%. The worst EIRR in case of 50% cost overrun is 11.7%. The EIRRs in all other cases are more than 12%. Furthermore, the costs of constructing new national highways in the case "Without the Project" were excluded. Consequently, the effects this project will give to the national economy are considered highly favourable.

CHAPTER 8 FINANCIAL ANALYSIS

CHAPTER 8 FINANCIAL ANALYSIS

8 - 1 Objective and Method of Financial Analysis

8 - 1 - 1 Objective:

The objective of the financial analysis is to analyze and evaluate the profitability of the project and the cash flow as the result of the implementation of the project.

8 - 1 - 2 Method of Financial Analysis

The Financial Internal Rate of Return (FIRR) is calculated as an index for evaluating the profitability of the project. The FIRR is the discount rate which would make aggregate total of the net present value of cash flow for each year of the project life become zero.* It is expressed by the following equation:

* See the explanation given in Appendix 9-2-2 (Reference 2)

$$0 = \sum_{i=1}^{n} A_i/(1+FIRR)^{i-1}$$

where: n: Project life (31 years, 1990-2020)

A_i: Cash flow (see 8-3)

Two fund raising plans are assumed and net cash flow for each year of the project life is calculated. Net cash flow is analyzed and evaluate the debt repayment ability and the soundness of the fund raising plan. Sensitivity analysis are conducted in the case of revenue reduction and cost overrun.

8 - 1 - 3 Premises for Calculation

(1) Market price

The prices of the materials, equipment, commodities, and man-power to be used in this project are as of July 1989 and determined as follows:

— When locally procured

Market price is adopted.

— When imported

CIF price plus customs duty, auxiliary duty, and excise duty. Imported items in this project are considered as limited to the equipments related to the passenger information system and the car washing complex. The total duties imposed on them as follows:

Table 8.1.1 Imported Items and Tax

Item	Total duty
Passenger information equipment	165%
Car washing machine	135%

Each duty is based on Customs Tariff of India published by Centax Publication PVT. Ltd.

(2) Foreign exchange rate, inflation

As to these, the same premises as in the economic analysis are assumed.

(3) Project life, etc.

As for the project life, reinvestment, useful life, maintenance rate and residual value, the premises are the same as in the economic analysis.

8 - 2 Project for Analysis

Financial Analysis of Modernization of New Delhi Station, Improvement of Terminal Function and Facility in the Delhi Area and Improvement of Related Sections within a 200 km Radius of the Delhi Area. *

* Data for analysis of another project are attached in Appendix 9-2-2

8 - 3 Cost Elements in Cash Flow Calculation

This paragraph deals with cost elements in the calculation of cash flow.

The financial analysis of a project primarily aims to clarify its cash flow.

Note 1) Cash flow is the amount which remains disposable in the hand of the entrepreneur after he has made investment without relying on borrowing.

Cash flow = Operating profit + Depreciation - Investment

where Operating profit = Operating revenue - Operating cost

where Operating cost = Working expense + Maintenance cost + Depreciation

2) Net cash flow is the cash amount which remains in the hand of the entrepreneur after he has made investment relying on borrowing.

Net cash flow = Cash flow + Borrowing - Repayment - Interest

8 - 3 - 1 Investment Cost

(1) Investment cost of the project

The estimated investment cost of the project consists of (1) the investment made under the Action Plan and (2) the investment corresponding with the investment amount given in the Column " Total" of Table 5.5.1(5). It includes the investments for the related sections, but excludes the investments for the Later Period which are given in the Tables 5.5.1(6)and(7). It includes.

however, the investment for the rolling stock. It can be classified according to the work categories as shown in Table 8.3.1

Table 8.3.1 The Estimated Investment Cost of the Project

(Unit: Rs in thousand)

Department	New Delhi Station	Delhi Area	Relevant Sections		Total
Civil Work	1,170,507 (197,400)	997,600 (155,300)	435,100 (434,200)		2,603,207 (786,900)
Signalling & Telecommunication	193,409 (35,000)	135,000 (28,500)	1,080,300 (129,700)		1,408,709 (193,200)
Electrification & Power Supply	67,492 (34,000)	143,320 (29,500)	125,002		335,814 (63,500)
Sub Total	1,431,408 (266,400)	1,275,920 (213,300)	1,640,402 (563,900)		4,347,730 (1,043,600)
Rolling Stock				12,255,980	12,255,980
Total	1,431,408 (266,400)	1,275,920 (213,300)	1,640,402 (563,900)	12,255,980	16,603,710 (1,043,600)
Grand Total	1,697,808	1,489,220	2,204,302	12,255,980	17,647,310

(See Table 5.5.1 for details)

Note: The costs in brackets show the costs planned in the Action Plan (on-going) below.

(1) New Delhi Station (Phase I) : washing/stabling lines at Nizamuddin and 2 additional platforms.

(2) Sahibabad-Ghaziabad 4th line.

(3) Ghaziabad : Remodelling of yard.

(4) Doubling between Rohtak ~ Jakhal.

(5) Doubling between Garhi-Harsaru and Khalilpur.

(2) No new investments after 2000

It is assumed in this financial analysis that no investment will be made after 1999-2000 (Ref. 1-3(3),2)). Those works referred to in Table 5.5.1(6) are, therefore, not included in the investment cost in this analysis. There are two exceptions: the rolling stock which will be increased in even after 1999 - 2000, and the reinvestment which will be made even after 1999 - 2000 when the

useful life of the asset will have been expired.

(3) Interest and repayment

The amounts of interest payment and repayment are assumed to be subject to the following fund raising plans.

(4) Fund raising plan

Direct fund raising by IR itself is not required because investment by IR is covered by the financial resources of the Government.

In this analysis, however, it is assumed that the investment (exclucing reinvestment) is directly financed by the financial resources.

The financing plans and their conditions are shown in Table 8.3.2 and 8.3.3.

Table 8.3.2 Financing Plan

Currency / Plan	Foreign Currency Portion	Local Currency Portion
1 (Base Case)	Government to Government Boroowing	Government Budget
2	Borrowing from International Financial Institution	Government Budget

Table 8.3.3 Terms and Conditions of Each Financing Source

Item / Sources	Interest rate (%)	Term (Years)	Grace (Years)	Repayment
Government Budget	6.5 (rate of dividend)	—	—	—
Government to Government Borrowing	2.5	30	10	Semi-annual installment
Borrowing from International Financial Institution	7.74	20	5	Semi-annual installment

8 - 3 - 2 Operating Costs

The Operating costs are calculated based on "working expense", "maintenance cost" and "depreciation".

(1) Incremental working expense

Working expense is calculated by the following equation:

Working expense

= Working expense per train-km (Table 8.3.5)

× Incremental train-kms within 200km circle (Table 8-3-4)

Table 8.3.4 Incremental Train-Kms Within 200 km Circle

(Unit: 1000 train-km)

Item	1995	2000	2005	2010
Passenger				
Diesel	699	2,362	3,180	530
Electric	1,126	2,177	2,177	5,317
Total	1,825	4,539	5,357	5,847
Goods				
Diesel	1,217	3,079	4,580	1,895
Electric	2,155	5,900	5,941	9,543
Total	3,372	8,979	10,521	11,438

Table 8.3.5 Working Expense per Train-Km

Passenger train	Working expense per train-km
Diesel	Rs 65.58
Electric	Rs 67.43
Goods train	Working expense per train-km
Diesel	Rs 78.59
Electric	Rs 87.19

Note: Sources: Railway Board, Northern Ry.

The difference of the figures compared with those in Table 7-3-6 under the same title, is the difference between the economic price and the market price.

(2) Incremental maintenance cost

They are calculated applying the maintenance rate given in Table 8.3.6 to the incremental assets in the project.

Table 8.3.6 Maintenance Rate

Department	Maintenance rate
Civil Work	3 % p.a
Signalling & Telecommunication	3 % p.a
Electrification & Power Supply	5 % p.a
Machinery	5 % p.a

(3) Depreciation

As to the depreciation cost, the straight line depreciation method is applied, useful life being assumed as the same as in economic analysis (see Table 7.2.1).

(4) Result:

Table 8.3.7 Incremental Operating Cost

(Unit: Rs in thousand)

Item	1995	2000	2005	2010
Passenger working expense	121,742	301,704	355,298	393,302
Goods working expense	283,496	756,398	877,946	981,042
Sub total	405,238	1,058,102	1,233,244	1,374,344
Maintenance cost	76,525	109,876	109,271	107,781
Depreciation cost	168,366	367,271	403,206	440,206
Total	650,129	1,535,249	1,745,721	1,922,331

8 - 4 Revenue Elements in Cash Flow Calculation

This paragraph deals with the revenue elements in the cash flow calculation. The incremental operating revenue is estimated by applying unit fare/tariff (per passenger-km/tonne-km) to the incremental traffic (passenger kms/tonne-kms).

8 - 4 - 1 Passenger Fare and Goods Tariff

(1) Unit passenger revenue i.e. passenger fare per passenger-km is calculated with the weighted average based on the statistics given in IR Annual Report & Accounts 1987-88 and coaching tariff. They are shown in Table 8.4.1.

Table 8.4.1 Passenger Fare

(Unit: Rs/passenger-km)

Type of train	Fare
Long Express	0.34
Mail/Express	0.10
Local	0.05

(2) Goods tariff

Unit goods revenue i.e. commodity wise goods rate per tonne-km is estimated based on IR data. They are shown in Table 8.4.2.

Table 8.4.2 Good Tariff

(Unit: Rs/tonne-km)

Commodity	Rate of tonne-km
Coal	0.253
Cement	0.298
POL	0.522
Food Grains	0.166
Iron & Steel	0.439
Fertilizers	0.238
Iron Ore	0.230
Others	0.277

8 - 4 - 2 Diverted traffic

As a result of completion of the project, there will be traffic diverted from other modes. The traffic volume of these diverted passenger and

goods which leave/arrive and pass through the 200km circle are estimated by the demand forecast considering the transport capacity. They are as shown in the Tables below:

Table 8.4.3 Diverted Traffic Volume of Passengers

(Unit: 1000 passenger-km)

Year / Type of train	1995	2000	2005	2010
Long Express	24,131	61,287	61,306	61,306
Mail/Express	1,581,021	3,660,528	4,479,331	4,707,385
Local	1,142,848	2,540.185	3,354,363	3,497,309
Total	2,748,000	6,262,000	7,895,000	8,266,000

Table 8.4.4 Diverted Traffic Volume of Good

(Unit: 1000 tonne-km)

Year / Commodity	1995	2000	2005	2010
Coal	1,041,000	4,394,000	4,759,000	5,097,000
Cement	125,000	332,000	434,000	530,000
POL	370,000	939,000	1,235,000	1,514,000
Food Grains	282,000	1,328,000	1,716,000	2,085,000
Iron & Steel	175,000	653,000	723,000	787,000
Fertilizers	173,000	482,000	570,000	652,000
Others	200,000	996,000	1,232,000	1,456,000
Total	2,366,000	9,124,000	10,669,000	12,121,000

8 - 4 - 3 Result (Increase in operating revenue)

(1) Increase in operating revenue is estimated as shown below:

Table 8.4.5 Passenger Revenue Increase

(Unit: Rs in thousand)

Type of train \ Year	1995	2000	2005	2010
Long Express	8,205	20,838	20,844	20,844
Mail/Express	158,102	366,053	447,933	470,739
Local	57,142	127,009	167,718	174,865
Total	223,449	513,900	636,495	666,448

Table 8.4.6 Goods Revenue Increase

(Unit: Rs in thousand)

Commodity \ Year	1995	2000	2005	2010
Coal	263,373	1,111,682	1,204,027	1,289,541
Cement	37,250	98,936	129,332	157,940
POL	193,140	490,158	644,670	790,308
Food Grains	46,812	220,448	284,856	346,110
Iron & Steel	76,825	286,667	317,397	345,493
Fertilizers	41,174	114,716	135,660	155,176
Others	55,400	275,892	341,264	403,312
Total	713,974	2,598,499	3,057,206	3,487,880

8 - 4 - 4 Revenue Accrued by Conceptual Plans for Later Period

It is assumed in this financial analysis that no new investment (excepting rolling stock) will be made after 1999-2000. The works referred to in Table 5.5.1(6) are only conceptual. Consequently, the traffic, hence, the revenue thereby accrued as assumed to be abandoned.

8 – 5 Incremental Net Earnings

The incremental net earning (incremental operating revenue — incremental working expense) is as shown in the Tables below:

Table 8.5.1 Net Earnings from Passenger Traffic Increase

(Unit: Rs in thousand)

Item	1995	2000	2005	2010
Revenue	223,449	513,900	636,495	666,448
Working Expense	121,742	301,704	355,298	393,302
Net Earnings	101,707	212,196	281,197	273,146

Table 8.5.2 Net Earning from Goods Traffic Increase

(Unit: Rs in thousand)

Item	1995	2000	2005	2010
Revenue	713,974	2,598,499	3,057,206	3,487,880
Working Expense	283,496	756,398	877,946	981,042
Net Earnings	430,478	1,842,101	2,179,260	2,506,838

8 - 6 Cash Flow Analysis

8 - 6 - 1 Cash Flow and FIRR

Based on the Method (8-1-2), premises (8-1-3) and cost/revenues obtained in the preceding paragraphs, the cash flow and FIRR of the Project is calculated.

(1) Summary of cash flow

The fund raising plan and terms and conditions are shown on the Table 8.3.2 and 8.3.3.

The cash flow and net cash flow for each financial plan is worked out as shown in the computer output.(See Appendix 9-2-1)

It can be summarized as in Table 8.6.1.

Table 8.6.1 Summary of Cash Flow

(Unit: Rs in thousand)

Plan	Item	1995	2000	2005	2010
	Operating revenue	937,423	3,112,399	3,693,701	4,154,328
	Passenger	223,449	513,900	636,495	666,448
	Goods	713,974	2,598,499	3,057,206	3,487,880
	Operating expenses	650,129	1,535,249	1,745,721	1,922,331
	Working expense	405,238	1,058,102	1,233,244	1,374,344
	Maintenance cost	76,525	109,876	109,271	107,781
	Depreciation	168,366	367,271	403,206	440,206
	Operating profit	287,294	1,577,150	1,947,980	2,231,997
	Investment	1,696,995	253,629	303,841	95,109
	Cash flow	Δ 1,241,335	1,690,792	2,047,345	2,577,094
1	Borrowing	1,696,995	248,630	279,680	0
	Loan repayment	0	0	3,751	3,751
	Interest payment	666,309	1,071,558	1,154,381	1,226,629
	Net cash flow	Δ 210,649	867,864	1,168,893	1,346,714
	(Cumulative NCF)	(Δ 210,649)	(1,757,521)	(7,067,730)	(13,637,081)
	Net profit	Δ 379,015	505,592	793,599	1,005,368
2	Borrowing	1,696,995	248,630	279,680	0
	Loan repayment	0	5,219	5,219	5,219
	Interest payment	670,493	1,075,742	1,156,545	1,227,242
	Net cash flow	Δ 214,833	858,461	1,165,261	1,344,633
	(Cumulative NCF)	(Δ 214,833)	(1,727,198)	(7,000,203)	(15,578,484)
	Net profit	Δ 383,199	501,408	791,435	1,004,755

Note: Figures with Δ mean deficit value.

NCF means net cash flow.

(2) Result of cash flow analysis

In both financial plan 1 and 2, the net cash flow becomes positive from 1997, and the cumulative deficit turns positive in 1998. The reason is attributed to the following.

1) Investment made in and after 1995 is financed by new borrowing
2) This project has high profitability.
3) Repayment of domestic borrowing is unnecessary
4) Borrowing from overseas is comparatively small in sum

In the base case, when it is assumed that the investment made in and after 1995 is not financed by new borrowing, the fiscal year in which the net cash flow turns into surplus would be 2000 and the cumulative deficit would be Rs. 5,228 millions in 1999. Total new investment cost accumulated from 1995 would be Rs 10,325 millions and the year when the cumulative deficit turns positive would be 2004. In the base case, maximum operating profit is Rs. 2,235 millions in 2015 and maximum loan balance is Rs. 18,906 millions in 2009.

(3) FIRR

In terms of discounted cash flow technique, FIRR works out to 12.13% by computer model.
(See Appendix 9-2-1 for details)

8 - 6 - 2 Sensitivity Analysis

Sensitivity analysis was conducted from pessimistic point of view i.e. 10% decreased in revenue and 50% increase in investment cost. The result is shown in Table 8.6.2.

Table 8.6.2 Result of Sensitivity Analysis

	Case	FIRR %
a	Base case	12.13
b	10% revenue reduction	10.24
c	20% revenue reduction	8.19
d	10% cost overrun	11.02
e	20% cost overrun	10.05
f	50% cost overrun	7.78
g	b + d	9.22

8 - 7 Evaluation

FIRR: 12.13% indicates a high potential of the project. As the rate of return is more than 10% (which is empirically considered as the border line), the project is considered as financially viable.

The sensitivity analysis shows that, even if the revenue reduction by 20% or, the cost overrun by 50%, each representing rather pessimistic case, FIRR would be 8.19% and 7.78% respectively. They are still higher than 6.50%, the rate of dividend for the Government funds in India.

In cash flow analysis, the net cash flow becomes positive from 1997 and remains positive up to the end of the project life.

When it is assumed that the new investment from 1995 is not financed by new borrowing, the net cash flow turns into surplus in 2000 and the cumulative deficit turns into black in 2004.

It can be concluded that, through overall results of the analysis, the project is feasible and financiably viable.

CHAPTER 9 EVALUATION OF THE PROJECT AND RECOMMENDATION

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9 - 1 Evaluation of Feasibility

(1) Technical feasibility

The Project consists of two plans.

The first plan (dealt with in Chapters 3 through 5, i.e., Master Plan) intends to make the routes clear to lead to New Delhi Station, by improving the line capacity of the sections involved. They are to comply with the estimated traffic demand.

The second plan (dealt with in Chapter 6, the Project of modernizing New Delhi Station itself) intends to make full use of the New Delhi Station by improving its train handling capacity to the utmost and by drastically modernizing its quality of passenger service. They are to comply with the travelling behavior of the Indian public dependent on railway mode.

As the result of the extensive study covering 200 km radius network around New Delhi, and as the result of the in-depth investigation into the actual train operation works, the both plans have been verified to be technically feasible. None of them will have particular technical difficulty in operation and execution.

(2) Economic/Financial Feasibility

The Financial Internal Rate of Return (FIRR) was calculated at 12.12% and the Economic Internal Rate of Return (EIRR) at 19.5%, over the period 1990-2020, in case when the investment is suspended and the traffic increase depending on this investment is ignored as abandoned in the latter half of the project.

Viewed from generally accepted values, these FIRR and EIRR are considered to be within a sound range. This Project is economically/financially feasible.

(3) Evaluation of Environmental Impacts

There is an opinion that the improvement of New Delhi would further increase the road congestion in the city centre. The opinion was taken into account in planning; The MG goods and passenger handling facilities at Delhi Main, Lahori Gate, Sarai Rohilla etc., are therefore planned to be shifted to Bijwasan and Patel Nagar. The New Delhi station front plaza is planned so as to alleviate the road congestion.

But the traffic volume will be twice in 2000, thrice in 2010 compared with the present. The ultimate solution of the road congestion can not be sought for in the dispersal of railway stations located in the city centre, nor in the construction of directional terminals in the periphery of the city. Because these measures would result only in giving rise to the equal or even additional road traffic from the periphery inward to the city centre, or vice versa.

Moreover, they could be enforced only at the cost of the great inconvenience of the public dependent on railway service, because they would have to change their travelling behaviors. The ultimate solution lies nowhere than in the provision of a guided urban mass transit system (LRT or underground) in such a large scale of a Metropolis as Delhi.

Meanwhile, this Project requires works no more than ordinary railway construction/reconstruction. They do not contain any work that would necessitate specific environmental assessment procedures.

9 – 2 Recommendation-1

It is recommended with a stress that the first plan is executed as an integral part of the second plan. The Project would become physically impossible without completing the part of the first plan mentioned in (1) below, and would become much ineffective without implementing the part of the first plan mentioned in (2) below.

(1) Part of the plan creating space at New Delhi

a. Shifting a part of car maintenance facilities at New Delhi to Nizamuddin to create the space in New Delhi for constructing two additional platforms.

b. Shifting the whole goods handling facilities at New Delhi to the terminal to be newly built at Holambi Kalan, to create the space in New Delhi for constructing the additional car maintenance facilities and Platforms.

(2) Part of the plan improving the train operability in the related sections and clearing the bottlenecks in Delhi area on the routes reaching New Delhi.

c. Track addition and automatization of signals in the related sections according to the Action Plan of Northern Railway and to the additional improvement plans as specified in Chapter 4.

d. Dispensing with MG trains passing the surface crossing at MG-BG west of Delhi Main by shifting MG goods and passenger handling at Delhi Main to Bijwasan and to Patel Nagar.

9 - 3 Recommendation-2

It is recommended that consultations at high levels be initiated as soon as possible between the Railway and the City authorities, to discuss the various issues which may arise when the New Delhi modernization work begins. The issues will include the problem of building/widening the roads improving access to major stations in Delhi area, problem of modifying water supply and sewage network in conjunction with the railway improvement works, etc. Even more important issue will be the possibility of Railway-City joint development of the urban mass transit system which should necessarily be connected with New Delhi Station.

9 - 4 Recommendation-3

The estimated traffic of the 200 km radius circle in the latter half of the project (2000-2010) requires improvement works of such a large scale of investment that the works can no longer stay being subprojects of the New Delhi modernization project. Their feasibilities should be verified separately. For example, the new "Delhi Avoiding Line" should be studied in the vista of a railway goods transport modernization project. The track quadrupling of Tundla and Mathura lines should also be studied in line with the New Corridor project.

It is recommended to conduct a feasibility study covering all these investments in a new wider vista, setting a geographical boundary larger. under a scope of work more extensive than this study.

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