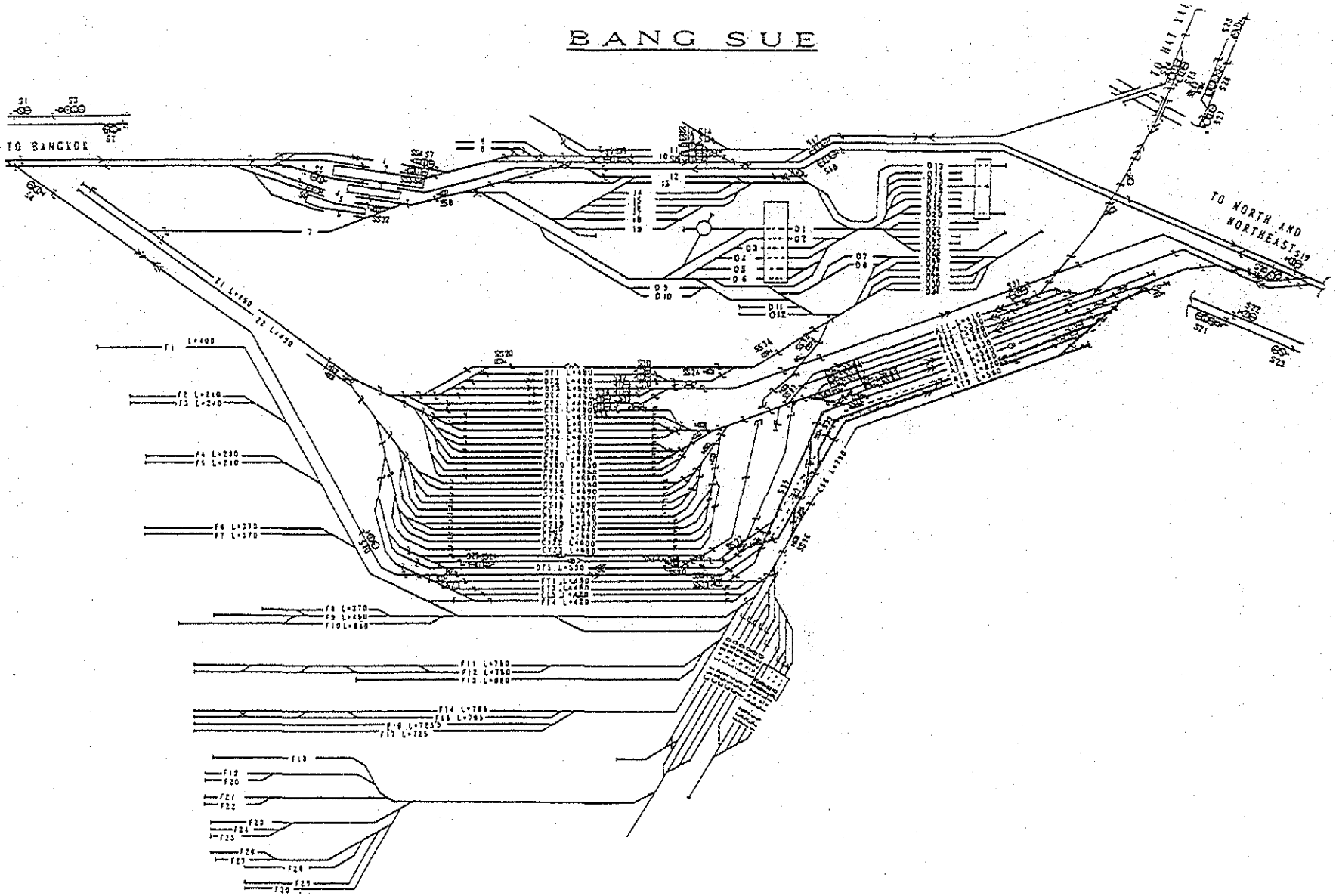


Fig. 7.4.8 Future Signalling Facilities at Bang Sue (F/S Plan)

3) Investment: 51.3 million bahts

7-5 Hat Yai (Starting and Terminating Station for Passenger and Freight Trains, Freight Train Control Yard, and Car Depot)

7-5-1 Present Condition of Yard Facilities

(1) General

This station is located in the largest city along the Southern Line, 45 km from the Malaysian border, and is a junction for Sungai Kolok and Padang Besar. Going towards these areas, tracks are connected to those of the Malaysian Railway, but in the direction of Padang Besar only international trains (passenger trains) are operated on specified weekdays. Freight trains going from Thailand to Malaysia have export cargo loaded and come back from Malaysia with empty cars.

Such international freight trains take a very long time, due to a difference in the coupling devices and shortage of locomotives on the Malaysian side. Thus, the station also serves as a control yard.

The track layout is as shown in Figure 7.5.1.

(2) Condition of the compound, land, and buildings

The compound has no vacant land and thus there is little space for installation of new or additional tracks.

The station building is three-storied and is in very fine condition. Around the station, an urban area extends from the station building on the left side of the tracks, and there are many houses on the right side of the tracks around the yard entrance and freight facilities.

(3) Yard facilities

As shown in Appendix 7.5.1.

(4) Signalling and telecommunication systems

1) Interlocking devices are of the electrical type (relay interlocking and route lever types).
2) Signals are of the electrical type, and there are approaching, starter and home signals.
3) Turnouts are of the electrical type.
4) Train detection is performed by track circuits.

5) Tokenless system is used when blocking with the adjacent station.

6) There are dispatching telephones, block telephones, exchangers, carrier terminal equipment, teleprinters, and radios. A talk-back is used for shunting work.

The signalling facilities are shown in Figure 7.5.2.

HAT YAI

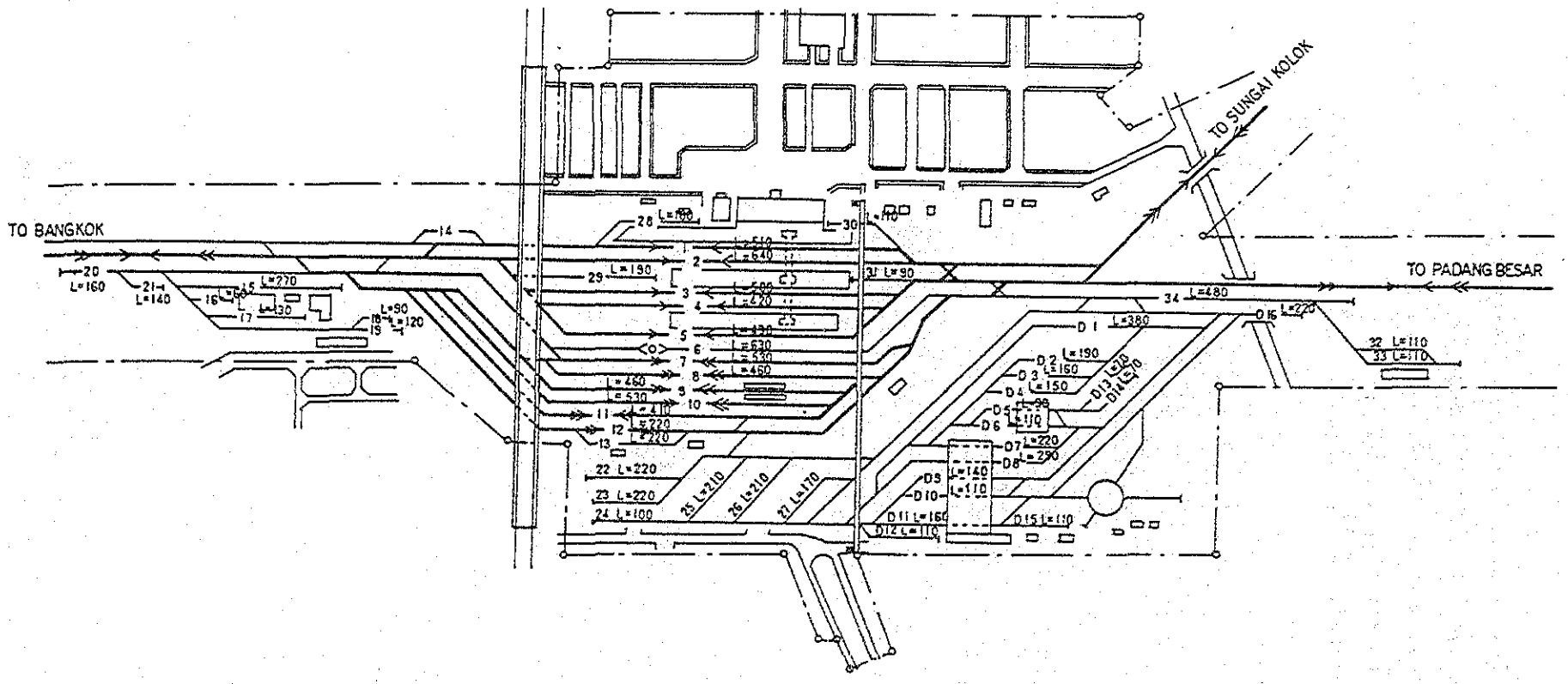


Fig. 7.5.1 Present Track Layout at Hat Yai Station

HAT YAI

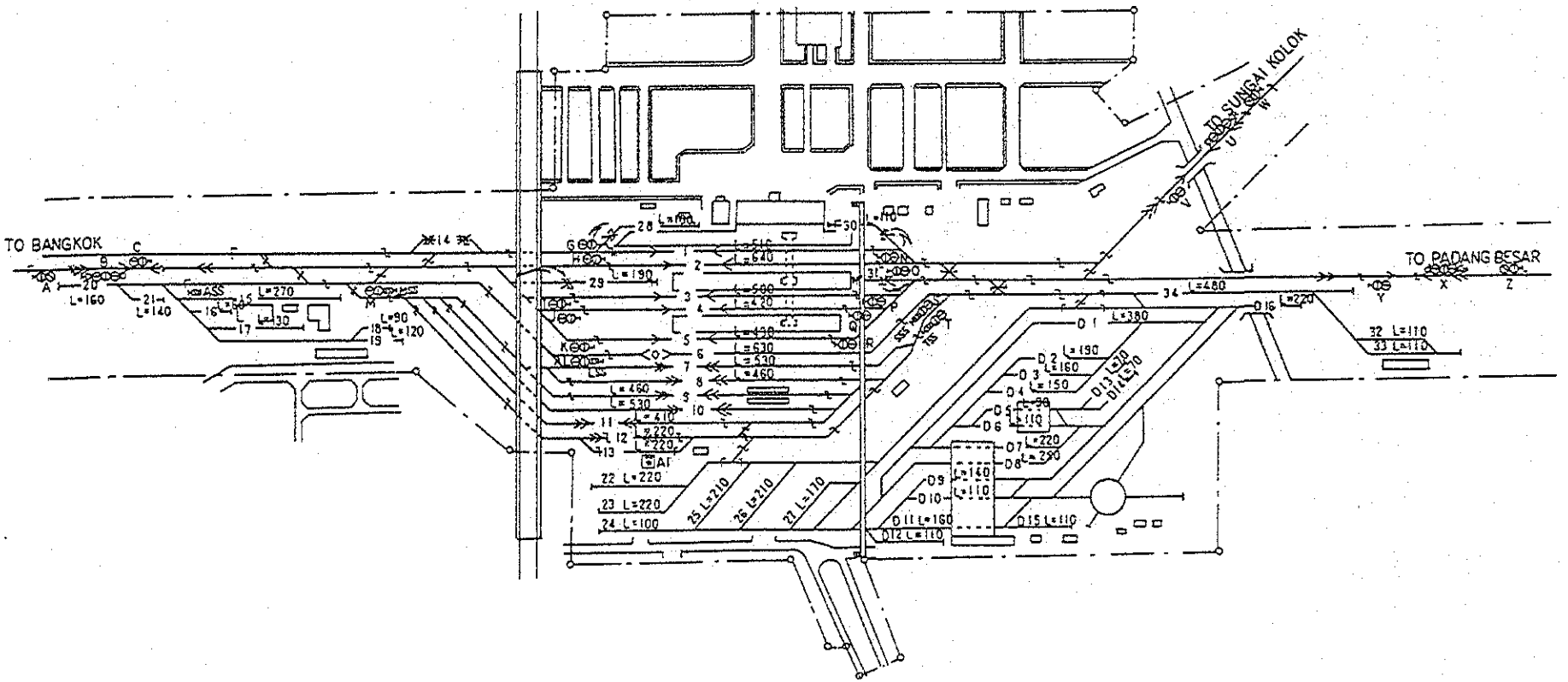


Fig. 7.5.2 Present Signalling Facilities at Hat Yai Station

(5) Summary of themes of improvement

1) Arrival and departure freight trains and freight shunting work concur on the Bangkok side.
2) Shunting work is done using the freight train arrival and departure tracks and is subject to the restriction of 1) above.
3) There is no freight car storage track to meet fluctuations.
4) The freight handling facilities are dispersed and are not efficient.

7-5-2 Master Plan

(1) Plan for improving existing facilities

1) Eliminating the concurrent operation of arriving and departing freight trains and shunting work

All of the freight train arrival land departure tracks, except for track 7, are connected via the drawing-out route, which is used to shunt freight cars to the main track. Thus, at the time of the arrival or departure of a freight train or changing of a locomotive, shunting work is suspended.

Tracks 7-9 will be directly connected to the main track to resolve concurrent operation.

2) Additional installation of freight car sorting and storage tracks

Freight car sorting work is done using the freight arrival and departure tracks. But, the effective lengths of these tracks are too short for sorting tracks (Appendix 7.5.2). Also, additional sorting and storage tracks are installed at the cargo loading and unloading yard in the back of the signal station, which is not used presently.

(2) Master plan

1) Ground plan

Under the Master Plan, measures for improvement pointed out in paragraph (1) are taken, while 2 tracks are added for the storage of passenger cars equivalent to 2 train units. The improvement plan is shown in Figures 7.5.3 and 7.5.4 in which the index numbers represent the following.

1) Changing of the track layout to eliminate the concurrence between arrival and departure of freight trains and shunting work.

2)-a Installation of additional freight car sorting tracks.

2)-b Removal of freight loading and unloading tracks.

2)-c Relocation of oil supply facilities.

3) Increase in passenger car storage tracks.

2) Outline of improvement of facilities

Facilities to be improved in accordance with the improvement plan are outlined below.

Table 7.5.1 Passenger and Freight Facilities

Tracks	Present facilities		Facilities to be improved		Increase/decrease
	Number of tracks	Effective length(m)	Number of tracks	Effective length(m)	
Freight handling (low floor)	10	90 - 220	5	90 - 140	5 Tracks Effective length decreased by 1,030 m
Formed passenger train storage track	0		2	400 and 420	2 Tracks Effective length increased by 820 m
Freight car sorting and storage track	0		3	340 - 360	3 Tracks Effective length increased by 1,060 m

3) Work execution plan and investment

a) Work period: 6 months (after acquisition of materials).

b) Track changeover is done during train intervals, and its work sequence is as shown in Appendix 7.5.3 (provided the track engineers are available at the site).

c) Improvement of the signalling and telecommunication systems is done as track changeover progresses.

d) Investment: 48.2 million bahts.

7-5-3 Items of Improvement in F/S Plan

The Master Plan is regarded as an improved F/S Plan.

HAT YAI

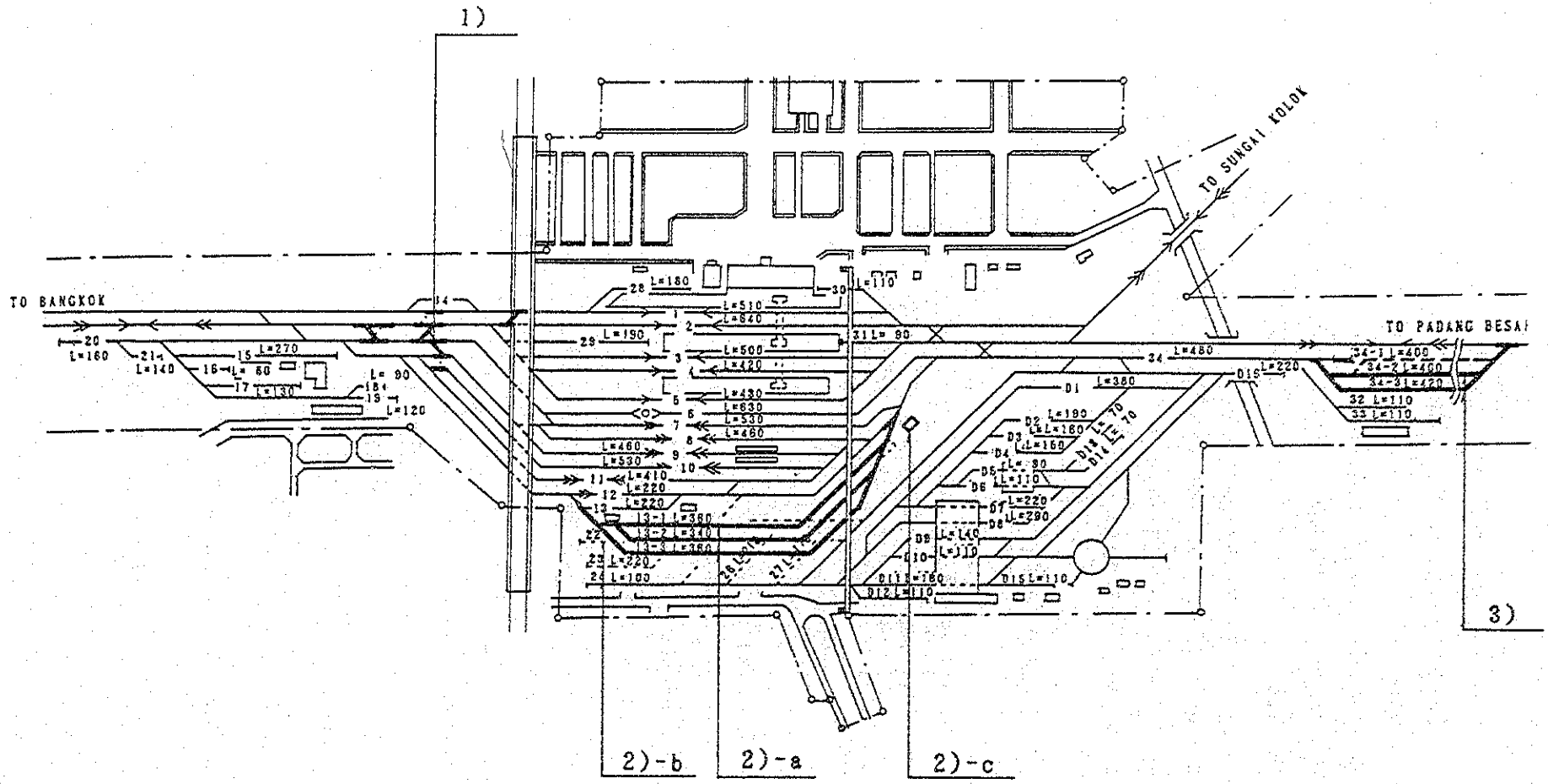


Fig. 7.5.3 Future Track Layout at Hat Yai Station

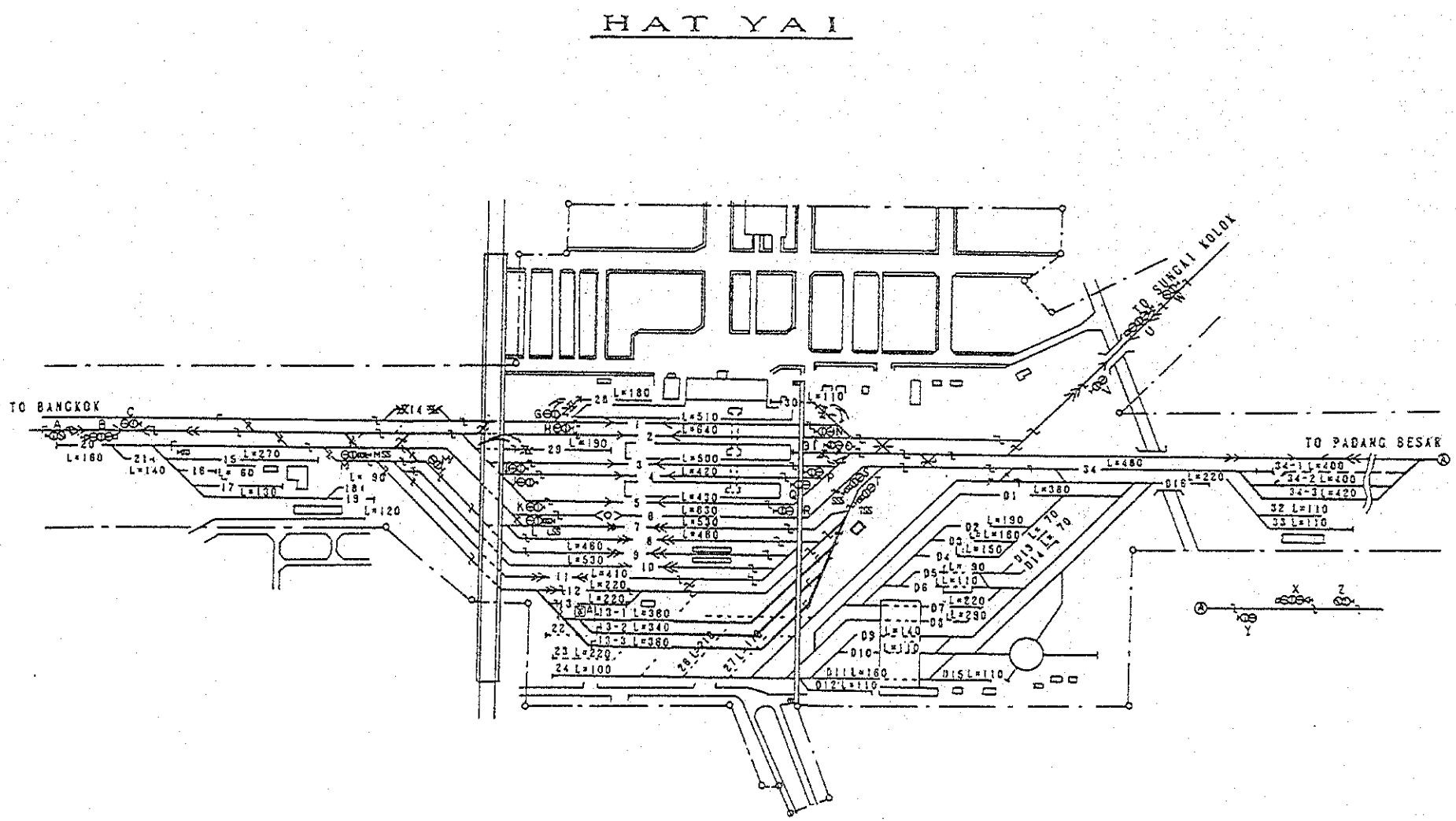


Fig. 7.5.4 Future Signalling Facilities at Hat Yai Station

7-6 Ban Phachi (Junction Station, Freight Uncoupling Part of the Yard)

7-6-1 Present Condition of Yard Facilities

(1) General

This station is located 89 km 950 m from Bangkok and is a junction of the Northern and Northeastern Lines.

Except for one shuttle, passenger trains start from or terminate at Bangkok, the so-called through trains, while express trains do not.

Freight trains are largely those starting from or terminating at Bang Sue Yard. But, here, freight car relay work is done between the Northern and Northeastern Lines.

The track layout is as shown in Figure 7.6.1.

(2) Condition of the compound, land, and buildings

The yard has a vast amount of land, as it was a coal and water supply base in the SL age.

The buildings or, specifically, the station building, and signal station are old.

In the vicinity of the station, there is a shopping quarter on the right side of the main track at the rear end of the station; an extension around such a location is considered to be difficult.

(3) Yard facilities

The yard facilities are as shown in Appendix 7.6.1.

(4) Signalling and telecommunication systems

1) There are two sets of mechanical interlocking devices.
2) Signals are of the mechanical type, and there are approaching, starter and home signals.
3) Turnouts are of the mechanical type.
4) Train detection is performed by track circuits and detector bars.
5) Tokenless system is used when blocking with the adjacent station.
6) There are dispatching telephones and teleprinters.

The signalling facilities are as shown in Figure 7.6.2.

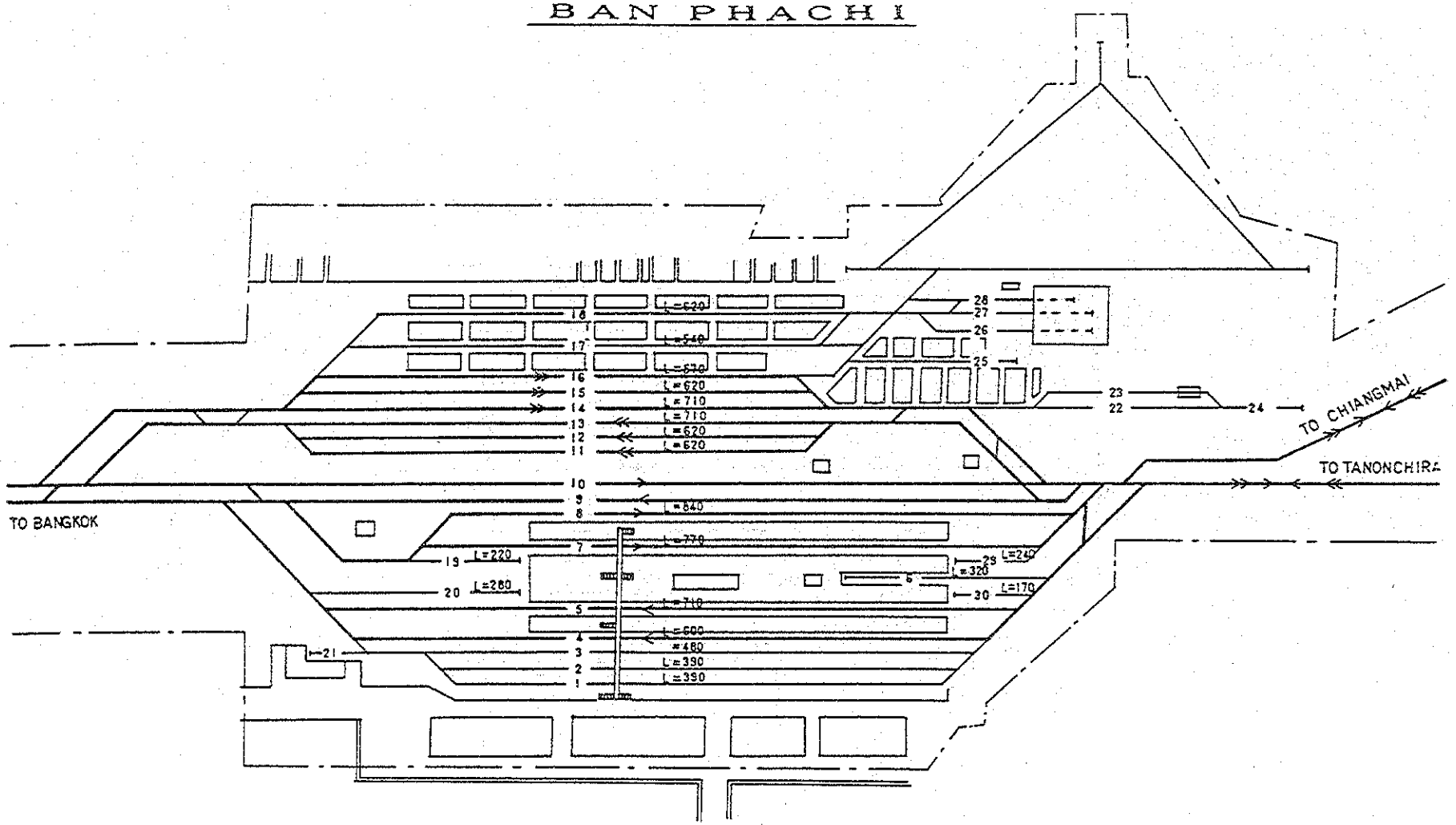


Fig. 7.6.1 Present Track Layout at Ban Phachi Station

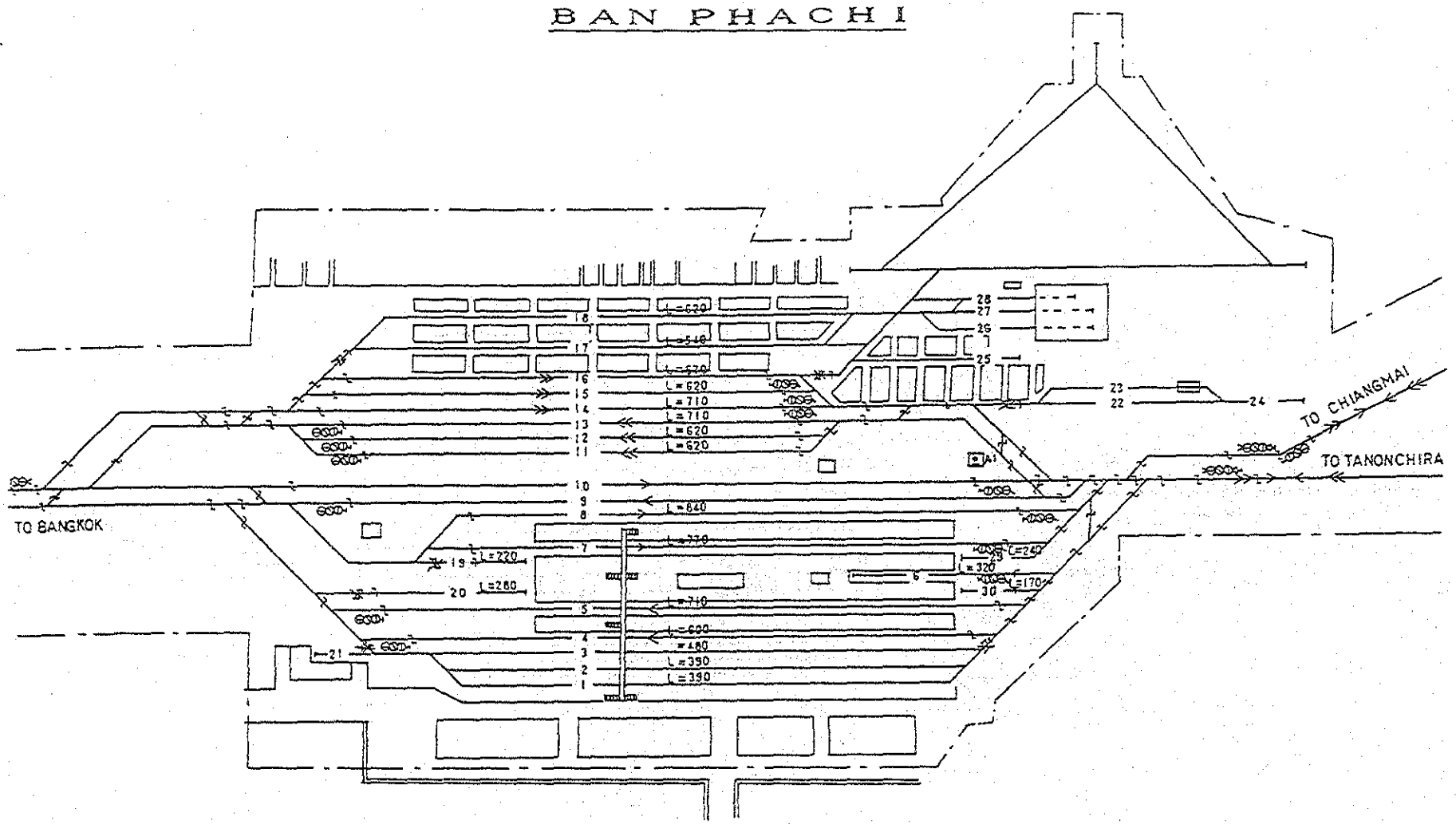


Fig. 7.6.2 Present Signalling Facilities at Ban Phachi Station

(5) Summary of themes of improvement

1) Freight car sorting tracks are located on the other side of the arrival and departure tracks across the main track, and thus work is restricted.

2) At about the junction point of the Northern and Northeastern Lines, tracks are arranged so as to cause concurrent operation of trains, causing disorder in the train diagram.

3) The passenger trains run on the turnout side of the turnout and are, therefore, subject to a speed limit (15 km/h).

4) The signalling system was installed in 1956 and has deteriorated greatly with the passing of time.

7-6-2 Master Plan

(1) Plan for improving existing facilities

1) Installation additional sorting tracks

The station is a junction of the Northern and Northeastern Lines. However, trains on the Northern and Northeastern Lines start from or terminate at Bangkok, as a rule, and thus the station is bypassed.

The work of the freight car yard includes only the relaying of the Northern Line versus the Northeastern Line, so it will not be necessary to improve the yard specifically. However, as there is no sorting track on the freight arrival and departure track side, shunting is done across the main track on tracks 1-3 on the passenger facility side.

To resolve the problem of crossing over the main track, sorting tracks are provided on the freight arrival and departure track side.

2) Elimination of train concurrence

The Northern and Northeastern Lines are signal tracks at this station and are, therefore, restricted in preparing the diagram respectively. Moreover, trains proceeding into and out of the Northern and Northeastern Lines concur, aggravating train delay further. Particularly, a percentage of freight train delay is said to be due to waiting at this station for the opening of the route.

To reduce concurrent operating, the track layout is changed. By this change, the problem of concurrent operation can be reduced by 1/2 (Appendix 7.6.2).

3) Abolition of train speed limit

Inbound trains on the Northern and Northeastern Lines pass by the side of the turnout points and are, therefore, subject to a speed limit of 15 km/h. When the station is improved, this speed limit should be abolished.

4) Modernization of signalling and telecommunication systems

With electric facilities planned for the CTC project, the signalling and telecommunication systems will be modernized.

(2) Master plan

1) Ground plan

The improvement plan pointed out in preceding paragraph (1) is made into a master plan.

The improvement plan is shown in Figures 7.6.3 and 7.6.4 in which the index numbers represent the following.

1)-a Installation of additional freight car sorting tracks.

1)-b Removal of unnecessary facilities arising out of the foregoing.

2)-a Changing of track layout to eliminate train concurrence.

2)-b Removal of unnecessary facilities arising out of the foregoing.

2) Outline of facilities to be improved

Facilities to be improved in accordance with the improvement plan are outlined below.

Table 7.6.1 Passenger and Freight Facilities

Tracks	Present facilities		Facilities to be improved		Increase/decrease
	Number of tracks	Effective length(m)	Number of tracks	Effective length(m)	
Passenger arrival and departure	4	600 - 840	4	610 - 700	Effective length decreased by 310 m
Freight arrival and departure	6	570 - 710	6	570 - 740	Effective length increased by 60 m
Passenger storage	8	170 - 480	3	390 - 480	5 Tracks Effective length decreased by 1,230 m
Freight storage	5	170 - 620	-	-	5 Tracks Effective length decreased by 1,690 m
Engine	3	40 - 90	-	-	3 Tracks Effective length decreased by 205 m
Draw-out	2	60 - 100	1	460	1 Track Effective length decreased by 100 m
Freight sorting			3	400-480	3 Tracks Effective length increased by 1,680 m

3) Work execution plan and investment

a) Work period: 9 months (after procurement of materials)

b) The changeover of tracks should be carried out during train intervals as decribed in Appendix 7.6.3.

c) Improvement of the signalling and telecommunication systems is done as track changeover progresses.

d) Investment: 54.5 million bahts

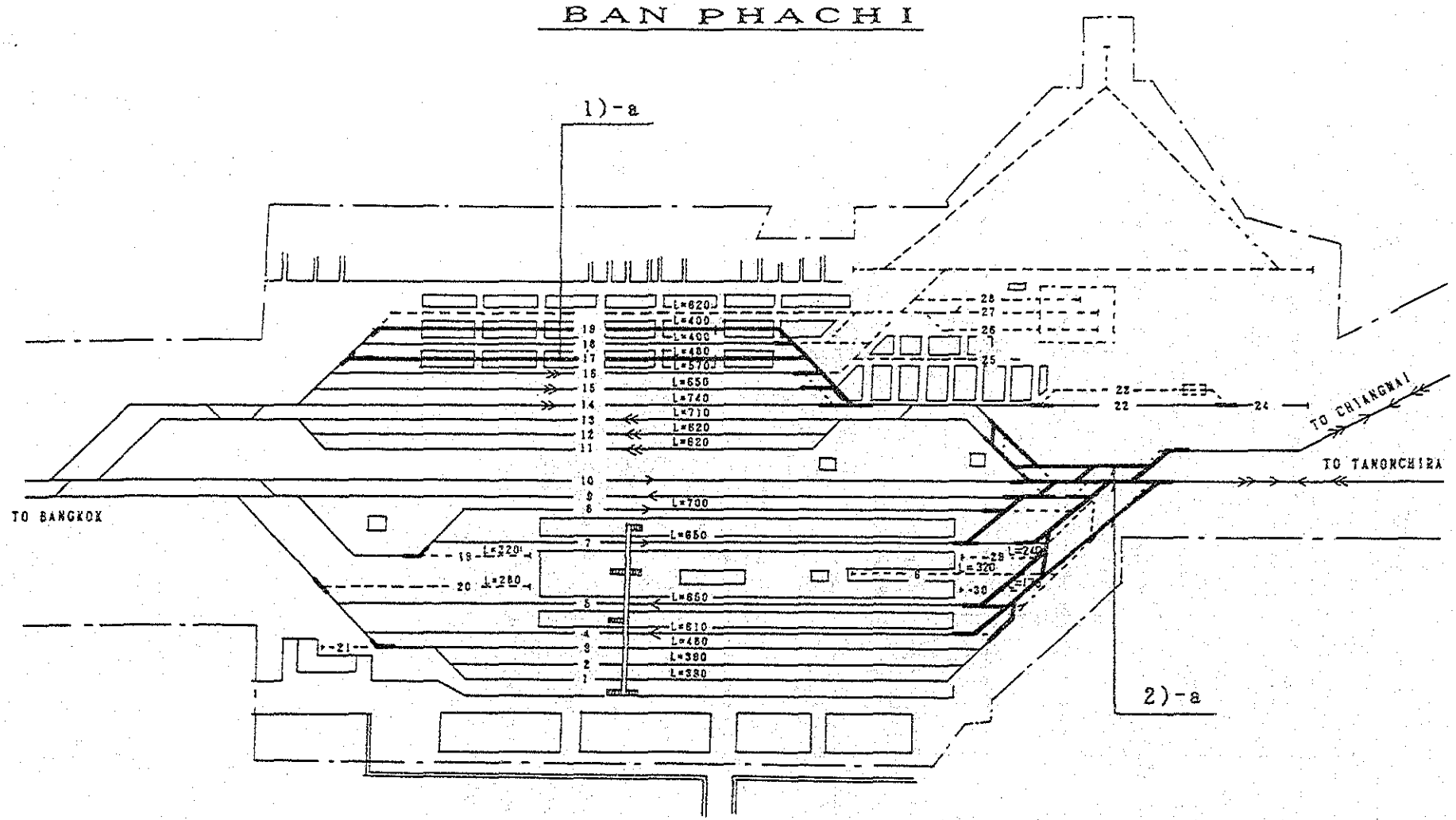


Fig. 7.6.3 Future Track Layout at Ban Phachi Station

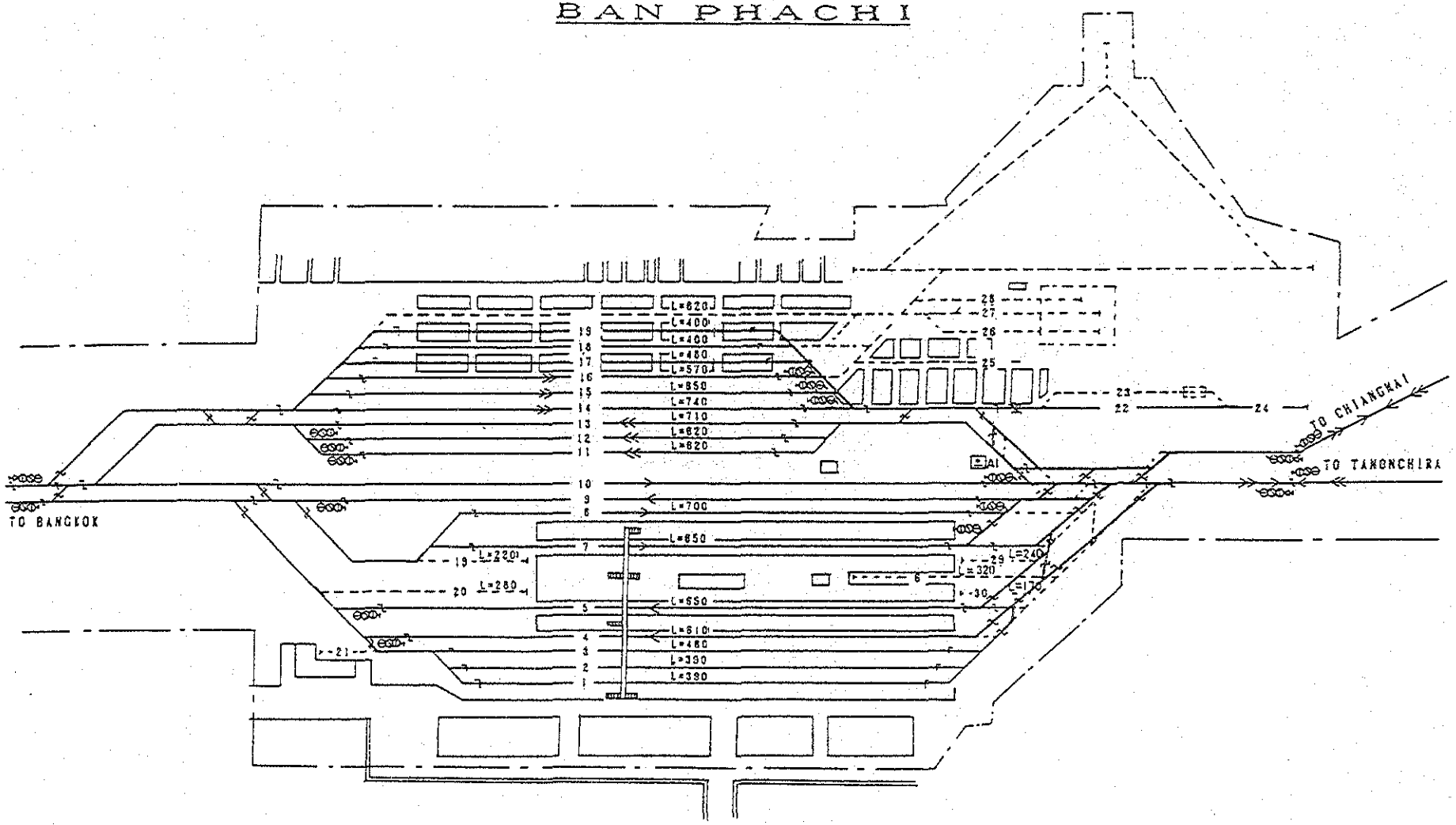


Fig. 7.6.4 Future Signalling Facilities at Ban Phachi Station

7-7 Phitsanulok (Starting and Terminating Station of the Passenger Train and Auxiliary Freight Train Yard)

7-7-1 Present Condition of Yard Facilities

(1) General

This is a major station along the Northern Line, and is responsible for the uncoupling and coupling of passenger cars and freight car control for the section up to the Ban Dara junction and its branch. The freight car shed has been integrated with another shed and is not operated presently, but locomotives come from Ban Phra for oil supplies.

The track layout is as shown in Figure 7.7.1.

(2) Condition of the compound, land, and buildings

The compound is limited in space and has no room for extension. In the vicinity of the station, there are a number of houses. Regarding the buildings, the station building is in very fine condition.

(3) Yard facilities

As shown in Appendix 7.7.1.

(4) Signalling and telecommunication systems

1) Interlocking devices are of the mechanical type.
2) Signals are of the mechanical type, and there are approaching, starter and home signals.
3) Turnouts are of the mechanical type.
4) Train detection is done with track circuits and detector bars.
5) Tokenless and tablet systems are used when blocking with the adjacent station.
6) There are dispatching telephones and block telephones. A talk-back is used for shunting work.

The signalling facilities are as shown in Figure 7.7.2.

PHITSANULOK

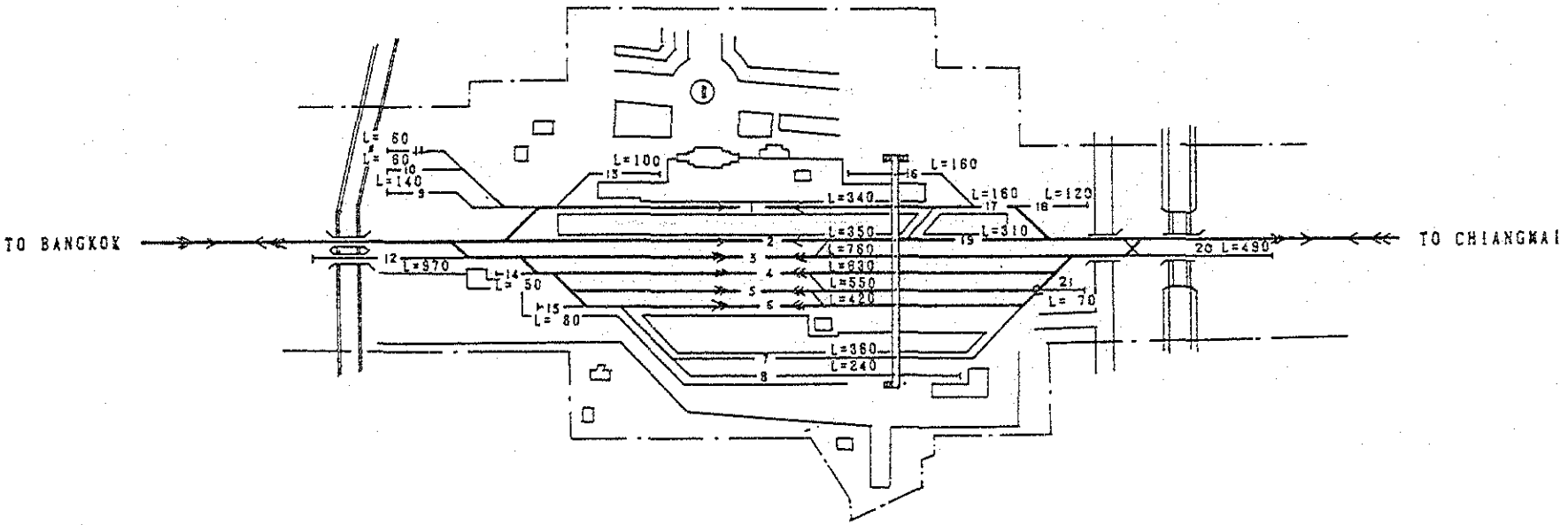


Fig. 7.7.1 Present Track Layout at Phitsanulok Station

PHITSANULOK

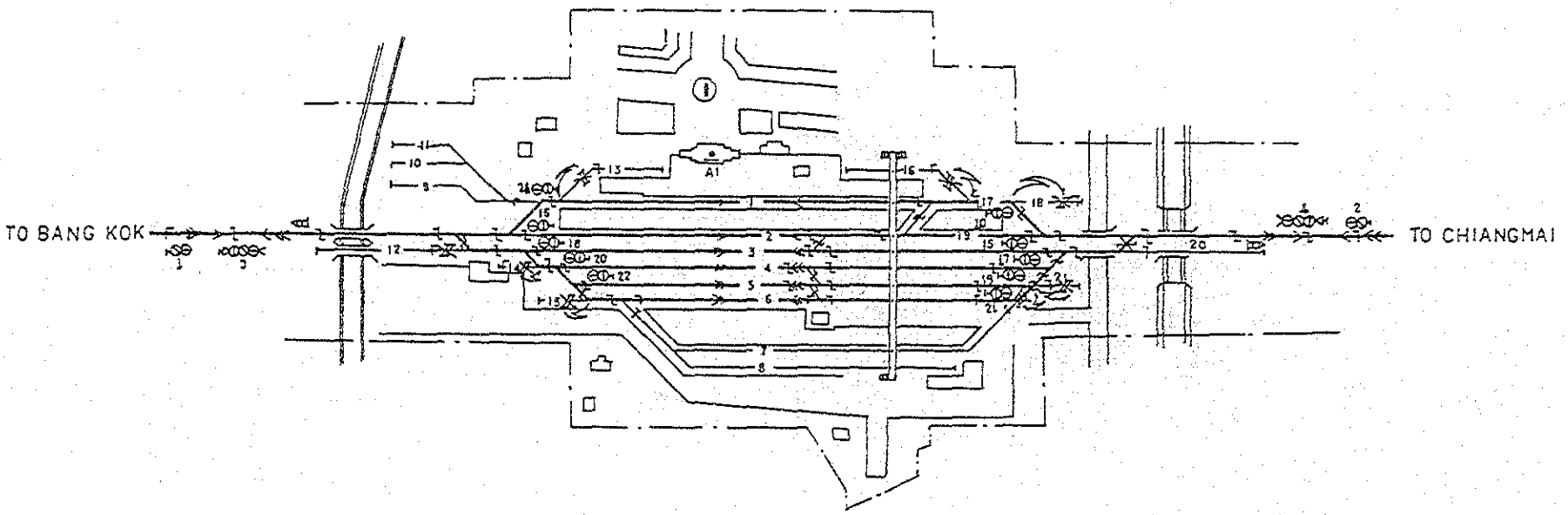


Fig. 7.7.2 Present Signalling Facilities at Phitsanulok Station

(5) Summary of themes of improvement

1) Freight facilities are dispersed and inefficient.

2) The signalling system was installed in 1971 and has deteriorated greatly.

7-7-2 Master Plan

(1) Plan for improving existing facilities

1) Freight facilities

Regarding freight facilities, no appreciable growth is expected in freight transportation, so no investment is made for integration.

2) The signalling system has electric type facilities planned for the color lights project and is thus modernized.

(2) Master Plan

1) Ground plan

a) Passenger car storage tracks are increased for 2 train compositions in order to cope with the increase in arrival and departure trains in the future.

The improvement plan is as shown in Figure 7.7.3.

2) Outline of facilities to be improved

Facilities to be improved in accordance with the improvement plan are outlined below.

Table 7.7.1 Passenger Facilities

Tracks	Present facilities		Facilities to be improved		Increase/decrease
	Number of tracks	Effective length(m)	Number of tracks	Effective length(m)	
Passenger storage	2	100 - 160	4	100 - 320	2 Tracks Effective length increased by 640 m

3) Work execution plan and investment

a) Work period: 4 months (after acquisition of materials)

b) Investment: 12.7 million bahts

PHITSANULOK

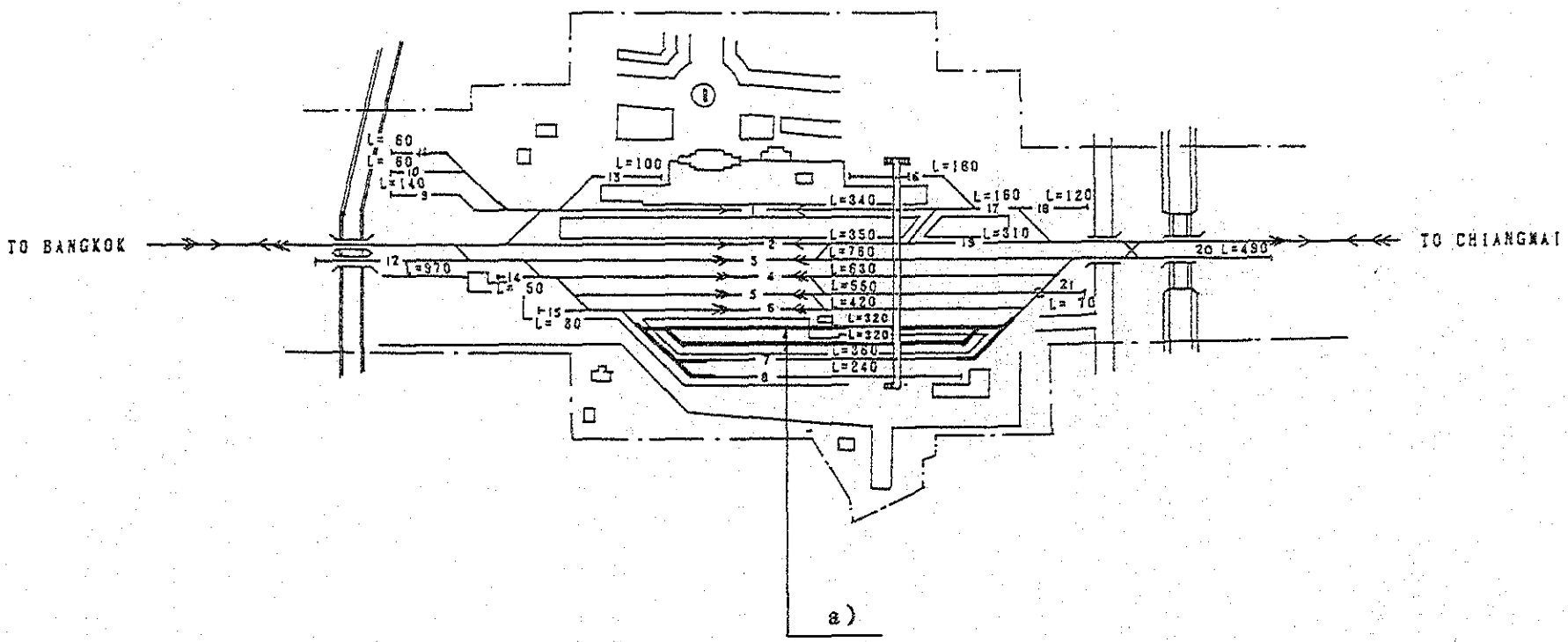


Fig. 7.7.3 Future Track Layout at Phitsanulok Station

7-8 Nakhon Ratchasima (Passenger Terminal, Freight Yard and Car Depot)

7-8-1 Present Condition of Yard Facilities

(1) General

The station is located along the Northeastern Line and is responsible for the uncoupling and coupling of some starting and terminating trains, and for trains along the Northeastern Line turning out at the next station, Thanon Chira (in the two directions of Aranyaprathet and Ubon Ratchathani).

The engine depot has 14 DLs and 48 DRCs assigned and inspects them every 1, 3, and 6 months.

The plant also handles the overhauling of passenger and freight cars.

The track layout is as shown in Figure 7.8.1.

(2) Conditions of the compound, land, and buildings

The compound is congested, and due to houses and factories around the station, extension is difficult.

The buildings are not new but are usable.

(3) Yard facilities

As shown in Appendix 7.8.1.

(4) Signalling and telecommunication systems

1) Interlocking devices are of the mechanical type.
2) Signals are of the mechanical type, and there are approaching, starter and home signals.
3) Turnouts are of the mechanical type.
4) Train detection is done with track circuits and detector bars.
5) Tokenless and tablet systems are used when blocking with the adjacent station.
6) There are dispatching systems, radios, exchangers, carrier terminal equipment, and block telephones. A talk-back is used for shunting work.

The signalling facilities are as shown in Figure 7.8.2.

(5) Summary of themes of improvement

1) The signalling system, installed in 1956, has greatly deteriorated with the passing of time.

NAKHON RATCHASIMA

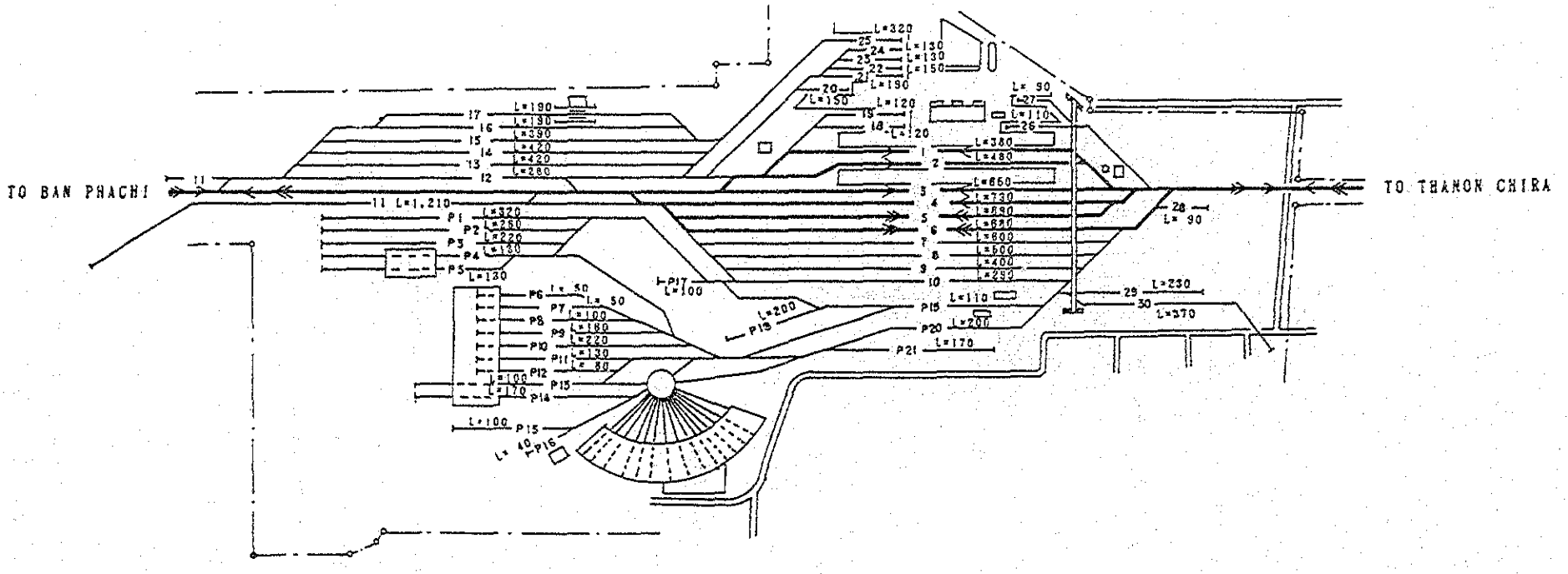


Fig. 7.8.1 Present Track Layout at Nakhon Ratchasima Station

NAKHON RATCHASIMA

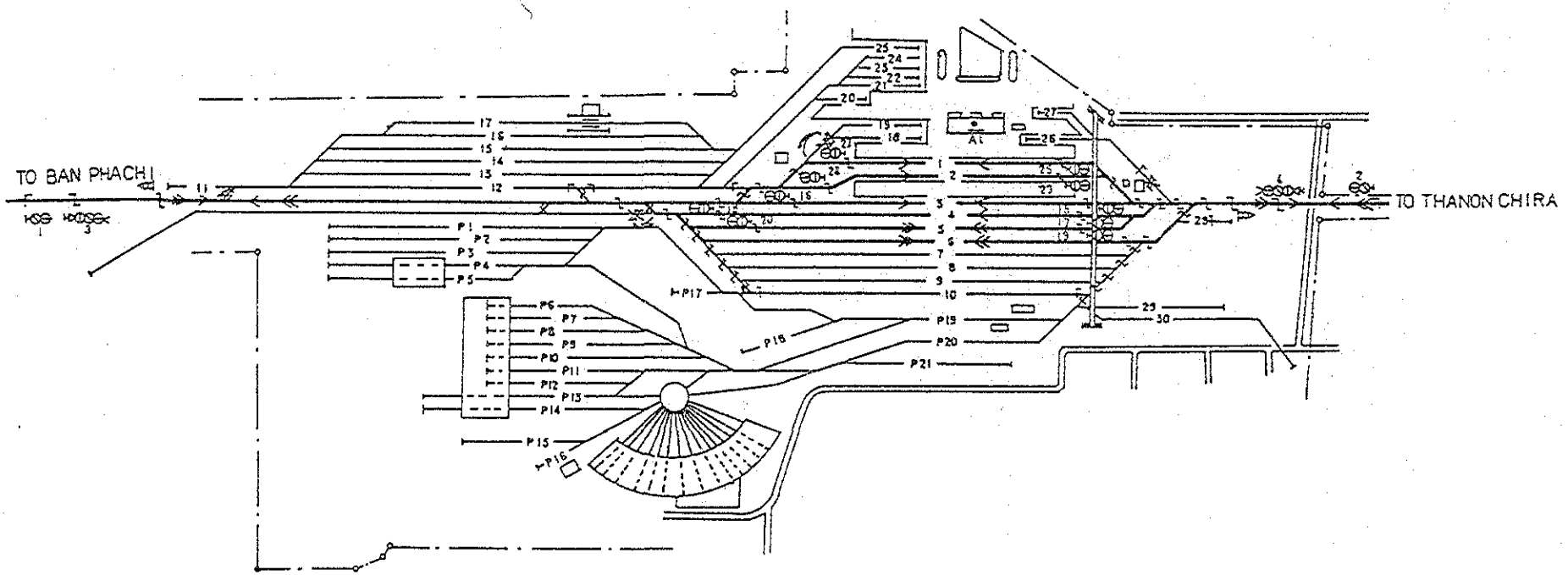


Fig. 7.8.2 Present Signalling Facilities at Nakhon Ratchasima Station

7-8-2 Master Plan

(1) Plan for improving existing facilities

1) The signalling system has electric type planned for the color lights project and is thus modernized.

(2) Master plan

1) Ground plan

a) Passenger car storage tracks are increased for 2 train compositions in order to cope with the increase in arrival and departure trains in the future.

The improvement plan is as shown in Figure 7.8.3.

2) Outline of facilities to be improved

Facilities to be improved in accordance with the improvement plan are outlined below.

Table 7.8.1 Passenger and Freight Facilities

Tracks	Present facilities		Facilities to be improved		Increase/decrease
	Number of tracks	Effective length(m)	Number of tracks	Effective length(m)	
Passenger storage	0		2	230	2 Tracks Effective length increased by 460 m
Freight storage	7	90 - 320	5	90 - 320	2 Tracks Effective length decreased by 240 m

3) Work execution plan and investment

a) Work period: 4 months (after acquisition of materials)

b) Investment: 4.8 million bahts

NAKHON RATCHASIMA

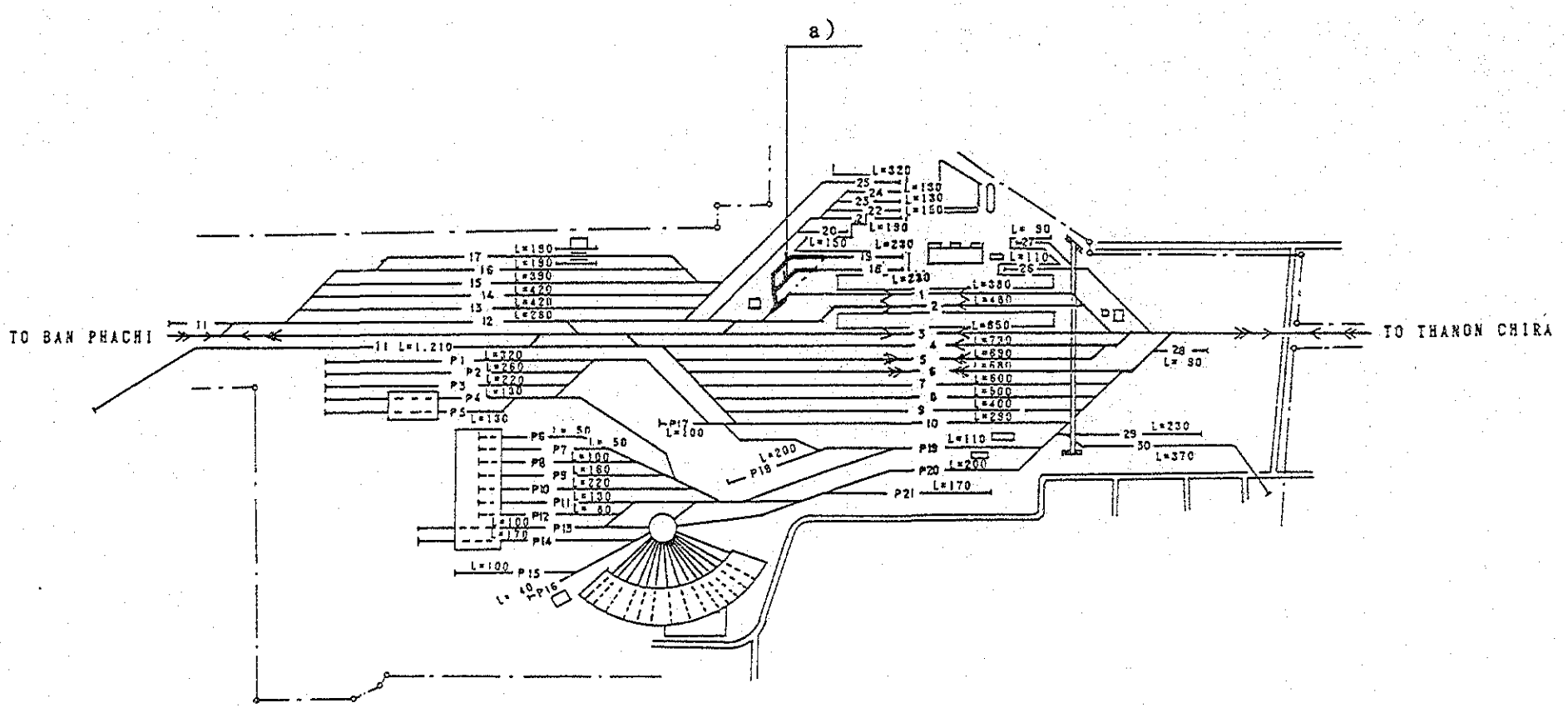


Fig. 7.8.3 Future Track Layout at Nakhon Ratchasima Station

7-9 Chumphon (Starting and Terminating Station for Some Passenger Trains and Auxiliary Freight Train Yard)

7-9-1 Present Condition of Yard Facilities

(1) General

This station is the most important in the Chumphon Province. It handles the uncoupling and coupling of some passenger cars, and controls and adjusts the hauling capacity of local freight trains. The engine depot is responsible for only minor repairs.

The track layout is as shown in Figure 7.9.1.

(2) Condition of the compound, land, and buildings

The compound is vast with a vacant area of land from the old SL age. The buildings are not worth mentioning, except for the station building.

The surroundings of the station include, the lodging quarters of SRT on the left side of the track and an area akin to a market on the right side toward the starting point; however, these areas are not built-up.

(3) Yard facilities

As shown in Appendix 7.9.1.

(4) Signalling and telecommunication systems

1) Interlocking devices are of the mechanical type.
2) Signals are of the mechanical type, and there are approaching, starter and home signals.
3) Turnouts are of the mechanical type.
4) Train detection is done with track circuits and detector bars.
5) Tokenless and tablet systems are used when blocking with the adjacent station.
6) There are dispatching telephones and block telephones. A talk-back is used for shunting work.

The signalling facilities are as shown in Figure 7.9.2.

(5) Summary of themes of improvement

There are no particular themes of improvement to be cited.

7-9-2 Master Plan

As for future facilities, the existing passenger and freight facilities and car depot will be utilized.

Regarding the signalling system, that part which is mechanical will become electric in accordance with the color lights project.

CHUMPHON

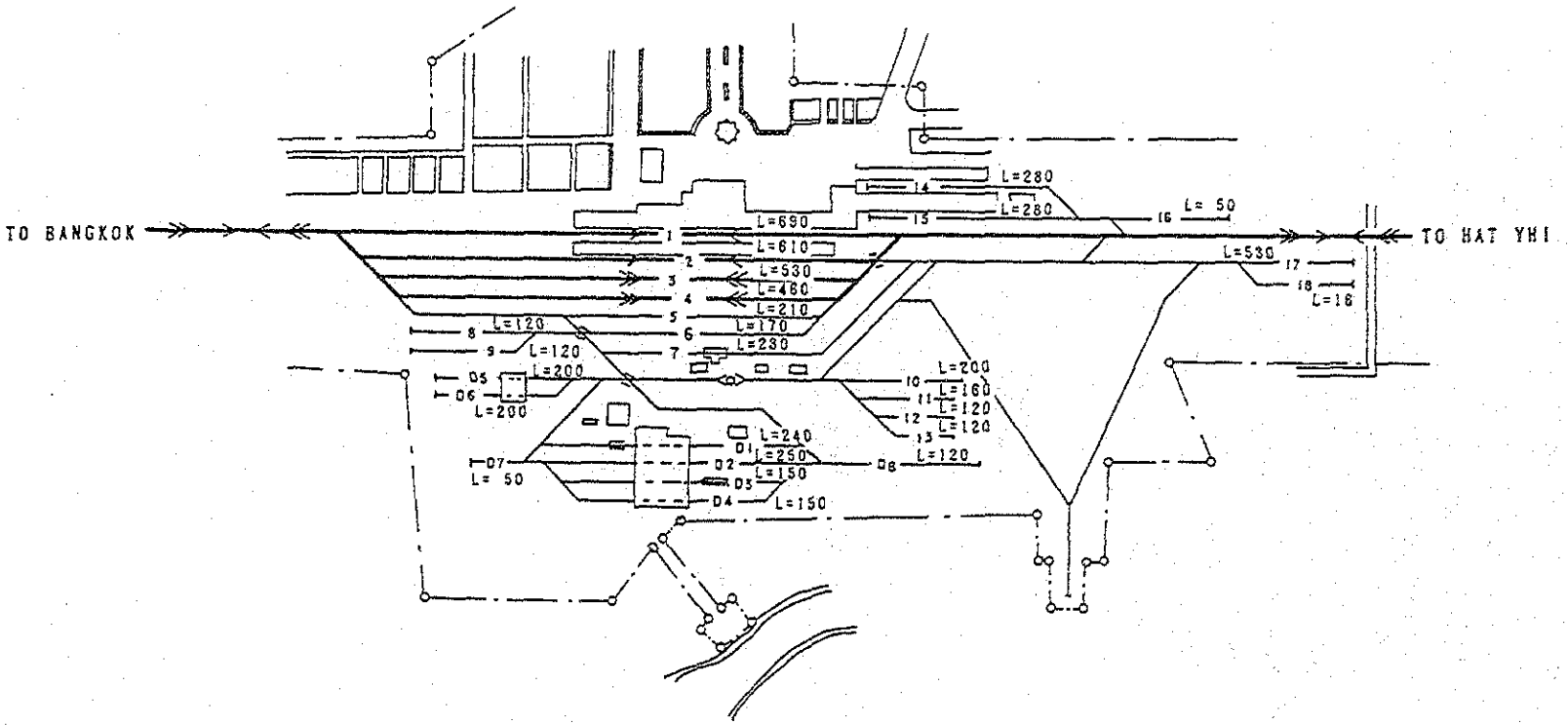


Fig. 7.9.1 Present Track Layout at Chumphon Station

CHUMPHON

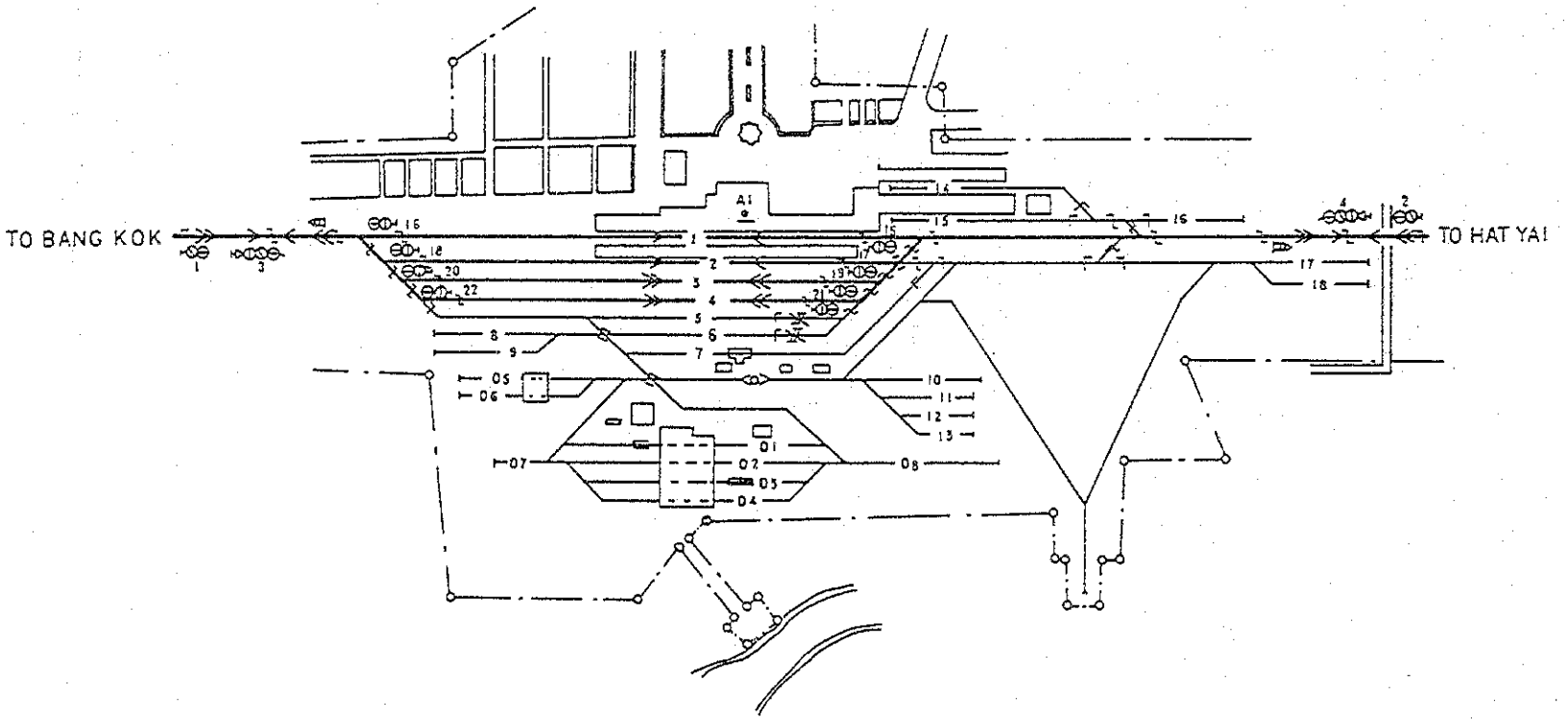


Fig. 7.9.2 Present Signalling Facilities at Chumphon Station

/-10 Surat Thani (Starting and Terminating Station for Some Passenger Trains and Auxiliary Freight Yard)

7-10-1 Present Condition of Yard Facilities

(1) General

The station is located along the Southern Line and is the starting and terminating station for Bangkok-Hat Yai trains and local passenger trains to Hat Yai.

It also handles the uncoupling and coupling of mixed trains entering the line to Khiri Ratthanikhom, separating at the next Ban Thung Pho junction toward Bangkok.

The track layout is as shown in Figure 7.10.1.

(2) Condition of the compound, land, and buildings

Including tracks from the SL age, this yard has some leeway.

The station building is also in fine condition, but the others are not worth mentioning. In the vicinity of the station, houses are located in front of the station building. The back of the station is contiguous to a river, and water-land transfer facilities are provided, but are not used presently.

(3) Yard facilities

As shown in Appendix 7.10.1.

(4) Signalling and telecommunication systems

1) Interlocking devices are of the mechanical type.
2) Signals are of the mechanical type, and there are approaching, starter and home signals.
3) Turnouts are of the mechanical type.
4) Train detection is done with track circuits and detector bars.
5) Tokenless system is used when blocking with the adjacent station.
6) There are dispatching telephones, block telephones and teleprinters. A talk-back is used for shunting work.
7) The signalling system, installed in 1970, has greatly deteriorated.

The signalling facilities are as shown in Figure 7.10.2.

7-10-2 Master Plan

As for future facilities,the existing facilities are utilized for both passengers and freight. The signalling system is planned to be modernized by changing it into a color and electric signal system.

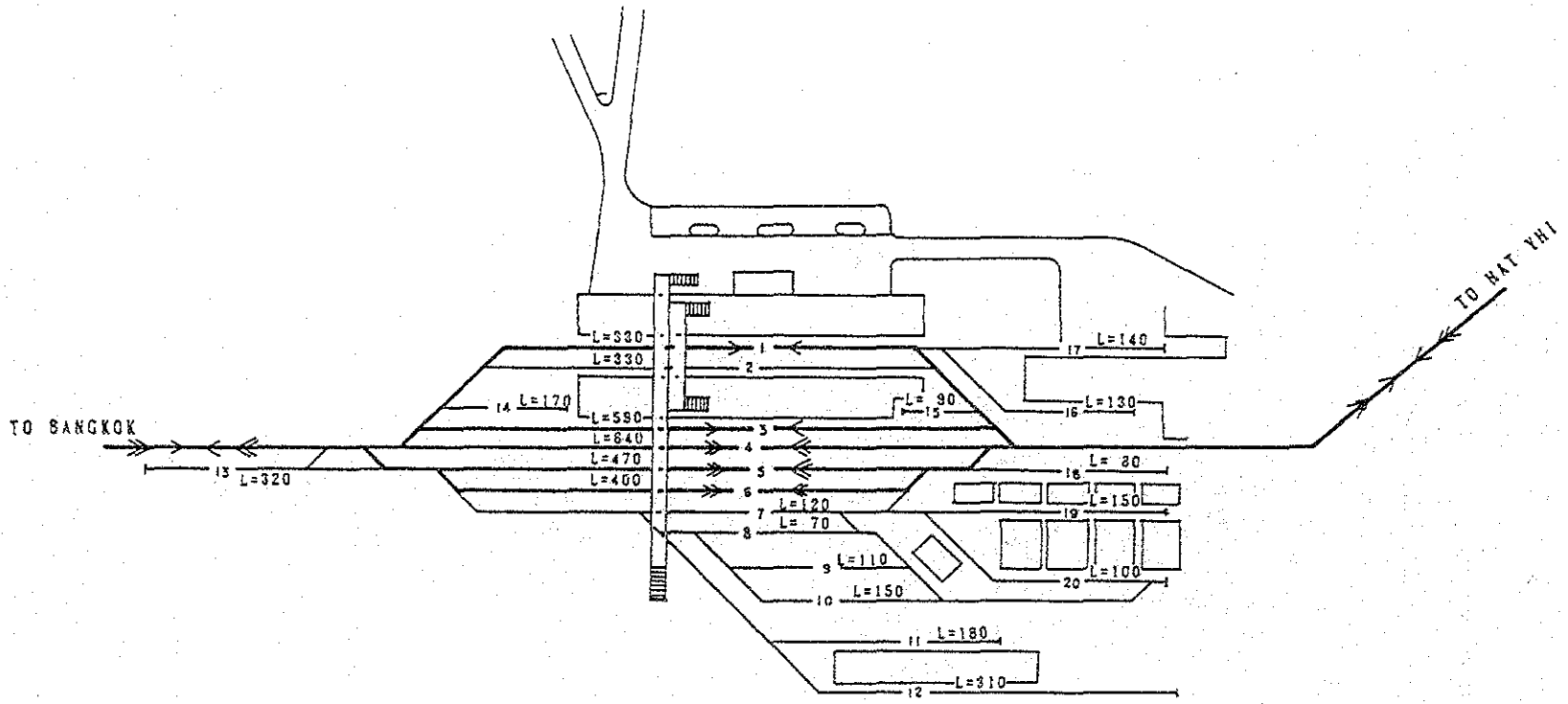


Fig. 7.10.1 Present Track Layout at Surat Thani Station

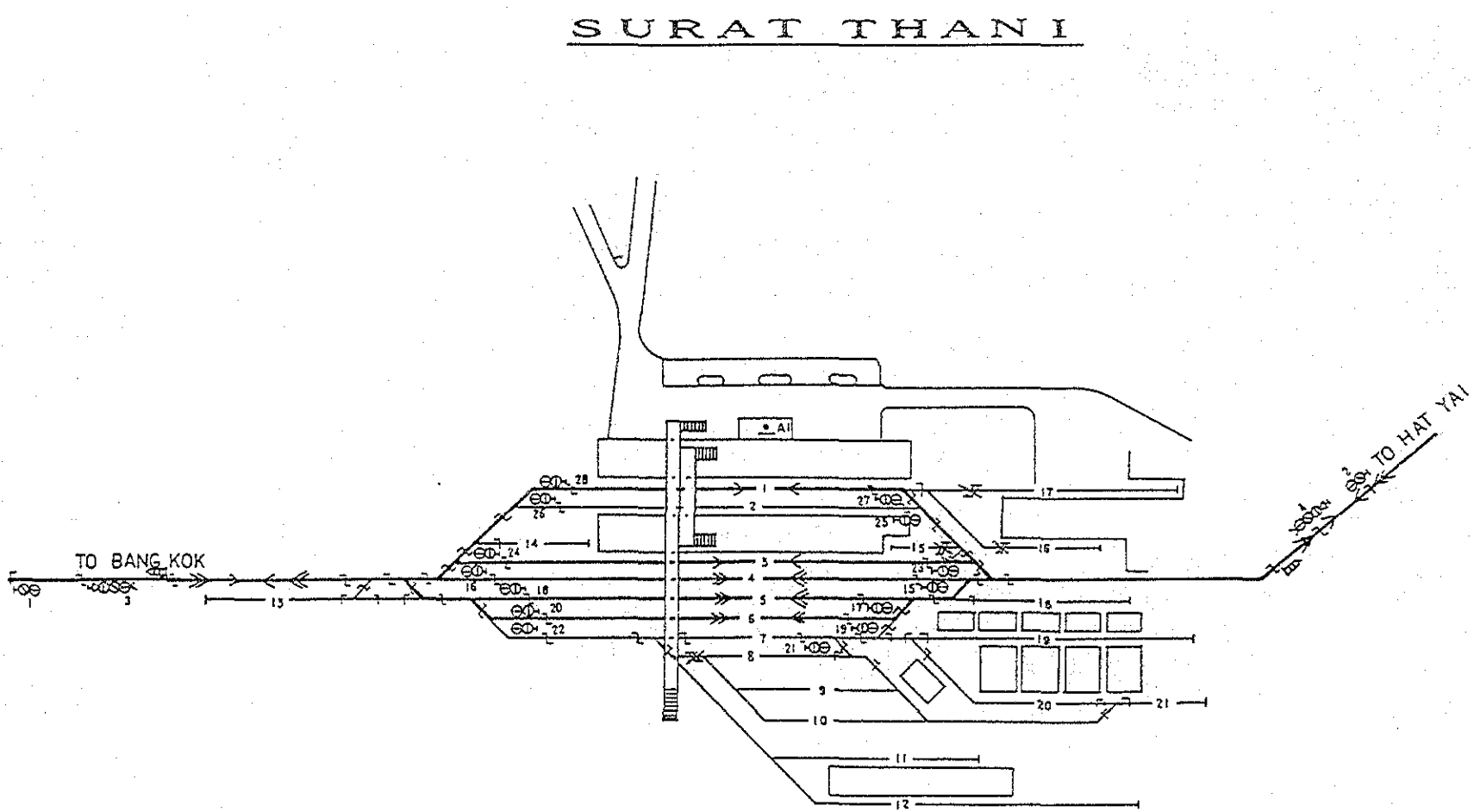


Fig. 7.10.2 Present Signalling Facilities at Surat Thani Station

7-11 Thung Song (Starting and Terminating Station for Some Passenger Trains, Freight Car Yard and Car Depot)

7-11-1 Present Condition of Yard Facilities

(1) General

The station is located along the Southern Line and is a junction point to Kantang, and uncouples and couples passenger and freight trains in both directions.

The car depot is responsible for the inspection and repairing of DLs and the overhauling of passenger and freight cars, but the engine depot is to be integrated with Hat Yai in the future.

The track layout is as shown in Figure 7.11.1.

(2) Condition of the compound, land, and buildings

The station compound is limited in space, but the car depot is vast and has locomotive and freight car wrecks blocking the tracks and vacant land.

The buildings or, specifically, the station building, engine depot, and passenger and freight car yard, are all in fine condition.

In the vicinity of the station, houses are located only near the present cargo handling station, with the central part of the town being far from the station.

(3) Yard facilities

As shown in Appendix 7.11.1.

(4) Signalling and telecommunication systems

1) Interlocking devices are of the electrical type (relay interlocking and route lever systems).
2) Signals are of the electrical type, and there are approaching, starter and home signals.
3) Turnouts are of the electrical type.
4) Tokenless system is used when blocking with the adjacent station.
5) There are dispatching telephones, block telephones, exchangers, carrier terminal equipment, teleprinters, and radios.
6) Train detection is done with track circuits.

The signalling facilities are as shown in Figure 7.11.2.

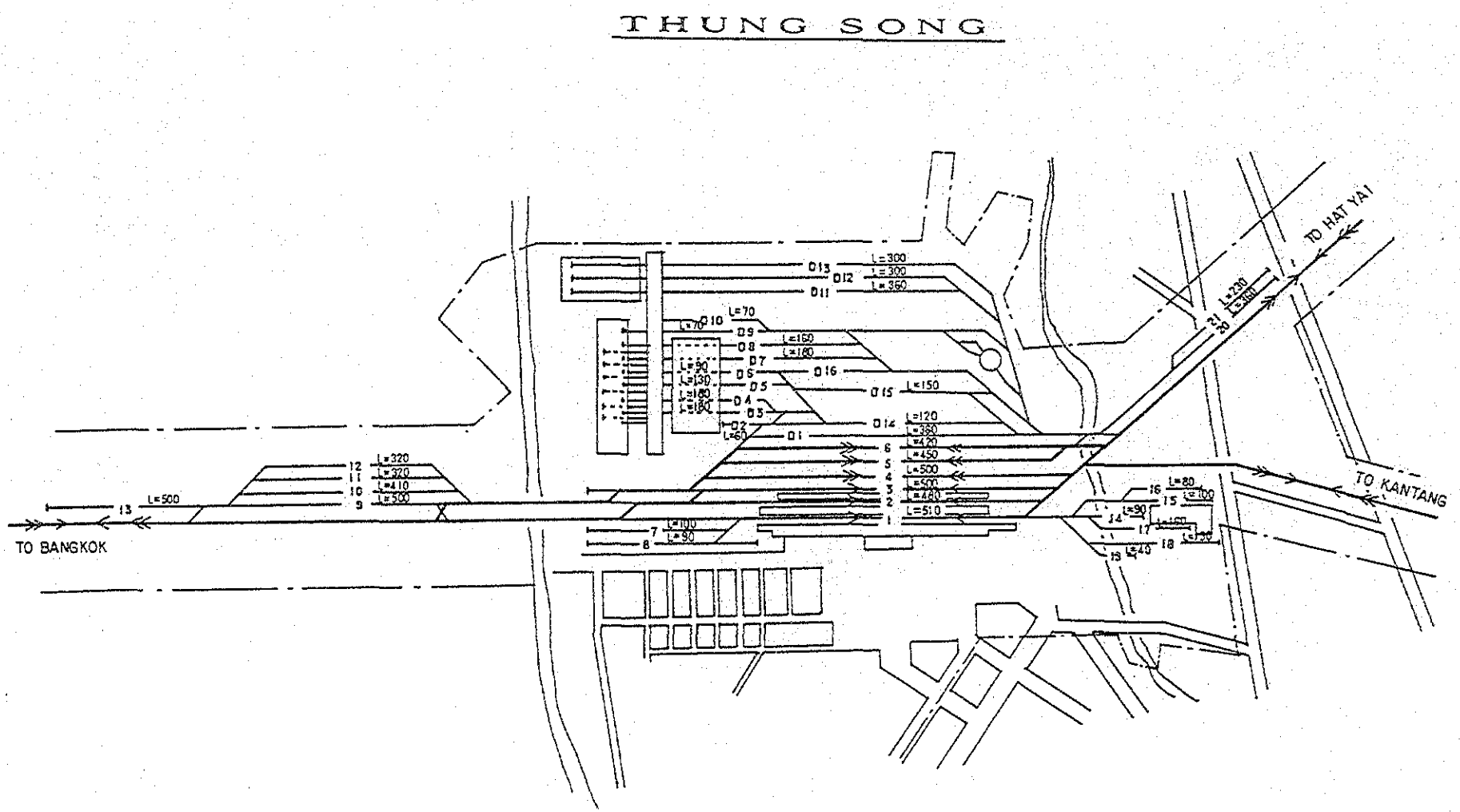


Fig. 7.11.1 Present Track Layout at Thung Song Station

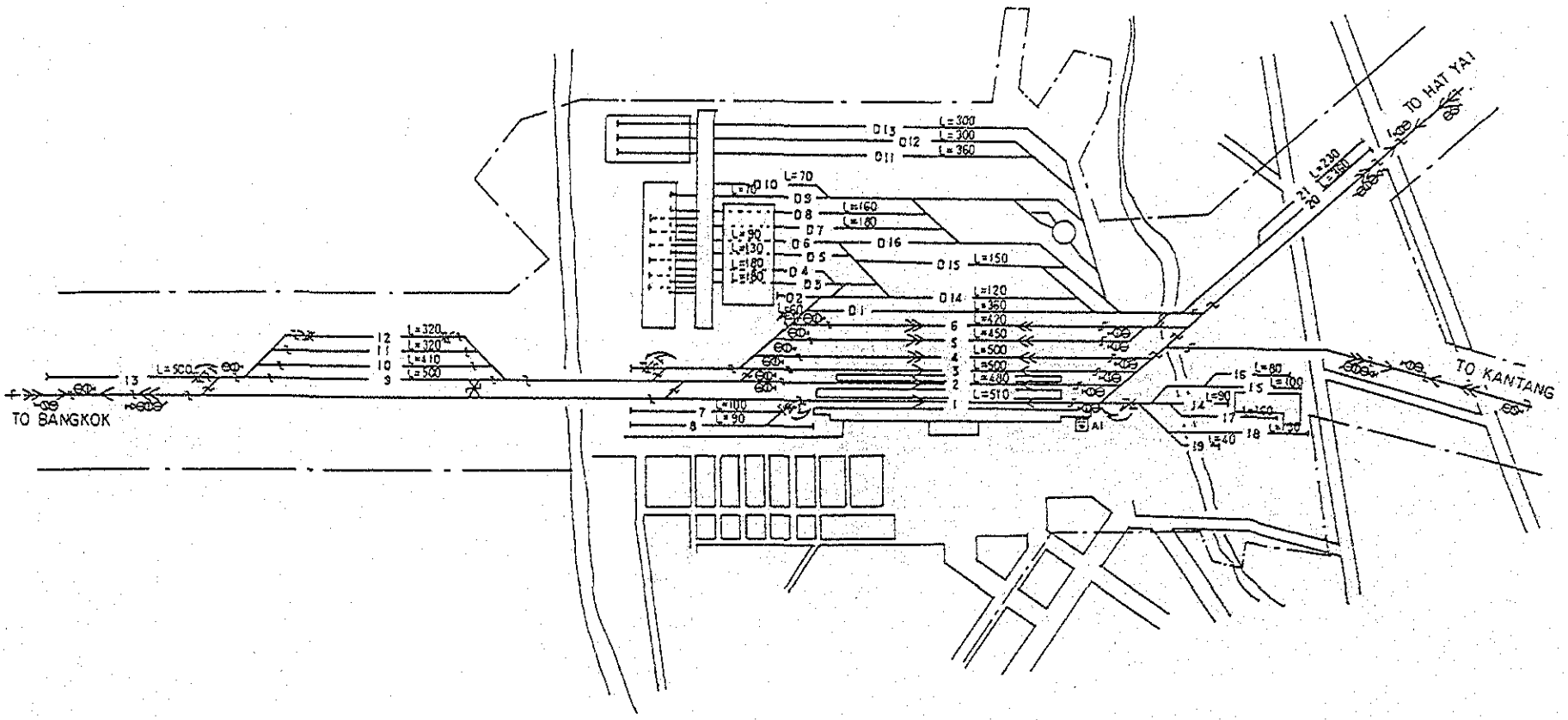


Fig. 7.11.2 Present Signalling Facilities at Thung Song Station

(5) Summary of themes of improvement

1) Shunting freight cars to the cargo handling station is done by pushing them onto the main track of passenger trains, which have the highest frequency of use, making shunting work difficult and restricting work time.

2) Sorting work is done on the freight arrival and departure tracks and is thus subject to restrictions. Also, passenger cars that have passengers on board are often kept between freight cars during shunting, which is dangerous.

7-11-2 Master Plan

(1) Plan for improving existing facilities

1) The cargo handling station is located on the side of the station building, so freight car shunting uses track 1, which is located in front of the station building and is most important as a passenger train arrival and departure track.

Also, the handling station is located in a direction reverse to that of freight car removal, so shunting is done by pushing in. Thus, an engine running track is required for replacing shunting locomotives. This kind of work is not economical and seems to be the reason for requiring 2 shunting locomotives. Also, the work is done during the intervals of the arrival and departure trains on track 1, so it is under a restriction of time.

As a remedial measure, the cargo handling station is relocated to a place near the present draw-out tracks 20 and 21.

2) Installation of additional freight car sorting tracks

At present, 4 freight car sorting tracks are available on the Bangkok side. However, they are separate from track 20, which is used by the shunting locomotive as a draw-out track.

The shunting of passenger and freight cars is done on the same tracks, or tracks 4-6, which are the freight arrival land departure tracks, and thus the working time is limited. To resolve the work problem on the arrival and departure tracks, part of the car depot is rearranged, and additional sorting tracks installed.

(2) Master plan

1) Ground plan

The improvement plan is shown in Figures 7.11.3 and 7.11.4 in which the index numbers represent the following.

1)-a Installation of cargo loading and unloading facilities

1)-b Removal of cargo loading and unloading facilities

2)-a Additional installation of freight sorting tracks

2)-b Relocation of PC and FC storage tracks

2)-c Relocation of oiling track and oiling facilities

2)-d Removal of turntable

2) Outline of facilities to be improved

Facilities to be improved in accordance with the improvement plan are outlined below.

Table 7.11.1 Passenger and Freight Facilities

Tracks	Present facilities		Facilities to be improved		Increase/decrease
	Number of tracks	Effective length(m)	Number of tracks	Effective length(m)	
Freight arrival and departure	3	420 - 500	3	400 - 500	Effective length decreased by 20 m
Freight handling	4	90 - 160	2	50	2 Tracks Effective length decreased by 380 m
Freight handling	2	40 - 80	1	130	Decrease in 1 Track Effective length increased by 10 m
Freight sorting	0		2	330, 360	2 Tracks Effective length increased by 690 m

3) Work execution plan and investment

a) Work period: 6 months (after procurement of materials)

b) The changeover of tracks should be carried out during train intervals as described in Appendix 7.11.2.

c) Improvement of the signalling and telecommunication system is done as track changeover progresses.

d) Investment: 31.5 million bahts

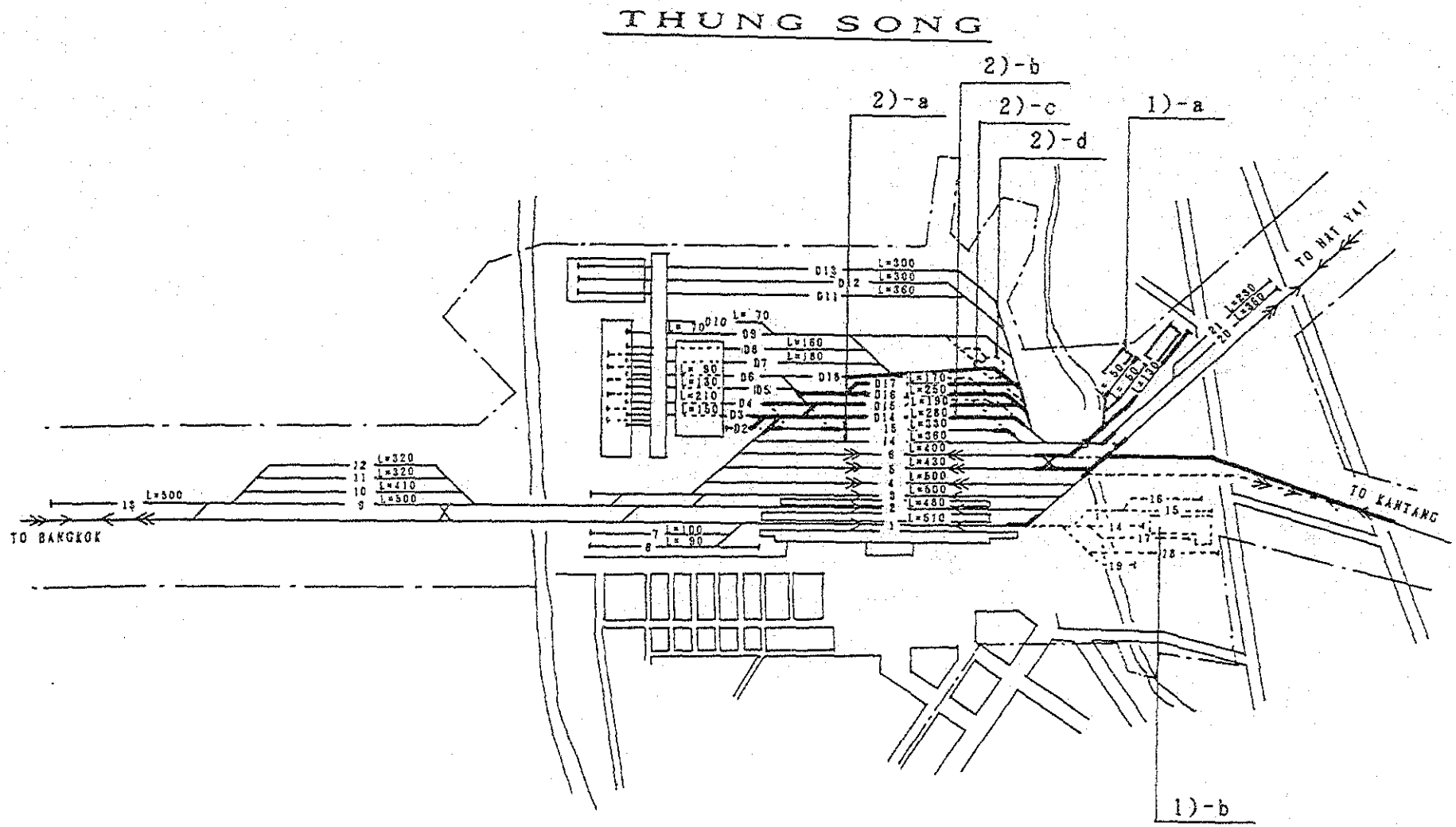


Fig. 7.11.3 Future Track Layout at Thung Song Station

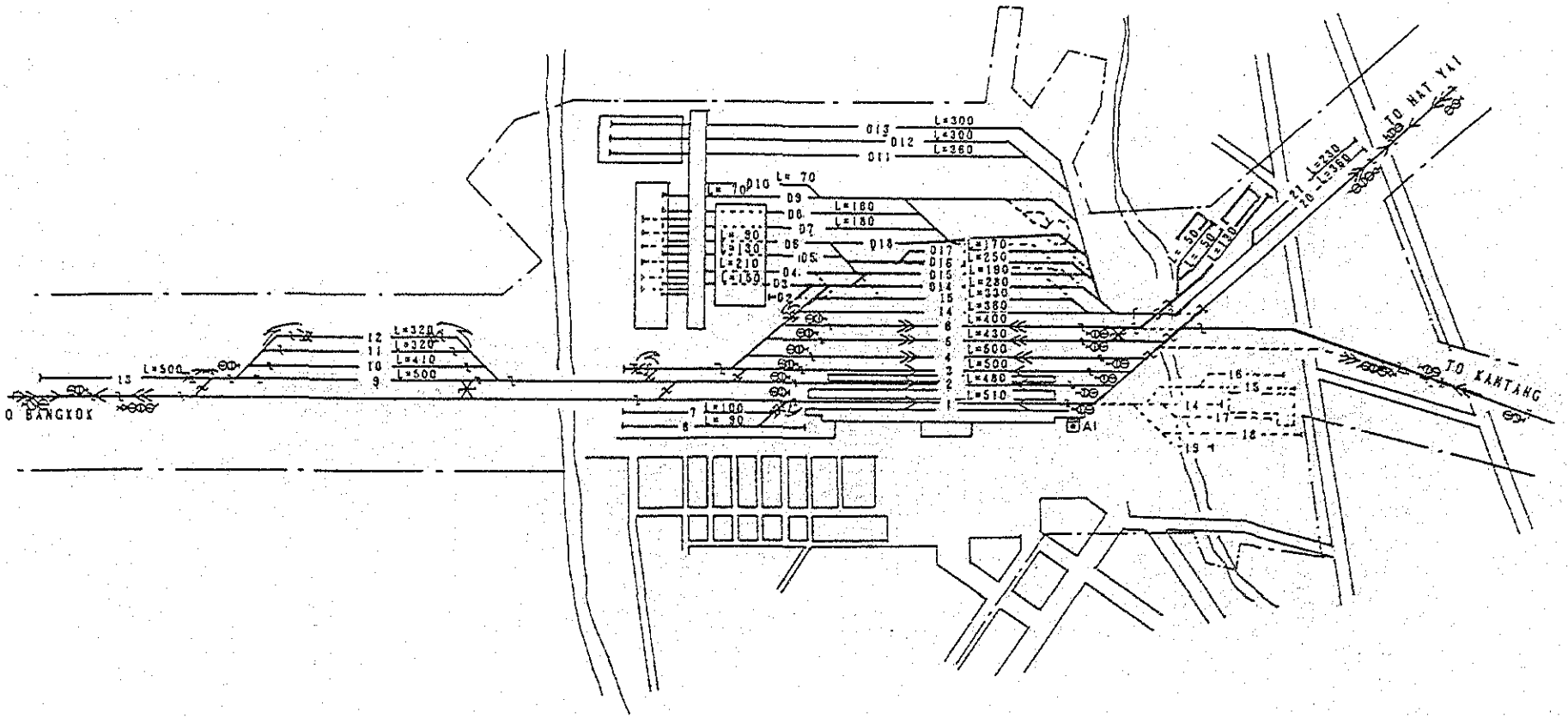


Fig. 7.11.4 Future Signalling Facilities at Thung Song Station

7-12 Estimate of Investment Cost

7-12-1 Items of Cost

Costs are calculated by station for the following items.

1) Right-of-way
2) Railway bed
3) Bridges
4) Station facilities
5) Track facilities
6) Buildings
7) Signalling facilities
8) Overhead expenses
9) Engineering consultant fee

7-12-2 Commodities Purchased with Foreign Currency

Commodities purchased with foreign currency must come under the following rules.

1) A commodity must not be produced in Thailand.
2) If a commodity is produced in Thailand, the amount produced must be small and its experience in the market short.

The following commodities are to be purchased with foreign currency in accordance with the agreement with SRT.

1) Steel for buildings
2) Rails
3) Turnouts and Crossings
4) Rail attachments
5) Signalling facilities
6) Engineering consultant fee

Other commodities, except for the above, are to be purchased with domestic currency.

7-12-3 Prices of Major Items

The commodity prices and wages for labor presented by SRT for each site area are used.

Table 7.12.1 Prices of Major Items

(Unit: Bahts)

Item	Unit	Purchased with foreign currency	Purchased with domestic currency
Rail: 80A	m	1,000	
70A	m	875	
Turnout, Crossing: 80A 12	one unit	60,000	
70A 12	one unit	50,000	
Concrete sleeper	a piece		1,000
Ballast	m^3		130
Ready-mixed concrete	m^3		3,000
Steel	ton	23,000	
Signalling cable 10 mm^2 x 4C	km	74,200	
Track worker	man		200
Worker	man		140

7-12-4 Procedure for Calculating Cost

1) Right-of-way

The cost for right-of-way is decided in discussions with SRT.

2) Railway-bed facilities

Costs are calculated by item and purchasing currency.

3) Track facilities

New rails, turnouts, crossings, sleepers and ballast are used as a rule. Costs are calculated by item and purchasing currency.

4) Signalling Facilities

New interlocking device and cables are used as a rule. Old signals and electric switches are transferred and used as much as possible. Calculations are done by work item and purchasing currency.

5) Administration expense

With little experience in the changeover of tracks, SRT needs Japanese specialists to be dispatched to Thailand to instruct its

employees. Therefore, an administration expense for construction is needed. Tracks will be changeovered on an average of every two or three weeks for each station.

In addition with the construction of bridges, transfer of fuel facilities, and installation and repairing of interlocking devices, all of which are near the railway, more Japanese specialists will have to be dispatched. Therefore, administration expense will consist of two parts.

7-12-5 Conclusion

Table 7.12.2 Total Investment

(Unit: million Bahts)

Station	Master Plan		F/S Plan		Remarks
	Cost	Foreign currency	Cost	Foreign currency	
Bangkok	162.0	119.1	162.0	119.1	
Mae Nam	91.8	13.3	91.8	13.3	
Bang Sue	130.0	71.6	51.3	33.9	Master Plan and F/S Plan are different.
Hat Yai	48.2	33.6	48.2	33.6	
Ban Phachi	54.5	36.2			
Phitsanulok	12.7	8.2			
Nakhon Ratchasima	4.8	2.7			
Thung Song	31.5	17.3			
Total	535.5	302.0	353.3	199.9	

Investment by station in detail is as shown in appendix 7.12.1

CHAPTER 8 ECONOMIC AND FINANCIAL ANALYSIS

CHAPTER 8 Economic and Financial Analysis

8-1 Objectives

This study aims at drawing up a master plan for the improvement of railway yards with a target year of 2006, and confirming its feasibility for those yards selected that most urgently need to be taken up with a target year of 1996.

Investment in transportation facilities is characterized by huge construction costs due to the indivisibility of facilities, the long durable life of facilities and the prolonged periods of construction. Thus, any project to construct transportation facilities should be evaluated considering the efficient allocation of relatively scarce resources (optimum resource allocation), economic benefits to be produced by the project, and the costs required to implement the project, and then compared to determine whether the project is to be carried out or declined in favour of investment projects other than those for the transportation facilities.

Furthermore, not a few transportation projects require a large investment in excess of their own financial capability, so that a government subsidy and/or equity becomes necessary. For this reason, the profitability of such projects should be accurately assessed in advance to confirm the financial requirements to be borne by the government.

Based on the above standpoints, this chapter deals with studying the feasibility or profitability of a project from national economic and financial viewpoints.

8-2 Yards to be Dealt with in the F/S

The Master Plan examined the ten principal yards of Thailand, while the Feasibility Study is implemented for yards selected from those ten which most need improvement.

In this section, some justifications for the yards selected to be covered in the Feasibility Study are preliminarily examined by giving priorities to each yard (see Table 8.2.1). Full analyses will be conducted in the following sections.

(1) Selection of three yards in Metropolitan area.

It is considered that the selection of the three yards in the Metropolitan area are most suitable and have the highest priority among the 10 yards for the following reasons.

1) Bang Sue and Mae Nam are located in Bangkok city, which is the center of Thailand's freight transportation. They handle a large number of freight cars and are SRT's biggest freight yards or freight handling stations and are therefore key yards.

2) Improvements in their yard facilities are worth studying in more detail in order to correspond with SRT's future freight transportation system.

3) Bangkok station is a terminal station and has been playing a very important role in passenger transportation. Considering the estimated increase in future railway passenger traffic, Bangkok station will emerge as a bolttleneck from the viewpoint of it's existing yard facilities. This would be particularly so for commuter traffic.

(2) Selection of an additional yard

Based on the following reasons, it is recommended that Hat Yai be selected as the additional yard.

1) Hat Yai is a central yard in South Thailand, and will handle the largest number of freight cars after Bang Sue and Mae Nam.

2) Hat Yai is the only yard that has a capacity ratio for freight handling that is predicted to be over 1.0; therefore, the necessity for improvement is high.

8-3 Economic Analysis

8-3-1 Methodology

Economic analysis is conducted under the principle of "with and without the project". Transportation services to satisfy estimated traffic demand in the future would be provided by these two cases, with the sum of the required investments and economic benefits compared and evaluated.

(1) "With the project" and "without the project"

"With the project" ..... The case where the project is implemented

"Without the project" ..... The case where the project is not implemented and traffic demand is satisfied by the existing transportation system

(2) Benefits and costs to be analyzed

1) Benefits of possible savings in both time and cost to be generated by the project (see Fig. 8.3.1)

2) Investment and procurement cost of: Railway yard facilities (civil engineering work, track, signals), rolling stock (diesel locomotives, diesel railway cars, passenger cars, freight cars), railway right-of-way, and road vehicles (cars, buses, trucks).

(3) Accounting prices

The value of goods and services related to transportation facilities are based on economic prices, which are determined by adjusting market prices in accordance with certain criteria.

(4) Criteria for project evaluation

In general, a project is evaluated in accordance with the following three methods:

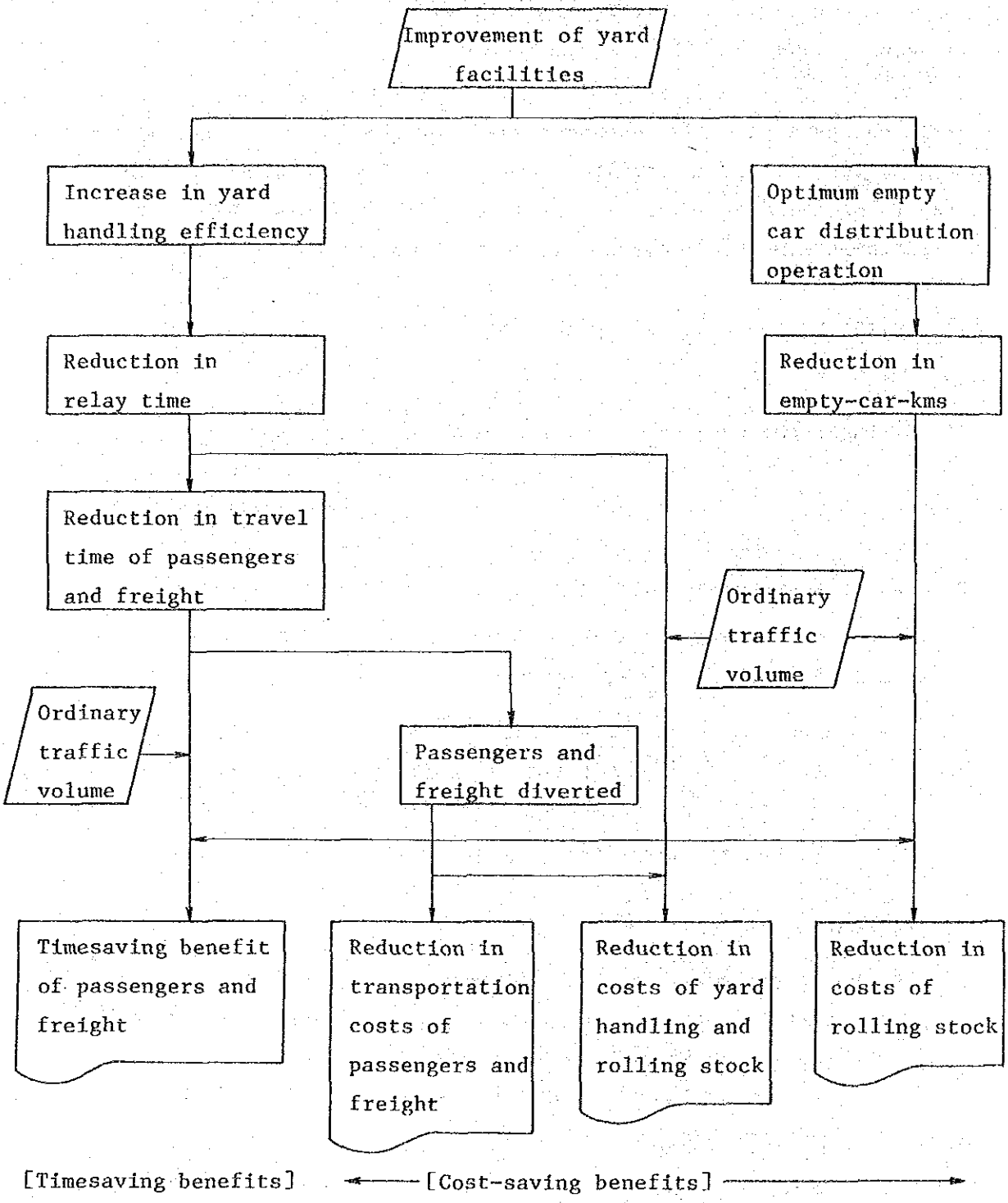


Fig. 8.3.1 Economic Benefit

1) Net Present Value (NPV)

$$NPV = \sum_{i} \frac{Bi}{(1+r)^{i}} - \sum_{i} \frac{Ci}{(1+r)^{i}}$$

Given as the difference between the present value of total benefits and costs for the project life, which are determined by discounting benefits and costs for each period using a certain discount rate.

2) Benefit/Cost Ratio (BCR)

$$BCR = \sum_{i} \frac{Bi}{(1+r)^{i}} \Big/ \sum_{i} \frac{Ci}{(1+r)^{i}}$$

Given as the ratio of the present value of the benefits to the present value of the costs for the project life.

3) Economic Internal Rate of Return (EIRR)

$$\phi(\rho) = \sum_{i} \frac{Bi}{(1+r)^{i}} - \sum_{i} \frac{Ci}{(1+r)^{i}}$$

Given as the value representing a discount rate by which the present value of the benefits equals the present value of the costs for the project life.

This report's analysis is conducted using the EIRR in 3), which is widely used in project evaluation.

8-3-2 Assumption

The economic analysis is based on the following assumptions.

(1) Traffic volume

We assume that the railway will serve the following two types of traffic demand:

a. Ordinary traffic volume: Traffic volume that will exist even if the project is not executed.

b. Diverted traffic volume: Traffic volume that will be attracted from other modes (road vehicles, aircrafts, and coastal ships) to the railway due to the project reducing travel time, securing train punctuality, increasing frequencies, etc.

Ordinary and diverted traffic volumes are estimated in terms of passenger-kms for passenger traffic and tonne-kms for freight traffic, on the basis of a demand forecast by mode in Chapter 3.

(2) Establishing the "Without the project" case

As in the other transportation systems in the case of "Without the project," car and bus transportation take into account passengers and truck transportation freight, in addition to the existing railway mode doing both, in order to satisfy the future traffic demand when the project is not implemented. Air and coastal shipping, of which there is insufficient data, is excluded from this economic analysis, since road transportation is expected to account for 90 percent or more of the total diverted traffic volume.

(3) Market price versus economic price

Market prices are adjusted in accordance with the following procedures.

1) Costs of imported equipment/material

According to the Thai Imported Customs Rate Table, the following rates are imposed on imported equipment and materials.

(Unit:%)

Track-related equipment/materials	5.0
Signals	22.0
Diesel locomotive	22.0
Diesel railcar	18.0
Passenger car	18.0
Freight car	18.0

These customs rates are deducted from the market price of each item. In addition, the normal profit rate of 11.0 precent, business tax of 9.0 percent, and municipal tax of 10.0 percent are also deducted, in accordance with the 1966 Announcement (No. 18) of the Secretary General of the Tax Authority and the Business Tax Rate Table, Class 1 (a) of Category 1 (Sales of goods).

2) Equipment/material costs (domestic portion)

The business tax (9.0 percent) is deducted from the market price of domestically produced equipment and materials in accordance with the Business Tax Rate Table, Class 1 (a) of Category 1 (Sales of goods). The municipal tax of 10.0 percent is also deducted.

3) Labour cost (domestic portion)

Personal income tax (10.0 percent) is deducted from the labour cost, referring to Thai's average taxable income (i.e., gross income minus some deductions) and Personal Income Tax Table.

4) Fuel cost

As to high-speed diesel oil, an excise and municipal tax of 20.2 percent is deducted from the retail price and the Oil Fund contribution of 6.37 percent added to it (Source: Business and Industrial Statistics compiled by the Bank of Thailand).

5) Others

The price distortion of land prices, wage rate of workers, equipment/material prices and foreign exchange rates are not adjusted in this analysis. This is because the price distortion rate can be assumed to be fairly small, since the Thai economy generally works under a free market system.

Market prices are based mainly on the average prices of 1985 or the latest prices. The foreign exchange rate is set at Jpn yen 6.61 against one baht.

Future potential inflationary factors are not incorporated into market prices in accordance with general principles.

(4) Project life

The project life is established at 35 years, starting from 1987, with reference to the economic and physical lives of the facilities and their maintainability.

(5) Alternatives and construction schedule

In the economic and financial analyses, four alternatives to be studied are established in accordance with possible construction schedules. The schedule for each alternative is assumed to be as follows.

Table 8.3.1 Alternative and Construction Schedule

1

Name of Yard \ Year	1987	1988	1989	1990	1991
Bangkok	○				
Mae Nam			○		○
Bang Sue		○			
Hat Yai				○	
Ban Phachi					
Phitsanulok					
Nakhon Ratchasima					
Thung song					

2

Name of Yard \ Year	1987	1988	1989	1990	1991
Bangkok	○				
Mae Nam		○			○
Bang Sue		○			
Hat Yai			○		
Ban Phachi				○	
Phitsanulok				○	
Nakhon Ratchasima					○
Thung song			○		

3

Name of Yard \ Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Bangkok	○									
Mae Nam			○		○					
Bang Sue		○								
Hat Yai				○						
Ban Phachi							○			
Phitsanulok								○		
Nakhon Ratchasima									○	
Thung song						○				

4

Name of Yard \ Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Bangkok	○									
Mae Nam			○		○					
Bang Sue		○								
Hat Yai				○						
Ban Phachi			○							
Phitsanulok						○				
Nakhon Ratchasima							○			
Thung song		○								

Furthermore, the improvement priority of each yard is assumed as follows, mainly from a technical viewpoint.

1) Bangkok Yard should be improved first, since it is presently almost at full capacity, and will face some difficulties in operating quite soon.

2) The next yard that should be improved is Bang Sue, since its improvement will assist in increasing the number of direct trains and simplifying yard handling work.

3) The third station to be improved should be Mae Nam, since it is located in the Bangkok area and has functionally close relations with the other yards there. In addition, the number of cars handled in Mae Name is expected to be much larger than that of Hat Yai (see Table 6.2.1). Thus improving Mae Nam sooner than Hat Yai can be justified.

4) Improvement in Mae Nam is assumed be devided into two stages: first, the relocation and installation of tracks; and second, construction of a shortcut line since it requires a centain amount of time and funds to acquire land for right-of-way.

These improvement schedules indicate the progress of physical work in the economic analysis and the disbursement of funds in the financial analysis.

8-3-3 Economic Benefits

(1) Timesaving benefit

1) Reduced travel time

Because the time required for moving from one place to another is considered as having an "opportunity cost", the timesaving effect due to faster transport service is valued as a benefit of the project. Travelling during business hours is assumed to cause a loss in work time and production. The same logic can be applied to movement during non-business hours as well, because it would cause disutilities by restricting available leisure time.

To assess the timesaving benefit of the project, average travel time per unit distance for the existing railway, car, bus, and truck (each including access/egress time and loading/unloading time) is determined for the "Without the project" case. At the same time, the average travel time required for the railway after completion of the project is estimated. Then, the average travel timesaving, a result of the project (due to an increase in yard handling efficiency and a reduction in relay time), is obtained by comparison. These figures coincide with the assumptions for demand forecasting in Chapter 3.

Passenger transportation

(Unit: h/km)

	1996	2006
Railway	0.00653	0.00628
Diversion from car/bus to railway	-0.00860	-0.00720

Freight transportation

Railway	0.00629	0.00610
Diversion from truck to railway	-0.03900	-0.03780

2) Time value

On the basis of figures, which are estimated by the Least Sacrificed Volume Model in Chapter 3, the time value of passengers is determined as follows:

(Unit: Baht/person hours)

	1996	2006
Railway	13.6	28.0
Car/bus	21.8	40.9

These figures are cross-checked with the average wages of each industry, each region, and each type of job (source: Bangkok Chamber of Commerce, "Outlook of Thai Economy").

Also, based upon the same model as mentioned above, the time value of freight is obtained as follows:

(Unit: Baht/tonne hours)

	1996	2006
Railway	7.1	7.8
Truck	13.6	15.0

These figures are also cross-checked with the prices per tonne of major loading commodities such as rice, cement, petroleum, etc. (Source: National Statistical Office)

3) Timesaving benefit

Using the above figures, timesaving benefits can be calculated by the following formula:

Timesaving benefits

Reduced travel time x Time value of passengers/freight x Railway traffic volume (ordinary and diverted)

(2) Cost-saving benefit

The cost-saving benefits of this project are divided mainly into two categories: one is an increase in yard handling efficiency or reduction in relay time, and the other optimum empty-car distribution operation or reduction in empty-car-kms.

1) Optimum distribution

This benefit is calculated by the following formula:

Cost-saving benefit (1)

$$\frac{\text{Reduction in empty-car-kms}}{\text{Empty-distribution-kms per one car}} \times \left(\begin{array}{l} \text{procurement and maintenance} \\ \text{costs of rolling stock per} \\ \text{car-year} \end{array} \right)$$

The data used for this calculation is as follows:

	1996	2006
Reduction in empty-car-kms* (Thousand kms/year)	31,041	35,291
Empty-distribution-kms** (Thousand kms/car-year)	155.9	155.9
Rolling stock (FC)** (Thousand baht/car, economic price)	811	811
Maintenance percentage rate of FC** (%, per car-year)	0.4	0.4

* These figures are calculated on the basis of linear programming optimization in 5-3.
** Source: SRT

2) Yard handling efficiency

a. Ordinary traffic volume

This benefit is calculated by the following formula.

Cost-saving benefit (2)

$$\frac{\text{Reduction in yard relay time per year}}{\text{Yard relay time per car}} \times \left(\begin{array}{l} \text{Procurement and maintenance} \\ \text{costs of rolling stock per} \\ \text{year + Yard handling} \\ \text{expenses per car-year} \end{array} \right)$$

The data used is as follows.

	1996	2006
Reduction in relay time* (Thousand hours/year)	680	2,491
Relay time per one car* (Thousand hours/car-year)	8.76	8.76
Yard handling expenses** (Thousand baht/year, economic price)	25.2	25.2

* See Table 5.4.2
** Source: SRT

b. Diverted traffic volume

This benefit is deduced as the difference of maintenance, replacement, payroll and power costs between the "With the project" and "Without the project" cases.

a) Railway

Material/personnel costs necessary to maintain and replace the railway facilities and rolling stock and also necessary power and personnel costs for the railway operation, are estimated in accordance with the diverted traffic volume.

Fixed costs

	Maintenance rate (%)	Replacement rate (%)
Civil engineering work	0.37	--
Track	--	4.16
Signals	2.10	3.10
Diesel locomotive	1.00	--
Diesel railcar	8.60	--
Passenger car	2.00	--
Freight car	0.40	--

(Source: SRT/JNR standard)

Variable costs

Maintenance and replacement cost for the existing railway facilities	Personnel ... B 0.275/car.kms Material .... B 0.381/car.kms
Personnel cost (Traffic Dept.)	B 0.0476/person.kms B 0.0755/tonne.kms
Fuel cost	B 1.228/car.kms

(Source: SRT figures)

b) Road

Operating and maintenance costs of road vehicles are estimated from the following:

Toyota Corona (1600 cc) for passenger cars, Hino BX321 (50 persons) for buses, and Hino FM176 (13 tonne) for trucks.

These figures are based upon the reports of the Ministry of Highways, "Calculation of Road User Costs for Hat Yai Bypass and Route 35 Improvement Feasibility Studies" and "Report on Vehicle Operating Cost and Passenger Occupation Survey for Hat Yai and Samut Sakhon". All costs are expressed by the economic price term.

(Unit: Baht/car.kms)

	Car	Bus	Truck
Crew wages	0.95	3.08	3.16
Running Cost (fuel, oil, tyres, maintenance)	0.99	2.08	2.51

8-3-4 Composition of Investment

The amount of investment used for this analysis is calculated as the total investment of the "with the project" case, in excess of the total in "without the project" case, i.e., the incremental investment cost.

(1) "With the project" case

The amount of investment for this case is basically the same as the one shown in Appendix 7.12.1 (summarized as the following table 8.2.2), except for the following points:

1) Market prices are adjusted to economic prices.

2) Reinvestment after depreciation and residual value at the end of project life for the facilities are included. Each facility is assumed to be depreciated over the following years in accordance with SRT standards.

(Unit: Year)

Civil engineering structure	40
Signals	32
Diesel locomotive	20
Diesel railcar	11
Passenger car	33
Freight car	33

Table 8.3.2 Construction Cost

(Unit: Millions of bahts)

Name of yard	Civil/track	Signals	Total
Bangkok	60.5	101.5	162.0
Mae Nam	91.8	——	91.8
Bang Sue	30.7	20.6	*51.3
Hat Yai	29.8	18.4	48.2
Ban Phachi	32.7	21.8	54.5
Phitsanulok	8.5	4.2	12.7
Nakhon Ratchasima	3.9	0.9	4.8
Thung Song	24.1	7.4	31.5
Total	282.0	174.8	456.8

* Master Plan and F/S Plan are different.

These prices are all included in the market prices.

Table 8.3.3 Rolling Stock Cost

Type of rolling stock	Unit price (Thousands of bahts, economic price)	No. of cars	
		1996	2006
Diesel locomotive	30,767	27	35
Diesel railcar	23,319	171	231
Passenger car	12,245	147	214
Freight car	811	1,002	1,190

(Note: The number of cars here are estimated in accordance with the diverted traffic volumes)

(2) "Without the project" case

The following investment items and amounts are included in this case. The amounts are based upon the same sources as mentioned above in 8-3-3 (2).

	Car (Toyota Corona)	Bus (Hino BX321)	Truck (Hino FM176)
Vehicle price (baht)	129,188	542,910	619,515
Average life (year)	10	11	12

These prices are all included in the economic prices.

8-3-5 Categorization of Yard Improvement Effects

For the purpose of economic calculations, the following three categories of effects, which yard improvements generate, are focused on.

(1) Direct effects

a. Timesaving: An effect occurring from the reduction in relay time and then in travel time of passengers and freight of ordinary traffic volume.

b. Cost-saving: An effect occurring from the reduction in yard handling costs (personnel and materials) and of rolling stock (procurements and maintenance).

No effect of the diverted traffic volume is taken into account in this category.

(2) Direct and indirect effects (1)

In this category, in addition to the direct effects, the effects of the diverted traffic volume are taken into consideration, which have reached their limit and flattened after a certain period in accordance with the assumption that SRT's existing rolling stock is fully utilized and no new rolling stock is purchased.

From the following, passenger traffic volume is expected to be inhibited in 1996, while freight traffic volume will have no limitations due to reasonable increases in the operating efficiency of FCs.

Passenger

	1985 (actual)	1996	2006
Total passenger traffic volume (mil.person.kms)	9,140	15,054	18,120
Number of DRCs			
On record	204		
Actually in service	190		
Necessary number of DRCs	-	506	596
Load factor of DRCs (%, commuter/ordinary)	-	150/100	150/100
Insufficient number of DRCs	-	316	406
Number of PCs			
On record	1,111		
Actually in service	822		
Necessary number of PCs	-	528	660
Load factor of PCs (%, express/rapid)	-	100/100	100/100
Excessive number of PCs	-	294	162
Number of DLs			
On record	277		
Actually in service	194		
Necessary number of DLs	-	165	193
Excessive number of DLs	-	29	1

Freight

	1984 (actual)	1996	2006
Total freight traffic volume (mil.tonne.kms)	2,618	3,213	3,634
Number of FCs			
On record	9,207		
Actually in service	8,239		
Necessary number of FCs	-	8,239	8,239
Operating efficiency (%)	12.3	16.3	18.5

(3) Direct and indirect effects (2)

In this category, it is assumed that the number of rolling stock that meet increased railway traffic demand are all newly purchased and that there is no limitation on railway traffic volume and thus effects.

8-3-6 Result

(1) EIRR

On the basis of benefits and investment costs described in the previous sections, the economic internal rate of return (EIRR) has been calculated for each alternative and category of effects as follows.

Table 8.3.4 EIRR

(Unit: %)

	Direct effects	Direct and indirect effects (1)	Direct and indirect effects (2)
Alternative 1	72.21	18.29	17.33
Alternative 2	67.74	14.71	13.40
Alternative 3	-	-	15.95
Alternative 4	-	-	14.77

1) Internal rate of return

As far as the EIRR is concerned, the yard improvement project is economically feasible, since all of these figures exceed the average discount rate (8.0%-12.0%) of typical international aid and lending institutions such as USAID, ODM, IBRD, ADB, etc.

2) Alternative 1 vs Alternative 2-4

Improvement costs of the major four yards (Bangkok, Mae Nam, Bang Sue, and Hat Yai) account for 77.3% of total improvement costs, while the improvement effects of the four yards for passengers and freight are 87.0% and 89.5% respectively for the total effects. Therefore, the EIRR of alternative 1 is the highest of all the alternatives.

(2) Cost saving

By implementing this project, the following savings can be made.

Table 8.3.5 Cost Saving

	Alternative 1		Alternative 2	
	1996	2006	1996	2006
Reduction in number of rolling stock*	241	444	277	510
Reduction in yard handling expenses (Thousands of bahts, market prices)	1,885	6,847	2,162	7,872

* These figures are cumulative.

(3) Benefit and cost

Economic benefits and investment costs of this project are shown by the following tables.

Table 8.3.6 Economic Benefit

(Unit: Million of bahts)

		1996	2006
Direct effects			
Alternative 1	Timesaving	1,168	2,527
	Cost saving	6	38
	Total	1,174	2,565
Alternative 2	Timesaving	1,168	2,527
	Cost saving	4	41
	Total	1,172	2,569
Direct and indirect effects (1)			
Alternative 1	Timesaving	458	1,153
	Cost saving	102	130
	Total	560	1,283
Alternative 2	Timesaving	357	1,002
	Cost saving	115	148
	Total	472	1,150
Direct and indirect effects (2)			
Alternative 1	Timesaving	458	1,144
	Cost saving	102	171
	Total	560	1,315
Alternative 2	Timesaving	357	945
	Cost saving	115	195
	Total	472	1,139
Alternative 3	Timesaving	357	945
	Cost saving	187	244
	Total	545	1,188
Alternative 4	Timesaving	357	945
	Cost saving	142	222
	Total	499	1,167

Table 8.3.7 Investment Cost

(Unit: Million of bahts)

		1992*	1996*
Direct effects			
Alternative 1, With case,	Facilities	287	287
	Rolling stock	-	-
	Total	287	287
Without case		-	-
Alternative 2, With case,	Facilities	372	372
	Rolling stock	-	-
	Total	372	372
Without case		-	-
Direct and indirect effects (1)			
Alternative 1, With case,	Facilities	287	287
	Rolling stock	5,766	6,506
	Total	6,053	6,793
Without case		2,095	2,367
Alternative 2, With case,	Facilities	372	372
	Rolling stock	6,584	7,432
	Total	6,956	7,804
Without case		2,397	2,708
Direct and indirect effects (2)			
Alternative 1, With case,	Facilities	287	287
	Rolling stock	5,766	6,506
	Total	6,053	6,793
Without case		2,095	2,367
Alternative 2, With case,	Facilities	372	372
	Rolling stock	6,584	7,432
	Total	6,956	7,804
Without case		2,397	2,708
Alternative 3, With case,	Facilities	313	372
	Rolling stock	5,766	6,531
	Total	6.079	6,903
Without case		2,095	2,377
Alternative 4, With case,	Facilities	368	372
	Rolling stock	6,040	6,872
	Total	6,408	7,244
Without case		2,204	2,510

Note: * The above figures for 1992 and 1996 are cumulative.

8-4 Financial Analysis

8-4-1 Basic Concept

Financial analysis is carried out to determine the profitability of a given project by calculating the financial internal rate of return (FIRR), the debt service coverage ratio (DSCR) and other financial statistics.

FIRR is defined as the discount rate (ρ) at which $\phi(\rho) = 0$, and is obtained in the following formula.

$$\phi(\rho) = \sum_{i} \frac{Ri - Ci}{(1 + \rho)i}$$

Where;

Ri = Operating profit before depreciation (after tax reduction) in the year i and residual value at the end of the project life

Ci = Investment cost in the year i

FIRR suggests the profitability of the project and thus its financial viability.

DSCR is defined as follows.

DSCR = Ri/Pi

Where;

Ri = Ditto

Pi = Principal repayment and interest payment in the year i

This ratio indicates the financial soundness of the project, i.e., whether the profit generated by the project itself can cover debt services such as both principal and interest payments. It is required for the ratio to exceed 1.0 for the project life; otherwise, it must be financed by some other sources.

If a project is considered feasible in the economic analysis but evaluated as otherwise in the financial analysis, the project will place financial burdens on the national economy. Therefore, the objective of the financial analysis is to evaluate the project's profitability, financial soundness, and other related aspects, and to determine the optimum scheme for financing the project's cost. Also considered is how the negative cash flow during the project life should be supplemented by government subsidies and/or short-term loans.

8-4-2 Scope of Analysis and Assumption

(1) Items to be included in the analysis

Items included in this analysis are operating revenue generated by the project (diverted passenger traffic in terms of passenger-kms x unit fare, diverted freight traffic in terms of tonne-kms x unit tariff), operating expenses required for the project (maintenance, replacement, personnel, power and depreciation), capital expenditures (civil engineering work, track, signals, rolling stock and land aquistion), and a preliminary financial plan (SRT funds, long-term loans, and short-term loans).

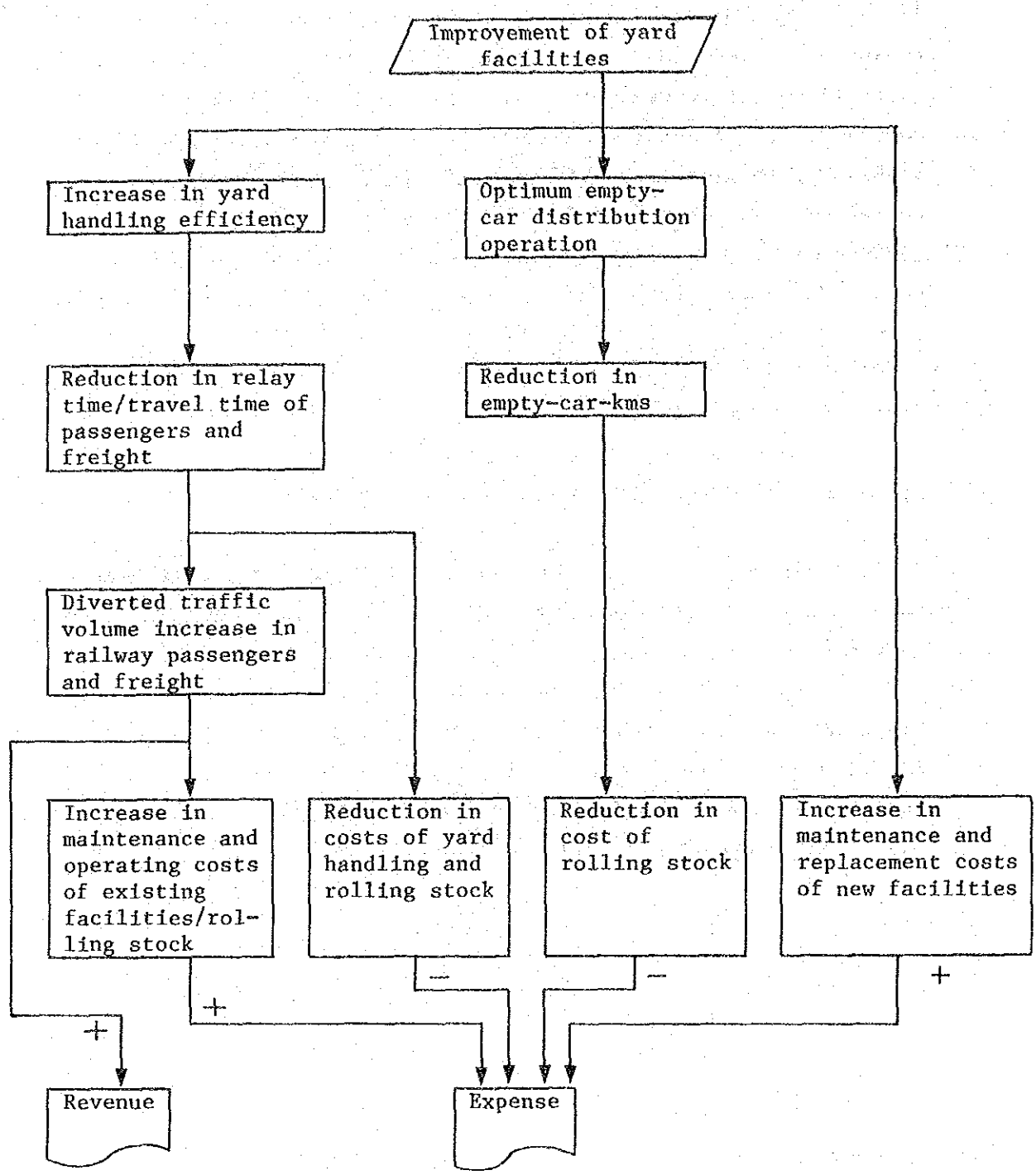


Fig. 8.4.1 Operating Revenue and Expense

(2) Assumption

1) All prices related to the project are based on market prices. In addition, an annual price escalation rate of 5.0% is assumed during the project life, as well as a zero price escalation.

2) The fare and tariff for the financial analysis are set with reference to the present ones as follows:

Fare ..... 0.22 bahts per person.kms
Tariff ..... 0.37 bahts per tonne.kms

(1985 figures)

A decrease in actual revenues due to inflation is assumed to be compensated by equivalent increases every three years.

3) Maintenance and replacement expenses of the new facilities, variable expenses of existing facilities in accordance with increased railway traffic volumes, savings on maintenance and replacement corresponding to a reduction in empty-car-kms/reduction in yard relay time, and fuel and personnel expenses for the project, are all calculated on the basis of the same data as mentioned in 8-3-3 (2).

4) The amount of investment is basically the same as that shown in Appendix 7.12.1, to which reinvestment after depreciation and residual value at the end of project life for the facilities are added in the manner described in 8-3-4, with price escalations for each year included. The straight-line method is applied for depreciation. The project life, construction schedule and alternatives to be studied are the same as those in 8-3-2 (4) and (5).

5) It is assumed that the investment required for each construction stage would be financed from the following sources:

a. SRT fund ..... Neither principal repayment nor interest payment

b. Long-term loan .. 13.0 percent interest rate p.a., ten-year maturity from a loan agreement contract, and five-year grace period

In addition, short-term loans (13.0 percent interest rate p.a.) are financed if the available cash flow is deficient. This loan is repayed when the available cash flow turns to surplus.

8-4-3 SRT's Financial Situation

Generally, two cashflows can have independent, substitute, complementary, or partial relations with each other. The cashflow of this yard's improvement project has a partial relation with SRT's cashflow, so it is necessary to observe SRT's financial and management situation for implementation of the new project.

1) The share of personnel expense over SRT's total operating expenses is comparatively high.

Table 8.4.1 Operating expenses

(Unit: Millions of bahts %)

	1983	1984	1985
Personnel	1,770 (51.0)	1,832 (51.1)	1,916 (52.9)
Materials and supply	784 (22.6)	784 (21.9)	749 (20.7)
Fuel	706 (20.3)	703 (19.6)	658 (18.2)
Depreciation	211 (6.1)	266 (7.4)	297 (8.2)
Total	3,471 (100.0)	3,585 (100.0)	3,620 (100.0)

Source: SRT Information Booklet

2) As railway traffic volume increases, rolling stock procurement and personnel expenses must increase, which will worsen the SRT's financial situtation.

Table 8.4.2 Operating revenue and variable costs per train-kms

(Unit: Baht/train-kms per year)

Operating revenue	98.9
Personnel	48.6
Materials and supply	16.9
Fuel	23.2
Rolling stock	111.0

Source: SRT (Average of 1983 and 1984 figures)

3) The productivity of SRT's staff is not so high when compared with Japan's figures, though it is higher than that of other Asian countries.

Table 8.4.3 Productivity of workers

(Unit: Train-kms/worker)

Thailand	1,096.2 (1984)
Malaysia	833.5 (1983)
Indonesia	413.3 (1980)
JNR	1,892.0 (1984)
Japanese private railway co.	4,223.2 (1983)

Source: JICA reports and JNR booklet

8-4-4 Result

On the basis of the above-mentioned assumptions and data, some financial statistics have been calculated for the following 12 cases.

Case	Alternative	Price escalation (%)	Financial plan (%)	
			SRT fund	External borrowing
1	1	5.0	100	
2	1	5.0	50	50
3	1	5.0		100
4	1	0.0	100	
5	1	0.0	50	50
6	1	0.0		100
7	2	5.0	100	
8	2	5.0	50	50
9	2	5.0		100
10	2	0.0	100	
11	2	0.0	50	50
12	2	0.0		100

The results of some of the cases are as follows (The results of Case 5 and 11 are selected in respect to the availability of SRT's funds and also because it is easy to ascertain their financial statistics owing to constant prices).

(1) Direct effects

The following direct financial effects can be considered as an imputed profit of total investment costs, other conditions remaining unchanged.

a. Reduction in costs of yard handling (personnel and materials).

b. Reduction in costs of rolling stock (procurements and maintenance).

Financial calculations in this category are as follows:

Case 5

Yearly Debt Service Coverage Ratio (decimal)	0.05-3.00
Cumulative Debt Service Coverage Ratio (ditto)	0.38-3.00
Financial Internal Rate of Return (ROI) (%)	6.55
Ditto (Return on SRT's funds) (%)	-12.44
Year when positive net income turned	Never turned
Year when tax payment started	Never started
SRT funds (mil.bahts)	208
Long-term loans (mil.bahts)	208
Maximum amount of short-term loans (mil.bahts per year)	290 (2021)
Maximum balance of short-term loans (mil.bahts per year)	1,938 (2021)
Year when repayment of short-term loans completed	Never completed

Case 11

Yearly Debt Service Coverage Ratio (decimal)	0.01-2.60
Cumulative Debt Service Coverage Ratio (ditto)	0.20-2.60
Financial Internal Rate of Return (ROI) (%)	4.81
Ditto (Return on SRT's funds) (%)	-19.69
Year when positive net income turned	Never turned
Year when tax payment started	Never started
SRT funds (mil.bahts)	266
Long-term loans (mil.bahts)	266
Maximum amount of short-term loans (mil.bahts per year)	475 (2021)

Maximum balance of short-term loans (mil.bahts per year)	3,683 (2021)
Year when repayment of short-term loans completed	Never completed

(2) Direct and indirect effects (1)

The fundamental concept of this category is the same as that in 8-3-5. The results of some of the cases are as follows.

Case 5

Yearly Debt Service Coverage Ratio (decimal)	1.21-4.05
Cumulative Debt Service Coverage Ratio (ditto)	2.07-4.05
Financial Internal Rate of Return (ROI) (%)	19.72
Ditto (Return on SRT's funds) (%)	22.64
Year when positive net income turned	1992 (starting year of operations)
Year when tax payment started	1992 (ditto)
SRT funds (mil.bahts)	208
Long-term loans (mil.bahts)	208
Maximum amount of short-term loans (mil.bahts per year)	0
Maximum balance of short-term loans (mil.bahts per year)	0
Year when repayment of short-term loans completed	-

Case 11

Yearly Debt Service Coverage Ratio (decimal)	0.89-3.40
Cumulative Debt Service Coverage Ratio (ditto)	1.62-3.40
Financial Internal Rate of Return (ROI) (%)	16.12
Ditto (Return on SRT's funds) (%)	17.44
Year when positive net income turned	1992 (starting year of operations)
Year when tax payment started	1992 (ditto)
SRT funds (mil.bahts)	266
Long-term loans (mil.bahts)	266
Maximum amount of short-term loans (mil.bahts per year)	9 (1993)
Maximum balance of short-term loans (mil.bahts per year)	9 (1993)
Year when repayment of short-term loans completed	1995

(3) Direct and indirect effects (2)

This effect is also the same concept as that in 8-3-5.

Major results of this category are as follows.

Case 1-12

Yearly Debt Service Coverage Ratio (decimal) ..... Below 1.0

Cumulative Debt Service Coverage Ratio (ditto) ..... Below 1.0

Financial Internal Rate of Return (ROI) (%) ..... Below 0.0

Ditto (Return on SRT's funds) (%) ..... Below 0.0

Year when positive net income turned ..... Never turned

Year when tax payment started ..... Never started

The reason why the financial statistics of this category are worse is because rolling stock procurement costs are very expensive; thus, a large amount of funds are required if rolling stock is newly purchased in accordance with increments in railway traffic demand (see 8-4-3).

Therefore, one of the effective ways to improve the financial statistics is to economize on rolling stock procurement costs by

a. Raising load factors of DRCs and PCs,

b. Raising locomotive-kms of DRCs,

and

c. Raising operating efficiency of FCs.

		Case 5	Case 11
Base case	FIRR (%)	Below 0.0	Below 0.0
	DSCR (decimal)	Below 1.0	Below 1.0
70% saved	FIRR	Ditto	Ditto
	DSCR		
100% saved	FIRR	21.24	18.09
	DSCR	2.07-4.05	1.62-3.40

(4) Summary of FIRR

Table 8.4.4 FIRR

(Unit: %)

	Case 5 (Alternative 1 and no price escalation	Case 11 (Alternative 2 and no price escalation)
Direct effects	6.55	4.81
Direct and indirect effects (1)	19.72	16.12
Direct and indirect effects (2)	Below 0.0	Below 0.0
100% savings on rolling stock in (2)	21.24	18.09

8-5 Sensitivity Analyses

8-5-1 Economic Analysis

In this subsection, the extent to which the economic feasibility of the project is affected by assuming major deviations (e.g. construction costs, construction schedule, and railway demand forecast) from the base case is examined.

(1) Cost overrun

With respect to alternatives 1 and 2, impacts on the economic internal rate of return (EIRR) are evaluated in the direct and indirect effects (2) as follows, for the case where the total yard improvement costs rise by 15 per cent and 30 per cent respectively as compared with the original cost estimations.

(Unit: %)

	Alternative 1	Alternative 2
Base case	17.33	13.40
15% increase	17.09	13.22
30% increase	16.87	13.05

(2) Delay in the construction schedule

It is assumed in the base case that Bangkok Yard is improved in 1987 for both Alternatives 1 and 2, and Bang Sue Yard for Alternative 1 and Bang Sue and Mae Nam yards (excl. shortcut construction) for Alternative 2 in 1988. Impacts on the EIRR in the direct and indirect effects (2) are estimated as follows, for the case where the above start-up schedule is delayed about one year, i.e., the improvement work in 1987 is delayed until 1988, and the work in 1988 unitl 1989, with the rest implemented as originally scheduled.

(Unit: %)

	Alternative 1	Alternative 2
Base case	17.33	13.40
Schedule delay	17.48	13.48

(3) Decrease in traffic demand

With respect to Alternative 1 and 2, impacts on the EIRR in the direct and indirect effects (2) are calculated as follows, for the case where the railway passenger and freight traffic volumes are reduced by 15% and 30% respectively.

(Unit: %)

	Alternative 1	Alternative 2
Base case	17.33	13.40
15% decrease	17.19	13.31
30% decrease	17.01	13.18

8-5-2 Financial Analysis

In this subsection, the extent to which the financial viability of the project is influenced by assuming major deviations from the base case is examined.

(1) Direct effect

In this category, since only a cost-related aspect can be varied, sensitivity analysis focuses on a cost overrun case and a cost reduction case where SRT's unused track materials (rail, sleeper, ballast, turnout, etc.) are effectively utilized.

FIRR (ROI)

(Unit: %)

	Case 5	Case 11
Base case	6.55	4.81
15% increase in improvement costs	5.08	3.45
30% increase in improvement costs	3.91	2.37
15% reduction in improvement costs	8.45	6.59
30% reduction in improvement costs	10.70	9.00

(2) Direct and indirect effects (1)

In this category, a cost overrun case and a decreased railway traffic demand case are analysed respectively for caution's sake.

FIRR (RO1)

(Unit: %)

	Case 5	Case 11
Base case	19.72	16.12
15% cost overrun	17.53	14.09
30% cost overrun	15.74	12.45
15% decrease in railway traffic demand	18.23	14.81
30% decrease in railway traffic demand	16.63	13.42

(3) Direct and indirect effects (2)

In this category, cases where there are increase in fares and tariffs and a subsidy injection (no principal repayment nor interest payment) are analysed in order to improve the financial conditions.

Elasticity of demand to price

(Unit: Decimal)

	Passengers	Freight
5% increase	-0.64	-2.36
10% increase	-1.07	-2.95
20% increase	-2.72	-3.83

FIRR (ROI)

(Unit: %)

	Case 5	Case 11
Base case	Below 0.0	Below 0.0
10% increase in fare and tariff	Ditto	Ditto
20% increase in fare and tariff	Ditto	Ditto

It is also analysed whether short-term loans are substituted by subsidy injection if the available cashflow is insufficient.

Subsidy injection

(Unit: Millions of bahts)

	Case 5	Case 11
Required amount p.a.	507-6,963	606-7,982
Yearly average	1,097	1,291

8-6 Concluding Remarks

a. This yard improvement project is economically feasible since every figure of the economic internal rate of return exceeds the average discount rate (8.0%-12.0%) of typical international aid and lending institutions such as USAID, ODM, IBRD, ADB, etc.

b. Furthermore, this project retains its robustness despite deviations from the basic assumptions (e.g. cost overrun, construction delay, and demand forecast decrease).

c. On the other hand, this project is financially viable if SRT's existing rolling stock is efficiently used and money saved on new procurements by increasing load factors, operation efficiencies, car-kms, etc.

d. For further assurance of financial viability, project costs should be reduced as much as possible by effective utilization of present track materials (rail, sleeper, ballast, turnout etc); also, financial sources with better terms and conditions should be sought.

Table 8.6.1 Results of Economic and Financial Analyses

		EIRR (%)	FIRR (ROI, %)	DSCR (decimal)	SRT funds (mil.bahts)	Long-term Loans (mil.bahts)	Maximum amount of short-term loans (mil.bahts, year)	Maximum balance of short-term loans (mil.bahts, year)	Year when repayment of short-term loans completed	Year when positive net income turned
I Direct effects	Alt. 1	72.21	6.55	0.05 - 3.00	208	208	290 (2021)	1,938 (2021)	Never completed	Never turned
	Alt. 2	67.74	4.81	0.01 - 2.60	266	266	475 (2021)	3,683 (2021)	Ditto	Ditto
II Direct and indirect effects (1)	Alt. 1	18.29	19.72	1.21 - 4.05	208	208	0	0	-	1992
	Alt. 2	14.71	16.12	0.89 - 3.40	266	266	9 (1993)	9 (1993)	1995	1992
III Direct and indirect effects (2)	Alt. 1	17.33	-20.52	Below 1.0	208	208	46,985 (2020)	444,677 (2021)	Never completed	Never turned
	Alt. 2	13.40	-21.06	Ditto	266	266	54,695 (2020)	517,570 (2021)	Ditto	Ditto
	Alt. 3	15.95	-	-	-	-	-	-	-	-
	Alt. 4	14.77	-	-	-	-	-	-	-	-
IV 100% savings on rolling stock in III	Alt. 1	-	21.24	1.21 - 4.05	208	208	0	0	-	1992
	Alt. 2	-	18.09	0.89 - 3.40	266	266	9 (1993)	9 (1993)	1995	1992

* In the financial analysis, Cases 5 and 11 are chosen for Alternatives 1 and 2 respectively.

** Improvement cost: 353.3 mil.bahts for Alternative 1 and 456.8 mil.bahts for Alternatives 2 - 4.

Table 8.6.2 Results of Sensitivity Analyses

		Alternative 1	Alternative 2
Economic Analysis (EIRR, %)			
1. Direct and indirect effects (2)*			
Base case		17.33	13.40
Cost overrun	15% increase	17.09	13.22
	30% increase	16.87	13.05
Schedule delay		17.48	13.48
Traffic demand	15% decrease	17.19	13.31
	30% decrease	17.01	13.18
Financial Analysis (FIRR, %)			
1. Direct effects			
Base case		6.55	4.81
Construction cost	15% increase	5.08	3.45
	30% increase	3.91	2.37
	15% decrease	8.45	6.59
	30% decrease	10.70	9.00
2. Direct and indirect effects (1)			
Base case		19.72	16.12
Construction cost	15% increase	17.53	14.09
	30% increase	15.74	12.45
Traffic demand	15% decrease	18.23	14.81
	30% increase	16.63	13.42
3. Direct and indirect effects (2)			
Base case		Below 0.0	Below 0.0
Fare and tariff	10% increase	Ditto	Ditto
	20% increase	Ditto	Ditto
Subsidy (mil. bahts)	Required amount p.a.	507~6,963	606~7,982
	Yearly average	1,097	1,291

Note: * Almost the same results can be obtained in "Direct and indirect effects (1)" as well.

CHAPTER 9 CONCLUSION

CHAPTER 9 Conclusion

9-1 Proposal for Improving Business Performance in Transportation of Passengers and Freight

The programs proposed here for improvement of yards at Bangkok and other stations have been worked out to achieve two goals which are imminent and of prime importance for SRT, "an increase in income" and "a reduction in expenses."

With these programs implemented, the passenger transportation will have the neck at Bangkok resolved, ensuring further development in the future. For the freight transportation, services answering to the needs of the consignors can be provided through improvement of the facilities failing to meet the demand of the age. Moreover, losses in yard works are eliminated, and so reduction of the transportation cost is realizable. Therefore, the programs should be carried out as soon as practicable.

These goals can be obtained only along with the progress of the reform programs for the transportation system as a whole, mentioned in previous chapters and summerized below.

1) Improvement of commuter service in Metropolitan Bangkok
   Previously, with sparsely placed SRT stations in the small Metropolitan Bangkok area, commuter trains were conveying only small numbers of passengers and hence not much progress was expected. With the recent expansion of the metropolitan area, however, the number of commuters using trains has been gradually increasing. In the commutable areas, 20 to 40km from Bangkok, establishment of stations and the introduction of frequent service through the use of DRCs with high movability are necessary, thus taking full advantage of commuter train transportation in urban districts.

2) Betterment of service
   As the road network has been spreading throughout the country and local airports set up at key locations, the railway is now under

severe competition with buses in short-distance passenger transportation, and with buses and airplanes for medium- and long-distance passenger transportation. Faster, more frequent, and more comfortable service are needed if the railway is to survive. For this purpose, DRCs with high movability fit for short- and medium-distance transportation and sleeping cars for long-distance transportation are required.

3) Examination of arrangement of freight stations and their function

Arranging many freight stations, each as a sales base, in many places is really necessary not only for improving business performance but also for fulfilling the social duty imposed on SRT as a public body. However, loading/unloading and shunting work at a freight station where very small quantities of freight are handled would become a great obstacle to freight conveyance in total. We should like to recommend that freight handling functions of such small stations (which handle less than 1000 tons of freight a year) be integrated or abolished as much as possible and that key stations for local freight transportation be equipped with necessary functions in accordance with the amount of freight they must handle to provide better service and a wider range of choice with the consignor.

4) Transportation that could satisfy the consignor's demands

Demands of consignors have changed greatly: they used to be satisfied only by their freight being conveyed. But they are now choosing among several means of conveyance considering fares, the time required for delivery and definite time of arrival. SRT already started unit freight train for special commodities to meet these demands. Also, with extending this system to other commodities, introduction of fast transportation between main stations for miscellaneous goods is necessary. In this case, promotion of a door-to-door transportation system by means of containers is to be considered.

5) Securing punctual train operation

Delay is an everyday occurrence in SRT, especially for freight trains. Punctual operation is of prime importance for modern transportation customers. One of the major causes of delays is that the train schedule of small- or medium-sized stations do not take into account the time required for loading/unloading and shunting work.

This delays not only the train concerned but also the following trains and trains passing each other. This problem can be solved by abolishing freight handling at small- or medium-sized stations or securing adequate time for necessary work.

6) Rationalization and labour saving

Thailand has ample human resources so most of the work is labour intensive. As a result, SRT's expenses are mostly labour related which exceeds its income (operating ratio of 112) and requires improvement of management that would be possible through appropriate rationalization, labour savings and increased productivity. The "Work Diagram" will help make work in each section more efficient. Some facilities and equipment are left unused because they fail to fit the current transportation situation. In order to reduce the number of workers and maintenance costs for these facilities, their scales must be made smaller and usable again.

7) Effective use of rolling stock

Quite a few locomotives, passenger coaches and freight wagons have become obsolete and operation efficiency of freight wagons are low due to an imbalanced distribution of freight among the stations. Strengthening of the repair and inspection system, and improvement of wagon assignment can yield increases in the efficiency of the rolling stock operation and bring about a reduction in rolling stock required.

9-2 Recommendation

This yard improvement project is worth implementing since it is expected to be of a great benefit to the Thai economy as compared with the transportation situation where the project is not carried out. To implement the project, the following should be taken into account, which will contribute to the improvement of SRT's financial condition.

(1) Fares and tariffs of the Thai railway are fixed at a relatively low level in order to compete with other transportation modes and to serve as a public railway transportation service. It is difficult in such a situation for operating revenue to fully cover rolling stock procurements to meet increasing railway traffic volume. Thus, by raising load factors, operation efficiencies, car-kms, and being thorough in inspections and repairs, SRT's use of existing rolling stock should be maximized and money for new procurements economized on as much as possible, to handle the increasing railway traffic demand that the project produces.

(2) Since saving on the construction cost is important in executing the improvement work, as many of SRT's existing materials as possible should be utilized after close examination. As to manpower required, existing SRT personnel should also be effectively allocated instead of arranging for outside workers.

(3) In raising funds for the project, more advantageous financing than that offered by commercial loans such as government subsidies and soft loans should be sought for in addition to SRT's own funds, if necessary.

(4) As the major purpose of this project is to improve yard operations and thus increase income and reduce expenses, SRT's management and financial condition are closely related. Consequently, this project should be implemented along with the revamping of management efficiency, worker productivity, and the financial situation of SRT.

APPENDIX

Appendix 3.2.1 Population and GRP by Zone

Thousand person, Mil. Baht.

	Population			G.R.P.		
	1984	1996	2006	1983	1996	2006
BANGKOK	6,293.2	8,527.4	9,791.8	133,469.2	250,787.7	355,656.8
ZONE 1-6	6,293.2	8,527.4	9,791.8	133,469.2	250,787.7	355,656.8
NORTHERN	10,281.2	11,666.2	12,749.0	45,812.0	82,148.9	127,064.1
ZONE 7	1,793.1	2,034.7	2,223.6	9,125.2	16,363.1	25,309.7
ZONE 8	2,181.1	2,474.9	2,704.6	8,632.4	15,479.4	23,942.8
ZONE 9	1,319.5	1,497.3	1,636.3	5,265.3	9,441.6	14,603.8
ZONE 10	2,252.7	2,556.1	2,793.3	11,400.7	20,443.4	31,620.9
ZONE 11	2,734.8	3,103.2	3,391.2	11,388.4	20,421.4	31,586.9
NORTHEASTERN	17,638.0	20,865.0	23,487.9	48,838.3	97,408.0	163,222.1
ZONE 12	4,379.7	5,181.0	5,832.3	13,737.9	27,400.2	45,913.3
ZONE 13	4,479.4	5,298.9	5,965.0	9,635.9	19,218.8	32,204.1
ZONE 14	3,031.8	3,586.5	4,037.4	11,389.1	22,715.6	38,063.5
ZONE 15	5,747.1	6,798.6	7,653.2	14,075.4	28,073.4	47,041.3
CENTRAL	10,070.8	11,980.7	13,696.2	81,172.6	165,284.4	275,782.1
ZONE 16	2,034.3	2,210.9	2,337.3	15,382.0	28,830.0	43,971.6
ZONE 17	1,478.6	1,607.0	1,698.7	7,463.4	13,988.4	21,335.2
ZONE 18	1,473.7	1,601.6	1,693.2	17,237.3	32,307.3	49,275.2
ZONE 19	1,097.0	1,192.2	1,260.4	8,407.8	15,758.4	24,034.8
ZONE 20	1,998.8	2,822.3	3,630.3	11,047.3	26,210.3	49,896.3
ZONE 21	1,186.3	1,675.0	2,154.6	15,333.7	36,380.1	69,256.5
ZONE 22	802.1	871.7	921.5	6,301.1	11,809.9	18,012.5
SOUTHERN	6,299.9	7,438.8	8,415.3	33,586.6	62,088.5	99,690.1
ZONE 23	3,477.6	4,106.3	4,645.3	19,872.0	36,735.6	58,983.2
ZONE 24	2,822.3	3,332.5	3,770.0	13,714.6	25,352.9	40,706.9
ALL ZONES	50,583.1	60,478.1	68,140.2	342,878.7	657,717.5	1,021,415.2

Apppendix 3.2.2 Freight Items Covered

Classification	Included Commodities
1. Rice	Rice
2. Other Agricultural Products	Maize, Tapioca pillet, Mung beans, Ground nuts, Soy-beans, Sesame, Coconut, Caster Seeds, Cotton, Jute & Kenaf, Kapok & Bambax Fiber, Tabacco Leaves
3. Cement	Cement, White Cement
4. Petroleum	Petroleum, LPG and Crude Oil Produced in Larn Krabue
5. Miscellaneous	(1) Mining Products excluding Lignite and Marl
	(2) Forest Products
	(3) Commercial Fish
	(4) Manufacturing Products (Sugar, Molasses, Condensed & Evaporated Milk, Beer, Cigarettes, Liquor, Soft Drinks, Soda Water, Weaving and Knitting (man-made & Cotton Fabrics), Jute Products, Synthetic Fibre, Plywood, Paper (Printed and written), Detergent, Galvanized Iron Sheets, Tin Plate
	(5) Rubber
	(6) Other Imported and Exported Commodities

Note: Main commodities excluded, excepting the above, are sand, gravel, vegetables, fruits, livestocks, imported crude oil, etc.

Appendix 3.3.1-(1) Estimated Zonal Generation and Attraction (1983)

Unit: Thousand tons

Zone	1. Rice		2. Other Agricultural Products		3. Cement		4. Petroleum		5. Miscellaneous		6. Total	
	Generation	Attraction	Generation	Attraction	Generation	Attraction	Generation	Attraction	Generation	Attraction	Generation	Attraction
1-6 Bangkok	380.9	1,849.2	34.4	586.0	-	2,764.6	4,938.9	3,567.3	1,264.8	4,858.4	6,618.9	15,289.5
	-	3,476.5	-	4,888.0	-	-	2,013.6	-	4,744.1	4,385.9	6,757.7	11,086.4
	380.9	5,325.7	34.3	5,474.0	-	2,764.6	6,952.5	3,567.3	6,008.9	9,244.3	13,376.6	26,375.9
7 Chiengmai	516.5	526.2	96.2	168.1	-	208.6	-	276.2	199.7	369.0	812.4	1,548.1
	-	-	-	-	-	-	-	-	-	-	-	-
	516.5	526.2	96.2	168.1	-	208.6	-	276.2	199.7	369.0	812.4	1,548.1
8 Lampang	1,211.4	640.7	198.6	204.4	-	191.0	-	252.9	182.7	338.4	1,592.7	1,627.4
	-	-	-	-	-	-	-	-	-	-	-	-
	1,211.4	640.7	198.6	204.4	-	191.0	-	252.9	182.7	338.4	1,592.7	1,627.4
9 Uttradit	460.8	388.0	207.2	98.9	-	114.9	-	152.1	139.7	200.4	807.7	954.3
	-	-	-	-	-	-	-	-	-	-	-	-
	460.8	388.0	207.2	98.9	-	114.9	-	152.1	139.7	200.4	807.7	954.3
10 Nakhon Sawan	1,592.3	661.5	946.9	210.6	1,027.9	245.9	-	325.6	614.1	455.2	4,181.2	1,898.8
	-	-	-	-	-	-	-	-	-	-	-	-
	1,592.3	661.5	946.9	210.6	1,027.9	245.9	-	325.6	614.1	455.2	4,181.2	1,898.8
11 Phitsanulok	1,761.4	804.2	1,230.3	255.0	-	236.4	232.1	313.1	294.5	404.3	3,518.3	2,013.0
	-	-	-	-	-	-	-	-	-	-	-	-
	1,761.4	804.2	1,230.3	255.0	-	236.4	232.1	313.1	294.5	404.3	3,518.3	2,013.0
12 Khon Kaen	1,447.4	1,287.3	1,328.8	406.2	-	290.6	-	464.1	636.6	517.7	3,412.8	2,965.9
	-	-	-	-	-	-	-	-	-	-	-	-
	1,447.4	1,287.3	1,328.8	406.2	-	290.6	-	464.1	636.6	517.7	3,412.8	2,965.9
13 Roi Et	2,107.0	1,317.0	699.6	415.2	-	200.6	-	265.5	220.7	357.2	3,027.3	2,555.5
	-	-	-	-	-	-	-	-	-	-	-	-
	2,107.0	1,317.0	699.6	415.2	-	200.6	-	265.5	220.7	357.2	3,027.3	2,555.5
14 Nakhon Ratchasima	447.8	890.4	2,526.5	281.5	-	210.1	-	278.1	385.7	373.2	3,360.0	2,033.3
	-	-	-	-	-	-	-	-	-	-	-	-
	447.8	890.4	2,526.5	281.5	-	210.1	-	278.1	385.7	373.2	3,360.0	2,033.3
15 Sisaket	2,989.5	1,688.7	811.3	533.2	-	284.0	-	376.0	219.3	505.0	4,020.1	3,386.9
	-	-	-	-	-	-	-	-	-	-	-	-
	2,989.5	1,688.7	811.3	533.2	-	284.0	-	376.0	219.3	505.0	4,020.1	3,386.9
16 Kanchana-buri	811.9	596.2	673.7	188.4	-	326.5		432.2	1,472.9	571.9	2,958.5	2,115.2
	-	-	-	-	-	-	-	-	-	-	-	-
	811.9	596.2	673.7	188.4	-	326.5		432.2	1,472.9	571.9	2,958.5	2,115.2
17 Lop Buri	1,232.9	434.1	501.2	138.0	-	153.0	-	202.5	157.4	272.5	1,891.5	1,200.1
	-	-	-	-	-	-	-	-	-	-	-	-
	1,232.9	434.1	501.2	138.0	-	153.0	-	202.5	157.4	272.5	1,891.5	1,200.1
18 Ayuttaya	891.8	432.6	368.5	136.4	5,246.7	345.5	-	457.4	939.0	607.9	7,446.0	1,979.8
	-	-	-	-	-	-	-	-	-	-	-	-
	891.8	432.6	368.5	136.4	5,246.7	345.5	-	457.4	939.0	607.9	7,446.0	1,979.8
19 Nakhon Pathom	237.8	318.7	50.7	101.7	-	180.1	-	238.4	630.0	320.3	918.5	1,159.2
	-	-	-	-	-	-	-	-	-	-	-	-
	237.8	318.7	50.7	101.7	-	180.1	-	238.4	630.0	320.3	918.5	1,159.2
20 Kabinburi	1,212.4	587.2	1,358.0	185.1	-	226.2	-	299.4	437.7	412.9	3,008.1	1,710.8
	-	-	-	-	-	-	-	-	-	-	-	-
	1,212.4	587.2	1,358.0	185.1	-	226.2	-	299.4	437.7	412.9	3,008.1	1,710.8
21 Pattaya	206.2	349.3	1,564.4	110.1	-	423.8	2,506.4	561.4	1,095.8	754.9	5,372.8	535.5
	-	-	-	2,493.2	-	-	-	-	344.4	-	344.4	4,157.2
	206.2	349.3	1,564.4	2,603.3	-	423.8	2,506.4	561.4	1,440.2	754.9	5,717.2	4,692.7
22 Prachap Kirikhan	144.9	236.4	118.1	65.9	335.2	139.1	-	197.7	354.9	264.6	953.1	903.7
	-	-	-	-	-	-	-	-	-	-	-	-
	144.9	236.4	118.1	65.9	335.2	139.1	-	197.7	354.9	264.6	953.1	903.7
23 Surat Thani	484.9	1,022.7	167.5	317.3	710.0	475.1	-	628.9	2,444.0	798.5	3,806.4	3,242.5
	-	-	-	569.9	-	-	-	-	109.3	569.9	109.3	1,139.8
	484.9	1,022.7	167.5	887.2	710.0	475.1	-	628.9	2,553.3	1,368.4	3,915.7	4,382.3
24 Hat Yai	442.2	834.7	115.2	284.3	-	303.8	-	402.2	1,194.4	655.1	1,751.8	2,480.1
	-	238.4	-	359.6	-	-	-	-	271.0	359.5	271.0	957.5
	442.2	1,073.1	115.2	643.9	-	303.8	-	402.2	1,465.4	1,014.6	2,022.8	3,437.6
Total	18,580.0	14,865.1	12,997.0	4,686.3	7,319.8	7,319.8	7,677.4	9,691.0	12,883.9	13,037.4	59,458.1	49,599.6
	-	3,714.9	-	8,310.7	-	-	2,013.6	-	5,468.8	5,315.3	7,482.4	17,340.9
	18,580.0	18,580.0	12,997.0	12,997.0	7,319.8	7,319.8	9,691.0	9,691.0	18,352.7	18,352.7	66,940.5	66,940.5

Appendix 3.3.1-(2) Estimated Zonal Generation and Attraction (1996)

Unit: Thousand tons

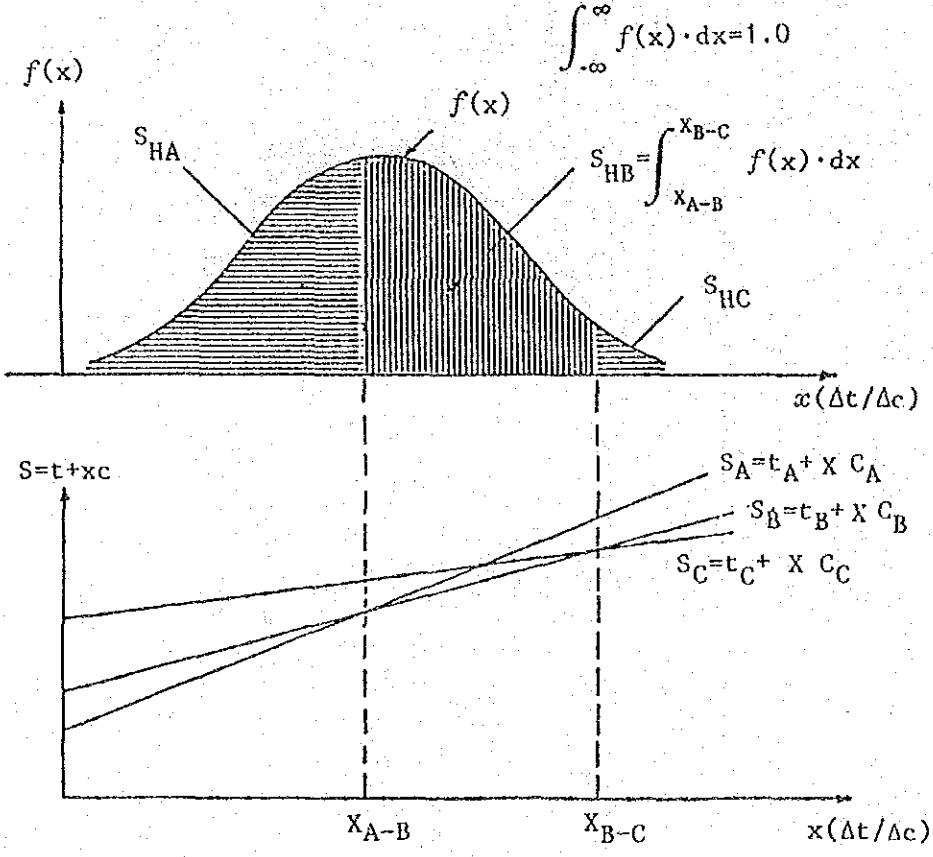
Zone \ Item	1. Rice		2. Other Agricultural Products		3. Cement		4. Petroleum		5. Miscellaneous		6. Total	
	Generation	Attraction	Generation	Attraction	Generation	Attraction	Generation	Attraction	Generation	Attraction	Generation	Attraction
1-6 Bangkok	525.1	2,560.1	50.4	807.1	-	5,262.7	6,709.1	5,426.6	1,595.0	6,140.6	8,879.6	20,197.1
	-	6,977.7	-	7,191.2	-	-	2,957.0	-	5,136.4	4,748.6	8,093.4	18,917.5
	525.1	9,537.8	50.4	7,998.3	-	5,262.7	9,666.1	5,426.6	6,731.4	10,889.2	16,973.0	39,114.6
7 Chiengmai	712.0	610.9	141.3	192.6	-	342.3	-	352.9	240.0	445.2	1,093.3	1,943.9
	-	-	-	-	-	-	-	-	-	-	-	-
	712.0	610.9	141.3	192.6	-	342.3	-	352.9	240.0	445.2	1,093.3	1,943.9
8 Lampang	1,669.9	743.0	291.7	234.2	-	324.4	-	334.4	220.0	408.1	2,181.6	2,044.1
	-	-	-	-	-	-	-	-	-	-	-	-
	1,669.9	743.0	291.7	234.2	-	324.4	-	334.4	220.0	408.1	2,181.6	2,044.1
9 Uttradit	635.2	449.5	304.3	141.7	-	198.8	-	204.9	166.7	241.2	1,106.2	1,236.1
	-	-	-	-	-	-	-	-	-	-	-	-
	635.2	449.5	304.3	141.7	-	198.8	-	204.9	166.7	241.2	1,106.2	1,236.1
10 Nakhon Sawan	2,195.0	767.4	1,390.6	241.9	1,938.3	429.3	-	442.6	738.3	549.8	6,262.2	2,431.0
	-	-	-	-	-	-	-	-	-	-	-	-
	2,195.0	767.4	1,390.6	241.9	1,938.3	429.3	-	442.6	738.3	549.8	6,262.2	2,431.0
11 Phitsanulok	2,428.1	931.6	1,806.7	293.7	-	427.9	1,160.7	441.2	353.3	487.4	5,748.8	2,581.8
	-	-	-	-	-	-	-	-	-	-	-	-
	2,428.1	931.6	1,806.7	293.7	-	427.9	1,160.7	441.2	353.3	487.4	5,748.8	2,581.8
12 Khon Kaen	1,995.3	1,555.4	1,951.2	490.4	-	575.6	-	593.5	850.0	694.9	4,796.5	3,909.8
	-	-	-	-	-	-	-	-	-	-	-	-
	1,995.3	1,555.4	1,951.2	490.4	-	575.6	-	593.5	850.0	694.9	4,796.5	3,909.8
13 Roi Et	2,904.5	1,590.8	1,027.4	501.5	-	403.0	-	415.6	293.3	479.0	4,225.2	3,389.9
	-	-	-	-	-	-	-	-	-	-	-	-
	2,904.5	1,590.8	1,027.4	501.5	-	403.0	-	415.6	293.3	479.0	4,225.2	3,389.9
14 Nakhon Ratchasima	617.3	1,076.7	3,710.2	339.4	-	476.2	-	491.0	515.0	500.9	4,842.5	2,884.2
	-	-	-	-	-	-	-	-	-	-	-	-
	617.3	1,076.7	3,710.2	339.4	-	476.2	-	491.0	515.0	500.9	4,842.5	2,884.2
15 Sisaket	4,121.1	2,041.1	1,191.4	643.5	-	589.4	-	607.7	293.3	678.0	5,605.8	4,559.7
	-	-	-	-	-	-	-	-	-	-	-	-
	4,121.1	2,041.1	1,191.4	643.5	-	589.4	-	607.7	293.3	678.0	5,605.8	4,559.7
16 Kanchanaburi	1,119.2	663.7	989.3	209.3	-	604.6		623.3	1,848.3	721.8	3,956.8	2,822.7
	-	-	-	-	-	-	-	-	-	-	-	-
	1,119.2	663.7	989.3	209.3	-	604.6		623.3	1,848.3	721.8	3,956.8	2,822.7
17 Lop Buri	1,699.6	482.4	736.0	152.1	-	294.0	-	303.1	198.3	344.1	2,633.9	1,575.7
	-	-	-	-	-	-	-	-	-	-	-	-
	1,699.6	482.4	736.0	152.1	-	294.0	-	303.1	198.3	344.1	2,633.9	1,575.7
18 Ayuttaya	1,229.4	480.8	541.2	151.6	9,893.5	677.7	-	698.8	1,178.3	765.7	12,842.4	2,774.6
	-	-	-	-	-	-	-	-	-	-	-	-
	1,229.4	480.8	541.2	151.6	9,893.5	677.7	-	698.8	1,178.3	765.7	12,842.4	2,774.6
19 Nakhon Pathom	327.8	357.9	74.5	112.8	-	331.3	-	341.6	790.0	403.1	1,192.3	1,546.7
	-	-	-	-	-	-	-	-	-	-	-	-
	327.8	357.9	74.5	112.8	-	331.3	-	341.6	790.0	403.1	1,192.3	1,546.7
20 Kabinburi	1,671.3	847.3	1,994.3	267.1	-	550.7	-	567.8	695.0	659.4	4,360.6	2,892.3
	-	-	-	-	-	-	-	-	-	-	-	-
	1,671.3	847.3	1,994.3	267.1	-	550.7	-	567.8	695.0	659.4	4,360.6	2,892.3
21 Pattaya	284.2	502.9	2,297.4	158.5	-	763.3	3,404.8	787.0	1,741.7	1,204.2	7,728.1	3,415.9
	-	-	-	4,676.9	-	-	-	-	1,445.7	925.4	1,445.7	5,602.3
	284.2	502.9	2,297.4	4,835.4	-	763.3	3,404.8	787.0	3,187.4	2,129.6	9,173.8	9,018.2
22 Prachap Kirikhan	199.7	261.7	173.4	82.5	632.1	248.4	-	256.2	445.0	333.9	1,450.2	1,182.7
	-	-	-	-	-	-	-	-	-	-	-	-
	199.7	261.7	173.4	82.5	632.1	248.4	-	256.2	445.0	333.9	1,450.2	1,182.7
23 Surat Thani	668.4	1,232.8	246.0	388.6	1,338.7	771.6	-	795.5	3,026.9	993.4	5,280.0	4,181.9
	-	-	-	916.3	-	-	-	-	141.5	737.1	141.5	1,653.4
	668.4	1,232.8	246.0	1,304.9	1,338.7	771.6	-	795.5	3,168.4	1,730.5	5,421.5	5,835.3
24 Hat Yai	609.6	1,000.5	169.2	315.4	-	531.4	-	547.9	1,478.3	814.6	2,257.1	3,209.8
	-	478.5	-	578.2	-	-	-	-	350.9	464.8	350.9	1,521.5
	609.6	1,479.0	169.2	893.6	-	531.4	-	547.9	1,829.2	1,279.4	2,608.0	4,731.3
Total	25,612.7	18,156.5	19,086.5	5,723.9	13,802.6	13,802.6	14,274.6	14,231.6	16,666.7	16,865.3	86,443.1	68,799.9
	-	7,456.2	-	13,362.6	-	-	2,957.0	-	7,074.5	6,875.9	10,031.5	27,694.7
	25,612.7	25,612.7	19,086.5	19,086.5	13,802.6	13,802.6	14,231.6	14,231.6	23,741.2	23,741.2	96,494.6	96,494.6

Appendix 3.3.1-(3) Eastimated Zonal Generation and Attraction (2006)

Unit: Thousand tons

Item / Zone	1. Rice		2. Other Agricultural Products		3. Cement		4. Patroleum		5. Miscellaneous		6. Total	
	Generation	Attraction	Generation	Attraction	Generation	Attraction	Generation	Attraction	Generation	Attraction	Generation	Attraction
1-6 Bangkok	640.0	2,877.6	63.5	907.2	-	6,458.9	8,588.8	6,343.4	1,626.5	6,478.7	10,918.8	23,065.8
	-	10,478.4	-	9,207.0	-	-	3,785.2	-	5,960.6	5,510.9	9,745.8	25,196.3
	640.0	13,356.0	63.5	10,114.2	-	6,458.9	12,374.0	6,343.4	7,587.1	11,989.6	20,664.6	48,262.1
7 Chiengmai	868.0	653.5	180.8	206.0	-	460.0	-	451.8	266.9	510.9	1,315.7	2,282.2
	-	-	-	-	-	-	-	-	-	-	-	-
	868.0	653.5	180.8	206.0	-	460.0	-	451.8	266.9	510.9	1,315.7	2,282.2
8 Lampang	2,035.7	794.8	373.8	250.6	-	434.1	-	426.3	243.7	469.7	2,653.2	2,375.5
	-	-	-	-	-	-	-	-	-	-	-	-
	2,035.7	794.8	373.8	250.6	-	434.1	-	426.3	243.7	469.7	2,653.2	2,375.5
9 Uttradit	774.3	480.9	388.5	151.6	-	265.3	-	260.6	185.7	277.9	1,348.5	1,436.3
	-	-	-	-	-	-	-	-	-	-	-	-
	774.3	480.9	388.5	151.6	-	265.3	-	260.6	185.7	277.9	1,348.5	1,436.3
10 Nakhon Sawan	2,675.7	820.9	1,781.1	258.8	2,604.3	575.0	-	564.7	822.1	632.2	7,883.2	2,851.6
	-	-	-	-	-	-	-	-	-	-	-	-
	2,675.7	820.9	1,781.1	258.8	2,604.3	575.0	-	564.7	822.1	632.2	7,883.2	2,851.6
11 Phitsanulok	2,959.9	996.6	2,313.7	314.2	-	573.2	1,392.8	562.9	394.6	561.7	7,061.0	3,008.6
	-	-	-	-	-	-	-	-	-	-	-	-
	2,959.9	996.6	2,313.7	314.2	-	573.2	1,392.8	562.9	394.6	561.7	7,061.0	3,008.6
12 Khon Kaen	2,432.2	1,713.9	2,497.0	540.3	-	834.7	-	819.8	1,025.1	865.1	5,954.3	4,773.8
	-	-	-	-	-	-	-	-	-	-	-	-
	2,432.2	1,713.9	2,497.0	540.3	-	834.7	-	819.8	1,025.1	865.1	5,954.3	4,773.8
13 Roi Et	3,540.5	1,753.0	1,314.5	552.6	-	584.3	-	573.9	354.0	597.0	5,209.0	4,060.8
	-	-	-	-	-	-	-	-	-	-	-	-
	3,540.5	1,753.0	1,314.5	552.6	-	584.3	-	573.9	354.0	597.0	5,209.0	4,060.8
14 Nakhon Ratchasima	752.4	1,186.5	4,749.6	374.0	-	691.9	-	679.5	620.9	624.4	6,122.9	3,556.3
	-	-	-	-	-	-	-	-	-	-	-	-
	752.4	1,186.5	4,749.6	374.0	-	691.9	-	679.5	620.9	624.4	6,122.9	3,556.3
15 Sisaket	5,020.4	2,249.0	1,524.6	709.0	-	855.1	-	839.8	354.0	843.6	6,899.0	5,496.5
	-	-	-	-	-	-	-	-	-	-	-	-
	5,020.4	2,249.0	1,524.6	709.0	-	855.1	-	839.8	354.0	843.6	6,899.0	5,496.5
16 Kanchana-buri	1,364.4	686.9	1,265.6	216.5	-	797.6	-	783.4	2,031.0	818.1	4,661.0	3,302.5
	-	-	-	-	-	-	-	-	-	-	-	-
	1,364.4	686.9	1,265.6	216.5	-	797.6	-	783.4	2,031.0	818.1	4,661.0	3,302.5
17 Lop Buri	2,073.1	499.2	943.1	157.4	-	387.7	-	380.7	216.6	389.5	3,232.8	1,814.5
	-	-	-	-	-	-	-	-	-	-	-	-
	2,073.1	499.2	943.1	157.4	-	387.7	-	380.7	216.6	389.5	3,232.8	1,814.5
18 Ayuttaya	1,498.6	497.6	693.9	156.9	13,296.3	894.1	-	878.1	1,294.0	869.0	16,782.8	3,295.7
	-	-	-	-	-	-	-	-	-	-	-	-
	1,498.6	497.6	693.9	156.9	13,296.3	894.1	-	878.1	1,294.0	869.0	16,782.8	3,295.7
19 Nakhon Pathom	399.6	370.4	95.3	116.8	-	435.9	-	428.1	868.5	458.0	1,363.4	1,809.2
	-	-	-	-	-	-	-	-	-	-	-	-
	399.6	370.4	95.3	116.8	-	435.9	-	428.1	868.5	458.0	1,363.4	1,809.2
20 Kabinburi	2,038.8	1,066.9	2,553.2	336.3	-	907.1	-	890.8	953.6	933.6	5,545.6	4,134.7
	-	-	-	-	-	-	-	-	-	-	-	-
	2,038.8	1,066.9	2,553.2	336.3	-	907.1	-	890.8	953.6	933.6	5,545.6	4,134.7
21 Pattaya	346.6	633.2	2,939.2	199.6	-	1,257.7	4,450.9	1,235.2	2,386.9	1,706.7	10,123.6	5,032.4
	-	-	-	6,885.4	-	-	-	-	1,678.2	1,074.1	1,678.2	7,959.5
	346.6	633.2	2,939.2	7,085.0	-	1,257.7	4,450.9	1,235.2	4,065.1	2,780.8	11,801.8	12,991.9
22 Prachap Kirikhan	243.5	270.8	222.3	85.4	849.6	326.5	-	320.6	489.4	377.8	1,804.8	1,381.1
	-	-	-	-	-	-	-	-	-	-	-	-
	243.5	270.8	222.3	85.4	849.6	326.5	-	320.6	489.4	377.8	1,804.8	1,381.1
23 Surat Thani	814.9	1,365.1	315.2	430.4	1,799.3	1,070.3	-	1,051.2	3,499.0	1,186.1	6,428.4	5,103.1
	-	-	-	1,243.0	-	-	-	-	164.2	855.4	164.2	2,098.4
	814.9	1,365.1	315.2	1,673.4	1,799.3	1,070.3	-	1,051.2	3,663.2	2,041.5	6,592.6	7,201.5
24 Hat Yai	743.1	1,107.9	217.4	349.3	-	740.1	-	726.9	1,709.9	972.8	2,670.4	3,897.0
	-	718.6	-	784.0	-	-	-	-	407.2	539.4	407.2	2,042.0
	743.1	1,826.5	217.4	1,133.3	-	740.1	-	726.9	2,117.1	1,512.2	3,079.6	5,939.0
Total	31,221.7	20,024.7	24,432.3	6,312.9	18,549.5	18,549.5	14,432.5	18,217.7	19,342.4	19,572.8	107,978.4	82,677.6
	-	11,197.0	-	18,119.4	-	-	3,785.2	-	8,210.2	7,979.8	11,995.4	37,296.2
	31,221.7	31,221.7	24,432.3	24,432.3	18,549.5	18,549.5	18,217.7	18,217.7	27,552.6	27,552.6	119,973.8	119,973.8

Appendix 3.3.2 Concept of Least Sacrificed Volume Model



SH_A, SH_B, SH_C : Shares of mode A, B, and C

SH_A, SH_B, SH_C : Shipper's burden (amount of time) when mode A, B, and C are used respectively.

X_{A-B} : Where at the point of $S_A = S_B$, $X_{A-B} = t_B - t_A \ / \ C_B - C_A$

Appendix 3.3.3 Revision Method of Estimated Value Based on Actual Measurements

1. Where: WO ≦ AS

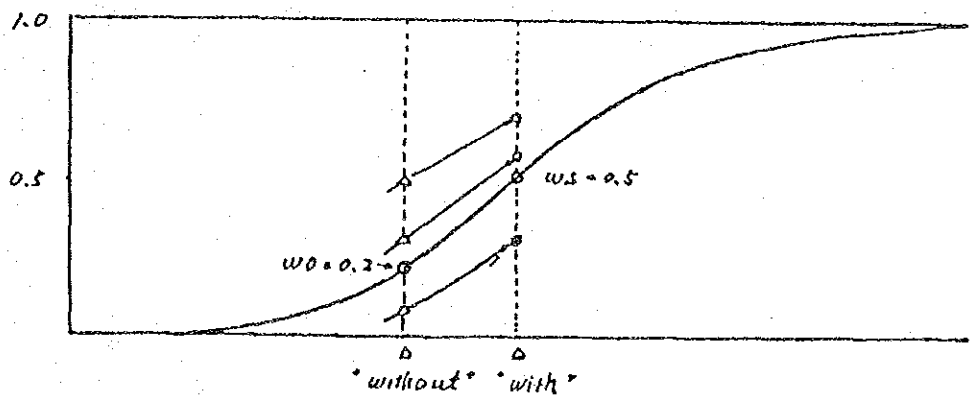
$$MS = AS + (1 - AS)\frac{WS - WO}{1 - WO} \quad \text{---------- (1)}$$

Where, MS: Share value after revision
AS: Share value based on actual measurements
WS: Estimated share "with" project
WO: Estimated share "without" project

2. Where: WO > AS

$$MS = AS \times \frac{WS}{WO} \quad \text{---------- (2)}$$

3. Conceptual Figure



4. Calculation Examples

(1) Where the share of actual measurement (AS) is 0.3,

$$0.3 + (1 - 0.3) \times \frac{0.5 - 0.2}{1 - 0.2} = 0.5625$$

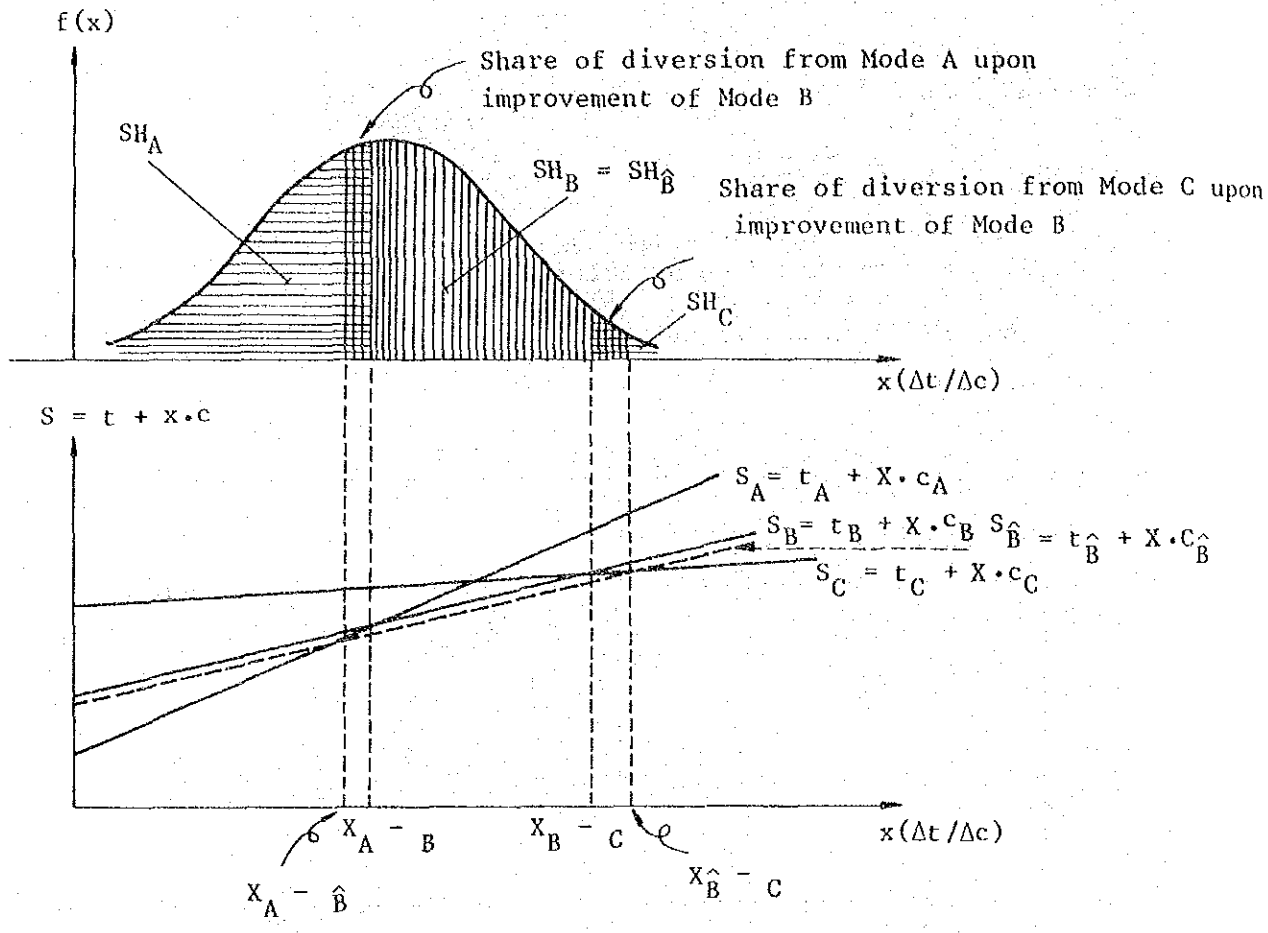
(2) Where the share of actual measurement (AS) is 0.5,

$$0.5 + (1 - 0.5) \times \frac{0.5 - 0.2}{1 - 0.2} = 0.6875$$

(3) Where the share of actual measurement (AS) is 0.1,

$$0.1 \times \frac{0.5}{0.2} = 0.25$$

Appendix 3.3.4 Diversion from Other Modes upon Improvement of Services



Note: Refer to Appendix 3.3.2
$\hat{B}$ means the improvement mode of Mode B.

Appendix 3.3.5 Traffic Volume and Services Improvement at Each Yard

(As of 1996)

	Traffic Volume		Improvement ("yes" = 1, "no" = 0)	
	Number of Passengers	Number of Cars	Passenger	Freight
1 Bangkok	26,649,565	-	1	-
2 Mae Nam	-	1,000	-	1
3 Bang Sue	-	1,155	0	1
4 Ban Phachi	1,228,701	40	1	1
5 Phitsanulok	1,794,316	210	1	0
6 Nakhon Ratchasima	654,762	210	1	0
7 Chumphon	337,132	75	0	0
8 Surat Thani	704,484	55	0	0
9 Thung Song	528,441	250	1	1
10 Hat Yai	1,407,919	330	1	1
Total	33,305,320	3,325	6	5

Appendix 3.4.1-(1) 1984 OD Table, Passenger Traffic Volume

1000passengers

	1	2	3	4	5	6	7
1	3.4	0.0	1163.4	453.5	0.0	1.7	208.0
2	0.1	0.0	0.0	0.1	0.0	0.0	0.0
3	1360.5	0.3	1180.9	319.7	0.0	3.0	17.0
4	474.7	0.1	519.1	1583.0	0.0	0.1	0.0
5	0.0	0.0	0.0	0.0	42.9	280.5	0.0
6	3.0	0.0	3.0	0.0	267.8	34.3	0.0
7	208.4	0.0	7.2	0.0	0.0	0.0	8.9
8	58.4	0.0	3.5	0.0	0.0	0.0	36.0
9	263.2	0.0	55.0	0.0	0.0	0.0	58.2
10	173.0	0.0	93.0	0.0	0.0	0.0	14.8
11	472.7	0.0	176.5	0.2	0.0	0.0	80.3
12	580.0	0.0	28.5	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	214.5	0.0	45.5	0.0	0.0	0.0	0.5
15	1213.9	0.0	57.2	0.0	0.0	0.0	0.7
16	82.7	0.0	34.6	0.0	386.1	6.3	0.0
17	428.2	0.0	136.6	0.0	0.0	0.0	16.7
18	692.7	0.0	803.2	0.9	0.0	0.0	9.5
19	30.4	0.0	16.2	0.1	421.9	58.3	0.0
20	509.7	0.1	1.2	651.7	0.1	0.3	0.6
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	58.4	0.0	12.5	0.0	33.7	1.3	0.0
23	537.1	0.0	9.4	0.0	43.5	0.3	0.3
24	525.9	0.0	1.2	0.0	99.7	0.1	0.4
25	8077.9	0.6	4347.8	3009.5	1295.7	376.1	452.0

	8	9	10	11	12	13	14
1	58.5	261.5	150.0	459.0	436.8	0.0	156.5
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	9.1	60.4	108.4	198.6	93.5	0.0	67.9
4	0.0	0.0	0.0	0.4	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	35.3	53.9	11.8	74.3	0.1	0.0	3.9
8	240.5	73.1	6.4	50.2	0.5	0.0	0.2
9	75.1	1966.5	40.8	455.7	0.8	0.0	0.2
10	6.5	39.0	2375.8	384.4	0.1	0.0	0.7
11	52.3	480.1	391.1	3910.3	0.1	0.0	2.9
12	0.5	0.1	0.1	0.1	521.4	0.0	218.1
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.1	6.3	1.0	2.0	228.9	0.0	5176.9
15	0.4	0.5	1.1	1.8	11.4	0.0	764.1
16	0.2	0.0	0.2	0.7	0.0	0.0	0.1
17	7.4	25.3	429.7	123.8	21.8	0.0	20.3
18	1.6	11.6	51.3	49.0	42.5	0.0	340.4
19	0.9	0.0	0.0	0.7	0.0	0.0	0.1
20	0.9	0.1	0.2	0.6	0.0	0.0	0.1
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.1	0.5	0.4	0.3	0.0	0.6
23	0.2	0.3	0.1	0.2	0.1	0.0	0.2
24	0.2	0.0	0.0	0.4	0.2	0.0	0.0
25	499.4	2973.1	3578.4	5712.6	1358.7	0.0	6753.1

	15	16	17	18	19	20	21
1	1383.5	74.3	329.7	710.5	20.5	518.9	0.0
2	0.9	0.0	0.0	0.0	0.0	0.1	0.0
3	156.8	38.7	161.6	928.5	18.6	1.0	0.0
4	0.0	0.0	0.1	1.9	0.1	597.3	0.0
5	0.3	233.1	0.0	0.0	459.1	0.0	0.0
6	0.3	6.0	0.0	0.0	60.1	0.4	0.0
7	0.7	0.0	16.6	10.1	0.0	0.0	0.0
8	0.5	0.0	7.8	4.3	0.0	0.0	0.0
9	0.7	0.0	27.8	11.7	0.0	0.1	0.0
10	1.0	0.2	428.8	53.4	0.0	0.1	0.0
11	1.1	0.1	127.6	56.2	0.1	0.5	0.0
12	10.3	0.0	19.7	38.2	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	775.5	0.1	29.2	102.0	0.1	0.1	0.0
15	5735.5	0.0	0.2	86.1	0.0	0.1	0.0
16	0.0	830.6	0.5	0.3	108.0	0.1	0.0
17	0.6	0.4	454.6	515.4	0.2	0.1	0.0
18	98.4	0.3	509.9	4474.9	0.1	0.6	0.0
19	0.1	115.8	0.3	0.2	681.3	0.3	0.0
20	0.2	0.1	0.1	0.5	0.2	2573.2	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.2	118.2	1.0	0.3	36.4	0.5	0.0
23	0.5	44.8	0.1	0.1	36.2	0.1	0.0
24	0.2	30.3	0.1	0.0	20.7	0.0	0.0
25	7865.6	1493.0	2116.1	7204.5	1441.6	3693.6	0.0

	22	23	24	25
1	68.6	584.7	497.4	7251.9
2	0.0	0.0	0.0	0.3
3	16.2	54.6	21.1	4816.5
4	0.0	0.0	0.0	3176.8
5	32.7	106.9	96.4	1251.7
6	0.9	0.1	0.1	365.9
7	0.1	0.3	0.4	432.9
8	0.0	0.2	0.2	492.2
9	0.0	0.0	0.0	2955.7
10	0.3	0.0	0.0	3571.1
11	0.1	0.1	0.4	5752.8
12	0.0	0.1	0.2	1417.3
13	0.0	0.0	0.0	0.0
14	0.5	0.1	0.2	6777.6
15	0.4	0.1	0.2	7884.2
16	121.0	48.4	20.2	1639.9
17	0.8	0.2	0.1	2181.9
18	0.1	0.1	0.0	7090.2
19	34.5	25.8	14.0	1398.9
20	0.5	0.1	0.0	3738.5
21	0.0	0.0	0.0	0.0
22	877.3	161.8	42.9	1356.5
23	169.5	6452.3	471.8	7927.2
24	40.1	468.3	8828.3	10016.0
25	1363.7	7904.2	9993.8	81488.0

Appendix 3.4.1-(2) Case II 1996 OD Table, Passenger Traffic Volume

1000 passengers

	1	2	3	4	5	6	7
1	7.3	0.2	2589.1	826.8	0.0	3.3	306.4
2	0.2	0.0	0.0	0.2	0.0	0.0	0.0
3	3027.8	0.6	2561.3	542.5	0.0	4.4	25.0
4	970.2	0.2	880.8	3699.0	0.0	0.2	0.0
5	0.0	0.0	0.0	0.0	136.5	750.6	0.0
6	5.8	0.0	4.4	0.0	716.6	74.8	0.0
7	306.9	0.0	10.7	0.0	0.0	0.0	13.0
8	99.4	0.0	5.1	0.0	0.0	0.0	52.3
9	359.0	0.0	75.0	0.0	0.0	0.0	77.3
10	279.7	0.0	150.3	0.0	0.0	0.0	20.8
11	666.9	0.0	249.1	0.2	0.0	0.0	110.3
12	813.0	0.0	40.0	0.0	0.0	0.0	0.1
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	317.2	0.0	67.3	0.0	0.0	0.0	0.6
15	1598.8	0.0	75.4	0.1	0.0	0.0	0.8
16	108.9	0.0	45.6	0.0	508.0	8.3	0.1
17	653.6	0.0	208.6	0.0	0.0	0.0	21.0
18	1091.1	0.0	1265.1	1.5	0.0	0.0	12.5
19	39.1	0.0	20.9	0.1	541.7	74.8	0.0
20	805.3	0.2	1.9	1029.6	0.1	0.5	0.8
21	36.7	0.0	10.4	46.9	6.2	6.2	53.9
22	116.8	0.0	21.3	0.0	57.6	2.2	0.1
23	962.1	0.0	13.0	0.0	60.0	0.4	0.4
24	714.1	0.0	1.6	0.0	135.3	0.1	0.5
25	12980.0	1.2	8296.9	6246.9	2162.0	925.8	695.9

	8	9	10	11	12	13	14
1	86.5	357.4	258.6	647.6	612.2	0.0	231.4
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	13.3	82.4	175.2	280.2	131.1	0.0	100.5
4	0.0	0.0	0.1	0.6	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	52.7	72.6	16.6	102.0	0.3	0.0	5.0
8	307.4	91.8	9.2	72.3	1.2	0.0	0.2
9	94.0	2092.9	46.3	527.8	0.9	0.0	0.2
10	9.3	44.2	2616.5	483.9	0.2	0.0	0.9
11	75.4	554.0	491.2	4538.3	0.2	0.0	3.5
12	1.0	0.1	0.2	0.1	687.1	0.0	274.4
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.4	0.4	1.3	2.4	288.0	0.0	5546.4
15	0.5	0.6	1.2	2.6	19.8	0.0	1057.5
16	0.0	0.0	0.3	1.0	0.0	0.0	0.2
17	9.3	27.3	524.0	153.1	28.9	0.0	32.9
18	6.1	13.7	76.2	66.2	52.6	0.0	439.2
19	0.0	0.0	0.0	0.7	0.0	0.0	0.1
20	0.0	0.1	0.4	2.0	0.2	0.0	0.2
21	70.5	150.2	125.4	393.3	311.1	0.0	49.5
22	0.0	0.1	0.5	0.4	0.4	0.0	0.7
23	0.2	0.4	0.1	0.2	0.1	0.0	0.2
24	0.2	0.0	0.0	0.4	0.3	0.0	0.0
25	726.8	3488.2	4343.3	7275.1	2134.6	0.0	7743.0

	15	16	17	18	19	20	21
1	1427.1	99.6	503.3	1102.1	26.3	822.3	22.4
2	0.0	0.0	0.0	0.0	0.0	0.2	0.0
3	206.5	51.9	246.8	1440.3	23.9	1.6	39.7
4	0.0	0.0	0.1	2.9	0.1	946.6	35.6
5	0.0	312.4	0.0	0.0	589.6	0.1	4.5
6	0.0	8.0	0.0	0.1	77.2	0.6	4.1
7	0.8	0.0	20.9	13.3	0.0	0.0	53.9
8	0.6	0.0	9.8	5.8	0.0	0.0	70.5
9	0.8	0.0	30.0	13.9	0.0	0.2	150.2
10	1.1	0.3	523.0	78.4	0.0	0.3	125.4
11	1.5	0.1	157.8	75.9	0.1	1.8	393.4
12	17.8	0.0	26.2	47.2	0.0	0.1	311.1
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	1073.3	0.1	47.5	394.8	0.1	0.2	49.5
15	6361.9	0.0	0.8	117.9	0.0	0.7	230.6
16	0.0	811.6	0.8	0.7	113.1	0.2	9.0
17	0.6	0.7	485.4	581.3	0.2	0.1	167.2
18	120.7	0.6	575.5	5036.3	0.1	1.1	124.6
19	0.1	121.2	0.3	0.2	661.2	0.4	13.1
20	1.3	0.2	0.1	1.1	0.3	3124.9	0.0
21	230.6	9.0	167.2	124.6	13.1	0.0	0.0
22	0.3	146.7	1.2	0.4	48.7	0.9	22.3
23	0.6	59.0	0.1	0.1	47.8	0.2	69.0
24	0.2	34.1	0.1	0.0	23.2	0.0	75.1
25	9445.8	1655.5	2796.9	9037.2	1625.0	4902.5	1971.2

	22	23	24	25
1	116.6	807.2	675.6	11629.3
2	0.0	0.0	0.0	0.6
3	27.6	75.3	28.7	9086.6
4	0.0	0.0	0.0	6536.4
5	55.5	147.5	130.9	2127.6
6	1.5	0.2	0.2	893.6
7	0.1	0.3	0.4	669.5
8	0.0	0.2	0.2	726.0
9	0.0	0.0	0.0	3468.5
10	0.4	0.1	0.0	4334.8
11	0.1	0.1	0.5	7320.4
12	0.1	0.1	0.3	2218.9
13	0.0	0.0	0.0	0.0
14	0.6	0.2	0.2	7790.5
15	0.5	0.1	0.2	9469.9
16	149.7	63.7	22.7	1843.9
17	0.9	0.2	0.1	2895.4
18	0.2	0.1	0.0	6883.4
19	46.2	34.1	15.7	1569.9
20	0.8	0.1	0.0	4970.1
21	22.3	69.0	75.1	1971.2
22	953.3	209.8	49.9	1633.6
23	218.7	6660.7	552.4	8645.7
24	46.7	548.3	9009.7	10589.9
25	1641.8	8617.3	10562.8	109275.9

Appendix 3.4.1-(3) Case II 2006 OD Table, Passenger Traffic Volume

1000 passengers

	1	2	3	4	5	6	7
1	8.6	0.2	2872.0	1042.1	0.0	3.8	425.2
2	0.2	0.0	0.0	0.4	0.0	0.0	0.0
3	3475.3	0.7	2959.4	605.0	0.0	5.4	34.7
4	1090.9	0.2	982.3	4441.8	0.0	0.2	0.0
5	0.0	0.0	0.0	0.0	32.0	897.5	0.0
6	6.6	0.0	5.4	0.0	856.9	96.2	0.0
7	426.8	0.0	14.8	0.0	0.0	0.0	18.1
8	136.8	0.0	7.0	0.0	0.0	0.0	53.6
9	463.4	0.0	96.8	0.0	0.0	0.0	85.4
10	404.1	0.0	217.1	0.0	0.0	0.0	30.7
11	877.9	0.0	327.9	0.3	0.0	0.0	143.0
12	934.2	0.0	45.9	0.0	0.0	0.0	0.2
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	429.1	0.0	91.0	0.0	0.0	0.0	0.9
15	1757.9	0.0	82.9	0.1	0.0	0.0	1.2
16	108.0	0.0	45.2	0.0	503.9	8.2	0.1
17	864.4	0.0	275.8	0.0	0.0	0.0	28.5
18	1215.3	0.0	1409.2	1.6	0.0	0.0	17.7
19	38.8	0.0	20.7	0.1	538.7	74.4	0.0
20	942.1	0.2	2.2	1204.6	0.1	0.6	1.1
21	30.2	0.0	8.6	38.6	5.1	5.1	64.3
22	131.4	0.0	24.0	0.0	64.8	2.5	0.1
23	1080.3	0.0	14.6	0.0	67.4	0.4	0.5
24	883.5	0.0	1.9	0.0	167.5	0.1	0.6
25	15305.8	1.3	9604.6	7334.8	2236.4	1094.3	905.9

	8	9	10	11	12	13	14
1	119.0	461.2	373.7	846.6	703.5	0.0	313.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	18.2	106.4	253.1	366.3	150.6	0.0	135.9
4	0.0	0.0	0.1	0.8	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	53.9	80.7	24.5	136.2	0.5	0.0	7.0
8	337.9	94.9	13.6	106.3	1.4	0.0	0.3
9	97.1	2170.0	45.7	541.6	1.0	0.0	0.2
10	13.8	43.6	2727.4	528.4	0.3	0.0	1.3
11	110.8	567.9	535.8	5050.4	0.2	0.0	4.7
12	1.3	0.1	0.2	0.1	710.9	0.0	289.1
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.5	0.4	1.8	3.2	303.5	0.0	6140.2
15	0.7	0.9	1.5	3.7	34.0	0.0	1403.4
16	0.0	0.0	0.5	1.5	0.0	0.0	0.2
17	12.5	26.4	557.5	199.1	27.3	0.0	54.3
18	8.6	12.3	81.8	93.3	51.6	0.0	484.5
19	0.0	0.0	0.1	0.9	0.0	0.0	0.1
20	0.0	0.1	0.3	1.7	0.1	0.0	0.2
21	84.3	240.7	144.8	615.7	419.5	0.0	48.9
22	0.1	0.1	0.7	0.6	0.4	0.0	1.0
23	0.3	0.4	0.1	0.3	0.1	0.0	0.3
24	0.3	0.0	0.0	0.5	0.3	0.0	0.1
25	859.3	3806.1	4763.2	8497.2	2405.2	0.0	8884.7

	15	16	17	18	19	20	21
1	1569.1	98.9	665.6	1220.6	26.2	963.3	18.5
2	0.0	0.0	0.0	0.0	0.0	0.2	0.0
3	227.0	51.5	326.3	1595.2	23.8	1.9	32.7
4	0.0	0.0	0.2	3.2	0.1	1108.8	29.3
5	0.0	310.3	0.0	0.0	586.3	0.1	3.7
6	0.0	8.0	0.0	0.1	76.8	0.7	3.4
7	1.2	0.0	28.4	18.8	0.0	0.0	64.3
8	0.8	0.0	13.1	8.1	0.0	0.0	84.3
9	1.2	0.0	28.9	12.5	0.0	0.2	240.7
10	1.4	0.5	556.5	84.0	0.0	0.2	144.8
11	2.1	0.2	205.2	107.0	0.1	1.6	615.9
12	30.7	0.0	24.8	46.3	0.0	0.1	419.5
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	1420.0	0.2	78.3	438.2	0.1	0.2	48.9
15	6739.1	0.0	1.0	154.2	0.0	0.5	281.6
16	0.0	746.1	1.3	1.3	106.9	0.4	7.3
17	0.8	1.1	501.7	568.3	0.2	0.1	204.4
18	158.0	1.1	562.8	4895.5	0.2	1.2	135.5
19	0.1	114.6	0.3	0.2	600.4	0.8	11.5
20	1.0	0.3	0.1	1.2	0.5	3232.9	0.0
21	281.6	7.3	204.4	135.5	11.5	0.0	0.0
22	0.3	161.7	1.5	0.5	63.4	1.6	23.1
23	0.9	83.3	0.1	0.1	67.8	0.3	76.7
24	0.2	43.3	0.2	0.0	29.3	0.0	94.1
25	10435.5	1628.4	3200.7	9290.8	1593.6	5315.1	2540.2

	22	23	24	25
1	131.0	906.6	836.2	13704.9
2	0.0	0.0	0.0	0.9
3	31.0	84.6	35.5	10520.4
4	0.0	0.0	0.0	7658.1
5	62.4	165.7	162.0	2220.0
6	1.7	0.2	0.2	1056.1
7	0.1	0.4	0.5	876.2
8	0.0	0.3	0.3	858.7
9	0.0	0.0	0.0	3784.7
10	0.5	0.1	0.0	4754.7
11	0.1	0.2	0.6	8551.9
12	0.1	0.1	0.3	2503.9
13	0.0	0.0	0.0	0.0
14	0.8	0.2	0.2	8957.7
15	0.6	0.2	0.3	10463.8
16	164.7	89.8	28.8	1814.2
17	1.1	0.3	0.1	3323.9
18	0.2	0.1	0.0	9130.5
19	61.4	48.4	19.8	1531.3
20	1.4	0.2	0.0	5390.9
21	23.1	76.7	94.1	2540.0
22	965.7	238.7	64.1	1746.3
23	248.0	6953.3	702.8	9298.0
24	59.9	697.6	9977.0	11856.4
25	1753.8	9263.7	11922.8	122643.5

Appendix 3.4.2-(1) 1984 OD Table, Freight Traffic Volume

1000tons

	1	2	3	4	5	6	7
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	11.1	0.0	0.0	0.0	208.0
3	0.0	1.1	0.0	0.0	0.0	0.0	9.5
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.1	0.0	0.0	0.0	0.0	0.1
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	30.5	1.5	0.0	0.0	5.6	0.0
8	0.0	9.1	0.4	0.0	0.0	0.0	0.0
9	0.0	64.2	2.1	0.0	0.6	5.3	2.6
10	0.0	1.0	469.7	41.0	27.7	0.0	39.4
11	0.0	765.3	2.3	0.0	0.0	0.0	3.5
12	0.0	20.8	1.9	0.0	0.0	0.2	0.3
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	8.7	4.7	0.2	0.0	0.0	0.1
15	0.0	30.1	3.9	0.0	0.0	0.0	0.6
16	0.0	4.5	42.1	0.0	0.4	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	2.6	380.0	27.8	68.2	0.0	6.6
19	0.0	0.0	0.0	0.0	0.0	0.0	0.1
20	0.0	0.6	0.4	3.4	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.1	54.0	0.0	1.7	0.0	2.6
23	0.0	102.1	12.5	0.0	24.5	11.8	11.1
24	0.0	17.4	11.8	0.0	18.6	0.4	1.0
25	0.0	1058.6	398.4	72.3	142.7	23.3	285.5

	8	9	10	11	12	13	14
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	184.5	88.4	82.4	137.7	404.0	0.0	93.8
3	3.8	3.0	1.6	7.3	8.5	0.0	2.2
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	10.6	0.0	0.3	0.0	0.0
8	0.2	0.2	6.2	0.1	0.0	0.0	0.1
9	0.7	2.3	21.9	0.4	0.1	0.0	0.1
10	8.9	2.0	1.5	5.3	0.7	0.0	0.5
11	1.9	0.4	94.4	0.1	0.0	0.0	0.1
12	0.0	0.1	2.8	0.0	0.6	0.0	0.2
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.2	0.1	2.1	0.0	1.6
15	0.0	0.0	0.9	0.0	0.0	0.0	2.0
16	0.0	0.0	1.5	0.0	0.0	0.0	0.2
17	0.0	0.0	0.0	0.0	0.1	0.0	0.0
18	1.9	0.0	11.9	0.0	34.1	0.0	46.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.1	0.2	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	2.4	1.9	1.8	7.9	3.2	0.0	1.0
23	0.4	1.3	4.6	6.7	3.3	0.0	19.2
24	0.1	0.1	0.3	0.7	0.5	0.0	0.3
25	204.9	99.8	242.7	166.5	457.5	0.0	167.5

	15	16	17	18	19	20	21
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	140.6	7.1	0.0	60.6	0.0	3.6	0.0
3	13.5	0.8	0.0	0.3	0.1	2.6	0.0
4	0.0	0.0	0.0	0.0	0.0	17.4	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.1	0.0	0.0	0.0	0.0	0.0
8	0.0	0.1	0.0	0.0	0.0	0.0	0.0
9	0.0	0.2	0.0	0.0	0.4	8.3	0.0
10	1.8	0.1	0.0	0.5	0.1	0.9	0.0
11	0.0	1.0	0.0	15.1	3.4	0.0	0.0
12	0.0	0.7	0.1	0.0	1.6	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.7	2.3	0.0	0.8	0.5	4.2	0.0
15	0.2	1.5	0.0	5.5	2.5	0.1	0.0
16	0.0	0.2	0.0	1.4	0.0	0.0	0.0
17	0.0	0.0	0.0	0.2	0.0	0.0	0.0
18	45.0	0.2	0.0	0.3	23.6	26.5	0.0
19	0.0	0.1	0.0	0.0	0.1	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.4	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	1.0	0.2	1.2	0.0	11.8	0.1	0.0
23	2.9	19.2	0.0	5.0	6.9	0.0	0.0
24	1.1	0.2	0.0	0.0	0.3	0.0	0.0
25	207.4	33.9	1.4	120.0	51.4	64.5	0.0

	22	23	24	25
1	0.0	0.0	0.0	0.0
2	0.0	17.9	96.3	1536.2
3	0.5	30.3	77.0	162.1
4	0.0	0.0	0.0	17.4
5	0.0	13.0	67.8	81.0
6	0.0	0.3	0.0	0.4
7	0.0	1.6	3.6	53.8
8	0.0	2.0	3.2	21.7
9	0.5	14.3	49.0	173.0
10	0.2	4.7	30.7	636.8
11	0.7	10.5	63.1	992.1
12	0.1	10.1	27.5	67.0
13	0.0	0.0	0.0	0.0
14	3.4	10.5	14.3	54.6
15	4.8	9.8	60.4	122.8
16	0.2	3.2	41.2	94.9
17	0.0	0.0	0.2	0.6
18	0.0	1.7	5.1	681.9
19	1.1	4.6	28.8	34.8
20	0.0	0.1	0.3	5.4
21	0.0	0.0	0.0	0.0
22	0.9	0.6	21.6	114.2
23	6.8	96.3	196.7	531.3
24	0.7	2.5	67.3	124.2
25	20.0	234.1	853.8	5506.4

Appendix 3.4.2-(2) Case II 1996 OD Table, Freight Traffic Volume

1000 tons

	1	2	3	4	5	6	7
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	25.8	0.0	0.0	0.0	165.8
3	0.0	0.8	0.1	0.0	0.0	0.0	7.8
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.1	0.0	0.0	0.0	0.1	0.1
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	23.1	1.1	0.0	0.0	4.2	0.0
8	0.0	8.0	0.4	0.0	0.0	0.0	1.3
9	0.0	57.0	1.5	0.0	0.5	3.8	1.8
10	0.0	2.4	546.4	47.4	32.0	0.0	39.8
11	0.0	765.0	2.4	0.0	0.0	0.0	2.2
12	0.0	22.9	1.6	0.0	0.0	0.2	0.3
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	9.7	5.2	0.1	0.0	0.0	0.1
15	0.0	36.4	3.4	0.0	0.0	0.0	0.4
16	0.0	19.2	192.2	0.0	0.4	0.1	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	4.1	591.0	35.6	87.7	0.0	6.6
19	0.0	0.0	0.0	0.0	12.1	6.6	0.0
20	0.0	1.5	1.1	0.1	0.0	0.0	0.0
21	0.0	71.7	168.4	0.3	74.0	0.3	23.1
22	0.0	7.4	76.5	0.0	9.0	3.1	1.9
23	0.0	157.6	19.0	0.0	35.2	18.0	8.9
24	0.0	17.5	11.8	0.0	18.6	0.4	0.7
25	0.0	1204.6	1647.7	83.7	270.4	36.8	260.8

	8	9	10	11	12	13	14
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	150.2	76.1	74.2	123.2	314.4	0.0	110.4
3	3.2	2.4	3.1	7.1	6.8	0.0	2.4
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	1.3	0.0	3.4	0.0	0.5	0.0	0.0
8	0.2	0.3	3.3	0.1	0.0	0.0	0.1
9	0.5	2.4	12.2	0.6	0.8	0.0	0.1
10	9.6	2.1	1.1	6.9	0.9	0.0	0.7
11	1.5	0.7	15.1	0.1	0.0	0.0	0.1
12	0.0	0.7	3.5	0.4	0.2	0.0	0.2
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.3	0.1	2.4	0.0	2.2
15	0.0	0.0	0.7	0.0	0.0	0.0	1.6
16	0.0	0.0	4.0	0.0	0.0	0.0	0.4
17	0.0	0.0	0.0	0.0	0.1	0.0	0.0
18	2.0	0.0	10.5	0.0	41.4	0.0	68.8
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.1	0.3	0.0	0.0	0.0
21	19.5	9.6	19.4	18.3	35.9	0.0	26.3
22	1.5	1.6	1.3	5.5	2.3	0.0	0.8
23	0.2	1.1	3.6	4.6	2.4	0.0	16.8
24	0.1	0.1	0.2	0.5	0.4	0.0	0.3
25	190.1	97.3	156.2	167.7	408.4	0.0	231.3

	15	16	17	18	19	20	21
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	148.3	36.9	0.0	100.5	0.0	5.7	78.3
3	11.5	3.4	0.0	3.8	4.8	5.7	39.4
4	0.0	0.0	0.0	0.0	0.0	23.3	0.0
5	0.0	0.1	0.0	0.0	0.4	0.0	15.2
6	0.0	0.0	0.0	0.0	1.8	0.0	8.9
7	0.0	0.1	0.0	0.9	0.0	0.0	6.9
8	0.1	0.1	0.0	0.0	0.0	0.0	12.9
9	0.0	0.1	0.0	0.0	0.3	1.2	13.1
10	2.4	0.2	0.0	3.1	0.1	0.8	63.4
11	0.0	0.7	0.0	4.0	2.6	0.0	73.1
12	0.0	0.6	0.1	0.0	1.4	0.0	96.9
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	1.0	2.4	0.0	1.5	0.6	0.7	105.6
15	0.8	1.2	0.0	2.9	1.8	0.1	60.5
16	0.0	0.4	0.1	6.3	1.1	0.1	17.5
17	0.1	0.0	0.3	1.1	0.0	0.0	22.5
18	57.5	1.6	3.1	0.0	28.2	11.6	137.7
19	0.0	0.7	0.0	0.0	0.1	0.0	0.6
20	0.0	0.0	0.0	0.0	0.0	0.4	0.6
21	59.4	9.1	15.9	12.5	0.5	0.9	0.0
22	0.7	0.2	0.9	0.0	14.4	0.0	7.4
23	2.1	16.7	0.0	5.2	6.6	0.0	23.1
24	0.9	0.1	0.0	0.0	0.4	0.0	9.5
25	284.9	74.8	20.3	141.1	65.1	50.7	793.1

	22	23	24	25
1	0.0	0.0	0.0	0.0
2	0.0	19.2	66.1	1495.3
3	11.8	43.1	55.8	213.2
4	0.0	0.0	0.0	23.4
5	0.7	19.2	51.9	87.7
6	0.0	0.5	0.0	11.3
7	0.0	1.2	3.5	45.2
8	0.0	1.5	2.9	31.0
9	0.4	9.9	41.6	148.0
10	0.1	4.0	24.8	788.2
11	0.4	7.2	53.5	928.4
12	0.1	7.7	26.3	163.1
13	0.0	0.0	0.0	0.0
14	2.2	7.1	11.9	153.1
15	3.2	6.9	54.9	175.4
16	0.2	3.2	32.2	277.6
17	0.0	0.0	0.2	24.2
18	0.0	1.7	4.3	1093.7
19	1.2	3.9	21.4	46.7
20	0.0	0.1	0.1	4.4
21	1.8	86.3	134.4	787.8
22	1.3	1.4	19.2	156.2
23	11.6	75.4	197.7	606.1
24	0.7	2.7	29.8	95.5
25	35.6	302.2	832.8	7355.5

Appendix 3.4.2-(3) Case II 2006 OD Table, Freight Traffic Volume

1000 tons

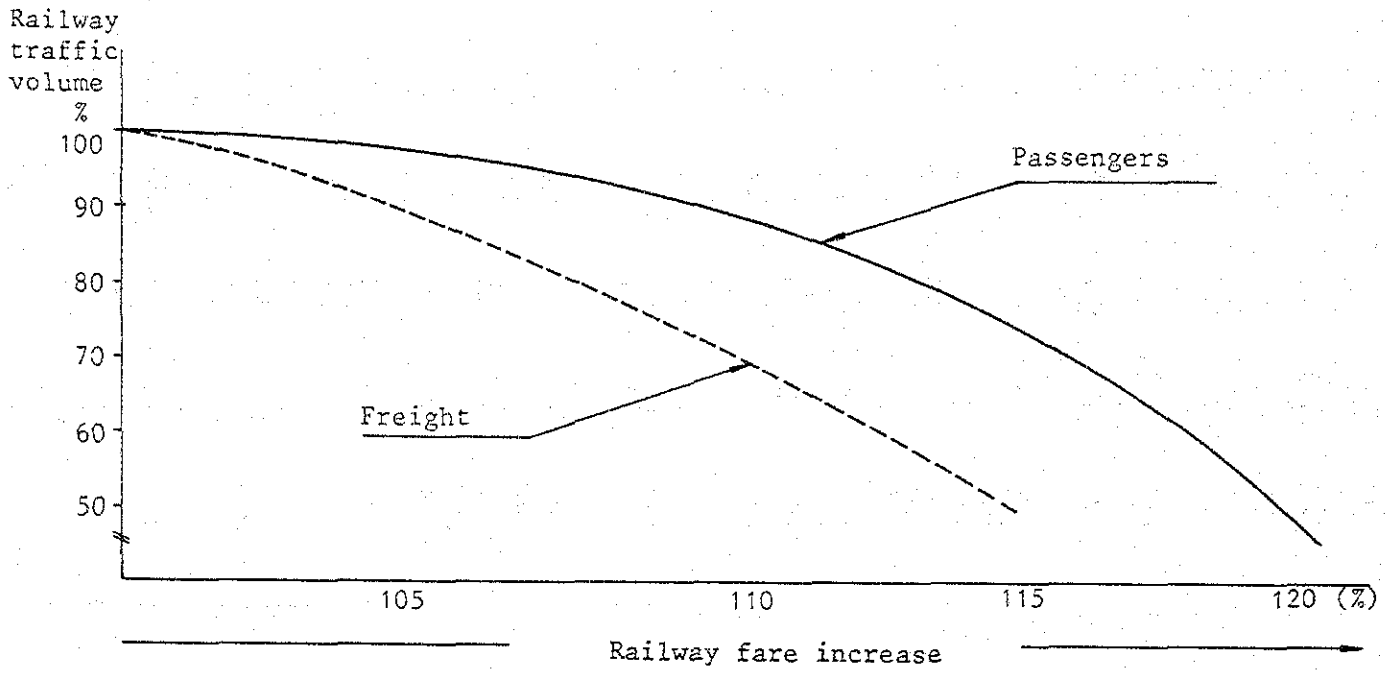
	1	2	3	4	5	6	7
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	28.4	0.0	0.0	0.0	182.3
3	0.0	0.9	0.1	0.0	0.1	0.0	8.5
4	0.0	0.0	0.1	0.0	0.0	0.0	0.0
5	0.0	0.1	0.0	0.0	0.0	0.1	0.1
6	0.0	0.1	0.0	0.0	0.0	0.0	0.0
7	0.0	23.8	1.2	0.0	0.0	4.3	0.0
8	0.0	8.0	0.4	0.0	0.0	0.0	1.4
9	0.0	63.0	1.5	0.0	0.6	4.0	1.5
10	0.0	2.5	571.3	49.6	33.5	0.0	47.0
11	0.0	759.6	2.4	0.0	0.0	0.0	2.0
12	0.0	28.6	1.8	0.0	0.0	0.2	0.3
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	11.0	5.6	0.1	0.0	0.0	0.1
15	0.0	46.6	3.8	0.0	0.0	0.0	0.4
16	0.0	20.4	204.1	0.0	0.4	0.1	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	4.3	623.6	37.4	92.0	0.0	7.4
19	0.0	0.0	0.0	0.0	13.5	7.3	0.0
20	0.0	1.8	1.3	0.2	0.0	0.0	0.0
21	0.0	86.1	202.1	0.4	88.8	0.4	23.6
22	0.0	8.2	74.6	0.0	9.9	3.5	1.5
23	0.0	173.8	21.0	0.0	38.6	19.8	9.4
24	0.0	19.0	12.7	0.0	21.1	0.4	0.6
25	0.0	1257.9	1756.9	87.7	298.5	40.1	286.6

	8	9	10	11	12	13	14
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	163.6	83.9	81.1	134.9	371.4	0.0	138.1
3	3.5	2.7	3.5	7.7	7.7	0.0	2.8
4	0.0	0.0	0.1	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	1.5	0.0	3.8	0.0	0.6	0.0	0.0
8	0.3	0.3	3.7	0.1	0.0	0.0	0.1
9	0.5	2.7	11.4	0.7	1.0	0.0	0.1
10	11.4	2.4	1.3	8.2	1.1	0.0	0.8
11	1.4	0.7	15.8	0.1	0.0	0.0	0.1
12	0.0	0.8	4.1	0.5	0.3	0.0	0.3
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.4	0.1	3.0	0.0	2.7
15	0.0	0.0	0.8	0.0	0.0	0.0	1.7
16	0.0	0.0	4.4	0.0	0.0	0.0	0.4
17	0.0	0.0	0.0	0.0	0.1	0.0	0.1
18	2.3	0.0	11.9	0.9	49.7	0.0	86.3
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.2	0.4	0.0	0.0	0.0
21	20.0	10.0	20.2	19.1	39.7	0.0	29.1
22	1.3	1.4	1.2	4.8	2.1	0.0	0.7
23	0.2	1.0	3.7	4.1	2.2	0.0	17.9
24	0.1	0.1	0.2	0.4	0.4	0.0	0.2
25	206.1	106.2	167.6	181.1	479.4	0.0	281.3

	15	16	17	18	19	20	21
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	181.5	41.1	0.0	111.9	0.0	8.0	96.1
3	13.3	3.8	0.0	4.3	5.6	7.5	48.4
4	0.0	0.0	0.0	0.0	0.0	33.7	0.0
5	0.0	0.1	0.0	0.0	0.4	0.0	18.6
6	0.0	0.0	0.0	0.0	2.1	0.0	11.0
7	0.1	0.1	0.0	0.0	0.0	0.0	9.6
8	0.1	0.1	0.0	0.0	0.0	0.0	18.3
9	0.0	0.1	0.0	0.0	0.3	1.5	18.6
10	2.9	0.2	0.0	3.6	0.1	1.1	86.4
11	0.0	0.7	0.0	4.4	2.4	0.0	100.6
12	0.0	0.6	0.1	0.0	1.5	0.0	135.6
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	1.2	2.8	0.0	1.8	0.7	1.0	134.9
15	1.0	1.1	0.0	3.5	1.8	0.2	83.5
16	0.0	0.5	0.1	7.1	1.3	0.1	21.9
17	0.1	0.0	0.3	1.3	0.0	0.0	29.5
18	69.9	1.8	3.5	0.0	31.6	15.5	212.2
19	0.0	0.8	0.0	0.0	0.1	0.0	0.8
20	0.0	0.0	0.0	0.1	0.0	0.7	0.9
21	65.4	10.2	16.0	13.5	0.7	1.5	0.0
22	0.7	0.3	0.7	0.0	15.1	0.0	11.0
23	2.1	19.1	0.0	5.7	7.7	0.1	31.8
24	1.0	0.1	0.0	0.0	0.3	0.0	12.3
25	339.1	83.5	20.7	157.2	71.6	70.9	1081.9

	22	23	24	25
1	0.0	0.0	0.0	0.0
2	0.0	23.4	63.0	1710.0
3	13.7	49.4	62.3	245.5
4	0.1	0.0	0.0	33.9
5	0.8	22.0	56.6	99.0
6	0.0	0.6	0.0	13.7
7	0.0	1.1	4.0	49.9
8	0.0	1.5	3.3	37.3
9	0.3	8.7	44.0	160.6
10	0.1	4.9	27.0	855.4
11	0.4	5.6	57.4	954.6
12	0.1	7.2	29.6	211.5
13	0.0	0.0	0.0	0.0
14	1.8	6.3	12.7	186.1
15	2.9	6.3	60.0	213.4
16	0.2	3.6	34.8	299.3
17	0.0	0.0	0.2	31.5
18	0.0	1.8	4.9	1256.4
19	1.3	3.8	20.5	48.2
20	0.0	0.1	0.1	5.8
21	2.3	109.5	171.9	930.6
22	1.3	1.5	21.1	161.0
23	13.2	91.9	229.5	692.7
24	0.7	2.9	30.7	103.6
25	39.4	353.1	933.7	8300.4

Appendix 3.5.1 Sensitivity Analysis by Application of the Least Sacrificed Model



Appendix 3.5.2 Estimate of Railway Traffic Demands with Implementation of the Eastern Seaboard Development Project

(1) Population, GDP, and GRP of the whole country and those of the developed areas

		1976	1980	* Current year	Forecast results	
					1996	2006
Population (Thousand persons)	Country	43,214 85	46,962 93	50,583 100	60,478 120	68,140 138
	Zone 21	999 84	1,084 91	1,186 100	1,675 141	2,155 182
GDP, GRP (Million bahts)	Country	261,099 76	292,853 85	342,879 100	657,718 192	1,021,415 298
	Zone 21	11,582 76	12,058 79	15,334 100	36,380 237	69,257 451

* Current year is 1984 for population and 1983 for freight

(2) Railway traffic demands

		1976	1980	1984	* Forecast results	
					1996	2006
Passengers (Thousand persons)	Country	55,759 68	74,286 91	81,498 100	95,809 118	106,222 130
	Zone 21	--	--	--	2,420	2,890
Freight (Thousand tons)	Country	5,350 97	6,230 113	** 5,506 100	6,088 111	6,838 124
	Zone 21	--	--	--	1,313	1,673

* Case II, "without project"
** Based on the OD tables provided from SRT

(3) Estimate of the railway traffic demand of Zone 21 without implementation of the Eastern Seaboard Development Project

	1976	1980	1984	* Forecast results	
				1996	2006
Population (Thousand persons)	999	1,084	1,186	** 1,489	** 1,765
GRP (Million bahts)	11,582	12,058	15,334	*** 22,741	*** 30,726
Passengers (Thousand persons)	--	--	--	**** 590	**** 945
Freight (Thousand tons)	--	--	--	***** 1,313	***** 1,673

* Case II, "without"

** Estimate formula $\log POP = -7.438111 + 1.716827 \cdot \log t$,
POP: Population (Million persons)

*** Estimate formula $\log GRP = -10.73828 + 3.03711 \cdot \log t$
GRP: GRP (Billion bahts)

**** Estimate formula $\log TRF = -4.049996 + 1.00032 \cdot (POP \times GRP)$ (t)
TRF: Traffic volume (Million persons)

***** Railway freight traffic demand is assumed to generate with implementation of the development project. In other words, if the development project is not implemented, the freight traffic demand occuring in this area is handled entirely by roads and waterways.

(4) Traffic demand percentages of Zone 21, with the development project, of the total traffic demand in 2006

Passenger percentage (WTp): WTp = (2890-945)/2890 = 0.673
Freight percentage (WTf): WTf = 1,673 ÷ 1,673 = 1.000

Appendix 4.1.1 Passenger Fluctuation by Month