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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

OFFICE OF THE NATIONAL ECONOMIC AND SOCIAL DEVELOPMENT BOARD
STATE RAILWAY OF THAILAND
THE KINGDOM OF THAILAND

THE STUDY
ON
AN IMPROVEMENT PLAN
FOR RAILWAY TRANSPORT
IN AND AROUND THE BANGKOK METROPOLIS
IN CONSIDERATION OF URBAN DEVELOPMENT
I N
THE KINGDOM OF THAILAND

FINAL REPORT

EXECUTIVE SUMMARY

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YACHIYO ENGINEERING
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PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct the Study on an Improvement Plan for Railway Transport in and around the Bangkok Metropolis in Consideration of Urban Development in the Kingdom of Thailand and entrusted the study to the Japan International Cooperation Agency (JICA).

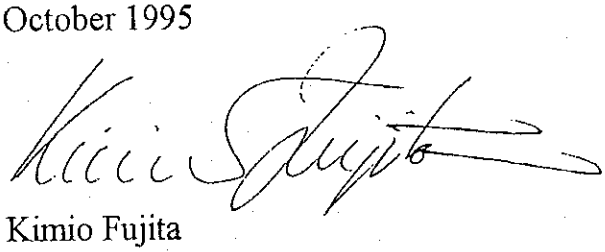
JICA sent to Thailand a study team headed by Dr. Misao Sugawara, a Board Member of Japan Railway Technical Service (JARTS), consisting of JARTS, Yachiyo Engineering Co., Ltd. and ALMEC Corporation, 6 times between August 1993 and August 1995.

The team held discussions with the officials concerned of the Government of Thailand, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

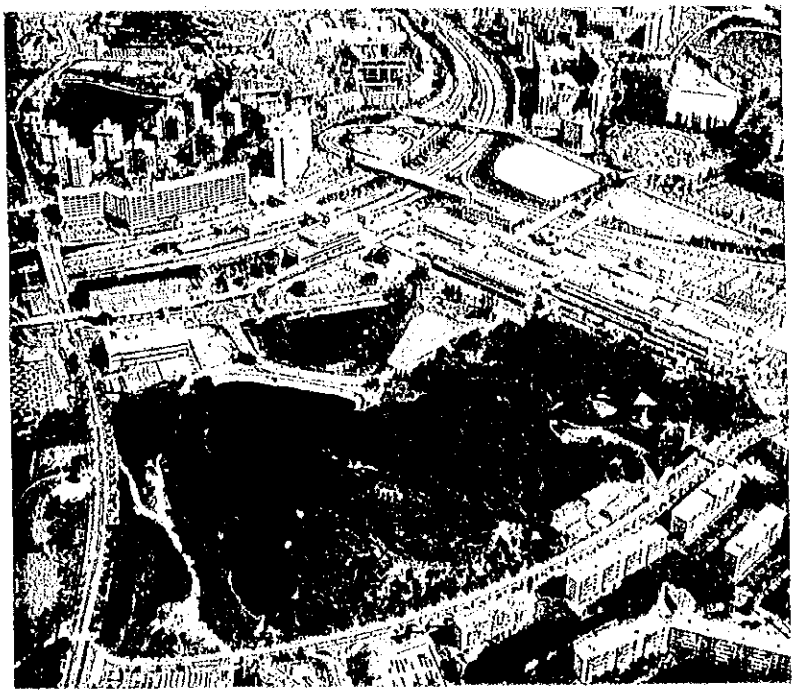
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

October 1995

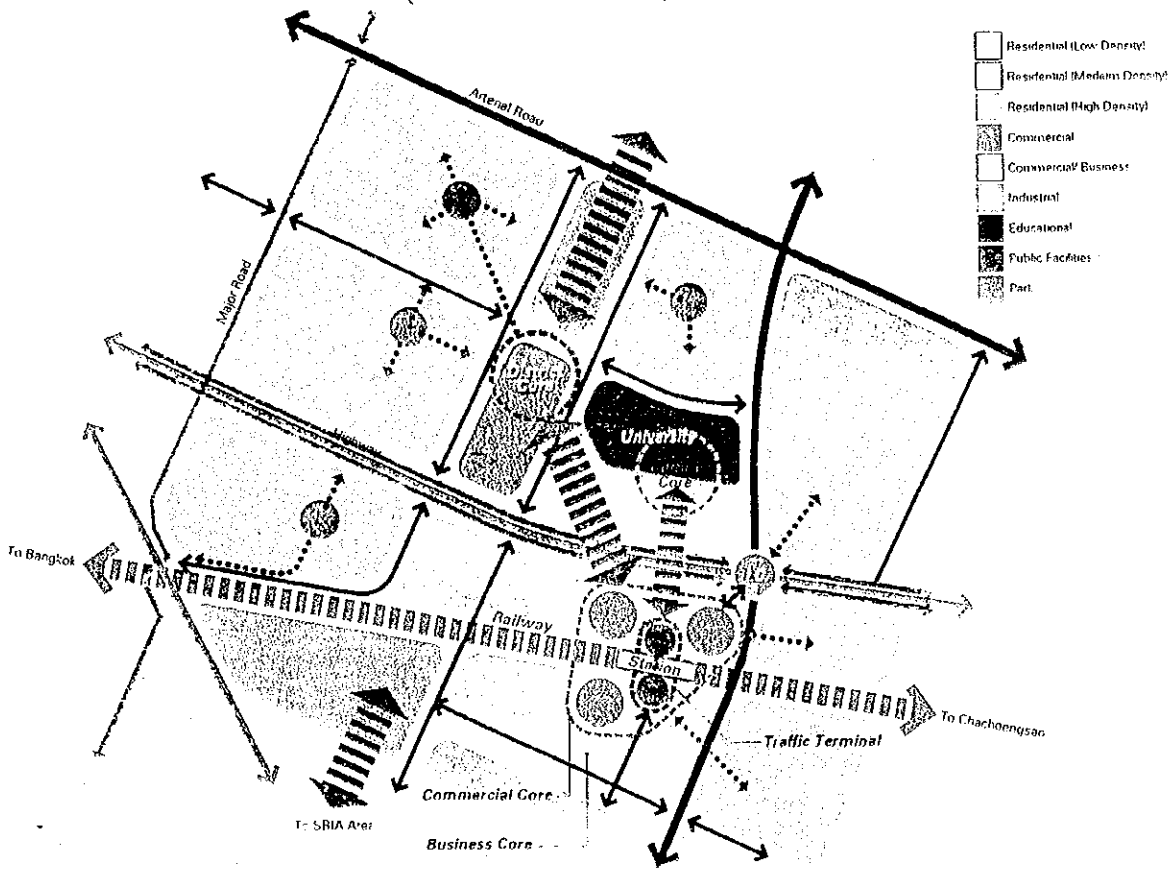


Kimio Fujita
President
Japan International Cooperation Agency



Example of Integrated Urban and Railway Development

(Senboku New Town)



General Structure of Urban Center Development

around Lat Krabang East Station

THE STUDY
ON
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- ABSTRACT -

1. Purpose and Object of the Study

The Study aims at confirming the necessity and feasibility of the urban development integrated with railway improvement, in order to cope with the road traffic congestion in Bangkok and entailed environmental disruption including air pollution, as well as to provide favorable living conditions to the suburbans who will further increase in the future by inducing the transfer of traffic from roads to the railway for commuting to the city center. For that purpose, the Study Team made a master plan on improvement and reinforcement of railway transport integrated with urban development along the railway lines in and around Bangkok Metropolis (within a radius of 200 km from the center), and also carried out a feasibility study on the Eastern Line (a railway line with a length of approx. 100km) as the priority project selected in the master plan.

2. Outline of the Study

2.1 General

(1) A master plan was drawn up for the urban development integrated with the railway improvement along the Eastern, Northern, Southern, and Maeklong Lines of SRT. Then, based on the social, economic, financial, and technical evaluations for each line, the Eastern Line was selected as a high-priority object of the feasibility study.

(2) Concerning the Eastern Line of SRT, a detailed plan of reinforcing railway transport capacities was drawn up, and the possibility of the urban development integrated with the railway improvement was studied for the regions 20 to 50km from the city center. Especially, for the region of 120 ha centering on Lat Krabang East Station, a detailed plan for urban development was drawn up by placing emphasis on railway utilization.

(3) As a concrete measure for the urban development, the method of the land readjustment for which legalization is in progress in Thailand was used. At the same time, the amount of the development benefit was estimated together with the increase in the land utility due to the reduction of the commuting time to the city center of

Bangkok.

(4) For the Eastern Line of SRT, the railway transport improvement integrated with the urban development along the route was planned, and economic and financial analysis was made concerning the plan including the transport demand which would increase by the urban development. At the same time, the amount of the external free fund necessary for making the project feasible was estimated.

(5) For local cities within the zone of 200km from the city center of Bangkok and not covered by the integrated urban and railway development described above, transport improvement by such measures as the introduction of intercity express trains was planned, in order to promote the growth of these cities.

(6) In order that the development benefit from the full-scale urban development along the Eastern Line can be recycled for the investment for the railway transport improvement to the extent possible, the organizations and systems necessary for such recycling were studied and related recommendations were made.

2.2 Target Year of the Study

The target year of the study is 2010.

2.3 Population Distribution Plan

(1) For the master plan

For mapping out the master plan of the integrated development plan, the distribution of the newly developed population was assumed as shown in the Table-S.1.

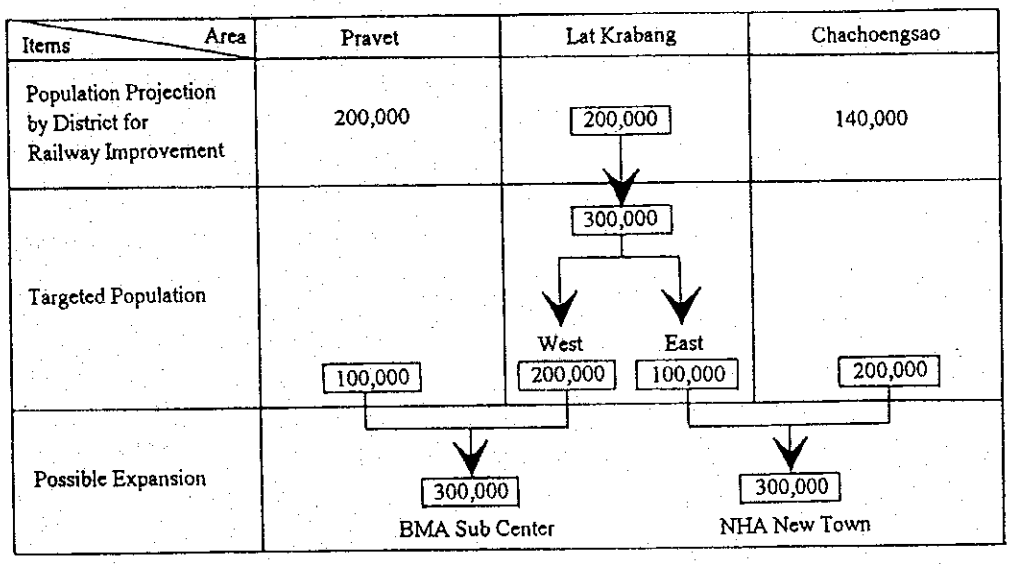
Table-S.1 Distribution Plan of the Newly Developed Population for the Master Plan

Name of Line / Item	East	North	South	Maeklong	Total
Newly developed population	500	640	360	200	1,700

(2) For the feasibility study in the area along the Eastern Line

For the feasibility study in the area along the Eastern Line, the newly developed population was assumed as shown in the Table-S.2, taking into account the policy of the population projection in the area along the Eastern Line of SRT.

Table-S.2 Population Projection and Target Population for the Feasibility Study in the Area along the Eastern Line



2.4 Improvement Plan of the Railway Transport

In the section where the Hopewell Project is being implemented, electrification facilities will be added to the above project.

In the other sections, the following measures will be taken for railway improvement.

- Electrification
- Strengthening structures, tracks, signaling systems, etc.
- Improvement of station facilities, level crossings with roads
- Introduction of electric railcars
- Reinforcement of services by diesel railcars, etc.

By the improvement of the above-mentioned facilities, railway service will be modernized as follows.

(1) Commuter and suburban transport on the sections covered by the integrated urban and railway development.
   a) Train speed: Scheduled speed, 65km/h (average of rapid and local trains)
   b) Frequency: 10 min. interval at peak time
      20 min. interval at off-peak time

(2) Access transport for the Second Bangkok International Airport
   a) Train speed: Scheduled speed, 70km/h (all trains are operated as rapid train)
   b) Frequency: 20 min. interval at effective time period

(3) Intercity express service for local cities within a radius of 200 km from the city center of Bangkok
   a) Train speed: Scheduled speed, 100km/h
   b) Frequency: 1h interval at effective time period (2h interval at early stage)

2.5 Amount of the Investment in the Eastern Line and the Economic/ Financial Evaluation of Railway Improvement

(1) Condition of analysis

a) Fare level

Analyses were made for the cases of the following fare levels.

① Commuter transport

- Basic condition: 0.215 Baht/km (Current 3rd class fare)
- Intermediate condition: 0.44 Baht/km (Current 2nd class fare)
- Upper limit fare: 0.7 Baht/km

② Access service for the SBIA

Out of the cases shown in the above, analyses were added for the cases as follows.

- To charge 10 baht as one-way special fare for SBIA (5.1 km)
- To charge 20 baht as one-way special fare for SBIA (5.1 km)

③ Intercity express service

0.6 Baht/km (current 2nd class fare, express charge, seat reserved and air-conditioned)

b) External free fund

Analyses were made for the following cases of external free fund for invetment in ground facilities.

- When the ratio of the external free fund is 0% of the total investment in ground facilities
- When the ratio is 50%
- When the ratio is 60%
- When the ratio is 70%

(2) Amount of the railway investment

The total amount of the investment for the improvement of railway service is shown in Table-S.3.

Table-S.3 Amount of Investment for the Eastern Line Transport Improvement

(million baht)

Cases / Items	Improvement for commuter service	Improvement for commuter and airport acces services	Improvement for commuter, airport access, and intercity express services
Ground facilities	7,940	8,910	9,570
Rolling stock	5,010	5,330	8,210
Total	12,950	14,240	17,780

(Note) Total amount of investment for the improvement of the four railway lines under the Master Plan: 51,680 million baht

(3) Result of economic / financial evaluation

a) Financial internal rate of return

① Commuter service improvement

The financial internal rates of return in several combinations of the fare level and the ratio of external free fund are shownn in Fig.-S.1.

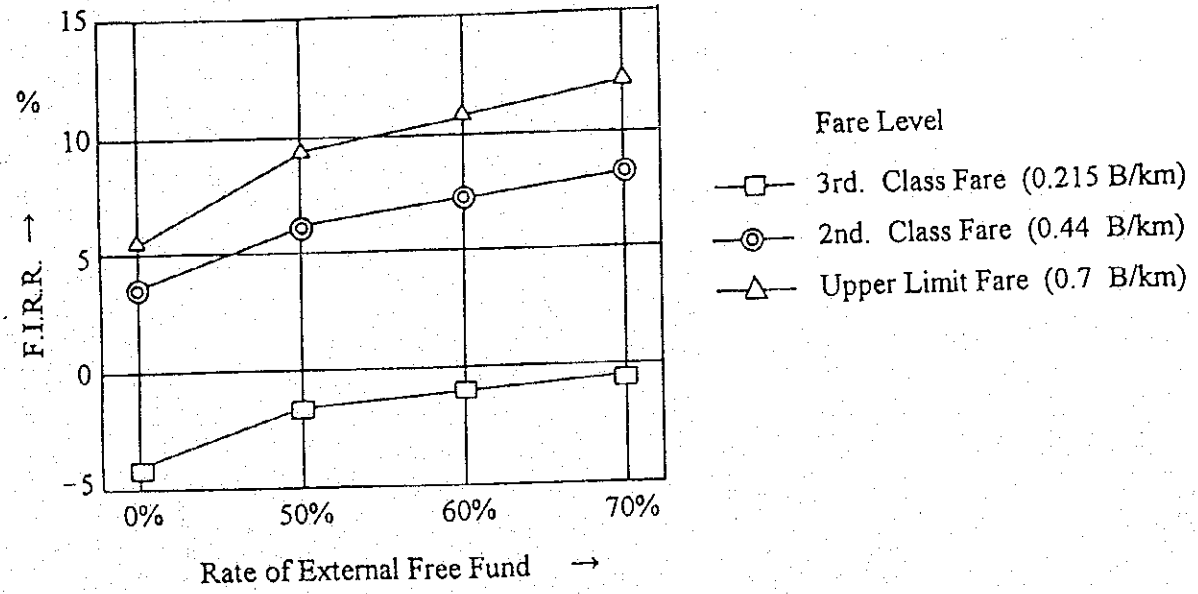


Fig.-S.1 Financial Internal Rate of Return

The financial internal rate of return is 7.1% in the case where fare level is the same as the current 2nd-class fare and 60% of the ground facilities investment is provided as external free fund. Therefore, the project can be considered as feasible.

② Commuter service improvement and access service for SBIA

③ Commuter service, airport access service, and intercity express service

In the cases of ② and ③, financial situation will change a little for the better, compared with the case of commuter service improvement only.

b) Economic Internal Rate of Return

The result of economic evaluation based on the forecasted traffic demand in the case of adopting the current 2nd-class fare is shown below.

① Improvement of commuter service : EIRR 15.2%

② Improvement of commuter service and access service for SBIA : EIRR 17.5%

③ Improvement of commuter service, access service for SBIA, and intercity express service : EIRR 14.1%

2.6 Investment for Urban Development and Value Capture

In the master plan study, the total amounts of investment cost and value capture were roughly estimated for the entire development area along four lines of SRT. And in the feasibility study, a plan of the model city of 120 ha centering on Lat Krabang East Station on the Eastern Line of SRT was drawn up by using the method of land readjustment. Amounts of the investment cost and value capture are shown in Table-S.4.

Table-S.4 Investment cost for Urban Development and Value Capture

Items / Cases	Development area (ha)	Investment cost (M. baht)	Value capture (M. baht)	Remarks
Master plan for development area along 4 lines	47,850	354,000	454,000	
Feasibility study for the area along Eastern Line	120	1,300	6,700	Total development area 4000 ha

3. Conclusion and Recommendation

3.1 Conclusion

(1) Master plan

A master plan has been drawn up for the urban development integrated with the railway transport improvement. In the plan, it is aimed to allocate 1.7 million persons to the regions along the railway lines in four directions, out of the 5 million population estimated to increase in the future in the Bangkok Metropolitan Area. The total amount of the development benefit from the railway improvement is estimated to be about 15 times the amount of the necessary external free fund. If about 7% of the development benefit is recycled, the necessary amount of the external free fund for railway investment can be covered.

Thus, it has been confirmed that the integrated development will become feasible from the financial aspect as well, by establishing the organization and systems necessary for the recycling.

Furthermore, if the commuter tranport on each line of SRT is improved and feeder

systems are reinforced at the same time to reduce the access time to stations by 30%, the economic internal rate of return based on the transport time reduction, operational cost saving, etc. is estimated to be 17 to 23% depending on the situations of respective lines. Therefore, it can be said that this is a sufficiently feasible project from the economic standpoint.

In addition, by inducing the transfer of commuting trips and the like from roads to the railway, the implementation of this project will produce large favorable effects in the alleviation of air pollution, saving of energy consumption, and reduction of traffic accidents, although it is difficult to quantify these effects. Large benefits, such as promotion of employment and transfer of advanced technologies, will also be obtained.

(2) Model city development

In the feasibility study for the integrated development project along the Eastern Line of SRT, a plan of the model city with an area of 120 ha centering on Lat Krabang East Station has been drawn up. According to the study, it is estimated that, if this project is implemented by using the method of land readjustment, large development benefit will be produced together with the effect of reducing commuting time to the city center. This development benefit is estimated to be 6,700 million baht on trial, after covering the construction cost for the development. It is necessary to recycle such benefit to land owners and public sectors, and also to establish appropriate organizations and systems so that the benefit can be recycled for the investment cost for the railway improvement. Since the total area covered by the urban development along the Eastern Line is 4000 ha, further greater development benefit can be expected by promoting development for the entire region in the similar way as in this model city.

(3) Feasibility of the railway improvement for the Eastern Line of SRT

Of the railway corridors in four directions proposed in the Master Plan, the Eastern Line of SRT has been selected as a high-priority project, and economic and financial analysis has been made. As a result, it has been found that, when the present 2nd-class fare is applied, the project will be financially feasible if external free fund amounting to 4,760 million baht is used for 60% of the ground facilities investment. In view of the amount of the development benefit estimated for the model city development, there is a possibility of securing external free fund of this scale by recycling, for the railway investment, several % of the benefit from the urban development for the entire region along the route. Therefore, it is necessary to urgently establish organizations, systems, etc. for the integrated development in order to ensure smooth recycling of the development benefit.

3.2 Recommendation

(1) Tasks on organizations and systems for implementing urban development

For implementing the integrated development, it is recommended that the following four institutionalized systems should be established.

① Eastern Corridor Development Board

② System for the integrated urban and railway development

③ System for implementing land readjustment (Promotion)

④ SRT Urban Development Corporation (Including a joint venture with adequate organizations, such as SRT and NHA)

(2) It is necessary to establish an urban railway network plan and also to review the General Plan.

(3) It is also essential to achieve consensus within the Thai Government on introducing external free fund for the railway improvement.

(4) The on-going construction of intra-city rapid transit systems should be further promoted.

(5) Measures to be urgently taken

In addition to the basic matters shown in the above (1) to (4), it is recommended that the following measures should be urgently taken.

a) Stage-by-stage promotion of the integrated urban and railway development

For promoting the integrated urban and railway development, it is recommended, as the 1st step, to urgently carry out the improvement of commuter transport to Khlong Luang Phaeng in the 40-km area from the city center of Bangkok, together with the integrated development of new towns in Lat Krabang East and Lat Krabang West. Then, it is advisable to proceed to the next step after widely fostering railway-oriented consciousness among commuters around Bangkok by realizing, at an early date, a comfortable and reliable commuting system using the railway and also after confirming the results of such effort.

b) Land procurement and administration by the public sector

It is recommended that, by the time the full-scale systems for implementing the urban development described in the above (1) are established, advance procurement of land should be made by public sectors for specified areas (such as areas around scheduled sites of future stations), as part of the preparations for the desirable urban development in the future.

c) Regulation of land speculation

In parallel with the establishment of many systems for implementing the full-scale urban development, it is necessary for the Thai Government to take measures for regulating land speculation in areas around scheduled sites of future stations, etc.

d) Elimination of level crossings and promotion of grade separation

It is a fatal disadvantage to the modernization of SRT that there are many level crossings with roads in the railway. Therefore, it is hoped that the main level crossings in the city center will be removed as a result of the promotion of the Hopewell Project. At the same time, it is necessary to proceed with the measures for level crossings on the sections that are not covered by the Hopewell Project.

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ABBREVIATION

JICA	Japan International Cooperation Agency
NESDB	Office of the National Economic and Social Development Board
SRT	State Railway of Thailand
NHA	National Housing Authority
IEAT	Industrial Estate Authority of Thailand
DUIT	Department of Highways
OEPP	Office of Environmental Policy and Planning
BMA	Bangkok Metropolitan Administration
BMR	Bangkok Metropolitan Region
ESB	Eastern Seaboard
UCR	Upper Central Region
SBIA	Second Bangkok International Airport
IURD	Integrated Urban and Railway Development
MRT	Mass Rapid Transit System
CBD	Central Business District
EIRR	Economic Internal Rate of Return
FIRR	Financial Internal Rate of Return
OD	Origin/ Destination
AS	Automatic Train Stop (System)
PSO	Public Service Obligation

MASTER PLAN

1. Master Plan

1.1 Introduction

The Study proposes establishing integrated urban and railway development, the principal transport means of which will be railways, instead of roads, providing fine housing for approximately 1.7 million of the 5 million expected population increase from now to 2010 in the Bangkok Metropolis (within a radius of 200 km from the city center), to order to in order to alleviate the remarkable traffic congestion and environment disruption in the center and suburban areas.

This chapter presents a summary of the proposal on the Master Plan of Integrated Urban and Railway Development, an evaluation of the Master Plan in each direction of the four lines of the SRT (including economic/financial analysis), and selection of the eastern corridor along the Eastern Line as the priority project.

1.2 Background and Circumstances of the Study

1.2.1 Background of the Study

Bangkok, the capital of Thailand, had a population of 6 million in the BMA and a population of 13 million in the BMR, including the periphery, in 1990. Up to 2010, this city is expected to have an additional population of about 5 million. It is an important policy of the Thai government to decentralize city functions into regional core cities in order to improve the overall concentration in Bangkok (Fig. 1).

On the other hand, the railways in the Bangkok urban area are not provided with a system suitable for large volume passenger transport and there are many level crossings with roads. Furthermore, since the urban development in the periphery of Bangkok has been mainly carried out along the trunk roads, passengers are forced to utilize road transport so that the road traffic in the center of the city is very congested, coupled with cars waiting for a level crossing.

In addition, since modernization of the railways in the Bangkok metropolitan area is far behind, for example, the railways in this area have many single track sections, transport

capability cannot catch up with the increase in demand, which is a major obstacle to the economic growth of Thailand.

Under these circumstances, the Japanese Government, responding to the request of the Thai Government, decided to cooperate in The Study on an Improvement Plan for Railway Improvement in and around the Bangkok Metropolis in Consideration of Urban Development", and the Japan International Cooperation Agency (JICA) has been executing the Study.

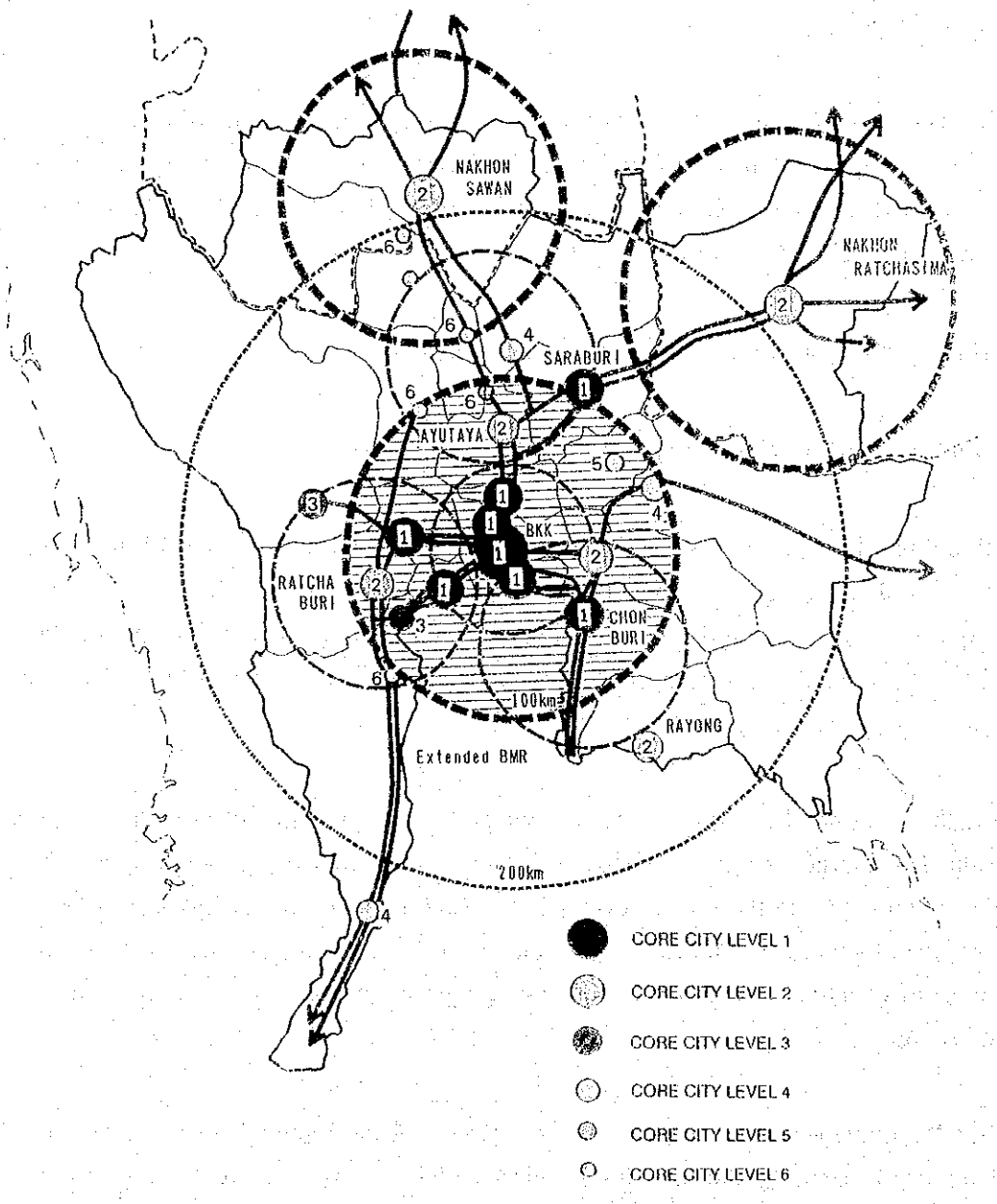


Fig. 1 Locational Structure of Urban Center

The JICA Study Team stayed in Thailand three times between August, 1993 and August, 1994 and based on the mutual agreement on lively discussions formulated the Master Plan on integrated urban and railway development in Bangkok Metropolis and proposed the priority project on which a feasibility study was to be carried out in succession.

1.2.2 Purpose of the Study

The purpose of this Study is to make a master plan on improvement and reinforcement of railway transport integrated with urban development along the railway lines in and around Bangkok Metropolis (within a radius of 200 km from the center) as well as to carry out a feasibility study on the Eastern Line (a railway line with a length of approx. 100km) as the priority project selected in the master plan.

The Hopewell Project, in which the right-of-way of the SRT in a range of 10 to 30 km from the center of Bangkok is utilized, has already been approved and been carried out. Therefore, the section covered by the Hopewell Project is excluded from the target area of this Study (Fig. 2).

1.2.3 Scope of the Study

(1) Objective of the work

The objective of the work is to supply housing with fine environmental conditions in the area about 50 km from the center of Bangkok for those who concentrate in Bangkok and its environs in the future and to divert car users flowing into the center of the city to railway users as much as possible, as well as to make a traffic improvement plan which helps to alleviate traffic congestion in the center of the city and prevent environmental disruption.

Furthermore, in the areas 100 km and 200 km from the center of Bangkok, limited express trains connecting the city center with local cities will be operated with fairly high frequency, and proposals will be made concerning connection with access modes of transport and development of station periphery in local cities, so as to contribute to the growth of key local cities.

When this project is completed, it is expected that residential areas will be efficiently

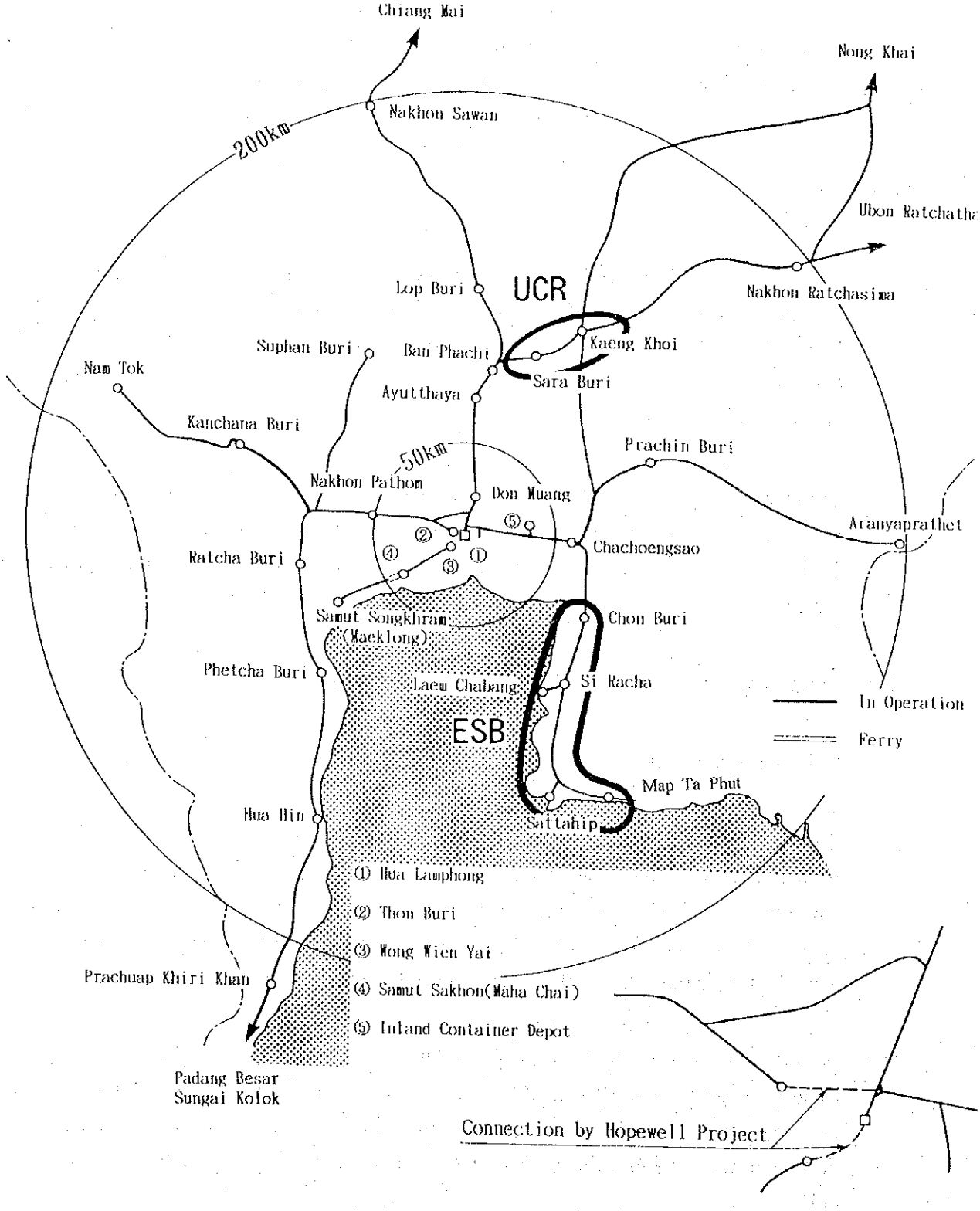


Fig. 2 The Existing Railway Network in the Study Area

connected with business areas, commercial areas, the airport, etc. and a modal shift from automobiles and buses to the railway will be made so that the losses caused by traffic congestion and environmental disruption can be reduced, economic development in Thailand will be promoted and a sound society will be formed.

Upon mapping out this project, good use must be made of the existing SRT right-of-way along the railway line.

Land around the railway stations including private land should be developed by applying a land readjustment so as to meet the above mentioned purpose.

(2) Target year

The target year for mapping out the master plan is 2010. Accordingly, work for the allocation of population to areas along the railway route and improvement of transport services to the residents will be started from 1997.

(3) Coordination with related projects

There are some on-going large-scale projects within the area of this Study and this Study must be harmonized with these projects. The major national projects are as follows:

- Strategic Planning for Metropolitan Bangkok
- Metropolitan Region Structure Plan Development
- Infrastructure Surrounding the Second Bangkok International Airport
- High Speed Train

The following plan has not yet been determined by the Thai government, but it is also taken into account in this Study.

SRT Master Development Plan

Furthermore, this Study is conducted on condition that the following MRT projects in the center of the city under consideration (some of them already have been determined and started) are completed and function by the target year of each project (Fig. 3).

- Hopewell Project (Fig. 4)

- BMA Mass Transit Project (Tanayon) (Fig. 5)

- MRTA Metropolitan Area Rapid Transit Project (Sky Train)

Since this Study will be most affected by whether these related projects succeed or not and their schedule, it is necessary to be fully aware of how they proceed 15 at all times.

(4) Subject area for the Study

The subject area is within a radius of 200 km from the center of Bangkok and it is divided into 3 or 4 zones (Fig. 6).

i) Within 30 km

This is a zone corresponding to BMA which is already a built up area. Its major portion is covered by the Hopewell Project.

ii) 30 to 50 km

This is a zone corresponding to BMR where urbanization will possibly advance rapidly as the suburbs of Bangkok. There are many pieces of land suitable for urban development such as housing in combination with railway improvement including establishment of new stations.

iii) Range of 50 to 200 km

This is a zone which has a direct and indirect influence on the center of Bangkok. The Thai Government intends to decentralize urban functions and develop this zone as an independent city. Therefore, a modal shift to the railway is encouraged by enhancing the railway functions, shortening the time required for arriving at a destination, providing comfortable coaches, improving access means to the station, providing convenient transfer facilities, setting attractive fare policies for the railway users, etc.

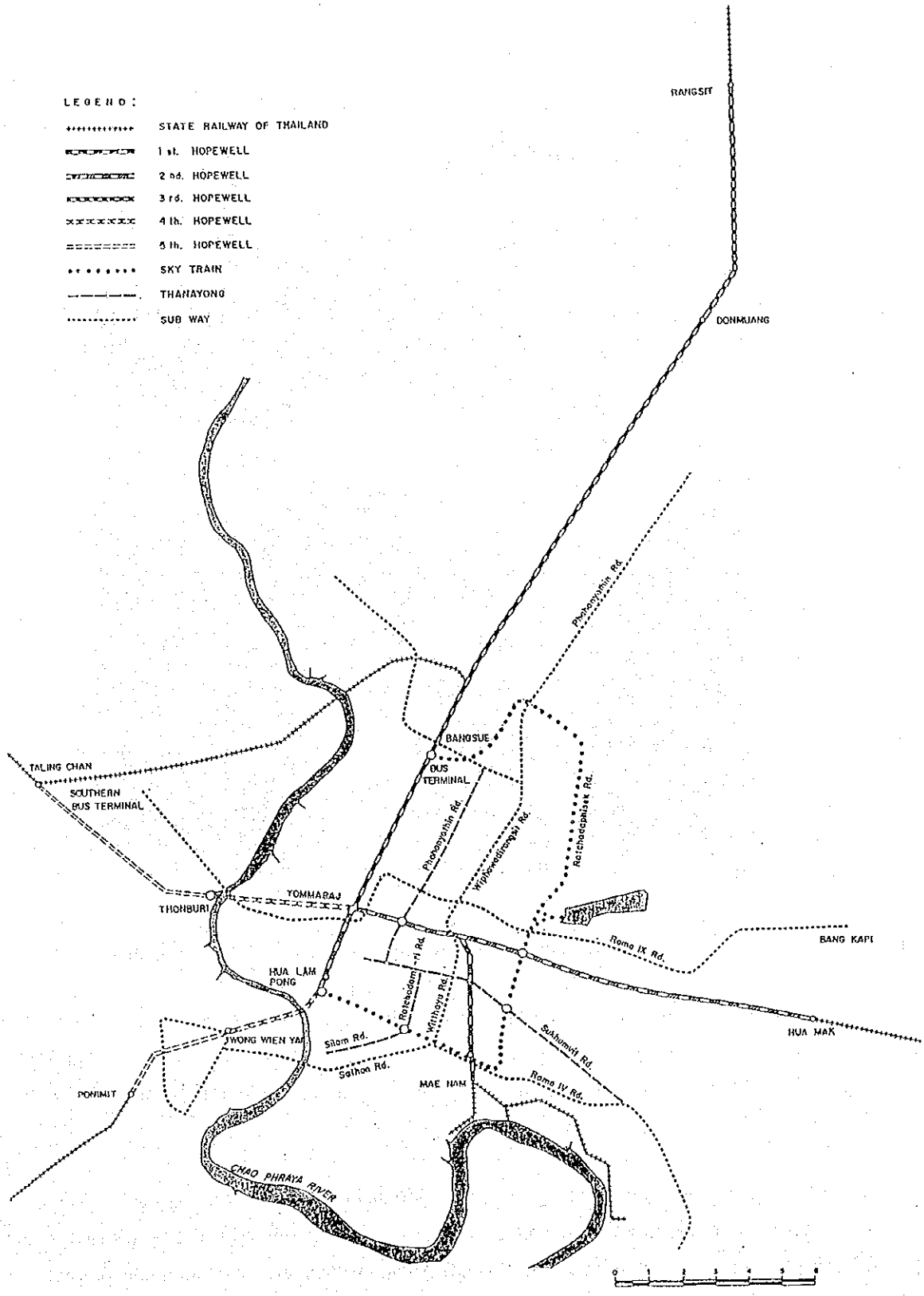


Fig. 3 MRT Projects in the Center of Bangkok

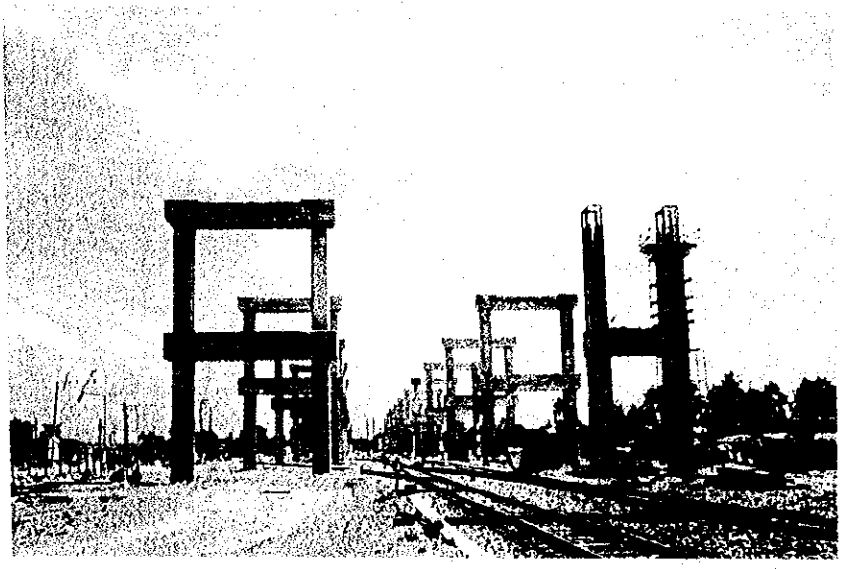


Fig. 4 Hopewell Project under Construction (at Bang Sue)

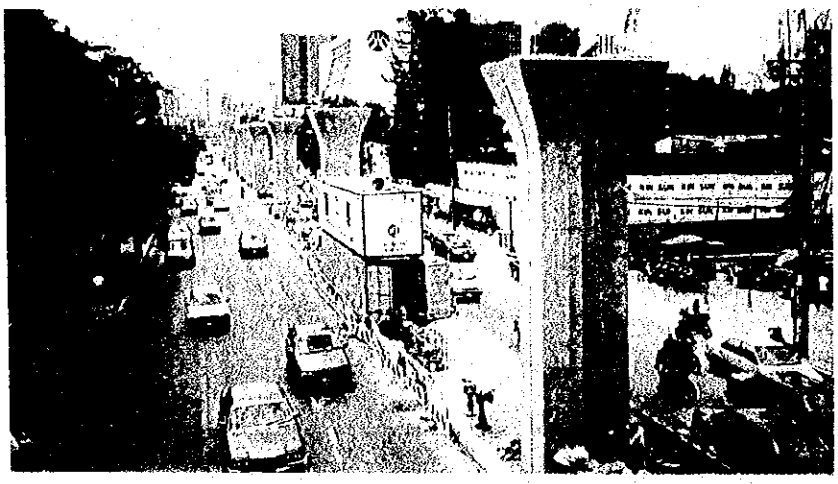


Fig. 5 Tanayong Project under Construction (on Phloenchit Road)

(5) Evaluation of the project and proposal to execute feasibility study of urgent projects

In this Study, urban development is planned by searching for an area suitable for development in each direction along the East Line, North Line, South Line and Maeklong Line of the SRT, and railway improvement is planned integrated with the urban development.

Benefits or an increase of profits against the additional investment/operating cost in this case are calculated and a synthetic judgement is made in view of other local characteristics, the urbanization plan, environmental protection, financing issues, etc. to evaluate the project.

Based on the results of this evaluation, line sections to be taken up with high priority in the future are selected, and feasibility studies for these sections are also proposed.

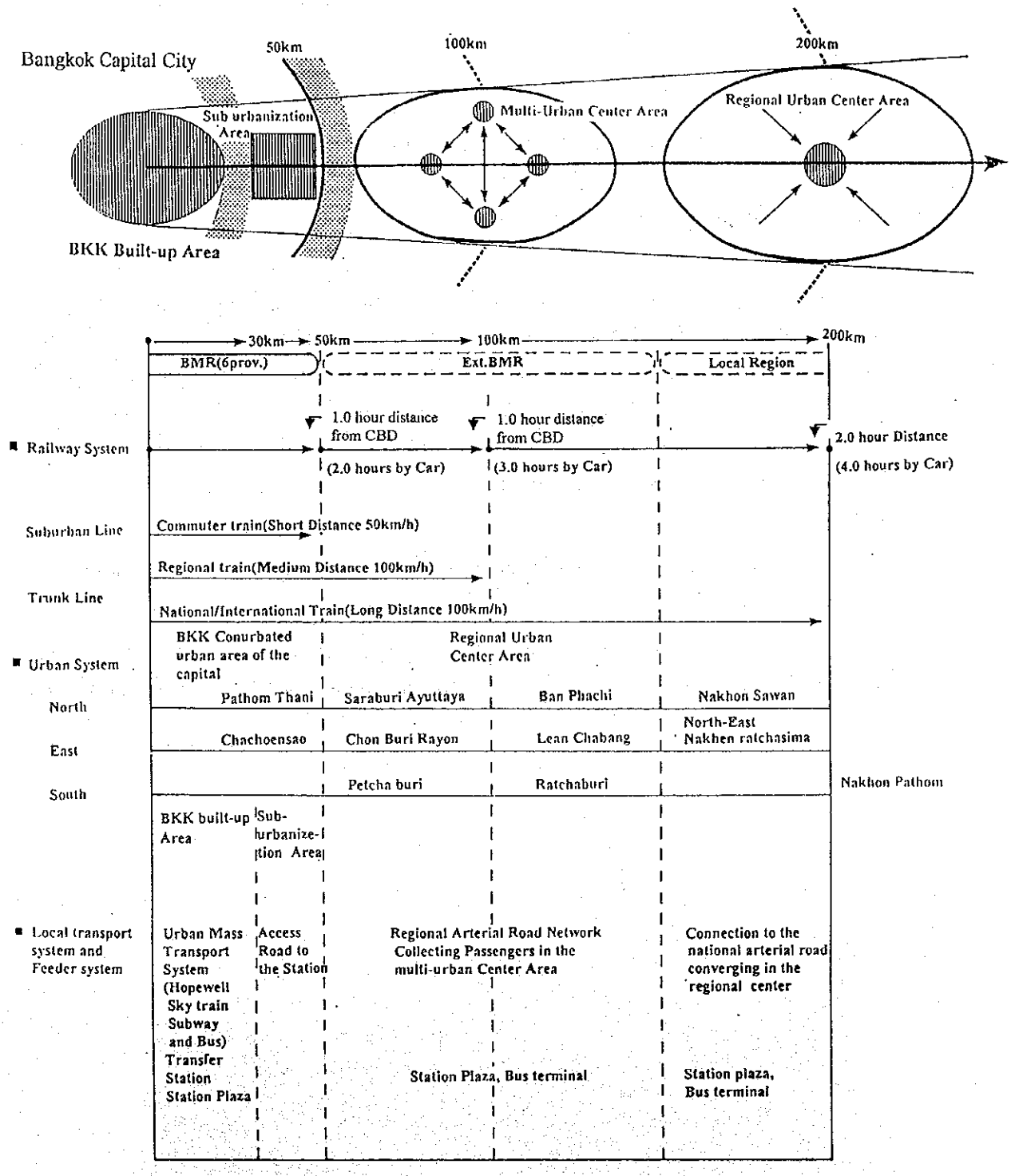


Fig. 6 Concept of Integrated Urban and Railway Development

1.3 Concept of Integrated Urban Development and Railway Improvement

1.3.1 Objectives

The objective of the integrated development is to provide housing with a better traffic environment for an increasing number of people as well as to contribute to the managerial improvement of the railway business.

Furthermore, by introducing the integrated development method the transport system in Bangkok Metropolis is to be converted from the conventional road-dependent system to a railway-oriented system. In this case, the aime is to drastically ease the severe traffic congestion in and around Bangkok by eliminating the bottleneck of the Thai economy a well as ensuring its citizens a more comfortable and cultural life and realizing a Bangkok Metropolis with less environmental pollution.

1.3.2 Physical Coordination of Urban Development and Railway Improvement

In order to shift from road transport to railway transport for commuting and business purposes in the greater Bangkok area, new railway transport services must be formulated.

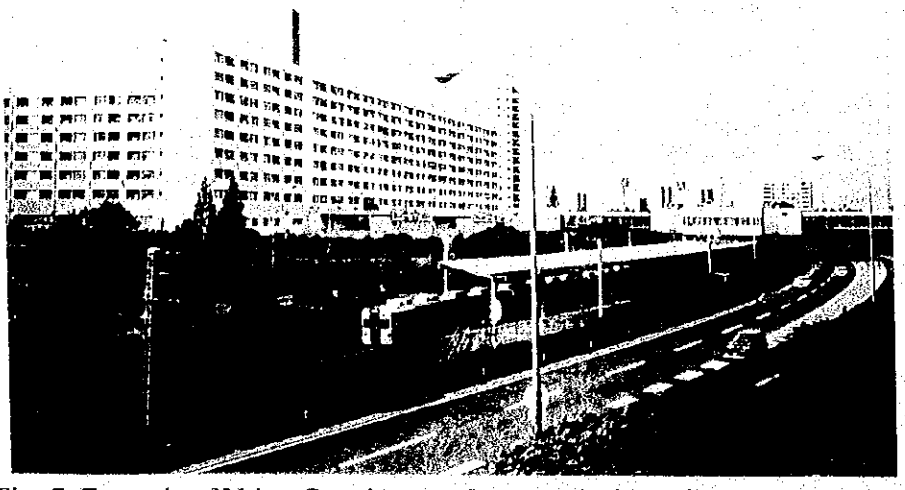


Fig. 7 Example of Urban Development Integrated with Railway Improvement

(Senboku New Town, Osaka Japan)

This system must be integrated with urban development projects. For example, access means, including buses, "park and ride" and "kiss and ride", must be well taken into account when urban development projects are to be introduced. Needless to say, frequency, travel time, comfort and other factors relating to railway operation must fit the citizens and urban life (Fig. 7).

Also, facilities and events appealing to the people and passengers must be introduced into the surroundings of railway stations located outside the center of Bangkok. This will work to counterbalance the centralization and flow of people to Bangkok.

1.3.3 Securing Funds for Investment and Managerial Increase

Inthe railway business, especially the railway business centering on commuter transport, it is not easy to make stable profits (See Table 1). This is because commuter transport is characterized as a one-directional and wave-like movement and because a very low transport fare is a must as a means of public transport.

Table 1 Example of Economic and Financial Evaluation on Rapid Transit System for Commuter

Item / Project	System	Length	Forcasted traffic demand (000 persons/day)	E I R R (%)	F I R R (%)
A	Subway	13.5	1,000	8.7	1.1
B	MRT (Elevated)	14.2	200	9.2	4.3
C	Railway (Surface)	30.0	90	16.4	5.7

Note: EIRR; Economic Internal Rate of Return
FIRR; Financial Internal Rate of Return

Generally the funds for railway investment and operation are procured by the following systems:

- Direct collection system (Fares charges)
- Indirect collection system (Cost sharing by beneficiaries, special purpose taxes)
- General tax system (General taxes)

Beside the above, fund procurement by issuing bonds can be considered. In the final stage, however, the funds for the bond redemption are obtained by the above three systems.

Many countries subsidize the commuter railway business using public fund. The Government of Thailand is also proposing compensation for the losses caused by commuter railway business as a PSO (public service obligation).

On the other hand, railway investment enhances the utilization of the surrounding land, raising land prices. In some land development methods, an unreasonable practice that railway investment is borne by public funds or funds from railway enterprises and most profits from the land development are received by landlords and developers, prevails.

For a nation which has fixed asset tax, urban planning tax and other similar taxation systems, a small portion of such railway development profits is returned to the government in the form of increased taxes. However, these tax increases far from offset the deficit of the railway investment and managerial cost increases.

The main financial purpose of the integration of urban development and railway improvement is to recover development profits in order to cover the deficits of railway investment and management.

This report discusses and analyzes appropriate development and investment methods, and implementation systems.

1.3.4 Refunding by Value Capture through an Integrated Development

(1) Value capture

Many theoretical studies have been carried out so far, which are based on the assumption that reduction of transport cost and time through the introduction of new transport means or improvements of existing transport means will enhance the utilization of surrounding land.

The most classical theory was introduced in the 19th century for agricultural fields This theory simply calculated value capture under the assumption that land prices decreased in a straight line from the business district, the center of the area projected.

However, it must be taken into account that the reduction of transport cost and time to and from a particular city will lead more people to live there. The boundary areas enjoying traffic

conveniences will also be affected. When functions of a railway are upgraded, areas with a permissible maximum commuting time will expand (Fig. 8).

Detailed calculation of the value capture brought by railway improvement projects is carried out in the Feasibility Study for some specified railway sections.

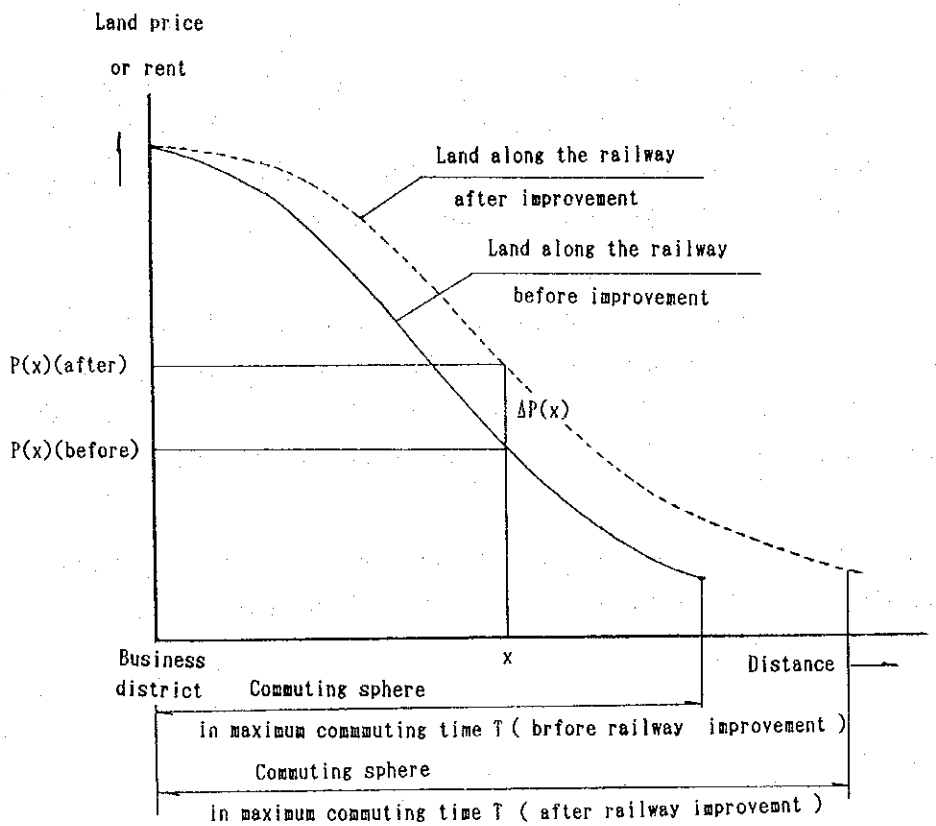


Fig. 8 Concept of Relation Between Travel Time and Land Price

(2) Integration of urban development and railway improvement

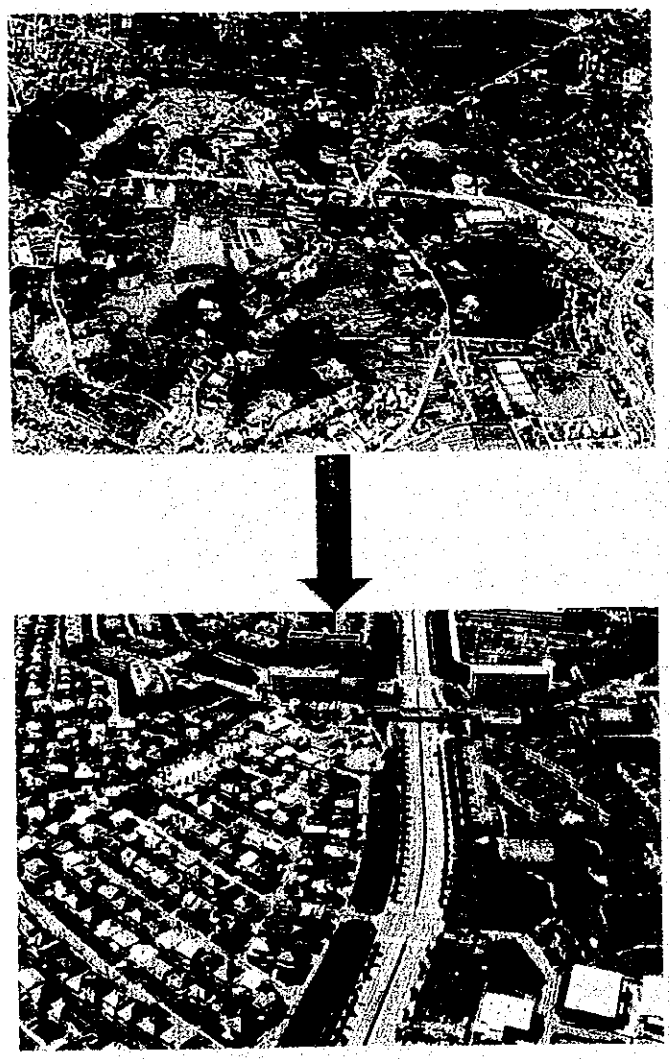
1) General

If the purchasing of land for public transport and for urban development is easily made by the enterprise for the project, there would be no problem obtaining value capture.

In other words, if the railway operator has the opportunity to purchase any land at the original price and introduce a new transport means, by disposing of or leasing the railway-surrounding land with an increased utilization, or by constructing houses and other urban facilities, the development profits can be directly obtained by the railway operator himself.

However, generally, the above land purchases and railway construction are not supported by owners of railway-designated land. Therefore, in order to carry out land acquisition and railway construction, a system which guarantees development profits are shared with the railway operator, surrounding communities and landlords must be made.

Creation of land for railway construction and public facilities by means of the "land readjustment system" effectively meets the above objective (See Fig. 9).



[Before]

* Public facilities: roads, parks, sewerage, drainage, river works etc. are inadequately provided.

[After]

* Public facilities: roads railways, parks, sewerage drainage, river works etc. are developed in an integrated manner.

* Building sites: lots are regularly shaped and have frontages on roads or railway: water supply, drainage and sewerage are adequately provided.

Fig. 9 Effect of Land Readjustment

2) An example of integrated new railway line construction and urban development (A case executed by an enterprise)

A good example of integrated railway construction and urban development on the outskirts of Tokyo is shown in Fig. 10. Tama Den'en Toshi is located 18 to 36 km southwest of Tokyo. The development area covers some 5,000 ha and today's population is half a million. Since the development project started, 40 years have passed.

At the beginning of the project, over 50 section readjustment unions were formed in surrounding areas to create new land for urban development and railway construction. Tokyu Corporation, the railway operator, worked for the land readjustment unions as secretary-general of the unions. The company utilized reserved land and exchanged land for railway construction, station-surrounding area development and housing at the same time.

As a result, the railway construction cost was partially financed by the development profits. At the same time, the surrounding area development contributed to more passengers and eventually to good management of the railway company.

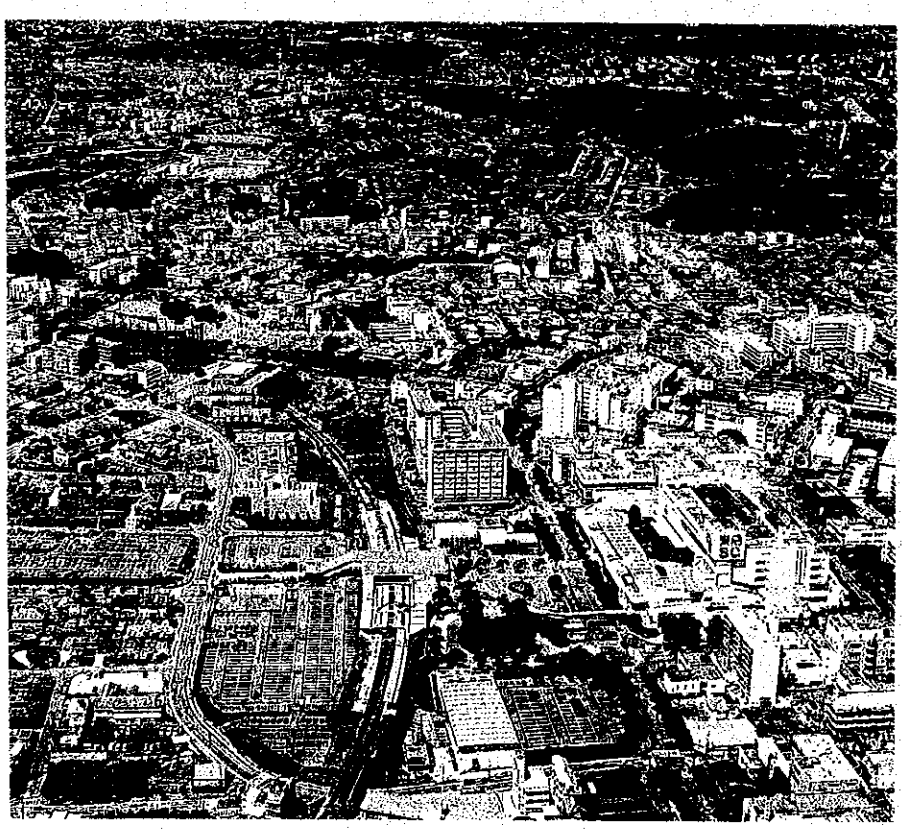


Fig. 10 Tama Den'en Toshi Development Integrated with Construction of Railway

3) An example of integrated new railway line construction and urban development (A case executed by local government and a third sector)

A successful example of integrated new railway line construction and urban development in a suburb of Osaka, Japan is described below. Senboku New Town Project was executed by Osaka Prefecture, for housing development at three areas in hilly districts extending to the south about 20 to 25 km from the city center, and by the third sector, in which Osaka Prefecture has invested, for construction and operation of a 12.1 km railway connecting with the existing railway line passing nearby (Fig. 11). (Third sector: a joint venture of local government and private business)

The railway new line, Senboku Kosoku Railway, connects the three new stations at the new town with the existing station, Nakamozu of the Koya Line of Nankai Electric Railway, forming its double-tracked, 12.1 km branch line. Senboku New Town expands 1,520 ha of newly developed areas. The project started in 1965 and now, 30 years later, the population has reached 160,000.

The development of this new town was executed by a department of Osaka Prefecture and the construction and operation of the railway was executed by an enterprise in which Osaka Prefecture has invested. Therefore, very cooperative planning and timely construction work were realized, and the railway is working successfully to serve commuters of the new town (Fig. 12).

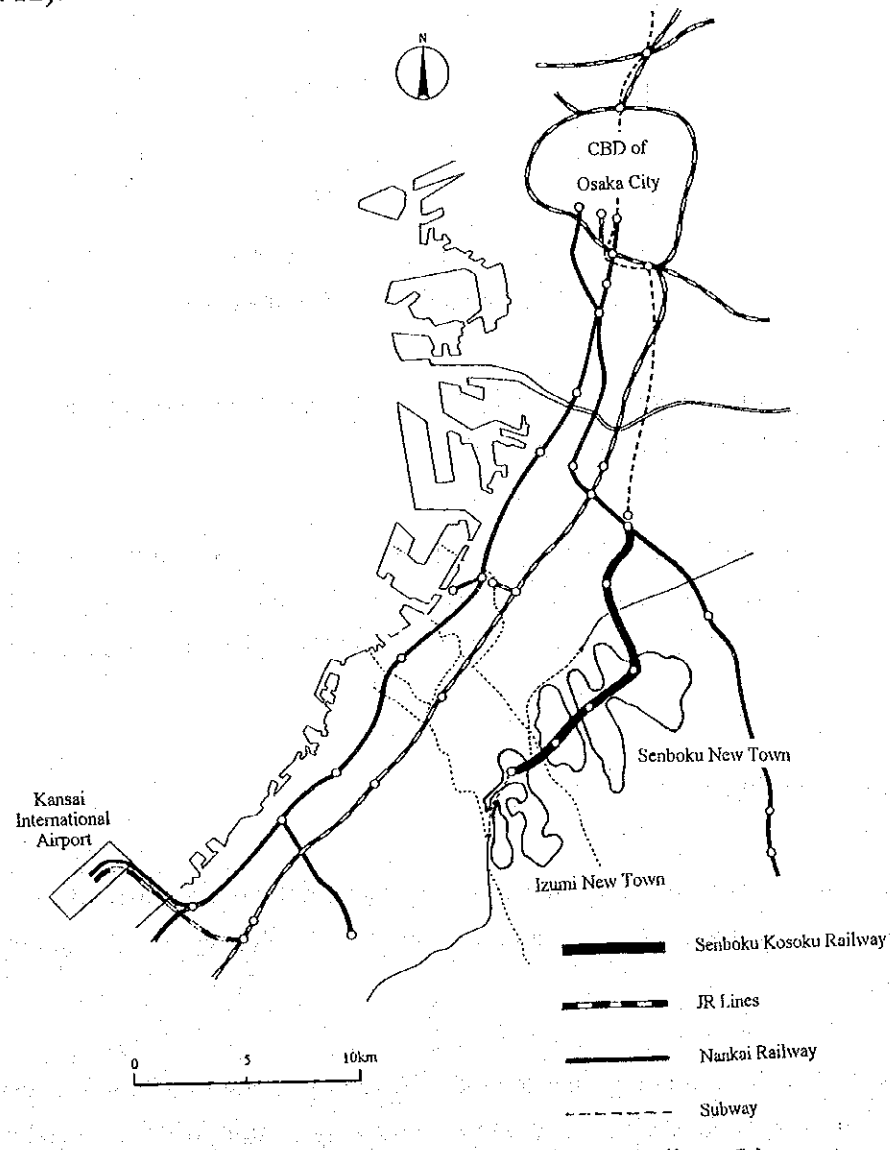


Fig. 11 Senboku New Town and New Railway Line

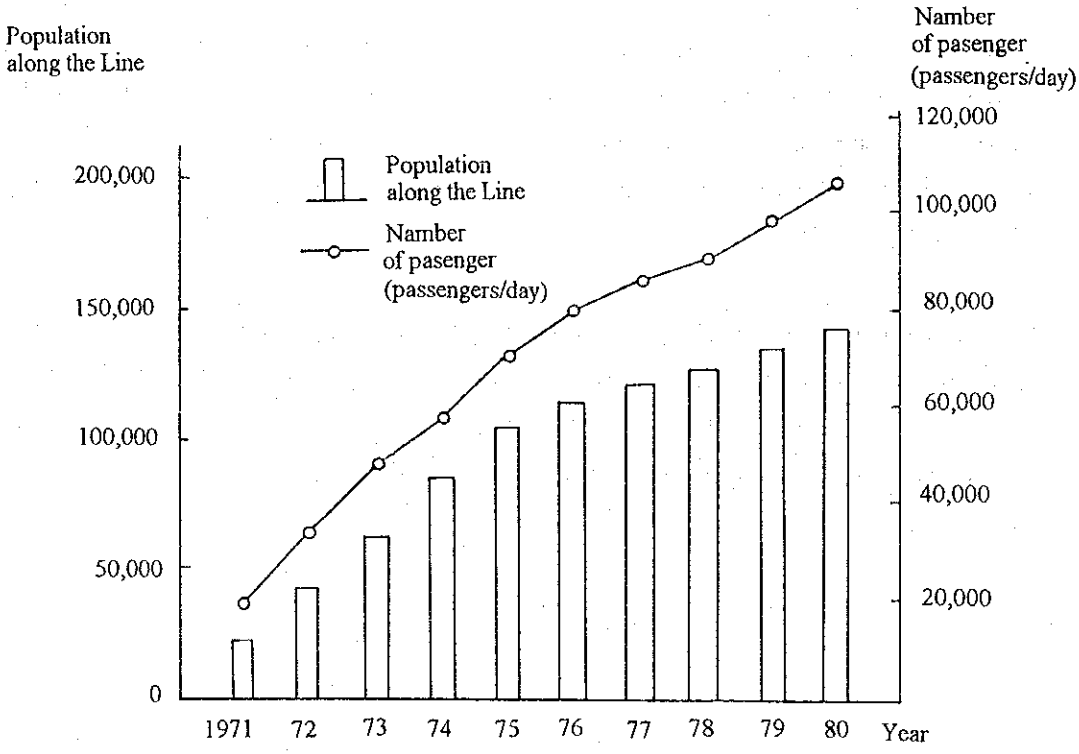


Fig. 12 Change of Population of Senboku New Town and Number of Passengers of Senboku Kosoku Railway

As for the construction cost, at the initial stage, Osaka Prefecture granted an interest free loan, so that the railway has managed well.

The line extended (2.2 km) to Izumi-Chuo, at the center of Izumi New Town Project, executed by the Housing and Urban Development Corporation with the subsidy system of the "new town system". The project started in 1984 and the railway has opened in April, 1995.

(c) New Town with new station

There are many cases where a community requests a railway enterprise to establish a new station on the existing railway line and new housing development is carried out around the station.

In these cases the burden borne by the beneficiary is only within the extent of the construction cost of the station and a part of the compensation for loss caused by expenses of managing the station in the case of a few customers, and most of the development gain falls to the community and the owners of lands around the station.

A case realized recently by the East Japan Railway Company (JR-East) that the development gain can return broadly for reinforcement of the railway facilities as well as the increase of management expenses is described below.

The Housing and Urban Development Corporation, which is carrying out a land readjustment project of 174 ha at Ushiku City (60 km from the center of Tokyo in the northeast direction) recently changed its regulations taking into consideration cooperation on an urban development project with a railway enterprise in 1994 so as to make it possible to transfer lands to the railway enterprise who would establish the new station on the exiting related line.

JR-East will buy 2.3 ha of land near the planned new station within the project area at the current price, construct condominiums and sell them when the new station is opened in 1997. Thus, the Housing and Urban Development Corporation can provide housing with a convenient commuting means and, on the other hand, JR-East can attain a part of the development gain directly in addition to the direct cost of the new station construction borne by the corporation and besides, customers of the railway will be ensured. (Fig. 13) JR-East actively participates in land readjustment projects on other lines also and is carrying out land acquisition.

The Housing and Urban Development Corporation intends to promote establishment of new stations on other lines of other companies as well in order to expand new town development projects.

Another example of integrated development was realized in Sapporo City with a population of 1.7 million. In the western part of the city at a distance of 15 km from the center, a private company has executed housing development including establishment of a new station (Hoshimi Sta.). The area of development is 21.1 ha, the area of land for sale is 10.3 ha and planned population is 1.550.

In this project, the railway enterprise, JR Hokkaido, has joined in the project as well as was payed construction cost of the station facilities and management expenses at the initial stage. A company in which JR Hokkaido invests has purchased about a half of the developed land with no buildings and has been carrying out housing development and selling the lots (Fig. 14).

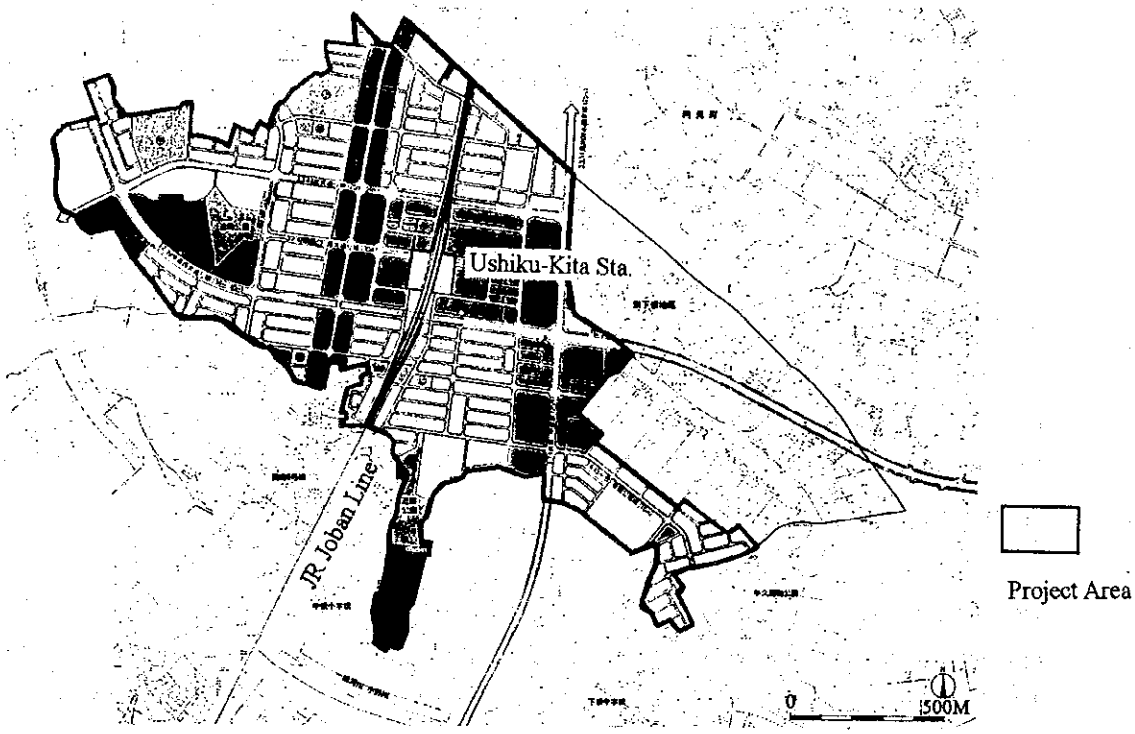


Fig. 13 Example of New Town with New Station (1) Ushiku-Kita

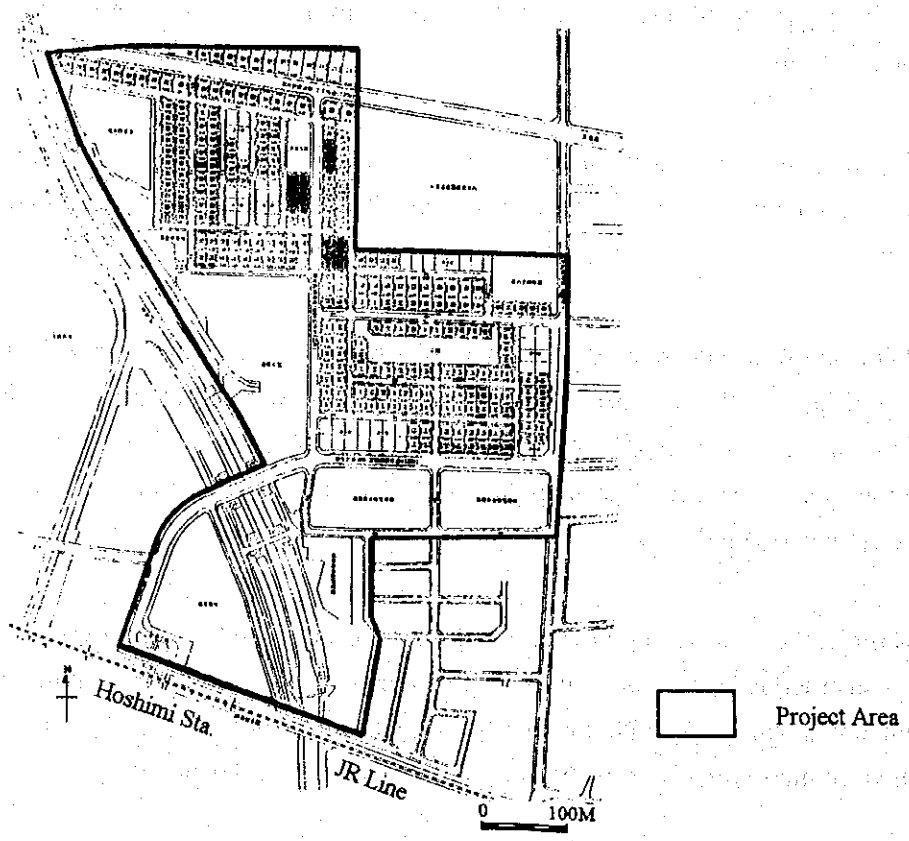


Fig. 14 Example of New Town with New Station (2) Hoshimi

1.4 Proposal of the Master Plan for Integrated Urban Development and Railway Improvement

1.4.1 Policy of Urban Development Integrated with Railway Transport

The population increase in the area of Extended BMR up to the year 2010 is estimated to be about 5 million, of which about 1.7 million people will be induced to live in the new cities to be developed in combination with the railway network.

As built-up areas in the suburbs of Bangkok have been developed mainly along roads, most residents commuting to the center of Bangkok have to depend on automobile and bus transport. There is no guided transport system but the SRT in the city center of Bangkok, causing serious road traffic congestion. The situation has become worse with the increase in automobile traffic from suburbs. This is causing a waste of time for Bangkok citizens as well as damage to the city environment.

Since three rapid transit systems, including the Hopewell Project, are in progress to alleviate traffic congestion in the city center, this Study aims to improve transport systems by integrated implementation of railway improvement and urban development in the suburbs in combination with reinforcement of access transport systems, so that the railways can become a major means of transport by providing high-speed, reliable, comfortable, and safe service.

As mentioned above, in this project, introduction of railways and promotion of a modal shift from roads to railways are proposed, founded on such characteristics and role of the railway that follows.

Characteristics of railways are listed as follows on the Master Plan:

i) Merits

- Fast
- Reliable (Punctual)
- Safe
- Comfortable

- Inexpensive (for large volume transport)

- Suitable for large volume transport

- Environment-friendly

- Natural-resource-saving (for large volume transport)

- Space-saving (small space requirement / availability of underground because of no problem of exhaust fumes)

ii) Demerits

- Not door-to-door

- Not at any time

The roles of railways should be those which can make the most of the merits and minimize the demerits. The roles are specialized to "large volume" and "fast and reliable" transport as enumerated below. In great city areas, railways are the only transport means "saving valuable, hard-to-get space".

i) Commuter service in large city areas

ii) Intercity express service / shuttle freight service

iii) National/international trunk line service

Among the above roles, "Commuter service in large city areas" and "Intercity express service" are the objects of this Study, for which railway improvement integrated with urban development will be examined and proposed.

1.4.2 Location of Urban Development

(1) Areas in and around Bangkok

The areas along the Eastern Line of the SRT have a high potential for development in the future, because there are many large-scale concrete projects such as the Eastern Sea Board (ESB), Second Bangkok International Airport (SBIA), Inland Container Depot and NHA City Development Project.

The areas along the Northern Line of the SRT, already have an international airport, and are densely populated toward Ayutthaya and Sara Buri. The railway line up to Ban Pachi is double-tracked, and the region along the route has a high potential of developing favorable residential areas if at-grade crossings in the Bangkok city center can be eliminated.

As for the areas along the Southern Line of the SRT access to the city center is insufficient because the railway conecting with the city center is partitioned by the Chao Phraya River and is forced to make a large detour. Therefore, although fairly urbanized areas can be seen along the roads, urbanization along the railway route is delayed. However, if the east-west connection by railway is realized by the Hopewell Project, the potential of the regions will greatly increase.

Along the Maeklong Line of the SRT, large development of city areas is seen up to Maha Chai, and urbanization along the road is especially remarkable. Therefore, city formation integrated with railway reinforcement will progress, if railway service is improved in such respects as speed frequency, reliability and comfort. Especially, if the Hopewell Project is completed, this area will be much developed because of short distance to the Bangkok city center.

The above is an outline of the situation in each direction along the railway routes centering around Bangkok. In general, there remains a great deal of land suitable for urban development along the existing railways in the suburbs of Bangkok. Therefore, urban development taken up by the study has mainly been limited to the development of areas along the existing railways from the standpoint of investment efficiency and urban development by new line construction has been excluded. However, from a long term view, a case of integrated implementation of new railway line construction and urban development can occur.

On the other hand, the Second Bangkok International Airport is scheduled to be constructed 2 to 7 km away from the Eastern Line of the SRT. Needless to say, a guided transport system as access to the airport is essential. Therefore, the aim is to construct an access railway from the Eastern Line to the airport for the convenience of passengers.

In improving railway transport, bus routes will be reorganized. In the review, the bus routes running in parallel with the railways will be modified to directly connect with the railway terminals or railway stations as much as possible, in order to realize integration of railway and bus transport.

(2) 200 km radius area

In the 200 km radius area, further away from the suburbs of Bangkok, there are influential regional core cities such as Nakhon Sawan and Nakhon Ratchasima. The Government of Thailand is taking measures for urban decentralization, based on the Metropolitan Region Structure Plan. It is thus advisable to foster these cities as independent cities by keeping contact with the mother city Bangkok so as to ensure close exchange of information.

Accordingly, facilities convenient for connection with access transport systems (bus and other automobiles) will be installed at railway stations in these cities. At the same time, development of areas around stations will be promoted in order to make these areas charming community centers of the cities. It is also planned to take such measures as introducing high-performance diesel-car trains between these cities and Bangkok Central Station to ensure reliable operation at intervals of one to two hours.

1.4.3 Contents of the Master Plan

The proposed master plan of urban development is shown in Fig.15. Items of railway improvement incorporated with urban development are as follows:

Commuter service improvement

Improvement of at-grade crossings, improvement of station facilities, track strengthening, electrification, improvement of signalling/telecommunication system, introduction of electric railcars, improvement / establishment of station plazas, improvement of secondary access means, development around stations, track-doubling, etc.

Intercity express special improvement

Improvement of at-grade crossings, reinforcement of crossing loops and refuge tracks, introduction of high performance diesel railcars, improvement of station plazas, improvement of access means, development around stations, etc.

These measures are to be executed in the following three phases:

Step I 1996 - 2000

Step II 2001 - 2005

Step III 2006 - 2010

Allocated population in the urban development and investment costs of the railway improvement by line are shown in Table 2.

Table 2 Allocated Population and Railway Improvement by Line

Item / Line	Step	Allocated population (1000 persons)	Railway Improvement costs (million baht)		
			Commuter service	Intercity express service	Total
Eastern Line *	I		7,340	1,060	8,400
	II		3,970	700	4,670
	III		1,720	140	1,860
	Total	499	13,030	1,900	14,930
Northern Line	I		6,490	2,130	8,620
	II		5,820	980	6,800
	III		2,030	170	2,200
	Total	636	14,340	3,280	17,620
Southern Line	I		140	1,530	1,670
	II		4,080	720	4,800
	III		4,950	490	5,400
	Total	364	9,170	2,740	11,910
Maeklong Line	I		100		100
	II		6,510	(None)	6,510
	III		610		610
	Total	197	7,220	(None)	7,220
Grand Total	I		14,070	4,720	18,790
	II		20,380	2,400	22,780
	III		9,310	800	10,110
	Total	1,696	43,760	7,920	51,680

Remarks: Urban development area: 47,850 ha
Urban development construction costs: 354 billion baht

*: Including SBIA Branch Line

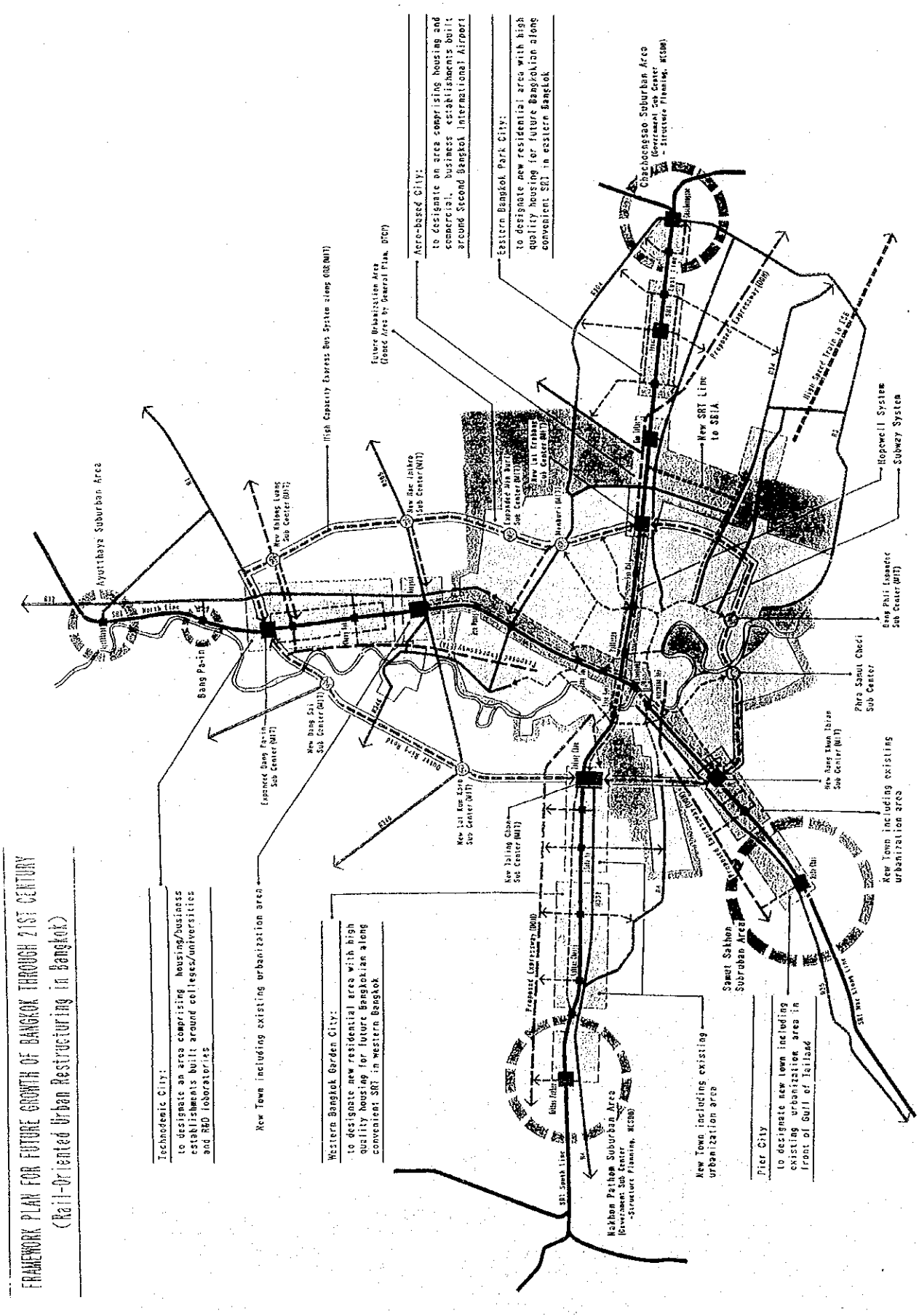


Fig. 15 Proposed Master Plan of Urban Development Integrated with Railway Improvement

1.4.4 Evaluation of the Master Plan

(1) Process and assumptions of project evaluation

1) Process of project evaluation

The process of project evaluation is explained in Fig. 16. As shown in the figure, the Master Plan study starts by forming "the concept of integrated urban development and railway improvement". Subsequently, urban development planning, railway improvement planning and demand forecasting (including mutual feed-back) are carried out. Based on this, benefit, revenue and project costs/expenses are calculated. Finally, economic/financial analysis is conducted.

2) Setting up the assumptions and cases for project evaluation

(a) Level of service

Fast, reliable, convenient transport service is to be offered, as described in 1.4.3.

(b) Railway facilities and rolling stock

To provide the above mentioned services, high grade railway facilities and high-performance, comfortable rolling stock are to be provided, as described in 1.4.3.

(c) Demand

The demand is estimated for cases under the combined assumptions that follow:

i) Assumptions concerning urban development and railway improvement

The following combined assumptions are set up.

(Urban development)

i. With "Integrated urban development"

ii. Without "Integrated urban development"

(Railway and access)

a. Railway improvement only

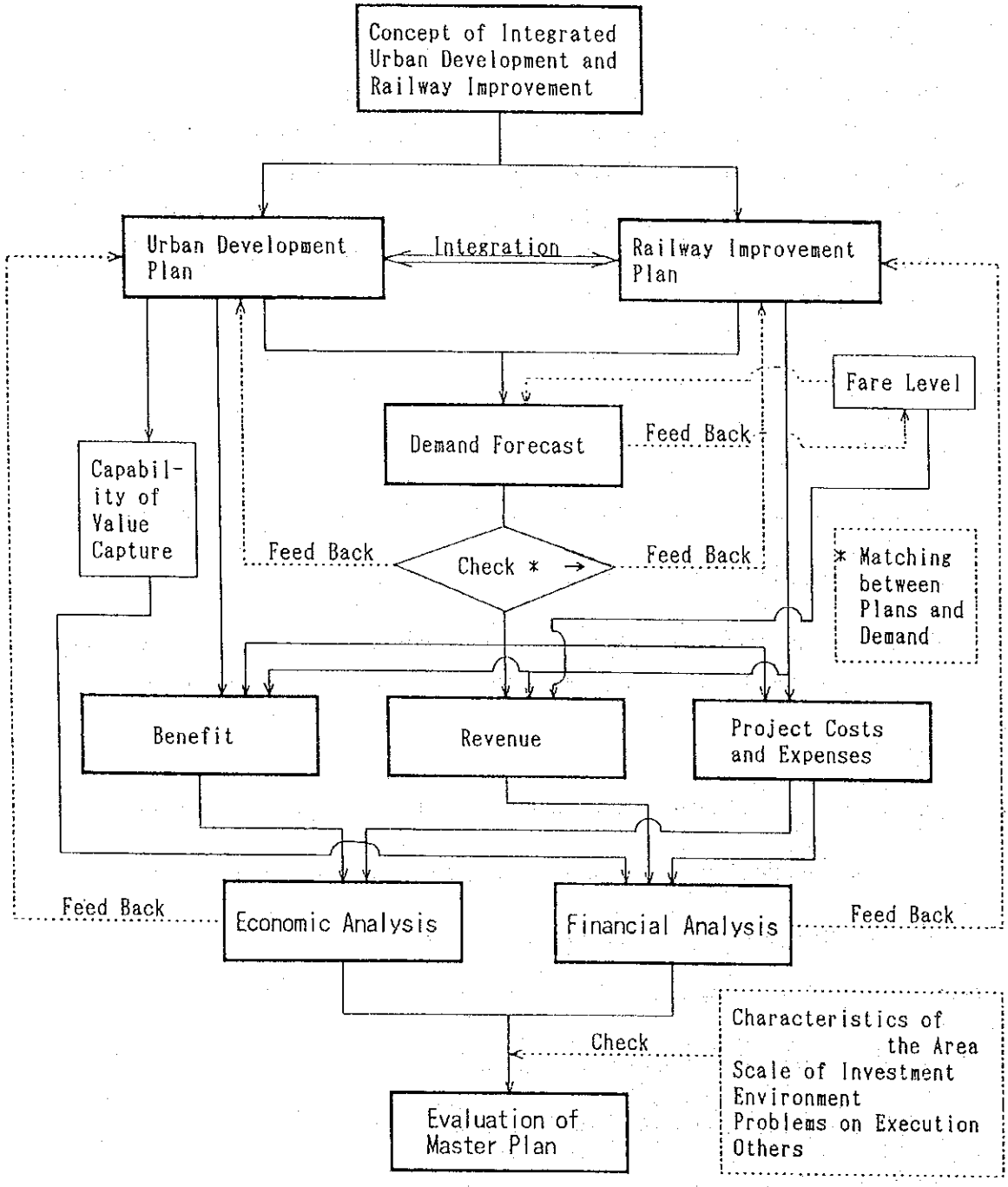


Fig. 16 Flow of Master Plan Evaluation

b. Railway improvement and feeder service improvement in time (average access/egress cost decrease: 30%)

c. "b" and feeder service improvement in cost (average access/egress cost decrease: 30%)

Six combinations of assumptions, i.a./i.b./i.c./ii.b./ii.c., are set up.

ii) Assumptions concerning railway fares

For the commuter service, the following three fare levels are set:

i. Basic condition : 0.215 baht/km (Current 3rd class fare)

ii. Medium : 0.44 baht/km (Current 2nd class fare)

iii. Upper limit : 1.0 baht/km

For the intercity express service, the following fare rate is set, taking into consideration competition with air-conditioned buses.

0.6 baht/km (2nd class including express, reserved seat and air-conditioning charge)

(d) Benefits

In order to carry out the economic analysis, a conception of benefits mentioned below is adopted.

i) Classification of benefits

In this study, benefits are classified as follows:

a. Time saving of railway users

b. Time saving of road transport users brought by decrease of traffic congestion

c. Savings in operation expenses of railways and automobiles

d. Others: Tourism development along the lines; promotion of housing, commercial, industry; reduction in traffic accidents and air pollution; reduction in natural resource consumption; creation of higher living standard; etc. and a rise in land value brought about by all of the above

Out of those benefits, as quantifiable items, amounts of "time saving benefit" and "operation expense saving benefit" are calculated.

ii) Time value

Time value of automobile users and railway passengers is estimated as shown in Table 3. based on the time-value factor and composition ratio by trip purpose, which are shown in Table 4.

Table 3 Estimated Time Value

Year	Estimated time value
2000	19.3 baht/hour
2010	25.9 baht/hour

Table 4 Time Value Factor and Composition Ratio by Trip Purpose

Trip purpose	Time value factor	Composition ratio
Business	100%	11.0%
To work	50%	18.6%
To home	50%	42.5%
To school	0	11.6%
Private	0	16.3%

(e) Revenue

In order to carry out financial analysis, revenue is calculated applying three kinds of fare rates based on person-kilometers founded on estimated demand.

(f) Investment costs and operation expenses

The investment costs of railway facilities and rolling stock and expenses for railway operation and management are calculated, corresponding to the proposed service level and estimated demand. Rolling stock investment costs and operation expenses are varied corresponding to demand that changes depending on a settled fare level.

(2) Estimated demand

1) Commuter service

As a major example, the estimated demand for commuter service with the following conditions is shown in Fig. 17, which is the most positive and the greatest case.

With integrated urban development

Railway improvement and feeder service improvement both in time and in cost (Average access/egress time/cost decrease 30%)

Fare 0.215 baht/km (Basic condition)

2) Intercity express service

Estimated demand of intercity express service is shown in Table 5.

Table 5 Estimated Traffic Volume of Intercity Express Service
(Passengers/day × direction)

Section \ Year	1997	2000	2010
Hua Lamphong - ESB	1,700	2,400	5,300
Hua Lamphong - Nakon Sawan	1,350	1,600	3,000
Hua Lamphong - Nakhon Ratchasima	1,400	1,100	3,200
Hua Lamphong - Hua Hin	1,550	1,900	3,600
Hua Lamphong - Kanchana Buri	1,350	1,600	3,000

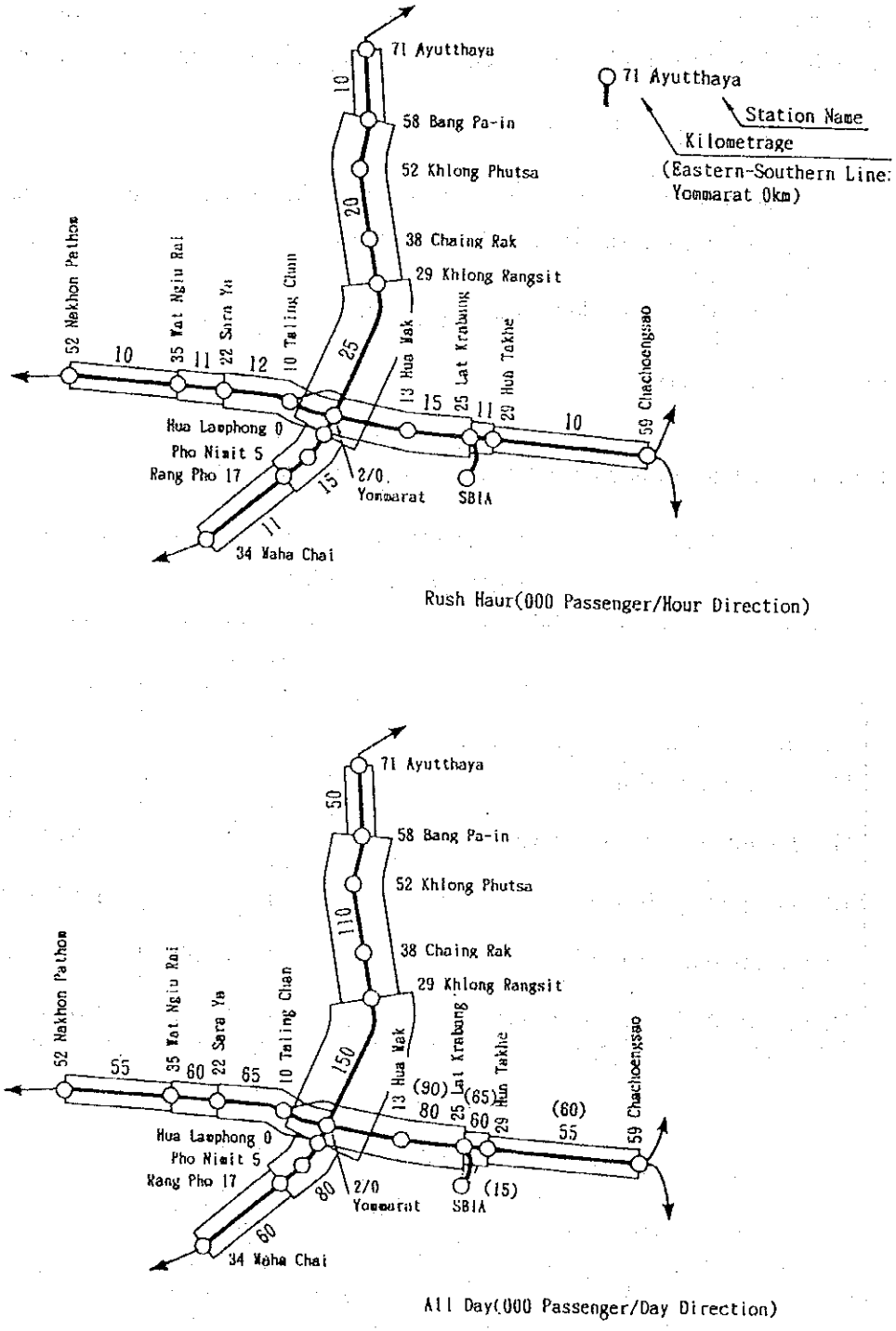


Fig. 17 Estimated Traffic Volume of Commuter Service

(3) Evaluation

1) Economic evaluation

The economic internal rate of return (EIRR) classified by combinations of improvement (in commuter service only / intercity express service as well and with/without integrated urban development) in assumptions mentioned previously is shown in Table 6 and Table 7.

As shown in the tables, in most cases, investment efficiency from the view point of the national economy is high. The EIRR exceeds 12%, which is the standard for Thailand. In the case of railway improvement with integrated urban development, the investment efficiency is higher. It is suggested that improvement of feeder service, reducing access/egress time and cost, increases the demand for railway transport which raises the investment efficiency.

Table 6 EIRR of Railway Improvement for Commuter Service

(%)

Case \ Line		Eastern Line	Northern Line	Southern Line	Maeklong Line
With integrated urban development	Railway improvement only	-	13.0	0	13.2
	Railway improvement and feeder service improvement in time (30% decreace)	17.8	23.1	16.7	19.2
	In addition to the above feeder service improvement in cost (30% decrease)	20.8	30.9	21.2	25.9
Without the integrated urban development	Railway improvement only	-	-	-	-
	Railway improvement and feeder service improvement in time (30% decrease)	9.9	14.4	-	14.9
	In addition to the above feeder service improvement in cost (30% decrease)	10.8	20.4	-	24.1

Remarks: "-" Not available or not calculated

Table 7 EIRR of Railway Improvement for Commuter Service and Intercity Express Service

(%)

Case \ Line		Eastern Line	Northern Line	Southern Line
With integrated urban development	Railway improvement only	-	11.3	-
	Railway improvement and feeder service improvement in time (30% Decreace)	18.0	16.7	16.9
	In addition to the above feeder service improvement in cost (30% decrease)	22.6	23.4	22.1
Without integrated urban development	Railway improvement only	-	-	-
	Railway improvement and feeder service improvement in time (30% decrease)	11.5	11.3	-
	In addition to the above feeder service improvement in cost (30% decrease)	14.8	16.7	-

Remarks: "-" Not available or not calculated

Maeklong Line does not provide the intercity express service.

2) Financial evaluation

(a) Revenue

In the financial evaluation, the revenue to be evaluated was limited to passenger fares calculated by multiplying the fare rate with the passenger-kilometer.

As fare rates, the following were applied:

i) Commuter Service

- Basic Condition (Third class: 0.215 baht/km
- Medium (Second class: 0.44 baht/km)

- Upper limit (1 baht/km)

ii) Intercity Express Service

- 0.6 baht/km (Second class including express, reserved seat and air-conditioning charge)

(b) Development profit

As a result of urban development, large amounts of profit will be gained from sale/rental of the developed land. In the feasibility study to be carried out after the Mater Plan study, it will be necessary to calculate the specific development profit based on the actual land price distribution and to propose the necessary procedures, institutions and organizations so that the development profit may be returned to the railway improvement projects.

According to the results of NESDB's study, the following equation, representing the relationship between the land price and the distance from the Bangkok city center, is adopted.

$$Vx = e^{-0.06x + 16.6}$$

Where x: Distance (km)
Vx: The land price at distance x from the city center (million baht/rai)

If the land price for 47,850 ha in the area to be developed is estimated on the basis of the findings of the above study, the land price would rise from 11.7 million baht/ha to 38.1 million baht/ha on the average, supposing that the reduction of travel time by the railway improvement has the same effect as the shortening of the distance (x) to the center of the city.

As a result, the development profit may roughly be estimated as follows:

- Total rise of the land price:
  (38.1 - 11.7) million baht/ha × 47,850 ha = 1,264,000 million baht

- The amount to be returned to the public project: 456,000 million baht

- Development work expenses: 354,000 million baht

- Net development profit: 454,000 million baht

Since the above estimated net development profit is the maximum amount returnable, an important point would be what proportion of such profit may be returned to the railway reinforcement.

With the total amount of 51,680 million baht invested in the railway improvement, in the calculation of the internal rate of return, cases where 1/2 or 3/4 of the amount to be invested in facilities would be by external free fund are set up, because it can be expected that a certain portion of the development profit might be thus returned.

(c) Financial internal rate of return (FIRR)

When the long-term balances of the projects of the individual lines (taking the above conditions into account) are estimated, it is found that the investment could not be recovered in a case where the current 2nd class fare rate is applied without any subsidies granted and, therefore, a deficit would be accumulated.

Therefore, referring to the examples in Japan and other countries, the assumption that 1/2 of the investment in facilities (3/4 for the Maeklong Line and the SBIA New Line) would be by external free fund is set up and trial calculations of internal rate of return are made, applying the second-class fares (in the case of the Airport Branch Line the maximum fare). The results are indicated in Tables 8 and 9.

Although the above financial internal rate of return is calculated on the basis of several assumptions, they may be effectively utilized in reviewing the relative effectiveness of the project on each line.

Concerning Table 8, in case 1/2 is by external free fund, the Eastern and Northern Lines may be regarded as feasible, provided that the second-class fares are applied.

Concerning the Maeklong and SBIA New Lines, since large amounts must be invested, it is essential that the ratio of external free fund be enlarged to 3/4 of the amount required.

Table 8 FIRR of Railway Improvement for Commuter Service

Case \ Line	Eastern Line	Northern Line	Southern Line	Maeklong Line	SBLA New Line
Adopted fare level	Medium (0.44B/km)	Medium (0.44B/km)	Medium (0.44B/km)	Medium (0.44B/km)	Upper Limit (1.0B/km)
"1/2" of investument cost of railway facilities by external free fund	9	12	5	5	6
"3/4" of investment cost of railway facilities by external free fund	-	-	-	9	11

Remarks: "-" Not calculated

Table 9 FIRR of Railway Improvement for Commuter Service and Intercity express Service

Case \ Line	Eastern Line	Northern Line	Southern Line
Adopted fare level	Medium (0.44B/km) Ic. Express (0.6B/km)	Medium (0.44B/km) Ic. Express (0.6B/km)	Medium (0.44B/km) Ic. Express (0.6 B/km)
"1/2" of investument cost of railway facilities for commuter service by external free fund.	11	12	7

Remarks: Maeklong Line and SBIA New Line do not provide intercity express service.

In addition, in the case of the SBIA New Line, it is necessary to apply the maximum fare so as to make the project feasible.

As commuter transport is undulatory in general, a large amount of investment in facilities is required. However, because of its public nature, the fare rate may not be raised so much. Therefore, in order to make it feasible, external free funds are indispensable for investment in facilities.

As to a source of revenue for investment, in case the project is integrated with urban development and a considerable amount is returned from the land-development profit, the project would also be sufficiently feasible.

(d) Financial burden of the government of Thailand

The specific amount to be borne by the government of Thailand for the execution of this project will be estimated as a result of the feasibility study. However, in the stage of the Master Plan the following are considered:

The total amount of the government budget of Thailand was 450 billion baht in 1992, out of which 130 billion baht was expended as investment including 31 billion baht invested in the field of transport and communication. As to the past SRT investment, 8.8 billion baht was invested in total (during the five years from 1989 to 1993), and the average amount per year was 1.8 billion baht.

The amount of investment proposed here by the Master Plan is 354 billion baht for the fifteen years from 1996 to 2010 and the average per year is 23 billion baht. As for the improvement of commuter transport by the SRT, the amount proposed is 52 billion baht for fifteen years, and the average per year is 3.4 billion baht. The amounts to be invested according to the Master Plan account for considerably large ratios of the entire amounts of both the national and SRT budgets.

However, in urban development, by introducing a method like land readjustment, development gains can be internalized to a fairly large extent. In the case where the development gains are smoothly recycled, the investment may not be a substantial burden on the government and the SRT even if the subsidy for the railway improvement is included. The problem is how to finance the amounts to be invested.

It is necessary, therefore, to adjust timing of urban development and railway improvement in appropriate stages, and to obtain development gains so as to be applied to the next investment for urban development and railway improvement.

(4) General evaluation

The proposed Master Plan where urban development and railway improvement are integrated is to improve the existing four lines of the SRT during the period from 1996 to 2010 as well as to provide 1,700,000 persons with residences with a good living environment. As a result, the following effects will be obtained:

i) Since the commuters may reach their places of work (situated in the Bangkok city center) by safe, fast and reliable trains, the loss of time would be reduced compared with the cases where they drive to their places of work, and thus a stable rhythm of life may be ensured.

ii) The trip from Bangkok to the regional core cities may be supported by the intercity express train leaving the Bangkok city center once an hour (once every two hours in the beginning). Moreover, since the access traffic from the railway stations will also be reinforced, it will be easier for people to use railway services. There fore, the opportunities for business trips and exchange of information will increase, and it will also help to develop the local core cities.

iii) Accompanied by the enlarged tendency to use railway services more frequently among the people living in the existing residential areas, the number of cars arriving at the Bangkok city center may decrease. In addition, coupled with the completion of the MRT projects, this may also alleviate the traffic congestion and air pollution.

iv) With the possible saving of the traffic time and operational expenses of transport facilities, the EIRR exceeds the 12% which is the standard applied to projects in Thailand and, consequently, the Master Plan is considered feasible.

v) In addition to the easily measured results mentioned above, the following advantages may be obtained by executing the Master Plan.

- Reduced air pollution would save Bangkok's urban environment from destruction.

- The modal shift from car driving with wasteful use of oily fuel to railway operation enabling more efficient use of natural resources may be realized. Besides, the burdens on the global environment such as those caused by the discharge of carbon dioxide will be alleviated.

- By converting from street traffic to railway traffic, traffic accidents in which many people are killed and injured may decrease.

vi) According to the results of financial analysis, concerning the Eastern and Northern Lines the projects may be feasible in case 1/2 of the investment in facilities is by external free funds and second-class fares are applied. On the other hand, concerning the Macklong and SBIA New Lines external free funds of 3/4 of the necessary investment are required to make the projects feasible and as to SBIA New Line the application of the maximum fares may also be required. In view of the presumed rise in the price of land subject to development, the maximum returnable amount of the development gains is estimated to become approximately eight times as large as the total amount to be invested in the railway improvement. Therefore, by adjusting the execution system, it may be possible to allot the amount to be subsidized out of the development gains.

As a precondition to this Master Plan, the Hopewell Project (which covers the area within 10-30 km from the center) should be executed as scheduled. It is expected that when the twenty or more at-grade crossings situated within the Hopewell Project area would all be converted to grade separated crossings and each line would be double (triple) tracked, the time required to reach the city center by railway would be reduced and the restriction on the number of trains operated would be removed.

Consequently, should the Hopewell Project fail to progress as scheduled, the railway improvement would be realized only in the sections other than the section covered by the Hopewell Project and the prospective effects mentioned above would be reduced to a large extent.

1.4.5 Execution of the Master Plan

(1) Urban development program

The program of integrated urban and railway development is prepared taking the following factors into account:

- The east-west axis and north-south axis of the Bangkok Metropolis
- The passengers to be attracted and developed

- Priority of the execution scheduled per direction and line

- The adjustment in the pace and period of execution between urban development and railway improvement

The execution phases of the urban development and railway improvement based on the above factors are indicated in Figs. 18-20.

The most important matter to be noted is that residences should be built as soon as possible in the newly developed urban area so that the population there may increase. For this purpose, railway services should be started there as reliable transport facilities. Especially in the initial stage of the urban development, the effect of the new investment in railways such as electrification may not be reflected instantly. During such a period, it is important to improve the railway service by introducing diesel cars, etc.

(2) System and method

The integration of urban development and railway improvement is aimed at the following points:

- To contrive a physical adjustment between plans for urban development and railway improvement

- To ensure financing resources to cover the shortage in the fund for investment and increase in operational costs

The desired system to support the execution of the project where two kinds of social developments are integrated would be as follows:

- A new system based on new regulations on the integrated development

- Close cooperation among the existing organizations such as the SRT, the NHA, etc.

- A new sector including private organizations based on new regulations

When similar projects were executed in Japan in the past where urban development and railway improvement were integrated, various systems to support their execution were examined. Among them projects which were executed with a great success were: Tama

Figure 5.1.2 Development Phase

Fig. 18 Development Phases for Each Line

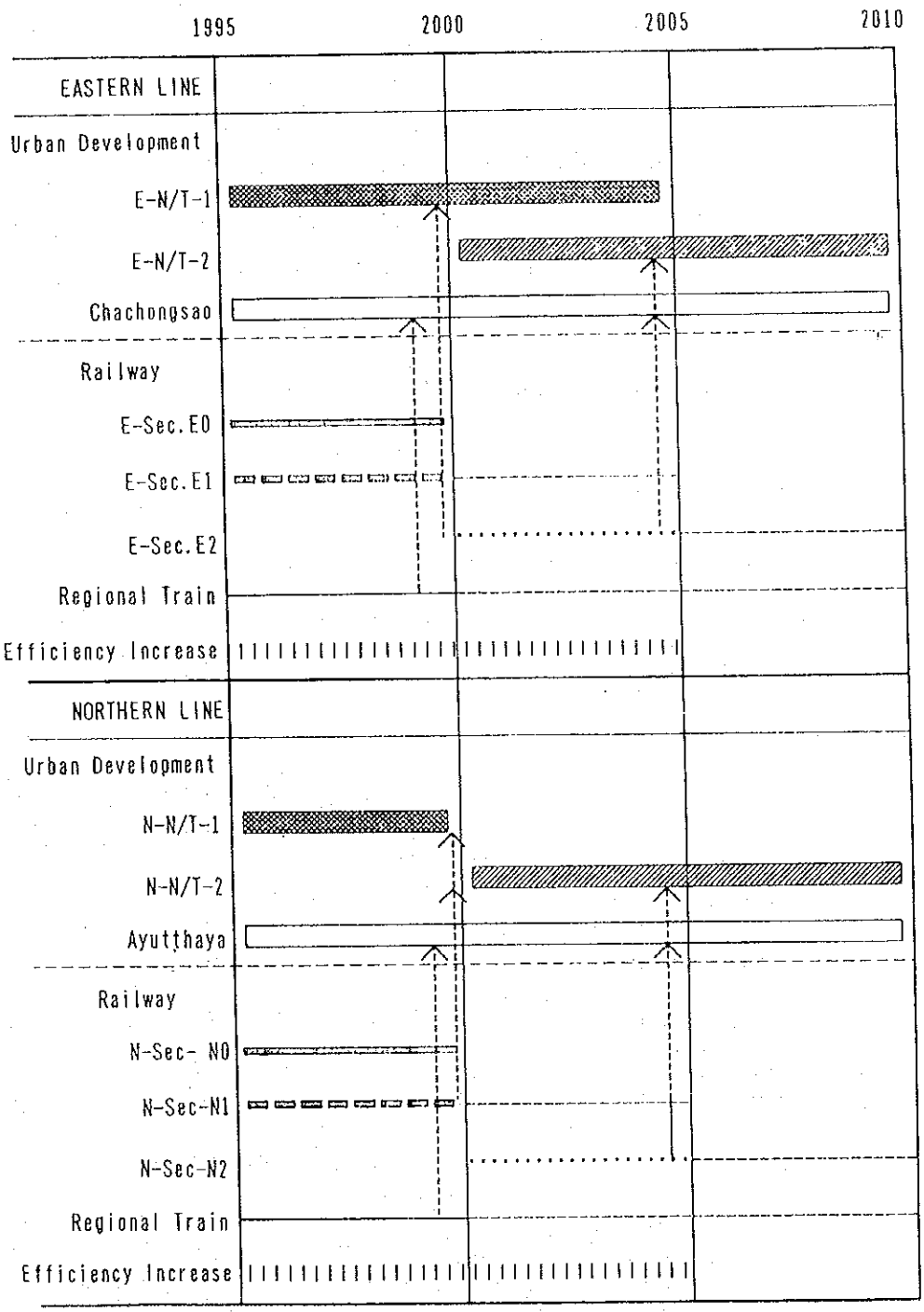


Fig. 19 Development Program for the Eastern and Northern Lines

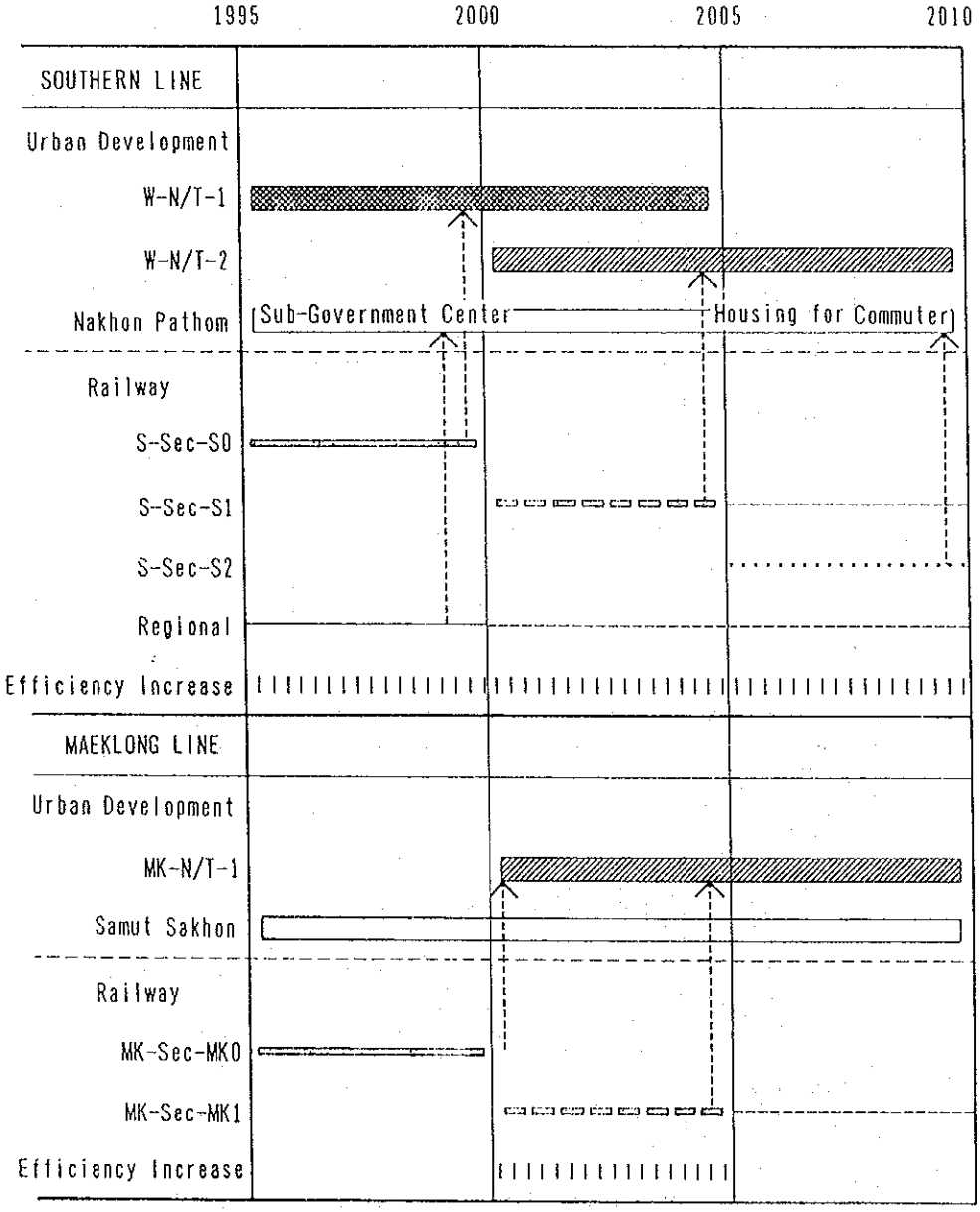


Fig. 20 Development Program for the Southern and Maeklong Lines

Den'en Toshi by a single private company, Senboku New Town by a local government (Osaka Prefecture) and a third sector in which Osaka Prefecture has invested, etc. Many examples which were supported by multiple existing organizations working in close cooperation with one another also can be enumerated.

In a recent case, a new organization (of the third sector) started to undertake a project where construction of the New Joban Line was integrated with urban development. All the local governments along the line participated in the project, and the government granted a tax reduction and interest-free loan. In order to ensure the acquisition of the land for the intended railway, they used the method of land readjustment by specifying zones oriented to the railway facilities beforehand.

Specific systems to support the execution of the projects in Thailand will be proposed in the stage of the feasibility study. It can be pointed out here that the method of land readjustment is a quite effective means although various modifications will have to be made on the basis of the local situations.

(3) Financial resources for investment

According to the result of the financial analysis of the Master Plan, a large development profit is expected in the case where urban development is integrated with railway improvement. However, with regard to the investment and management of the railway alone, unless external free funds are allocated to cover 1/2 (3/4 for some lines), feasibility would not be anticipated.

Thus, the way to return development gains to the railway investment constitutes an important point of the project.

In order that the project can be financially realized, the capital flow should be as indicated in Fig. 21.

That is to say, it is proposed that the financing resources of the investment in the SRT should consist of the revenue from fares, subsidies and the amount returned from the development gains. In addition, with regard to the PSO which the SRT has been discussing with the government on public transport, it is proposed that the compensation should be received from the Government of Thailand.

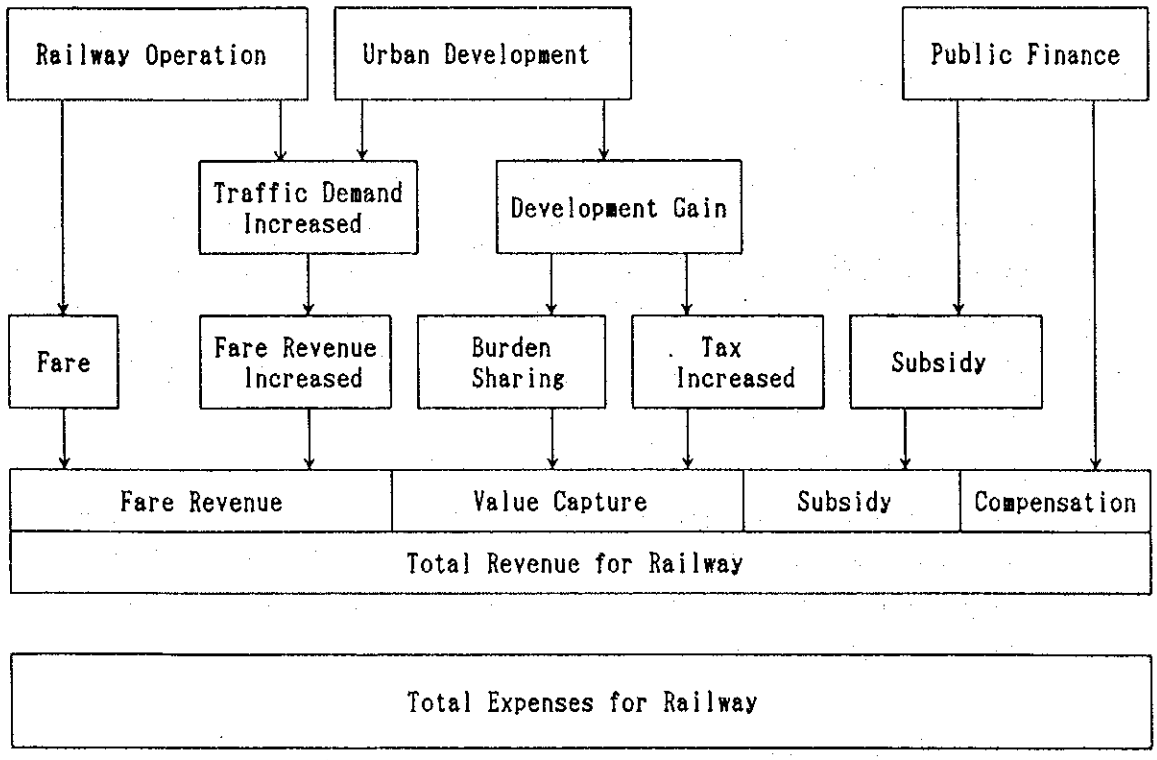


Fig. 21 Financing Resources for Railway Operation

The fare revenue includes the amount of revenue caused by the increase in the number of passengers attracted to the developed urban area.

Concerning the development gain, various means should be examined such as increased tax revenue to be allotted to the SRT and the development gain to be directly allotted to the SRT.

A direct method to have the development gains returned is that the SRT obtains such profit directly through acquisition and sale or rental of land. In practice, however, various restrictions may be placed on this method.

As mentioned above, an effective means for the railway enterprises, local communities and land owners to gain profit is to adopt the method of land readjustment. This method will be discussed later in the actual stage of the Feasibility Study by making proper modification to meet with local situations.

1.5 Recommendation of Lines to Be Examined in the Feasibility Study

1.5.1 Selection of the High-priority Projects

The areas along the SRT lines in the four directions radiating from Hua Lamphong have respective possibilities of urban development integrated with railway improvement.

In order to compare priority concerning the four lines, examination in accordance with the following evaluation items is proposed:

- The scale of urban development
- Total amount of investment in railways
- Internal rate of return
- Local characteristics
- Relationship with the relevant projects
- Environmental problems
- Problems concerning execution

Since the government of Thailand lays stress on the development of ESB, the improvement of railway transport is urgently required especially on the Eastern Line. Also, the large-scale national projects have been realized along the line as follows:

- Second Bangkok International Airport (SBIA)
- Residential Area Development by NHA
- Inland Container Depot

Furthermore, the High Speed Rail Project between the Bangkok city center and ESB has been proposed. The Second Bangkok International Airport is now under construction so that it is necessary to draw up development plans for the neighboring areas at an early date.

Table 10 shows the evaluation as compiled per items for each line.

Table 10 Evaluation of Priority in Investment by Line

Item \ Line		Eastern Line		Northern Line		Southern Line		Maeklong Line	
Planned population in urban development (000 persons)		500	○	640	◎	360	○	200	△
Total amount of investment for railway (billion baht)		14.9	○	17.6	△	11.9	○	7.2	◎
EIRR (%)	Improvement only for commuter service	20.8	○	30.9	◎	21.2	○	25.9	○
	For both commuter and ic. express service	22.6	○	23.4	○	22.1	○	-	-
FIRR (%)	Improvement only for commuter service	9	○	12	◎	5	△	5	△
	For both commuter and ic. express service	11	◎	12	◎	7	○	-	-
Characteristics of the area		Close relation with ESB Project SBIA	◎	UCR Development Don Muang Airport	○	Delay in developing	○	Advantage in distance to the CBD	○
Relevant big projects	Hopewell Project	15km length	□	30km length	□	Crossing Chao Phraya River Passing by the Royal Palace Land acquisition in downtown	△	Crossing Chao Phraya River Land acquisition in downtown	△
	Housing development by NHA	Ongoing	◎	-	-	-	-	-	-
	SBIA	Ongoing	◎	-	-	-	-	-	-
	HSR Project	Under examination	◎	-	-	-	-	-	-
Environment		-	□	-	□	-	□	-	□
Problems on execution		-	□	-	□	-	□	-	□

Remarks: Marks show degree of urgency/effect of railway improvement and urban development.

◎: Urgency/effect; Large

○: Urgency/effect; Medium

△: Effect; Small

□: No special mention

By comparing the results per item indicated in Table 10, the projects along each line are feasible from the viewpoint of economic evaluation. However, from the viewpoint of financial evaluation, it is indicated that the Eastern Line and the Northern line will be feasible and each of them is considered as a powerful proposed project.

Taking into consideration that the related projects such as the residential area development along the Eastern Line by NHA and the Second Bangkok International Airport are in progress and the Government of Thailand attaches greater importance to the development of ESB, it is proposed that the project of integrated urban and railway development along the Eastern Line should be taken up as top priority, and the feasibility study should be implemented.

The line to connect the Second Bangkok International Airport (under construction) with the Eastern Line may not be feasible itself. However, since a unified operation may be effective in the case of the railway, it is proposed that the feasibility study of the Eastern Line should include the SBIA New Line in reviewing to cover the investment in facilities as well as the level of fares. (Infrastructures such as tunnels and viaducts within the airport area are to be provided for in the Airport Project. This suits the conditions.)

1.5.2 Concept of the Lines to be Examined in the Feasibility Study

(1) Sections to be studied

It was decided at the discussion on the Scope of Work held in December, 1992 between the representatives of the governments of Japan and Thailand that 100 km of railway section, excluding the Hopewell Project area, would be studied on feasibility after the Master Plan is established.

In deciding the section of 100 km to be selected for the feasibility study along the Eastern Line (other than the sections in Hopewell Project area), the first priority may be given to the section where land suitable for residential development is included and large-scale transport is involved. In addition, the section includes the regional core cities, Chon Buri and Chachoengsao, and the branch line to the Second Bangkok International Airport. The section thus selected is as follows:

- Hua Mak - Chonburi of the Eastern Line, SRT: 93 km

- Second Bangkok International Airport Branch Line: 7 km

(2) Transport improvement investment plans

- Electrification between Hua Lamphong and Chachoengsao
- Automatic brook signalling sistem with ATS-P
- Track strengthening
- Electric railcars for commuter service
- Diesel railcars for intercity express service
- Track-doubling between Hua Mak and Chachoengsao (On-going, out of the Study)
- Others

(3) Train operation plan

To be examined for the following points depending on the results of the feasibility study:

- Commuter service:

Rush hour	10-minute headway (each of rapid and local)
Off-peak hours	20-minute headway (each of rapid and local)

- Intercity express service:

One train per hour (One train every two hours in the beginning)

- Schedule speed:

Commuter service	65 km//h (Average of rapid trains and local trains)
Intercity express service	100 km/h (Maximum speed, 120 km/h)

(4) Urban development

- Population newly attracted to the areas along the railway line:

0.5 million persons

- To consider the number of passengers who use the airport, and those who have been added by the development around the airport

- To calculate the effect of development in the areas along the railway line

FEASIBILITY STUDY

2. Feasibility Study

2.1 Introduction

This chapter explains a summary of the Feasibility Study on the Integrated Urban and Railway Development along the Eastern Line of the SRT which is selected as the priority project in the Master Plan Study.

Along each line of the SRT lies land suitable for development. It can be developed, integrated with improvement of railway service, by reinforcing facilities and rolling stock of the railway.

In the Master Plan Study four areas along the four lines radiating from the center of the Bangkok Metropolis were compared. In the view point of economic and financial evaluation, those along the Eastern Line as well as the Northern Line are of advantage. Along the Eastern Line, the national projects such as the residential area development by NHA and the Second Bangkok International Airport (SBIA) are on-going and the government of Thailand lays stress on the development of the Eastern Seaboard (ESB). Thus, taking into account such situations, integrated development along the Eastern Line is selected as the priority project.

Accordingly, by the agreement of the Japanese side and the Thai side, the Feasibility Study on Integrated Urban and Railway Development along the Eastern Line of the SRT has been executed.

2.2 Concept of the Integrated Urban and Railway Development along the Eastern Corridor

2.2.1 General Classification of Mass Rapid Transit Systems

The mass rapid transit systems should be applied mainly to serve transport demands, which are deemed to be of great importance from the view point of solution of urban transport problems, especially elimination of road traffic congestion, and urban social/economic development.

Types of mass rapid transit systems are classified by targeted areas and targeted trips as shown in Table 11.

Table 11 Targeted Areas and Trips of Mass Rapid Transit Systems

Types of MTS applied	Targeted Area	Targeted Trip
Intra-Urban MTS (consisting of the planned MRT including Hopewell, Tanayon, MRTA, subway and others)	Densely populated area and CBD within 20 km radius area	High-density short-distance trips
Suburban MTS (SRT suburban line)	Expanded urban area beyond 20 km radius up to 40 km	Medium-density medium-distance trips
Inter-Urban/Regional MTS (SRT Regional/National Trunk Line)	Regional urban centers and their hinterlands (changwat)	Low-density long-distance trips

2.2.2 Structured Development of Eastern Corridor and Population Distribution

In the preceding Master Plan Study, taking into account the NESDB population projection for 2010, the total control population, trend population and the new development potential population are calculated as shown in Table 12.

Table 12 Population Projection for 50 km Radius Area

1	Total control population in 50 km radius	Total of NESDB projection by changwat	14,000,000
2	Trend population	Total of trend population by district	12,300,000
3	New development potential population	Difference between 1 and 2	1,700,000

In the Master Plan Study, the 1.7 million new development potential population is distributed among the four (4) corridors radiating from the center of Bangkok. About 0.5 million of this population is allocated to the new town development along the Eastern Corridor. It is disputable whether the figure of 0.5 million is an under or over estimate, especially taking into account the expected high development potentials represented by such big projects as SBIA and SBIA-related projects, Eastern Seaboard Development and so on.

At thirty two percent (32%) share of the population of the SBIA Master Plan area along the Eastern Corridor to the total population of the 50 km radius area in the year 1990 is applied as the most probable and certain index so as to determine the share of new development population along the Eastern Corridor to the estimated total potential population of 1.7 million.

It also can be stated that as far as the railways are improved based on this basic population projection, the railways can easily respond to an unexpected population increase, if any, beyond the population projection through the additional measures of increasing transport capacity.

Thus the control total new development population on the Eastern Corridor is set at 544,000 (1,700,000 × 0.32).

The basic employment is estimated at 81,000 with the ratio of employment to population of 0.15 being applied to the new towns of 540,000 population.

The regional development employment is distributed, especially with the special attention paid to the development effect of the improved railway, as shown in Table 13.

Table 13. Distribution of Regional Development Employment

District / New town	Potential	Employment share
Pravet	Relatively high as a part of Bangkok's built-up area, and serving the increasing population	25%
Lat Krabang	High potential 1. Large volume of new town population 2. Gateway to SBIA 3. Within one hour travel time to CBD	50%
Muang Chachoengsao	Relatively high based on the potential of Chachoengsao	25%

2.2.3 Railway Network in the Eastern Corridor

The proposed railway network in the Eastern Corridor is shown in Fig. 22. The railway route and integrated urban development plan in the 50 km radius area where integrated urban development and railway improvement will be carried out according to priority is shown in Fig. 23.

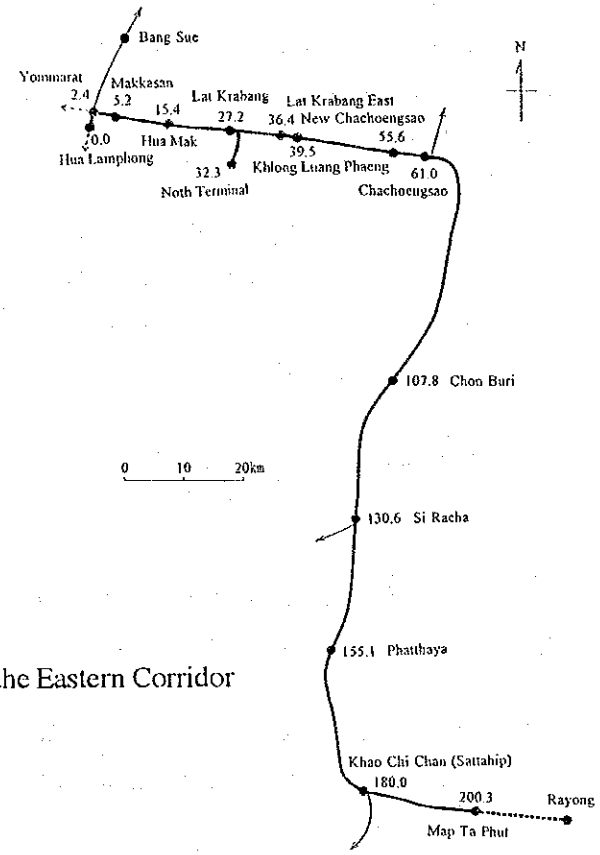


Fig. 22 Railway Network in the Eastern Corridor

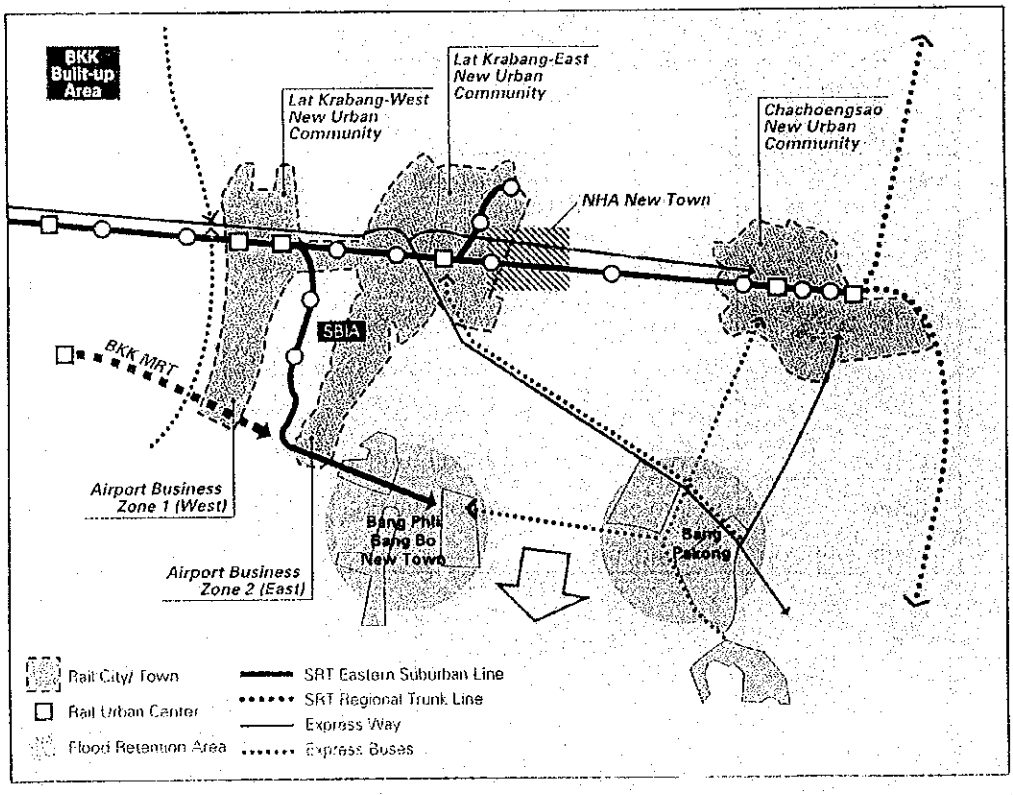


Fig. 23 Proposed Railway Route and Integrated Urban Development in the 50 km Radius Area

2.3 Demand Forecast

2.3.1 Method of Demand Forecast

Major steps for demand forecast applied to this study were as follows:

i) Examination of existing OD tables
ii) Updating existing OD tables in consideration of Urban Development
iii) Pre-loading of private and truck traffic on road, and diversion of the public mode to bus and rail

The methods are summarized in Fig. 24.

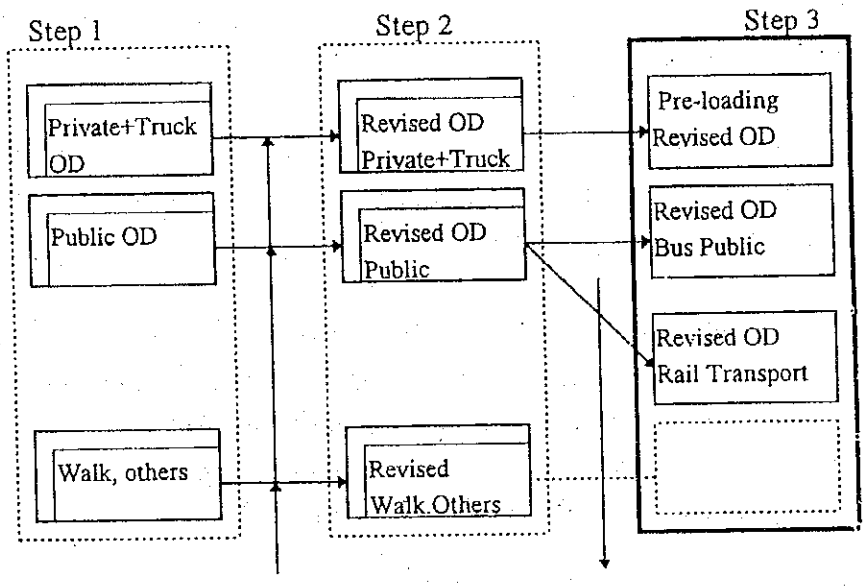


Fig. 24 Flow of Demand Forecast

2.3.2 Prerequisite for Demand Forecast

(1) Bus transport, etc.

The implementation of an urban railway system requires adjustment of existing public transport. This includes the rerouting and streamlining of existing bus lines to avoid duplication of service which causes losses to management and the introduction of feeder bus services. Through tickets of railways and feeder buses will be issued in a later phase. In addition, station facilities for "park and ride" or "kiss and ride" will be provided as well.

(2) Consideration of type of developing new town

The number of generated trips depends upon the size of the planned new town. The distribution of trips and the condition of the commuting trip will be affected by the type of new town to be created.

The types of the new towns mainly can be classified into two categories. One is a regional core satellite town which is relatively independent of the mother town (type 1) and the other is a bedtown of the Bangkok Metropolis (type 2).

In this study, bedtown development (type 2) is assumed to be created. Therefore, it is assumed that the population composition will be quite similar to the present Bangkok as migrant population will be mainly transferred from the Bangkok area. Following to this assumption, the new town population composition and generated commuting trip to Bangkok are estimated in Table 14 and Table 15, respectively.

Table 14 New Town Population Composition by Job

Primary	Secondary	Tertiary*	Service**	Student	Housewife	Others
0.8%	10.8%	19.6%	16.0%	29.8%	11.9%	11.1%

* Tertiary: excludes service workers in the new town
** Service: workers who serve in the new town

Table 15 Composition of Generated Commuting Trips

Intra-town	To BKK
34.5%	65.5%

(3) Alternatives on integrated urban and railway development plan

There are several proposed project plans for the Eastern line. The number of alternatives which can be obtained as a result of combinations of these plans are humerous. To examine the project carefully and make suitable proposals, the following alternatives have been prepared:

Alternative 1: Integrated urban development and railway commuter service improvement within the 50 km radius area

Alternative 2: Alternative 1 and SBIA accesses service establishment

Alternative 3: Alternative 2 and intercity express service improvement between Bangkok and ESB.

(4) Service level

Transport service level is set up as shown in Tables 16 and 17.

Table 16 Service Level of Commuter Transport

Mode / Item	Railway	Bus
Fare	0.215 baht/km or 0.44 baht/km	0.4 baht/km
Speed	65 km/h (average)	CBD 12.6 km/h Suburbs 28.6 km/h
Frequency	Rush hour 10 min. Off peak 20 min.	CBD 5 min. Suburbs 10 min.

Table 17 Service Level of Intercity (Express) Transport

Mode / Item	Railway	Bus
Fare	0.6 baht/km	0.77 baht/km
Speed	80 km/h	48.6 km/h
Frequency	1 hour	Peak 15 min. Off peak 30 min.

The value of passengers is set up as follows:

Business and work purpose: 48.5 baht/hour

Other purpose: 16.4 baht/hour

2.3.3 Results of Demand Forecast

(1) Commuter transport

The results of demand forecast of commuter transport on the Eastern Line is as shown in Table 18.

Table 18 Forecasted Demand of Commuter Transport on the Eastern Line

(trips/day)

Item \ Alternative	Do minimum	Railway improvement	Railway improvement Feeder
Without urban development	73,000	138,000	201,000
With urban development	-	-	289,000

(2) SBIA access transport

Demand for SBIA access transport is forecasted as shown in Table 19 based on the "SBIA Ground Access Plan".

Table 19 SBIA Ground Access Plan

(trips/day)

Item \ Year	2000	2020
Airline user	15,138	78,653
Worker	5,760	15,910
Total	20,898	94,563

(3) Intercity express transport

The results of demand forecast of intercity express transport on the Eastern Line is as shown in Table 20.

Table 20 Forecasted Demand of Intercity Express Transport on the Eastern Line

(trips/day)

Alternative	Do minimum	Railway improvement	Railway improvement/ Feeder
Demand	20,000	26,000	28,000

2.4 Rail Town Development Plan

2.4.1 Concept of Rail Town Development Plan

A new town which develops centering a railway station and planned to utilize a railway as a principal transport means is called a "Rail Town" here. Rail town developments shall be implemented in conforming with the planning framework and guidelines set up in the proposed structure plan in this study.

It is quite hard to map out the land use plan in detail with the high certainty of implementation at this moment in time as it is dependent on the unfixed destinies of the existing proposed development projects. What can be presented at this moment is just a model development.

Highest priority is placed on the earlier establishment of a complete suburban commuter line on the main section of the Eastern line. Correspondingly, the study focuses the model development on the main section, especially in the district of Lat Krabang.

The model development plan targets a 300,000 population for the district of Lat Krabang which includes the West and East new towns. The Lat Krabang West New Town with a planned population of 200,000 and East New Town with 100,000 are designed to expand and develop into the BMA Suburban Center and NHA New Town with a targeted population of 300,000 respectively if/when they are successfully implemented as planned. That is shown in Table 21.

Table 21 Population Projection and Targeted Population