JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

VIETNAM RAILWAYS (VR)

STUDY FOR THE FORMULATION OF HIGH SPEED RAILWAY PROJECTS ON HANOI – VINH AND HO CHI MINH – NHA TRANG SECTION

FINAL REPORT

SUMMARY

June 2013

ALMEC CORPORATION
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO., LTD.
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PREFACE

In response to the request from the Government of the Socialist Republic of Vietnam, the Government of Japan decided to conduct the Study for the Formulation of High Speed Railway Projects on Hanoi – Vinh and Ho Chi Minh – Nha Trang Section and entrusted the program to the Japan International cooperation Agency (JICA).

JICA dispatched a team to Vietnam between April 2011 and June 2013, which was headed by Mr. IWATA Shizuo of ALMEC Corporation and consisted of ALMEC Corporation, Japan International Consultants for Transportation Co., Ltd., Oriental Consultants Co., Ltd., Nippon Koei Co., Ltd. and Japan Transportation Consultants, Inc.

In the cooperation with the Vietnamese Counterpart Team including the Ministry of Transport and Vietnam Railways, the JICA Study Team conducted the study which includes traffic demand analysis, natural and socio-economic conditions, alignment planning, consideration of various options including the upgrading of existing railway, technical standards for high speed railway, implementation schedule and institutions, and human resource development. It also held a series of discussions with the relevant officials of the Government of Vietnam. Upon returning to Japan, the Team duly finalized the study and delivered this report in June 2013.

Reflecting on the history of railway development in Japan, it is noted that Japan has indeed a great deal of experience in the planning, construction, operation, etc., and it is deemed that such experiences will greatly contribute to the railway development in Vietnam. JICA is willing to provide further cooperation to Vietnam to achieve sustainable development of railway sector and to enhance friendly relationship between the two countries.

It is hoped that this report will contribute to the sustainable development of transport system in Vietnam and to the enhancement of friendly relations between the two countries.

Finally, I wish to express my sincere appreciation to the officials of the Government of Vietnam for their close cooperation.

June 2013

Kazuki Miura
Director, Economic Infrastructure Department
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ABBREVIATIONS

AC	Alternating Current
AFC	Automatic Fare Collection
AGR	Average Growth Rate
AT	Auto Transformer
ATC	Automatic Train Control system
ATS	Automatic Ticketing System
B/C	Benefit-Cost Ratio
CFEZ	Central Focal Economic Zone
CO_2	Carbon Dioxide
CSR	Compensation, Support and Resettlement
D/D	Detailed Design
dB	Decibel
DF/R	Draft Final Report
DS-ATC	High-speed railway signal system in Japan
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMU	Electric Multiple Unit
ETCS	European Train Control System
EVN	Vietnam Electricity
F/R	Final Report
F/S	Feasibility Study
FBR	Fare Box Ratio
FDI	Foreign Direct Investment
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Product
GHG	Green House Gas
GRDP	Gross Regional Domestic Product
GSO	General Statistics Office
HCMC	Ho Chi Minh City
HPC	Hanoi People's Committee
HQ	Headquarters
HSR	High Speed Railway
IC	Integrated Circuit
IC/R	Inception Report
IEE	Initial Environmental Examination
IGBT	Insulated Gate Bipolar Transistor
IT	Information Technology
IT/R	Interim Report
JICA	Japan International Cooperation Agency
JR East	East Japan Railway Company
Km	Kilometer
KOICA	Korean International Cooperation Agency
KVA	Kilovolt Ampere
KV	Kilovolt
kW	Kilo Watt
LCC	Low Cost Carriers
LCX	Leaky Coaxial Cable
LRT	Light Rail Transit
LZB	Continuous train detection system in German high-speed train ICE
mil.	Million
MLIT	Ministry of Land, Infrastructure, Transport And Tourism
MOC	Ministry of Construction
MOT	Ministry of Transport
MPI	Ministry of Planning and Investment
MRD	Mekong River Delta

NATM	New Austrian Tunneling Method
NCPFP	National Committee for Population and Family Planning
NH1	National Highway 1
NNW	North-Northwest
NPV	Net Present Value
NSHSR	North-South High Speed Railway
O & M	Operation and Maintenance
OCC	Operation Control Center
OD	Origin-Destination
OHS	Occupational Health and Safety
OP	Operational Policy
P/R	Progress Report
PAPs	Project Affected Peoples
PCI	Provincial Competitive Index
PCT	Prestressed Composite Truss
PCU	Passenger Car Unit
PMU	Project Management Units
PWM	Pulse Width Modulation
RAP	Resettlement Action Plan
RR	Ring Road
RRP	Rehabilitation and Resettlement Plan
RRPF	Resettlement and Rehabilitation Policy Framework
SEA	Strategic Environmental Assessment
SEDP	Socio-Economic Development Plan
SEDS	Socio-Economic Development Strategy
SFEZ	Southern Focal Economic Zone
SHM	Stakeholder Meeting
SIA	Social Impact Assessment
SP	Sectioning Post
SSP	Sub-sectioning Post
SSW	South-Southwest
TDS	Transport Development Strategy
TR	Technical Report
TRICC	Transport Investment And Construction Consultant Joint Stock Company
TVM	Transmission Voice-Machine
TWG	Technical Working Group
UMRT	Urban Mass Rapid Transit
UNDP	United Nations Development Project
UNFPA	United Nations Population Fund
USD	United States Dollar
VITRANSS2	The Comprehensive Study On The Sustainable Development Of Transport System In Vietnam
VJC	Vietnam-Japan Consultancy Joint Venture
VND	Vietnamese Dong
VNR	Vietnam Railways
VNRA	Vietnam Railway Administration
VR	Vietnam Railways
VVVF	Variable Voltage Variable Frequency
WAN	Wide Area Network

1 INTRODUCTION

1.1 Outline of the Study

1) Background

1.1 Vietnam has achieved remarkable economic growth since the commencement of the policy of Doi Moi. In Vietnam, the North-South High-Speed Railway (HSR) Project is expected to become a promoter of the country's further economic development as well to serve as a symbol of its successful growth. During the period of 2007-2010, the Japanese government provided technical assistance through the Japan International Cooperation Agency (JICA) to conduct "The Comprehensive Study on the Sustainable Development of Transport System in Vietnam" (VITRANSS2) upon the request of the Vietnamese government. In VITRANSS2, a substudy on the HSR project was carried out and a preliminary development strategy was formulated. During the same period, a pre-feasibility study of the HSR was also conducted by the Vietnam-Japan Consultancy Joint Venture (VJC), consisting of the Transport Investment and Construction Consultant Joint Stock Company (TRICC) and Japanese consultants, under Vietnam Railways (VR). Although a cabinet decision was made in March 2010 based on this pre-feasibility study to construct a high-speed railway based on the Japanese Shinkansen system, this was not approved in the National Assembly in June 2010 and hence became open for discussion once again.

1.2 For the HSR project to be approved by the Assembly, a detailed analysis supported by scientific and objective grounds has to be conducted on the issues raised in the previous National Assembly. Given these circumstances and upon the request of the Vietnamese government, Japan has again provided technical assistance through JICA, this time to carry out the "Study for the Formulation of High Speed Railway Projects on the Hanoi-Vinh and Ho Chi Minh-Nha Trang Sections."

2) Objective

1.3 The study aims to conduct a study on HSR development, analyze development alternatives, propose the optimal plan, develop a project implementation plan for the selected sections (namely, the Hanoi-Vinh and Ho Chi Minh-Nha Trang sections), and promote a better understanding of the HSR project among various stakeholders. Specifically, the study's objectives are as follows:

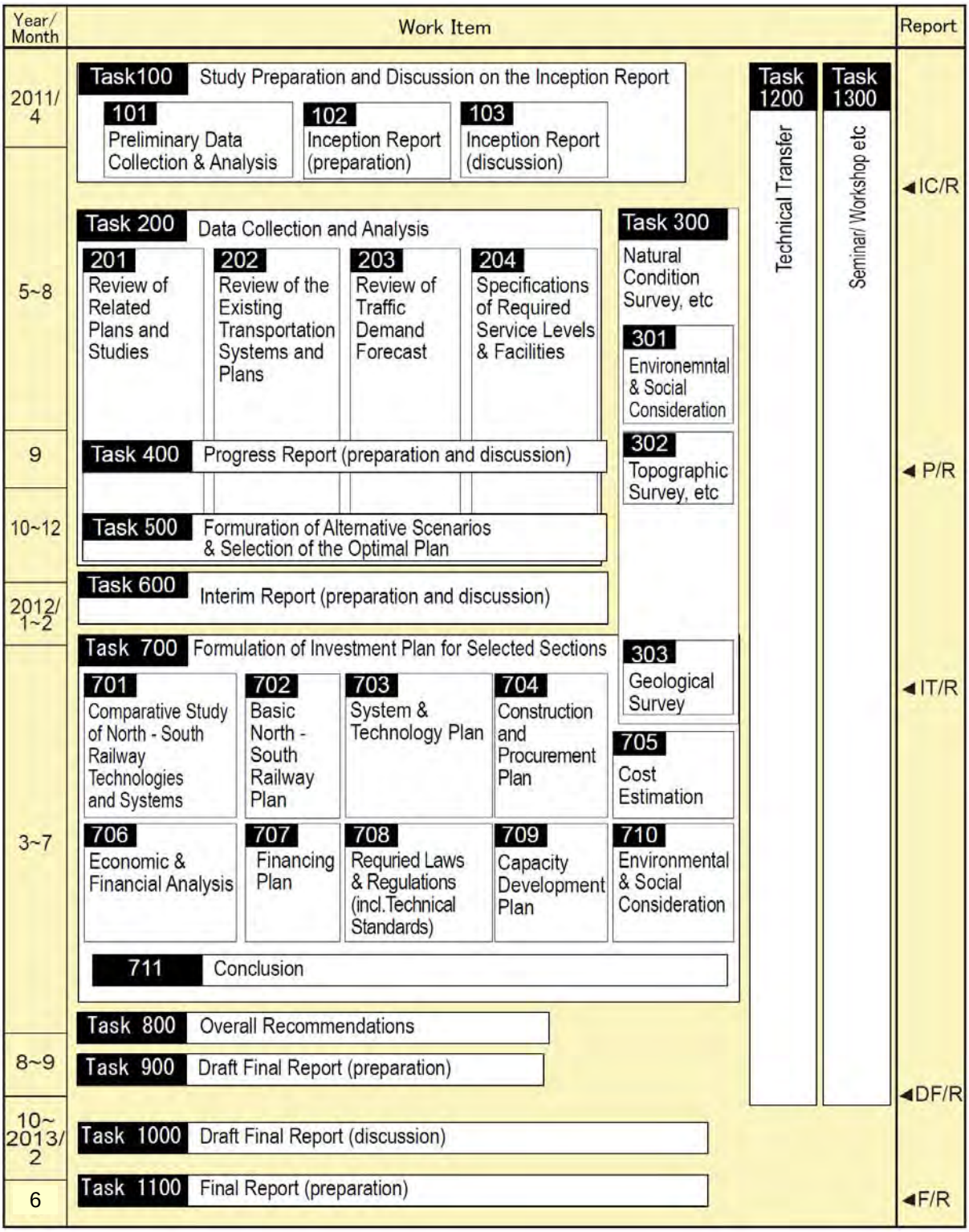
(a) Formulate a basic development plan for the HSR;

(b) Formulate detailed development plans for both north and south priority sections; and

(c) Prepare the documents needed for the environmental and social considerations.

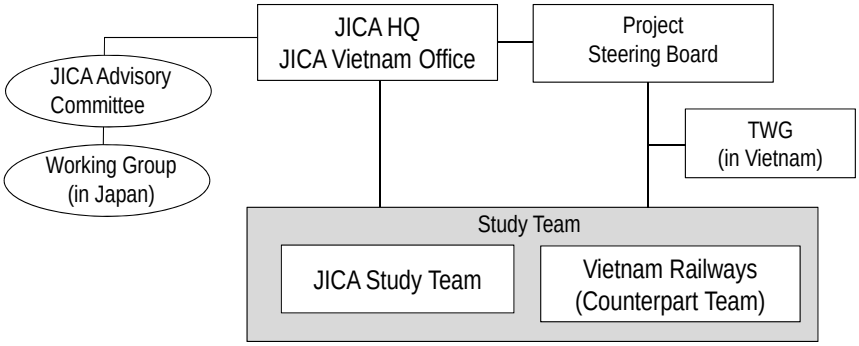
3) Study Organization

1.4 The study was conducted under the cooperation of both Japan and Vietnam sides to ensure smooth implementation of the study. While the Vietnam side established a Steering Board consisted of representatives from MOT, VR, and related agencies and a Technical Working Group consisted of railway experts, the Japan side established an Advisory Committee consisted of experts from MLIT, university, and railway operators. The study team is a consortium of five different Japanese consulting firms.



Source: JICA Study Team.

Figure 1.1 Overall Workflow of the Study



Source: JICA Study Team
Note: HQ = Headquarters, TWG = Technical Working Group

Figure 1.2 Study Organization

4) Study Implementation

1.5 The study commenced in May 2011, and the following activities were conducted to formulate the Final Report.

(a) **Formulation and discussion on the Inception Report:** The Inception Report on the overall study framework, contents and methodology was formulated, and this was submitted to and discussed with the Vietnam Side in May 2011.

(b) **Formulation and discussion on the Progress Report:** Supplemental surveys, review of related projects and plans, study on the constraints and opportunities of improving the existing line, preliminary analysis of the alternative scenarios on the development of north-south high-speed railway were conducted, and this was summarized in the Progress Report. The report was submitted to and discussed with the Vietnam side in September 2011.

(c) **Formulation and discussion on the Interim Report:** Site surveys, supplemental surveys, review of related projects and plans, study on the constraints and opportunities of improving the existing line, analysis of the alternative scenarios on the development of north-south high-speed railway, needs for high-speed railway, selection of optimal alternative for priority sections were conducted, and this was summarized in the Interim Report. The report was submitted to and discussed with the Vietnam side in May 2012.

(d) Technical, economic and financial, environmental and social, operational aspects regarding the priority sections were studied, and an implementation plan was formulated. This was summarized in the Draft Final Report, then finalized as the Final Report.

(e) **Stakeholder Meetings, Workshops, Seminars:** During the study period, workshops with counterparts, stakeholder meetings in provinces along the alignment, seminars in Hanoi and HCMC were held in order to collect opinions from wide stakeholders and to promote a better understanding of the HSR project among various stakeholders.

(f) **Steering Board Meeting:** 6 Steering Board Meetings were held in May 2011, September 2011, February 2012, August 2012, November 2012, and March 2013 respectively to explain the progress and outputs of the study to the Steering Board members.

(g) **Advisory Committee:** In order to receive advice on the contents and implementation of the study, a total of 10 Advisory Committees were held in Japan.

5) Structure of the Report

1.6 The Final Report is composed of the following reports:

(a) Summary

(b) Main Text which comprise the following volumes:

Volume I Development of North-South Railways

Volume II Part A Detailed Study on Hanoi – Vinh Section of NSHSR

Part B Detailed Study on HCMC – Nha Trang Section of NSHSR

Volume III Environmental and Social Considerations

(c) Technical Report which comprise the following seven reports:

TR1 Assessment of Existing Railway and Improvement Options

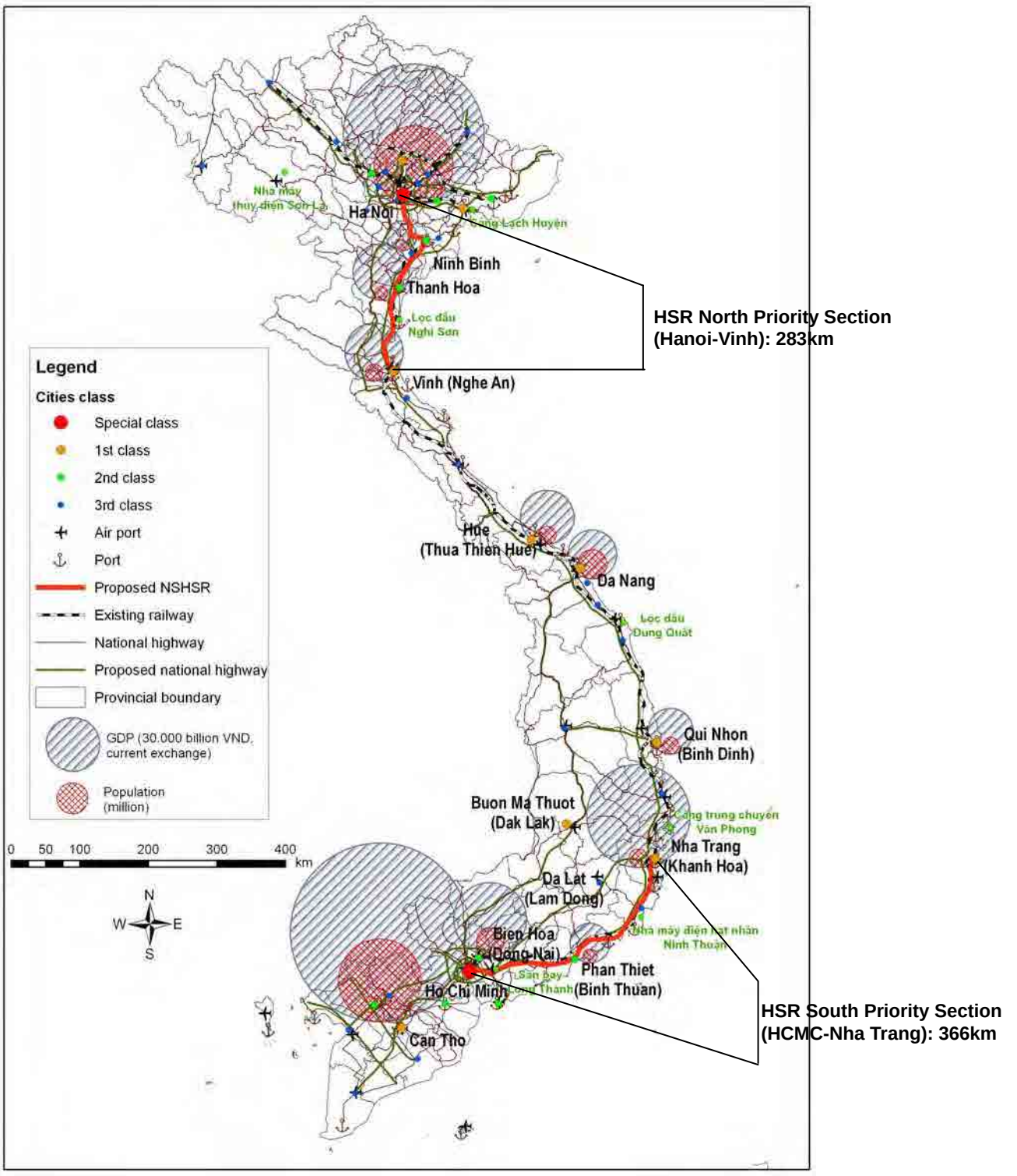
TR2 Demand Forecast and Transportation Cost

TR3 Baseline Survey for Environmental and Social Considerations

TR4 Environmental Sensitivity Map

TR5 Geological Survey and Preparation of Topographic Map

TR6 Questions and Answers to Comments



Source: JICA Study Team.
1) The value in the parenthesis indicates the GDP of the province or centrally governed city.

Figure 1.3 Study Area and Locations of North-South Railways[1]

[1] Class I cities are cities which have a population of more than 1 million and population density in inner city areas higher than 12,000 persons/km^2 for cities under the management of the Central Government, and more than 0.5 million and 10,000 persons/km^2 respectively for cities under the provincial management. Ratio of non-agriculture employment in inner-city area reaches at least 85% of total employment. Class II cities are cities which have a population of more than 0.8 million and population density in inner city areas higher than 10,000 persons/km^2 for cities under the management of the Central Government, and more than 0.3 million and 8,000 persons/km^2 respectively for cities under the provincial management. Ratio of non-agriculture employment in inner-city area reaches at least 80% of total employment.

1.2 Study Approach

1.7 The development of HSR has been studied by KOICA for Hanoi-Vinh and HCMC-Nha Trang section (F/S in 2007), Vietnam Railways (Pre F/S in 2009) and JICA (Basic Plan in 2010). Such previous studies were reviewed first in the initial part of this study.

1.8 This study was conducted under the basic understanding that the role railways play in the development of the north-south transport corridor, which is the most important corridor for the nation, is significant, and in order to respond to its high needs, both the existing railway and the new high-speed railway will be needed in the future. The basic approach to the study are as follows:

(a) **Step 1:** The first step was to review the alternative scenarios on overall north-south railway development which was discussed in the 2010 National Assembly. There are 6 scenarios which aim for north-south railway development and they are basically a combination of existing railway improvement for high-speed services and the construction of a new line to provide high-speed services. (see Table 1.1)

(b) **Step 2:** In this step, the constraints and opportunities to utilize the existing railway will be clarified. Especially Scenario 1 in which aims to upgrade to double track with dual gauge, and Scenario 2 in which aims to provide high-speed operation at 200km/h for both passenger and freight services on a double track standard gauge line were reviewed in detail, and the difficulties of upgrading the existing line to provide high-speed services were clarified.

(c) **Step 3:** While the difficulties of utilizing the existing railway to provide high-speed railway and the most appropriate level of improvement of existing railway were clarified. The improvement options consist of the improvement of existing single track railway (A1, A2) and double tracking the existing railway (B1, B2) (see Table 1.2) Then, detailed study on the construction of high-speed railway on a new line for priority sections were also conducted.

Table 1.1 Alternative Scenarios Discussed in National Assembly 2010

Alternative	Existing line	New line
Scenario 1	• Upgrading to double track with dual gauge (meter + standard) • Current maximum operating speed[1)] for passenger and freight	None
Scenario 2	• Upgrading to double track with standard gauge • Maximum operating speed (200km/h) for passenger and freight • Electrification	None
Scenario 3	• Single track • Improvement for local passenger and freight services	• Construction of new high-speed line (double track with standard gauge) • Maximum operating speed (200km/h) for passenger and freight services
Scenario 4	• Same as Scenario 3	• Same as Scenario 3 except maximum operating speed (300km/h)
Scenario 5	• Double track • Improvement for local passenger and freight services	• Same as Scenario 3
Scenario 6	• Same as Scenario 5	• Construction of new high-speed line (double track with standard gauge) • Maximum operating speed of 300km/h for passenger service only

1) 100 km/h (80 km/h for most of the sections) which reduces scheduled speed to 50-60 km/h except Hue – Danang (40 km/h).

Table 1.2 Options for Improvement of Existing Railway

Option		Contents
On-going Committed	A1	• Minimal improvement to ensure safe operation • Scheduled Speed: 60 km/h (Travel Time: 29.1 h (Hanoi-HCMC) • Capacity: 32 trains/day/both-direction
Future Options	A2	• Maximization of existing single track transportation capacity • Scheduled Speed: 70 km/h (Travel Time: 25.4h (Hanoi-HCMC) • Capacity: 50 trains/day/both-direction
	B1	• Double tracking with meter gauge • Scheduled Speed: 110 km/h (Travel Time: 15.6 h (Hanoi-HCMC) • Capacity: 170 trains/day/both-direction
	B2	• Double tracking with standard gauge • Scheduled Speed: 135 km/h (Travel Time: 12.7 h (Hanoi-HCMC) • Capacity: 170 trains/day/both-direction

2 REVIEW OF CURRENT SITUATION AND FUTURE TRANSPORTATION DEVELOPMENT DIRECTION FOR NORTH – SOUTH CORRIDOR

2.1 Regional Characteristics

1) Natural Condition

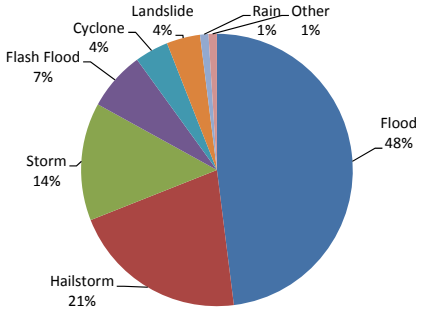
2.1 Vietnam is located on the east coast of the Indochina Peninsula. The total land is 330,000 km^2. The north-south length is 1,650 km, east-west length is 600km, and the narrowest width is 50 km only. There are two large delta regions in the north and south, the Red River Delta and Mekong River Delta, of which 70% of the total national population reside in. The Truong Son Mountains range from north to south, and the middle coastal plains is located at its foot. Major rivers are Hong River in the northern region, Ba River in the central region, and Dong Nai River in the southern region. The highest peak is Mt. Phang Xi Pang (3,143m), and the highest peak in Truong Son Mountains is Mt. Ngok Linh (2,598m).

2.2 The North – South Corridor is an S-shaped land covering 110,353 km^2 of land, equal to 33.6% of the national total. The coastal areas are also low and flat, which has enabled smooth traffic and efficient transportation development. The upland areas are high in elevation and have relatively steep slopes of more than 10% gradient.

2.3 Vietnam is a tropical country having high biological diversity and is one of emergence countries of the world in terms of biological diversity conservation. Forest resource of Vietnam is still very rich in the number of plant and wildlife species with various forest types: coastal mangrove forest, forest on fresh water marsh, broad-leaved evergreen forest, semi-deciduous forest on low land, limestone mountain forest, alpine evergreen forest and mixed pine forest. Up to now according to statistics Vietnam has over 7,000 high vascular tree species.

2.4 Every year, Vietnam suffers directly from 6 – 10 storms and tropical depressions causing heavy rain and flood. During a period of twenty years from 1989 to 2010, flood is the most reported with 48% of total disaster events. Storms and tropical depressions often occur from June to November but mainly in September and October. It often occurs in northern and central regions, occasionally in the southern region as well.

2.5 Geological conditions in Vietnam differ with longitude 15 degrees and 30” N as its boundary, wherein the northern mountainous regions are mainly formulated of sedimentary layer from the Paleozoic era and Mesozoic era, and a delta is formulated by rivers and sedimentation in the coastal areas of Tonkin Bay. The Red River Delta is alluvium soil which continues from Hai Phong in the east and Nam Dinh in the south, and soft layers are continuous of 40-50m.

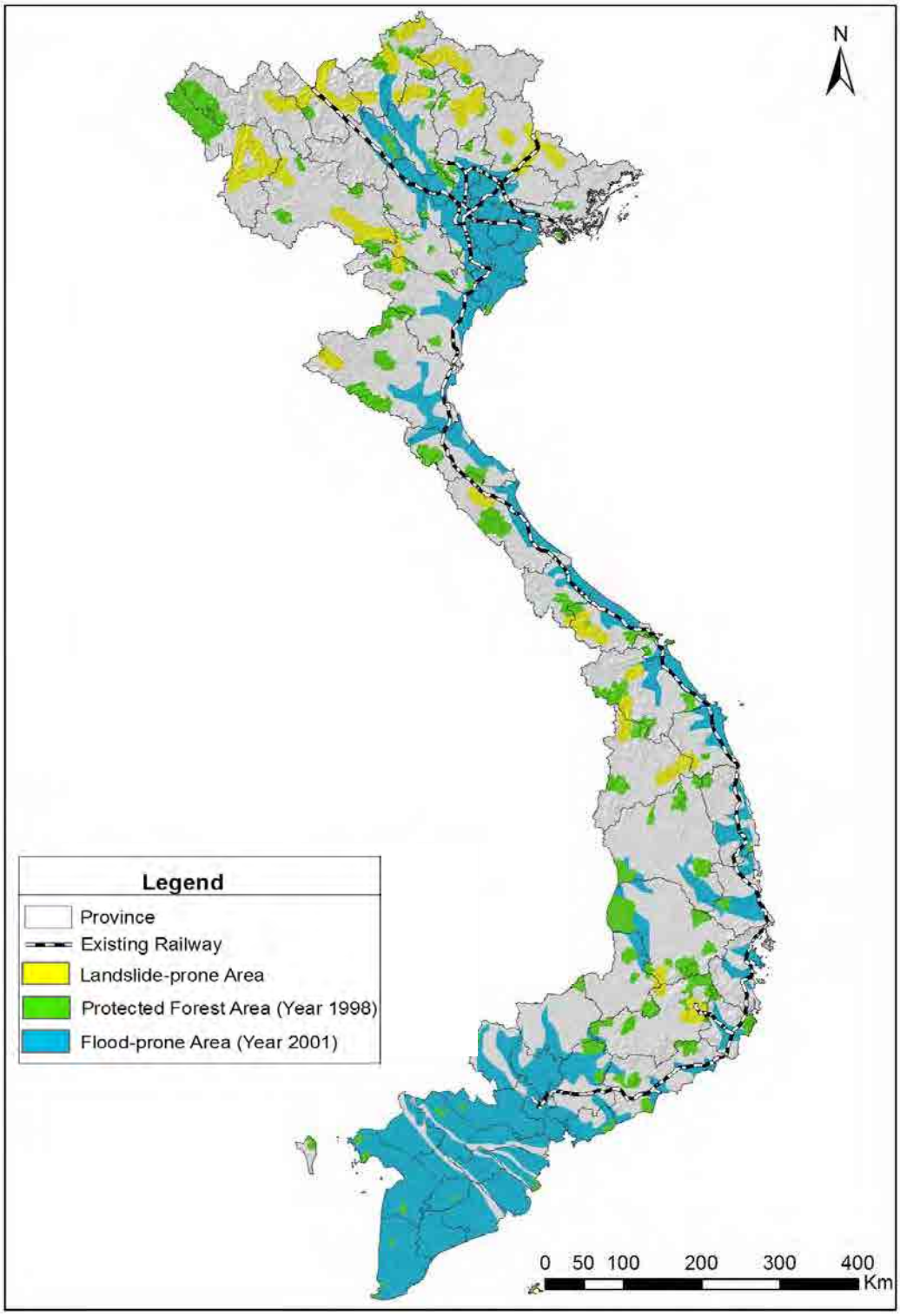


Source: “A Preliminary Analysis of Flood and Storm Disaster Data in Vietnam”, UNDP, 2011.

Figure 2.1 Proportion of Reported Natural Disasters in Vietnam (1989 – 2010)

2.6 On the other hand, southern area from 15 degrees and 30” N to 14 degrees N is mainly formulated of sedimentary layer from the Precambrian era and intrusive rocks,

which formulate the Kon Tum Mountains. The area from 14 degrees N to 12 degrees N is dominated by sedimentary layer from the Mesozoic era and intrusive rocks. In addition, basalt plateau is also found. The area south of Dong Nai River is a vast delta area formulated by the Mekong River, and soft layers are continuous of around 40m.



Source: JICA Study Team.

Figure 2.2 Distribution of Environmentally Sensitive Area

2) Socio-economic Conditions

2.7 North-south corridor is the most important backbone in Vietnam and covers 3 focal economic zones. Rapid urbanization and economic growth are expected along the corridor. Hanoi, Danang and Ho Chi Minh are the centers of 3 focal economic zones and there are 17 provinces along the route of HSR. (See Table 2.1).

2.8 The total population in this corridor is 40.0 million as of 2011, equal to 45% of the national total. Urbanization is occurring rapidly, especially in coastal cities. The corridor has seen high economic growth over the years, and the average GDP growth in this region is high at 7.1%/ year. This is especially high in Ha Nam, Ninh Binh, Quang Nam, Quang Ngai, Binh Thuan, and Dong Nai, which are expected to become economic engines to lead regional growth in the future after Hanoi and HCMC. This corridor also is home to many industrial zones, of which many are located along NH1. Investment is active, especially in the SFEZ. On the other hand, poverty is still an issue in many areas where the poor reside, and while some provinces have rather equally low per capita income levels, income inequality is large in major cities such as Hanoi.

Table 2.1 Development Indicators for Provinces along North – South Corridor

	Area (2011, km²)	Population (000)		Urbanization Rate (2011, %)t	GRDP[1)]		Per capita GRDP (2010, VND mil.)[1)]	Poverty Rate (2008, %)	FDI (88-09, USD mil.)	PCI: 2011 Ranking
		2011	AGR (05-11, %)		2010	AGR (05-10, %)				
Hanoi	3,328.9	6,779	2.3	42.5	246,723	6.4	38	2.4	22,307	36
Ha Nam	860.5	787	-0.1	10.5	13,235	9.3	17	11.6	217	62
Nam Dinh	1,652.2	1,834	-0.2	18.0	26,397	6.3	14	10.6	120	48
Ninh Binh	1,376.7	908	0.3	19.0	19,471	11.6	22	13.0	578	21
Thanh Hoa	11,131.9	3,413	-0.1	11.1	51,393	7.4	15	24.9	7,040	21
Nghe An	16,490.3	2,943	0.3	13.3	41,427	5.8	14	22.5	371	49
Ha Tinh	5,997.2	1,229	-0.2	16.0	15,890	7.0	13	26.5	8,068	7
Quang Binh	8,065.3	853	0.5	15.2	12,439	6.5	15	21.9	42	37
Quang Tri	4,739.8	605	0.4	28.8	9,888	6.8	16	25.9	83	13
T. T. Hue	5,033.2	1,103	0.5	51.7	19,664	7.7	18	13.7	1,990	22
Danang	1,285.4	952	2.8	87.1	28,896	6.1	31	3.5	3,431	5
Quang Nam	10,438.4	1,435	0.3	19.3	24,385	9.3	17	19.6	5,190	11
Quang Ngai	5,153.0	1,222	0.2	14.6	29,275	14.7	24	19.5	4,828	18
Binh Dinh	6,050.6	1,497	0.2	27.7	26,510	7.0	18	14.2	316	38
Phu Yen	5,060.6	872	0.7	23.2	13,761	8.2	16	16.3	8,061	50
Khanh Hoa	5,217.6	1,174	0.9	44.5	34,296	6.4	29	9.1	1,345	34
Ninh Thuan	3,358.0	569	0.6	36.1	6,720	6.2	12	19.3	10,056	46
Binh Thuan	7,813.0	1,180	0.7	39.3	24,404	11.4	21	9.2	914	40
Dong Nai	5,907.2	2,665	2.8	33.7	75,899	9.3	30	4.3	17,838	9
HCMC	2,095.0	7,521	3.0	83.1	414,068	6.3	56	0.3	30,981	20
Total	111,055	39,540	1.3	39.3	1,134,743	7.1	29	11.0	123,777	-

Source: General Statistics Office.
1) In 2010 price.

2.9 Although it is clear that Hanoi and HCMC will be the two main poles of development each expected to grow to a population of nearly of exceeding 10 million, cities such as Vinh, Thua Thien Hue, Danang, Quy Nhon, and Nha Trang, the medium-sized cities of today, will grow further in the future to become the regional catalyst of development. Danang especially will become the engine for development of the central region, expecting to reach a population of 3 million in 2030. Contrary to the development up to today in Vietnam based on industry, this city's development will be mainly based on the tertiary sector, especially tourism and new industries (IT, medical, eco-industry, etc.), attracting

workers from neighboring areas as well. Thua Thien Hue and Quy Nhon, belonging to the CFEZ, will be integrated and grow in line with Danang. Vinh and Nha Trang, each located at the end of the priority sections of this study will grow even further to become regional growth centers.

3) Transport Infrastructure

2.10 North-south corridor possesses all the four transport modes available in Vietnam. The national highway (NH1) runs the full stretch of the corridor in parallel with the north - south railway. These two transport routes are akin to large logistical pipelines that collect and distribute the country's tradable goods through the many seaports and airports located along the routes.

(i) The road has limited capacity (mostly 2 lanes along NH1). The pavement conditions are good in general; however, they have not been designed to accommodate the increasingly large volumes of heavy vehicles. The main bottlenecks for the road (NH1) are bridges. Although many bridges have been upgraded in recent years, there remain some bridges in bad condition. (Table 2.2)

(ii) Railway could attract a larger share of the corridor traffic, except for the fact that it is constrained by its single-track speed limitations at several sections. Slow operation at 30 - 60 km/h is required on 32 bridges, and in 7 tunnels at 15 – 50 km/h, both without mentioning to speed restrictions occasioned by short radii of curvatures. (Table 2.2)

(iii) There are international airports such as Noi Bai (Hanoi), Phu Bai (Hue), Danang (Danang), Tan Son Nhat (HCMC), and domestic airports such as Vinh (Nghe An), Dong Hoi (Quang Binh), Chu Lai (Quang Nam), Phu Cat (Binh Dinh), Dong Tac (Phu Yen) and Cam Ranh (Khanh Hoa). Runways are long in these airports. Passenger demand is significant in Hanoi and HCMC, followed by Danang and Hue; on the other hand, demands at other airports are modest. Air cargos are only handled in Noi Bai and Tan Son Nhat. (Table 2.3)

(iv) 1st Class Ports are located in almost all coastal provinces in the North-south corridor. Coastal shipping doesn't handle passenger demand and cargo shipping does not compete with road transport in most cases. (Table 2.4)

Table 2.2 Road and Railway on the North-south Corridor

	Segment		Hanoi – Vinh	Vinh - Danang	Danang – Nha Trang	Nha Trang - HCMC
Road (NH1)	Length (km)		1, 365	1, 650	1, 510	1, 350
	No. of Lanes		4 Lane:15% 2 Lane: 85%	4 Lane:12% 2 Lane: 88%	4 Lane:5% 2 Lane: 95%	4 Lane:20% 2 Lane: 80%
	Surface Condition		Good: 50% Fair: 18% Bad: 32%	Good: 37% Fair: 63%	Good: 85% Fair: 8% Bad: 7%	Good: 14% Fair: 68% Bad: 18%
	Bridge	No	56	175	264	94
		Length (m)	3,810	10,135	18,585	3,407
Railway	Track		Meter gauge (Single Track)			
	Length (km)		319.0	472.4	523.5	411.3
	Crossing (No.)		294	272	269	238
	Bridge	No.	127	270	487	267
		Length (m)	3,390	11,298	14,588	5,667

Source: VITRANSS2

Table 2.3 Airport on the North-south Corridor

Location		Hanoi (Noi Bai)	Vinh (Nghe An)	Quang Binh (Dong Hoi)	Hue (Phu Bai)	DaNang (DaNang)	Quang Nam (Chu Lai)	Binh Dinh (Phu Cat)	Phu Yen (Dong Tac)	Khanh Hoa (Cam Ranh)	HCMC (Tan Son Nhat)
International/Domestic		Int'l/ Domst	Domst	Domst	Int'l/ Domst	Int'l/ Domst	Domst	Domst	Domst	Domst	Int'l/ Domst
Runway(m)		3,800	2,400	2,400	2,700	3,048	3,658	3,048	2,743	3,048	3,800
Capacity	Pax (000/yr)	6,000	100	300	582	1,000	291	291	20	243	15,000
	Cargo (ton/year)	150,000	-	-		-	-	-	-	-	150,000

Source: VITRANSS2

Table 2.4 Seaport on the North-south Corridor

Location		Quang Nam	Hai Phong	Thanh Hoa	Nghe An	Ha Tinh	TT Hue	Da Nang	Quang Ngai	Binh Dinh	Khanh Hoa	BR-VT	Dong Nai	HCMC
Class 1 Seaport		Cam Pha, Hon Gai	Hai Phong	Nghi Son	Cua Lo	Vung Ang	Chan May	Da Nang	Dung Quat	Quy Nhon	Nha Trang, Ba Ngoi	Vung Tau	Dong Nai	Ho Chi Minh
International/Domestic		Int'l/ Domst	Int'l/ Domst	Int'l	Int'l/ Domst	Int'l/ Domst	Int'l/ Domst	Int'l/ Domst	Int'l/ Domst	Int'l/ Domst	Int'l/ Domst	Int'l/ Domst	Int'l/ Domst	Int'l/ Domst
Berth	No.	12	51	6	9	4	7	20	3	8	6	34	22	82
	Length (m)	2240	5513	2292	836	304	780	2249	170	1120	749	5348	2791	9068
Depth (m)		-12	-8.7	-10	-7.5	-10.8	-12.5	-12	-9.5	-12	-11.8	-12	-9.5	-13
Capacity (000 ton/year)		5,115	9,712	N/A	786	501	287	2,044	29	1,669	2,572	1,623	790	12,422

Source: VITRANSS2

4) Transport Service

2.11 Transport Service: The service of each passenger transport mode is briefly summarized as follows;

(i) **Road Transport:** The road has limited capacity (mostly 2 lanes along NH1) and is occupied mainly by trucks. Therefore, average travel speed on roads is limited at present. Bus service along the corridor is quite developed and offered with high frequency (in Hanoi around 3,000 inter-city buses are operated for a day at four bus terminals while, in HCMC, also around 3,000 inter-city buses operated at two bus terminals.). Long distance buses from Hanoi to Ho Chi Minh (34 hours of travel) are offered for around 650,000 VND for seat and 920,000 VND for sleeper.

(ii) Railway: The single track North-south railway is connecting main cities along the corridor. The service frequency is around 14-22 trains/day for passenger and 10-12 trains/day for freight. The fastest train connects Hanoi and Ho Chi Minh in 30.0 hours costing around 600,000 VND for hard seat (no air conditioner) and around 1,600,000 VND for soft sleeper (level 1 with air conditioner).

(iii) Air Transport: Compared with bus and railway, the growth of air transport industry is remarkable. As of 2011, 438 flights/week are operated in Noi Bai Airport (among them, 424 flights/week are for the south direction) and 708 flights/week in Tan Son Nhat Airport (577 flights are for the north direction) for domestic travel. Besides the flag carrier, Vietnam Airlines, low cost carriers (LCC) also carry around 20% of air passengers. Noi Bai Airport and Tan Son Nhat Airport is connected by about 1 hour 50 minutes (time during on-board only). Accessibility from city center to airport differs in each location. In case of Hanoi, from Hoan Kiem District to Noi Bai airport, it takes 40-50 minutes while in Ho Chi Minh, from District 1 to Tan Son Nhat, it takes 20-40 minutes depending on traffic condition. The flight of Vietnam Airlines traveling between Hanoi and HCMC costs about 2,200,000 VND while LCC (Jet Star) offers the flights for the same route for about 1,300,000 VND.

2.2 National Traffic Demand: Present and Future

2.12 Based on the traffic survey result, the present OD data was updated from 2008 (VITRANSS2 traffic data) to 2010. The summary of inter-provincial transport demand of both passenger and freight in 2010 and 2030 is as follows (see Table 2.5):

(i) Total passenger travel demand in terms of number will increase from about 1 million to about 2.7 million a day between 2010 and 2030, while the demand in terms of passenger-kms will increase from 195 million to 711 million a day or by 3.7 times between the same period because people will travel in longer distance in the future.

(ii) Increase in freight transport demand is also notable. 1.4 million tons transported daily in 2010 will increase to 3.7 million tons in 2030 or by 2.7 times. Ton-kms will also increase due to longer haulage of various cargos.

(iii) Transport demand will increase both at inter-regional level and within the region.

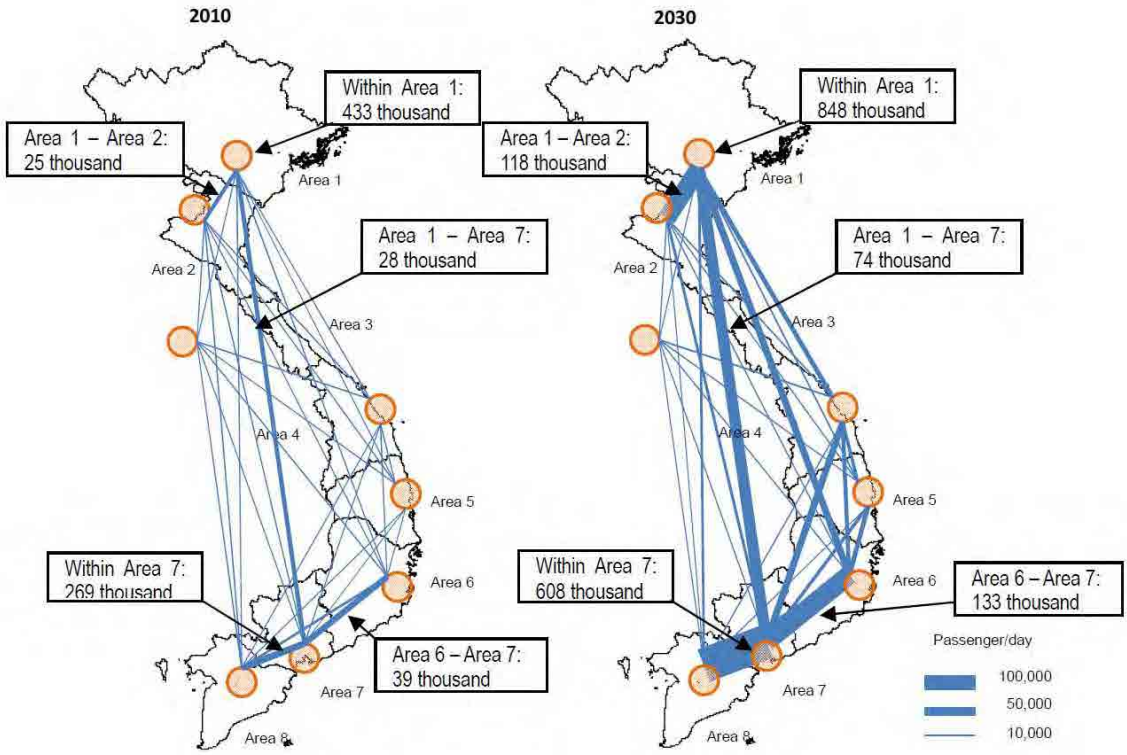
(iv) The largest traffic demand is observed between MRD and South-east in 2010, though inter-regional transport demand is expected to increase for other pairs of regions.

(v) North-south transport demand is expected to increase faster than national average. All inter-regional passenger transport demand related to the north-south corridor is expected to increase by 4.5 to 5.5 times between 2010 and 2030. Freight traffic along the north-south corridor is also expected to increase faster than the national average.

Table 2.5 Forecast Increase in Passenger and Freight Traffic

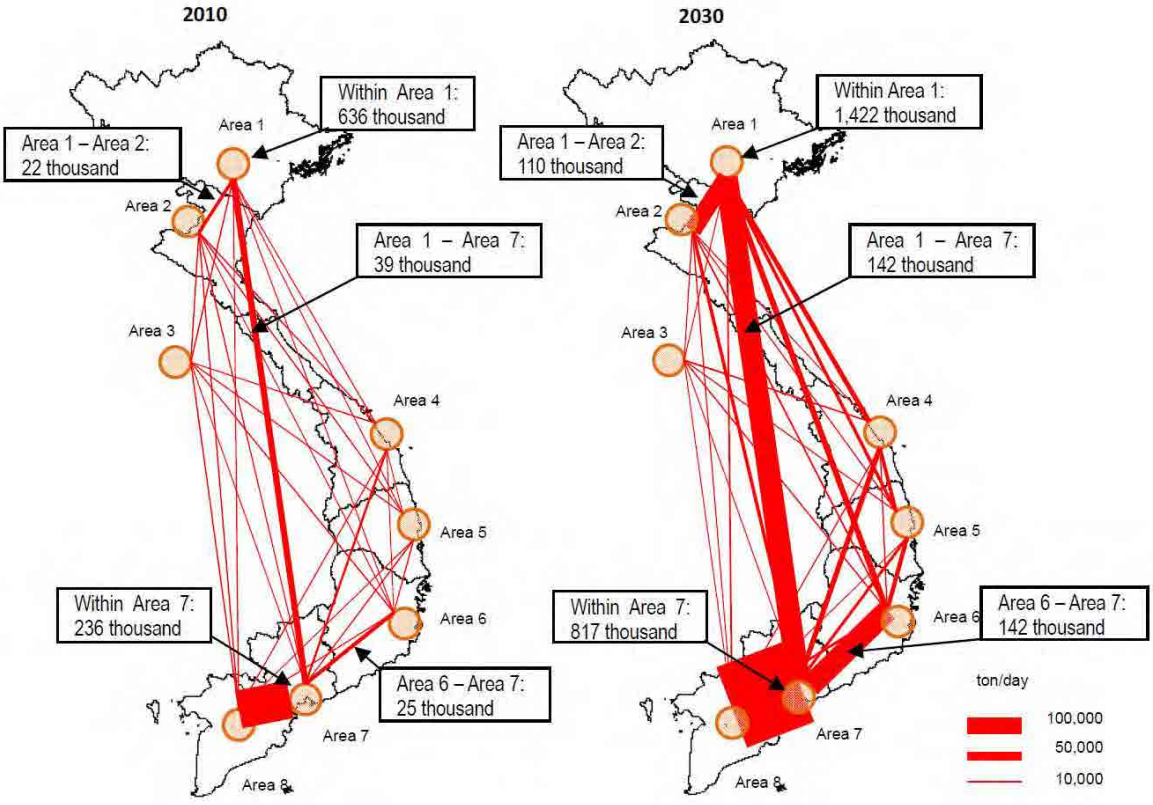
Item		2010	2030	Growth	
				2030/10	AGR (%)
Passenger (per day)	Number (000)	1,034	2,728	2.6	5.0
	Passenger-km (mil)	195	711	3.7	6.7
	Average Trip Length (km)	188	261	1.4	-
Freight (per day)	Tons (000)	1,377	3,732	2.7	5.1
	Ton-km (mil)	260	810	3.1	5.8
	Average trip length (km)	189	217	1.1	-

Source: VITRANSS 2 (JICA, 2010) and JICA Study Team.
1) Main assumptions include the following: Annual GDP growth ratio: 6.5% for 2010-2020 an d 6.0 for 2020-2030; annual population growth ratio: 1.0% for 2009-2020, and 0.7% for 2020-2030; annual urban population growth ratio: 3.0% for 2010-2020, and 2.5% for 2020-2030.



Source: JICA Study Team

Figure 2.3 Passenger Traffic Demand Distribution, 2010 and 2030



Source: JICA Study Team

Figure 2.4 Freight Traffic Demand Distribution, 2010 and 2030

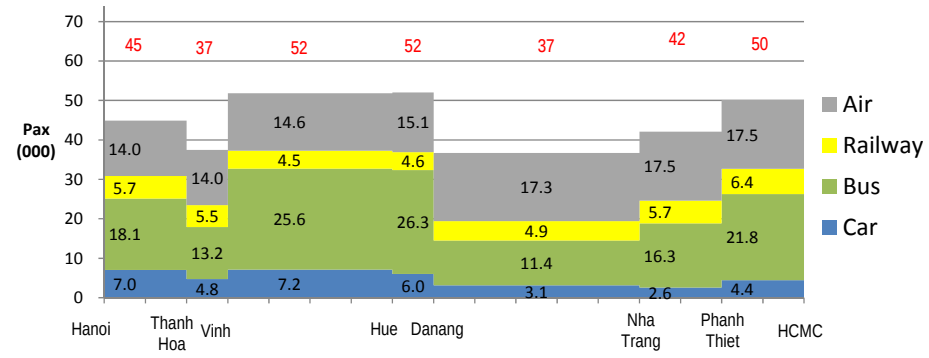
2.3 Traffic Demand on the North-South Corridor

1) Current Situation

2.13 The model share of passenger traffic demand along the north-south coastal corridor, which is directly related to the objective of the Study. is analyzed based on updated OD data (Figure 2.5). Main characteristics are as follows;

(i) Cross sectional passenger traffic is roughly between 37 to 50 thousand passengers a day, wherein the highest traffic volume is observed for Hue – Danang and Vinh – Hue section (52,000 passengers/day)

(ii) Bus shares the highest percentage in all sections. The share of railway is small but higher than the one of car for all the section excluding Vinh-Danang.



Source: JICA Study Team

Figure 2.5 Passenger Traffic Demand by Mode along North-South Coastal Corridor, 2010

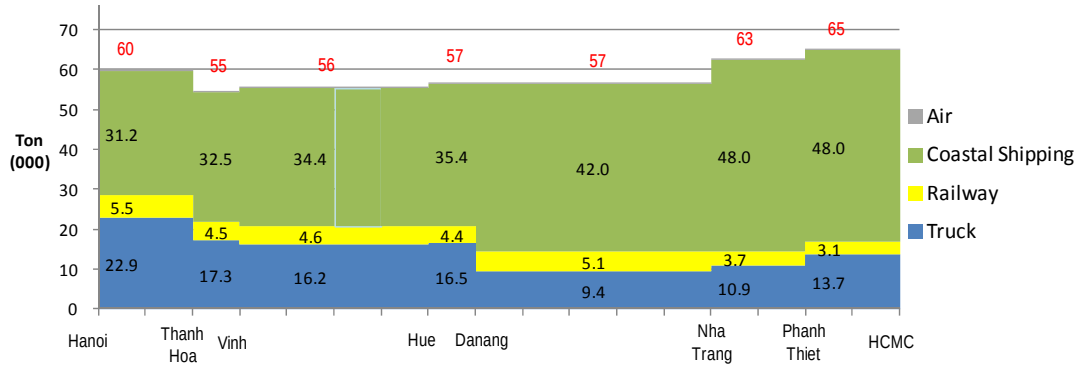
2.14 The same analysis was made on cargo traffic demand along the north-south coastal corridor. (see Figure 2.6) Main characteristics are as follows;

(i) There are cargo traffic demands of 55 to 65 thousand tons a day at main cross sections along the corridor.

(ii) Coastal shipping is the major mode of cargo transportation along the north-south corridor followed by truck.

(iii) Along the coastal corridor, overall situation is the same as the entire north-south corridor. The coastal shipping shares almost 50 to 80% of the traffic.

(iv) Railway transports 3,100 to 5,500 tons/day or 4.8% to 9.2% of the total cross section cargo traffic along the coastal corridor. The freight traffic is heavier for Hanoi – Vinh section than that for Nha Trang – HCMC section.



Source: JICA Study Team

Figure 2.6 Freight Traffic Demand by Mode along North-South Coastal Corridor, 2010

2) Future Traffic Demand on the North-south Corridor (without HSR)

2.15 In Baseline analysis, it is assumed existing transport network including committed projects will remain in 2030. The results of traffic demand analysis are presented by transport mode and by section of the north-south corridor (see Table 2.6 and Figure 2.7). Main findings are as follows;

(i) Passenger transport capacities of all modes including national roads, existing rail and air will be insufficient (the future growth of traffic demand will overwhelm the capacities of transport infrastructures).

(ii) Road transport demand on the coastal corridor overflows to inland routes; it occurs more explicitly in the north than in the south.

(iii) Air transport shares relatively high percentage of about 40% of cross sectional traffic.

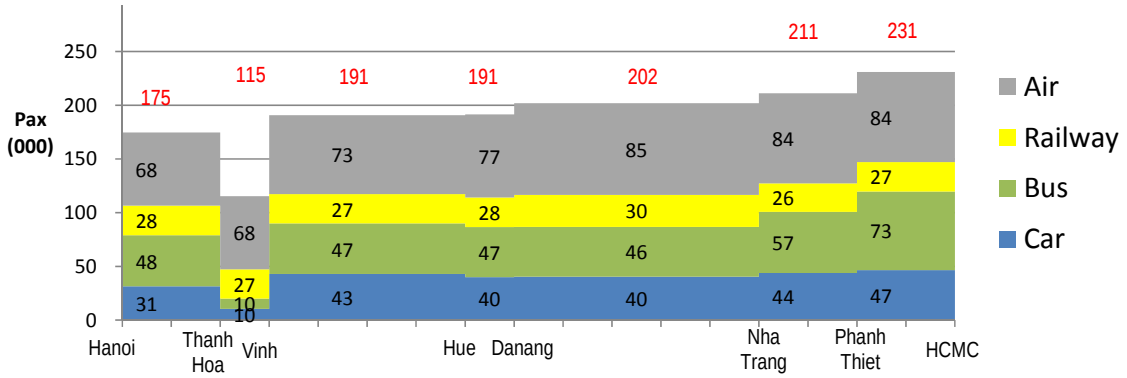
Table 2.6 Estimated Traffic Demand along North South Corridor (Baseline Scenario) 2030

				North		Central			South	
				N1. Hanoi – Thanh Hoa	N2. Thanh Hoa - Vinh	C1. Vinh - Hue	C2. Hue - Danang	C3. Danang – Nha Trang	S1. Nha Trang – Phan thiet	S2. Phan Thiet – HCMC
Passenger (no/day)	National Road		Car	31,395	10,445	42,874	39,939	40,490	43,885	46,611
			Bus	47,529	9,671	47,029	46,635	46,299	56,962	73,239
	Existing Rail			27,727	27,215	27,442	27,539	29,883	26,401	27,266
	Air			68,047	68,047	73,461	77,369	85,320	83,931	83,931
	Total			174,698	115,378	190,805	191,482	201,992	211,179	231,048
Transport Requirement (/day)	Road (pcu)	Passenger (pcu)		15,610	4,444	19,136	18,171	18,302	20,664	23,502
		Freight (pcu)		90,769	75,314	80,358	83,964	82,608	92,541	92,514
	Existing Rail	Passenger (no. of train)		28	28	28	28	30	27	28
		Freight (no. of train)		56	54	53	51	45	26	27
	Air	Passenger (no. of flight)		369	369	399	420	463	454	454
Capacity[1)]	Road (pcu)	Total (passenger and freight)		54,800	27,400	27,400	54,800	27,400	27,400	27,400
		For passenger		-35,969	-47,914	-52,958	-29,164	-55,208	-65,141	-65,114
	Existing Rail (no. of train)	Total (passenger and freight)		32	32	32	32	32	32	32
		For passenger		0	0	0	0	0	6	5
	Air	(No. of flight)					366-492			

Source: JICA Study Team

1) Capacities are estimated for total and that available for passenger transport after capacity required for cargo traffic demand is deducted from the total capacity

2) Airport capacity is assumed to be about 3 times of the present considering existing plans of airport development.



Source: JICA Study Team

1) In the sections where there are alternative roads on inland, traffic on coastal side (North South Corridor) overflows to such roads as the demand outnumbers the capacity.

Figure 2.7 Estimated Traffic Demand along North South Corridor (Baseline Scenario) 2030

2.4 Current Government Policy and Plan

2.16 The development of HSR is considered as a national project having huge impact on the social and economic development of North-South coastal corridor and the economy of the whole nation. On the other hand, it requires high investment cost, which is estimated as 55.8 billion USD for a whole section based on the estimation of prefeasibility study. Needless to say, such mega scale project should be consistent with the development orientations on national level, master plans in transport sector and other plans as it is not possible to be considered as a separate transport infrastructure among other transport systems and urban and rural development configurations.

2.17 Socio-economic development strategy (SEDS) and socio-economic development plan (SEDP), which to be formulated based on SEDS, are the highest level development strategy and plan. As of March, 2012, the SEDS for 2011-2020 and SEPD for 2012 and the 5 year period 2011-2015 have been drafted.

2.18 In the SEDS for 2011-2020, the main viewpoint of “sustainable development” is presented to pursue a new internal perception which reflects the close link between fast development and sustainable development and considers sustainable development is a requirement that run-through the Strategy.

2.19 SEDP for 2012 and the 5 years period of 2011-2015 has been formulated based on the review of the implementation of 5 year plan for 2006-2010 and the consideration of socio-economic context of Vietnam and the world. The followings are the general goals of the five-year socio-economic development plan for 2011-2015.

(i) Promote rapid economic development and sustainable innovation associated with the improvement of growth model and economic restructure towards higher quality, efficiency and competitiveness.

(ii) Ensure social welfare and social security

(iii) Improve spiritual and material life of the people

(iv) Enhance external affairs, and improve the efficiency of international integration

(v) Protect the independence, sovereignty, unity, territorial integrity and social order and safety

(vi) Create the foundation for our country, by 2020, to become an industrialized and modernized country.

2.20 On the lower level of SEDS and SEDP, there is Transport Development Strategy (TDS) and master plan for each transport sector. The latest TDS is approved by Prime Minister Decision No.35/2009/QD-TTG, “Approving adjustment to the Transport Development Strategy up to 2020 with a Vision toward”, on March, 3rd, 2009. The development orientations up to 2020 for major five subsectors and railway industry are shown in Table 2.5.1. These orientations are quite comprehensive and aim for the high level of infrastructure development. As for railway sector, the development of north-south express railway of 350 km/h is indicated for prioritization while the upgrading of existing railways with a speed of 120 km/h and urban railway development are, also, mentioned.

Table 2.7 Transport Development Orientation up to 2020

Sector	Development Orientation up to 2020
Road:	• To upgrade national highways and provincial roads to reach prescribed technical standards • To expand and build national highways with great transportation demands • To build a system of expressways • To upgrade external roads to reach technical standards of regional roads • To set up a road maintenance fund for allocating capital for the maintenance of road infrastructure facilities.
Railway:	• To complete the renovation and upgrading of existing railways up to national- and regional-railway technical standards with a speed of 120 km/h • To build new express railways and high-speed railways • To prioritize the building of the north - south express railway with a speed of 350 km/h • To rapidly develop iron-wheel transport in urban centers and railways in cities and suburbs as a core mass transit, firstly in Hanoi capital and Ho Minh City
Seaways:	• To develop a national system of ports, including an international transit port in Van Phong, international gateway ports and deepwater harbors in 3 key economic regions of accommodating new-generation container ships, general ports, special-purpose, ports passenger ports to meet socio-economic development and international integration • To invest in developing seaport infrastructure in a coordinated manner including harbors, port access fairways, port access traffic and port logistic services.
Inland waterways:	• To complete the upgrading of main inland waterway routes up to prescribed technical standards • To renovate and improve important sections and fairways • To increase the length of river sections and fairways under management and operation • To make intensive investment in upgrading and building major ports and cargo and passenger wharves, especially in the Red River and Mekong River deltas.
Airways:	• To complete the upgrading and expansion of existing airports and build new ones up to international standards • To concentrate investment in international airports in the Hanoi capital region and Ho Chi Minh City • To study and invest in new international airports with sizes and service quality on a par with major international airports in the region • To increase the operation capacity of airports by 3-3.5 times by 2020
Railway industry:	• To build modern and comfortable passenger and cargo carriages which are diversified in types for domestic use and export • To manufacture parts and accessories for and assemble modern locomotives.

Source: JICA Study Team based on Prime Minister Decision No.35/2009/QD-TTG, "Approving adjustment to the Transport Development Strategy up to 2020 with a Vision toward", on March, 3rd, 2009

2.21 Regarding to railway sector, the Strategy for Development of Vietnamese Railway Transport Up to 2020 with a Vision toward 2050 was formulated by VR, revised by MOT and approved by Prime Minister by Decision No. 1686/QD-TTg ,dated November 20, 2008. The strategy defined the specific key targets which are: at least 13% and 14% share of passenger and cargo traffic respectively with 37% share of passenger traffic on such main corridor as North-South corridor, 40% and over 45% share of passenger and cargo traffic respectively on the East-West corridor, and 20% share of urban passenger traffic. To achieve such targets, construction and upgrade projects are clarified including North-South High Speed Railway with the speed of 350 km/h giving priority to the early completion of Hanoi-Hue or Hanoi – Danang section and HCMC – Nha Trang section.

2.22 The latest comprehensive railway plan is "The Revise Master Plan on Railway Transport Development of Vietnam Up to 2020 with a Vision to 2030" formulated in consistent with the mentioned transport development strategy and railway transport strategy and approved by Prime Minister by Decision No. 1436/QD-TTg. It specifies the specific objectives and development plans for each aspect of railway transport, infrastructure, railway industry and traffic safety. To achieve the target of the increase of the share, the master plan contains the expansion of the network with accesses to major cargo origins/destinations and reinforcement of existing railway corridors. Furthermore, the master plan also includes the improvement of traffic safety covering the improvement of crossings system and the construction of cross-over.

3 CONSTRAINTS AND OPPORTUNITIES IN DEVELOPMENT OF THE EXISTING NORTH-SOUTH RAILWAY

3.1 Existing Conditions and Bottlenecks of the North-South Railway

3.1 The existing north-south railway is a 1,726km long single-track meter gauge non-electrified railway. Constructed in 1936, it was destructed greatly during the war period and hence decrepit. Although currently rehabilitation measures are being taken including many improvement projects, there still remains various bottlenecks along the alignment which limits the operation speed, resulting in a 30 hour long journey from Hanoi to HCMC. (see Table 3.2) The number of trains is also limited at a maximum of 30 trains per day due to such bottlenecks.

3.2 The main bottlenecks of the existing railway are as follows: (see Figure 3.1)

(a) Critical bottleneck sections include the Hai Van Pass, Khe Net Pass and Hoa Duyet – Thanh Luyen sections, which total to 44.2km length and 1.5 hours to pass. (see Table 3.2)

(b) The average distance between stations is 10km and is considered appropriate, however out of the 167 sections, those that fall between 10-15km are 71 sections, those over 15km are 24 sections, and such sections with long distances between stations limit the number of trains operated.

(c) Curve sections which have a small radius of curvature also limit the train operation speed. Those under R=300m are 267 sections equal to 39km and R=300-800m are 841 sections equal to 215km. Deteriorated bridges and tunnel sections also limit the train operation speed.

(d) There are 2,439 level crossings of which 1,047 are formally recognized by the government. These level crossings also suffocate safe operation and also are causes of accidents.

(e) The switch-back in Danang Station and loop in Nha Trang Station also lead to loss in travel time.

Table 3.1 Outline of Hai Van Pass, Khe Net Pass, Hoa Duyet – Thanh Luyen Sections

	Hai Van Pass	Khe Net Pass	Hoa Duyet - Thanh Luyen Section
Total length	21.4km	11.0km	11.8km
R≦500m sections	127 (Lang Co Station - Kim Lien Station)	32 (Dong Chuoi Station - Kim Lu Station)	18 (Hoa Duyet Station - Thanh Luyen Station)
Minimum radius of curvature	R=97m	R=125m	R=138m
Maximum gradient	17‰	17‰	6‰
Travel time	58 minutes	20 minutes	14 minutes
Average operation speed	21km/h	33km/h	51km/h

Source: JICA Study Team.

Source: JICA Study Team.

Figure 3.1 Location of Bottlenecks

Table 3.2 Summary of Existing Railway

Section			Northern Section		Central Section			Southern Section		Total (Average)
			Hanoi – Thanh Hoa	Thanh Hoa – Vinh	Vinh – Hue	Hue – Danang	Danang – Nha Trang	Nha Trang – Phan Thiet	Phan Thiet - HCMC	
Route (km)	Kilometerage		175.2	319.0	688.3	791.4	1,314.9	1,551.1	1,726.2	-
	Sectional distance		175.2	143.8	369.3	103.1	523.5	236.2	175.1	1726.2
No. of Stations			23	13	40	11	45	17	18	167
No. of sections by distance between stations		5 km ≤	2	0	2	2	1	0	4	11
		< 10.0 km	14	2	19	3	12	2	6	58
		< 15.0 km	5	8	18	5	21	8	6	71
		< 20.0 km	1	2	1	1	9	7	3	24
Average distance between stations (km)			8.0	11.1	9.2	9.4	11.6	13.9	9.7	10.3
Crossings[1)]	By class	Class 1	14	3	3	3	11	2	13	49
		Class 2	18	11	14	10	18	7	18	96
		Class 3	182	69	184	49	237	108	73	902
	Average distance (km)		0.81	1.73	1.84	1.66	1.97	2.02	1.68	(1.6)
Curvature	R≦300m	No.	9	5	76	147	7	13	10	267
		Length (km)	1.6	1.5	12.5	14.8	2.1	3.2	3.1	38.8
	300m≦R <800m	No.	123	55	153	37	308	60	105	841
		Length (km)	25.3	12.8	39.0	9.0	85.8	18.1	24.7	214.7
	800 m≦R <1200m	No.	45	33	92	5	123	75	48	421
		Length (km)	5.2	7.1	25.9	1.4	34.1	22.2	14.4	110.3
	1200m≦R	No.	107	29	40	13	28	7	8	232
		Length (km)	9.6	5.9	9.3	0.9	4.6	0.5	0.4	31.2
	Straight sections (km)		133.2	120.4	277.3	78.3	397.5	192	132.4	1331.1
Tunnel	No.		0	0	5	9	13	0	0	27
	Length (km)		0	0	0.7	3.2	4.4	0	0	8.3
Bridge	Steel	No.	15	13	41	14	42	24	8	157
		Length (m)	1166	823	4770	1139	7129	1303	916	17246
	Concrete	No.	43	56	284	99	588	190	48	1308
		Length (m)	632	836	3919	1744	9766	2606	743	20246
	Total length (m)		1798	1659	8689	2883	16895	3908	1659	37491
	Average length (m)		31	24	27	26	27	18	30	(26)
Velocity (km/h)[2)]	Maximum		80	100	80	80	90	80	80	-
	Minimum		30	70	25	30	50	60	40	
	Scheduled		53.9	57.9	51.2	40.2	52.6	58.1	51.5	-
Travel time (hours)			3.3	2.5	7.2	2.6	10.0	4.1	3.4	-

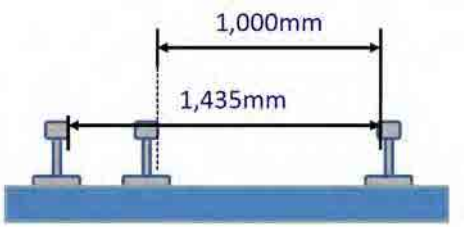
Source: JICA Study Team based on information from Vietnam Railways.

Note: 1) The level crossings are classified according to the grade of the crossing roads. The first class intersects with the Class 3 trunk road or higher road, Class 2 intersects with Class 4 road and Class 5 minor road, and Class 3 are other level crossings not listed in Class 1 and 2. The total number of level crossings is 2,439 including 1,047 authorized crossings and 1,392 non-authorized crossings. 2) The maximum speed for passenger trains is currently 90km/h while that of freight is 60 km/h.

3.2 Possibility of Converting the Existing Railway to High-Speed Railway

3.3 Scenarios 1 and 2 mentioned in Table 1.1 of Chapter 1 are the starting point of this study refers to the possibility of converting the existing railway to a high-speed railway. After thorough technical analysis and considerations, the following results are obtained:

(a) Scenario 1 aims to convert the current meter gauge to a standard gauge track to be used for passenger transport while the meter gauge will serve for freight services. However, not only will mixed operation limit the train speed at 100 km/h (80 km/h in most sections), there are no practices in the world in which dual gauge tracks are applied to such a route with 1,700km. This also connotes technical difficulties such as improvement of bridges and tunnels, and track layout must be changed as well. In addition, the operation suspension will be long and costs will be high. Hence this is not recommended.



Source: JICA Study Team.

Figure 3.2 Concept of Dual Gauge

(b) Scenario 2 aims to convert the existing single track to double-track and raise the operation speed to 200 km/h. This is not recommended because various substantial improvements will be needed for sections with a small radius of curvature, grade separation of level crossings at 2,000 locations, elevating sections in urban areas, thus leading to high costs and long operation suspension periods. The cost will be around half that of constructing a new line. Moreover, acquisition of lands including resettlement along the existing route may generate enormous social and environmental impacts.

(c) There are no practices in the world with mixed operation of passenger and freight services at 200 km/h, since the operation speed of freight trains is limited at 120 km/h due to safety reasons. In addition, mixed operation leads to inefficient train diagrams and operation as well due to differences in maximum speed and acceleration/ deceleration performances. It may also lead to complex signal systems.

3.4 Given the above, it is concluded that converting the existing railway to high-speed railway not only has technical difficulties and leads to long operation suspension obstructing train transport, leading to high costs as well. Hence this is not recommended, and high-speed services should be provided by a new line.

3.3 Improvement Options and Directions of the Existing Railway

3.5 However, improvement of the existing railway is important and needed. In order to determine the most appropriate level of improvement, the following four options were studied (see Table 3.3):

(i) A1: This is on-going rehabilitation and minor improvement work to ensure minimum level of safety and increase travel speed slightly. Capacity will remain 32 trains/ day and travel time between Hanoi and HCMC is 29 hours. Since A1 is already on-going, this cost is already taken into consideration in official plans of Vietnam. Note that these options are not meant to be implemented step-by-step in order, but each options rather express the ultimate target improvement level of the existing railway (however, A1 is a baseline plan).

(ii) A2: This intends to maximize the capacity of existing single track with meter gauge railway by removing main bottlenecks. Capacity will increase to 50 trains/ day and travel time between Hanoi and HCMC will reduce to 25.4 hours. The required investment cost is US$ 1.8 billion in addition to that of A1.

(iii) B1: This intends to convert the existing single track to double track with meter gauge by removing curve sections with less than 800m radius. With this, capacity will increase to 170 trains/ day, and maximum speed will increase to 120 km/h and travel time between Hanoi and HCMC will reduce to 15.6 hours. The required investment cost is US$ 14.5 billion.

(iv) B2: This intends to accommodate train operation with maximum travel speed of 150 km/h or above by double tracking by standard gauge, alignment improvement by removing sections with less than 1,200m radius, electrification of the system, grade separation of all level crossings, among others. With this, capacity will increase to 170 trains/ day and travel time between Hanoi and HCMC will reduce to 12.7 hours. The required investment cost is US$ 27.7 billion.

3.6 On the basis of the study, it is concluded and recommendations are made on the improvement directions of existing railway as follows:

(i) A1 level of improvement is absolutely necessary and must be completed at the earliest possible timing

(ii) A2 option shows the highest economic viability or the most cost effective solution for improvement of existing railway. However, the capacity falls short in various sections where demand is relatively high.

(iii) Although B1 option can enhance the capacity and performance of existing railway significantly, the required cost also becomes high. B1 option also cannot attract passenger demand sufficiently to utilize the capacity because its maximum speed is limited to 120 km/h due to level crossings. It is estimated that the future demand require more or less 40% of capacity or about 70 trains/ day including passenger and freight services. B1 option can be introduced for sections where demand is high.

(iv) Option B2 intends to accommodate high-speed operation of 150 km/h or above using the existing railway. As it is discussed in the previous section, constraints and required costs are so significant that it is not preferred. This option cannot be justified economically.

Table 3.3 Results of Improvement Options of Existing Railway

	A1	A2	B1	B2
Outline	Improvement through on-going and committed projects	Maximization of single-track railway	Double-tracking of meter gauge (non-electrified)	Double-tracking of standard gauge (electrified)
Main improvements	Bridge, roadbed, tracks, signals	Bottleneck sections, turnout stations, signals	Double-track, alignment improvement (R=800), ATS	Double-track, standard gauge, alignment improvement (R=1200), electrification, ATS
Maximum speed	90km/h (current)	90km/h (current)	120km/h	150km/h
Travel time (Hanoi - HCMC)	29.1 hours	25.4 hours	15.6 hours	12.7 hours
Capacity (total number, both directions)	32/day	50/day	170/day	170/day
Investment cost (US$ million)	-	1,800	14,500	27,700

Source: JICA Study Team.

4 DEVELOPMENT DIRECTIONS FOR NORTH-SOUTH RAILWAY

1) Passenger Traffic Demand and Economic Effect of HSR in North-South Corridor

4.1 There is no fixed amount for the traffic demand of the north-south railway, but traffic demand is rather dependent on and changes by various conditions. Such conditions include, among others, whether an expressway is available in parallel with the railway, or whether there are public bus services along this expressway, whether there are air transport available for the same section, and the level of fare of all these different modes of competing transport services. There are various transport modes along the north-south corridor, for example railway, road, air, coastal maritime, etc. As for railway, the existing railway and the planned high speed railway has strong relation to each other. In this study, the demarcation of roles among the existing railway and high speed railway has been clarified together with the overall analysis of the future traffic demand of the north-south corridor. The target year is 2030, and presuppositions are set as follows. The fare of HSR is considered at half the level of air fare[1].

(a) National Highway 1: The current 2-lane roads will be upgraded to 4-lane roads.

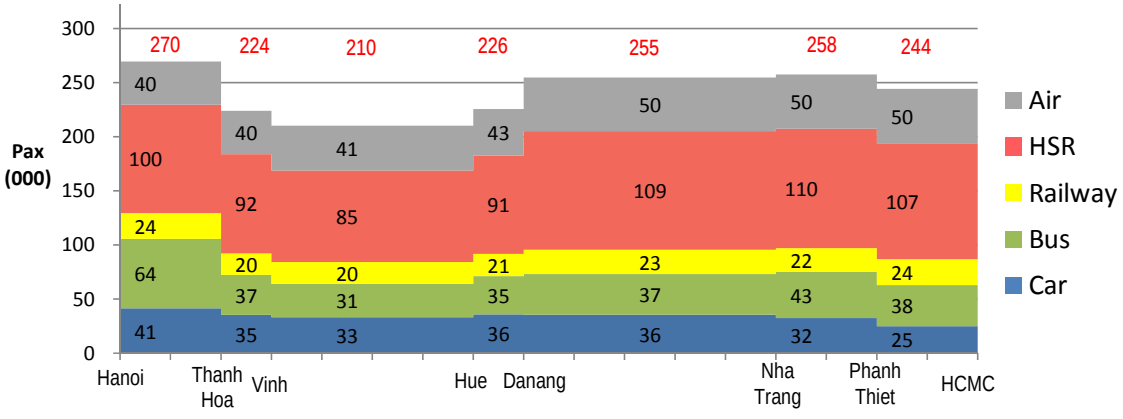
(b) Expressway: The north-south expressway and planned expressways connecting to these roads will be completed.

(c) Air: On-going and committed upgrading plans will be implemented and the capacity will increase to 3 times that of current.

(d) Existing Railway: A2 level improvement (maximization of single-track railway) discussed in Chapter 3.3 will be completed.

4.2 The results of traffic demand analysis indicate the following:

(a) Without the expressway, there will be high burdens on road and air, hence exceeding the capacity of the north-south corridor (see Table 2.6 and Figure 2.7 of Chapter 2). However, if the HSR is completed, there will be a large shift to HSR from road and air transport, thus improving the traffic situation of road and air transport. HSR will share more or less 40% of cross sectional traffic demand. (see Figure 4.1)



Source: JICA Study Team.

Figure 4.1 Passenger Traffic Demand in 2030

[1] Fare is set at half the level of air fare because HSR is a form of public transport in which shall be accepted widely in the society, and the willingness-to-pay survey conducted in this study also indicated that the average willingness-to-pay of users is around this level.

(b) The reason why HSR traffic demand is high in the future is attributed to that people demand higher speed services because their time value becomes higher and affordability to purchase better services will increase.

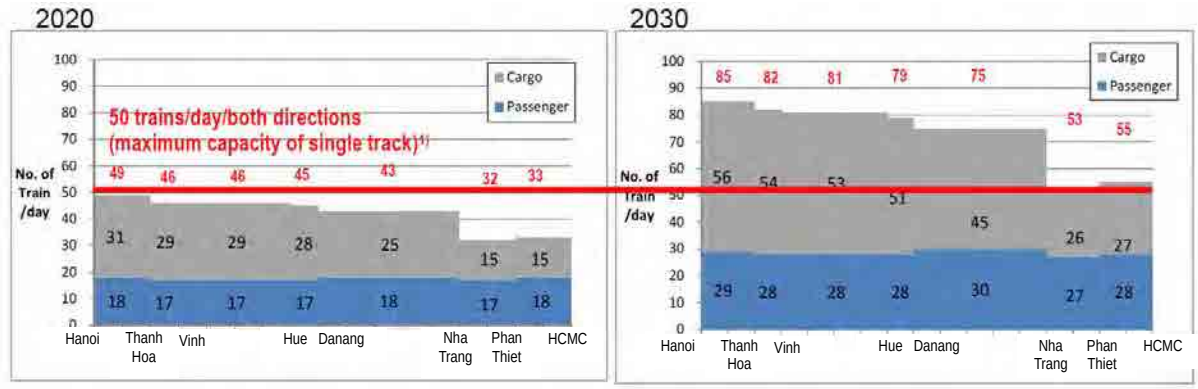
(c) In order to meet this demand, although it depends on the section, HSR operation of around 85-110 trains/ day will be needed (see Table 4.1).

(d) On the other hand, passenger traffic demand on existing railway travelling between provinces will be low. With adding freight traffic demand, this totals to around 48-70 trains/ day. Freight traffic demand is high in the Central Region and North Region. (see Table 4.1) This traffic demand exceeds the level of improvement at A2 level (50 trains/ day) in 2030. (see Figure 4.2)

Table 4.1 Future Traffic Demand (no. of trains/day) in the North-South Corridor in 2030

		Northern Section		Central Section			Southern Section	
		Hanoi – Thanh Hoa	Thanh Hoa – Vinh	Vinh – Hue	Hue – Danang	Danang – Nha Trang	Nha Trang – Phan Thiet	Phan Thiet – HCMC
Existing Railway	Passenger	24	20	21	21	23	22	24
	Freight	56	54	53	51	45	26	27
HSR		101	92	85	91	110	111	108

Source: JICA Study Team.



Source: JICA Study Team.
1) Average distance between stations is considered at 10km.
2) The traffic demand analysis for 2020 is the average of 2030 results and 2010 baseline data.

Figure 4.2 Supply-Demand Gap of Existing Railway for Passenger and Freight Transport (A2 Improvement Option)

2) Development Direction of North-South Railway

4.3 Given the aforementioned analysis, the basic direction for north-south railway development is summarized as follows:

(a) The HSR will be constructed as a new line exclusively for passenger transport, however the completion of the entire line will be a long-term plan.

(b) The improvement of the existing railway will be conducted at A2 level (maximization of single-track railway), which will be completed by 2020-25, and passenger and freight traffic demand will be met during this period.

(c) Although it cannot be clarified in this study, sections which high demand is expected can be double-tracked at B1 level, however further in-depth analysis is needed at an appropriate timing especially for freight traffic demand and local passenger traffic demand which are not studied in detail in this study.

5 ANALYSIS AND SELECTION OF HSR SYSTEM AND TECHNOLOGY

5.1 Selection of HSR System

1) Key Considerations

5.1 The basic HSR system to be applied to Vietnam has been proposed through comparison with international experiences. The most important point considered in this study is to avoid collision accidents to ensure a safe system when operating at high speed between Hanoi and HCMC. In addition, efficiency and compact infrastructure was defined as one of the key aspects for selection of HSR system.

5.2 Basic factors which must be met by the HSR system in Vietnam which were derived based on the international experiences are briefly as follows:

(i) Development of "New High-speed Passenger Railway" independent from existing railway by introducing highly reliable operation system and safety concept to avoid collision accidents completely.

(ii) Adoption of EMU system which enables compact infrastructure with light axle load, efficient and high density mass transportation and energy efficient and high density mass transportation and energy efficient operation which contribute to reduction in operation cost.

(iii) Introduction of single direction operation on single track and segregation of train operation and track maintenance to reduce delay in train operation and track maintenance to reduce delay in train operation, enhance operation stability and reduce construction cost due to compact infrastructure.

(iv) In addition to the above, by applying distinct rules such as non-stop policy in case of outbreak of fire in tunnels, the distance between track centers, track formation width, and tunnel cross sections are kept small and helps to keep the infrastructure compact and reduce construction costs.

Table 5.1 Comparison of Basic HSR Technology

Item	Japan	International
Rolling Stocks	• Selection of EMU system since 1994	• Recent transition from locomotive system to EMU system in European countries (e.g. IC3 in Germany in 2002) • Locomotive system but currently developing EMU system in South Korea • EMU system in China (opened in 2008) and Taiwan (opened in 2007)
Operation	• Single direction operation on single track	• Bi-direction operation on single track in countries other than Japan
Operation and Maintenance	• Separation of operation and maintenance time	• No separation of operation and maintenance time due to the selection of bi-direction operation on single track in countries other than Japan
Measures for Fire Accidents in Tunnels	• No stopping policy in tunnels – measures are taken outside tunnels. • Small tunnel cross section (63.4m^2).	• Train stops in tunnels and measures are taken. • Large tunnel cross section (80-100m^2).

Source: JICA Study Team.

2) Civil Structure and Track Specification

(a) Civil Structure

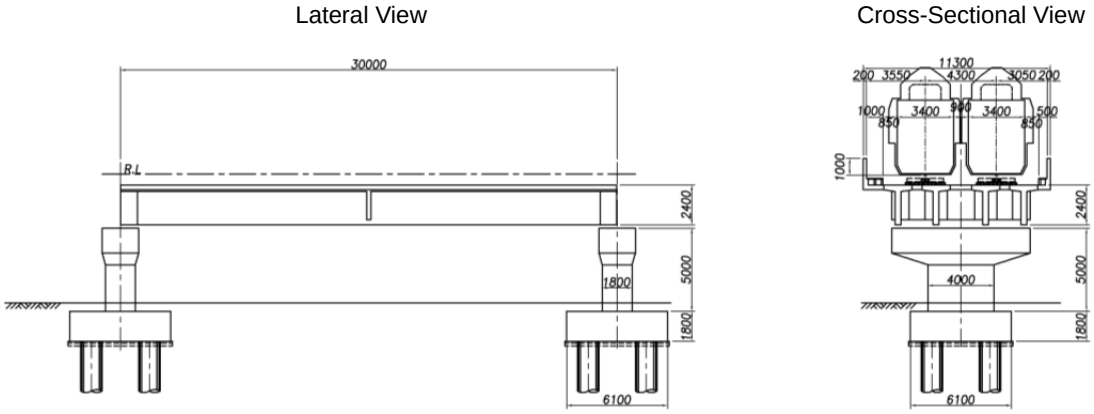
5.3 Main considerations in selecting civil structure are economic validity, easiness of construction, environment, maintenance, and land acquisition. Basically earth structures are applied, except when follows:

(i) Areas where population density is high to avoid hitting major buildings, roads, railways; or

(ii) Areas where soft alluvia of N values less than 5 are continuous for more than 20m deep thus the expected residual settlement of embankment is large.

5.4 **Cut and Embankment:** Civil structures (cut and embankment) have been long regarded as having much difficulty for maintenance, such as collapsing due to subsidence and rainfall, mud-pumping of roadbed, etc., however due to technical improvement, designing it likewise concrete and steel structures has become possible. In addition, it has been found that material for embankment can be easily attained in Vietnam. Therefore, wherever possible in open sections, cut or embankment was applied.

5.5 **Viaduct:** 30m tall PCT girder type viaduct will be mainly used in urban areas. This is adopted in Hanoi urban railway construction, and can be applied to Vietnam. The typical structure is shown in Figure 5.1.



Source: JICA Study Team.

Figure 5.1 Typical Girder Type Viaduct

5.6 **Tunnels:** The New Austrian Tunnelling method (NATM) will be applied. The effective inner cross section on double tracks will be 63.4m^2 as in Japan whereas this is 80-100m^2 in other countries. The small cross section implies the need of higher pressure for rolling stocks, however in order to reduce the cost this was applied. Although countermeasures for tunnel micro-pressure waves will be needed, this is already established. According to Railway Technical Research Institute in Japan, micro pressure waves can be controlled by adopting buffer tunnels at the speed of 350 km/h.

(b) Track Specification

5.7 The most appropriate track specification should be selected with regards to economic validity, easiness of construction, maintenance, environment, and life cycle costs. Track structure can be largely grouped to ballast tracks, ballastless tracks, and slab tracks. Normally for high-speed operation, non-ballast tracks are applied due to the easiness of maintenance, however in Vietnam, both ballast and slab tracks are adopted due to the following reasons:

(i) Slab tracks are applied inside tunnels because of maintenance difficulties and ballast scattering problems;

(ii) Slab tracks are also applied in viaduct and bridge sections since slab tracks are light in weight, and in urbanized areas the maintenance time should be kept as short as possible;

(iii) In sections with earth structure, ballast tracks are adopted because initial investment is smaller for ballast tracks compared to slab tracks, and manpower cost is lower in Vietnam for maintenance. In addition, the geographic structure of Vietnam shows that ballasts of good quality can be easily obtained.

(iv) Although there are 2 types of slab tracks, i.e. plate type slab and frame type slab, frame type slab is adopted since the construction cost is lower.

5.8 However, safety and running costs of ballast tracks will be studied in detail upon operation of the initial sections (see Chapter 15).

3) Electric System

5.9 The electric system has been selected from the viewpoint of selecting reliable technology by comparing international practices, and also by considering the latest technical development and maintenance after commencement of operation.

(a) Electric Power Receiving System

5.10 The lines from the ultra-high voltage power grid of EVN (Vietnam electricity) are separated by using T-branch method. The separated lines become regular circuit (one circuit, No.1 circuit) and stand-by circuit (one circuit, No. 2 circuit), and will be transmitted to HSR substations from two different power transmission lines. Two transformer substations will be set, one for regular times and the other as stand-by, and parallel operation will not be conducted. When one transformer substation is out of order, this line is automatically disconnected and changed to the stand-by line.

(b) Feeding Circuit System

5.11 Within alternating current electrification sections, different circuit systems meet, and sectioning posts and sub-sectioning posts are set to adjust these differences. By setting sub-sectioning posts, feeding sections can be confined upon accidents and maintenance times. Sub-sectioning posts are set in between transformer substations and sectioning posts.

(c) Feeding System

5.12 AT feeding system, in which uses auto transformers (AT) will be applied, which has been in use as a standard for AC electrification since 1970s. The advantages of AT feeding system includes, longer intervals between adjacent substations while supplying a large quantity of power in a stabilized form, inductive interferences can be cancelled, the feeding voltage is twice as that of the voltage of contact wire, and the system is suitable for large loads.

(d) Automatic Changeover Section

5.13 In jointing two different power sources such as adjacent substations, it is normally the case that a dead section is placed to prevent short circuits at the jointing point. However, this time, in order to enable HSR trains continue driving, automatic changeover section system is applied.

(e) Feeder System (catenary)

(a) Voltage: The proposed voltage for HSR is a maximum level of 80kv, normal level of 25kv, minimum level of 22.5kv, and instantaneous lowest voltage of 20kv.

(b) Structure: The proposed system is a simple catenary system, a basic and typical trolley wire (contact wire) hanging system widely used all over the world. Although the modified stitched simple catenary system is adopted in Germany and China, this will not be adopted because construction cost is high and difficulty in maintenance is expected.

(f) Transformer Substation

5.14 The feeding substation will be set as follows:

(i) Feeding substations will be placed with a 50km interval;

(ii) Sectioning posts will be placed in the middle of transformer substations;

(iii) In order to confine blackout sections upon accidents and maintenance times, sub-sectioning posts are placed between transformers and sectioning posts.

(iv) Air sections will be placed for transformer substations, sectioning posts, and sub-sectioning posts.

5.15 Feeding transformer: It is proposed that roof delta connected transformer, which is the latest technology for HSR in the world, will be applied. Roof delta connected transformer is smaller hence lighter compared to the conventional modified wood-bridge connected transformer (elimination of step up transformer), and uses less electricity, and is also lower in construction cost.

5.16 Auto transformer: Auto transformers will be placed in transformer substations, sectioning posts, sub-sectioning posts, and auto transformer posts. The capacity of auto transformers will be set at 7.5KVA.

4) Signal and Telecommunications

(a) Signal System

5.17 The basic plan is explained as follows:

(i) As a train control system for the Hanoi - Vinh and HCMC - Nha Trang sections, Vietnam shall adopt an interlocking-cum-ATC system of the car-mounted device relying control type, using digital transmission along with an operation control system of the autonomous decentralized data processing type that ensures the immunity of other stations from the failure at a station.

(ii) Comprehensive command post: A comprehensive command post for transport and facility shall be established in Hanoi and HCMC.

(iii) Operation block system: Regular block system: DS-ATC which ensures a safe distance between trains will be adopted for operation block system.

(iv) Substitute block system: This will be used in the case that DS-ATC cannot be used.

(v) Installation of Block Sections: The standard length of a block section is 1.2 km in open sections and 1 km in tunnel sections. A block section corresponds to a track circuit in principle except at sectioning posts.

(b) Train control system

5.18 DS-ATC (Japan), TVM (France), LZB (Germany), ETCS3 are candidates for train control system of HSR. DS-ATC is most recommended due to the following reasons:

(i) Level 3 system of ETCS (for HSR) which utilizes radiotelegraphy is still at development stage. Level 2 still uses track circuit system, hence radiotelegraphy is needed for information transfer. This option is roughly the same level as that of DS-ATC.

(ii) LZB situates induction coils on tracks, but this disturbs track maintenance, and hence is not recommended.

(iii) TVM is similar to DS-ATC in terms of function. DC-ATC is integrated with ATC, hence the system is simple and reliability is high. Cost can also be kept low. Hence, DS-ATC is recommended.

(c) Telecommunication System

5.19 **Trunk transmission route:** An optical PCM carrier system will be adopted using optical fiber cables as a trunk transmission route, which will be immune against the induction from contact wires. (PCM: pulse code modulation)

5.20 **Train radio system:** Space wave type mobile digital transmission system will be adopted for transmission between the ground and trains (message and data communications) as there is few tunnels in the section under consideration. For tunnel sections, a leaky coaxial cable (LCX) system will be used as a countermeasure against weak electromagnetic fields.

(d) AFC System

5.21 To ensure the convenience of users and the income from passenger services, an AFC System will be introduced. Automatic Fare Collection (AFC) system is composed of Fare Media, AFC Equipment (read/ write unit), Server, Clearing House Server, WAN network, etc. Magnetic tickets, tokens or non-contact IC cards are used.

5.22 For HSR, in principle, magnetic tickets will be used for fares and reservation. Upon the introduction of commutation tickets, an IC card shall be introduced. In this case, a separate reservation and ticket issuance system needs to be established.

5.23 For urban railways, IC cards will be mainly used for fares. In addition, magnetic tickets will also be used for fares and reservation. Upon the establishment of the system, it is desirable that common systems among HSR and urban railways be used to ensure smooth transfer.

5.24 There are three types of non-contact IC cards, i.e. Type A, Type B, and Felica Type. Type A is dominant in Europe and other countries while Type B is mainly dominant in the United States. Felica Type is popular in Japan and other Asian countries, and is used as transport cards and electronic money cards.

5.25 The advantages of Felica Type cards are high-speed reading and writing to ensure smooth pass through automatic gates, even during rush hours. It can also be used as electronic money. It is proposed that this system be adopted in Hanoi and HCMC areas as an integrated card system for transport facilities across the country.

5) Rolling Stocks

5.26 The basic requirements of rolling stocks for Vietnam HSR is as follows:

(i) High-speed operation: EMU rolling stocks which has experience of commercial operation over 300km/h is selected. This is due to the fact that tunnels with small cross sections with short distance between track centers have been selected in order to reduce the construction cost, and therefore is needed to select long nose type rolling stocks which are airtight. If the tunnel cross section is larger, such restrictions will be mitigated.

(ii) Mass transport: Wide enough for 5 seats in a row

(iii) Safety: Digital ATC

(iv) Stability: EMU rolling stock which operation is possible even when the main circuit unit is out of order

(v) Energy efficiency: Low energy consumption (light aluminium body, low axle load)

(vi) Environmental considerations: Selection of rolling stocks which reduce noise pollution to a minimum even for operation over 300km/h, and selection of pantograph with low noise pollution

5.27 The rolling stocks which fulfil the above requirements are summarized in Table 5.2.

Table 5.2 Technical Standards of Rolling Stocks for Vietnam HSR (draft, recommended)

Item	Specification
Track gauge	1435mm
Power supply	AC25kV 50Hz
Design maximum speed	350km/h
Operating maximum speed	320km/h
Number of cars	10 cars (8M2T)
Capacity	All seats can be reclined and can face different directions Total 759 (Executive Class 51 , Economy Class 708)
Weight	455 t / Train (Unloaded)
Maximum axle load	13.1t (100% passenger volume)
Major dimensions	
Length (lead car)	26250mm
Length (other cars)	25000mm
Maximum width	3350mm
Maximum height	3650mm
Distance (between bogies)	17500mm
Body structure type	Aluminum alloy double-skin extruded structure (Airtight Structure body)
Bogie	
Bogie type	Bolster less type
Wheel dimension	Φ =860mm
Wheel base	2500mm
Traction System	
Control system	VVVF Inverter-Converter control System with IGBT 3level PWM
Main motor	Induction Motor, power:300 kW / unit 32 units/train, 9,600 kW/ train
Pantograph	2 units/ train, single-arm pantograph (low-noise type)
Brake system	Electric command brake equipment with regenerative brake
Safety system	Digital ATC with onboard braking control
Train radio	Space wave & LCX (digital)

Source: JICA Study Team.

5.2 Proposed HSR Technology Standards

1) Key Considerations

5.28 By comparing and analyzing technical standards in the world, HSR technology is selected for Vietnam with due consideration to the following points:

(i) High-speed operation
(ii) Compact infrastructure
(iii) Low initial investment cost

2) HSR Construction Standards for Vietnam

(a) Speed

5.29 The design maximum speed is 350 km/h, the possibly highest speed in the future as of today, with consideration that high-speed is of utmost priority given the 1,500 km long distance between Hanoi and HCMC. The commercial operation speed is set at 320 km/h in which JR East in Japan is targeting to commence in 2013 spring.

(b) Curve Radius and Cant Value

(i) The minimum curve radius at 350 km/h is proposed at R=6000m when the maximum cant is 180mm. It has been confirmed that the cant deficiency is 60mm in this case, and does not affect riding comfort at all. In the case of KOICA study, 350 km/h is proposed at R=5000m, however the cant deficiency is around 110mm which generates sideways pressure and may affect both operation stability and riding comfort.

(ii) The maximum vertical curve radius is set at R=25000m[1], which fulfills vertical acceleration at less than 0.033g. This will ensure riding comfort.

(iii) The maximum cant value is decided from the perspective of operation stability in curve sections, track maintenance, etc.

(iv) The steepest slope is set at 25/1000, in consideration of both practices in Japan and performance of rolling stocks. This is set as not to limit the speed as much as possible.

(c) Distance between Track Centers and Track Formation Width

(i) The distance between track centers for operation over 300km/h is 4.3m in Japan whereas this is 4.5m in other countries. Considering the pressure when trains pass each other, it is better to have more width, but this will lead to the increase in construction costs. According to the Railway Technical Research Institute in Japan which analyzed the case for operation at 350 km/h, if the long nose rolling stocks[2] are applied, the maximum pressure when trains pass each other are around the same as that of 320 km/h operation for conventional rolling stocks. Although this imposes certain requirements on the rolling stock side, distance between track centers at 4.3m is applied from the aspect of construction cost.

(ii) Track formation width is set in accordance to the distance between track centers[3].

(d) Cross Section of Tunnels

[1] Adopted in Japan since the construction of Sanyo Shinkansen which commenced operation in 1972.
[2] E5 type, E954 type
[3] The experience from Kyushu Shinkansen in Japan is applied.

5.30 Regarding geological conditions, there are many sections having hard rocks. In addition, considering adverse effects from tunnel micro-pressure waves and need to keep rolling stocks airtight, it is desirable to have a larger cross section of tunnels, however this leads to higher costs. Tunnel cross section is 63.4m^2 in Japan whereas this is 80-100m^2 in other countries. According to the Railway Technical Research Institute in Japan, the adverse effects from tunnel micro-pressure waves at 350km/h operation can be reduced by placing tunnel entrance buffering hoods at the entrance and exit of the tunnels if long nose rolling stocks are applied. Although this imposes certain requirements on the rolling stock side, the tunnel cross section is set at 63.4m^2.

(e) Axle Load

5.31 The axle load is set at P16, due to the following reasons:

(i) The rolling stocks are around 13 tons, but when considering the possibility of introducing two-story rolling stocks in the future, P16 is desirable.

(ii) Considering the axle load of maintenance rolling stocks upon transporting rails, P16 is desirable.

(f) Track Specification

5.32 Both slab tracks and ballast tracks are applied (see Chapter 5.1 3) (b) for details).

(g) Main Structures

5.33 Main structures consist of embankment and cut, girder type viaduct (see Chapter 5.1 3) (a) for details).

3) Proposed Technical Standards for HSR in Vietnam (draft)

5.34 The proposed technical standards for HSR in Vietnam are summarized in Table 5.3. This is also compared with the Pre F/S and KOICA Study. High-speed operation at 350 km/h is maintained, and with compact infrastructure, the initial investment cost is kept as low as possible.

Table 5.3 Technical Standards for HSR in Vietnam (draft, recommended)

	Item	Unit	JICA Study Team	Pre F/S	KOICA (350km/h)
1	Gauge	mm	1,435	1,435	1,435
2	Lines		Double-track	Double-track	Double-track
3	Design max. speed	km/h	350	350	350
4	Operating max. speed	km/h	320	300	300
5	Minimum curve radius	m	6000	6000	5000
6	Maximum vertical curve radius	m	25,000	25,000	25,000
7	Largest cant	mm	180	180	180
8	Steepest slope	1/1000	25	25	25
9	Distance between track centers	m	4.3	4.5	5.0
10	Track formation width	m	11.3	11.6	13.2
11	Tunnel cross-section	m^2	63.4	80	Approximately 116
12	Axle load		P16	P16	UIC25
13	Tracks		Ballast tracks Slab tracks	Slab tracks	Ballast tracks
14	Main civil structures		Embankment, Cut, Girder type viaduct	Girder type viaduct	Embankment, Cut

Source: JICA Study Team.

6 TRAFFIC DEMAND ANALYSIS FOR TWO PRIORITY SECTIONS

1) Approach

6.1 For the purpose of traffic demand analysis of the HSR, the model developed in VITRANSS2 was modified based on the latest traffic data and information available. The basic update was conducted on 1) Modification of Zoning, 2) Update of Socio-economic Indicators (population and GDP), 3) Update of OD Table for 2030, 4) Update of Transportation Network (explained in Chapter 4.1), 5) Update of transport Conditions (parameters such as fare/cost, access time and travel speed) and 6) Update of Four Steps Method Model[1]. The traffic demand forecast for the improvement Option A2 was applied as a based case for the assessment of HSR development.

6.2 The very basic input of demand forecast is the socio-economic framework (population and GDP) for the future. As for population forecast, the General Statistics Office (GSO) under the Ministry of Planning and Investment in coordination with the United Nations Population Fund (UNFPA) estimated the population from 2009 to 2049. This data was applied with estimated breakdown based on National Committee for Population and Family Planning (NCPFP) forecast. Regarding to the future economic growth, the the growth was assumed referring the estimation of the government and international agencies and, then, breakdown was estimated considering the past trend and regional and provincial SEDP targets. (Table 6.1 and Table 6.2)

Table 6.1 Population and Urbanization Projection by Region

Region	2009		2020		2030		Average Growth Ratio for Pop. (%/year)	
	Pop. (000)	Urban (%)	Pop. (000)	Urban (%)	Pop. (000)	Urban (%)	09 - 20	20 - 30
Red River Delta	19,584	29.3	21,709	39.3	22,992	47.1	0.9	0.6
Northern midlands and mountain areas	11,054	15.9	12,327	17.8	13,225	20.0	1.0	0.7
North Central and Central coastal areas	18,835	24.0	20,222	30.4	21,436	37.7	0.6	0.6
Central Highlands	5,115	28.2	6,035	41.2	6,783	51.7	1.5	1.2
South East	14,068	57.2	17,379	61.3	19,300	68.8	1.9	1.1
Mekong River Delta	17,191	22.8	18,487	30.6	19,419	38.6	0.7	0.5
Vietnam Total	85,847	29.6	96,159	37.1	103,155	44.4	1.0	0.7

Source: JICA Study Team

Table 6.2 Projected GRDP by Region

Region	2010 (VND bil.)	2020 (VND bil.)	2030 (VND bil.)	AGR	
				10-20	20-30
Red River Delta	128,230	244,653	451,326	6.7	6.3
Northern midlands and mountain areas	36,498	68,150	124,779	6.4	6.2
North Central and Central coastal areas	80,893	150,029	268,429	6.4	6.0
Central Highlands	24,597	51,481	98,372	7.7	6.7
South East	175,749	322,982	556,280	6.3	5.6
Mekong River Delta	105,641	198,151	355,140	6.5	6.0
Vietnam Total	551,609	1,035,446	1,854,326	6.5	6.0

Source: Regional SEDPs (MPI), Provincial SEDPs (provincial governments) and Study Team.

[1] Applied demand forecast models follows the traditional four-step method, namely (i) trip generation/attraction, (ii) trip distribution, (iii) modal split, and (iv) traffic assignment used in VITRANSS2 as well.

2) Future Traffic Demand

6.3 Figure 6.1 shows trip generation/attraction. During 2010-2030, the total number of inter-provincial trip will increase by 2.6 times. While traffic will be huge in the north and the south, traffic demand in other areas will also increase at higher rate than the national average. While traffic distribution will be the most significant within the north and the south, the inter-regional traffic will also increase from 2010 to 2030 steadily and the traffic activity on the north-south corridor will be quite active.

Region	Generation/Attraction (000/day)		
	2010	2030	30/20
1	469	1,003	2.1
2	29	100	3.4
3	6	15	2.5
4	39	132	3.4
5	9	49	5.4
6	44	169	3.8
7	335	879	2.6
8	102	381	3.7
Total	1,032	2,728	2.6

Source: JICA Study Team

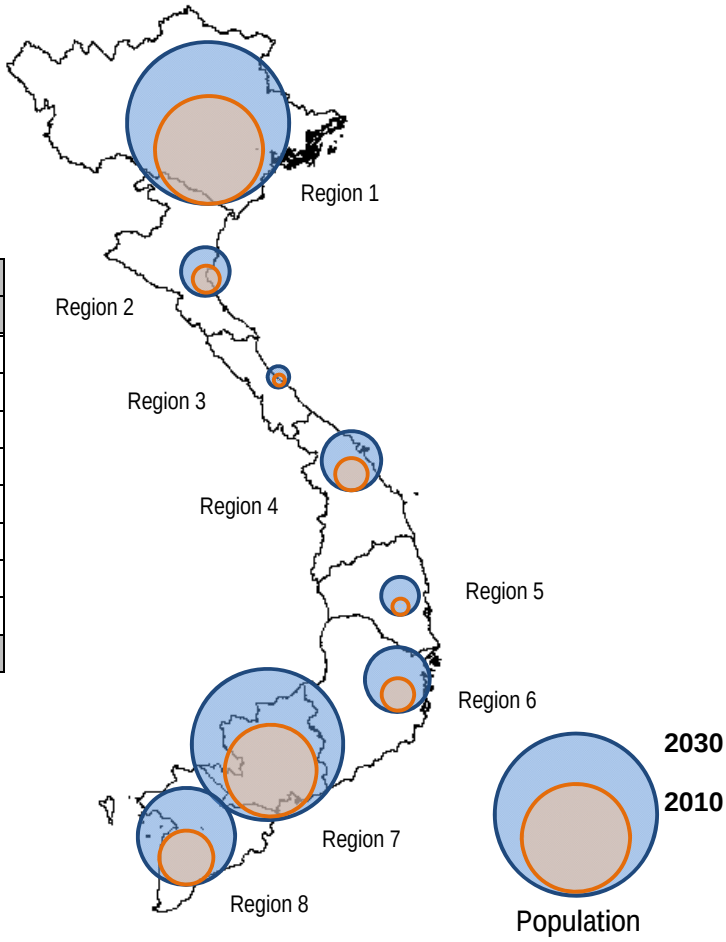


Figure 6.1 Trip Generation/Attraction per day (inter-provincial) (2010 & 2030)

6.4 The traffic demand along the north-south corridor will change greatly from 2010 to 2030. The number of passengers will increase by 2.7 times, the average trip length will increase by 1.4 times, and the passenger-km will increase by 3.6 times. Assuming that HSR will open in 2030, although the expressway will be complete and the capacity of the national highway and air transport will also be increased, the number of passengers for HSR will be 275,000, and the share of HSR will be 10% in terms of the number of passengers, 22% in terms of passenger-km. Bus and air transport users will mainly convert to the expressway.

Table 6.3 Demand Analysis Result by Mode[1)]

Year	Unit		Representative Mode of Transport					TOTAL
			Car	Bus	Railway (CR)[2)]	HSR[4)]	Air	
2010 (Base Year)	No. of passenger	000/day	304	675	30	-	25	1034
		%	29.4	65.3	2.9	-	2.4	100.0
	Passenger-km	mil./day	35.9	123.5	12.2	-	23.3	194.4
		%	18.5	63.5	6.3	-	12.0	100.0
	Average Trip Length (km)[3)]		118	183	407	-	932	188
2030	No. of passenger	000/day	733	1558	89	275	74	2728
		%	26.9	57.1	3.2	10.1	2.7	100.0
	Passenger-km	mil./day	150.7	290.8	47.0	155.9	65.3	709.7
		%	21.2	41.0	6.6	22.0	9.2	100.0
	Average Trip Length (km) [3)]		191	164	454	667	1250	261

Source: JICA Study Team
1) The transportation condition for demand forecast is shown in Table 6.4.
2) In case service level of railway is A2
3) Distance from final origin to final destination
4) Assuming that HSR is operated for Hanoi-HCMC section in 2030.

Table 6.4 Preconditions for Demand Analysis Result by Mode

Mode			PCU/Veh Ratio	Average Occupancy [1)]	Fare/Cost (VND/Pax-km)	Travel Speed(km/h)	Time at terminal (waiting time)(min)
Road	Road	Car	1	3.2	527	40	0
		Bus	2.5	20.5	525	32	20
	Expressway	Car	1	3.2	855	80	0
		Bus	2.5	20.5	653	64	20
Railway	Existing Railway		-	-	584	70	20
	High Speed Railway [3)]		-	-	873	280	20
Air Transport			-	-	1,745	600	60

Source: JICA Study Team
1) Based on traffic survey (2011)

6.5 Cross sectional traffic (the amount of traffic passing through two points) and modal share from the terminal cities in case Hanoi-Vinh and HCMC-Nha Trang sections are developed are shown in Figures 6.2 and 6.3, respectively. Besides the passengers using HSR from/to cities along the alignment, transferring passengers to use the HSR from other transport modes are also observable. 30% of passenger moving from Hanoi to Vinh (Nghe An) uses HSR, while 60% of passenger moving from HCMC to Nha Trang (Khanh Hoa) does.

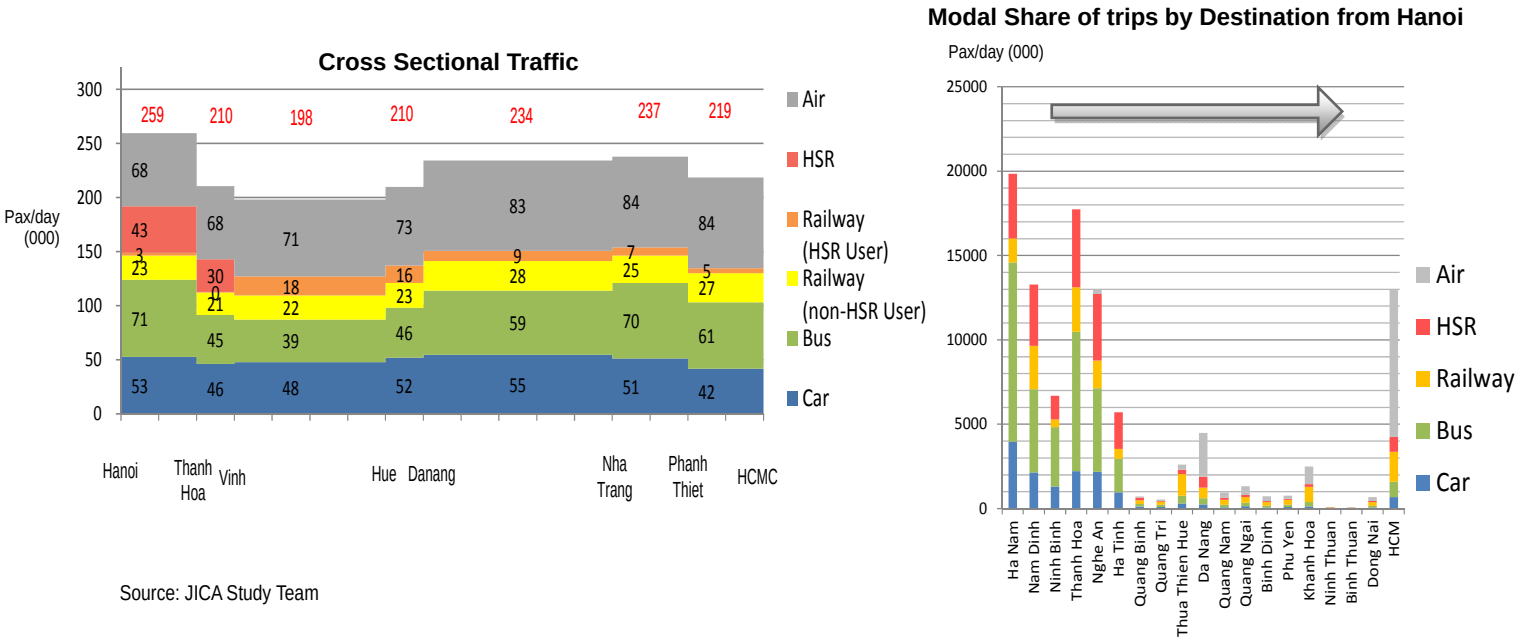


Figure 6.2 Cross Sectional Traffic & Modal Share of Trips from Hanoi (2030)
(Hanoi-Vinh Section is under operation)

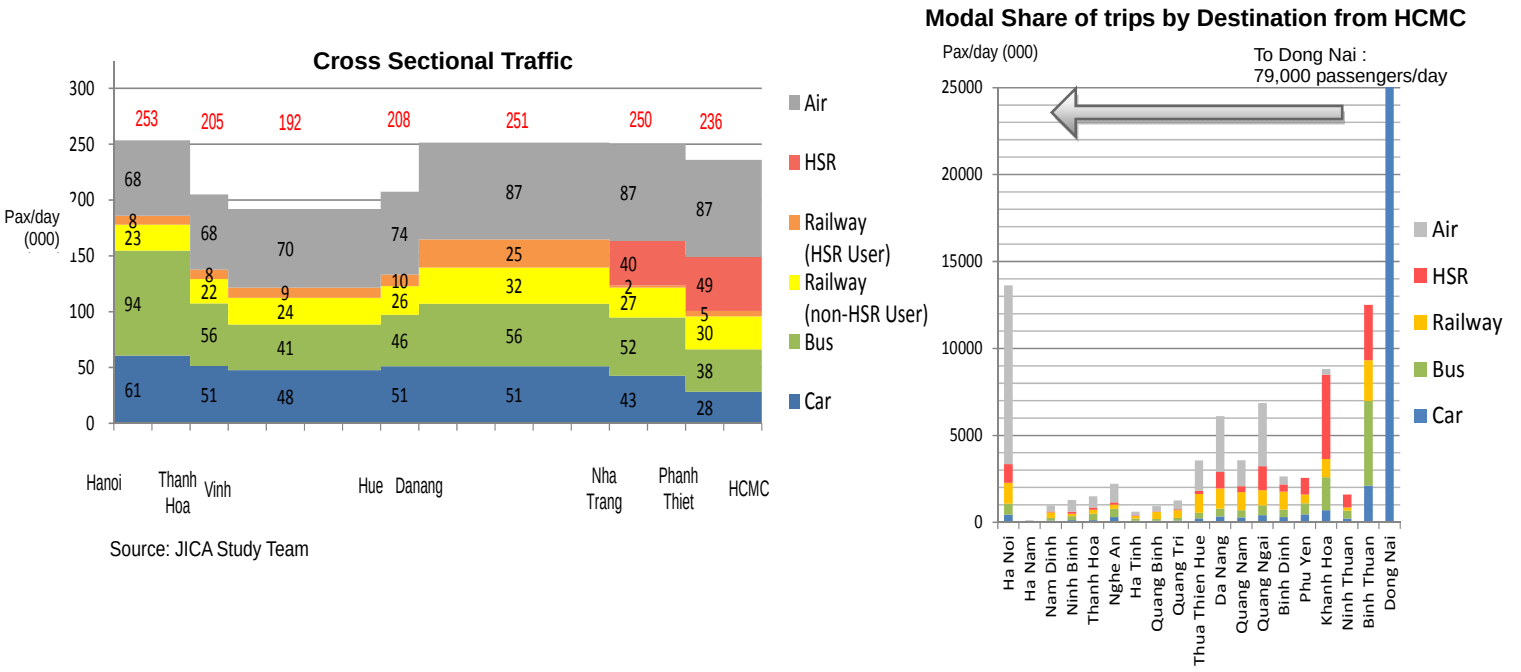


Figure 6.3 Cross Sectional Traffic & Modal Share of Trips from HCMC (2030)
(HCMC-Nha Trang Section is under operation)

7 ALIGNMENT PLANNING

7.1 Methodology

7.1 The alignment plan was formulated for the north and the south priority sections through the following activities, and also by observing the HSR system and technical standards explained in Chapter 5:

(a) Site survey by JICA Study Team along the planned alignment areas

(b) Review of alignment plan in past projects, i.e. Pre F/S and KOICA Study

(c) Formulation of a 1/10,000 scale topographic map based on the latest satellite images and analysis based on this map

(d) Consideration of conformity with urban and regional plans of the provinces along the alignment

(e) Environmental and social considerations of the provinces along the alignment based on the environmental sensitivity maps[1]

(f) Analysis of the results of geological survey to sort out problematic areas and countermeasures

(g) Discussions with Provincial People's Committee and the related departments

7.2 The alignment plan was considered as one process of a comparison exercise of alternatives and was hence discussed in stakeholder meetings in the provinces along the alignment as well as at the central level. Discussions on the alternatives for alignment and station location were conducted, and were finalized in the study.

7.3 Basic concept for alignment planning is as follows:

(a) Alignment: The alignment was planned so that it can accommodate a maximum speed of 350 km/h, setting the minimum radius of curvature at 6,000m and maximum gradient at 25‰.

(b) Station location: Stations were selected through a comprehensive review of provincial capital, built-up areas with high population density, connectivity with existing railway and planned urban railway, and existing urban and regional plans.

(c) Selection of structures: In order to minimize construction cost, earth structures were basically selected. Viaducts were applied to the areas where population density is high to avoid hitting major buildings, roads, railways, or to the areas where soft alluvia of N values less than 5 are continuous for more than 20m deep thus the expected residual settlement of embankment is large.

[1] A set of environmental sensitivity maps was prepared in order to identify the potentially sensitive areas that may require environmental and social considerations (e.g. topography, natural preservation areas, disaster prevention areas, historical and cultural preservation areas, ethnic minorities, high-density areas, industrial zones, focal development zones, religious facilities, military facilities, cemeteries, etc.), and prepare data sets in order to contribute to the alignment planning. These maps also help to clearly show that the selected alignments are drawn based on the due considerations of environmental and social aspects.

7.2 Northern Priority Section

1) Basic Local Conditions along the Route

7.4 The north section is a 284km long route which connects Ngoc Hoi (Hanoi City) and Vinh (Nghe An Province). Characteristics of the areas along the alignment are as follows:

(a) Natural Conditions

7.5 The north priority section from Hanoi City to Vinh falls into two regions, the Red River Delta Region and the Northern Central Coastal Region. The Red River Delta Region includes Hanoi City, Ha Nam Province, Nam Dinh Province, and Ninh Binh Province. While the average annual temperature is 24 Celsius, it rises as high as 40 Celsius in July, and declines as low as 3 – 8 Celsius in January. The average annual precipitation is 1700mm.

7.6 The Northern Central Coastal Region includes Thanh Hoa Province and Nghe An Province. The average annual temperature is 25 Celsius. The region is prone to storms and typhoons, and the average annual precipitation is as high as 2890mm.

(b) Land Use

7.7 The total area of the Red River Delta region covers 1.5 million hectares (4.5% to national), and 17 million people (around 22% to national) reside in this region. Agricultural land account for 58%, and forests account for 8% of the total land. As the land is fertile, double-cropping is practiced. Industrial zones are being developed recently in surrounding areas in Hanoi and also Phu Ly, Nam Dinh, etc.

7.8 The total area of the Northern Central Coastal Region covers 5.2 million hectares (15.6% to national). Agricultural land account for 14%, forests account for 43% of the total land. It has vast mountainous and hilly areas and limited plain lands. Major rivers include Ma River (Thanh Hoa Province) and Lam River (Nghe An Province). Thanh Hoa Province is abundant with limestone therefore has many cement factories.

(c) Environmental Conditions

7.9 Due to the rapid economic development in Vietnam, industrialization and urbanization is taking place in various areas in the Red River Delta Region. Hence the reservation of land for HSR shall be done as soon as possible. Regarding construction environment, as this region has soft grounds, geological survey and selection of structures shall be done carefully.

7.10 Likewise the Red River Delta, industrialization and urbanization is also taking place in the Northern Central Coastal Region and land shall be reserved urgently. Since this region is prone to direct impact from floods in the coastal areas, the alignment should run in the western hilly areas and mountainous areas.

2) Alignment Plan

(a) Ngoc Hoi - Phu Ly Section (46km)

7.11 Ngoc Hoi Station is planned as the first station of the Vietnam HSR, being located in the capital city of Hanoi. Ngoc Hoi Station is placed in an industrial redevelopment area 12km south of Hanoi Station, and Vietnam Railways is planning a large-scale depot in this area. Considering the accessibility towards Hanoi City, it is planned as an elevated station next to Ngoc Hoi Station for UMRT Line 1. The alignment from Ngoc Hoi Station to Phu Ly Station basically runs parallel with the expressway. A workshop & depot is planned between Ngoc Hoi Station and Phu Ly station. Phu Ly City is the capital of Ha Nam Province, and urban redevelopment is ongoing in the city center. Phu Ly Station is planned so that it conforms to the city's redevelopment plan. (see Figure 7.1 and 7.2)

(b) Phu Ly - Nam Dinh Section (22km)

7.12 It is approximately only 22km from Phu Ly Station to Nam Dinh Station, however due to local conditions (connectivity with neighboring provinces and coastal areas), Nam Dinh Station is needed. Nam Dinh Station will be planned at the crossing point with the existing railway line considering the connectivity of HSR with the existing railway.

(c) Nam Dinh - Ninh Binh Section (35km)

7.13 Paddy areas are dominant between Nam Dinh Station to Ninh Binh Station. Ninh Binh Station is located next to a new station to be built on the existing line avoiding urbanized areas currently under development. An elevated expressway is under construction in this area, and HSR will pass under a viaduct section of the expressway and is connected to the existing railway at the station on the ground. From Nam Dinh to Ninh Binh, there are several areas with especially soft grounds, and hence viaducts with pile foundations are applied.

(d) Ninh Binh - Thanh Hoa Section (51km)

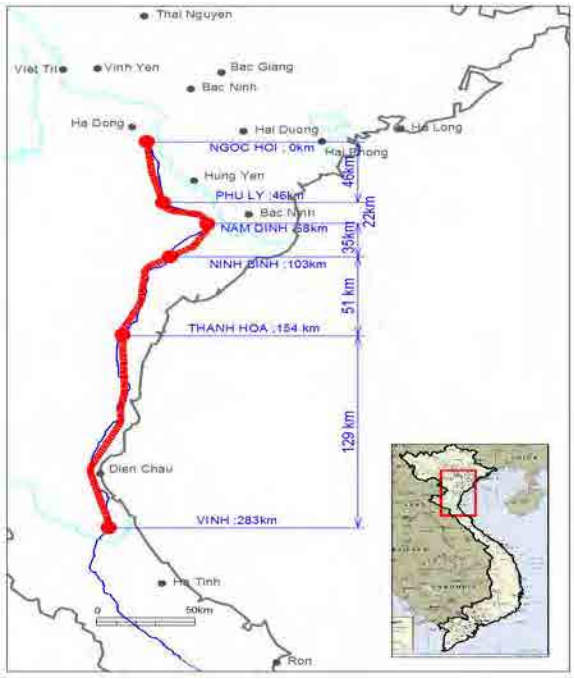
7.14 From Ninh Binh Station to Thanh Hoa Station, the alignment passes through mountainous areas in order to avoid the planned industrial areas. The geological conditions are favourable, hence earth structures are applied as much as possible. There are various plans for industrial zones in Thanh Hoa Province.

(e) Thanh Hoa - Vinh Section (129km)

7.15 From Thanh Hoa Station to Vinh Station, the alignment avoids industrial areas and agricultural areas and through the mountainous areas, 129km total in length. Since the distance between the two stations is long, a signal station is placed in the middle to locate a track & catenary maintenance base. As there is an urban development plan for an industrial city in this area, a new station shall be established in the future. Vinh Station is a terminal station for the northern priority section. Therefore the connectivity with the existing railway is of utmost priority. The plan for Vinh Station is a two-storied elevated station. A maintenance depot is also planned south of Vinh Station.

3) Structure Plan

7.16 Reflecting the results from previous studies (44 bridge improvement projects for existing railway) and the geological survey conducted in this study, it was identified that there were sections with extremely soft ground conditions in alluviums widespread in the Red River Delta Region. In addition, there are densely populated urbanized areas from Phu Ly – Nam Dinh – Ninh Binh, hence land acquisition needs to be kept to a minimum. Therefore, the ratio of applying viaducts is relatively high for the northern section. (see Table 7.2)



Source: JICA Study Team.

Figure 7.1 Location of North Priority Section

Table 7.1 Stations in North Priority Section

Station	Structure	Connectivity
Ngoc Hoi	Viaduct	UMRT Line 1
Phu Ly	Viaduct	Existing Railway
Nam Dinh	Viaduct	Existing Railway
Ninh Binh	At-grade	Existing Railway
Thanh Hoa	Viaduct	Existing Railway
Vinh	Viaduct	Existing Railway

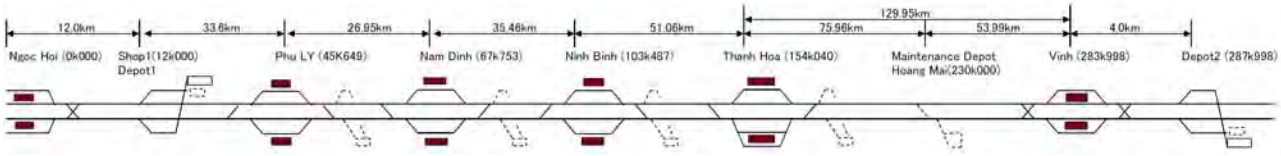
Source: JICA Study Team.

Table 7.2 Structures in North Priority Section

Section / Structure	Ngoc Hoi ～Phu Ly		Phu Ly ～Nam Dinh		Nam Dinh ～Ninh Binh		Ninh Binh ～Thanh Hoa		Thanh Hoa ～Vinh		Total	
	Length (m)	Ratio (%)	Length (m)	Ratio (%)	Length (m)	Ratio (%)	Length (m)	Ratio (%)	Length (m)	Ratio (%)	Length (m)[1)]	Ratio (%)
Station	615	1.4	650	2.9	650	1.8	650	1.3	1,820	1.4	4,385	1.5
Viaduct	32,198	70.7	16,044	72.5	29,221	81.7	13,926	27.7	37,344	28.6	128,733	45.3
Bridge	930	2.0	380	1.7	1,180	3.3	1,700	3.4	1,900	1.5	6,090	2.1
Embankment	11,780	25.9	5,050	22.9	4,666	13.2	24,404	48.5	73,730	56.5	119,630	42.1
Cut	0	0.0	0	0.0	0	0.0	3,200	6.4	6,660	5.1	9,860	3.5
Tunnel	0	0.0	0	0.0	0	0.0	6,390	12.7	9,010	6.9	15,400	5.4
Total	45,523	100.0	22,124	100.0	35,717	100.0	50,270	100.0	130,464	100.0	284,098	100.0

Source: JICA Study Team.

1) Total length from center of the station is 283k380m which totals to 284K098m when adding the station structure (308m＋410m=718m).



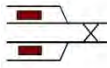
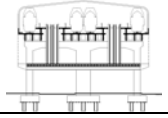
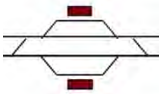
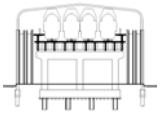
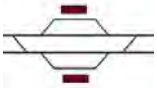
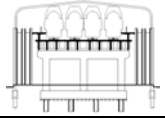
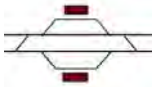
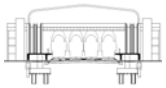
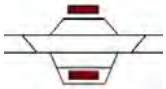
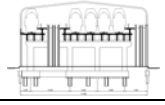
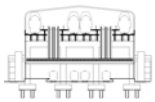
Source: JICA Study Team.

Figure 7.2 Rail Track Diagram for North Priority Section

4) Station Plan

7.17 There are 6 stations in the northern section, and all stations are elevated except for Ninh Binh Station. All stations are planned with consideration for accessibility from city center and connectivity with the existing railway and planned urban railways. In addition, separation of urban areas was avoided by elevating the station, and land acquisition was kept at a minimum. (see Table 7.1 and 7.3)

Table 7.3 Station Plan for North Priority Section

Station Name	Station Layout	Cross Section	Platform Type and Length	Area (m^2)			Connection to Existing Railway
				Station building	Platform	Concourse	
Ngoc Hoi (Hanoi City)			Island (260m)	21,700	10,900	5,300	Yes
Phu Ly (Ha Nam Province)			Side (260m)	17,400	8,300	2,400	Yes
Nam Dinh (Nam Dinh Province)			Side (260m)	17,400	8,600	2,500	Yes
Ninh Binh (Ninh Binh Province)			Side (260)	17,400	8,300	2,400	Yes
Thanh Hoa (Thanh Hoa Province)			Island/Side (260m)	30,900	10,900	3,200	Yes
Vinh (Nghe An Province)			Island (260m)	26,100	10,400	5,000	Yes

Source: JICA Study Team.

7.3 Southern Priority Section

1) Basic Local Conditions along the Route

7.18 The south section is a 366km long route which connects Thu Thiem (HCMC) and Nha Trang (Khanh Hoa Province). Characteristics of the areas along the alignment are as follows:

(a) Natural Conditions

7.19 The southern section from HCMC to Nha Trang has a hot climate all year round, and can be divided into 2 seasons, the rainy season (May to November) and the dry season (December to April). The region along HSR alignment can be grouped to South East Region and Southern Central Coastal Region.

7.20 The South East Region is located in the eastern side of Mekong Delta, and includes HCMC and Dong Nai Province. Major rivers in this region include the Sai Gon River and Dong Nai River, and the latter which the HSR crosses has a basin area of 45,000 km^2 and average flow of 500 m^3/s.

7.21 On the other hand, the Southern Central Coastal Region is a mountainous and hilly region, and the small deltas of medium and small rivers. This region is one of the driest areas in Vietnam, and the average annual precipitation is under 1000mm and the average annual temperature is 26 Celsius. This region includes Binh Thuan Province, Ninh Thuan Province and Khanh Hoa Province.

(b) Land Use

7.22 The total area of the South East Region covers 3.5 million hectares (11% to national total), of which agricultural land account for 49%, and forest land account for 30%. The area along the HSR alignment (HCMC, Dong Nai Province) is developed primarily for industrial use, but is also home to agricultural crops such as rubber and corn. On the other hand, the total area of the Southern Central Coastal Region covers 3.3 million hectares (10% to national total), of which agricultural land account for 16%, and forest land account for 36%. Aquaculture, marine services and tourism serve greatly for the overall economic development of this region.

(c) Environmental Conditions

7.23 The main areas to be considered from an environmental aspect are flooding areas, natural preservation areas and natural heritages. In the South East Region, adverse effects to the environment and increase of population in urbanized areas due to economic growth are in concern. Drainage and sewage treatment around HCMC and surrounding areas is also an issue, and this leads to flooding hampering urban development. Flooding is also an issue around Dong Nai River and Sai Gon River.

7.24 On the other hand, Southern Central Coastal Region is not facing major environmental issues, but emerging threats that the ongoing mass resort developments will lead to serious environmental issues in the future. Main areas for environmental protection in the region include Tra Cu (Binh Thuan Province) and Nui Chua (Ninh Thuan Province) Natural Preservation. Ninh Thuan also beholds famous Champa relics. Flooding issues along the coastal areas are also a problem.

2) Alignment Plan

(a) Thu Thiem - Long Thanh Section (36km)

7.25 The station for HCMC will be located in the area of Thu Thiem Urban Development Project which is ongoing on the east of Sai Gon River. UMRT Line 2 is planned to be connected to Thu Thiem, therefore the HSR station will be placed parallel with the UMRT Line 2 station. The alignment from Thu Thiem to Long Thanh will basically runs along an expressway, and due to the soft ground of the Mekong Delta, viaducts are selected. Long Thanh Station is planned at the center of the Long Thanh International Airport, according to its master plan. A workshop & depot for general inspection, periodical inspection, overhaul, light repair and accommodation of train-sets is also planned in this section.

(b) Long Thanh - Phan Thiet Section (117km)

7.26 In this section, there are no developed cities in between, hence the distance between the two stations is as long as 117km. Dong Nai Province and Binh Thuan Province along this alignment are requesting for an intermediate station, however at this point this will not be proposed, but the alignment is planned so that future establishment of a new station is possible if enough demand is expected due to regional development. The ground in this section is basically in favourable conditions, therefore earth structures were mainly applied. Phan Thiet Station is planned to intersect diagonally right above the existing station which is approximately 3km away from the city center.

(c) Phan Thiet - Tuy Phong Section (67km)

7.27 In the middle of this section, there is a very loose sandy area along the coast, and from the results of site survey and geological investigations, it was concluded that passing through this area is inappropriate from the aspects of construction cost and future maintenance, hence the route avoids this sandy area. Tuy Phong Station will be an at-grade station for cost reduction, and will be located along National Highway 1A which is close to the center of Phan Ri Cua Town.

(d) Tuy Phong - Thap Cham Section (63km)

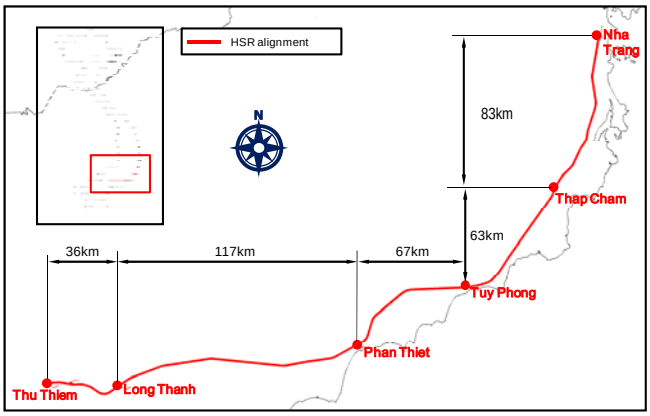
7.28 A 13.6km long tunnel, the longest one planned in this study, is planned in Ca Na Mountain which is in between Binh Thuan Province and Ninh Thuan Province. The tunnel being mainly formulated of granite, no major construction problems are expected. Other sections are basically hilly areas with good geological condition, therefore earth structure is mostly applied. Thap Cham Station is planned as an elevated station at the location of the station for the existing railway. National Highway No.27 runs close to this station, and Ninh Thuan Province's major tourism destination, Champa relics is also located nearby.

(e) Thap Cham - Nha Trang Section (83km)

7.29 The route in this section encompasses valleys, running basically parallel to National Highway No. 1 and the existing railway. There are a total of 8 tunnels in this area ranging from a length of 250m to 7.6km, totalling to 20.7km in length. The expected geological conditions of these tunnels are basically granite-based, hence less problems are expected upon construction. Nha Trang Station will be located approximately 3.3km west of the current station location which formulates a loop in the inner city. Hence this station for the existing railway will also be relocated as well, which will enable smooth transfer to and from areas north of Nha Trang. A maintenance depot will be located 2.8km north of this station for periodic maintenance, light repair and train-sets accommodation.

3) Structure Plan

7.30 Structure plan was based on the technical standards noted in Chapter 7.1. In soft grounds in the Mekong Delta and densely populated urbanized areas along the alignment, viaducts were applied. Areas north of Long Thanh Station were generally hilly areas of diluvial epoch, hence the ratio of earth structure (cut, embankment) is relatively high. (see Table 7.5)



Source: JICA Study Team.

Figure 7.3 Location of South Priority Section

Table 7.4 Stations in South Priority Section

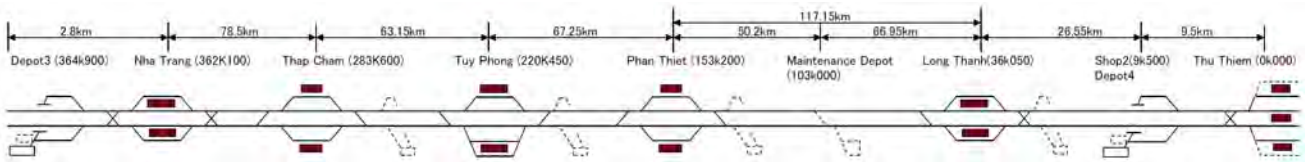
Station	Structure	Connectivity
Thu Thiem	Viaduct	UMRT Line 2
Long Thanh	Excavation	UMRT Line 2, LRT
Phan Thiet	Viaduct	Existing Railway
Tuy Phong	Ground	-
Thap Cham	Viaduct	Existing Railway
Nha Trang	Viaduct	Existing Railway

Source: JICA Study Team.

Table 7.5 Structures in South Priority Section

Structure \ Section	Thu Thiem ~ Long Thanh		Long Thanh ~ Phan Thiet		Phan Thiet ~ Tuy Phong		Tuy Phong ~ Thap Cham		Thap Cham ~ Nha Trang ~ Depot		Total	
	Length (m)	Ratio (%)	Length (m)	Ratio (%)	Length (m)	Ratio (%)	Length (m)	Ratio (%)	Length (m)	Ratio (%)	Length (m)	Ratio (%)
Station	795	2.2	820	0.7	1,650	2.4	650	1.0	820	1.0	4,735	1.3
Viaduct	23,355	65.1	9,375	8.0	9,175	13.5	1,075	1.7	5,845	7.1	48,825	13.3
Bridge	1,600	4.5	1,330	1.1	760	1.1	1,230	2.0	1,170	1.4	6,090	1.7
Embankment	5,550	15.5	61,000	52.0	31,760	46.7	33,630	53.4	37,550	45.8	169,490	46.3
Cut	4,590	12.8	44,710	38.1	24,730	36.3	12,780	20.3	16,021	19.5	102,831	28.1
Tunnel	0	0.0	0	0.0	0	0.0	13,610	21.6	20,669	25.2	34,279	9.4
Total	35,890	100.0	117,235	100.0	68,075	100.0	62,975	100.0	82,075	100.0	366,250	100.0

Source: JICA Study Team.



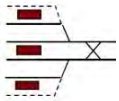
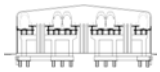
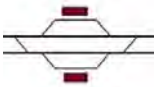
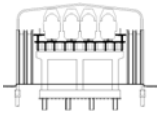
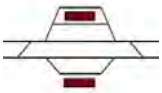
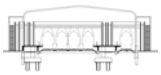
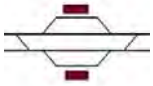
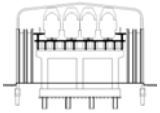
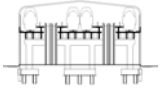
Source: JICA Study Team.

Figure 7.4 Rail Track Diagram for South Priority Section

4) Station Plan

7.31 There are six stations in the southern section, four of them are elevated while Long Thanh is open-cut and Tuy Phong on the ground. At Phan Thiet, Thap Cham and Nha Trang the connectivity with existing railway is considered, and at Thu Thiem and Long Thanh the connectivity with urban railways (UMRT Line 2, LRT) is ensured. Tuy Phong Station does not connect to the existing railway, but selects the station location close to the center of Phan Ri Cua along National Highway 1A. (see Table 7.4 and 7.6)

Table 7.6 Station Plan for South Priority Section

Station Name	Station Layout	Cross Section	Platform Type and Length	Area (m^2)			Connection to Existing Railway
				Station building	Platform	Concourse	
Thu Thiem (HCMC)			Island (260m)	37,800	16,100	7,800	Yes
Long Thanh (Dong Nai Province)			Island (260m)	26,100	10,400	3,400	Yes
Phan Thiet (Binh Thuan Province)			Side (260m)	17,400	8,300	2,400	Yes
Tuy Phong (Binh Thuan Province)			Island (260m)	30,900	10,500	3,100	No
Thap Cham (Ninh Thuan Province)			Side (260m)	17,400	8,300	2,400	Yes
Nha Trang (Khanh Hoa Province)			Side (260m)	26,100	10,400	5,000	Yes

Source: JICA Study Team.

8 STATION AND STATION AREA PLANNING

8.1 Upon construction of the HSR, not only the location of the station is important, but also station area planning is very significant. A station should have two functions, one to ensure smooth access to transport modes for users, and the other to fulfill urban development function becoming a center providing service and commercial activities for various users. Through this function the station and the surrounding areas form a new urban center, and generate HSR users and contribute to urban development as well. In this study, the stations selected in the alignment plan and their surrounding areas were planned based on the following concepts:

(a) Conformity with urban plans: Most provinces and cities have an urban development master plan, and conformity with such plans were taken into consideration.

(b) Increasing potential as a development point for areas around HSR station: Access roads and other transport modes (especially existing railway) were taken into consideration, and good connectivity was ensured. Transport connection facilities such as station squares were planned carefully as well.

(c) Promotion of integrated development: Ideal land use and development concepts were presented, with due consideration to realistic development methodologies.

8.2 Development plans for station and station area planning for all stations in north and south priority sections were formulated, clarifying the contents of major facilities (see Table 8.1).

Table 8.1 Development Concept for Station and Station Area Planning

Station		Land Use around Station		Connectivity with other Transport Modes	Development Concept for Station Area
		Current	Future		
North Priority Section	Ngoc Hoi (Hanoi City)	Suburban	Urbanized	UMRT Line 1, Existing Railway, RR4, National Highway 1A	• Gateway of Hanoi Metropolitan Area • New urban development • Development of station square (22,000m^2)
	Phu Ly (Ha Nam Province)	Suburban	Urbanized	Urban Railway, Existing Railway, Expressway, National Highway	• Center of regional and urban transport • New urban development • Urban living with comfort and convenience by public transport. • Development of station square (5,600m^2)
	Nam Dinh (Nam Dinh Province)	Suburban	Urbanized	Existing Railway, National Highway	• Center of regional and urban transport • Urban living with comfort and convenience by public transport. • Development of station square (10,350m^2)
	Ninh Binh (Ninh Binh Province)	Suburban	Suburban	Existing Railway, National Highway 1A	• Center of regional transport • Administrative and tourism center • Development of station square (8,450m^2)
	Thanh Hoa (Thanh Hoa Province)	Suburban	Suburban	Existing Railway, National Highway	• Center of regional transport • New urban development with natural environment • Development of station square (12,875m^2)
	Vinh (Nghe An Province)	Urbanized	Urbanized	Existing Railway, National Highway	• Commercial and tourism center • Urban living with comfort and convenience by public transport. • Development of station square (9,600m^2)
South Priority Section	Thu Thiem (HCMC)	Suburban	Urbanized	UMRT Line 2, Ring Road	• Eastern gateway of HCMC • Commercial and residential development • Urban living with comfort and convenience by public transport. • Development of station square (9,600m^2)
	Long Thanh (Dong Nai Province)	Suburban	Urbanized	Expressway, Airport, National Highway, (Urban Railway)	• Southern international gateway • Commercial and logistics service center • Minimized station size for airport security (4,760m^2)
	Phan Thiet (Binh Thuan Province)	Suburban	Urbanized	Existing Railway, National Highway	• Center of regional and urban transport • Commercial and tourism center • Promoter of urban living in harmony with natural environment • Development of station square (9,000m^2)
	Tuy Phong (Binh Thuan Province)	Suburban	Urbanized	National Highway 1A	• New urban development • Promoter of urban living in harmony with natural environment • Development of station square (8,000m^2)
	Thap Cham (Ninh Thuan Province)	Urbanized	Urbanized	Existing Railway, National Highway	• Center of regional and urban transport • Tourism (historical) and commercial center • Development of station square (15,100m^2)
	Nha Trang (Khanh Hoa Province)	Suburban	Urbanized	Existing Railway, National Highway	• Center of regional and urban transport • Accessibility to tourism destinatinos • Development of station square (16,200m^2)

Note: Based on current Master Plans of provinces and cities along the alignment.

9 COST ESTIMATION

1) Methodology of Cost Estimation

9.1 In estimating the costs, followings were basically considered:

(i) Although safety is the utmost priority, much consideration was taken to reduce the total cost upon design and cost estimation.

(ii) For unit cost of civil works, costs in Vietnam were referred to.

(iii) For unit cost of tracks, maintenance depots, workshops, electricity, signal and telecommunications, etc., practices from Japan's Shinkansen were referred to.

9.2 Other considerations on main types of work include flowing:

(a) **Selection of Structures:** In the case that either the alignment possibly obstructs buildings, roads, railways etc. in urban areas, or the alignment passes soft ground and residual settlement are significant, viaducts were applied. Otherwise earth structures were selected.

(b) **Civil Works:** This includes the following.

(i) Unit cost for construction, i.e. embankment, cut, viaduct, box culverts, bridges, tunnels (road tunnels), costs in Vietnam were referred to.

(ii) Since reinforced roadbed were applied for embankment and cut for ballast track sections, the unit costs used for expressways in Vietnam were referred to.

(iii) For viaducts and bridges, the planned unit costs for urban railways and standard unit costs from MOC were referred to.

(iv) For tunnels, unit costs for road tunnels in Vietnam were referred to.

(v) For the unit cost of environmental measures (sound-proof wall, tunnel entrance buffering hood), practices from Japan's Shinkansen were referred to by discounting the rate to match local situation in Vietnam.

(c) **Tracks, Stations, Maintenance Depots and Workshops:** For tracks, stations, maintenance depots and workshops, and relevant facilities, practices from Japan's Shinkansen were referred to.

(i) For the unit cost of tracks, practices from Japan's Shinkansen were referred to by discounting the rate to match local situation in Vietnam.

(ii) For stations, the planned unit costs for elevated stations for urban railways were referred to.

(iii) Appropriate rates are applied for other civil works, buildings, and facilities.

(iv) For maintenance depots and workshops, unit costs in Vietnam were referred to for civil works and building construction, and on the other hand practices from Japan's Shinkansen were referred to for facilities and equipment.

(d) **Electricity:** For electricity, signal and telecommunications, practices from Japan's Shinkansen were referred to, by estimating the unit cost per km. This includes transformer substations, power substations, sectioning post (SP), sub-sectioning post (SSP), overhead lines, signal and telecommunication equipment room and relevant systems, operation control center, etc.

2) Total Project Cost

9.3 Based on the aforementioned conditions, the project cost for north and south priority sections were calculated. The main points are summarized as follows. (see Table 9.1)

(i) The total project cost (including infrastructure, rolling stocks, land acquisition and compensation, contingencies, tax) is 10.2 US$ billion for the north, and 9.9 US$ billion for the south. Project cost per km is 35.0 US$ million for the north, and 27.1 US$ million for the south.

(ii) Excluding taxes, the total project cost is 10.0 US$ billion for the north, and 9.7 US$ billion for the south. The cost for rolling stocks are 1 US$ billion for both sections. The reason that total project cost for the north section is high is because of higher land acquisition and compensation costs in the north. Without land acquisition and compensation costs, the project cost is nearly the same: 9.22 US$ billion in the north, and 9.25 US$ billion for the south. The length of the south line is about 29% longer than the north.

Table 9.1 Project Cost for North and South Priority Sections

Item		North Priority Section (Ngoc Hoi – Vinh: 284km)		South Priority Section (Thu Thiem – Nha Trang: 366km)	
		US$ mil.	%	US$ mil.	%
1. Civil Works and Structures		3,511	34.3	3,128	31.5
2. Tracks		698	6.8	738	7.4
3. Stations		476	4.6	519	5.2
4. Power System		1,397	13.6	1,652	16.6
5. Signal and Telecommunications		646	6.3	756	7.6
6. Maintenance Depots and Workshops		294	2.9	294	3.0
Subtotal (1 - 6)		7,022	68.6	7,087	71.3
7. Maintenance Equipment		101	1.0	114	1.1
8. Equipment for Training		26	0.3	26	0.3
Subtotal (1 - 8)		7,149	69.8	7,227	72.8
9. Rolling Stocks		1,045	10.2	1,045	10.5
10. Land Acquisition and Compensation		1,020	10.0	685	6.9
Subtotal (1 - 10)		9,214	90.0	8,957	90.2
11. Consulting Service (3.5% of items 1-10)		282	2.8	285	2.9
12. Contingencies (5% of 1-10)		475	4.6	462	4.6
13. Other tax [1]		266	2.6	229	2.3
Subtotal (11, 12, 13)		1,023	10.0	976	9.8
TOTAL	1 - 13	10,237		9,933	
	Excluding Rolling Stocks	9,192		8,888	
	Excluding Land	9,217		9,248	
	Excluding R.S. and Land	8,172		8,203	
Project Cost per km	1 - 13	35.0		27.1	
	Excluding Rolling Stocks	32.4		24.3	
	Excluding Land	32.4		25.3	
	Excluding R.S. and Land	28.7		22.4	

1) Assuming local cost * 50% (ratio of material) * 10% (tax)
2) Price escalation is not reflected to the above cost.

10 ECONOMIC AND FINANCIAL ANALYSIS

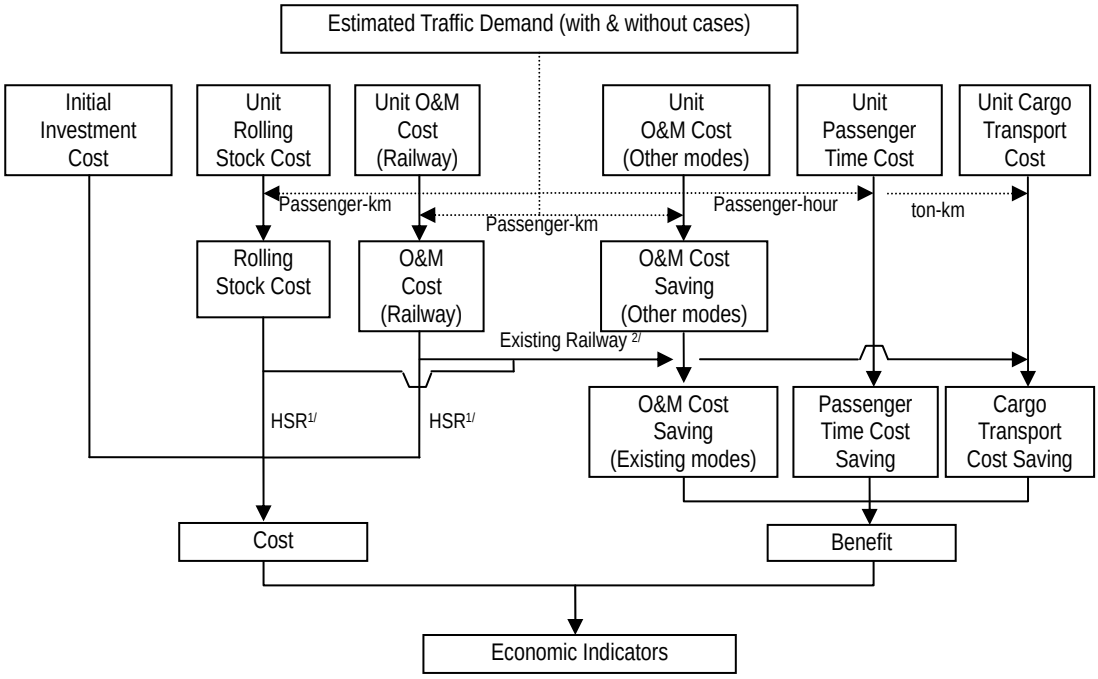
1) Approach

10.1 Economic analysis is for the purpose of evaluating the validity of a project from national economic perspective. The analysis is conducted by comparing economic cost and economic benefit engendered during the economic period of durability. The indicators for evaluation are Economic Internal Rate of Return (EIRR), Benefit-Cost Ratio (B/C) and Net Present Value (NPV). The cost consists of construction cost and operation cost of HSR and the benefit includes passenger-time cost saving and operation cost saving of other modes. Although other benefits such as the reduction of traffic accidents, additional traffic demand induced by high quality of HSR service, these are not included because of the difficulty of quantitative analysis and evaluation. Urbanization is analysed as a separate case.

10.2 Financial analysis is for evaluating profitability of a project. The cost covers financial construction cost and operation cost of HSR and is compared with fare revenue. Financial Internal Rate of Return (FIRR) and Fare Box Ratio (FBR) are the indicators for the evaluation.

2) Economic Analysis

10.3 Economic indicators are essential to assess validity of projects and to determine or prioritize project investments. The framework of evaluation is shown in Figure 10.1.



Source: JICA Study Team, 2012
1/ In case of HSR project (new mode),
2/ Rolling stock cost and O&M cost are considered at benefit side

Figure 10.1 Basic Framework of Economic Evaluation

10.4 In the 2030 opening case, at 9.3%, the Northern HSR is way below the threshold value of 12%, while the Southern HSR (=12.0%) exceeds it only by a narrow margin. Excluding land acquisition, the corresponding values jump to 10.4% and 12.9%, respectively (Table 10.1).

10.5 High urbanization would increase travel demand for all modes. The intensive urban development scenario is set by positioning the MPI population forecast (see Technical Report No.2 for details) as the “low scenario”, and the estimation by the JICA Study Team as “high scenario”. Both figures are averaged to form the “medium scenario” which is used as input figures for this intensive urban development case. Whereas the urbanization rate in the “low scenario” is 38.6% and 76.0% for northern and southern sections, respectively, these figures for the “medium scenario” are 45.3% and 82.6%, respectively, implying an increase of urban population of 1.3 million for the north, and 1.1 million for the south compared to the MPI estimates. Likewise the “high scenario” implies an increase of urban population of 2.5 million for the north, and 2.1 million for the south. The more passengers shift to HSR under that scenario, the higher the economic benefits will be. The predicted daily passenger kilometer on HSR will increase by 57.4% and 21.9%; and assuming proportionate increase in benefits, the EIRR would rise to 14.3% and 14.5%, which approximates the effect of a 39% and 20% reduction in project cost (north and south sections, respectively for the aforementioned figures).

10.6 Although it is clear that economic viability of the HSR is greatly dependent on traffic demand, this demand is also related to the urban development along the alignment and the income level of the users (time value). Deferring the opening year increases the economic viability is a matter of fact since Vietnam’s economic growth and urbanization is seen to increase long in the future. Hence, it can be concluded that both north and south sections are economically viable in the medium to long term. Results also indicate that promotion of integrated regional and urban development of cities along the alignment through the development of HSR has great political significance as well.

10.7 However, by deferring the project by 5 years, the EIRR for the Northern HSR increases to 12.7%, and the Southern HSR to 14.5%, both sections becoming economically viable.

Table 10.1 Results of Economic Analysis (2030 Opening Case)

Section	Case	EIRR (%)	B/C	NPV (US$ mil.)
Hanoi-Vinh	Including land cost	9.3	0.79	-1,928
	Excluding land cost	10.4	0.88	-1,014
	Intensive urban development (Incl. Land)[1)]	14.3	1.20	1,806
HCMC-Nha Trang	Including land cost	12.0	1.00	30
	Excluding land cost	12.9	1.08	644
	Intensive urban development (Incl. Land)[1)]	14.5	1.21	1,893

Source: JICA Study Team

1) Medium scenario. See Volume II Chapter 3 Sensitivity Analysis and Chapter 10 for details.

Table 10.2 Results of Economic Analysis (2035 Opening Case)

Section	Case	EIRR (%)	B/C	NPV (US$ mil.)
Hanoi-Vinh	Including land cost	12.7	0.88	-664
	Excluding land cost	14.2	0.97	-146
	Intensive urban development (Incl. Land)[1)]	17.1	1.38	2,007
HCMC-Nha Trang	Including land cost	14.5	1.21	1,121
	Excluding land cost	15.5	1.29	1,469
	Intensive urban development (Incl. Land)[1)]	21.2	1.86	4,611

Source: JICA Study Team

1) Medium scenario. See Volume II Chapter 3 Sensitivity Analysis and Chapter 10 for details.

3) Financial Analysis

10.8 In financial analyses, the revenues from rail passengers take the place of benefit inflows. The outflows are the same: capital and operating costs. Not surprisingly, the financial returns in terms of project FIRR, are very low – like typical rail projects. FIRR for the north section is -10.96%, and slightly better at -10.25% for the south section. The fare box ratio is promising: at 0.9 for the north and 1.2 for the south. With the support of the government for infrastructure and land, FIRRs are -7.96% in the north and -6.50% in the south. Even with intensive urbanization – with its corresponding increased ridership, the FIRRs are still in the negative territory without the support of the government for infrastructure.

Table 10.3 Results of Financial Analysis (2030 Opening Case)

Section	Case	FIRR (%)		Fare box ratio (2035)
		Base case	Without track infrastructure	
Hanoi-Vinh	Including land cost	-10.96	-8.49	0.9
	Excluding land cost	-5.08	-7.96	0.9
	Intensive urban development (Incl. Land)1)	-5.49	7.03	1.4
HCMC-Nha Trang	Including land cost	-10.25	-7.02	1.2
	Excluding land cost	-10.08	-6.50	1.2
	Intensive urban development (Incl. Land)1)	-6.85	7.42	1.4

Source: JICA Study Team

1) Medium scenario. See Volume II Chapter 3 Sensitivity Analysis and Chapter 10 for details.

Table 10.4 Results of Financial Analysis (2035 Opening Case)

Section	Case	FIRR (%)		Fare box ratio (2035)
		Base case	Without track infrastructure	
Hanoi-Vinh	Including land cost	-8.27	-4.51	1.1
	Excluding land cost	-7.97	-3.45	1.1
	Intensive urban development (Incl. Land)1)	0.37	7.03	1.8
HCMC-Nha Trang	Including land cost	-6.14	-0.89	1.4
	Excluding land cost	-5.87	0.23	1.4
	Intensive urban development (Incl. Land)1)	0.50	7.42	1.7

Source: JICA Study Team

1) Medium scenario. See Volume II Chapter 3 Sensitivity Analysis and Chapter 10 for details.

4) Summary

10.9 Under the assumption that HSR will be operated from 2030, EIRR is 9.30% for the north section and 12.04% for the south section. Although the figure of the north is lower than the threshold of 12%, by putting off the project for 5 years, it will exceed 12%. According to international experiences, the construction cost of HSR was approximately 2-4% of GDP at the time of starting operation in Japan, Korea and Taiwan; similarly, the construction of either of the priority sections will be at the same range (2-4% of 2030's GDP in Vietnam). Thus, the project could be justifiable from macro-economic perspective.

10.10 The result of financial analysis indicates difficulty. Regardless of fare level, FIRR is negative. As fare level increases, ridership decreases, which leads to the decrease of fare revenue. Financial support by the government is indispensable. The profitability is higher in the south section than the north one. The revenue of Vietnamese HSR per track-km is about 1/10 of Japanese one. Traffic density on Shinkansen in 2000 is 2.6x of the north section and 2.3x of south section[1]. The fare per-km is about 20% of the European HSR average.

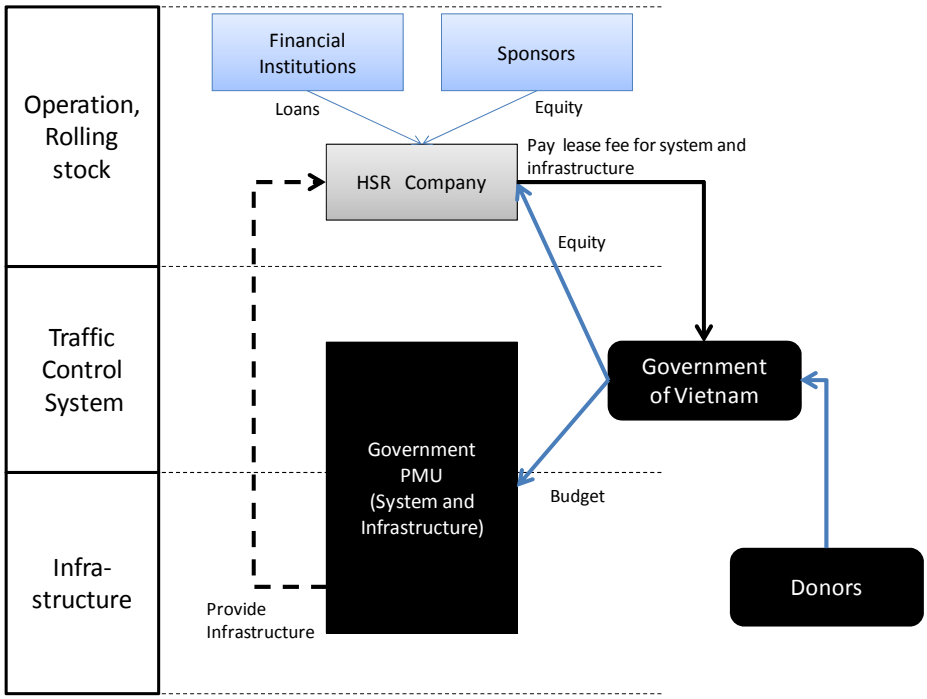
[1] Traffic density is the quotient of annual passenger-km to route length.

11 FUNDING OPTIONS

11.1 In considering funding options of the high speed rail (HSR) project, its implementing structure is discussed first. One of the possible measures would be setting up a public entity which will cover major risks of the HSR operations and management. It is also necessary to make the implementing structure favourable for private investors or financers. One of such examples is the recent development of Shinkansen in Japan, in which public bodies developed infrastructures and the operators own mainly rolling stocks. This section discusses a funding option, in which High Speed Railway Company (HSR Company) is set up to own rolling stocks and operate HSR.

1) Overview of Funding Options

11.2 As depicted in the financial and organizational structure (Chart 11.1), HSR Company and the government will share the responsibilities in the high speed railway project. The operator, High Speed Rail Company (HSR Company), owns rolling stocks and carries out the operations of HSR, while the government will be responsible for the initial and additional investment in the traffic control system and the infrastructure. To secure the safety and efficiency of the HSR operations, HSR Company carries out the maintenance of the rolling stocks, traffic control system and infrastructure, together with the operations of the HSR. The investments of HSR Company are mainly in rolling stocks used for the operations, and they are financed both by loans and equity. The minimum requirement to obtain such financings is that HSR Company can secure sufficient profits with major risks. Then, the government will have to be responsible for most of initial investments and to provide risk mitigation measures for HSR Company, such as revenue guarantees. The usage fees that HSR Company pays to the government, should not be determined to cover the investment costs, but at the level where HSR Company can achieve financial sustainability.



Source: JICA Study Team.

Figure 11.1 Implementing Structure

2) Risk Allocations

11.3 The responsibilities of the high speed railway are separated mainly to HSR Company and the government. The responsibilities of HSR Company are the ownership of rolling stocks, the operations of high speed railway, and the maintenance of rolling stocks and maintenance of the system and infrastructure. The development and investment of the traffic control system and infrastructure is under the responsibility of the government. Land acquisitions and resettlements are also carried out under the responsibilities of the government. The HSR project is subject to risks with various characteristics. Then, it is necessary to allocate risks to those who can manage them most appropriately, depending on the characteristics of risks. Risks before completion and after the completion of the project are explained separately. (see Table 11.1)

11.4 Land acquisition and resettlement are carried out only by the government, and thus associated risks are fully taken by the government. Any cost increases or losses of HSR Company due to the delays or problems in land acquisitions and resentment are also covered by the government. Cost overruns, time overruns or technical risks of the traffic control system and the infrastructure are primarily under the responsibility of the government, and the government would transfer parts of such risks to contractors.

11.5 HSR Company will cover the risks that might arise after the completions of the project, as HSR Company is responsible for the operational services of HSR and maintenance of rolling stocks, traffic system and infrastructure. Parts of the operational service risks are covered by the government through revenue guarantee. Hence, the government will cover demand risks exceeding a certain criteria. Foreign exchange risks, which cannot be mitigated by HSR Company, are also covered by the government. Foreign exchange risks arise, because the revenue of HSR Company is in domestic currencies, while debts of the company for purchasing rolling stocks are in foreign currencies.

11.6 Common risks, including institutional risks, force majeure risks and environmental risks are basically covered by the government. Institutional risks include any risks due to the changes in government rules and regulations, which might negatively affect the sustainability in the operations of high speed railways. Force majeure risks, such as natural disasters, are also covered by the guarantees by the government. Environmental risks, which are the risks that the project might have negative impacts on the natural and social environment during the construction and operations is under the responsibility of HSR Company.

Table 11.1 Allocation of Risks

	Types of Risks	Risks taken by		
		HSR Company	Government	Others
before completion	Land acquisition risks		✓	
	Resettlement risks		✓	
	Planning risks		✓	
	Cost overruns (System, infrastructure)		✓	Contractors
	Cost overruns (Rolling stocks)	✓		
	Time overruns (System, infrastructure)		✓	Contractors
	Time overruns (Rolling stocks)	✓		
	Technical risks (System, infrastructure)		✓	Contractors
	Technical risks (Rolling stocks)	✓		
	Sponsor risks	✓		
after completion	Operational service risks	✓		
	Maintenance risks	✓		
	Demand risks	✓	✓	

	Types of Risks	Risks taken by		
		HSR Company	Government	Others
	Foreign exchange risks		✓	
Common	Institutional risks		✓	
	Force majeure risks		✓	
	Environmental risks	✓		

Source: JICA Study Team.

3) Estimated Profitability of HSR Company

11.7 This section estimate the profitability of HSR Company for both (i) Hanoi – Binh Section and (ii) HCMC – Nha Trang Sections, based on the implementing structure mentioned above. HSR Company is responsible for the initial and additional investment for the rolling stocks, and the government is for the traffic control system and the infrastructure. HSR Company carries out the maintenance of the rolling stocks, system and infrastructure, but the government will allocate the budget for the maintenance of infrastructure, following the current arrangement. The government allocates the budget for the maintenance of infrastructure in the predetermined fixed amount, and HSR Company carries out the maintenance works by its own responsibilities. Please note that the government is supposed to provide additional budget for maintenance of the infrastructure, when the infrastructure had unexpected damages, such as by natural disasters.

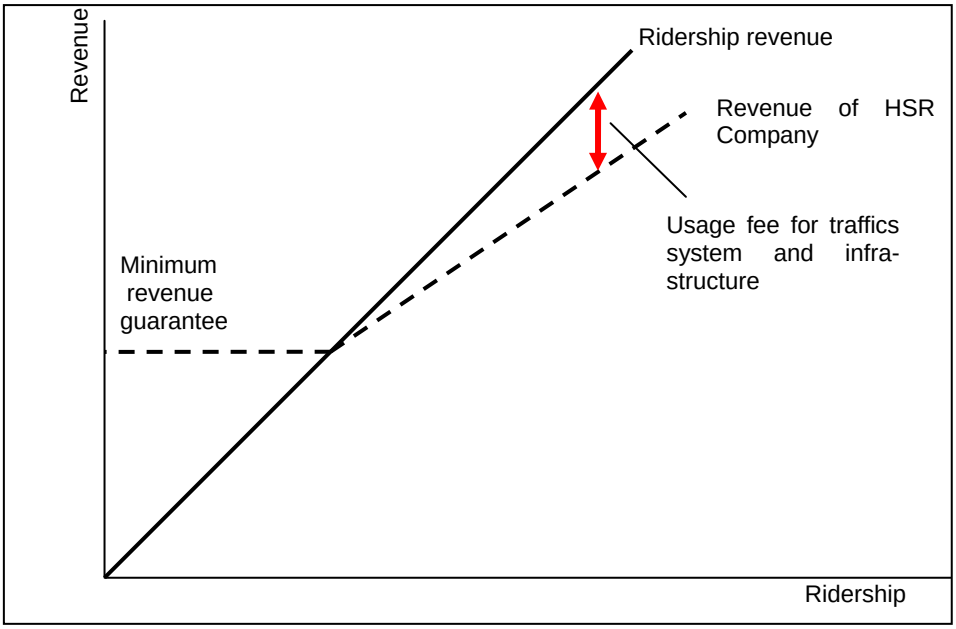
11.8 The profitability of the Hanoi-Vinh section is expected not to be very high, no matter if the maintenance budget for the infrastructure is allocated by the government. Due to the accumulated loss of HSR Company after the beginning of the commercial operations, the financial responsibilities of the shareholders are rather large. Therefore, financial supports by the government through revenue guarantee are necessary for this section. Suppose the government secures 10% operation profits of HSR Company by revenue guarantee, the financial supports by government will be US$ 269.1 million in total. By the financial supports of the government, HSR Company can clear the accumulated loss in the seventh year, and starts paying dividends to shareholders. The estimated IRR on equity is 6.6%, and this will be rather too low for investors.

11.9 The HCMC-Nha Trang section is expected to achieve higher profitability than the Hanoi-Vinh section. Although the accumulated loss is expected to reach at US$ 119.4 million, this can be cleared in the fourth year after the beginning of the commercial operations. The expected IRR on equity for this section will be 13.0%, given that the government provides the maintenance budget for the infrastructure and the financial supports through revenue guarantee.

4) Government Guarantee

11.10 The government is required to provide risk mitigation measures to HSR Company, so that HSR Company can avoid taking too heavy demand risks. If the ridership of high speed railway, especially at the beginning of the commercial operations, is much smaller than the expectations, HSR Company will post huge losses and face difficulties in sustaining operations.

11.11 In addition to the revenue guarantee or loss compensations, another measure to mitigate such demand risks is bargaining the system and infrastructure usage fees. HSR Company start paying usage fees when it started making sufficient profits.



Source: JICA Study Team.

Figure 11.2 Minimum Revenue Guarantee

Annex to Chapter 11

Table 11.2 Hanoi – Vinh Section Estimated Revenue (with revenue guarantee)

Income Statement		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
A Operating income					162.5	174.8	187.9	202.0	217.2	312.2	433.5	596.7
B Operating expenses					177.6	179.8	187.1	188.9	190.8	214.3	243.0	288.2
- Maintenance of Infrastructure					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
- Depreciation of rolling stock					37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7
C EBITDA: Earning before Interest, Tax and Depreciation)					22.7	32.7	38.5	50.8	64.1	135.6	228.2	346.2
D EBIT: Earning before Interest and tax (after depreciation)					-15.0	-5.0	0.8	13.1	26.5	97.9	190.5	308.5
E Interest Expenses		13.7	41.0	68.3	58.5	48.8	39.0	29.3	19.5			
F Net profit (after interest and depreciation) before tax		-13.7	-41.0	-68.3	-73.5	-53.8	-38.2	-16.1	6.9	97.9	190.5	308.5
G Rental Fee: Profit base x Rate	30%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.4	57.1	92.5
H Net profit (before subsidy, after rental fee)		-13.7	-41.0	-68.3	-73.5	-53.8	-38.2	-16.1	6.9	68.6	133.3	215.9
Corporate tax	25%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	17.1	33.3	54.0
Financial support by the government		0.0	0.0	0.0	89.8	71.3	57.0	36.3	14.8	0.0	0.0	0.0
K Net profit after tax (after subsidy)		-13.7	-41.0	-68.3	16.3	17.5	18.8	20.2	20.0	51.4	100.0	162.0
L Dividend	50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.7	50.0	81.0

Financing		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
Repayment (Years)	7				139.3	139.3	139.3	139.3	139.3	0.0	0.0	0.0
Loan Balance		195.0	585.1	975.2	835.9	696.6	557.3	417.9	278.6	0.0	0.0	0.0
Interest (Interbank rate + Margin)	7%	13.7	41.0	68.3	58.5	48.8	39.0	29.3	19.5	0.0	0.0	0.0

Dividend		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
Surplus / Deficit (before dividend)		-13.7	-54.6	-122.9	-106.6	-89.1	-70.4	-50.1	-30.2	102.8	326.6	691.7
Dividend	50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.7	50.0	81.0
Surplus / Defivit (after dividend)		-13.7	-54.6	-122.9	-106.6	-89.1	-70.4	-50.1	-30.2	77.1	276.6	610.7

Equity		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
Cash outflow		48.8	97.5	97.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cash inflow		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.7	50.0	81.0
Net Cash Flow		-48.8	-97.5	-97.5	0.0	0.0	0.0	0.0	0.0	25.7	50.0	81.0
Equity IRR	6.6%											

Table 11.3 HCMC – Nha Trang Section Estimated Revenue (with revenue guarantee)

	Income Statement		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
A	Operating income					237.2	255.0	274.2	294.8	317.0	455.5	632.5	870.6
B	Operating expenses					193.2	201.9	204.0	206.2	214.7	241.8	282.7	347.7
	- Maintenance of Infrastructure					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	- Depreciation of rolling stock					36.1	36.1	36.1	36.1	36.1	36.1	36.1	36.1
C	EBITDA: Earning before Interest, Tax and Depreciation)					80.0	89.1	106.2	124.6	138.3	249.8	385.9	559.0
D	EBIT: Earning before Interest and tax (after depreciation)					43.9	53.1	70.1	88.6	102.3	213.8	349.8	523.0
E	Interest Expenses		13.3	39.8	66.4	56.9	47.4	37.9	28.4	19.0			
F	Net profit (after interest and depreciation) before tax		-13.3	-39.8	-66.4	-12.9	5.7	32.2	60.1	83.3	213.8	349.8	523.0
G	Rental Fee: Profit base x Rate	30%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.1	104.9	156.9
	- Profit base = Profit before subsidy - repayment		-13.3	-39.8	-66.4	-148.4	-129.8	-103.2	-75.3	-52.1	213.8	349.8	523.0
H	Net profit (before subsidy, after rental fee)		-13.3	-39.8	-66.4	-12.9	5.7	32.2	60.1	83.3	149.6	244.9	366.1
	Corporate tax	25%	0.0	0.0	0.0	0.0	1.4	8.1	15.0	20.8	37.4	61.2	91.5
	Financial support by the government		0.0	0.0	0.0	36.6	19.8	0.0	0.0	0.0	0.0	0.0	0.0
K	Net profixt after tax (after subsidy)		-13.3	-39.8	-66.4	23.7	24.1	24.2	45.1	62.5	112.2	183.7	274.6
L	Dividend	50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.1	56.1	91.8	137.3

Financing		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
Repayment (Years)	7				135.4	135.4	135.4	135.4	135.4	0.0	0.0	0.0
Loan Balance		189.6	568.8	948.0	812.6	677.1	541.7	406.3	270.9	0.0	0.0	0.0
Interest (Interbank rate + Margin)	7%	13.3	39.8	66.4	56.9	47.4	37.9	28.4	19.0	0.0	0.0	0.0

Dividend		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
Surplus / Deficit (before dividend)		-13.3	-53.1	-119.4	-95.7	-71.7	-47.5	-2.4	60.1	329.1	749.7	1,375.5
Dividend	50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.1	56.1	91.8	137.3
Surplus / Deficit (after dividend)		-13.3	-53.1	-119.4	-95.7	-71.7	-47.5	-2.4	30.1	272.9	657.9	1,238.2

Equity		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20
Cash outflow		47.4	94.8	94.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cash iniflow		0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.1	56.1	91.8	137.3
Net Cash Flow		-47.4	-94.8	-94.8	0.0	0.0	0.0	0.0	30.1	56.1	91.8	137.3
Equity IRR	13.0%											

12 OPERATION MANAGEMENT AND HUMAN RESOURCE DEVELOPMENT

1) Major Considerations

12.1 The following points were considered upon proposing an operation and management institution for Vietnam HSR development:

(a) Railway is a huge comprehensive system of tunnels, bridges, roadbeds and tracks, rolling stocks, substations, telecommunication and signals, human resources such as operators and commanders, etc. The HSR is especially characteristic as a total system in which each technology is interrelated, therefore the need for an operation and management institution which enables the coordination of such various technologies and elements is crucial.

(b) Upon considering the operation management and human resource development for Vietnam HSR, firstly the current institutional structure of Vietnam Railways and its level was studied. Then, main considerations from an institutional aspect for HSR operation and acquirement of needed technology were analyzed.

(c) Regarding the operation management institution of HSR, regardless of its institutional position, its operation shall be independent from that of the existing railway, and field work shall also be controlled directly by the HSR institution (HSR Company). Acquirement of HSR technology and human resource development (methodology, order, timing, etc.) was proposed from the viewpoint to minimize the gap in the shortest possible time between the current technology level of Vietnam Railways and the level of technology needed for HSR operation.

(d) Practices in Japan and Taiwan were referred to upon proposal.

2) Institution for HSR Operation

12.2 The main points considered upon proposing the HSR Company were, among others, (1) safety, (2) disaster management, (3) education and human resource development, (4) IT system, and (5) relative institutions such as material procurement. The proposed size of the company are (1) 170 staff in headquarters, (2) 2,400 staff in Hanoi Branch, (3) 2,700 staff in HCMC Branch, totaling to 5,300 staff. (see Figure 12.1)

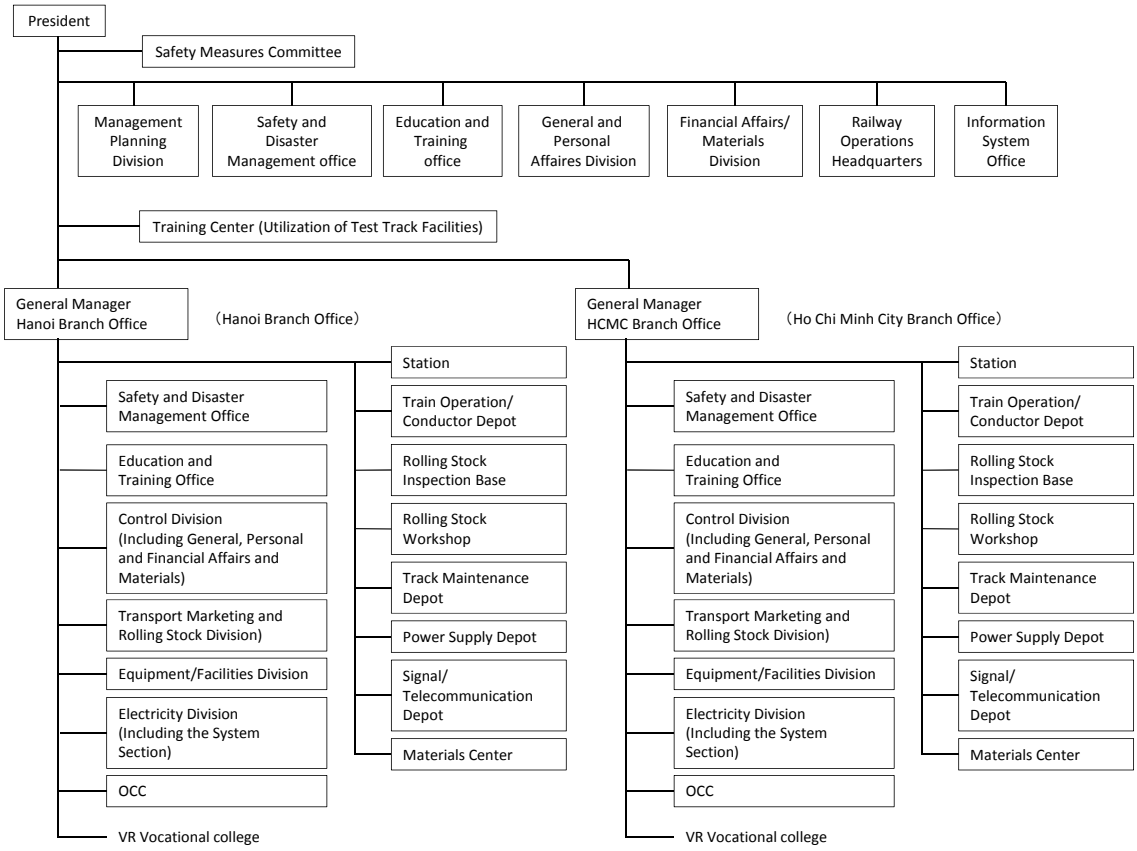
12.3 Institutional arrangement during HSR preparation and construction were proposed as follows:

(a) The construction of HSR is a huge project in which greatly affects the national economy of Vietnam. Therefore, regardless of the form of HSR Company and its position, the preparatory institution for HSR shall be placed within the government, preferably under MOT. This is because due to long periods expected to be needed for construction preparation to completion, it is difficult for the HSR Company to shoulder the burden for such long periods. In addition, approval of urban plans and establishment of relative laws and institutions regarding technical standards for HSR will be needed during this preparation period.

(b) Long periods of training will be needed to adequately transfer technology to the Vietnam side and complete sufficient training. Therefore, the establishment of an initial section (test track) for training will be essential. This initial section (test track) con-

notes training for technology transfer of both HSR construction, and operation & maintenance after HSR completion – thus shall be managed by the Government.

(c) Institutional arrangement for partial commercial operation based on initial section (test track) should be decided upon the size of the institution and staff number (initial section (test track) is expected to be less than 50km). A rough estimate is around 500 staff in total, including that of the headquarters.



Source: JICA Study Team.

Figure 12.1 Operational Structure of HSR Company

3) Human Resource Development

12.4 In order to raise the level of technology from the current level to that suitable for HSR operation, it is important to acquire technology for urban railways at an early stage, and to construct the initial section (test track) so that training for related HSR staff can be done as soon as possible. During the construction period for the initial section (test track), technology transfer for construction should be considered. During the 3 year period of initial section (test track) operation, nurturing of (1) core staff in which are expected to become trainers for future HSR training courses, and (2) preparatory staff for partial commercial operation based on initial section (test track), will be needed totaling to around 600 trained staff.

12.5 There are 7 years from partial commercial operation based on initial section (test track) to the commercial operation for north and south priority sections, and a total of 4,700 staff must be nurtured. Therefore, after the operation of the initial section (test track), this should be utilized as a training center to acquire HSR technology. Training buildings and facilities, training materials, track and wire inspection equipment, etc. will be provided for the initial section (test track).

13 INSTITUTIONAL DEVELOPMENT

1) Procedure for Railway Construction in Vietnam

13.1 Current situation concerning to railway construction in Vietnam are as follows,

(a) **Land use plan:** There are three laws on the land utilization in Vietnam: land law, construction law and urban planning law. Ministries in charge are Ministries of Construction, Natural Resources and Environment, and Planning and Investment.

(b) **Procedure of land acquisition for public work:** Lands shall be acquired in accordance with Land and Railway Acts, and actions shall be lead by the People's Committee. After approving a project, the government sets the Committee for Land Acquisition in the District People's Committee to create a plan for land acquisition. In case the land-owner has a complaint in land purchase, he/she is allowed to appeal it to the district people's committee. After determining a project, the project promoter makes it widely known. In case consensus with a house owner cannot be established through negotiation, the project promoter can resort to compulsory execution, in that he/she is allowed to move the house owner to the house proposed as indemnification.

(c) **The role of Ministries for development plans:** The Ministry of Construction (MOC), a competent Ministry for city planning schemes, is in charge of the parts of the projects under government control. The people's committee at each level implements the city planning schemes comprehensively in each local area though limited to overall plans. The Ministry of Transport (MOT) is in charge of the discussions on the construction of infrastructures related to public transport.

(d) **Procedure for railway construction work:** The Ministry of Transport implements the plans of railway construction work. The railway master plan is created by MOT and not by VNRA. VR prepares railway construction plans based on the master plan of the government. The projects to be submitted to the National Assembly require a prefeasibility study before submission thereto. The construction of a new railway is assigned to VNRA and remodeling of existing railways is to VR in principle. The project promoter (VR, VNRA) requires the local people's committee to purchase the lands for the railway.

2) Necessary Task for Introducing High Speed Railway

13.2 Necessary task for introducing high speed railway is as follows;

(a) **Establishment of the organizations to implement High-Speed Railways:** The hierarchical structure composed of the Ministry of Transport versus VNRA or VR head office versus affiliated railway operating companies makes the subject responsible for railway operation ambiguous. There are the VR head office and a number of affiliated companies with each having an independent personal management system. The head office, Vietnam Railway Company, is not directly related to train operation or commercial pursuits. Therefore, it is rather doubtful to what extent the worksite problems or customers' requirements are reflected in its policies. The high speed railway is different from the existing railway in facilities and operation method. The Shinkansen General Bureau was established for the first high speed railway operation in Japan. Thus, it is desirable to establish a high-speed railway operating subject having consistent responsibility to comprise the whole of planning, operation, commercial pursuits and maintenance.

(b) **Necessity to formulate railway comprehensive Master Plan:** In the Hanoi city, projects of the urban railway lines are now in progress. Although the concepts of VR construction plans are proposed in fragments, there are no plans currently in chronological harmony and linked with other projects. In constructing a railway, the project promoter shall prepare a comprehensive railway construction plan that is in conformity not only with related railways but also with transit facilities, grade-separated crossings, roads and other public facilities construction plans.

First of all, Vietnam shall create a comprehensive railway master plan that is in conformity with road construction and other public project plans from the viewpoint of the construction work schedule, based on which Vietnam shall specify, release to the public and authorize the lands required for public projects in the future.

The railway operator shall join the railway project planning with keeping responsibility and competence. To make railways sustainable, a system is required to sufficiently discuss operational problems at the stage of construction and reflect the results thereof in the completed railways.

(c) **Introducing of high speed railway council and authorize of comprehensive land use plan:** In Vietnam, project plans are formulated in accordance with the law on city planning schemes and others. Plans of railways, city construction, and private sector development are drawn up by consultants individually on request, consultants are supposed to survey other plans they are related to for the purpose of coordination. Due to the lack of comprehensive and transversal control ability, however, planners cannot perform coordination between different plans. It is essential that Vietnam improve the capability of planners to deal with widely-range services, while eliminating such institutional problems as the ill effects of vertically split administration and inappropriate transversal communications between divisions/sections. It is desirable, therefore, to adopt a system to eventually summarize all public land utilization plans and rules thereon in a sheet of city planning scheme after coordinated in advance between different divisions/sections by a deliberating council included stakeholders and widely disseminate its knowledge among people in the same way as in Japan.

(d) **High speed railway act enactment:** To realize a high-speed railway in Vietnam, it is desirable to institute laws corresponding to the Nationwide Shinkansen Construction Law in Japan. This law shall stipulate the definition of high speed railway, the coordination in advance regarding the procedure to determine high-speed railway construction plans, sections, periods and standards for construction, methods to secure budgets and the subjects of construction and business promotion. It is also desired to systematize the installation of a deliberative council in order to realize and authorize railway construction plans by incorporating the opinion of third parties.

(e) **Noise restriction:** Regulations on the noise emitted from non-stationary sources, such as that of railways, shall be established including the prescriptions on the measuring methods.

(f) **Railway certification:** There are no organizations currently to certify the safety of the equipment/facilities of urban or high-speed railways in Vietnam. To authenticate the safety of newly installed railway equipment/facilities and rolling stock, the Vietnamese government shall urgently train engineers and an organization for that purpose.

(g) **Improvement of the land acquisition system and Introduction of Land Readjustment/ Multi-Level Replotting and Land Expropriation Committee;** Following items shall be effective for improvement of land acquisition.

(i) Improvement of land acquisition institute and introduction of land readjustment /Multi level replotting

As a means to solve the land acquisition problem, reduced land replotting by readjustment or multi-level replotting in urban development is conceivable like in Japan. Vietnam is expected to adopt a system to produce public lands through readjustment when railways or roads are constructed in cities and make the gains from the development be enjoyed among the stakeholders in the related areas. If the concept of Promotion of integrated land development in metropolitan areas and railway line special measure Act in Japan is introduced, collective replotting to the lands for public projects through land readjustment scheme will become possible. Furthermore, internalization of developmental gains will smoothly accelerate the projects for railway construction and development of residential areas.

(ii) Introduction of a System of Land Expropriation Committee

In actuality, land purchasing negotiations often have a difficult sailing. This requires a standard on the fair amount of indemnification and a system to authorize the evaluation thereof. To obtain the consent of land owners, a third party organization, which is deemed to be fair and square, shall be established where the final amount of indemnification is to be determined. In this regard, Vietnam shall refer to the concept of land utilization for public purposes and the procedure of implementation stipulated in the German land expropriation law. A land expropriation committee composed of third party members farsighted for land prices, who are distant from administrative authorities or project owners, like the one in Japan, shall be thought as effective to solve the problems involved in non-compulsory land purchasing negotiations.

3) Schedule of Institution Preparation

13.3 Legal items required to implement public projects are all specified in relevant laws in Vietnam. As the laws required before the inauguration of the high-speed railway project, Vietnam shall enact a law on the procedure to construct high-speed railways by referring to the nation-wide Shinkansen network construction law in Japan and adopt the rules on the railway construction deliberating council by referring to the deliberating councils for building social capitals and for transport policies in Japan in order to formulate fair and square plans to construct high-speed railways and perform verification of their sustainability.

13.4 Besides the laws on the construction of high-speed railways, the laws/provisions that are immediately required include the Land Readjustment Act, multi-level replotting on Urban Redevelopment Act and provisions on the method to evaluate the fair amounts of indemnification of the compulsory expropriation procedure in the Land Law. As a measure required other than the above, Vietnam shall desirably reinforce the control of the development/ utilization of land and newly built architectures in accordance with city planning schemes and discuss the measure for fairness of the evaluation of land purchasing prices to guarantee the impartiality between the transferred and remained land owners and a taxation system for the beneficiaries of developmental gains.

14 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

1) Process of Environmental and Social Considerations

14.1 The objectives of the environmental and social considerations of this Study are:

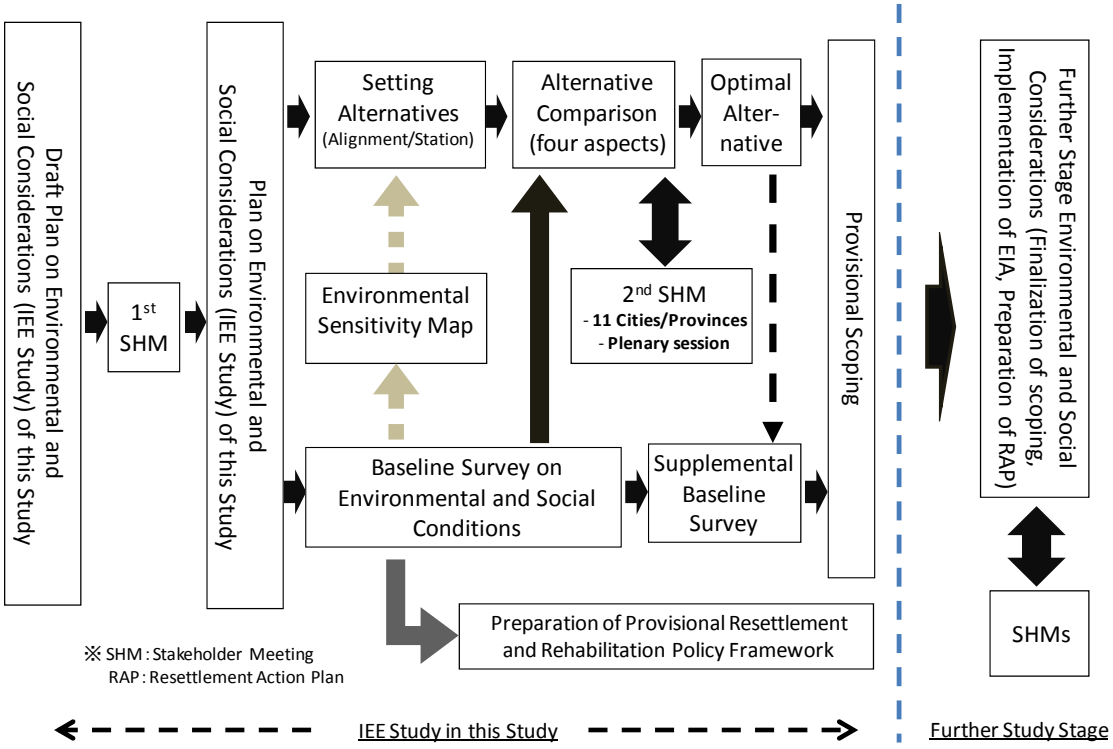
(a) To examine and incorporate alternatives or mitigation measures into the project planning in order to avoid or minimize adverse impacts;

(b) To propose important environmental and social considerations items to be studied in the subsequent stage of a full-scale EIA;

(c) To propose appropriate resettlement and rehabilitation policy framework for further stage of land acquisition process, and;

(d) To form a common understanding of the environmental and social issues confronting the Projects among the wide range of stakeholders.

14.2 In this study, an IEE study consisting of a baseline survey in provinces and cities along the proposed alignments for priority sections and a comparative study of alternatives on the HSR alignments and station locations was carried out. This was followed by scoping for the selected optimal alignment in order to clarify potentially significant environmental and social impacts by rating the degree of significance. Resettlement and rehabilitation policy framework (RRPF) has also been drafted in this study. RRPF contains basic policy and information which should be utilized for the preparation of an official Compensation, Support and Resttlement (CSR) Plan and Resettlement Action Plan (RAP) in the future after authorization of the projects.



Source: JICA Study Team.

Figure 14.1 Overall Flow of Environmental and Social Considerations in the Study

2) Conduct of Baseline Survey

14.3 The following activities were conducted for the baseline survey for environment and social considerations:

(a) **Review of past studies:** Analysis and results of environmental and social considerations derived from past studies of HSR (VITRANSS2, Pre F/S, KOICA) were reviewed.

(b) **Collection of secondary information:** Questionnaires were sent to each province and city and direct interview was also conducted, and secondary information regarding natural environment, living environment, and social environment were collected and reviewed.

(c) **Conduct of field reconnaissance:** Field reconnaissance was conducted along the proposed alignments.

(d) **Formulation of Environment Sensitivity Map:** A set of environment sensitivity maps was formulated in order to identify the potentially sensitive areas that may require environmental and social considerations.

3) Selection of Optimal Alternative

14.4 A comprehensive comparison of alternatives in accordance with the JICA Guidelines for Environmental and Social Considerations[1] was conducted. Four aspects, i.e., convenience and integrated development, environmental and social considerations (natural environment, living environment, social environment), high-speed serviceability, and economical efficiency, were taken into consideration for comparison of the alternatives including "Zero Option" i.e., the without HSR projects case. A series of stakeholder meetings were held at each province and city where the HSR alignment is proposed and plenary sessions were conducted in order to provide opportunities to exchange information and opinions on the alternatives. Finally, through the above exercises, comments, opinions and ideas received from stakeholders were consolidated and reflected on the HSR alignment and station location plan. The optimal alignment was then determined and selected.

14.5 For the selection of the optimal alternative, the following three initial alternatives of the alignment and station locations, and also "Zero Option" were set. These alternatives were compared based on the aspects and indicators mentioned above.

Table 14.1 Initial Set of Alternatives

Alternative	Characteristics of Alternatives	Station Location	Alignment	Structure
Alternative 1 (Alt1)	Station location and alignment based on this JICA study	In the urban area with integrated development in and around station area, connected with the existing railway	Minimum Curve Radius =6,000m	To consider the cost efficient balance of viaduct and embankment,
Alternative 2 (Alt2):	Station location and alignment based on Pre-FS in 2009 (submitted to the National Assembly)	In the urban area, not necessarily connected with the existing railway	Minimum Curve Radius =6,000m	Free to choose alignment by application more of elevated structures
Alternative 3 (Alt3):	Station location and alignment based on KOICA study in 2007	In suburban area avoiding existing city area, no connection with the existing railway	Minimum Curve Radius =5,000m	To reduce construction cost by choosing the alignment by embankment

Source: JICA Study Team

14.6 The set of initial alternatives shown were discussed among stakeholders during

[1] April 2004 and April 2010.

the stakeholder meetings conducted in each city/ province (see the outline of meetings in section 7 of this chapter). Based on the discussions held, the initial alternative 1 was revised reflecting comments from stakeholders and the comparative analysis of the alternatives were conducted again. The overall evaluation showed that Alternative 1 (revised) is the most optimal one (see Table 14.2).

Table 14.2 Result of Comparative Analysis

Section	Aspects/ Items	Alt. 1 (revised)	Alt. 2	Alt. 3	Zero Option
North Section	OVERALL EVALUATION	A	B	C	D
	1) Convenience and Integrated Development	A	B	C	D
	2) Environmental and Social Considerations	A	B	C	D
	2) – 1 Natural Environment	(B)	(C)	(C)	(C)
	2) – 2 Living Environment	(A)	(B)	(A)	(D)
	2) – 3 Social Environment	(B)	(C)	(D)	(A)
	3) High Speed Serviceability	A	B	C	D
	4) Economical Efficiency	B	C	B	C
South Section	OVERALL EVALUATION	A	B	D	D
	1) Convenience and Integrated Development	A	B	C	D
	2) Environmental and Social Considerations	A	B	C	D
	2) – 1 Natural Environment	(A)	(A)	(D)	(C)
	2) – 2 Living Environment	(A)	(B)	(A)	(D)
	2) – 3 Social Environment	(A)	(D)	(C)	(C)
	3) High Speed Serviceability	A	B	C	D
	4) Economical Efficiency	B	C	B	C

Note: A-Better, B-Good, C-Fair, D-No advantage
Source: JICA Study Team

4) Conduct of Scoping

14.7 Based on the JICA Guidelines for Environmental and Social Considerations, provisional scoping was carried out for the selected optimal alternative for both the north and the south priority sections. This forms part of the IEE study in order to clarify a range of significant and potentially significant environmental and social impacts which need to be assessed in detail in subsequent EIA study.

14.8 Provisional scoping was conducted for pre-construction, construction, and operation stages. The preliminary scoped items are shown in four categories, namely natural environment, living environment, social environment, and others (see Table 14.3). Based on the provisional results of this scoping, measures to mitigate environmental and social impacts, monitoring framework, and technical requirements of assessment for the EIA to be conducted in the future were drafted.

Table 14.3 Provisional Scoped Items

Category	Scoped Items (Draft)	
Natural Environment	• Topography • Soil erosion • Hydrology • Ground water	• Ecosystem, flora, fauna, biodiversity • Protected areas/ forest • Landscape • Natural disasters
Living Environment	• Air pollution • Water pollution • Soil contamination • Noise/ vibration	• Low frequency noise/ micro-pressure wave • Wave obstruction • Sunshine obstruction • Wastes/ hazardous waste
Social Environment	• Involuntary resettlement • Land use • Utilization of local resources • General, regional/city plans • Social institutions and local decision-making institutions • Social infrastructure and services • Local economy and livelihood • Unequal distribution of benefit and damage • Local conflicts of interest • Water usage, water rights and communal rights	• Cultural and historical heritages • Religious facilities • Sensitive facilities (e.g. hospital, school, precision machine factory) • Poor people • Ethnic minorities/ indigenous people • Gender • Public health (sanitation and infectious diseases) • Occupational health and safety (OHS)
Others	• Accidents	• Climate change

Source: JICA Study Team

5) Provisional Study of Measures to Mitigate Adverse Environmental Impacts from HSR

14.9 Railway noise and vibration pollution and tunnel micro-pressure wave are main adverse environmental impacts from HSR. The following measures are tentatively proposed in this study to mitigate such effects:

(a) **Railway noise pollution:** By adhering to international practices, an equivalent sound level of 60dB (A) for daytime and 55dB (A) for nighttime is proposed as provisional target levels. Proposed main countermeasures include covering of vehicle seam parts, adoption of low-noise pantographs and the placement of sound proof walls. If the preconditions remain as those assumed for the opening[2] of the HSR operation, a 1m-tall sound proof wall would be necessary.

(b) **Railway vibration pollution:** 70dB at peak level is proposed as a provisional target level. Proposed main countermeasures include lightening of rolling stocks, adoption of long rail and thorough maintenance of the rail.

(c) **Tunnel micro-pressure wave:** By reflecting on Japanese experiences, under 50Pa 20m away from the exit of the tunnel is proposed as a provisional target level. In order to meet this target, adoption of log-nose type head to rolling stocks and the placement of tunnel entrance buffering hood is proposed.

[2] Commercial operation at 320 km/h, 10 train sets and 69 laps per day.

6) GHGs Emission Reduction by HSR

14.10 GHGs emission reduction by HSR was also analysed. Two cases were compared, i.e., “with” and “without” HSR projects cases. The results indicate that approximately annual 135kt reduction of CO_2 is expected in 2030.

7) Conduct of Stakeholder Meetings

14.11 In this study, a series of stakeholder meetings was conducted in order to collect information and opinions from stakeholders to be reflected on the HSR planning. A total of 2 rounds of meetings were conducted in this study. The outline for each of the meeting stage is shown in Table 14.4.

Table 14.4 Outline of Stakeholder Meetings

Stage	Targets	Objective
Planning for Environmental and Social Considerations	Central Government, Provincial Government, Academia, others	• Promotion of understanding of contents of HSR and its impacts • Explanation of methodology of environmental and social considerations
Conduct of Alternative Comparison	Central Government, Provincial Government, Academia, others	• Comparison of alternatives (station locations and alignment)

Source: JICA Study Team.

8) Preparation of Resettlement and Rehabilitation Policy Framework

14.12 Based on the JICA Guidelines for Environmental and Social Considerations and the World Bank Safeguard Policy OP 4.12 (resettlement), a RRPF was formulated as a basis for the official CSR plan and RAP in the future after authorization is given for the projects.

(a) **Eligibility and entitlement of compensation and rehabilitation assistance:** Either the issuance date of the Decision regarding land acquisition from each province or the starting date of the census can be considered as the cut-off date (whichever is earlier), and those who are acknowledged for incurring losses of assets or for having severe effects to their livelihoods due to the projects are recorded to receive compensation and assistance. There will also be assistance for illegal occupants as well.

(b) **Compensation at replacement cost:** According to Vietnam laws and standards, compensation will be based on the official price indicated in the Decision regarding compensation fee. However, in the case that there is a gap between the official price and the market price, the official price will be adjusted based on the market price. Full replacement cost must be ensured if the HSR projects is planned to be funded by donor agencies.

(c) **Grievance redress:** All project affected people have the right to complain and express grievances about the results of the land acquisition and resettlement including compensation if this is not agreeable to them. This can be expressed through the District People’s Committee for resolution within 45 days. Since contacting the nearest local authority may be more convenient, it is proposed that the Commune People’s Committee be authorized to convey or lodge the complaints to the higher authorities as well, in addition to the current practice.

(d) **Monitoring system for land acquisition:** It is proposed that both internal and independent monitoring be conducted for land acquisition, resettlement and rehabilitation. Internal monitoring is the activity wherein the implementing agency confirms the implementation and issues regarding land acquisition follow the prepared RAP. On the

other hand, independent monitoring is conducted by a third-party institution for the same purpose through information collection and interviews to relative institutions and affected people.

(e) **Land acquisition impact:** The provisional estimation of land acquisition impacts are shown in Table 14.5.

Table 14.5 Provisional Estimation of Land Acquisition Impacts

Section	Affected agricultural area (ha)	Affected forest area (ha)	Affected Residential area (ha)	Affected buildings (no.)	Affected households (no.)
North	782	71	181	1,291	4,431
South	1,219	155	107	1,249	6,125

Source: JICA Study Team.

9) Further Steps and Recommendations

(1) Implementation of a Full-Scale Environmental Impact Assessment Study (EIA)

14.13 The Law on Environmental Protection and Decree No: 29/2011/ND-CP stipulates projects where EIA is required. The HSR projects are subject to this regulation. On the other hand, donor agencies have their respective guidelines or policies regarding environmental and social considerations or safeguards. If the HSR projects strive to procure funds from such agencies, the preparation of a full-scale EIA must be prepared to meet the agencies' requirements including holding stakeholders meetings.

(2) Necessary Actions for Land Acquisition, Resettlement and Rehabilitation

14.14 Derivative decrees and circulars are issued under the Law on Land for land acquisition, compensation, resettlement, etc. Moreover, it is noted in Decree No.69/2009/ND-CP that a CSR plan needs to be prepared and approved for land acquisition. However as explained in the preceding paragraph, the formulation of a detailed and comprehensive RAP will be indispensable to meet the funding agencies' requirements. In order to provide compensation at full replacement cost, procedures shown in Table 14.6 needs to be taken.

Table 14.6 Procedure for Compensation at Full Replacement Cost

Items	Planning Stage	Contents of Plan
Census	Post project approval upon decision of project area	• All PAP[1)]s • Confirmation of household size and structure
Inventory of Asset Loss	Post project approval upon decision of project area	• All PAPs • Confirmation of affected land/ assets of PAP and community
Socio-economic Survey	Post project approval upon decision of project area	• 25% of PAPs • Confirmation of properties and household income
Replacement Cost Survey	Post project approval upon decision of project area	• Confirmation of latest official and market price for land in project area
Preparation of RAP	Post project approval	• Impacts due to land acquisition, eligibility and entitlement, grievance mechanism, institutional framework, schedule and budget
Public Consultation Meetings	Upon formulation of draft RRP	• PAPs, Local Authorities • Basic explanation of RAP

Source: JICA Study Team.

1) PAP=Project Affected People

(3) Necessary Actions for Change of Forest Use Purposes for HSR Projects

14.15 Although the selected optimal alternative (alignment and station locations) has, as much as possible, avoided passing through or locating in special-use forest areas, still some sections or places had no recourse but to pass through some protection and pro-

duction forest areas. Therefore, according to existing relative regulations for forest protection and development such as Decree No.23/2006/ND-CP and its relevant circulars, HSR projects should take the necessary actions to comply with such laws and regulations for the changing of forest use purposes. This includes the preparation of a report on assessment of environmental impacts due to change of forest use purposes which would be covered by the EIA report based on Decree No.29/2011/ND-CP.

10) Recommendations

14.16 The following are recommended for the HSR projects to be implemented with due environmental and social considerations:

(a) Establishment of institutional and legal systems on railway noise and vibration by HSR projects;

(b) Establishment of compensation framework or guideline for electric wave interference and sunshine obstruction by HSR projects;

(c) Careful consideration of potential impacts by Natural Disaster in the HSR projects planning;

(d) Consideration of results of other EIA studies (Hanoi UMRT Line 1, Long Thanh International Airport, etc.);

(e) Establishment of strategic schemes to secure the project land (land readjustment, etc.);

(f) Further considerations for minimization of involuntary resettlement;

(g) Sufficient compensation for resettlement and rehabilitation;

(h) Careful considerations for indigenous people/ethnic minorities;

(i) Implementation of Social Impact Assessment (SIA) study;

(j) Continuous and sufficient consultations with local stakeholders and vulnerable social groups at least at commune level; and

(k) Implementation of environmental monitoring and utilization of its results.

15 IMPLEMENTATION PLAN

1) Roadmap for Development of North-South High-Speed Railway

15.1 Based on the analysis made in the Study, the main considerations in formulating the roadmap for development of North-South High-Speed Railway are as follows:

(i) To meet future transport demand of the north-south corridor;

(ii) To ensure economic viability and implementation timing;

(iii) To promote integrated development with existing railway; and

(iv) To ensure good preparation before construction and operation of high-speed railway.

15.2 The characteristics of the proposed roadmap are as follows (see Figure 15.1):

(a) The initial section shall be completed by 2021 to conduct test runs and training. During the construction period of the initial section, technical transfer of construction technology and maintenance shall be fully conducted.

(b) Preparatory work such as organization and institutional development, funding arrangement, land acquisition, etc. shall be conducted simultaneously. Incorporation of HSR route and locations of stations in approved urban plan is also necessary to maximize the benefit of HSR and integrated urban development.

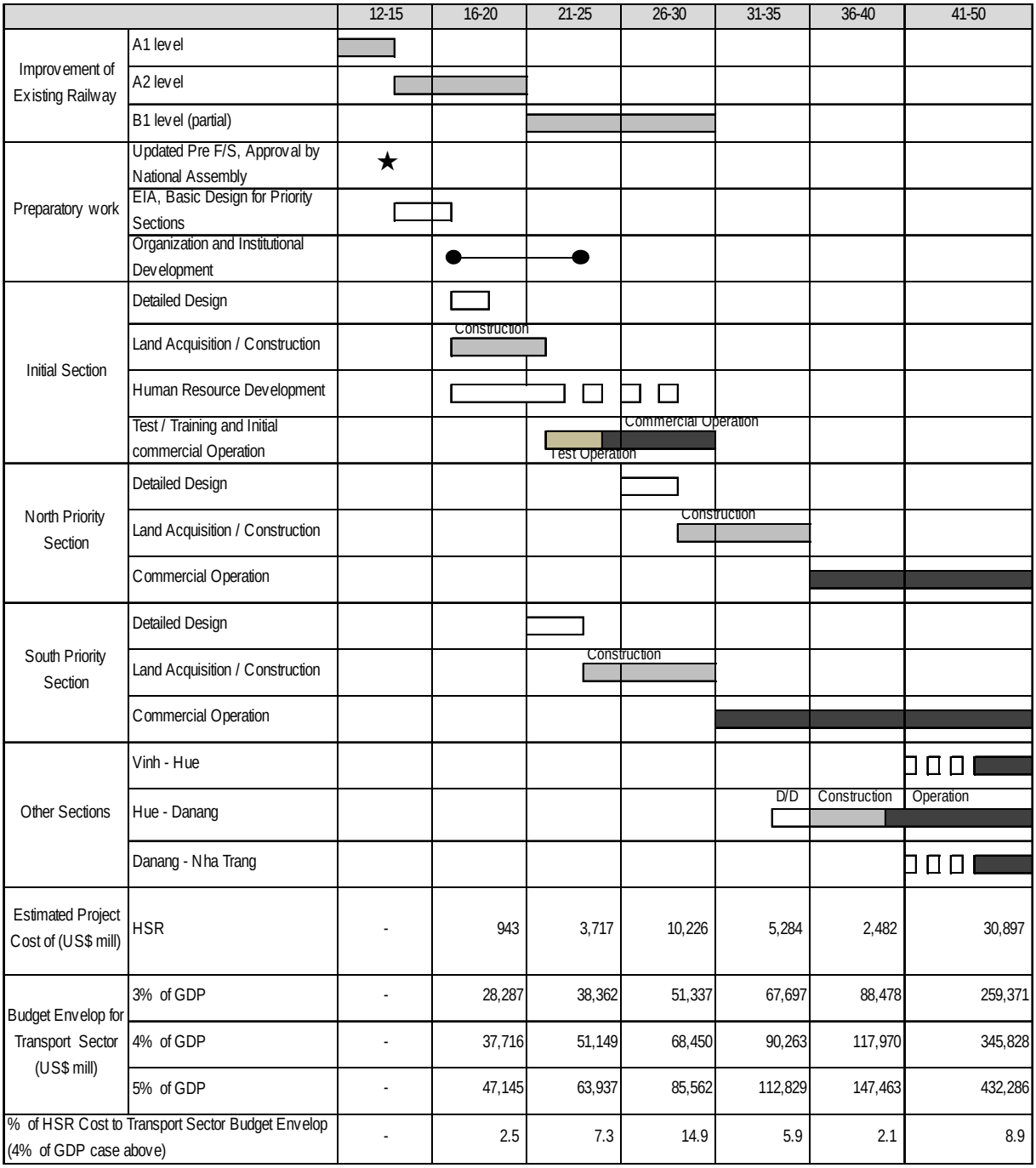
(c) The south section will be constructed first, and operation will commence in 2031. The north section will be constructed consequently to commence its operation in 2036.

(d) Hue-Danang section will commence its operation before 2040, and the remaining sections will be completed in the 2040s.

(e) It is conceived that the south is more suitable for the initial section (explained further in detail in the next section), however it is not necessarily needed to change the sequence of construction of priority sections.

(f) In the roadmap, the improvement of the existing railway is indicated along with HSR development. First A1 level improvement will be made, followed by A2 level development to be completed by around 2020. Then further upgrading for sections with high demand will be done, considering the progress of HSR development.

15.3 Based on this roadmap, the budget envelop for the transport sector will be estimated based on GDP and the % of HSR cost to this budget. (see Figure 15.1) As a result, the HSR cost to the budget envelop for the transport sector will be 7.3%, 14.9%, and 5.9% in 2021-25, 2026-30 and 2031-35, respectively. If the expected level of economic growth is to continue in the future, this is conceived as a realistic level of economic burden.



Estimated Project Cost of (US$ mill)	HSR	-	943	3,717	10,226	5,284	2,482	30,897
Budget Envelop for Transport Sector (US$ mill)	3% of GDP	-	28,287	38,362	51,337	67,697	88,478	259,371
	4% of GDP	-	37,716	51,149	68,450	90,263	117,970	345,828
	5% of GDP	-	47,145	63,937	85,562	112,829	147,463	432,286
% of HSR Cost to Transport Sector Budget Envelop (4% of GDP case above)		-	2.5	7.3	14.9	5.9	2.1	8.9

Source: JICA Study Team.
1) Average project cost for priority sections calculated by the JICA Study Team was used: 30.0US$ million/ km(average of north and south priority sections). In 2011 price. 1 USD=21,000 VND. GRDP was estimated based on revision made after the Communist Party National Congress XI (August 2008) to the latest “National Socio-Economic Development Plan, 2010-2015”, i.e. ’10-’20: 6.5%, ’20-’30: 6.0%, ’30-’40: 5.5%, ’40-’50: 5.0%.

Figure 15.1 Preliminary Roadmap for High-Speed Railway Development

2) Initial section (First Segment of HSR Priority Sections)

(a) Main Considerations

15.4 In order to pursue step-by-step development of HSR in Vietnam, the initial section is expected perform a significant role. It will have the following objectives:

(i) To provide an effective base for human resource development necessary for construction, operation and management of HSR based on actual system through the initial section.

(ii) To commence actual high-speed operation at early stage not only for training but also commercial purpose for experiences of the people and promoting social consensus on the HSR.

(iii) To provide inputs for preparation of necessary institutions such as regulations, technical norms and standards and other matters related to effective development of HSR.

15.5 Conditions that must be met by the initial section include following;

(i) A section of which land can easily be acquired should be selected to guarantee an early start of construction work;

(ii) The requirements for straight sections, curves, tunnels, bridges, route profile, ground facilities, and other conditions should be satisfied to allow collection of data for high-speed operation;

(iii) A distance of at least 30km or more to enable running at the maximum speed and acceleration/deceleration should be guaranteed to test the conditions of rolling stock, tracks[1], contact wires, and electric facilities (the first- and second-phase sections can be separated where necessary);

(iv) Adjacent areas should be acquired to serve as workshop and for inspection/repair facilities to fabricate carried-in cars, implement running tests, and maintain facilities;

(v) Staff accommodation for long periods is necessary for various tests and training;

(vi) For deepening the understanding of the people through promotions, initial sections are expected to be located near a big city.

(vii) It would be appropriate for initial sections to become a part of the revenue service line once commercial operations commence

(viii) The initial sections should be part of the North-South HSR line.

(ix) Project feasibility is high, such as high demand for commercial operation, easiness of land acquisition, etc.

(x) Possibilities to implement the project are high. For example, the project is incorporated to approved urban plans, land is available, coordination with other projects is ensured, etc.

(b) Candidate Initial Sections

15.6 From the above conditions, the two candidate initial sections are the following three sections (see Table 15.1):

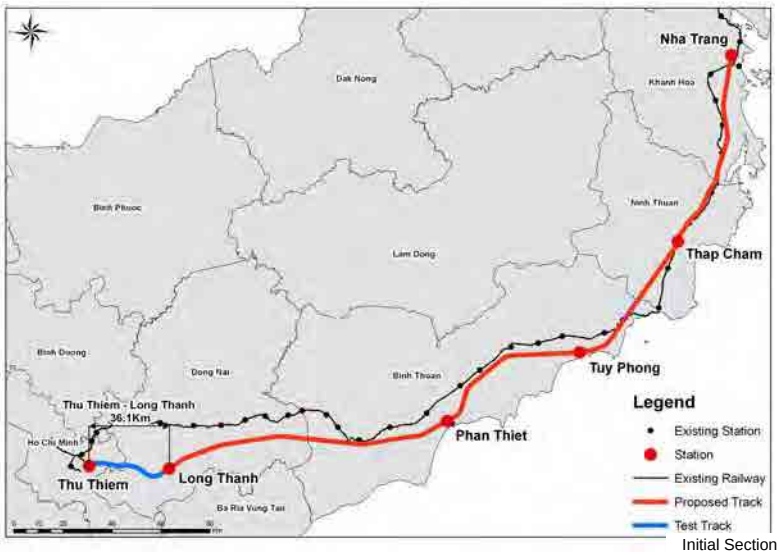
[1] The selection of ballast and slab tracks shall be decided after the operation of initial sections.

(a) **Ngoc Hoi – Phu Ly (45.6km):** This section is a part of the north priority section. It starts at the terminal station of Hanoi UMRT Line 1 and connects to the provincial capital of Ha Nam Province, Phu Ly Ciy with population of 80,000. This track can be widely used as a commuting line to travel to Hanoi City.

(b) **Thu Thiem – Long Thanh (36.1km):** This section connects two large-scale development projects, Thu Thiem New Town Development Plan and Long Thanh International Airport Plan. The alignment along this section is yet urbanized, so it will serve as an airport access line. However, in that case the extension of the urban railway to Thu Thiem Area will be needed.

Ngoc Hoi-Phu Ly Section

Thu Thiem-Long Thanh Section



Source: JICA Study Team.

Figure 15.2 Locations of Candidate Initial Sections

(c) Outline of Candidate Initial Sections

15.7 Hence the two candidate initial sections each have different characteristics, and the following criteria has been considered in order to consider the priority among the candidate sections: (i) satisfaction of technical requirements, (ii) training environment, (iii) demand, (iv) publicity, (v) regional development impact, (vi) investment cost, and (vii) others.

Table 15.1 Outline of Candidate Initial Sections

		Ngoc Hoi – Phu Ly	Thu Thiem – Long Thanh
Length (km)		45.6 km	36.1 km
Profile		• Connects UMRT Line 1 terminal station in Hanoi City to Phu Ly City, the capital city of Ha Nam Province (population of 80,000).	• Connects the new town in HCMC and the new Long Thanh International Airport (LTIA). • Plan for the extension of Line 2 of UMRT. • The estimated users of LTIA (passengers, pick-up and send-off, airport staff, etc.) total to 176,700/day in 2020 of which half will be shared by LTIA, the other half by Tan Son Nhat Airport. This figure will increase to 270,800 in 2030 of which likewise half will be shared by LTIA.
Infrastructure & System	Structure	Embankment: 11.8km Box Culvert: 0.2km Viaduct: 32.2km Bridge: 0.9km	Embankment: 5.6km Cut: 4.6km Box Culvert: 0.1km Viaduct: 23.4km Bridge: 1.6km
	Depot	Land is available. Area is planned at 12.2km from Ngoc Hoi Station, around 38ha. Structures and facilities will be established in proportion to the number of trains.	Land is available. Area is planned at 9.6km from Thu Thiem Station, around 32ha. Structures and facilities will be established in proportion to the number of trains.
	System	HSR specification proposed in Volume I Chapter 5.3 (p.5-86 onwards).	HSR specification proposed in Volume I Chapter 5.3 (p.5-86 onwards).
Rolling Stock and Operation		320 km/h 6 cars, 1 train set 1 -2 trains/ hour (commercial operation is possible)	320 km/h 6 cars, 1 train set 1 -2 trains/ hour (commercial operation is possible)
Human Resource Development Center		Training facility and machines will be provided in depots.	Training facility and machines will be provided in depots.
Environmental / Social Aspects		• Detailed study of EIA is needed. • Land allocated for HSR in Phu Ly City.	• Detailed study of EIA is needed.

Source: JICA Study Team.
1/ Construction cost excludes land acquisition costs, contingency, tax, and others.

15.8 The approximate project cost for each candidate initial section is summarized in Table 15.2.

Table 15.2 Approximate Project Costs for Candidate Initial Sections (US$ million)

Item \ Section	Ngoc Hoi — Phu Ly (45.6 km)	Thu Thiem — Long Thanh (36.1 km)
Costs of civil engineering construction work (civil engineering structures, viaducts, bridges)	651	508
Tracks (ballast tracks and slab tracks)	127	101
Stations (2 stations)	158	219
Power transmission (power transmission and substations, trolley wires, power)	363	352
Signal and telecommunication	173	150
Rolling stock depots and workshops	114	135
Costs of rolling stock	57	57
Education/training facilities and machines/materials for education	26	26
Total	1,669	1,548

Source: JICA Study Team.

(d) Estimated Demand for Candidate Initial Sections

15.9 While it is difficult to estimate the demand for initial sections, an analysis is made based on available information to indicate possible sources of demand.

(a) **Ngoc Hoi – Phu Ly section:** In 2010, the passenger demand between Hanoi and Ha Nam is 7,343/ day which is expected to increase to 39,700/ day in 2030 due to rapid progress of urbanization in Hanoi metropolitan region. Estimated demand for HSR in the priority section shows that a total of about 10,000 passengers/ day will use HSR. This indicates that if initial section is properly provided with access service to/ from the south especially Nam Dinh and Ninh Binh, it can attract more passengers. It is to be noted that this level of ridership is only possible when UMRT Line 1 and HSR is connected effectively at Ngoc Hoi Terminal Station. (see Table 15.3)

Table 15.3 Passenger Demand between Hanoi and Ha Nam

Mode	2010			2030		
	Between Hanoi and			Between Hanoi and		
	Ha Nam	Nam Dinh	Ninh Binh	Ha Nam	Nam Dinh	Ninh Binh
Car	664	1,786	1,177	7,360	4,391	2,556
Bus	6,643	5,352	572	19,697	10,237	6,831
Existing Railway	36	440	62	2,555	4,883	780
HSR	-	-	-	10,091	(7,406)[1)]	(2,933)[1)]
TOTAL	7,343	7,578	1,811	39,703	26,917	13,100

Source: JICA Study Team.

1) It is assumed that Ngoc Hoi – Vinh Section is opened.

(b) **Thu Thiem – Long Thanh section:** Although the passenger demand between HCMC and Dong Nai Province is very large as estimated in the study to be 69,500/day in 2010 and 159,600/day in 2030, the location of the initial section between Thu Thiem and Long Thanh has no relevance to the figure because both ends are located in green fields. Therefore the demand is largely dependent on the future development of Long Thanh International Airport. It is estimated in the Long Thanh International Master Plan Project that the total number of passenger demand in 2030 is

141,400/day[2]. It is also assumed in the study that about 25% of the passenger demand will use urban rail and HSR. This implies that approximately 35,000 passengers will use the initial section when it is in operation.

Table 15.4 Estimate of Long Thanh Airport Traffic Demand, 2030

Mode	Type of Passengers (no./day)			Total
	Air passenger	Airport worker	Well wishes	
Motorcycle	3,425	7,143	3,722	14,290
Car/ Taxi	17,123	3,571	13,023	33,722
Bus	47,945	25,000	20,472	93,417
TOTAL	68,493	35,714	37,222	141,429

Source: Long Thanh International Master Plan Project.

(e) Preliminary Evaluation of Initial Sections

15.10 The two candidate initial sections were evaluated based on the proposed criteria (see Table 15.5). The characteristics are explained as follows:

(i) Both candidate sections satisfy technical requirements;

(ii) Training environment was evaluated equally since the candidate sections are in the vicinity of large urban areas;

(iii) Traffic demand is larger in the south, however the premise is that the operation of Long Thanh International Airport should be as scheduled and the access (urban railway) from HCMC inner city area to Thu Thiem area needs to be ensured;

(iv) Publicity is rated higher for the South;

(v) Regional development impact is rated higher for the North (in which many cities are located);

(vi) There is no great difference in construction cost;

(vii) For the north, preconditions for smooth implementation are made relatively clear. For Ngoc Hoi terminal, HPC provided a total of 170ha including UMRT Line 1, existing railway and HSR, and a detailed plan is being prepared. For Phu Ly Station, the City has incorporated the location of HSR alignment and station in its approved urban plan to control the development within the land for HSR development.

(viii) For the south, the initial section will be affected by three large-scale projects including (i) Thu Thiem urban development (ii) new Long Thanh International Airport and (iii) connecting urban rail line between Thu Thiem and City Center in HCMC. In order for the proposed initial section to function effectively, the three projects must be implemented in coordinated manner timely.

15.11 Based on the above analysis, it is preliminarily concluded that priorities for the initial sections are in the order of (1) Thu Thiem – Long Thanh and (2) Ngoc Hoi – Hanoi, though differences are insignificant.

15.12 While it is recommended to construct Thu Thiem – Long Thanh by the Japan side based on the objective assessment by the JICA Study Team, the decision will be apt to political matters as well. Hence, the final decision shall be made swiftly by the Vietnam side to ensure smooth development of the HSR in the future.

[2] It is estimated that the number will increase to 565,700/ day when the airport is fully operational.

16 CONCLUSION AND RECOMMENDATIONS

1) Conclusion

16.1 The main conclusions of this study are as follows:

(a) In order to meet future transport demand along the north-south corridor quantitatively and qualitatively, provision of high-speed railway services is inevitable.

(b) Upgrading of existing railway to meet high-speed operation is not only technically difficult but also require lengthy construction periods and high cost which is comparable to that of a new line hence unadvisable.

(c) While the development of full section of HSR is economically justified only around 2040, it is important to improve existing railway for short to medium term. The most appropriate level of improvement of the existing railway is to maximize the transport capacity of single track with meter gauge. The proposed improvement includes, among others, removal of bottlenecks, improved efficiency of railway operation and services which must be completed by 2020-25. Farther improvement including double tracking will be undertaken for sections where demand is high.

(d) Development of HSR must be implemented in phases according to the proposed roadmap, and the results of detailed study on priority sections are as follows:

  (i) Both priority sections have sufficient demand for HSR, and its share will be around 30% of land transport in 2030.

  (ii) Alignment and HSR technology was studied and a suitable HSR system for Vietnam at the maximum speed of 320 km/h was proposed. The construction cost[1] is 10,237 US$ million for the north section, and 9,933 US$ million for the south section.

  (iii) While both priority sections will be economically feasible around 2030, financial viability is low hence project cost cannot be covered from fare revenue but operation cost[2] can be covered.

  (iv) Detailed study on environmental and social consideration was conducted and the plan was formulated so that adverse impacts due to HSR are minimized. Stakeholder meetings were held along the alignment as a part of the SEA process for the selection of the optimal alternative, and opinions from stakeholders were collected and thus reflected to the HSR plan. This meeting also served to promote the understanding of HSR project among stakeholders.

  (v) According to the results of the economic and financial analysis, the southern section shows higher viability.

(e) The operation of the priority section is assumed around 2030, and various preparation indicated in the proposed roadmap (see Figure 15.1) is needed in order to ensure smooth and effective project implementation.

(f) In order to ensure effective development of HSR both in terms of technical and operational aspects, early construction of an initial section (test track) is inevitable. Of the three sections including Ngoc Hoi – Phu Ly, Thu Thiem – Long Thanh and Hue –

[1] Including infrastructure, rolling stocks, and land.
[2] Including electricity, human resources, track maintenance fee, rolling stock maintenance fee, overhead fee.

Danang, it is comparatively evaluated that Ngoc Hoi – Phu Ly is given a higher score though differences among three are not significant. It may be possible to develop Thu Thiem – Long Thanh section through the integrated development of Thu Thiem urban development and Long Thanh International Airport, as an access line for the airport and reducing the burden of the Government. Although Hue – Danang section has lower assessment results compared to two other sections, it will serve to remove the main bottleneck of the existing railway[3].

(g) Management organizations of HSR must be distinguished from that of existing railway, and on-site work shall also be directly managed by this organization. Organization during the preparation and construction must be directly managed by the Government.

(h) Human resource development can be done in the most effective manner using initial section (test track) and through on-going urban rail projects. Training covers, among others, construction technologies, operation, maintenance and management, and nurturing of future trainers.

(i) Development of institutions is necessary to cover the following:

(i) Regulation on HSR development

(ii) Formulation of railway development plan

(iii) Inter-agency coordination and public information on the project

(iv) Related institutions for land acquisition and business activities

(j) Project financing requires an establishment of effective mechanisms to introduce private sector's financing, while efficient operation is maintained. For this, HSR company is established and financing for non-revenue generating infrastructure is the responsibility of the Government.

2) Recommendations

16.2 The main recommendations of this study are as follows:

(a) While this study can provide a useful basis for future discussions in the National Assembly, it is proposed to use Q&A which is prepared in the study based on the comments and inquiries raised by various experts and organizations.

(b) It is proposed to formulate a long-term HSR development program based on the road map prepared in the study for effective monitoring of the project.

(c) It is proposed to construct an initial section (test track) which functions as the core for various preparatory activities and to establish a solid implementation mechanism for effective implementation of such a significant national project.

(d) Involvement of local authorities who are part of the implementing body and also direct beneficiaries is important for effective development of NSHSR. It is proposed to establish a coordinating committee between the Central Government and local authorities to strengthen coordination for plan formulation, land acquisition, and sharing a part of construction cost.

[3] The planned population in Danang and Hue by 2030 is 2 million and 0.7 million, respectively, and the tourist demand is currently 4 million (international and domestic) both areas combined. Large demand is expected in the future due to the expansion of Danang International Airport, and there is also high possibility for double-tracking the existing railway.

(e) It is also necessary to establish adequate public information and participation to the project, because the project is not well perceived nor understood by many stakeholders.

(f) While the development of NSHSR is a long-term undertaking, it is important to improve the existing railway. It is proposed to conduct a detailed study and formulate a plan for improvement of existing railway in integration with proposed NSHSR wherein Danang – Hue section must be studied in detail.

3) Further Steps

16.3 The construction plan of new railway line with standard gauge proposed in this report provides a good base for various options with regards to aspects such as specification of rolling stocks (maximum operating speed 160km/h – 320km/h), connection with existing railway, etc. Reflecting on the history of railway development in Japan, it is noted that Japan has indeed a great deal of experience in the planning, construction, operation, etc., and it is deemed that such experiences will greatly contribute to the railway development in Vietnam. JICA is willing to provide further cooperation to Vietnam to achieve sustainable development of railway sector and to enhance friendly relationship between the two countries.