No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF TRANSPORT, VIETNAM

THE COMPREHENSIVE STUDY ON THE SUSTAINABLE DEVELOPMENT OF TRANSPORT SYSTEM IN VIETNAM (VITRANSS 2)

Subsector Report No. 02
RAILWAY TRANSPORT

May 2010

ALMEC CORPORATION
ORIENTAL CONSULTANTS CO. LTD.
NIPPON KOEI CO. LTD.

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Exchange Rate Used in the Report

USD 1 = JPY 110 = VND 17,000

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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 Comprehensive Study on the Sustainable Development of Transport System in Vietnam (VITRANSS2) and entrusted the program to the Japan International cooperation Agency (JICA)

JICA dispatched a team to Vietnam between November 2007 and May 2010, which was headed by Mr. IWATA Shizuo of ALMEC Corporation and consisted of ALMEC Corporation, Oriental Consultants Co., Ltd., and Nippon Koei Co., Ltd.

In the cooperation with the Vietnamese Counterpart Team, the JICA Study Team conducted the study. 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.

I hope that this report will contribute to the sustainable development of transport system and 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.

May 2010

HIROYO SASAKI,
Vice President
Japan International Cooperation Agency

May 2010

HIROYO SASAKI
Vice President
Japan International Cooperation Agency
Tokyo

Subject: Letter of Transmittal

Dear Sir,

We are pleased to formally submit herewith the final report of the Comprehensive Study on the Sustainable Development of Transport System in Vietnam (VITRANSS2).

This report compiles the results of the study which was undertaken both in Vietnam and Japan from November 2007 to May 2010 by the Team comprising ALMEC Corporation, Oriental Consultants Co., Ltd., and Nippon Koei Co., Ltd.

We owe a lot to many people for the accomplishment of this report. First, we would like to express our sincere appreciation and deep gratitude to all those who extended their extensive assistance and cooperation to the Team, in particular the Ministry of Transport of Vietnam.

We also acknowledge the officials of your agency, the JICA Advisory Committee, and the Embassy of Japan in Vietnam for their support and valuable advice in the course of the Study.

We hope the report would contribute to the sustainable development of transport system and Vietnam.

Very truly yours,

IWATA Shizuo
Team Leader
The Comprehensive Study
on the Sustainable Development
of Transport System in Vietnam
(VITRANSS2)

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ABBREVIATIONS

ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
AST	Automatic signaling system
ATC	Automatic Train Control
ATS	Automatic Train Stop
ATS-S	Automatic train stop system
BOT	Build-operate-transfer
CBD	Central business district
CTC	Central Train Control
DD	Detailed design
EIRR	Economic internal rates of return
EMU	Electric Multiple Unit
ESCAP	Economic and Social Commission for Asia and the Pacific
F/S	Feasibility Study
FC	Foreign Currency
FII	Function Improvement Item
FIRR	Financial internal rate of return
GDP	Gross domestic product
HCM	Ho Chi Minh
HCMC	Ho Chi Minh City
HSR	High-speed railway
ICD	Inland Container Depot
IMO	Infrastructure Maintenance & Operation
IRR	Internal rate of return
IWT	Inland waterway transportation
JICA	Japan International Cooperation Agency
JR	Japan Railway
JVC	Joint-venture company
Lao PDR	Lao Peoples' Democratic Republic
MCA	Multi-criteria analysis (MCA
MOF	Ministry of Finance
MOT	Ministry of Transport
NFEZ	Northern Focal Economic Zone
NH	National highway
N-S	North-south
NSHSR	North-South Highs-Speed Railway
VNR	Vietnam railway
O&M	Operation and management
OD	Origin-destination
ODA	Official development assistance
OECD	Organization for Economic Co-operation and Development
PC	Passenger cars
PPP	Public-private-partnership
PSO	Public service obligation
PSP	Private sector participation
ROW	Right of way
SBU	Chap 5
SFEZ	Southern Focal Economic Zone
SKRL	Singapore-Kunming Rail Link
SMI	System modernized Item
SOE	State-owned enterprise
SRI	System Reinforcement Item
SWOT	Strength-Weakness-Opportunity-Threat
TAC	Track Access Charge
TRICC	Transport Investment and Construction Consulting

USD	US Dollar
VITRANSS	The Study on the National Transport Development Strategy in the Socialist Republic of Vietnam
VITRANSS 2	The Comprehensive Study on the Sustainable Development of Transport System in Vietnam
VJC	Vietnam-Japan Consulting Joint Venture
VND	Vietnam dong
VNR	Vietnam railway
VNRA	Vietnam Railway Administration
WB	World Bank
WTO	World Trade Organization

1 INTRODUCTION

1.1 Purpose

This report consolidates into one volume the past performance, the present conditions, and a proposed road map for the future of the Railway Transport sub-sector of Vietnam. It looks at the sub-sector, not only on its own, but also as a component of the overall transportation system as well as its integral role in the nation's economic and physical development.

Railway has been influential to the formation and history of Vietnam, like in many European countries. However, because of increasing motorization and expansion of the road network, railway's role has been declining and it is losing its market share. Rail's market share has dropped from 13.2% in 1990 to 6.5% in 2007 in terms of passenger-kilometers, and from 4.8% to 3.1% in ton-kilometers of freights.

The plans for the sub-sector were meant to reverse the trend of railway's declining role by rebuilding its tracks and equipment, so that better supply and service would lead to higher demand. Unfortunately, the desired improvements did not meet expectation because actual investment was below requirements. To date, average commercial speed of the passenger service is 20-40km/h, with the commercial speed of freight service lower than this. In some sections of the north-south line, a faster travel speed has been achieved. But with a travel time of more than 29 hours between Hanoi and HCMC, traveling by train is still not attractive. Things are unlikely to change immediately, since fiscal inadequacy will continue into the medium-term. The outlook for its long-term future, however, has improved – because of increasing fuel prices. As a consequence, reinvigorating the long-term plan for railway has become timely to incorporate sustainability and inter-modality.

A sustainable transportation system for Vietnam is concerned with "meeting the mobility needs of the present without sacrificing essential human or ecological values today and in the future." It is about finding ways to move people and goods in ways that reduce its impact on the environment, the economy, and society. It goes beyond the traditional approach of transport supply to meet projected needs - as to include systems, policies, and technologies towards substitutes to movement.

On the other hand, inter-modality requires a simultaneous consideration of all modes of transport and then matching particular modes in meeting particular type of demand for transport service. Accordingly, rail transport becomes the preferred mode for the movement of passengers and freight by land over medium-to-long distances within the country. Rail is not competitive with road on short distance trips, even if it had been rehabilitated and upgraded. Compared to other alternatives, railway has a smaller land footprint (approximately one-half the land needed for a 4-lane highway), requires less energy per km (approximately 1/12 of the energy of a car per passenger-km), and provides a high-capacity mass-transport service.

1.2 Structure of the Report

This report is divided into the following chapters:

Chapter 1: Introduction provides an overview of the report's contents and a guide to understanding the full report.

Chapter 2: Present Conditions describes the current conditions of the railway transport in Vietnam. The historical performance of the sub-sector is reviewed, followed by discussions about the present situation, issues, as well as the institutional set up.

Chapter 3: Government Plans reviews and summarizes the plans for the railway sub-sector to be at par with railway systems in developed countries within the shortest possible time. It also includes a commentary about these plans, and the key issues that need to be addressed to place the sub-sector on a more sustainable path.

Chapter 4: Main Issues discusses the main problems confronting railways, based on analysis of present conditions and prospects for the future. The resolution of these issues will determine the state of the sub-sector 20 years in the future.

Chapter 5: Long Term Development Strategies contains the recommended strategy of the Study Team to develop the rail transport in a sustainable manner, based on an analysis of the sub-sector's current strengths and weaknesses, and future threats and opportunities.

Chapter 6: Sustainable Master Plan translates the strategies into specific programs and projects that address the key issues of the sub-sector. Based on a realistic estimate of the size of the budget envelope, it formulates a 10-year investment program of USD5.8 billion for rail that can be sustained in the 2011 to 2020 timeframe. Conclusions and Recommendations summarize the key findings and recommendations of VITRANSS 2 to strengthen the railway system and establish for the sector a significant share of the passenger and freight markets by 2030.

2 PRESENT CONDITIONS

2.1 Railway Network

The history of Vietnam Railways begins with the construction of a railway line between Saigon and My Tho in 1881 and operation began in 1885. The 1,726km line from Hanoi to Saigon was completed in September 2, 1936. The development of the trunk railway lines was as follows: 321km line from Hanoi to Vinh (started 1905) and 229km of railway from Vinh to Dong Ha (started 1927). Railway service from Hanoi to Da Nang began in 1927. This was followed by the opening of the following lines: 414km line from Saigon to Nha Trang (1913) and 524km line from Da Nang to Nha Trang (1936). The development of the other main lines is as follows:

(i) 163km line from Hanoi to Dong Dang (1902)

(ii) 102km line from Hanoi to Hai Phong(1902)

(iii) 296km line from Hanoi to Lao Cai (1906) where service commenced in 1901 on the Hanoi-Viet Tri route.

Vietnam Railways saw tremendous changes up until 1954. Rail facilities were destroyed by war and affected by weather in the period up to 1975. The service quality dramatically deteriorated. During the period of rebuilding, the government prioritized investment in rehabilitation of existing lines, rebuilding transport capacity and building new railway lines.

1) Hanoi-Saigon Line

The 1,726.2km Hanoi-Saigon line is single-track meter-gauge line which runs along the north-south route connecting major cities and industrial zones, including Hanoi, Nam Dinh, Thanh Hoa, Vinh, Hue, Da Nang, Quy Nhon, Bien Hoa, and Ho Chi Minh City. There are five bottleneck sections, including the Hai Van Pass and Khe Net Pass, where poor alignment, steep inclines and sharp curves constrain operation. There are 686 bridges, most of which are designated slow-speed sections. Some sections with significant deterioration caused by war damage and ageing have been rehabilitated with the support of Japanese ODA.

The Hanoi Saigon line should play a crucial role in Vietnam’s economic development as a vital link to key international ports of Hai Phong, Da Nang and Ho Chi Minh City. This line is also expected to support the development of an integrated national economy.

2) Hanoi-Hai Phong Line

The 101.75km Hanoi-Hai Phong line branches off at Gia Lam Station, which is located 5.5km north of Hanoi Station. This single-track meter gauge line has good alignment across flat plain, except for a short section with relatively steep 6 ‰ gradient.

Freight transportation from Hai Phong Port and Hanoi (which are 100km apart) is mainly by road transport due to inadequate loading and unloading facilities of railway line. This line runs through a relatively developed area in northern Vietnam. This line is expected to play an important role in cargo and passenger transportation between Hanoi and Hai Phong.

3) Hanoi□Lao Cai Line

This line branches from Yen Vien, which is located 10.9km north of Hanoi. This line covers the 293.5km distance from Hanoi to Lao Cai Station and provides international cargo transport from/to Kunming, China.

This single-track meter-gauge track runs along the Hong River. In section between Yen Bai and Lao Cai there are curved sections with radius of 100 to 200m as the route runs between the foot of a mountain range and the Hong River. The gradient is nearly flat along the entire route, with an average gradient of 3‰. The 142 bridges on this line are mostly deteriorated. An apatite rock mine is located near Pom Han Station, the terminal for a branch line from Pho Lu Station. The Asian Development Bank has provided a soft loan for rehabilitation of this line.

4) Hanoi-Dong Dang Line

This line stretches from Hanoi to Lang Son and Dong Dang, and extends to Nam Ning, China. Dual gauge of meter and standard gauge are installed from Gia Lam. The 162.5km route runs through a mountain region where the gradient increases 17‰. There are a series of sharp curves near the Lang Son area. The minimum curvature radius is 100m-50m.

5) Dong Anh-Quan Trieu

This line branches off at Dong Anh station which is 21.4km northwest of Hanoi and extends to Quan Trieu Station. It uses dual gauge of meter and standard gauge, between Yen Vien and Luu Xa. The section from Luu Xa Station to Quan Trieu Station has a meter gauge.

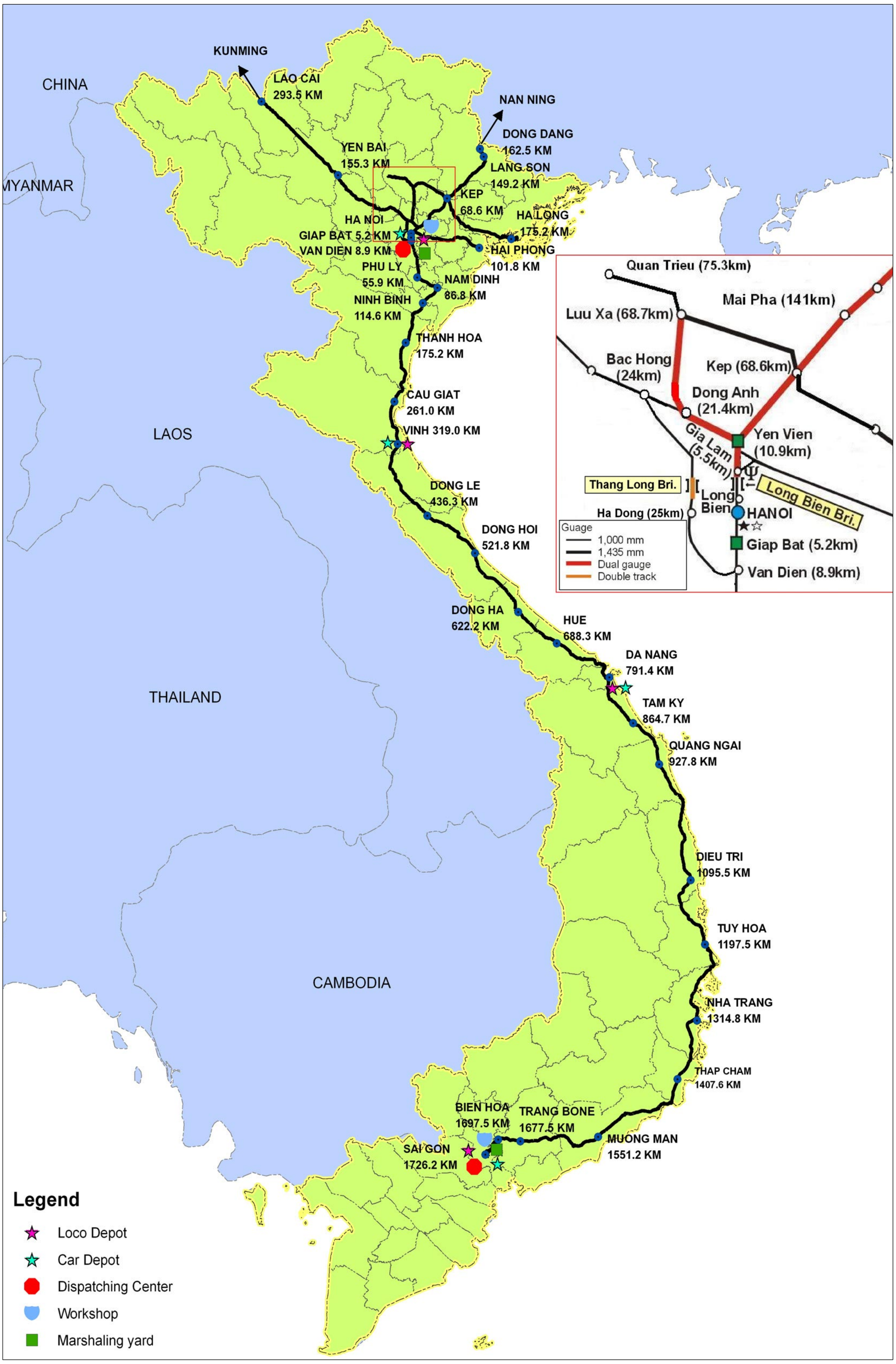
An apatite rock mine is located near Pom Han Station, the terminal for a branch line from Pho Lu Station. The area along the route has iron ore and copper mining potential. This line is a lifeline for the areas along the route due to the lack of a well connected road network. Since most areas along the route are mountainous, industrial development has been slow.

6) Luu Xa-Kep-Ha Long Line

The Luu Xa-Kep line has standard gauge and connects mines to Ha Long Port, but it is not currently in use. The Ha Long line branches from Kep Station which is located 68.6km north of Hanoi and extends to Ha Long. The aim is to provide freight transport, but only one train from Hanoi is operated for the small local communities along its wayside.

The Vietnam Railways network is shown in Figure 2.1.1

Figure 2.1.1 Vietnam Railways Networks



Source: VITRANSS 2 Study Team

2.2 Facilities and Equipment

The railway network can be characterized physically by two items, railway alignment and railway structures. Table 2.2.1 shows the main technical standards of railways in Vietnam.

Table 2.2.1 Main Technical Standard of Railway

No.	Technical Items	Hanoi-Saigon	Gia Lam-Hai Phong	Hanoi-Dong Dang	Ha Noi-Lao Cai	Dong Anh-Quan Trieu	Kep-Hạ Long	Kep-Luu Xa (not operate)
1	Gauge (mm)	1000	1000	Dual	1000	Dual	1435	1435
2	Gradient	9‰-17‰	6‰	6‰-17‰	9‰-12‰	6‰	6‰	6‰
3	R min (m)	300, partially<200	400	300	150	300	300	300
4	V max	Passenger: 90km/h Freight:50km/h	Passenger: 70km/h Freight:40km/h	60km/h	70km/h	50km/h	50km/h	50km/h
5	Formation Level	4.4m	4.4m	5.0m, partially 4.0-4.4m	4.4m	5.0m	6.4m	5.0m
6	Load Scheme	T14	T14	T14	T14	T14	T22	T14
7	Rail	P43	P43	P43	P43	P43	P43	P43
8	Turnout	Tg1/10	Tg1/10	Tg1/10	Tg1/10	Tg1/10	Tg1/10	Tg1/10
9	Sleeper	Concrete-2 blocks	Concrete-2 blocks	Concrete	K1,K3,Iront	Concrete	Concrete	Concrete
10	Communication	Optical Cable + Bare Cable	Bare Cable	Bare Cable	Bare Cable	Bare Cable	Bare Cable	
11	Conventional closing System	Central Electrifying + Semi-automatic	Semi-automatic	Semi-automatic	Semi-automatic+ Token System	Token	Token	

Source: VNR

1) Alignment

The horizontal alignment or track geometry consists of a combination of straight lines and curves to navigate through terrain and available right-of-way. The lengths of railway lines in Vietnam are shown in Table 2.2.2:

Table 2.2.2 Existing Railway Line (Track Length)

Section	Length Total (m)	1,000mm (m)	Dual (m)	1,435mm (m)
I. Trunk Lines				
1. Hanoi-Sai Gon line	1726	1726		
2. Hanoi-Dong Dang line	167	4	162	
3.Gia Lam-Hai Phong line	96	96		
4.Yen Vien-Lao Cai line	285	274	11	
5. Dong Anh-Quan Trieu line	55		55	
6. Kep-Ha Long line	106			106
7. Kep-Luu Xa line	56			56
8. Van Dien-Bac Hong line	41	41		
II. Feeder Lines				
Mai Pha-Na Duong line	30	30		
Chi Linh-Pha Lai line	15			15
Phố Lu-Pom Hán line	13	13		
Phu Ly-Kien Khe line	5	5		
Cau Giat-Nghia Dan line	30	30		
Dieu Tri-Quy Nhon line	10	10		
Muong Man-Phan Thiet line	12	12		
Da Lat-Trai Mat line	7	7		
Total	2654	2248	228	177

Source: VNR

2) Curvature

A railway track is desirable to be a straight line from the viewpoints of curve resistance, visibility, track maintenance, etc., but it is not avoidable to have curvatures in order to go around steep mountains and valleys or existing structures in the urban areas. A large radius of curvature is appropriate for increasing speed and ease of track maintenance. The curve radius influences construction cost and maintenance. The currently radius curvatures is small and should be improved. The existing route alignment selected saving construction cost for bridge at rivers, lakes and soft ground and minimize tunnel length which is why the alignment is meandering, steep, and sharply curved. Sections between Hanoi and HCMC with restricted speeds due to radius of curvature are as follows:

Table 2.2.3 Sections with Restricted Speed due to Radius of Curvature for Passenger Train

Restricted Speed	Radius of Curvature (m)		
	100m-200m	200m-300m	More than 300m
30km/h			1
35km/h	2		
40km/h			1
50km/h	1	1	1
55km/h	1	2	
60km/h		5	1
65km/h		8	
70km/h		1	1
75km/h			3

Source: VNR

Table 2.2.4 Sections with Restricted Speed due to Radius of Curvature for Freight Train

Restricted Speed	Radius of Curvature (m)		
	100m-200m	200m-300m	More than 300m
15km/h			1
30km/h	1		
35km/h	1		
40km/h	1	4	2
50km/h	1	12	18

Source: VNR

3) Gradient

It is desirable to adopt a horizontal railway gradient but it is not practical to construct long distance tunnels and bridges for the purpose of maintaining a horizontal gradient. It is common to gradients to follow terrain. The gradient of the railway influences train operation.

For the selection of route alignment, it is common to select and build the shortest route tunnel after climbing up a steep gradient slope. This results in the cheapest construction cost. There are however problems as follows:

(i) It decreases the length of the train and composition due to weak traction force of the locomotive.

(ii) It will increase energy consumption of the train.

(iii) It limits train operating speed.

(iv) Sections which have the steep gradient and small curvature require more maintenance on both tracks and vehicles.

Table 2.2.5 shows the maximum gradient in each line.

Table 2.2.5 Max. Gradient in Main Lines

Line	Max. Gradient (mm/m)	Section
Hanoi–Saigon	17	
Hanoi–Dong Dang	17	Pho Trang–Kep
Yen Vien–Lao Cai	15.8	Vu En–Am Thuong,
Gia Lam–Haiphong	9.15	Gia Lam–Cau Bay

Source: VNR

4) Railway Infrastructure

Railway is influenced more by gradient and the curve radius than roads. Therefore, in case of passing the railway across rivers and mountains, it is necessary to build infrastructures such bridges and tunnels with railway operation in consideration. The existing alignment was designed to follow contours of the mountain base and valley. Bridges and tunnels were avoided in general. Present rail infrastructure in Vietnam is shown in Table 2.2.6.

Table 2.2.6 Present Rail Infrastructure in Vietnam

No.	Item	Unit	Quantity
1	Trunk Line	Km	2,532
2	Station	All kinds of Station	281
3	Crossing	Crossing	1,200
4	Road Crossing	Road Crossing	4,233
5	Bridge	Bridge/ length(km)	1,813/57
6	Tunnel	Tunnel/km	39/115

Source: VRA

(1) Bridges

Railway bridges in Vietnam are mostly through bridges. As shown in Table 2.2.7, there are 1,813 bridges and their total length is approximately 57km. Speed restriction on bridges is shown as follows:

Table 2.2.7 Speed Restriction on Bridges (2007)

Line	Train Speed (km/h)					
	>40	>30	>15	>10	>5	Total
HN- TP.HCM	9	17	6			32
Gia Lam -Hai Phong	6(1drain)					6
HN-Đong Dang	2		2			4
Dong Anh-Quan Trieu		1	1			2
Yen Vien-Lao Cai		14				14
Kep-Ha Long			2	2		4
Total	17	32	11	2		62

Source: VNR

As for VNR's existing bridges between Hanoi and Saigon, there are still speed restrictions in spite of rehabilitation works with the assistance of the Japanese Government. These restrictions are obstructions to improving train operation speed. Profile of speed restrictions at bridges are shown in the following tables.

Figure 2.2.1 Truss Bridge with 1 Meter Gauge

Source: Vitranss2 Study Team

Table 2.2.8 Bridge Sections with Speed Restrictions for Passenger Trains

Restricted Speed	Quantity
15km/h	1
30km/h	13
40km/h	3
50km/h	4
60km/h	4

Source: VNR

Table 2.2.9 Bridge Sections with Speed Restrictions for Freight Trains

Restricted Speed	Quantity
15km/h	6
30km/h	17
40km/h	4
50km/h	2

Source: VNR

There are several factors that lead to restricted speed sections at bridges, in particular deterioration of bridges. Bearing capacities are also reduced by degrees or selecting small radius of curvature as a result of decisions to construct the shortest length of bridges over rivers orthogonally.

(2) Level Crossing

At most of level crossings, crossing keepers are used to operate crossing barriers in response to a train approach. There are only a few crossing gates which have automatic warning devices.

At the present situation of limited train frequency, it is practical to operate crossing barriers by both train operation diagram and train approach information from adjacent stations. But in case of failure by crossing keepers, there is a significant risk of casualties and derailment as a result of collision between trains and vehicles.

If train frequency is increased and when there is a delay of train operation or change of train operation order occurs, the present method of operating crossing barriers will be ineffective, and prone to accidents at level crossings. It is recommendable to install both automatic alarming devices and automatic gates at more traffic crossings and to install automatic alarming devices at some sites. Moreover, it was pointed out in studies of train accidents that intentional crossing of pedestrians and motorists is a key factor in many accidents. It is further recommended to undertake a safety awareness campaign.

5) Track Structure

Track is composed of rail, fastening device, sleeper and track bed. Track structure is designed by taking into account track maintenance works as well as strength, vehicle yawing and riding comfort in accordance with vehicle's running speed and passing tonnage. VNR's track structure is as follows:

(1) Rail

In Vietnam, 12.5m long rail is mainly used. Rail weight is mostly 43kg, and 50kg is used in some test sections. For comparison Japan uses 25m rail which is welded to a total length of 200m. Rail joint is a discontinuous point and is a weak point in terms of vehicle operation and track structure. The higher the vehicle passing speed and the more number of trains, vehicle yawing increases and riding comfort deteriorates. Consequently, rail joints cause track irregularity which requires maintenance works. Reduction of rail joints by using longer rail length is desirable. However rail length is restricted by the manufacturing process and logistics.

(2) Fastening Devices

When a train passes, the rail undergoes repeated corrugating movements. The contact surface of the sleeper then wears and the rail then damages the sleepers. In order to prevent damage to sleepers, an elastic plate is placed between the rail and the sleeper which is called the tie plate.

A dog spike was commonly used before in order to fasten the rail and the wood sleeper, but, the dog spike has no restorability after causing a gap between the rail bottom and the sleeper due to floating of the spike. Since concrete sleepers are used, the elastic fastening method is utilized by pressing with a spring force in order not to cause a gap. The fastening method by putting a rubber pad on the sleeper and pressing the rail with a spring is called the double fastening method.

Recently, the Pandrol clip or Vossloh fastening method are widely used. These fastening devices have simple structures using wire spring as cast iron anchor, and have a small number of parts and have strong fastening force. As a result, these devices are advantageous in terms of minimizing labor.

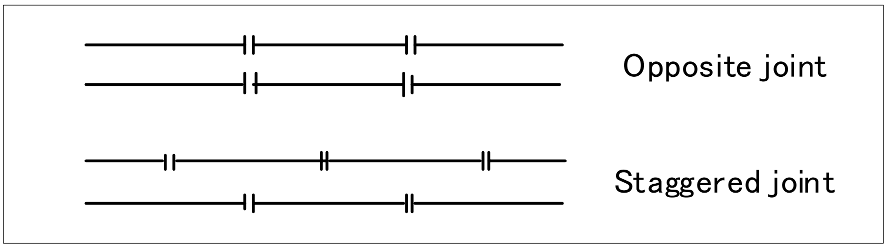
(3) Joints

Rail joint is a place rail edges are connected. As described before, the rail joint is a discontinuous point. At the rail joint there occurs large impulse from train operation and is a weak point in terms of riding comfort, safety and track maintenance. Required function of the rail joints is as follows:

(i) Similar level of strength and bending stiffness compared to segments without joints.
(ii) Structural strength to handle axle force and rail enlargement and shrinkage owing to temperature change.

There are several kinds of rail joints. In terms of functional phase, there are normal joint, insulation joint which locates circuit edge of signal current, and expansion joint used at long rail sections. In terms of structural phase, there are butt joint and skew joint. In terms of laying of rail joints, there are opposite joints and staggered joints (as shown in Figure 2.2.2).

Figure 2.2.2 Opposite and Staggered Joints



Source: VITRANSS 2 Study Team

The staggered joint is easy to yaw from right to left especially in irregular track such as dipped joint. Therefore, the opposite joint is generally adopted, but in curved sections, the staggered joint is convenient because the outer rail is longer than the inner one.

VNR adopts a suspending joint instead of a supported joint for rail joints. Suspending joint is generally said that if there are loose and dropped joints, the suspending joint has comparatively less riding comfort than that of the supported one and it requires more track maintenance. Consequently, the supported joint using wider width sleeper is recommended. Japan railways mainly use supported joints.

(4) Sleepers

VNR adopts 4 types of sleepers, wood, steel, two block concrete and pre-stressed concrete (PC) sleepers. Sleepers of freight tracks and passing through tracks are wood, steel, and twin-block concrete sleepers are gradually replaced to PC sleepers.

The purpose of a sleeper is to maintain the gauge between rails and to distribute the train load to the track bed. Sleepers' requirements are as follows:

(i) To fasten the rail firmly and to have sufficient strength of propping the train load.
(ii) To have elasticity, buffering property, durability and reasonable price.
(iii) To have large horizontal resistance of track bed and have shape and sizes that is easy to rod the track bed.
(iv) To be easy to mass produce and easy to handle.

Sleepers are classified in Table 2.2.10. Comparison between wood and PC sleepers is shown in Table 2.2.11.

Table 2.2.10 Classification of Sleepers

Classification by Laying Method	Classification by Using Plase	Classification by Materials
Cross-sleeper(common) Stringer(In the direction of rail) Block sleeper(Used at straight track bed)	Regular sleeper(Common) Crossing sleeper(Longer) Bridge sleeper(Large sectional area) Joint sleeper(Wide width)	Wood sleeper PC sleeper Steel sleeper Plastic sleeper(*1)

Source: VITRANSS 2 Study Team

Note: (*1) Plastic sleeper is composed of combined materials both of expanded polyurethane and glass fiber which have features of wooden sleepers' advantages such as elasticity, high electric insulation, plasticity. The plastic sleeper is used as the bridge and the joint sleepers in Japan.

Table 2.2.11 Comparison of Wooden & PC Sleepers

Kind	Wooden Sleeper	PC Sleeper
Advantage	• Sufficient elasticity • Easy to fasten rail • Easy to deal with • High electric insulation • Reasonable price	• Long service life(4~6 times as wooden one) and superior durability • Thrift of maintenance cost because of suppressing track irregularity by using double elastic fastening • Possibility of high speed operation by using long rail laying because of large buckling resistivity owing to heavy weight
Disadvantage	• Easy to be suffered mechanical damages such as wear, break, burnout and decay • Decay resistant treatment is required • Unsuitable for track strengthening aiming at long rail laying because of low buckling resistivity of the track	• Difficult to handle such as laying due to heavy weight • Fragile in case of tamping and impossible to reuse • Expensive than wooden sleeper

Source: VITRANSS 2

In the beginning of railway installation, wooden sleepers were used throughout the world. Wooden sleepers have elasticity and strength. And they're widely used because they're comparatively easy to fasten rails and have a reasonable price. With respect to the kinds of wood, chestnut, beech, pine tree, oak, etc. are used. However, these wooden sleepers are being replaced by PC sleepers due to technical development, degradation, and decay of wooden sleepers.

Figure 2.2.3 Steel Sleepers and their Fastening Devices with Bolts and Nuts

Figure 2.2.4 Twin-block Sleeper

Figure 2.2.5 Concrete Sleepers and Vossloh Fastenings

Figure 2.2.6 Suspending Joint

Source: VITRANSS 2 Study Team

(5) Track Bed

A track bed or ballast bed (crushed stone ballast) props sleepers and distributes vehicle load to the roadbed. The track bed has elasticity, and functions to alleviate train impulse to improve riding comfort.

(a) **Quality of Materials**

Quality of the track bed has following quality aspects and should be available in large quantities and reasonably priced.

(i) To have stiffness, strength and tolerance against wear
(ii) To have neither clay, mud nor organic matters

(b) **Particle Grading**

In case of larger particle grading tamping work is difficult while smaller particle grading has poor drainage properties. Moreover if the range of particle size distribution is large, the finer particles shifts to the lower area of the track bed due to train vibration. Proper particle grading should be designed and implemented.

(c) **Ballast Thickness**

The thickness of the track bed is the minimum depth from the bottom surface of the sleeper just under the rail to the surface of the roadbed. And the depth is decided by the distribution of impulse due to train load, train speed and sleeper intervals. Ballast thickness under the sleeper is 30cm according to the rail maintenance manual. But in some sections, especially in urban sections, the thickness is lower. The edge ballast that resists the transverse force of the track is not enough. The reason of shortage of the edge ballast is due to inadequate width of formation level (4.4m) and poor maintenance.

(6) Turnout (switch)

The turnout is composed of three parts including: point, crossing and lead sections. A running direction of vehicles is decided by shifting the tongue rail at point section. Structural weak points where vehicle impulse on the turnout occurs are the place where the wheel gets on the tongue rail at the point section and the crossing gap. Therefore, the train speed passing over the turnout is limited.

2.3 Rolling Stock

1) Locomotives

VNR has 346 diesel locomotives, including 325 diesel locomotives with 1000mm gauge and 21 diesel locomotives with 1435mm gauge. D8E diesel locomotives were manufactured by VNR in 2003, and other locomotives were imported from various countries. Recently, large-scale D19E and D20E diesel locomotives were imported from China and Germany, respectively. There was an increase of four trains in the number of Through Operation Trains in the 1998-2008 periods.

Fifty-five percent of the locomotives can be used in D4H. Also, the D9E-type of old diesel locomotives has been used for 40 years since they were manufactured.

Table 2.3.1 Specification of Locomotives by Type

as of Feb.2008

SpecifIcation	D4H	D5H	D8E	D9E	D10H	D11H	D12E	D13E	D18E	D19E	D20E	Total
Manufacturing country	Russian	Australia	Vietnam	USA	China	Rumnia	Sec	India	Belgium	China	Germany	
Year of manufacturing	1975/88	1966/70	2003	1963/65	1978/82	1980	1986/90	1984/85	1985	2002/07	2006/07	
Rated power (HP)	400	500	870	870	1,100	1,100	1,200	1,350	1,800	1,940	2,000	
Design speed (km/h)	50	65	120	114	50	100	80	96	105	120	135	
Type of transmission	H	H	E	E	H	H	E	E	E	E	E	
Tare weight (ton)	24	41	56	50	58	54	56	72	84	81	81	
Weel arrangement	Bo-Bo	Bo-Bo	Bo-Bo	Bo-Bo	Bo-Bo	Bo-Bo	Co-Co	Co-Co	Co-Co	Co-Co	Co-Co	
Axle load (ton)	6	10/16	14	12,5	14,5	13,5	14	12	14	13,5	13,5	
Number of owned	76	13	2	33	30	23	40	24	16	52	16	325
Number of operable	42	13	2	33	30	23	40	24	16	52	16	291
Overall length (m)	9,590	11,110	17,020	11,644	12,676	14,006	13,306	14,326	15,500	16,895	19,180	
Width (m)	2,717	2,820	2,860	2,734	3,046	2,780	2,754	2,730	2,800	2,900	2,688	
Height (m)	3,458	3,810	3,910	3,785	3,793	3,650	3,854	3,635	3,875	3,920	3,945	

Note:apart from these,there 21locomotive for 1,435mm

Source: VNR

2) Passenger Cars

VNR has 842 passenger cars, including 834 for 1000mm gauge and 8 for 1435mm gauge. Comparing 1998 and 2008, the number of bed cars and buffet cars has increased by 7.7 times from 71 to 550 cars, and by 2.1 times from 42 cars to 90 cars, respectively. This rapid increase was due to an increase in Through Operation Trains.

Table 2.3.2 Specification of Passenger Cars by Type

Specialization	Soft berth	Hard berth	Soft seat	Hard seat	Long seat	Dining	Baggage	Service-Electric power	Total
Tare weight (ton)	36	38/30	36	30	20	38	28	38,8/41,5	
Load (ton)	8	8/10	8	10	10	6	16	2,5	
Body length (m)	20,005	18,600	20,005	20/18,6	16,000	20,005	20,005	20,005	
Overall length (m)	20,676	20,6/19,6	20,676	20,6/19,6	17,000	20,676	20,676	20,676	
Passenger capacity	28	42	64	80	80	28/6staffs	-	21staffs	
Max.speed (km/h)	100	100/80	100	80	80	100	100	100	
Number	289	261	244	280	60	90	50	101	834

Source: VNR
Note: Apart from these, there are 8 passenger cars for 1,435-mm track

3) Freight Wagon

VNR has 4,856 wagons, including 4,501 wagons with 1000mm gauge and 355 with 1435mm gauge. Comparing 1998 and 2008, the number of covered wagons and flat wagons increased by 1.3 times from 1,566 wagons to 2,073 wagons, and by 1.4 times from 404 wagons to 596 wagons, respectively. On the other hand, the number of sided wagons and tank wagons has not changed in the last decade.

Table 2.3.3 Specification of Wagons by Type

Specialization	Covered wagon	High sided wagon	Short sided wagon	Flat wagon	Tank wagon	Total
Tare weight (ton)	18/19	18/19,7	17/12,85	16,5/15,5	18,6	
Load (ton)	35/30	35/30	35/25	39,5/35	30	
Body length (m)	15,0/13,5	14,0/11,5	14/12,5	14,0/12,8	11,6	
Overall length (m)	15,9/14,5	14,9/12,4	14,9/13,4	14,9/13,7	12,6	
Max.Speed (km/h)	80	80	80	80	80	
Number	2,073	1,261	392	596	179	4,501
		1,653				

Source: VNR
Note: Apart from these, there are 355 wagons for 1,435-mm track

4) Maintenance System

(1) Locomotive Maintenance

The Rolling Stock Department of NVR's Head Office is responsible for planning and implementation of rolling stock operation and maintenance. Actual maintenance work is done by workshops and depots under the instruction and supervision of the Transportation Department.

Maintenance of locomotives is conducted in accordance with an inspection cycle determined for each type of locomotive as shown in Table 2.3.4

Table 2.3.4 Locomotive Inspection Cycle

RO (km)	RT(km)	R1 (km)	R2 (km)	R3 (km)	RK (km)	RG (km)
1,000 +/- 20%	5,000 +/- 20%	10,000 +/- 20%	30,000 +/- 20%	-	60,000 +/- 10%	240,000 +/- 20%
-	5,000	10,000	40,000	-	120,000	480,000
3000~ 3,500	6,000~ 7,000	18,000~ 20,000	60,000~		120,000~	-
-	5,000	25,000	50,000	100,000	200,000	800,000
1,000 +/- 20%	10,000 +/- 20%	30,000 +/- 20%	100,000 +/- 20%	-	200,000 +/- 20%	-
-	5,000	25,000	50,000	100,000	200,000	-
4000 +/- 20%	12,500 +/- 20%	25,000 +/- 20%	75,000 +/- 20%	125,000 +/- 20%	250,000 +/- 20%	-
Depot	Depot	Depot	Depot	Depot	Depot	Workshop

Source: VNR

(2) Passenger Car Maintenance

Maintenance of passenger cars is conducted in accordance with inspection cycles determined for each type of car as shown in Table 2.3.5

Table 2.3.5 Passenger Car Inspection Cycles

Type of Inspection	Inspection Cycle	Place of Inspection
Yearly Inspection	150,000+/-10%	Depot
	300,000+/-5%(new car)	
Overhaul	750,000+/-10%	Workshop

Source: VNR

(3) Freight Car Maintenance

Maintenance system of freight cars is shown in Table 2.3.6

Table 2.3.6 Maintenance Cycles

Type of Inspection	Inspection Cycle
Yearly Inspection (Depot)	1 year +/- 2 months 2 years – roller bearing and new wagons
Overhaul (Workshop)	5 years – plain bearing wagons, 6 years – roller bearing wagons

Source: VNR

5) Workshops

Three workshops handle rolling stock maintenance. Two are directly managed by VNR Head Office as shown in Table 2.3.7.

Table 2.3.7 List of Workshops

Name of Workshop	Subject Rolling Stock	Parent Organization
1. Gia Lam Train Company (workshop)	DL, PC	Railway traction Union
2. Di An Train Company (workshop)	PC, FC	VNR
3. Hai Phong Carriage Joint Stock Company (workshop)	PC, FC	VNR

Source: VNR

6) Depot

There are 11 depots for maintenance and repair of rolling stocks (as show in table 2.3.8), of which 5 locomotive Enterprises (locomotive depots) are belonging to railway traction company. The other 6 car depots which is controlled by 3 transport companies, that are Hanoi passenger transport company, Saigon passenger transport company and Freight transport company respectively. These 11 depots as mentioned above are added up functions of workshop and depot, they are in responsible from maintenance to overhaul repair of rolling stocks.

Table 2.3.8 List of depots

No	Name depots	Locomotive	Wagon and Car		Parent Organization
		Maintenance and repair (from Ro to overhaul)	Maintenance& overhaul PC	Maintenance & overhaul FC	
1	Hanoi locomotive Enterprise	X (D4H,D8E,D12E,D19)			Railway traction Union
2	DaNang locomotive Enterprise	X (D11H,D9E,D12E,D20E)			Railway traction Union
3	YenVien locomotive Enterprise	X (D4H,D5H, D10H, D12E,D14E, D19E)			Railway traction Union
4	Vinh locomotive Enterprise	X (D4H,D9E,D13E,D18E)			Railway traction Union
5	Sai Gon locomotive Enterprise	X (D9E,D13E,D19E)			Railway traction Union
6	Hanoi car repair Enterprises		X		Hanoi passenger transport company
7	Hanoi freight operation car Enterprise			X	Freight transport company
8	Saigon freight operation car Enterprise			X	Freight transport company
9	Vinh car Enterprise		X	X	Freight transport company
10	Da Nang Car Enterprises		X	X	Freight transport company
11	Saigon Car Enterprises		X		Saigon passenger transport company

Sources: VNR

2.4 Train Operation and Safety Devices

1) Train Operation

(1) Hanoi-Saigon Line

The 1,726 km North-South Line between Hanoi and Saigon operates diesel locomotives on single track. There are 166 stations. The average distance between stations is 10km. Average train operating speeds are 90km/h in 0.2% of the route; 70-80km/h in 89.8%; 7.3% at 50-60km/h; and 2.6% run at an average speed of 25-40km/h.

Train dispatching systems at each station use semi-automatic interlocking devices which turn a switch at the station yard and guide the course using signal control boards in the station office. Train operation uses a block system between stations that is driven by one train between stations.

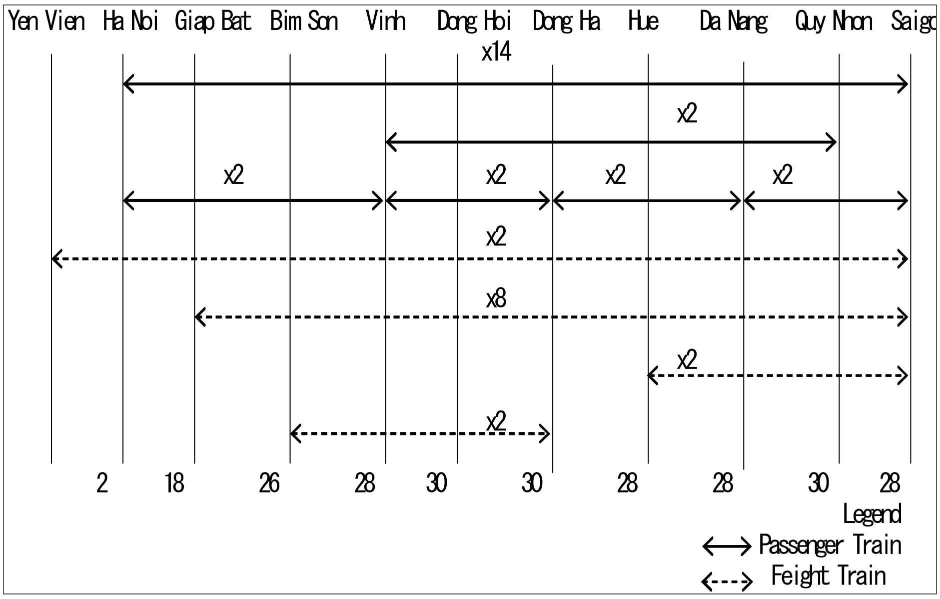
There are no safety siding tracks for the main line and the sub-main line. Also an Automatic Train Stop device, which is the backup equipment when an operator does not follow the signal, is not installed at each station.

(a) **Number of Passenger and Freight Operations**

A total of 14 passenger trains are operated directly between Hanoi and Saigon. Another two passenger trains are operated by section such as Hanoi-Vinh, Vinh-Dong Ha, Dong Ha-Da Nang, Vinh-Quy Nhon and Da Nang-Saigon.

Eight cargo trains are operated between Giap Bat and Saigon, and 2 cargo trains are operated in the following sections; (i) Yen Vien-Saigon, (ii) Bim Son-Dong Ha and (iii) Da Nang-Saigon. Thirty trains, including passenger and freight, are operated between Vinh and Dong Hoi. Figure 2.4.1 shows numbers of train operations.

Figure 2.4.1 No. of Train Operations (N-S Line)



Source: VITRANSS 2 Study Team

(b) **Operating Speed**

The maximum operation speed is 90km/h in the North-South Line. However, only 0.2% operates for whole length at 90km/h. 90 % operate in the 70-80km/h speed range. On the other hand, slow operation, at 30-60km/h, is required on 32 bridges and in 7 tunnels at

15-50km/h. Moreover, it is necessary to drive slowly in curved sections.

Table 2.4.1 Operation Speed (N-S Line)

Operation Speed	25km/h	30km/h	40km/h	50km/h	60km/h	70km/h	80km/h	90km/h	Total
Distance(Km)	1.5	30.8	13.5	45.3	80.8	816.8	732.2	4.0	1724.78
%	0.1	1.8	0.8	2.6	4.7	47.4	42.5	0.2	

Source: VITRANSS 2 Study Team
Note: Freight train Danang – Thanh Khe, 1.5km excluded

(c) Track Capacity

Track capacities between stations have been estimated for 166 stations on the North-South Line, using a formula which considers not only operating time in each direction but also lost time for determining of train direction after turning of the switch. The lowest capacity of about 30 trains per day is in the Hai Van Pass section, and in a section between Dong Chuoi and Kim Lu in the Ke Net pass. Those sections require a long running time because of steep gradients and speed restrictions in tunnels.

Also, sections with line capacities between 30 and 40 trains per day account for 39% of the bottle-necks. Although 60 trains per day may be attained by introducing additional signaling stations and partial double tracking. The aim of such measures is to introduce additional trains, but it is not possible to draw up a train-operation diagram for reduction of travel time.

$$\text{Track capacity (Trains)} = \frac{1.440}{\text{Operating Time} + \text{Signal Handling Time}} \times \text{Track Occupation Raito (0.6)}$$

Table 2.4.2 Track Capacity (N-S line)

Track Capacity	more 30 Trains	more 40 Trains	more 50 Trains	more 60 Trains	more 70 Trains
Between Station	22	42	37	38	27
Ration	13%	26%	22%	23%	17%

Source: VITRANSS 2 Study Team

(d) Operation Diagram Setting and Issues

Train operation diagrams are restricted by line capacity between stations because the North-South Line is single-track. In particular, the line capacity between Hue and Da Nang where the trains going to south and north overlap is from 37 to 46 trains per day. The capacity is relatively small.

Although VNR plans to construct a tunnel at Hai Van Pass, this cannot be expected to have a large effect such as drastically shortening time or increasing trains with the current single-track line. Also, if partial increases of lines and of arrival/departure lines are implemented at sections with a capacity from 30 to 40 trains per day (which account for 39% of the total line length); the line capacity will increase to 60 trains a day. Still, it is difficult to set a reasonable operation diagram. On the other hand, the present operation diagram is set to operate a large number of trains, and waiting for arrival times at crossing station is required. Therefore, operating diagrams with the above-mentioned minor improvements will leave the capacity almost the same as it is now.

In detail, the SE3 Train and SE4 Train, which are high-priority in terms of arrival times between Hanoi and Ho Chi Minh, would benefit from the effect of shorter times. However, the measures discussed would be ineffective for the other trains. All trains could be set for an operation diagram between Hanoi and Ho Chi Minh with same operating times as the SE3 and SE4 Trains, if the North-South Line becomes double-track.

(2) Hanoi-Hai Phong Line

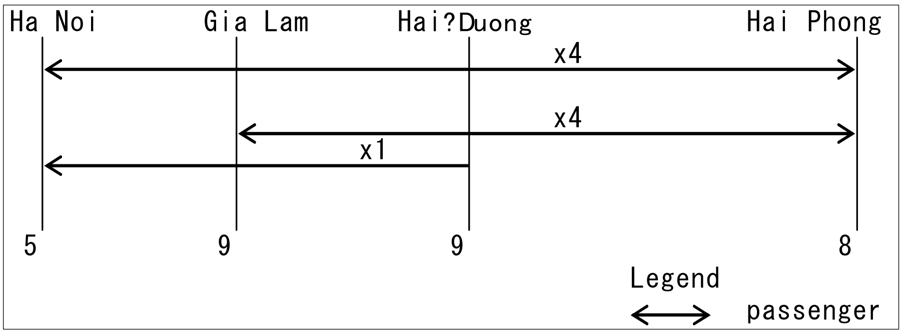
The operating length of the Hai Phong Line is 101.8km. Trains are pulled by diesel locomotives in a single-track section with 14 stations. Train passing track is installed at all stations. Operating speeds on this line include a 70km/h section (94%), a 50km/h section (3%), and a 30km/h section (3%).The course composition of each station includes second-class relay inter locking devices that are the same as those introduced on the North-south Line, and a block system between stations, with semi-automatic or staff equipment.

From Hanoi to Hai Phong Port which is approximately 100km distance, national road No.5 operates in parallel therefore most of cargo is transported by trucks. Cargo transport by railway is temporary operated when there is demand.

(a) **Number of Trains in Operation**

Eight trains operate between Hanoi and Hai Phong, and four trains are in sectional operation between the two cities. Four trains run between Gia Lam and Hai Phong, and one middle-distance train operates between Hanoi and Hai Duong. Freight trains sometimes must wait at certain stations because priority is given to passenger trains. Therefore travel time for freight trains is longer.

Figure 2.4.2 No. of Trains in Operation (Hai Phong Line)



Source: VITRANSS 2 Study Team

(b) **Operating speeds**

Operation speed in the Hai Phong Line is 70km/h section's in 94% of the route, 30~50km/h in 6%, restricted 50km/h is on bridge, and 30km/h driving in Hai Phong Station premises.

Table 2.4.3 Operation Speed (Hai Phong)

Operating Speed	30km/h	50 km/h	70km/h	Total
Length (km)	3.0	3.0	90.0	96.0
%	3.0	3.0	94.0	100

Source: VITRANSS 2 Study Team

(3) Hanoi-Lao Cai line

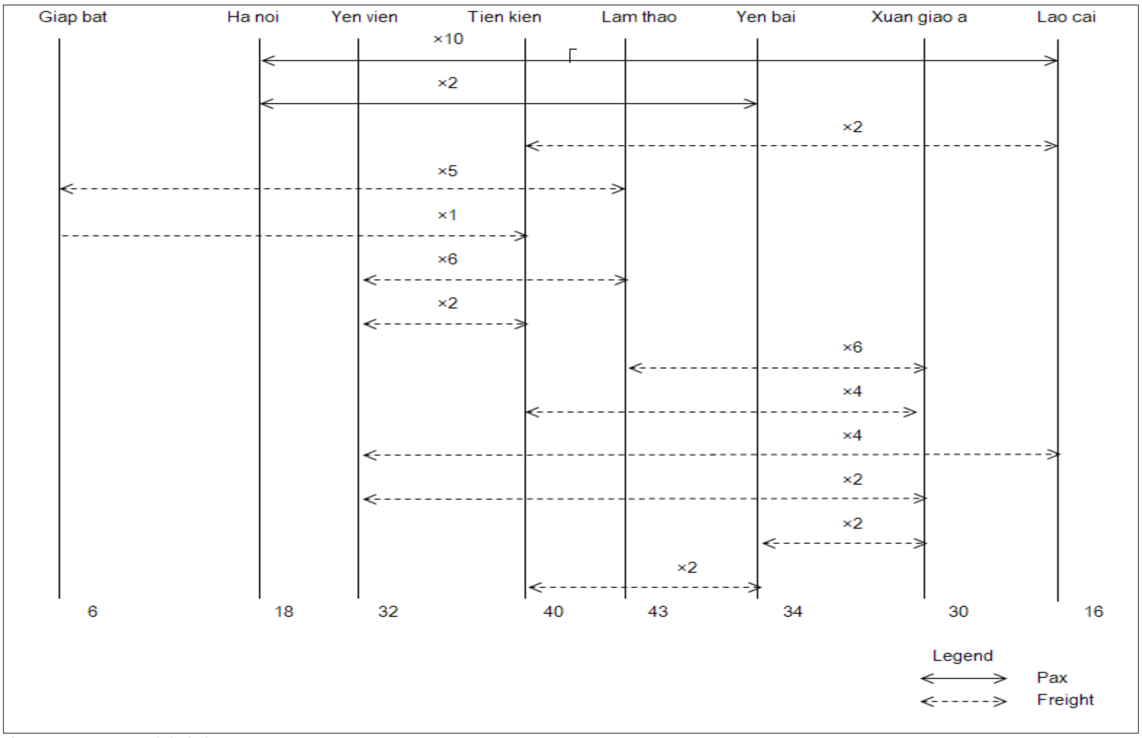
The 293.5km Lao Cai Line runs between Hanoi and Lao Cai. Trains are pulled by diesel locomotives on a single-track section with 35 stations. A train passing track is installed at all stations. Sharp curves with radii in the 150-200m range are located on the line, which was built to run along the Red River.

Train operating speeds are 45km/h (41%); 50km/h (22%); and 55km/h (10%). D12E locomotives are used for passenger train use (1,000Hp: shunting works used in Japan) for 11 passenger coaches. Block drives between stations use semaphore type and staff type, without installation of departure signals at stations.

(a) Train Operation

Ten passenger trains are operated between Hanoi and Lao Cai. Two trains run between the Hanoi and Yen Bai. Freight trains link Lao Cai and Yen Vien and Giap Bat to meet user demand. Figure 2.4.3 shows the sections with passenger and freight operations.

Figure 2.4.3 No. of Train Operation (Lao Cai Line)



Source: VITRANSS 2 Study Team

(b) Operating Speeds

Locations with speed limitations have increased due to small curvature radius of 150 to 200 meters. Train operating speeds are 35-55km/h for 78.3% of the operating distance. Ageing bridges also restrict running speeds. Table 2.4.4 shows train running speeds.

Table 2.4.4 Operation Speeds (Lao Cai Line)

Running Speed	15km/h	35km/h	45km/h	50km/h	55km/h	60km/h	70km/h	80km/h	Total
Length (Km)	0.4	13.1	117.3	63.7	29.3	3.3	41.0	17.3	285.25
%	0.1	4.6	41.1	22.3	10.3	1.1	14.4	6.1	100%

（Yen Vien-Lao cai）

Source: VITRANSS 2 Study Team

(c) **Maintenance Problems**

(i) Installation of Departure Signals

Departure signals are not installed on the Lao Cai Line. Instead, they use staff blockage devices. The station master handles the staff key for the use of blockage devices, and the key is passed to the train driver or assistant. This is with approval for train dispatch. They hold this key to the next station where they hand it over to the station master. Therefore this system does not require departure signals.

The aspect of departure signals that indicates turnout positions for approval for departure is also shown as no train in the block section. This departure signal is required for safe train operation.

(ii) Handling of Cargo

The ninth car is used as a luggage wagon in passenger trains. Loading and unloading at each station leads to waiting times at stations.

The luggage car should be remodeled for use in passenger trains. Big doors for openings are installed in luggage wagons and a low floor platform is used with the luggage wagon for loading and unloading of cargo. Sometimes they handle their luggage through windows. Therefore along time is required for handling.

Remodeling the door for the luggage car, to have a built-in larger door that open in both right and left directions, and to enable low platform to high platform work would reduce train stopping times.

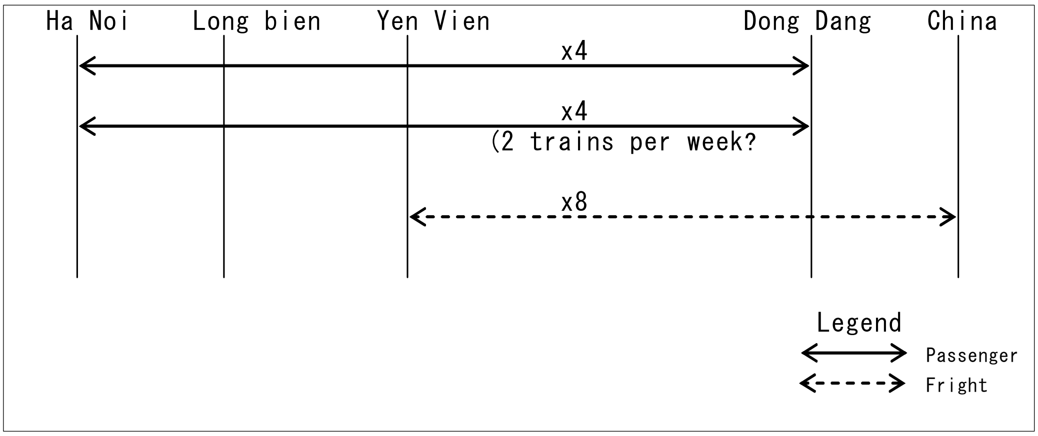
(4) Hanoi-Dong Dang Line

The Dong Dang line runs 162.5km away from Hanoi to Dong Dang, and connecting to Nam Ninh in China. A dual gauge system has been introduced on this line. International freight trains and passenger trains are operated on this section. A second-class interlock device is installed. It is set up in the station office, on a signal control table that composes the course. A blockage method is used between stations where one train is driven. Train collision is at risk because automatic train stops (Automatic Train Stop Devices) are not set up on the Dong Dang Line.

(a) **No. of Passenger and Freight Trains in Operation**

Four daily passenger trains run between Hanoi and Dong Dang, and two international trains per week run from/to China. Eight trains from China are driven to Dong Anh. Figure 2.4.4 shows the number of train in operation.

Figure 2.4.4 No. of Trains Operation (Hanoi-Dong Dang Line)



Source: VITRANSS 2 Study Team

(b) **Running Speeds**

Operating speeds are relatively high, at 70km/h section for 34.1% of the total distance.

Table 2.4.5 Running Speeds

Operating Speed	25km/h	30km/h	40km/h	50km/h	60km/h	70km/h	Total
Distance (Km)	1.72	2.23	78.408	17	9.67	56.38	165.408
%	1.0	1.3	47.4	10.3	5.8	34.1	100%

Source: VITRANSS 2 Study Team

(c) **Yen Vien Yard**

Loading and unloading is not done with pallets at the siding in the Yen Vien yard. To improve freight handling, the loading and unloading, now done by hand, must be converted to pallet loading and the use of forklifts.

2) Signal and Communication Equipment

The share of signals using colored lights is 80%. Semaphore accounts for the remaining 20% at VNR. Eighty-seven percent of the blockade devices are semi-automatic. They are of the same type used in Japan.

The semi-automatic type enables an operation method in which small orbit circuits are installed for station signals. These orbit circuits detect train departures and arrivals between stations. And the use of mutual detectors makes for one train operating between stations. An automatic block system is applied only for the section from Hanoi to Dong Dang. The token system is the same as the tablet block system in Japan. The token type is another method to be operated for one train between stations, delivering the token which is shaped like a stick. This is the same as the tablet block system used in Japanese train stations. The course composition by interlocking devices is conducted by hand.

Table 2.4.6 Signal and Communication Devices

Line	Signal		Block Sytem		Interlocking System		
	Color Light	Semaphore	Automatic	Semi-automatic	Token	Automatic	Manual
Dong anh - Quan trieu		D.phuc-Qt:6			D.phuc-Qt:7		D.phuc-Qt:6
Giap bat - Sai gon	164.000			163			10
Gia lam - Hai phong	5.000	9		14			14
Yen Vlen - Lao cai	HN-YV:5			YV-PY:5			PY-LC:5
Kep - Ha long		11			11		11
Kep - Luu Xa		3			3		3
Ha noi - Dong Dang	HN-YV:3	YV-DD:11	HN-YV:1	HN-YV:2 YV-DD:13	YV-DD:5		YV-DD:14
Dau moi - Hanoi		3			3		3
Total	177	43	1	197	29	0	66

Source: VITRANSS 2 Study Team

2.5 Railway Traffic

1) Passenger Transport

Approximately 11.6 million passengers used railway transport in 2006. The Hanoi–HCMC Line accounted for more than 50% of the ridership on all lines. Passenger volume increased 18% from 2000 to 2006, but it has decreased 4% annually since 2004. International train operation from/to China was operated via Lao Cai and Dong Dang. However the Lao Cai Line was stopped due to an international transport agreement for the safety operation purpose. The average travel distance was 375km. The passenger volume and the passenger-km data are listed in Tables 2.5.1-2.5.2.

Table 2.5.1 Passenger Transport Volume

Unit: 1000 passenger

No	Lines	2000	2001	2002	2003	2004	2005	2006
I	Domestic Total	9,806	10,677	10,782	11,586	12,941	12,769	11,573
1	Hanoi – Hai Phong	1,389	1,507	1,479	1,555	1,624	1,488	1,269
2	Hanoi – Lao Cai	2,073	2,317	2,612	2,890	3,361	3,382	3,308
3	Hanoi – Dong Dang	770	776	777	895	939	690	499
4	Hanoi – Ha Long	124	119	148	142	132	133	137
5	Hanoi – Quan Trieu	239	232	242	255	354	335	237
6	Hanoi – HCMC	5,150	5,461	5,461	5,767	6,443	6,671	6,083
7	Hanoi – Bac Hong	61	64	64	82	87	70	39
II	International Total	9	22	22	20	9	8	5
1	Hanoi – Lao Cai	2	1	1	-	-	-	-
2	Hanoi – Dong Dang	7	21	21	20	9	8	5
III	Total Volume	9,814	10,805	10,805	11,606	12,950	12,777	11,577

Source: VNR

Table 2.5.2 Passenger–km

Unit: million passenger-km

No	Lines	2000	2001	2002	2003	2004	2005	2006
I	Domestic Total	3,200	3,430	3,697	4,042	4,376	4,558	4,336
1	Hanoi – Hai Phong	92	101	99	139	110	102	102
2	Hanoi – Lao Cai	235	279	337	433	474	500	530
3	Hanoi – Dong Dang	49	46	44	68	49	37	29
4	Hanoi – Ha Long	7	7	9	12	8	17	12
5	Hanoi – Quan Trieu	11	11	12	19	18	17	12
6	Hanoi – HCMC	2,800	2,979	3,191	3,363	3,710	3,890	3,663
7	Hanoi – Bac Hong	5	6	5	8	7	6	4

Source: VNR

2) Freight Transport

Freight transport volume was approximately 11.0 million tons in 2006, increased 1.63 times from 2000 to 2006. The Hanoi-HCMC and Hanoi-Lao Cai services accounted for 60%. International cargo volume, which accounted for 13% of the total volume, increased 2.3 times from 2000. Freight transport is now slightly decreasing on a ton-km basis. The average transport distance is 297km. Freight volume and ton-km data are shown in Tables 2.5.3 and 2.5.4.

Table 2.5.3 Freight Volume

Unit: 1000ton

No	Lines	2000	2001	2002	2003	2004	2005	2006
I	Domestic Total	6,139	6,336	6,944	8,282	8,771	8,688	9,622
1	Hanoi – Hai Phong	335	496	431	600	653	577	511
2	Hanoi – Lao Cai	1,994	1,907	2,129	2,595	2,740	2,800	3,295
3	Hanoi – Dong Dang	536	615	586	637	1,060	1,070	1,514
4	Hanoi – Ha Long	732	770	951	1,155	1,105	1,106	999
5	Hanoi – Quan Trieu	235	239	199	221	236	239	79
6	Hanoi – HCMC	2,292	2,308	2,646	3,072	2,973	2,915	3,222
7	Hanoi – Bac Hong	13	2	3	2	3	2	1
II	International Total	619	673	756	1,029	1,275	1,227	1,409
1	Hanoi – Lao Cai	452	499	592	777	689	755	725
2	Hanoi – Dong Dang	167	175	164	251	586	472	684
III	Total Volume	6,758	7,010	7,700	9,311	10,046	9,915	11,032

Source: VNR

Table 2.5.4 Freight ton-km

Unit: million ton-km

No	Lines	2000	2001	2002	2003	2004	2005	2006
I	Total Volume	1,889	1,999	2,338	2,675	2,682	2,928	2,858
1	Hanoi – Hai Phong	74	94	85	108	126	112	193
2	Hanoi – Lao Cai	550	552	604	633	690	725	345
3	Hanoi – Dong Dang	188	223	241	245	282	324	204
4	Hanoi – Ha Long	42	47	56	63	63	68	37
5	Hanoi – Quan Trieu	34	33	33	44	43	48	22
6	Hanoi – HCMC	1,000	1,050	1,318	1,581	1,478	1,650	2,057
7	Hanoi – Bac Hong	1	0	1	0	1	0	1

Source: VNR

2.6 Railway Administration, Operation and Funding

1) Structural Reform of Vietnam's Railways

In 2003, the Vietnamese government decided to introduce a separated structure for the Vietnam Railway Federation to the Vietnam Railway Administration (VRA), which is an Government organ under MOT in responsibility for the whole national railway administrative and the Vietnam Railways (VNR), which is an SOEs directly controled by PM in responsibility to operate and do business on the national railway network. The progress at this stage includes ongoing renovation of railway structures under a new enterprise law and a new railway law (Railway Law, No. 35/2005/QH 11 enacted and promulgated in June, 2005);

Currently the following assets belong to the VNR:

(i) Station: land and facilities in station such as buildings, warehouses, and ground facilities, etc.
(ii) Locomotive and car depots: land, depot facilities

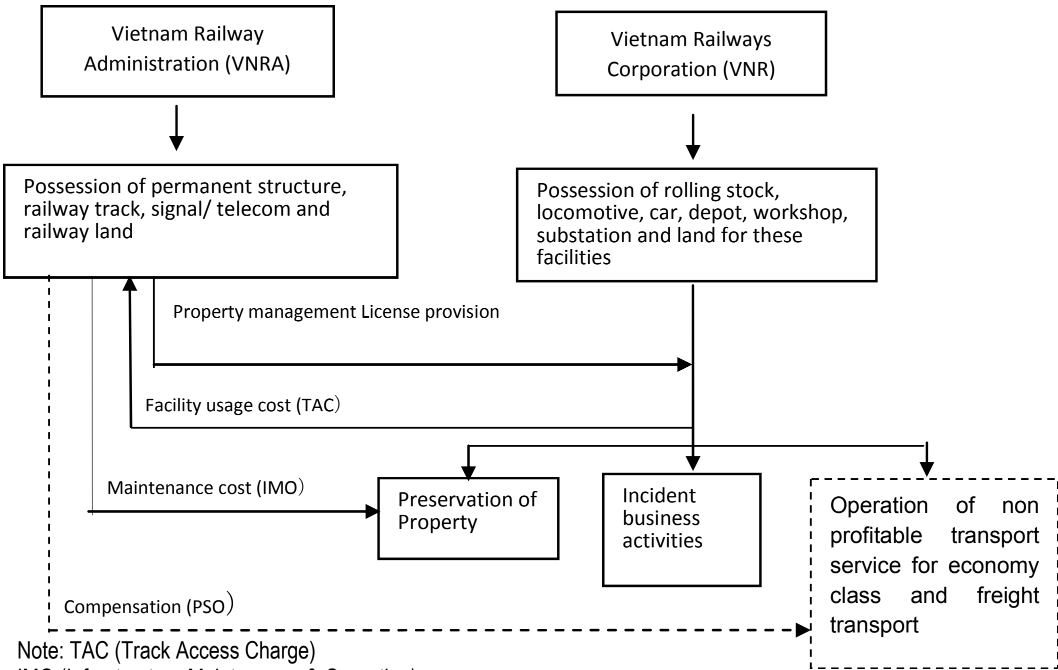
Properties that belong to the State (VRA) include:

(i) Bridges, tunnels, tracks including related land areas and superstructures
(ii) Signals and telecommunication systems

Figure 2.6.1 shows the major roles and obligations, and indicates the public service obligation (PSO), however, there are no subsidies for passenger and freight transport and determination of fare depends on VNR.

The government has made a commitment to provide grant funds for rehabilitation, infrastructure upgrading, and maintenance expenses. Previously these had been paid by the railway sector along with investment in developing infrastructure.

Figure 2.6.1 Roles of VRA and VNR



Note: TAC (Track Access Charge)
IMO (Infrastructure Maintenance & Operation)
PSO (Public Service Obligation)
Source: VITRANSS 2 Study Team

2) Administrative Framework of VRA

Vietnam Railway Administration (hereafter so-called VRA) were established in 2003 based on Decree No. 34/2003/ND-CP of the Government on stipulating MOT's responsibilities, functions, competences and its organizational structure. The responsibilities, functions, competences and organizational structure of VRA are regulated by Decision No.1891/2003/QD-BGTVT of the MOT dated 01 July 2003. VRA is the state administrative agency to do the state management on overall national railway field.

New Decree No.51/2008/ND-CP of the Government dated 22 April 2008 was issued to replace Decree No.34/2003/ND-CP. Based on new decree, Decision No 1891/2003/QD-BGTVT of MOT was replaced by a new one – Decision No.33/2008/QD-BGTVT. According to the new decision, Vietnam Railway Administration is abbreviated as VRA (Refer to Appendix 3).

Responsibilities, functions and competences of VRA are as follows: (For detail, please refer to Article 1, 2 & 3 of MOT decision 33/2008/ QD-BGTVT in Appendix 3)

(i) To promulgate the railway development strategies, master plans, annual and five years plans, national programs and projects.

(ii) To promulgate legal bases and other documents related to railway sub-sector; and participate in the establishment of laws and related legal bases.

(iii) To promulgate technical standards and process by:

- Introducing the national standard and code on railway infrastructure and transport operation.
- Participating with Vietnam Register in what mentioned in (i), concerning railway facilities inspection.

(iv) To popularize railway legal documents such as laws, regulations, strategies, plans master plans and so on.

(v) Regarding Infrastructure

- To be investment decision maker or an investor of railway infrastructure projects (funded by the state budget) assigned by MOT.
- To be a state supervisor of BT, BTO, BOT, BOO projects
- To propose the annual maintenance plan for national railway system
- To propose economic and technical standard for railway maintenance, application of infrastructure fee, methods of fee collection and railway transport charges.
- To license construction certificates, regarding Railway Right of Way, vehicles, and participation in urban railway and specialized railway.
- To issue the technical classification for national railway lines
- To participate in giving approval of maintenance cost estimation

(vi) Railway facilities: Take apart in appraising technical design and licensing.

(vii) Human resources training: To organize training programs; to supervise and give guidelines to training schools, examination and provision of certificates, introduction of training requirements.

(viii) To encourage policies and mechanisms that can create favorable conditions for railway transport and multimodal transport; to give instruction and supervision on railway operation business and other supplement services, announcement for operating time of stations; to guide international railway transport activities and stations.

(ix) Traffic Safety: To offer regulations on railway safety, programs or plans accompanied by instructions for implementation; to examine and license certificates on safety; to be a member of Flood Control-Search and Rescue Board of MOT and an investigator/advisor in case of accidents.

(x) Science and Technology: To contribute to formulating and submitting the railway scientific and technological plans and guidance for scientific researches funded by the Government.

(xi) Environmental Protection: To formulate regulations on railway environment, plans for environmental protection; to manage and conduct railway environmental researches financed by the Government; to participate in Evaluation of Environment Strategy and Evaluation of Environmental Effectiveness; to take a guide on evaluating the enforcement of regulations on environmental protection.

(xii) International cooperation: To offer the international co-operation programs; participating in negotiation, signing the international agreements and treaties, and annual protocols on cross-border railway line.

(xiii) Inspection: To settle complaints, reports and internal corruption of VRA.

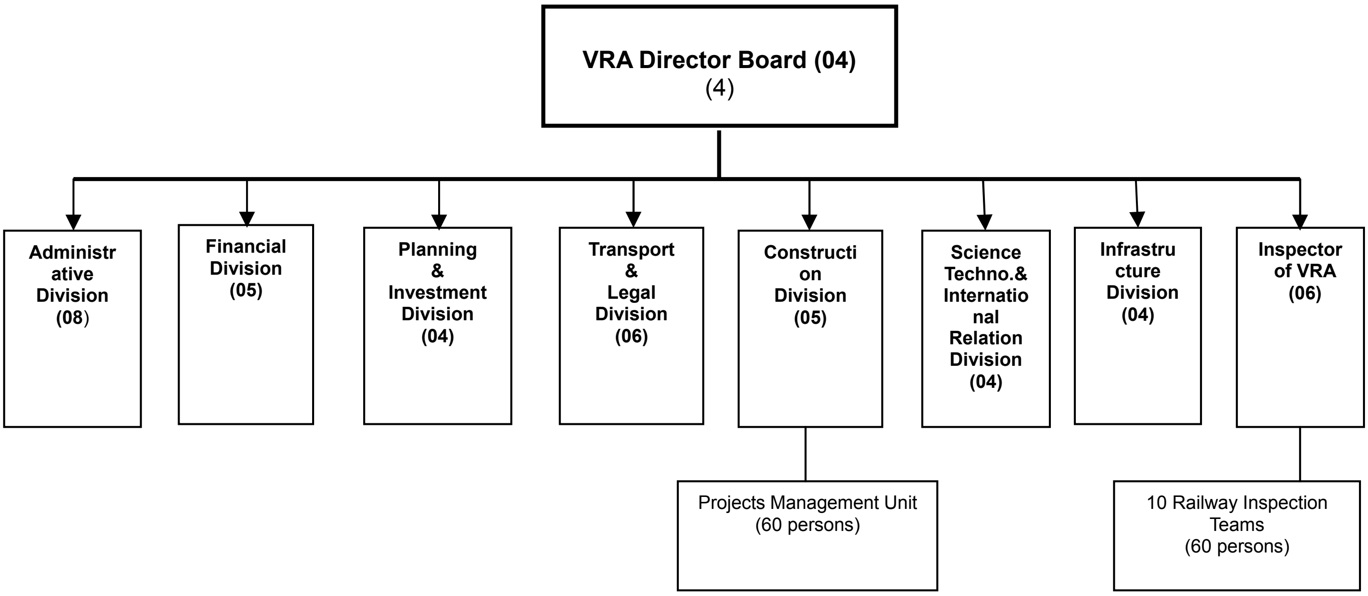
(xiv) To perform of the administrative reform

(xv) To assess and offer prices for public services

(xvi) Fixed assets: To make budget allocation and guidance on fee collection.

VRA structure (see Figure 2.6.2)

Figure 2.6.2 VRA Organization Chart



Sources: VITRANSS2 Study Team based on VRA documentations

3) Operation Framework of VNR

Decision No 34/2003/QD-TTg, article 3 is stipulated on VNR organization and its activities (VNR organization chart is described in figure 2.6.3).

VNR's actual position is indicated in Figure 2.1 in Appendix 2.

VNR has a total of 42,430 personnel (data 2008), as following:

(i) Management board

(ii) Director board

(iii) Office comprises of 16 functional departments with over 300 staffs to support board of directors.

(iv) Transport Division has a total of 21,827 staffs and consists of :

(a) Transport operation center.

(b) Hanoi passenger transport company

(c) Saigon passenger transport company

(d) Freight transport company

(e) Rail Traction Union

(v) Infrastructure Division has 14,171 staffs, in which:

(a) 15 track and bridge maintenance companies.

(b) 05 signal & telecommunication maintenance companies.

(vi) Construction Division has 4,070 staffs, in which:

(a) 09 track and bridge engineering & construction companies.

(b) 01 signal and telecommunication installation company.

(c) 01 engineering and consultant company.

(vii) Material and transport services bloc

(a) 16 hotels

(b) 02 print companies

(c) 08 companies of material and transport services.

(viii) Non productive bloc:

Project management Units (PMUs) has 135 persons, in which:

(a) Railway PMU

(b) PMU Region I

(c) PMU Region II

(d) PMU Region III

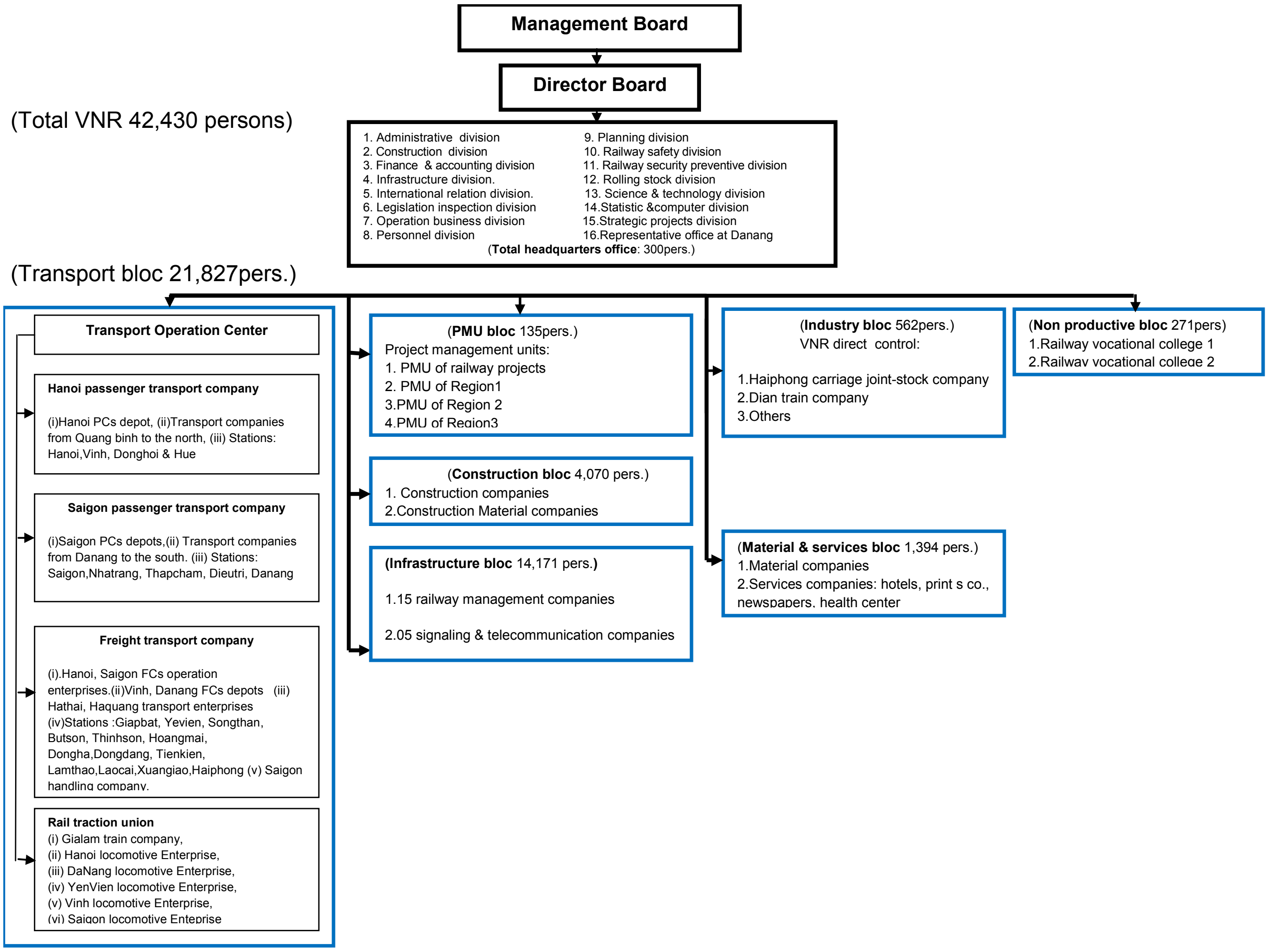
(MOT official dispatch No 4087/BGTVT is promulgated VNR play role as investor of rail construction projects by source of government budget that locates on ongoing operation rail lines).

(ix) Vocational training schools: 02 vocational training colleges No.1 & No.2

Passenger service is operated by two companies: Hanoi Passenger Company and Saigon Passenger Company. Each takes care of transport service in a half of the country (North and South). Freight service is operated by only one Freight Transport Company. VNR has established a study team for getting the reformative advices and toward a reform since 2009. The study team has proposed four reforming options; however no final decision has been come up. Train operation agencies have their own management and accounting system.

Vietnam Railways is the sole provider of rail service and control enterprises to implement construction projects and maintenance activities on the existing railway infrastructure and other commercial activities. Though the separation of infrastructure management from operation management has been defined, operation and maintenance of infrastructure is still done by railway management companies of Vietnam Railways.

Figure 2.6.3 VNR Organization Chart (by sectors)



Sources: Study Team (documentations from VNR)

4) Income and Expenditure

The Vietnam Railways has reasonable fares, and pays fees to the State as a responsible agency of the VRA for the usage of infrastructure.

Table 2.6.1 shows income and expenditure of the VNR Transport Division. Income means operating revenue, but does not include investment costs. VNR income and expenditures for 2006 were approximately VND 2,200 billion. The charge for using railway infrastructure was VND 200 billion in 2006, which is approximately 9% of income.

VNR could rationally adjust fare with the following:

(i) Market mechanisms to compete with other transport modes
(ii) Present situation of the company
(iii) People's living standards and owners of bonded goods

However, when fuel costs constantly increase over a short period, in order to avoid a heavy impact on people's livelihood, VNR has to follow MOT and Ministry of Finance guidelines. In general, the average growth rate of freight transport fare is 5% and passenger fare has been increasing at 3% per year.

Table 2.6.1 Income and Expenditure

Unit: billion VND

Item	1996	2002	2003	2004	2005	2006
1. Income	899.2	1,460,9	1.683,1	1.849,9	1,980,0	2,226.4
1)Passenger Income*1	466.1	906,8	1,046.1	1,169.1	1,274.6	1,350.0
2)Freight Income*1	407.1	523.9	608.7	649.0	656.6	797.2
3)Baggage Income	26.0	30.2	28.3	31.8	31,8	34.9
4)Other Income *2					16.9	44.3
2. Expenses	869.2	1,449.9	1,672.1	1,846.5	1,975.5	2,220.8
1) Salary	193.4	353.5	407.3	447.7	475.1	531.0
2) Social Insurance	13.5	28.0	37.5	39.4	53.8	62.0
3) Materials *3	139.9	160.8	162.9	179.7	173.5	167.8
4) Fuel	105.2	196.2	236.6	273.4	352.2	488.0
5) Electricity	9.6					
6)Basic depreciation	99.1	250.9	269.7	283.0	300.2	324.5
7)Large repair*4	82.1			106.2	81.2	72.2
8)Others	100.1	314.4	389.8	332.1	343.2	355.7
9) Collection on Capital	36.4					
10) Other Expenses*5	116.5	146.1	168.3	185.0	196.3	219.6
a. Infrastructure Tax*6	89.9	146.1	168.3	185.0	196.3	219.6
b. Revenue Tax	26.6					

Source: VNR
Notes:
*1: The fare systems for passenger and freight are determined by railway law and MOT regulations. However tariff formulation has been revised by the MOF and MOT for special market mechanisms.
*2: New policy for renting stores, land, etc.
*3: New locomotive and rolling stock are replacing aged items, savings on cost parts are achieved.
*4: Locomotive, rolling stock and others
*5: Include transactions, meetings, land tax, etc.
*6: For usage of infrastructure (8% of transport revenue)

2.7 Summary of Current Issues

Issues currently faced by the VNR are summarized in Table 2.7.1

Table 2.7.1 Current Tasks for VNR

Item	Subject	Present Condition	Proposal/Effects
Safety	Tunnels & Bridges	Almost all facilities have deteriorated due to ageing, war damage, and disaster. Locates many restricted-speed sections.	Rehabilitation or new construction is recommended to reduce maintenance costs and enhance safety.
	Tracks	Rail and turnouts deteriorated due to aging.	Replacement to 50kg/m is proposed for strengthening of rails, including turnouts.
	Signaling	Interlocking system between turn-outs and signals on station premises is inadequate.	Relay interlocking system needed to prevent accidents caused by mishandling. Also an ATS system is recommend preventing train collisions.
	Railroad Crossing	Disregard of approaching train by cars, motorcycle and others; time spent at sliding gates. Illegal railroad crossings are increasing	ROW management, install automatic gate and grade separate structure to reduce accidents. Also reduce gatekeepers. Program to raise safety awareness is also required.
Reliability	Flood Protection	Submergence, washed-away track beds and ballast during heavy rainy season	Establish inspection system, pre-preservation works, deform record for prevent disaster for saving restoration costs.
	Track Structure	Lost railway fastening bolt and shortage of fixing bolt, broken 2 block concrete sleeper, shortage of ballast	Creation of reporting system from site workers to head office for quick action keeping good track structure.
	Track Maintenance	Seems most of section was adding ballast; however, maintaining thickness of 20cm under the sleeper.	High speed inspection-car, multiple tie tamper and machined maintenance required for reliable train operations.
	Equipment at Workshop and Deport	Still use aged equipment and some of equipment for steam locomotive	Introduce new equipment for reduction of repair and maintenance time.
Transport Capacity	Train Diagram	Long-distance trains have priority operation, especially N-S line; when one train delays other trains directly sacrifice this delay.	Revise long-distance diagram and introduce intermediate trains based on demand and for increasing track capacity.
	Introduce Double track	Small curvature and steep gradient reduces track capacity.	Introducing signal station to improve track capacity; however double track is most effective way, or partial double track in bottleneck section.
	Rolling Stock	Some high power locomotives are introduced, but most of rolling stocks are deteriorated and ageing.	Procure rolling stock in response to demand, extend effective track length in station for long train formation.
Service Level	Station Front Plaza	Existing station front plazas do not function as interface between railway and city and/or no station front plaza at main stations.	Provide space for feeder system such as local bus terminal, taxi pools, etc.; increasing train operation is essential.
	Lower operating Speed	Small curve, railroad crossing, narrow wayside make reduce train running. Also, on-off time at station results in longer travel times.	Low speed influences travel time and track capacity. Recommend improvements. High level platform also recommend reducing on-off time.
Transport efficiency	Passenger Information system	Aged communication network hinders passenger service.	Need to renovate, strengthen operation control. Upgrade passenger information system for ticket reservation and sales, etc.
	Freight information system	Marketing control, delivery system and efficient utilization of empty wagon system are delayed	Demand creation is one way to improve current slack condition. Wagon monitoring system is one way to utilize empty wagons.
Management	Organization	Shortage of budget, lack of smooth coordination between each division for creation of demand and improving services.	Railway operation requires high level conglomerate sense for rolling stock, signal & telecommunication, infrastructure, operator and investment/maintenance of facilities.
	Manpower	Productivity is still low level in comparison with other countries.	Labor-intensive system required for passenger and freight transport field.
	Education and training	Education and training facilities and equipment do not meet present requirement.	Provide latest training materials and facilities needed for modernized train operation system.
	Commercial and marketing	Still low level of consciousness for commercial and marketing to create positive railway business	Provide better transport service to meet user requirements more than other transport sectors.

Source: VITRANSS 2 Study Team

3 CURRENT POLICIES AND PLANS

3.1 Review of Government Plans and Policy Direction

In November 20, 2008, the development strategy for Vietnam's railway sub-sector and the Vision until 2050 was approved by the Prime Minister (under Decision No. 1686QD-TTg). This decision re-oriented the long-term development of Vietnam's railway towards modernization, sustainability, and safety and environment friendliness. The plans of MOT and VNR amplified and followed closely this directive.

1) Adjusted Vietnam Transport Development Strategy 2020 and vision to 2030 (MOT)

The MOT prepared new transport development strategy in 2007, and submitted to government in 2008 and was approved by the Prime Minister (Decision No. 357 35/2009/QĐ-TTg of Prime Minister, dated 03.03.2009) on adjusted transport development strategy up to 2020 and vision up to 2030;

MOT also called for a review of previous progress on approved strategy, with a development target based on balanced transport modes and services. This target has not been realized. Investment in the railway sector was very small in relation to plans and in comparison with other sectors. In particular, progress has been very slow in the upgrading of the North-South railway where only one-third of the required investment was realized.

For the railway development plans up to 2020, the qualitative target is to complete the improvement and upgrading of existing railway lines to meet the national and regional technical standards (speed 120 km/h). It would be considered to construct express railway and high-speed railways lines. Priority is given to the north –south high speed railway with the speed of 350 km/h and developing urban railways in Hanoi and Ho Chi Minh City.

Railway vehicles and facilities are to be developed by diversifying and rationalizing vehicle capacity, modernizing, lowering costs and fares, and applying advanced technologies in building new vehicles. The railway development directions are defined as follows:

(a) **2020 Target:** (i) build an express railway with 1435mm track for Hanoi-Ho Chi Minh route: Hanoi-Vinh and Nha Trang-Ho Chi Minh and some sections in central region of Viet Nam. (ii)Constructing the high-speed railway line of two economic corridors and one belt with China. (iii) Build railway Bien Hoa-Vung Tau and Di An –Loc Ninh to integrate to the Asian Railway line. (iv)Construct the Ho Chi Minh- My Tho- Can Tho railway line.

(b) **Vision to 2030:** Complete the system for Hanoi-Ho Chi Minh City expressway railway. Railway system Vietnams will meet the technical standards and integrate with the Asian railway

2) Vietnam Railways Transport Sub- Sector Strategy up to 2020 and vision to 2050

The 'Vietnam Railways Transport Sub-sector strategy' was formulated by VNR, reviewed by MOT and approved by Prime Minister by decision Nr. 1686/QD-TTg, dated 20.11.2008, It sets the agenda for the development of Vietnam railways transport system to year 2020 and vision to 2050. This would entail investments in building and developing a rational, modern and uniform railway network nationwide, on scales suitable for each region, forming integrated centers of railway transport infrastructures and services, facilitating the exploitation of existing potentials, and building the capability of the railway transport sector.

Its key targets by year 2020 are: 13% share of the passenger movement markets (HK-Km), 14% of the inter-provincial cargo movement market (T.Km), on the main corridor like North–South corridor, the market share will be 37% and east-west corridor of 45% and 20% of the daily urban commuting trips in Hanoi and HCMC. These objectives were defined the priority of completing and operating the Lao Cai-Ha Noi-Hai Phong and Ha Noi- Dong Dang lines (belonging to two economic corridor and one belt Viet Nam-China);invest to build, complete and operate the North – South high speed railway to enable running speed of 350 km/h with prioritized to complete sections of Ha Noi – Hue/Ha Noi –Da Nang and Ho Chi Minh – Nha Trang; complete and put in operation of the Yen Vien – Pha Lai-Ha Long- Cai Lan, railway connecting to seaport, industry zone and tourism zone. It is also supposed to be achieved by upgrading the existing network to enable running speeds of 120km/h for interprovincial, cargo transport and integrating to the ASEAN country's railway.

Construction of the Hanoi−HCMC High Speed Railway up to 2020 is pinpointed as priority. This is viewed as a catalyst for socio-economic development and the industrialization and modernization of the country, enhance economic integration, and contribute to national security, political development, and defense.

The key targets by year 2050 are to meet 20% share of passenger and cargo movement markets (Hk-km and Tkm). On the main corridors like north –south corridor, these shares would be 40% on passenger and 50% on cargo market share. Similar the share of East-West corridor would be 45% and 50%.

3) Government Investment Program

In Decision 412/QD-TTg 2007 issued on 11 April 2007, the Prime Minister provided guidelines and investment strategy for key transport infrastructure projects up to 2020. Investment in railway infrastructure will be drawn from the State Budget and recovered in the form of infrastructure fees (see Table 3.1.1). The required investments for railway sub-sector was placed at VND98,051 billion - broken down into VND23,530 billion for the period 2001-2010, and VND74,521 billion for the period 2010-2020.

Table 3.1.1 Railway Investment Program

No	Project	Scope	Estimated Cost	Period	Present Status			
					PFS&FS	Consultancy	Fund Sources	Remarks
1	Hanoi-HCMC Express Rail	1630km	33,000 M$	2009-2010 3,000 M$ 2010-2020 30,000 M$	PRS/FS = na	Expecting Japanese cooperation	Japanese ODA and co-donors	Commitment between Vietnam and Japan
2	Improve, upgrade Yen Vien-Lao Cai	280km	160 M$	2007-2010	F/S will approved soon	ADB / VR consul	ADB finance + SB	Agreement ADB No. 2302 Jan 2007
3	Development of Lao Cai-Hanoi - Hai Phong	398km Gauge 1,435mm	9760 M$ After 2020	2005-2010 2,760 M$ 2010-2020 7,000 M$	F/S=na	Non	Expecting Chinese ODA	No commitment
4	Improve and upgrade Dong Dang-Hanoi	165km	100 M$	2010-2020	F/S=na	Non	Expecting Chinese ODA	No commitment
5	Development of railway line serving aluminum transport	435km Planned 1,435mm	130 M$	2010-2020	F/S=na	Non	Expecting BOT	No commitment

Source: VRA (412/QD-TTg)

Another document (1290/QD-TTg issued 26 September 2007) outlined the foreign investment plan or the so-called BOT projects for 2006 to 2010. It listed rail projects intended for BOT implementation, as shown in Table 3.1.2.

The plan for new railway lines is depicted on Figure 3.1.1. It is clear that the focus is to expand the network considerably, and not merely improve or upgrade existing lines.

Table 3.1.2 Rail Projects for Foreign Investment (BOT)

Unit: USD Million

No	Project	Work Covers	Financial Support	Estimated Cost
1	Development of Lao Cai-Hanoi-Hai Phong	Length: 389km Track gauge	BOT	530 M$
2	Development of railway for tourism in Da Lat-Thap Cham	84 km Rack track	BOT	320 M$
3	Development Boa Lam-Phan Thiet	100km	BOT	500 M$
4	Yen Vien-Ngoc Hoi	28.8 km	BOT	1,618M$ (1st stage 1,130M$9)
5	Bien Hoa -Vung Tau	78km	BOT	NA
6	Trang Bom-Hoa Hung	49km	BOT	550M$
7	Saigon-Loc Ninh	131km	BOT	300 M$
8	Hanoi -Ha Dong	13.1km	BOT	370 M$
9	Hanoi -San bay Noi Bai	27km	BOT	370 M$
10	Hanoi- Lang Hoa Lac	33.5km	BOT	938.1 M$
11	Albumin-Highland Central	1,435 gauge	BOT	100 M$
12	Saigon-My Tho	87km	BOT	447 M$
13	Hai Van tunnel	8-10km	BOT	200 M$

Source: VRA (1290/QD-TTg)

Figure 3.1.1 Railway Network Development Plan to 2020

Source: VITRANSS 2 Study Team

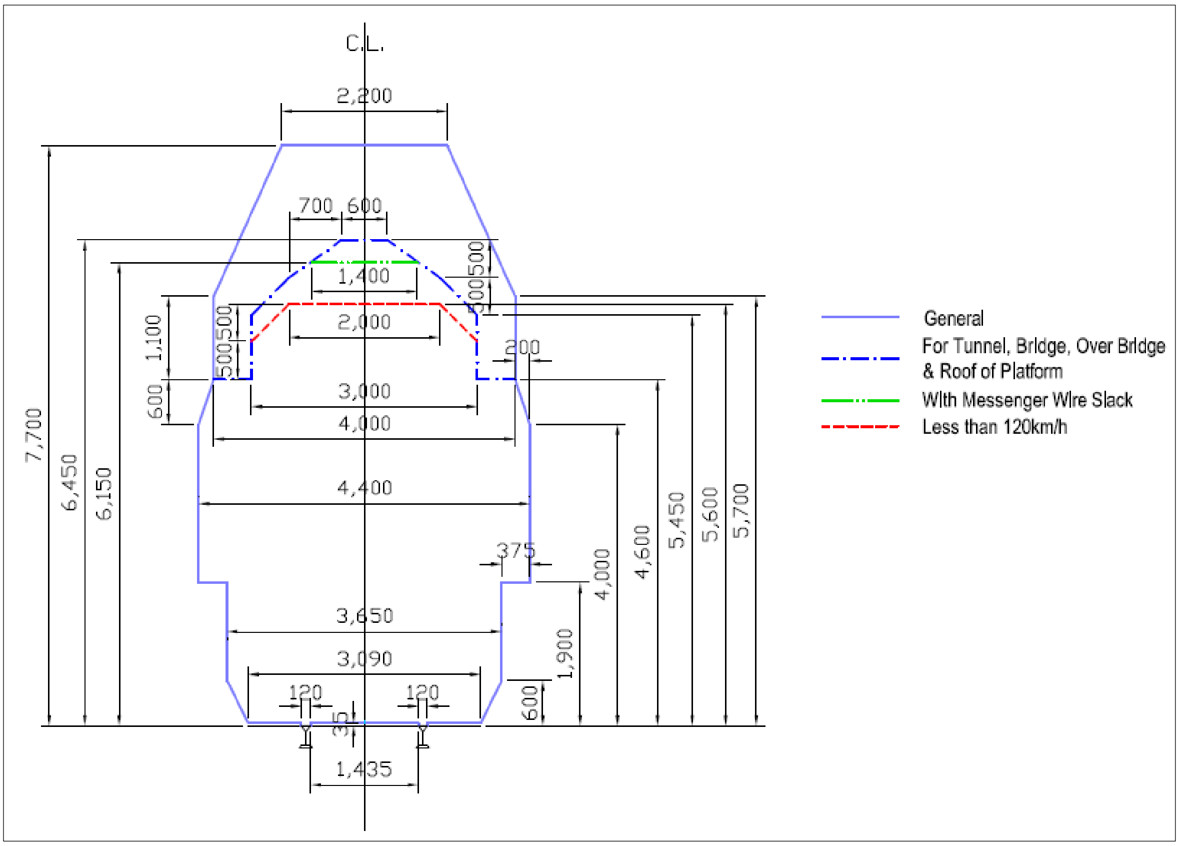
3.2 The Plan for HSR

1) Technical Features

The VNR initiated a feasibility study for the N-S High Speed Railway (HSR) sometime in 2008. This was conducted by the Japan Consultant Joint Venture (VJC) and entitled the study of "Establishing Report on Construction Investment of High Speed Railway Line Hanoi-Ho Chi Minh City". Its key features are as follows:

(a) **Kinetic Envelope:** The clearance gauge, based on evaluation of several types of HSR, shall be 4.4m, excluding 500mm allowance for vibration and any horizontal displacement of car body during operation. This is illustrated in Figure 3.2.1.

Figure 3.2.1 Kinetic Envelope of HSR



Source: VITRANSS 2 based on a figure on VJC report

(b) **Design Criteria:** The proposed HSR was prepared assuming the EMU-type Shinkansen whose are parameters are shown in Table 3.2.1.

(c) **Route Alignment:** The VJC study team selected the Ngoc Hoi-Thiem route. In the selection of routes, the factors considered were the physical conditions of the area in terms of topography and geology, the locations of cultural assets and artefacts, the patterns of urban settlements, the characteristics of existing rail tracks as well as roads and planned expressways. The characteristics of the resulting alignment are indicated in Table 3.2.2.

Table 3.2.1 Design Criteria for the North South HSR

No	Items	Unit	Adopted for the Project
1	Railway gauge	mm	1435
2	The number of main lines		Double track
3	Maximum Design speed	Km/h	350
4	Maximum Operation speed	Km/h	300
5	Minimum curve radius	m	6000
6	Minimum vertical curve radius	m	25.000
7	Maximum super-elevation	mm	180
8	Maximum super-elevation deficiency	mm	110
9	Maximum gradient	‰	25
10	The distance between track centers	m	* 4.5
11	Width of roadbed	m	* 11.6
12	The standard cross section of tunnel	m2	80
13	Design load		P-16
14	Track		Ballast-less
15	Rail	Kg/m	60
16	Power supply		
	Feeding voltage	-	AC25kV 50Hz
	Feeding system	-	Auto transformer
17	Signaling		
	Signaling system	-	Internal signal with ATC
	Train control	-	Digital ATC
	Bilateral operation	-	*Allowed

Source: VJC Report

Table 3.2.2 Characteristics of the Proposed Route

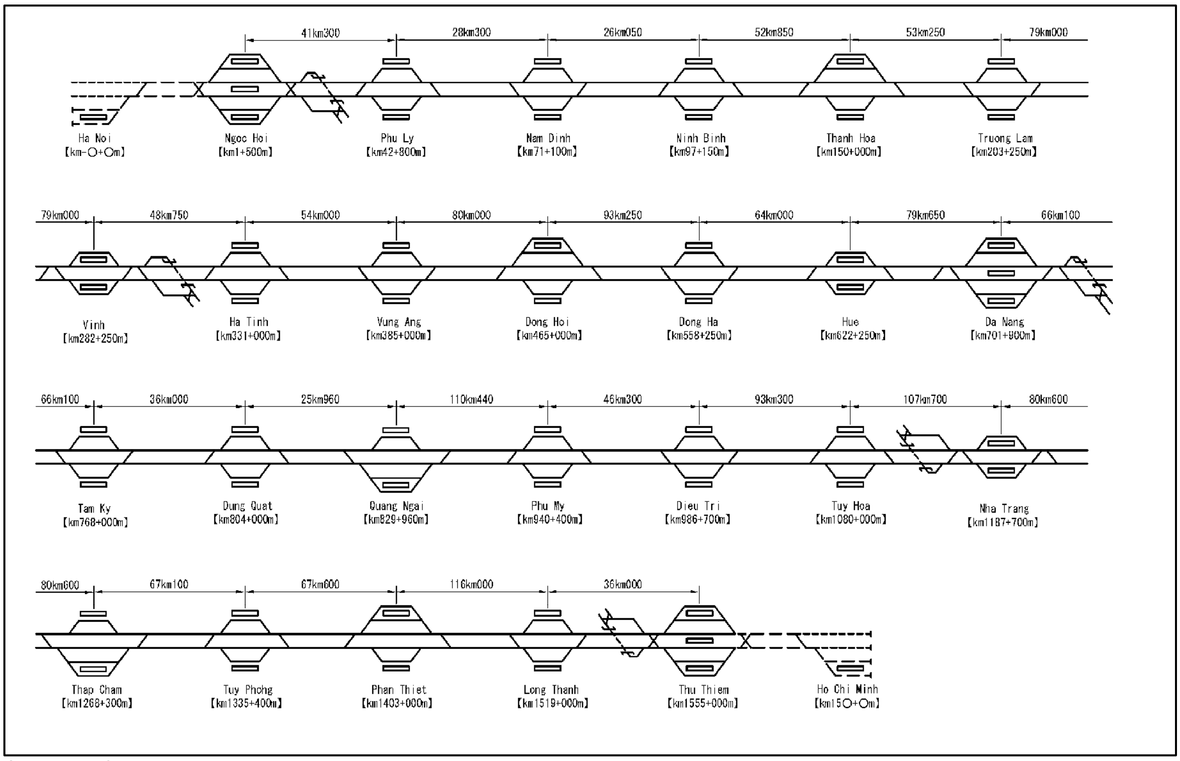
Route Plan	
Total length	1,556.0km (100%)
Straight sections	1,273.0km (81.8%)
Curve sections	283.0km (18.2%)

Longitudinal Profile	
Gradient $0 \leq G < 1$ ‰	1,054km (67.7%)
Gradient $1 \leq G < 15$ ‰	502km (32.3%)
Gradient $15 \leq G < 25$ ‰	0km (0%)

Source: VJC Report

(d) **Station and Track Layout Plan**: Location of stations were chosen with due consideration to the ideal 50-km interval, location of depot, and projected demand from cities along the HSR route. Twenty-five stations, excluding the terminal stations at both ends, were identified. The station interval is 26km between Dung Quat and Quangai, and 116km between Phan Thiet and Long Thau. Figure 3.2.2 shows the proposed station and track layout plan.

Figure 3.2.2 Station and Track Layout Plan



Source: VJC Report

(e) **Civil Structures:** The track civil works was designed with a distance between track centers of 4.5m, a formation level of 11.6m that takes into account the need for evacuation/maintenance passage width of 1m at both sides of the track, and safe clearance between trains travelling in opposite directions. Other factors were also considered – such as peripheral environments, construction cost and methods. The result is shown on Table 3.2.3.

Table 3.2.3 Type of Civil Structures

Type of Structure		Number	Length (m)	Ratio	Remarks
Bridge	Railway	21	420		
	National Road	28	1,160		
	General Road	31	930		
	Planned Road	9	450		Highway
	River	227	39,428		
	Valley	4	2,000		
	Lake	4	1,100		
	Canal	4	220		
Subtotal		324	45,708	2.9	
Viaduct	Main Line	456	998.317		
	Station	25	30,800		
Subtotal		481	1,029,117	66.2	
Tunnel		72	116,550	7.5	
Earthwork	Cutting	220	149,870		
	Embankment	103	214,355		
Subtotal		323	364,225	23.4	
Total		1,201	1,556,600		

Source: VJC Report

(f) **Rolling Stocks:** The latest Japanese Shinkansen rolling stock design was adopted. It is capable of speed of 300kph and maximizes number of passengers per train set. The distributed traction of the EMU system contributes to a reduction of vehicle weight and consequently to reduction of the construction cost of the track infrastructure. It was calculated that demand could be met with a train set of 10 cars at the time of partial start of operation in 2020, extendible to 12 cars in 2035, and 16 cars at the maximum. Station facilities considered the maximum train length.

(g) **Power Supply System:** The power supply system is similar to the highly reliable system as proven in Shinkansen operations; however, it took into consideration latest advances in power electronics affecting the overhead contact lines, feeding of alternating currents, transformers, and the like.

2) Implementation Schedule for HSR

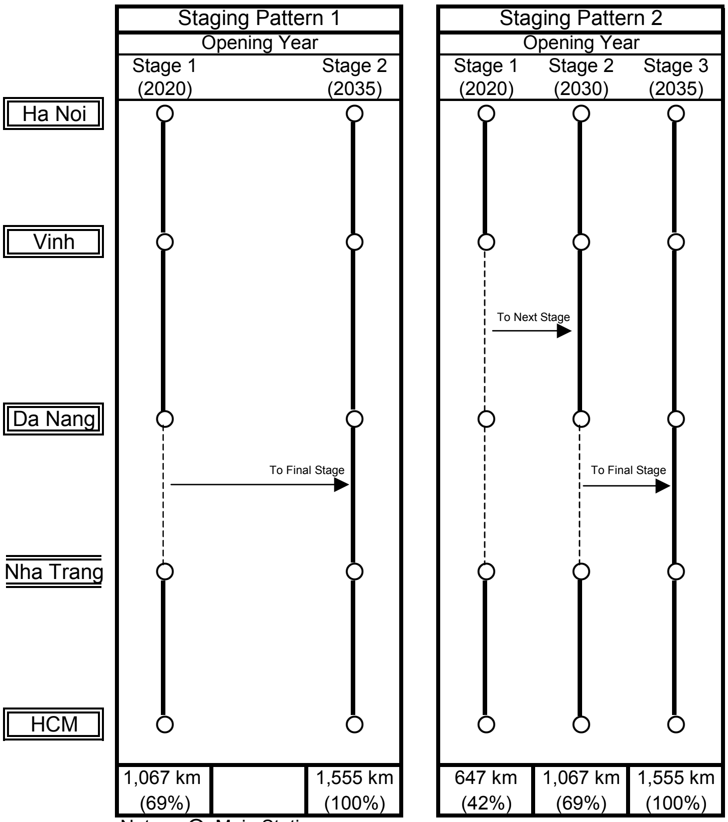
Assuming no financial obstacle, a development schedule was drawn up considering the technical aspects of preparing a more detailed feasibility study, detail design, tendering, land acquisition, and organizational development. Two-stage construction alternatives are shown in Table 3.2.4 and Figure 3.2.3.

Table 3.2.4 2-Stage Construction Options

Option	Stage	Opening Year	Section
Sequence 1	1	2020	Ha Noi-Da Nang Ho Chi Minh-Nha Trang
	2	2035	All sections (Ha Noi-Ho Chi Minh)
Sequence 2	1	2020	Ha Noi-Vinh Ho Chi Minh-Nha Trang
	2	2030	Vinh-Da Nang
	3	2035	All sections (Ha Noi-Ho Chi Minh)

Source: VJC Report

Figure 3.2.3 Two-Stage Development Options



Source: VJC Report

3) The cost of HSR

The estimated total project cost for the HSR project is USD55,785 million, as shown on Table 3.2.5.

Table 3.2.5 Cost Breakdown of HSR Project

Items	Million USD
A. Main Cost	47,439
1. Construction Cost	19,445
2. Station	2,818
3. Deport	732
4. Electricity Equipment	7,008
5. Signal-Communication System	5,352
6. Rolling stock and maintenance equipment	9,587
7. Construction Services	707
8. Land Acquisition	1,790
B. Contingency (5% of A)	2,346
C. Tax and import tax etc.	6,000
Total	55,785

Source: VJC Report
Notes:
1) Average construction cost for 1km of tracks is estimated 4.4 million USD.
2) Construction service cost is 2% of items 1, 2, 3 and 4.
3) Estimated average cost of construction per km is 24.6 million USD
4) Average cost per rolling stock is 4.0 million USD.

3.3 Commentary on Government Plans and On-going Projects

1) Unrealistic Targets

The railway plan set very high targets and fails to consider the likely size of the budget envelope. It is not surprising, therefore, for the railway sector to fall short of its planned developments.

For example, to get a 20% share of the total passenger market by 2020, the ridership on rail must increase 20 times faster than the overall transport demand. Stated another way, rail must expand its ridership by a 33% every year. To put this into historical context, rail only managed to post less than 5% growth in the last 5 years.

The annual investment program for rail was pegged at VND2,350 billion, but it was able to get only about 25% of that amount. A shortage of funds, of course, will lead to implementation delays for on-going projects and deferred commencements on new projects. At this investment rate, the plans for 2010 can only materialize by year 2040.

With the increase in the price of construction materials, the budgetary issues of the railway sector can only get worse. Take for example, the price of steel, an important material for rail track and the manufacture of rolling stocks. Its 2008 price in the global market has jumped by 50% compared to 2006.

Some rail projects also encountered several delays, such as:

(i) Tedious bidding procedures,

(ii) Delays in the review and approval of technical document;

(iii) Difficulty in identifying land owners and lack of funding for the land compensation

2) Issues on Priorities

The plans have put a premium on early shift – from narrow to standard gauge. It scheduled the shift to happen too soon, or too rapidly. For example, the plan for the NFEZ calls for three railway lines radiating from Hanoi to be converted to 1435mm gauge by 2015. The direction of the SFEZ plan is similar, although the rail projects are different. In the northern region, the Luu Xa–Kep–Ha Long line was recently built using 1435mm, but is presently under-utilized. Given the current and extensive rail network on narrow gauge, and the potentials to extract some more capacities from the rail assets, the incremental benefits of a shift would be small in the medium term compared to the transition costs.

The general direction to get the trains moving at faster speed and thereby increase capacity is sound. However, the railway plans are ambiguous as to which section of what line deserves to be first for implementation. The transport demand on the various lines will not grow in similar fashion. Therefore, the priority should go to the section showing the largest increase in demand. By proposing comprehensive improvement or capacity expansion, the plans have opted to take a network approach, instead of the project approach, to planning. In an environment of limited funding, the project approach or selective approach is practical.

3) Issues on Inter-modal Competition

It seems that the railway plans were conceived without regard to the plans for the other transport sub-sectors. This is apparent when one examines the different transport plans for specific corridors. In the Hanoi-Hai Phong (Ha Long) corridor No.3, for example, two expressways are proposed to be built. One of them would be on the same timing frame as the proposal to build a high-speed railway line on the same corridor. Considering existing and forecasted demand, the two projects would end up competing for the same demand, and thereby split the market. Many other cases can be cited to illustrate this point. Nevertheless, nowhere is this issue more critical, and strategic, than in the case of the north-south corridor. In this corridor, the passenger and freight market would split in three-ways (high-speed rail, expressways, aviation) depending on cost, time, and scale.

It will be recalled that the Eurotunnel was built during 1987-1994 for over £10 billion to link the European continent with the United Kingdom. It offered competition against sea and air transport across the Atlantic Ocean. After more than 10 years of operation, the Eurotunnel has proven to be a financial disaster to its investors and lenders.

There is nothing inherently wrong with having several modes compete for the same market on the same transport corridor. However, considering a limited budget envelope and the size of the market, it is prudent to favor the one mode that is more sustainable than the others are.

4) Issues on the HSR

The technical feasibility of the HSR can be conceded. However, its financial and economic viability are so marginal to justify early implementation before 2020. Its project cost alone cannot exceeds the budget envelope (estimated at USD37 billion) for the 2010-2020 timeframe. The project cost is also beyond the scale of ODA funding. In addition, because of its poor financial returns (as shown in Table 3.3.1) compounded by uncertain demand, private sector participation is also deemed unlikely.

Table 3.3.1 Financial Internal Rate of Return

Stage Construction Pattern	Fare Policy	FIRR (%)
Sequence 1	Policy 1: Equal to Airfare at Full Operation	- 0.3
	Policy 2: Half of Airfare at Partial & Full Operation	-2.4
Sequence 2	Policy 1	-0.4
	Policy 2	N.A.

Source: VJC Report

The economic returns, shown in Table 3.3.2, are also below the threshold 12% that is normally applied in Vietnam.

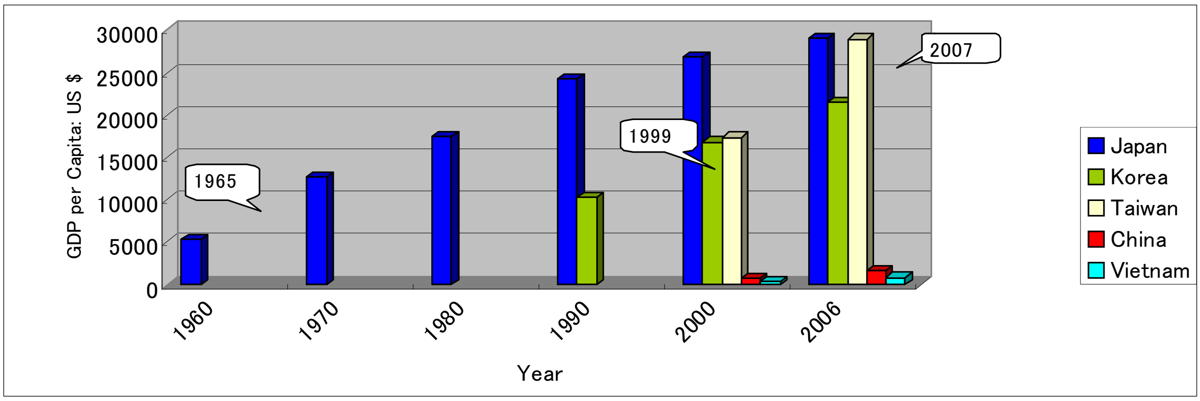
Table 3.3.2 Economic Internal Rate of Return

Stage Construction Sequence	Fare Policy	EIRR (%)
Sequence 1	Policy 1: Equal to Airfare at Full Operation	4.6
	Policy 2: Half of Airfare at Partial & Full Operation	6.5
Sequence 2	Policy 1	5.5
	Policy 2	8.9

Source: VJC Report

What the preliminary results suggest is a deferment of the HSR project, until such time that large cities and greater economic activities emerge between Hanoi and HCMC. The countries with HSR were able to build HSR over shorter lines (~300km) because their urban nodes were not very far from each other. Moreover, their GDP per capita when their HSR systems were built were considerably higher than Vietnam, as shown on Figure 3.3.1.

Figure 3.3.1 GDP per Capita at Introduction of HSR



Source: US Department of Labor (2007 July) and CIA World Fact Book

4 MAIN PLANNING ISSUES

4.1 Overview of Issues

The main issue facing the railway sector is a choice between the still-usable old railway system and developing a new system. The overarching inclination is to replace the old system (diesel-locomotives and narrow-gauge combination) with the newer technologies that also carry the image of modernity and higher standards. Unfortunately, moving full-scale on the latter path is not possible or practical for many reasons. First, it would require massive investments and funds are quite limited. Second, the modernization requires having a time and it cannot be done in a short period. Third, the existing system has been the object of more than a decade of rehabilitation works that cannot just be shut down and abandoned. Fourth, the rapid growth of road transport has eroded the market share of railways and the modernization of the railway system will not necessarily regain its railways previous prominence. This dilemma is nowhere more obvious in the building of new lines – which are all planned on the parameters of the new: standard gauge and are electrified.

Compounding the issue are three competing directives in the railway sub-sector. These are: the old and established railway system, new urban metros, and ultra-modern high-speed railway (HSR). The scope for each may overlap, but not congruent. The three are actually in competition for scarce financial and human resources.

(i) All projects and proposals to improve, upgrade, and maintain the existing railway lines of VNR belong to the first group. The flagship project is the Hanoi-HCMC Express railway, and it possesses the largest rail assets in need of rehabilitation.

(ii) Urban railway transit projects for HCMC and Hanoi comprise the second group, which has a significant impact to railway policy because the scale of committed investments far exceeds that was allocated historically for the railway sub-sector;

(iii) The HSR is still under discussion but is attracting political support. Should it be implemented, the scale of investment will be unprecedented as to dwarf not only the improvement of the existing railways and development of metros combined but also all the other infrastructure sectors of Vietnam.

There are also organizational issues, particularly to the improvement of the existing railways. A decision has been made to split Vietnam railway organization into two which includes a track infrastructure entity (VRA) and an operations entity (VNR). However, there appears to be doubts on whether this new business model is apt. This can be traced partly to the difficulty of reforming a rigid structure from within, and partly to the division of resources wherein one part of VNR absorbs the unprofitable section and the other absorbs the profitable section.

The master plan for railways called for an increase in speed and capacity across all of the six (6) lines – without any consideration to the size of its target market. The technical solutions to what constrains the railway sector are known, and they are being proposed across the board. But funding fell below what was planned or desired. A more practical and affordable solution is to be selective, and to tailor-fit the solutions to specific lines and to projected demand in those lines. Expansion of track capacity may not be necessary in all the 6 lines.

More than ten (10) railway projects were listed for implementation via BOT schemes. None has yet to materialize, in part because of the stalled splitting of the railway organizations, the regulatory regime, and because these projects are not yet ready for tender, and un appetizing for private sector..

4.2 Issues on Existing Lines

1) Transition to a New Organizational Culture

A decision to change the business model of Vietnam railways has already been made a few years ago – separating track infrastructure from rolling stock operations. It is a necessary step towards a more sustainable railway. However, progress has been so slow that:

(i) Commercial development of each of the market segments is still minimal, with the focus of attention more on decreasing costs rather than on increasing revenues;

(ii) Business development planning is still unclear, as the organizational culture is still not used to market orientation;

(iii) Coordination problems and information gaps between units continue to constrain organizational efficiency;

(iv) The rail sub-sector is still saddled with excess employees, with no clear downsizing plan and performance-driven human resource management system;

(v) The accountability within and between the separated companies is not well established.

The logic behind the separation is to inject a commercial and financially driven culture into VNR. On the other hand, VRA is expected to be a more technical and service-oriented organization. It is reported that a different business model is being considered. Whichever is finally selected, the transition needs to be accelerated, so that the new organization can address the external challenge, which is the competition from other transport modes.

2) Backlogs in Rehabilitation and Upgrading Works

At present, the railway network of VRA is mostly narrow gauge, and single-track - with a few section in dual-gauge and standard gauge. Most of the infrastructure has been rehabilitated from the damages of war, but a few sections such as bridges and track beds are still in need of rebuilding and improvements. Some sections are vulnerable to disruption from natural elements, such as storms and floods. Capacity of single track maybe adequate in some lines, but inadequate in others. Under a single-track regime, one delayed train cascades into other trains and thereby degrade the level of service and turns off customers.

The basic objective is to provide a comfortable, frequent, affordable and reliable transport for passengers and cargo. This can be met without necessarily replacing or upgrading the old system. Improvement of railway facilities can be in one big step or a series of small steps. When funds are scarce, small and low-cost steps are more realistic than one big but expensive step. Replacement of old railway bridges belongs to the first. So are the adoption of disaster-mitigation measures, better facilities at numerous rail and road crossings, and the computerization of back-office activities and ticketing system. Construction of double-track and electrification are considered as major projects, while adding bypass stations and increasing radius in tight curves are doable small-scale but high impact projects. Where demand is low, major upgrading is a waste of resources.

Increasing capacity by small-scale measures entail the following:

(a) **Extension of Track Effective Length:** By introducing high-traction powerful locomotives, it becomes possible to lengthen the number of wagons and cars in a train formation. The corresponding track lengths in station yards have to be extended also.

(b) **Passing Station (Signaling Station):** When a passing station is introduced at a bottleneck section, two trains in opposing directions could continue instead of stopping.

(c) **Improvement of Tight Curves and Gradients**: Train operating speed is restricted on sections with small radius of curvature and where gradient is steep.

(d) **Automatic Signaling:** Presently, Vietnam Railway still uses tablet block system on many lines. When automatic block system is introduced, it becomes possible for trains to operate safely at higher frequencies or shorter headways.

(e) **Grade Separation at Railroad Crossings and in Urban Districts:** Train speeds are slowed down at railroad crossings and in crowded urban districts. With grade separation, safety and higher speeds are also achieved.

(f) **Track Addition (double track):** Double tracking increases capacity of single track by approximately three times, aside from reducing waiting times for passing of trains and enabling faster recovery from delays.

3) Profitability of Operation

The profit-and-loss reports of VNR show a profitable operation. This is contrary to the general belief (and global experiences) that rail loses money and requires public subsidies. A comparison of its performance against other countries' railways says otherwise. If railway is profitable, why then could it not mobilize capital to invest in new lines and finance its development plans? Why re-structure at all? The driving force towards rail re-structuring is reduce the subsidy into a more sustainable level by forcing one component (VNR) to cover its cost and channeling the subsidy into the other component (i.e., VRA).

The determination of what the subsidies would be, operating as well as capital, is a major issue. It entails balancing what the State Budget can afford to allocate, and what the irreducible minimum operating cost for the two rail entities. A practical framework is to scale down to zero the operating subsidy to the service entity (VNR) in as short a period as possible, of say, 5 years. Capital subsidy to VNR for investment in new rolling stocks, modernization of rail vehicles, and others can take a slightly longer period, of say 10 years. On the other hand, VRA is expected to require continuing State subsidy in both its operating and capital accounts. Track age fees from VNR and the other rail operators is unlikely to cover all of VRA operating expenses because of the huge burden of maintaining a lengthy rail network. Nevertheless, the right fee between VNR and VRA has not been defined and may need technical assistance as basis for future adjustments.

4) PSP in Railway

Private sector participation in railway is desirable to the extent that it brings in a more commercial culture to that specific railway segment that gets privatized. It also leads to infusion of additional capital that would otherwise have been shouldered by the State. Accordingly, VRA listed more than 10 railway projects to be funded via BOT arrangements.

Mere publication and invitation to foreign investors to undertake BOT railway projects will not automatically bring in the desired investments. There are basic steps, or foundations, that must be put in place before the tendering can succeed. For one, the re-structuring process mentioned earlier must be accelerated and nearly finished, before the private sector can confidently come in. Secondly, the business case for each project must be studied beforehand, and the contractual structure defined for guidance of prospective bidders. There is a strong probability that the projects would still require capital shares from the State, or from VNR or VRA. Thus, a public-private-partnership (PPP) model is more likely. Thirdly, in the absence of precedence and experience in Vietnam, investors would be cautious. A success story should be created first; hence, care must be done to ensure that the first one will inspire confidence to the rest. Starting with the freight transport is more likely to succeed than the construction or upgrading of track infrastructure. By their very nature, the revenue base from tracks is slim and limited; an investor cannot earn sufficient returns from track age fees alone. If set too high as to get a reasonable return, the resulting fee could discourage usage of the track and render unviable the operations of transport service providers.

A small step towards PSP is the leasing out of some trains to private entities. VNR has existing contracts with such travel agencies as Victoria Hotel, Truong Sinh, Livitranss-Express, Ratraco, and Tulico Company. Passenger coaches are retrofitted by the travel agencies and marketed by them to tourists as distinct products. In addition, freight trains are being rented out on long-term basis to such firms as Cuong Thinh Limited, Southern Railway Commercial and Transport Service Enterprise, Ratraco Joint Stock Company, East Sea Joint Stock Company, and Bach Dang Construction and Transport Joint Stock Company-Hai Phong Port. Freights, especially of the bulk commodities type, need long-term assurance that it can be served by rail; hence, once they decide to use rail transport, they cannot just switch to road transport. In short, they are ideal long-term customers. That is why in many countries, freight service by rail is usually the first to be privatized.

There is another implicit reason that hinders PSP in rail sector. Because of bureaucratic inertia, the drive for transitioning into a commercial culture is unlikely to come from within the railway organizations. This may have to be infused from outside entities, or outsourced, but those within the organization may resist or oppose such measures. There are three strategic markets for railway: long distance passenger market, freight market, and short-distance commuter market. Each of these segments needs to formulate a practical business development plan, executed, and periodically adjusted depending on results and evolving markets.

4.3 Issues on New Rail Lines

1) North-South Railway

The largest and most important transport demand is along the north-south corridor. Undoubtedly, railway transport is vital in ensuring an efficient and reliable linkage between Hanoi and HCMC, with its beneficial spillover effects on adjoining provinces. The government has invested a lot on the improvement and upgrading of this line. It is only natural to consider the next step - which is to increase the travel speed to reduce travel time. With the surge in petroleum prices, rail has become more attractive than road transport over long distances.

In this particular line, the tension between the upgrading of existing assets and developing new systems is heightened. One option is the step-wise upgrading of the existing narrow-gauge diesel-powered system, including double tracking, to enable speeds of up to 120km/h (from the current average speed ~70km/h). Another option is a proposal to replace the system into a standard gauge, or even introduce a High-Speed Rail capable of speeds of 300km/h. The increase in project cost is geometric. In the case of the HSR, the issue is one of lumpiness and risk. It requires a huge investment of about USD50 billion upfront, and the potential of delaying other important transport projects over a stretch of at least 10 years because the HSR will absorb all of State funds for the transport sector. Either the entire 1,540km HSR line from Hanoi to HCMC is built, or not at all. This is because there are only two centers, which generate sufficient traffic, and they happen to be too far apart.

Because of inadequate funding from State budget, past railway investment plans had experienced only about 30% realization rate – which implies that a 5-year program had to stretch into 15 years. The capital requirement of a HSR is more severe, as to be impractical and unsustainable.

2) Trans-Asian Railway Project

For years, the ESCAP has been promoting the Trans-Asian Railway project that interconnects the railway systems of several countries on the Asian mainland. Of particular concern to Vietnam is the Singapore-Kunming Railway Link that was proposed at the 5th ASEAN Summit in Bangkok in 1995. This route is called SKRL (Singapore - Kunming Railway Line) and has a total length of 5,500km (see Table 4.3.1).

Table 4.3.1 SKRL Segments in Vietnam

<table>
<tr><th>Country</th><th>Section</th><th>Length (km)</th><th>%</th><th>Length in Vietnam</th></tr>
<tr><td>China</td><td>Kunming-Lao Cai</td><td>468</td><td>8</td><td></td></tr>
<tr><td rowspan="6">Vietnam</td><td>Lao Cai-Hanoi</td><td rowspan="6">2,125</td><td rowspan="6">39</td><td>296</td></tr>
<tr><td>Hanoi-Vinh</td><td>319</td></tr>
<tr><td>Vinh-Da Nang</td><td>472</td></tr>
<tr><td>Da Nang-Nha Trang</td><td>524</td></tr>
<tr><td>Nha Trang-Ho Chi Minh</td><td>411</td></tr>
<tr><td>Ho Chi Minh-Loc Ninh</td><td>105</td></tr>
<tr><td>Cambodia</td><td>Loc Ninh-Phnom Penh</td><td>305</td><td>6</td><td></td></tr>
<tr><td>Thailand</td><td>Phnom Penh-Bangkok</td><td>621</td><td>11</td><td></td></tr>
<tr><td>Others</td><td>Bangkok-KL-Singapore</td><td>1,994</td><td>36</td><td></td></tr>
<tr><td></td><td>Total</td><td>5,513</td><td>100</td><td></td></tr>
</table>

Source: ESCAP Report

In the planning and development of its own railway, Vietnam has to take into account the requirements of SKRL. Recent information on the progress of the SKRL development program is as follows:

(i) Vietnam has completed a feasibility study on the HCMC-Loc Ninh missing link and is negotiating with Cambodia for the location of connecting points. A feasibility study for a spur link from Vung Ang to Tan Ap-Mu for further links with Vientiane is also being undertaken.

(i) In December 2006, ADB approved a US$60 million loan to Vietnam to assist in the rehabilitation of the Hanoi-Lao Cai section and a US$2 million loan to Cambodia to assist in the rehabilitation of the Cambodia railway that includes a section of the SKRL route. ADB is also undertaking a detailed design study on the Phnom Penh-Loc Ninh section with financing from China.

It should be noted that narrow-gauge track still accounts for 92% of the SKRL line from Lao Cai to Singapore. Premature shifts to standard gauge system, therefore, maybe counterproductive for the seamless movements between the countries on the SKRL route.

3) Railway System for the Two-Corridor-One-Belt

The aim of developing a train route between Yen Vien-Pha Lai and Ha Long-Cai Lan, including the construction of a new railway section, is to connect the east and west corridor via the Hanoi-Lao Cai line and Hanoi-Dong Dang Line. This project was approved by the Prime Minister (1686QD-TTg) on November 20, 2008 on approving the railway transport strategy up to 2020 and vision to 2050.

Freight and passenger trains are operated on this route in the northeast economic corridor linking Quang Tay and Van Nam in China and the Cai Lan International Port. The route passes through Hanoi, Quang Ninh and Haiphong, which are important economic centers.

This project is positioned as part of the "two corridors one belt" project of the Vietnam-China cooperation program. Because the railways on the Chinese side (Yunnan and Guangxi province) are built on the standard-gauge standard, Vietnam is faced with two choices. It can either introduce dual-gauge (as what had been done on Hanoi – Dong Dang Line), or upgrade its tracks immediately into standard gauge. It is reported that VRA wants to undertake a major system change and follow the rail standards on the China side of the border. This shift, will of course, facilitates cross-border transport via rail. However, demand is still uncertain and the cost would be substantial.

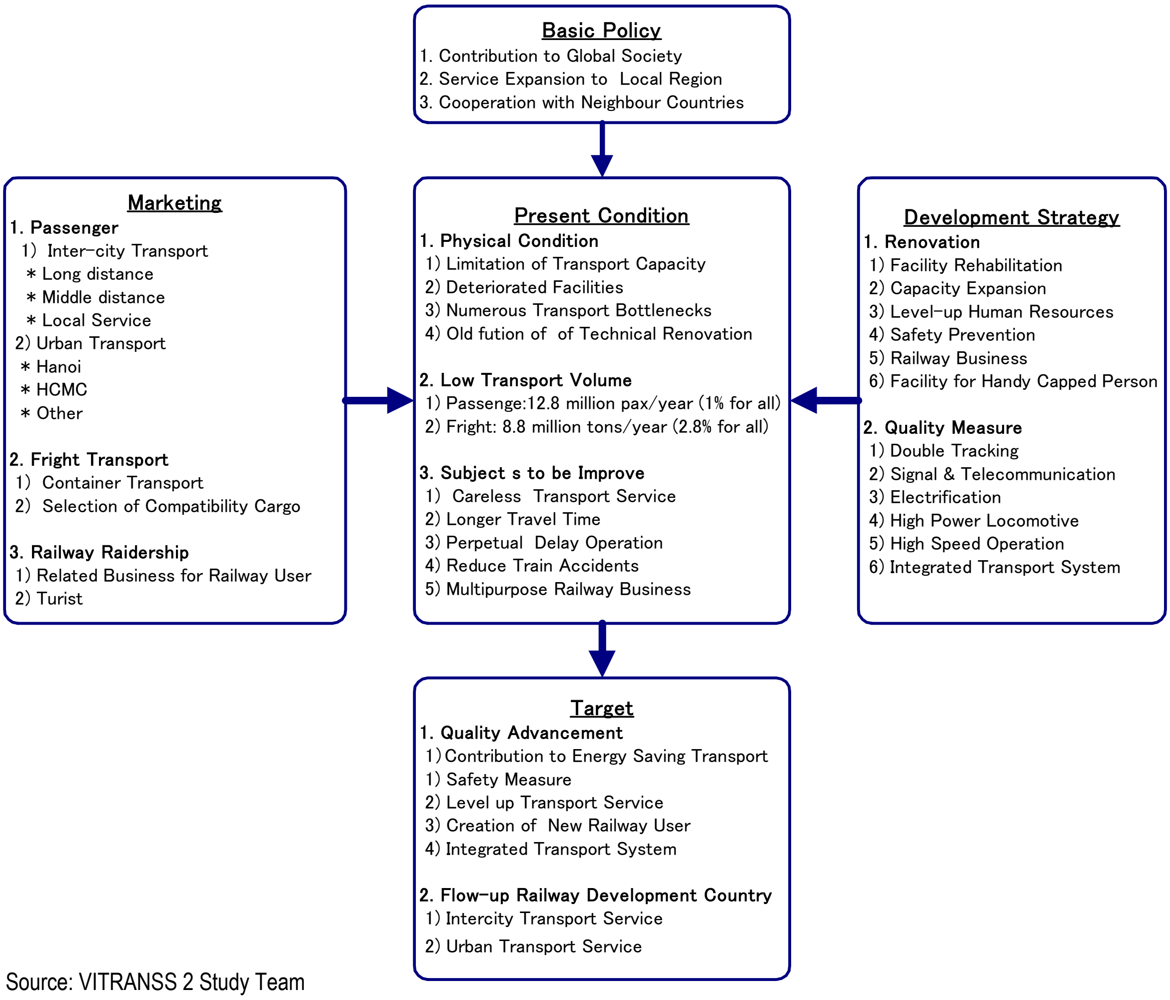
5 DEVELOPMENT STRATEGIES

5.1 Generic Approach

Historically railway has dictates land development; thereby demand is generated wherever railways are built, because for some time railways were the most competitive mode of transport. In the modern age of motorization and containerized shipping, the success formula of railway no longer works. Customers have other choices and will move to the mode that offers them reliability, speed, cost, comfort and convenience.

Figure 5.1.1 is a stylized presentation of the generic development strategy for railways – which emphasize technical approaches to attract the customers at a huge public subsidy. While this approach has merits, it is very risky and requires enormous investments in order to succeed. The reality is that the required investment and subsidy are, almost always, not available. Tracks are fixed and relocation, in case of a mistake or a change in demand pattern, is not a practical option.

Figure 5.1.1 Generic Strategy to Railway Development



Source: VITRANSS 2 Study Team

When applied to the specific situation of Vietnam's railway, the above chart translate into Table 5.1.1 below.

Table 5.1.1 Measures to Improve Rail Performance

Item	Subject	Present Condition	Remedial Measures
Safety	Tunnels & Bridges	Almost all facilities have deteriorated due to ageing, war damage, and disaster. There are many restricted-speed sections.	Rehabilitation or new construction is recommended to reduce maintenance costs, enhance safety, and lift speed restrictions.
	Tracks	Rail and turnouts are deteriorated due to ageing.	Replace tracks to 50kg/m for stronger rails, including turnouts.
	Signaling	Interlocking system (between turn-outs and signals on station premises) is inadequate.	Relay interlocking system needed to prevent accidents caused by mishandling. Also an ATS system is ideal in preventing train collisions.
	Railroad Crossing	Disregard of approaching train by cars, motorcycle and others; time spent at sliding gates. Illegal railroad crossings are increasing	Install automatic gate and grade-separated structures to reduce accidents and reduce gatekeepers. Conduct road-safety campaigns aimed at motorists who cross railtracks.
Reliability	Flood Protection	Submergence, washed-out track beds and ballast, during heavy rains	Establish inspection system, pre-preservation works, and disaster prevention schemes, to minimize restoration costs.
	Track Structure	Lost railway fastening bolts and shortage of fixing bolts, broken block concrete-2 sleepers, shortage of ballast	Creation of reporting system from site workers to head office for quick action to fix tracks.
	Track Maintenance	Focus is on addition of ballast, to maintain 20 cm thickness under the sleeper.	High speed inspection-car, multiple tie tamper and machinery for maintenance required for quick response maintenance works.
	Equipment at Workshop and Deport	Aged equipment still in use at workshops, with some gears suited for steam locomotive	Procure new equipment appropriate to modern rolling stocks for more efficient repair and maintenance works.
Transport Capacity	Train Diagram	Long-distance trains have priority on tracks, especially N-S line; a single delay cascades into other train schedules.	Revise long-distance diagram and introduce intermediate trains based on demand.
	Double track	Single track limits two-way train frequency and adds to longer travel times.	Partial double-tracking at bottleneck sections, introduce signal station to allow bypass. Double track for the entire length of line is the long term solution.
	Rolling Stock	Majority of rolling stocks are old with very few powerful and efficient locomotives.	Procure additional rolling stocks in response to demand, extend effective track lengths at stations to permit long train formation.
Service Level	Station Front Plaza	Existing station front plazas and main stations do not provide efficient transfers from/to other modes.	Redesign layouts at stations to provide space for bus, taxi, car loading/unloading, as well as parking for waiting vehicles.
	Low Operating Speed	Tight curves, at-grade railroad crossings, narrow waysides impose speed restrictions. Travel time is less predictable, with delays at stations.	Low speed directly influences travel time and track capacity. Recommend improvements. High level platform also recommend reducing on-off time.
Transport efficiency	Passenger Information system	Old communication network hinders provision of more passenger-friendly services.	Upgrade passenger information system for ticket reservation and sales, and improve customer care
	Freight information system	No cargo tracking and visibility compounded by inefficient utilization of wagons	Introduce freight and wagon monitoring system to attract more customers and raise wagon utilization/productivity.
Management	Organization	Lack of coordination between divisions toward improving demand and services.	Greater coordination across units responsible for rolling stock, signal & telecommunication, infrastructure, operations, and maintenance.
	Manpower	Productivity is still low in comparison with other countries.	Labor-intensive system can be resorted to in many aspects of passenger and freight operations.
	Education and training	Education and training facilities and equipment do not meet present requirement.	Provide latest training materials and facilities needed for modernized train operation system.
	Commercial and marketing	Inadequate commercial and marketing program to boost railway business	Change management culture either by radical re-structuring and/or entry of private sector participation.

Source: VITRANSS 2 Study Team

5.2 Competitive Advantages of Rail

The most important change from the generic rail development strategy is to focus only in corridors where rail retains its competitive edge over other transport modes. A comparison with other modes (shown on Table 5.2.1) provides some guidelines.

Table 5.2.1 Comparative Advantages of Transport Modes

	Characteristics		Rail	Car	Marine	Air	Note
Quality of service	Safety	Less accidents	◎	×	○	○	Death/injury ratio
	Punctuality	Scheduled operation	◎	×	○	△	Air freight affected by weather conditions
	Speed	Operating Speed	○	○	×	◎	Road congestion in urban areas
	Convenience	Ease of route selection	○	◎	×	×	Longer time required to reach port/airport
	Comfort	Relax during travel	○	○	○	○	Seat space, privacy, riding, etc.
Operational efficiency	Labor saving	Minimized labor force	○	×	◎	△	Staff requirement for one unit transport
	Mass transport	Quantity per unit	○	○	◎	○	Car/marine assumed cargo transport
	Energy saving	Utilization of motive power	○	×	◎	×	Fuel consumption per transportation unit
External requirement	Less pollution	Contribution to environmental preservation	○	×	◎	△	Noise problem in vicinity of airports
	Land occupation	Right of way	○	×	○	×	Roads and airports require large space per person

Source: Railway Technology (Dr. Amano)
Note: ◎: Very good ○: Good ▯: Fair ×: Below average

A more practical strategy entails cross-tabulating Tables 5.1.1 and 5.2.1 with the projected demand on the corridors where rail operates. This is discussed in the next sections.

5.3 Demand-driven Approach

1) Prioritize Routes with Highest Demand

A more realistic and sustainable development strategy for railways has to consider the following:

(i) Public funds will be limited, and rail will not be able to generate the resources to upgrade its facilities (as suggested in Table 5.1.1) across all lines and market segments;

(ii) Rail can be competitive in long distance markets, more so for passengers (average trip length = 400km) than for freight (average trip distance=376km);

(iii) Of the 6 railway lines, rail was able to attract more than 3 thousand passengers per day and more than 3,000tons/day on 2 lines (Hanoi-Saigon, Hanoi-Lao Cai). Freight demand was also significant on the Hanoi-Dong Dang Line. Passenger demand was also significant on the Hanoi-Hai Phong Line.

(iv) Expressways are under construction for the Hanoi-Lao Cai and Hanoi-Hai Phong corridors. Railway is likely to be competitive on the longer routes, but will uncompetitive on shorter routes. Hence, demand projection on the 101km Hanoi-Hai Phong segment is highly dependent on upgraded service.

(v) Rate of growth of demand (see Table 5.3.1) is highest at Hanoi-Quan Trieu, more than 9x in passenger volume and 50x in freight, because of the current poor road network. Since the situation is likely to change, and the distance is short, the robustness of demand is highly dependent on the mining industries (apatite, iron, copper) in the area. In addition, total traffic would still be small which can be fully met by the existing single-track diesel operation.

Table 5.3.1 Demand Forecasts by Line

	Section	Length	2008*2	2030 (Projection)*2		Growth Factor
		Km		With HSR	Without HSR	w/out HSR
Passenger(pax/day)	Hanoi-Saigon Line	1726.2	5,735~6,930	12,078~28,704	15,501~32,530	4.83
	Hanoi-Lao Cai Line	293.5	5,065~6,751	6,208~26,846	3,894~18,193	1.87
	Hanoi-HaiPhong Line	101.75	3,500	32,328	16,057	4.59
	Hanoi-Dong Dang Line	162.5	637~818	5,688~29,049	5,031~22,128	4.59
	Hanoi-Ha Long Line	176.2	301	5,267~5,971	4,533~5,237	16.2
	Hanoi-Quan Trieu Line	75.3	596	6,983	5,418	9.09
Freight(ton/day)	Hanoi-Saigon Line		3,171~9,828	29,225~70,133		7.64
	Hanoi-LaoCai Line		8,600~7,270	13,949~32,392		2.92
	Hanoi-HaiPhong Line		318	18,774		59.03
	Hanoi-Dong Dang Line		8,600~9,270	16,375~38,701		3.08
	Hanoi-Ha Long Line		974	3,333		3.42
	Hanoi-Quan Trieu Line		180	9,083		50.46

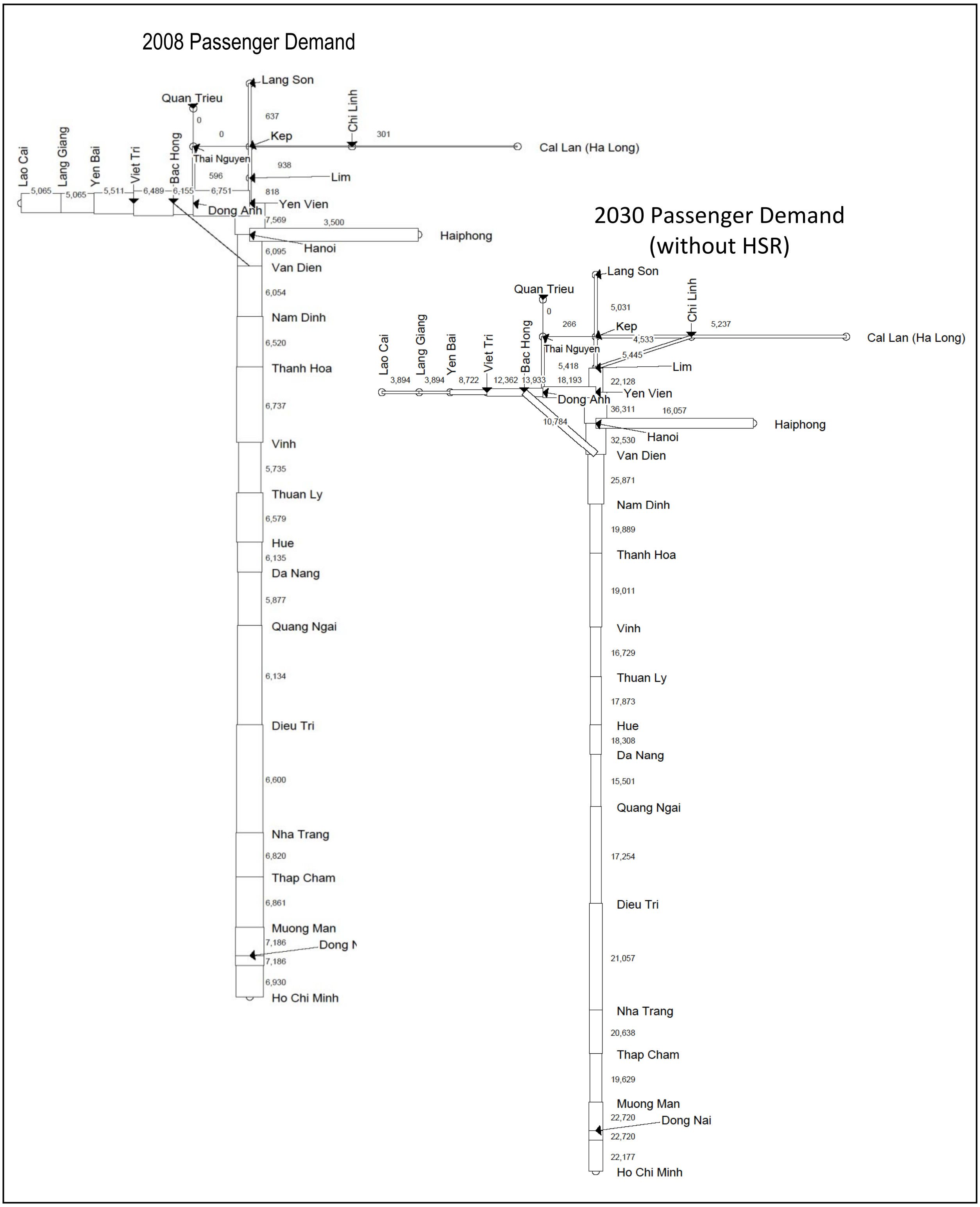
Note: *1 Introduced from VITRANSS 1 report
*2 Source: VITRANSS 2 Study Team

A selective and targeted rail development strategy would therefore focus on the following:

(i) Hanoi-Saigon Line: increase passenger capacity to 5 times and freight capacity to 8 times the current levels, respectively;

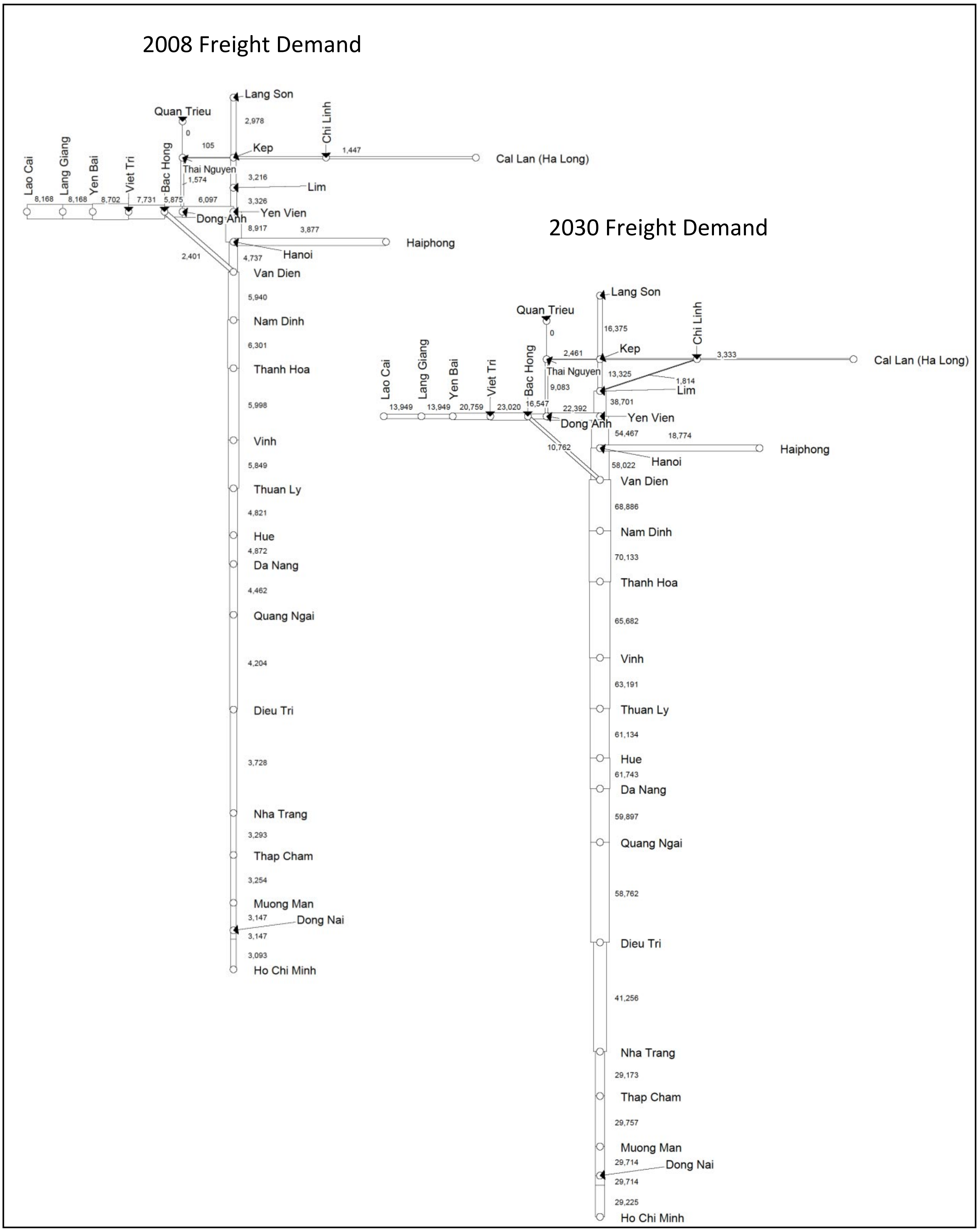
(ii) Hanoi-Lao Cai Line: increase passenger capacity to 2 times and freight capacity to 3 times

Figure 5.3.1 Passenger Demand in 2008 and in 2030



Source: VITRANSS 2 Study Team

Figure 5.3.2 Freight Traffic on Rail – 2008 and 2030



Source: VITRANSS 2 Study Team

2) Least-cost Increase in Capacity

All railway lines should be planned to meet projected demand. For the existing railway lines, the increase in capacity shall be achieved in a step-wise fashion, in the following order:

(i) 1st-improve train operation and add/increase trains

(ii) 2nd-ease bottlenecks, such as tight radius of curvature and old bridges, to permit higher train speeds on the existing tracks;

(iii) 3rd-add signaling stations to allow bypass operations under a single-track operation;

(iv) 4th-improve signalization to permit higher train frequencies;

(v) 5th-double tracking to increase track capacity by as much as 3 times;

(vi) 6th-new railway technologies such as electrification, standard gauge, high-speed rail.

Assuming the tracks can handle more trains, the least-cost step is to add more trains to meet demand. Nevertheless, at some point, a limit will be reached. Hence, the next step is to remove bottlenecks. Curves and gradients constrain train speed and traction power. If a train's traction power is larger, its climbing speed on a gradient becomes faster. But the train speed on curves is determined by the radius of curvature, rather than the train's power. Therefore, radius curvature is more important than gradient in boosting train speed. Table 5.3.2 shows the speed limits at various radii based on the formula $V = 4.1\sqrt{R}$, where V= train speed in km/h.

Table 5.3.2 Train Speed and Radius of Curvature

Train Speed (km/H)	Radius Curvature (M)
100	600
92	500
82	400
71	300
58	200
41	100

Source: VITRANSS 2 Study Team

The most economical strategy is to make the most out of existing narrow gauge and diesel train sets, before replacing them with the latest rail technologies (i.e., shifting to new technology). There is no economic reason for jumping to the fourth type of solutions (i.e. improvement of signalization) if the demand can be satisfied by introducing incremental improvements of the first and second types (i.e. improve train operation and add/increase trains and ease bottlenecks). The threshold is approximately 50 trains per day, at which point the third type of improvements becomes justifiable (i.e. signaling stations to allow bypass operations).

Where a rapid increase within a short period is foreseen, then it might be worthwhile to adapt to the next higher level of treatment. Conversely, where the demand can be met without moving to the next higher level of treatment, then the most prudent course is status quo maintenance.

(1) New Rail Lines

An issue arises when a new rail line is to be built. Should it follow the predominant narrow gauge and diesel-train technology (to be replaced in the future) or start with the new standard-gauge electric system (and avoid future replacement)?

Standard gauge is being contemplated for the North Corridor connecting Kunming and Nanning in China and the international ports of Cai Lan and Hai Phong in Vietnam, as well as for the Trans-Asian Railway (SKRL segment to Cambodia). Construction of a new line is also being considered to link HCMC with new industrial estates and international ports in Thi Vai, Cai Mep, Vung Tau and Can Tho. Another new line is the HCMC-Loc

Ninh route. All the proposed lines are based on standard gauge and electrification.

Current policy favors standard gauge and new design standards for new rail lines. Apparently, the Luu Xa-Kep-Halong line followed this policy; it is under utilized at present, with less than 400 passengers per day in traffic.

It is the recommendation of VITRANSS 2 to follow a more flexible demand-driven strategy. If more than 50 trains per day would be needed within 10 years of completion, then the use of better technological standards is advisable. Otherwise, the narrow-gauge-diesel standards would be adequate at lesser cost. This prescription should not be interpreted as an abandonment of the future technical standards (under decision No. 34/2007/QD-BGTVT) that VNR is aiming for (see Tables 5.3.3 and 5.3.4), but rather a caution against premature shift..

Table 5.3.3 New Standards for Narrow Gauge System

Technical Parameters	Present Standards	Future Standards
1. Gauge (mm)	1000	1000
2. Gradient	9‰-17‰	Double or Triple header locomotives or new alignment (e.g. Tunnel)
3. Minimum curvature (m)	300,particularly <200	More than 600m (Grade 2 level)
4. Maximum Speed	Passenger: 90km/h Freight: 50km/h	Passenger: 120km/h Freight: : 80km/h
5. Formation Level	4.4m	5.2m or more
6. Load Scheme	T14	T16
7. Rail	P43	50kg rail
8. Turnout	Tg 1/10	Tg 1/12
9. Sleeper	Concrete-2 blocks	Pre-stress concrete sleeper
10. Communication	Optical Cable + Bare Cable	Optical cable
11. Block System	Central Electrifying + Semi-automatic	Automatic or semi-automatice

Source: VNR

Table 5.3.4 Standards for the 1435mm Gauge System

Classification	High speed railway	Sub-high speed railway	Grade 1	Grade 2	Grade 3	Remarks
Passing number of trains (up and down) day and night	≥ 50	≥ 30	-	-	-	
Transport volume (million ton/year)	-	-	≥ 20	≤10 ≤ 20	≤ 10	
Design speed (km/h)	350	200	150	120	70	
Horizontal Curve Radius (m)	5,000	2,000	1,200	800	400	
Minimum Horizontal Curve Radius (m)	Adjust radius on speed	600	400	300	250	
Maximum longitude gradient-1 (%)	25	25	12	18	25	Except in mountainous areas, sections before and after station, and other difficult conditions.
Maximum longitude gradient -2 (%)	30	30	18	25	30	For new-electrified railway, the maximum longitude gradient is 30‰, shall apply to all railway grades.

Source: Ministry of Transport

5.4 SWOT Analysis

To summarize the factors that shape strategies, Figure 5.4.1 shows the strengths and weaknesses, as well as the threats and opportunities, to the railway sub-sector of Vietnam.

Table 5.4.1 SWOT Analysis of the Railway Sector

	PRESENT	FUTURE	
STRENGTHS	• Institutional market in bulk freight at long distances; • A long history and constituency within government; • Rail lines are located in corridors of high development and densities; • Greater predictability of rail travel times, over road transport	• High price of oil likely to become permanent + global concern on climate change tilts the balance in favor of railway • Top-level interest on HSR for the north-south line • Push for a Trans-Asian railway network highlights possible rail connections in the north;	OPPORTUNITIES
WEAKNESSES	• Slow transition to the new business model separating tracks from operations prevent early benefits; • Speed restrictions on many sections of the tracks due to deteriorated bridges and curve limitations; • Overstaffing is still endemic; • Low allocations from State budget in the last 7 years have caused delays of vital improvements	• Rapid development of expressways on same corridor as rail lines could erode market share of rail • Absence of a sustainable financing strategy to cover deficits and subsidies • Early investments in Metros (for Hanoi and HCMC) likely to use scarce resources from national government and crowd out other required investments	THREATS

Source: VITRANSS 2 Study Team

1) Strategy Components

Based on the preceding matrix, a set of logical strategies for the railway sector can be derived. These are shown in Table 5.4.2, and elaborated in subsequent paragraphs.

Table 5.4.2 Strategies for the Railway Sector

	In Response to Threats	To Capture Opportunities
Capitalizing on Strengths	• Selection of priority lines and sections to be improved, so as to gain early benefits; • Promote equity-of-incumbent rule (i.e., old railway first) against new expressways that parallel existing railway lines	• Accelerate implementation of new rail structure, bring in foreign entities to invest in appropriate segments; • Formulate explicit (performance-based) subsidy policy to stabilize operations of VNR; • Maximize revenue generation from non-rail businesses
Remedying Weaknesses	• Accelerate privatization of the freight train business in order to concentrate on viable market segments, and to generate funding • Establish the business case for rail projects being offered on BOT, prior to auction/marketing	• Modernize equipment using proceeds of privatization, private sector and foreign interests in rail, and pre-set subsidy; • Improve management of rail enterprises, following the OECD Guidelines on Corporate Governance of SOEs.

Source: VITRANSS 2 Study Team

2) Pragmatic Upgrading of Existing Assets

In recognition of the fact that higher budgetary allocations to railway sector is not feasible in the short term, a priority project selection approach that targets specific sections of the track infrastructure for early improvements is most logical. This means that available resources should be spent on those lines where demand is high and in the following order of importance:

(i) First priority: rehabilitation of existing assets and facilities, starting with bottleneck sections as maybe revealed from analysis of the Operation Diagrams.

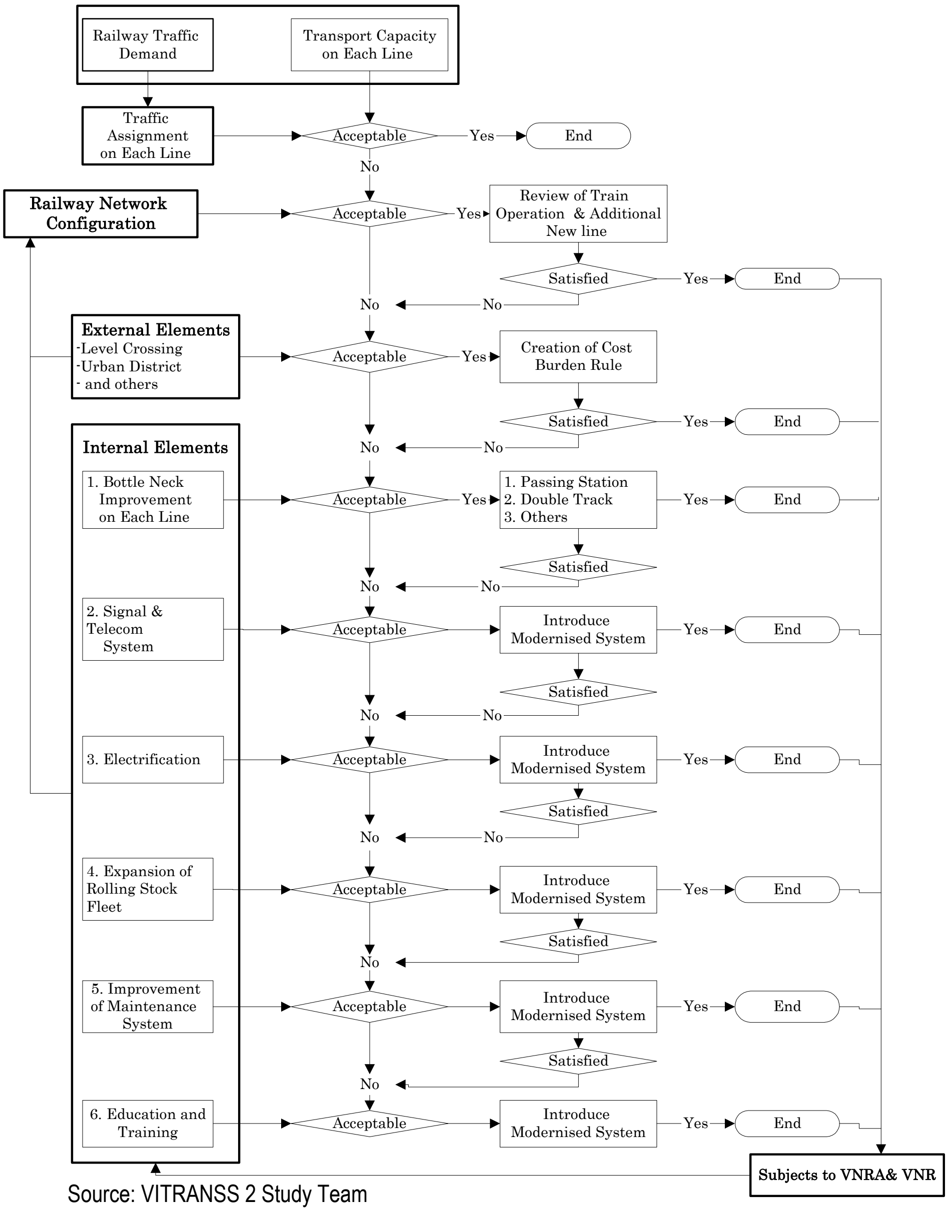
(ii) Second priority: sectional increase in track capacity through bridge replacements, modification of vertical and horizontal alignments, track re-ballasting, road-rail crossing treatments, and upgrading of signaling system

(iii) Third priority: introduction of new generation (standard gauge, electrification, and high-speed) railway technologies

The modernization of the existing rail assets will involve three things: (i) improvement and upgrading of the track infrastructure, (ii) improving the signaling and communication system, and (iii) fleet rehabilitation and replacement.

An incremental, and pragmatic, approach to development is shown in Figure 5.4.1. The starting point is the transport demand, not on the whole system, but at specific corridors and sections of the network.

Figure 5.4.1 Step-wise Approach to Railway Development

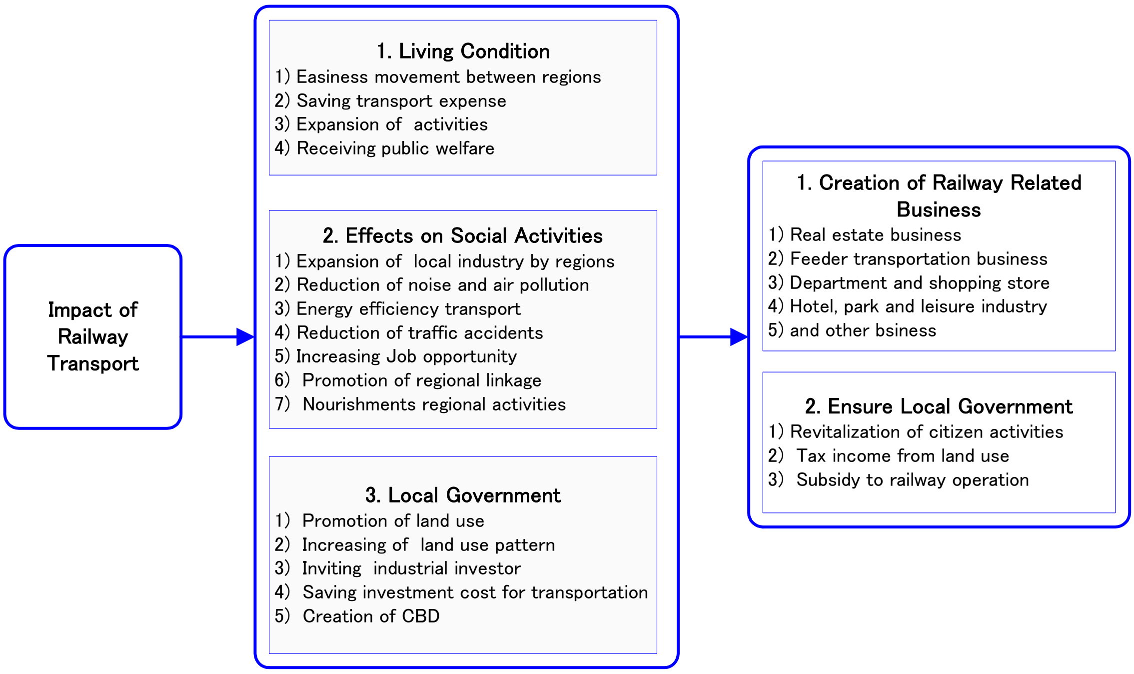


Source: VITRANSS 2 Study Team

3) Maximize Non-rail Incomes

A railway system rarely generates sufficient revenues to cover all its costs, because of inability to capture or monetize public transit externalities. Thereby nearly all railway enterprises in the world are subsidized. Since public subsidy is not a limitless source and undesirable, tit is important to increase incomes from non-fare commercial activities at or around stations. The concept is depicted on Figure 5.4.2.

Figure 5.4.2 Monetizing Secondary Benefits from Railways



Source: VITRANSS 2 Study Team

Available data suggests that VNR is already pursuing railway-related businesses, which generate nearly 50% of gross revenues. The accounting of data however needs to be carefully reviewed because it points to a 30% profit margin from rail operations, which is contrary to the experiences of most rail systems in the world.

Property and commercial developments around train stations are potentially lucrative for railways. This may include leasing areas for office and residential purposes, renting out areas within stations for convenience stores and other retailing activities. One way to inject commercial culture in the stodgy world of rail service is via cross posting – making the business-oriented officers in other SBUs be responsible for generating new business in the rail SBU. Leasing out specific coaches to block re-sellers also bring in private sector expertise in marketing, a step that VNR has already taken.

6 A SUSTAINABLE PLAN FOR RAILWAYS

6.1 Basic Development Framework

The plan puts priority on re-enforcing the existing railway lines to meet projected demand to 2030 with due consideration to railway's competitive advantage over other transport modes in the same corridor. While each of the six existing lines has to be upgraded, the extent of improvement will differ in response to market requirements – rather than in pursuit of higher technical standards or supply-side approach. This implies that the level of service will not necessarily be the same across all lines. Variety and selectivity shall characterize the development trajectory for the railway sub-sector. Expansion of the rail network will take second priority, unless demand is sufficiently high at which rail is more advantageous and competitive, such as in dense urban areas.

On key segments of the existing railway network, international considerations shall play a major influence in their planned development. These strategic segments will serve domestic and international traffic, since they form part of international commitments of Vietnam – such as the Singapore Kunming Railway Link (SKRL) project and the cross-border railway system to China's southern provinces. A more recent proposal is to add to the SKRL the HCMC-Loc Ninh rail link via Cambodia.

While demand on railway transport will continue to grow, the rate of growth will be different for the six existing railway lines and passenger and freight traffic also exhibiting different patterns. This is due to the expected improvement in other transport modes, particularly roads. Market share of railways in the long-distance passenger market is seen to stabilize at about 4%, but its share for long-distance freight can increase by 2.7 times the 2008 level, provided the corresponding capacity is also developed. A major factor for the increasing role for rail in logistics is the global carbon emission and fossil fuel constraints.

6.2 Incremental Improvements of Lines

The series of improvements to the existing rail lines can be grouped into three: (i) Function-Improvement Items (FII) which are small and low-cost steps to address weak aspects of single-track infrastructure, (ii) System Reinforcement Items (SRI) which are intended to optimize capacity on single track at modest cost, but without changing the fundamental technology; and (iii) System Modernization Items (SMI) which leads to a big increase in capacity as well as level of service, but entail high costs and change in technology. In all cases, the interventions must fit into the interactions of tracks, rolling stocks, and signaling system without compromising safety.

Increasing train frequency is the simplest way to increase capacity. It may or may not need additional cars or wagons – depending on route distance and fleet size. More often than not, more frequency on single track will require the construction of signals or bypass stations to permit trains in opposing directions to move without delay. Such a FII-type project can raise capacity to 50 trains per day, and require no more than the installation of signal devices and additional short tracks.

When train operation reaches more than 50 trains in some sections of the line, SRI-type projects can be justified. This may entail improvements of horizontal and vertical alignments in those sections with speed restrictions, and/or construction of double tracks in part or in full. When a line gets double-track in full, capacity increase of more than three times becomes feasible due to higher operating speeds and reduced potential for delays.

When traffic demand can no longer be met through FII and SRI interventions, then it would be justifiable to consider SMI-type solutions. Shift to standard gauge, electrification, and adoption of advanced signaling system transform the railway into another technological level. High Speed Rail technology provides a level of service comparable to air travel in speed, comfort, cost, and convenience. SMI-type of solutions is expensive, aside from necessitating adjustments of urban spaces in terms of grade-separations of carriageways and expanded station footprints.

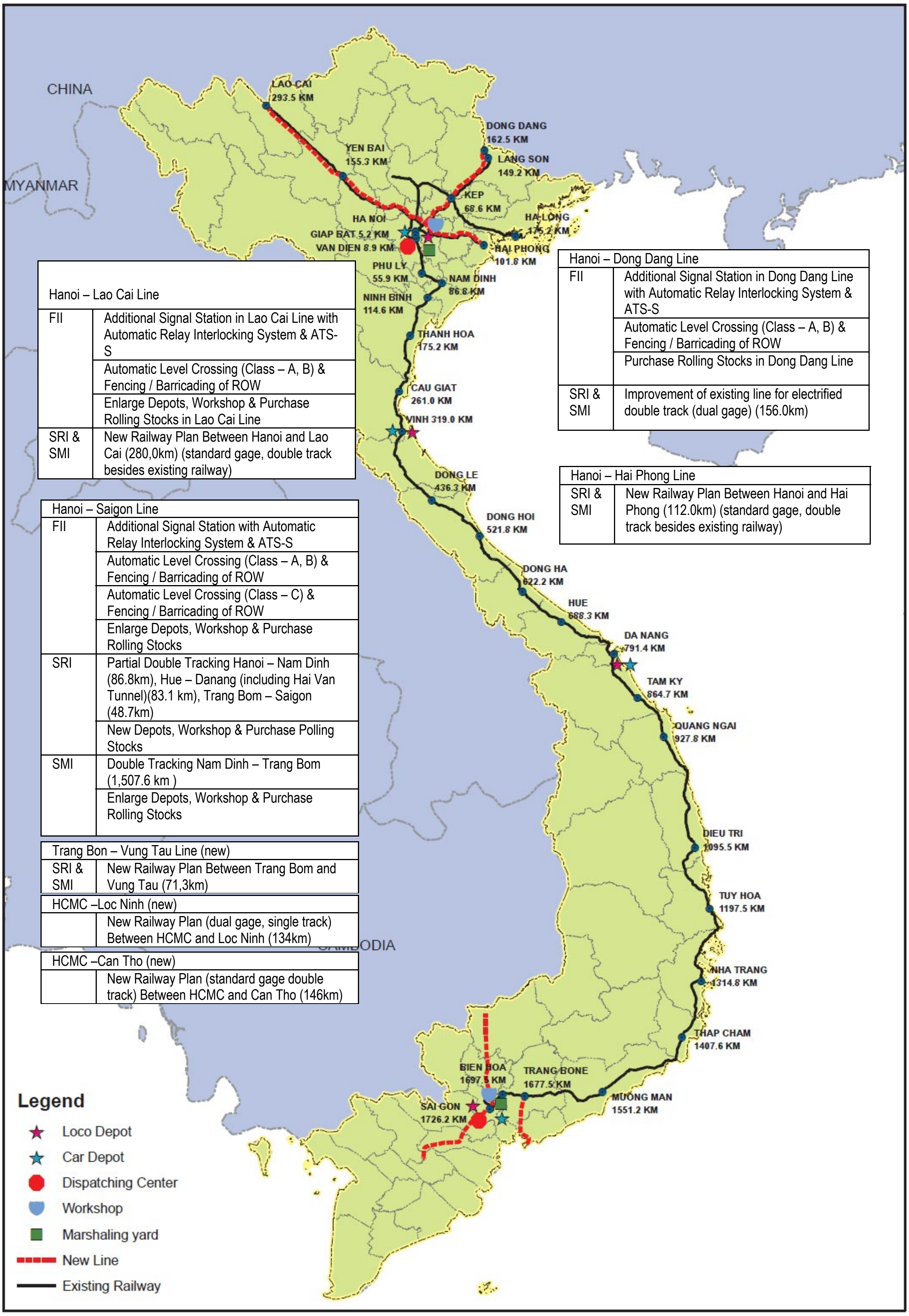
Following the demand-driven strategy, the recommended development plan for railways is outlined in Table 6.2.1 and shown on Figure 6.2.1.

Table 6.2.1 Rail Development Plan to 2030 (Proposed Projects)

Line or Corridor	2030 Demand (Trains/Day)	Type of Improvements			Remarks
		Short Term	Medium Term	Long Term	
Existing Lines:					
Hanoi-Saigon	137-318	FII	SRI	SMI	Demand for medium-distance (~500km) trips would be beneficial
Hanoi-Hai Phong	101	none	none	SRI&SMI (new rail)	Can be deferred until impact of Expressway is determined
Hanoi-Lao Cai	58-154	none	FII	SRI&SMI (new rail)	Dependent on cross-border trade with Yunnan in China
Hanoi-Dong Dang	69-184	none	FII	SRI&SMI	Dependent on cross-border trade with Guangxi in China
Hanoi-Quan Trieu	51	none	none	(FII)	Dependent on growth of mining in the area.
Hanoi-Ha Long	19	none	none	(FII)	Dependent on growth of tourism
New Lines:					
Metro	n.a.	Hanoi Line 1; HCMC Line 2	Hanoi Line 2		Per urban transport plans of Hanoi and HCMC
Line Extensions & New Lines	-	Trang Bom to Vung Tau Section (SRI & SMI)		HCMC to Loc Ninh. HCMC to Can Tho	Can be deferred until impact of Expressway is determined

Source: VITRANSS 2 Study Team

Figure 6.2.1 Proposed Railway Development Plan to Year 2030



Hanoi – Lao Cai Line	
FII	Additional Signal Station in Lao Cai Line with Automatic Relay Interlocking System & ATS-S
	Automatic Level Crossing (Class – A, B) & Fencing / Barricading of ROW
	Enlarge Depots, Workshop & Purchase Rolling Stocks in Lao Cai Line
SRI & SMI	New Railway Plan Between Hanoi and Lao Cai (280,0km) (standard gage, double track besides existing railway)

Hanoi – Dong Dang Line	
FII	Additional Signal Station in Dong Dang Line with Automatic Relay Interlocking System & ATS-S
	Automatic Level Crossing (Class – A, B) & Fencing / Barricading of ROW
	Purchase Rolling Stocks in Dong Dang Line
SRI & SMI	Improvement of existing line for electrified double track (dual gage) (156.0km)

Hanoi – Hai Phong Line	
SRI & SMI	New Railway Plan Between Hanoi and Hai Phong (112.0km) (standard gage, double track besides existing railway)

Hanoi – Saigon Line	
FII	Additional Signal Station with Automatic Relay Interlocking System & ATS-S
	Automatic Level Crossing (Class – A, B) & Fencing / Barricading of ROW
	Automatic Level Crossing (Class – C) & Fencing / Barricading of ROW
	Enlarge Depots, Workshop & Purchase Rolling Stocks
SRI	Partial Double Tracking Hanoi – Nam Dinh (86.8km), Hue – Danang (including Hai Van Tunnel)(83.1 km), Trang Bom – Saigon (48.7km)
	New Depots, Workshop & Purchase Polling Stocks
SMI	Double Tracking Nam Dinh – Trang Bom (1,507.6 km)
	Enlarge Depots, Workshop & Purchase Rolling Stocks

Trang Bon – Vung Tau Line (new)	
SRI & SMI	New Railway Plan Between Trang Bom and Vung Tau (71,3km)

HCMC –Loc Ninh (new)	
	New Railway Plan (dual gage, single track) Between HCMC and Loc Ninh (134km)

HCMC –Can Tho (new)	
	New Railway Plan (standard gage double track) Between HCMC and Can Tho (146km)

Source: VITRANSS 2 Study Team

6.3 Projects for the Short Term

1) Hanoi–Saigon Line (FII)

To increase capacity on the Hanoi-Saigon line, the following items need to be provided or installed:

(i) 46 new signal station with automatic relay interlocking will increase capacity by 1.5 times;

(ii) ATS-S wayside device at the same location as signal station for safety requirements;

(iii) Automatic level crossing & Fence/Barrier of ROW - The existing level crossing class-A (with watchman, slide-type or hanging gate barrier) and class-B (with auto-warning) will be replaced by mechanized automatic level crossing. Total number of class-A and class-B barriers is 581 units. The length of fencing of ROW is set at 200mx2x2 =800m per crossing, for a total of 464.8km. Class C (only X-mark board post) barriers in 439 locations.

(iv) Enlarge Workshops and Depots – to accommodate additional diesel locomotives, passenger cars and freight wagons. The approximate areas of workshops are 10.4ha for the Hanoi-Vinh fleet and 12.0ha for the Nha Trang-Saigon fleet; depots expansion of 4.1ha for Hanoi-Vinh, 7.5ha for VinhHue, and 11.4ha for the Nha Trang-Saigon.

Three improvement options were evaluated for the Hanoi-Saigon Line whose inter-station distance is longer than 10km. Due to the limitations of single track; the maximum number of trains that can be operated per day is 33 trains. New signal stations can be provided to allow trains to pass in both directions between stations that are 10km or more apart. The solution involves the installation of new signal stations between 55 stations where the track capacity is 30 to 40 trains. The scheme will increase capacity to 50 trains per day.

Table 6.3.1 Chosen Improvement Plan

Currently-Set Number of Trains	No. of Inter-Station Sections	No. of Signal Stations to be Installed		Remarks
30	16	55 stations	33%	All sections
40	39			50 trains/day
50	32			
55	15			1.5 times increase of
60	41	111 stations	67%	transport capacity
70	18			
80	4			
90	1			

Source: VITRANSS 2 Study Team

2) Trang Bom-Vung Tau Line (New, SRI & SMI)

A new line has been conceptualized to serve the international ports on the Cai Mep Thi Vai Region. Because of the dominant narrow gauge system in the South, the building of this line would have to examine whether it is more economical to follow the same standard or conform to the new standard gauge and electric standards. The latter is favored if intended mainly to connect the ports to the proposed Long Binh ICD and Trang Bom ICD. Initial length is 71.3km, with possible extension to Vung Tau Port after 2030.

3) Institutional and Management Reforms

The prevailing issue on the re-structuring model for VNR is not conducive to the long term development of the railway sub-sector. The adverse impact will fall on the inter-provincial rail lines. An accepted, but unimplemented, model is to split VNR into two entities: one for track infrastructure, and another for rolling stock and transport operations. This is akin to the model that was widely adopted in European countries, with the exception of UK. It is predicated on the assumption that railway will require continuing subsidy, which is usually channeled to the track entity. On the other hand, a more commercial culture is supposed to evolve on the second entity and to earn profits. The Japan National Railway model, on the other hand, split the railway system into several regional groups while retaining the vertical integration within each group. The freight service is treated as a special case, separate from the others in having multi-regional regional presence but paying for its track access. VNR is having reservations on the first model and is still developing the right business model. The government should make a decision as soon as possible, and accelerate the transition to a new structure. One possible approach is to adapt reforms similar to what had been done in aviation, which is the decentralization into three regional airport corporations and three airport authorities.

Intrinsic to the choice of business model is the issue on the role of government in railway transport and the social obligation that it imposes on rail. The financial viability of rail, and the corresponding level of funding that the State can afford and systematically allocate, depend on the early resolution of this issue. VITRANSS 2 cannot offer a preferred path for lack of information on the actual profitability of VNR. It is likely that Vietnam will lean towards imposing a larger social obligation on rail. Without an explicit policy on this issue, the railway sector will continue to be inefficient because of lack of incentive as a result of being assured of its continued existence regardless of poor performance.

At the same time, the government has to explore the extent that it would allow private sector participation in railways. While Vietnam Railway has listed a number of projects that it wants to implement via BOT arrangement. Announcements alone are insufficient without a firm assurance on how the private sector could recoup its investments. The absence of a regulatory framework is a major deterrent. A practical and less risky way is to start small and gradually step up in the following order:

(i) Management contracts over specified business units, such as the freight operations;

(ii) Turnkey arrangement where a project is designed and built by a private entity in accordance with specifications, and repaid fully or in installments, upon completion;

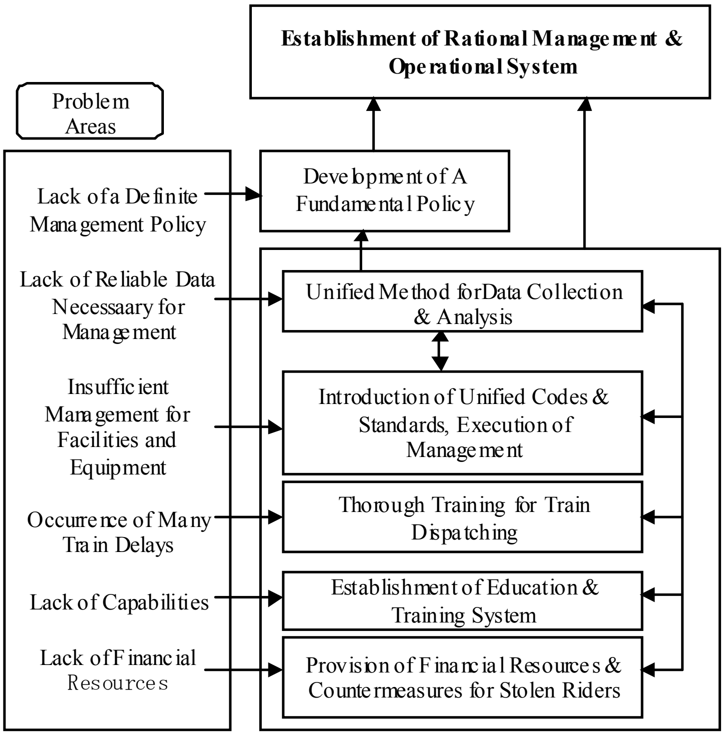
(iii) Operation and maintenance of an existing business, such as the property and non-rail businesses;

(iv) Rehabilitation of existing (but deteriorated) assets to predefined specifications;

(v) BOT and its variants, after gaining experience and confidence on the preceding projects.

There have been recommendations to improve the internal management system of the railway sub-sector, without first changing its bureaucratic structure. It is premised on the unreliable assumption that an established organization is capable of a radical change in its culture without external pressures. The general direction of these proposals is depicted in Figure 6.3.1. This is usually accompanied also by proposal to re-educate, train, and upgrade the skills of staff at various levels and aspects of railway activities. Relying on the ability of existing organizations to radically change itself has had very few, and rare, instances of success in other parts of the world.

Figure 6.3.1 Internal Problems and Countermeasures



Source: VITRANSS 2 Study Team

6.4 Projects for the Medium Term

1) Hanoi–Saigon Line (SRI)

SRI-type of investments to increase capacity on the Hanoi-Saigon line which includes partial double tracking, station improvements, installation of new signaling, and fleet procurement will be implemented, as follows:

(i) Double-tracking works:

- Hanoi-Nam Dinh = 87.0km;
- Hue-Da Nang =83.1km;
- Hai Van Tunnel=22.5km;
- Da Nang-Quang Ngai = 137km; Trang Bom-Saigon = 49km;

(ii) Station Improvement for 38 stations, following above-mentioned double-tracking;

(iii) Automatic Block System - between Hanoi-Vinh = 74.4km, Hue-Da Nang = 128.1km, Da Nang-Nha Trang = 124.4km, and Nha Trang-Saigon = 42.7km;

(iv) Enlarge Workshops and Depots – 20.0ha workshop for the Da Nang-Nha Trang fleet, 3 depots sites of 5.0ha for the Hanoi-Vinh, 12.6ha for the Hue-Da Nang, and 5.0ha for the Nha Trang-Saigon.

2) Hanoi–Lao Cai Line (FII)

The Yen Bai-Lao Cai section was built along the Red River. Trains run on consecutive 150-200m radius curved sections along the terrain. This makes improvement of alignment or construction of signal stations difficult. On the China side, new standard-gauge double-track lines are being built from Kunming to Lao Cai. On the Vietnam side, the plan is to adopt the same standard-gauge double track all the way from Lao Cai to Hai Phong. The interim solution to increase capacity is to provide signal stations between nine stations where the capacity is 34 to 50 trains per day, the result of which is to increase the train sets per day to 54.

Table 6.4.1 Improvement Plan for Hanoi–Lao Cai

Currently-Set Number of Trains	No. of Inter-Station Sections	No. of Signal Stations to be Installed		Remarks	
34	1	2 stations	9%	Total section 43 trains/day	
41	1				
43	6				
50	1			1.2 times increase of	
54	4	20 stations	91%	transport capacity	
60	3				
70	5				
80	1				

Source: VITRANSS 2 Study Team

FII-type of investments to increase capacity by about 1.5 times through the following measures:

(i) 9 new signal stations with automatic relay interlocking system;

(ii) ATS-S wayside device - at the same place as the signal stations;

(iii) Automatic level crossing & Fence/Barrier of ROW - The existing level crossing class-A and class-B will be replaced by mechanized automatic level crossing. Total number of barriers = 63. The length of fencing of ROW is 200mx2x2 =800m/location, and total length is 26.4km.

(iv) Enlarge Depots by 2.5ha for the additional fleet on the Hanoi–Yen Bai operation.

3) Hanoi–Dong Dang Line (FII)

With 8 sets of passenger trains and 8 freight trains per day for the Hanoi-Dong Dang Line, the track capacity is sufficient at present. Predicated on higher cross-border trade flows between China and Vietnam, the proposed interventions can be of the FII-type, consisting of the following measures:

(i) 4 new signal stations with automatic relay interlocking, plus corollary installation of ATS-S wayside devices;

(ii) Automatic level crossing & Fence/Barrier of ROW - The existing level crossing class-A and class-B will be changed to automatic level crossing. Total number of barriers = 88 sites. The length of fencing is 200mx2x2 = 800m per location, or a total length of 70.4km.

Table 6.4.2 Improvement Plan for Hanoi-Dong Dang

Currently-Set Number of Trains	No. of Inter-Station Sections	No. of Signal Stations to be Installed		Remarks	
20	3	4 stations	18%	Total section 43 trains/day	
30	1				
43	7				
50	6			1.6 times increase of	
60	4	18 stations	82%	transport capacity	
70	1				

Source: VITRANSS 2 Study Team

6.5 Projects for the Long Term

1) Hanoi–Saigon Line (SMI)

SMI-type of solutions consisting of full double tracking, station improvements, shift to ABS signaling, enlargement of depot and workshops to handle a bigger fleet, include the following:

(i) Double-track for the remaining sections Nam Dinh–Vinh = 232.0km, Vinh–Hue = 369.0km, Hue–Da Nang = 55.5km, Da Nang–Nha Trang = 387.0km, and Nha Trang–Saigon = 362.0km;

(ii) Improvement of 110 stations;

(iii) Automatic Block System between Hanoi–Vinh = 219.4km, Vinh–Hue = 328.1km, Hue–Da Nang = 55.5km, Da Nang–Nha Trang = 353.4km, and Nha Trang–Saigon = 333.7km;

(iv) Expansion of workshop facilities estimated at 62.4ha for Hanoi–Vinh, 20.0ha for Da Nang–Nha Trang, 72.0ha for Nha Trang–Saigon;

(v) Expansion of depots and facilities estimated at 24.6ha for Hanoi–Vinh, 45.0ha for Vinh–Hue, and 78.4ha for Nha Trang–Saigon.

2) Hanoi–Hai Phong (New line, SRI & SMI)

Upgrading of the Hanoi–Hai Phong line (constructing new line besides existing line) is predicated on cross-border trade flows coming from Kunming through Lao Cai that would also require transshipment at the international seaports of Hai Phong. Total length is 112.0km. The tracks would have to bypass the congested urban districts within Hanoi and Hai Phong, and link to a proposed North Logistic Park. SRI & SMI-type of investments (double tracking, electrified, standard gauge) may be considered. However, in the event that demand is served fully by the parallel Hanoi - Hai Phong expressway, SRI-type of investments may suffice.

3) Hanoi–Lao Cai Line (New line, SRI & SMI)

The final scope of this project needs to be established via a detailed feasibility study. Similar to the Hanoi–Hai Phong line, the demand on this corridor is highly dependent on the growth of cross-border trades with Kunming. Total length is 280km. On the optimistic side, the SRI & SMI-type project would entail double tracking, as well as new alignments, electrification, and probable shift to standard or dual gauge to enable through train operations from Yunnan.

4) Hanoi – Dong Dang (SRI & SMI)

Presuming robust trade with Nanning, SRI & SMI-type of project maybe justified on this line. This would entail 156km of double tracking on dual-gauge system and conversion to electric power. A rail link to the proposed North Logistics Park should increase its economic value.

5) HCMC – Loc Ninh (New line)

Singapore – Kuming railway link (SKRL) is a project included in ASEAN railway development projects for the revitalization of economic activities in Asian countries and HCMC – Loc Ninh section is a part of SKRL. Some studies for this section have been already implemented (Feasibility Study on HCMC – Loc Ninh section by Vietnam and

Detailed Design study for Phnom Penh –Lock Ninh by ADB). From a long term perspective, this link should be developed for the regional development.

6) HCMC – Can Tho (New line)

New railway route from HCMC to Can Tho and Cau Mau are proposed by the Prime Minister's Decision on the Approval of the Development Strategy of Vietnamese Railway Sector till 2020 and Vision till 2050 (No. 1686/QD-TTG November 20, 2008). This decision indicates to connect this section to North - South High Speed Railway line (only for passenger transport) and its target year is until 2050. On other hand, on the Vietnam Railway Transport Development Strategy up to 2020 and Vision 2050 transport (VNR September 2007), Asymptote High Speed Railway (for both of passenger and freight transport) was proposed and this plan is more applicable because of the possible volume of freight transport along this corridor. Although it is forecasted that HCMC – Cha Tho corridor will experience very high growth of traffic demand, the demand of this railway line highly depends on the development of expressway being located parallel.

7) The HSR Project

The High Speed Rail project partakes of a new line and on the highest technical standards of SRI & SMI-type of investment. As indicated in earlier chapters, this project is not financially-viable. Implementing the project within the next 10-15 years is premature. Nevertheless, the project will remain as a long-term solution.

To set the groundwork for later development of the HSR project, a solution to the bottleneck at Hai Van pass can be designed to cater to the existing Hanoi-Saigon railway and preparatory to subsequent HSR. This will involve the construction of a new Hai Van tunnel on HSR standard, but to be used initially by the existing (but upgraded) railway system. This concept is illustrated in Figure 6.5.1 and elaborated in Table 6.5.1.

Table 6.5.1 Developing the Existing Railway with HSR in Mind

Stage Construction Works	Railway Facilities & Operation			Service Provision		
	Tunnel	Operation	Station	Passenger		Freight
				1 m G	HSR	
HSR tunnel + 1m G access line (Access line connects to existing line)	HSR Standard	Existing operation shift to new route	Present station	○	-	○
HSR structure Hue ~ Da Nang Section (includes 1 m G track)	Use HSR tunnel	HSR structure use 1 m G operation	Present station	○	-	○
New tunnel + accesses line for 1 m G (includes double track works)	1m G Standard	1 m G operation shift to new improved line	Present station	○	-	○
HSR track + E&M	Use HSR tunnel	HSR Operation	HSR new station	-	○	-

Source: VITRANSS 2 Study Team

Figure 6.5.1 Proposed Hai Van Tunnel for Railways

Source: VITRANSS 2 Study Team

The Hai Van Pass is now the critical bottleneck to increasing the capacity of the Hanoi – Saigon Line. Without HSR, it can be addressed technically by double-tracking and improving the vertical and horizontal alignments. With HSR in mind, the first stage is to construct the Hai Van Tunnel on the width and alignment standards of HSR. A meter-gauge track link to the existing railway lines shall be provided, followed by construction of the Hue–Da Nang section. It is an expensive solution for the existing meter-gauge railways, but cheaper in the long run if HSR will materialize.

Once the Hai Van tunnel is built, the existing rail line on the old Hai Van Pass can be closed, albeit temporarily, to allow rehabilitation and improvement works to commence. The scope of works shall include countermeasures against frequent slope collapse and falling rocks, in addition to improvements of vertical and horizontal alignments.

When the HSR project is ready for implementation, the existing meter-gauge railway line can move back to the newly-rehabilitated Hai Van Pass and give way for the construction of the HSR tracks between Hue and Da Nang.

6.6 Candidate Projects for Master Plan

Some projects for improving existing lines or constructing new rail lines are committed or on-going, funded by state budget, ODA or both of them. These existing committed/on-going railway projects are supposed to be a part of the Master Plan up to 2020. Through the reviews of government plans and discussions with counterpart agencies, all committed/on-going projects, which are complied into 5 projects, were listed as shown in Table 6.6.1. The total amount of committed/on-going is expected to be USD 1.5 billion.

Table 6.6.1 Committed/On-going Projects

Project Code	Project Title	Original Schedule	Implementing Agency	Cost (Mil USD)	Fund Source
CR01	Improvement & Upgrading in North-South Railway Line	2007-2020	VNR	965	ODA + State budget
Components of CR01	Reinforcement of main tunnels	2007-2020	VNR	44	ODA+State budget
	Enhancement of bridge safety in N-S railway line (44 bridges)	2007-2020	VNR	159	ODA(JBIC)+State budget
	Modernizing station signals in N-S railway line	2007-2010	VNR	20	State budget
	Modernizing Vinh-Sai Gon signals & communication, N-S railway line (Phase 1)	2007-2020	VNR	64	ODA(China)
	Replacing K1, K2 sleepers by pressed concrete sleeper, expanding station approach, installing additional track No.3 in stations with two existing tracks in Vinh-Nha Trang section	2007-2020	VNR	233	State budget
	Improvement of Nha trang station area	2007-2020	VNR	38	State budget
	Relocation of Phan Thiet Station	2007-2010	VNR	4	State budget
	Improvement and upgrade of the remaining bridges in the N-S railway line	2007-2020	VNR	9	ODA+State budget
	Modernization of Hanoi-Vinh signals & communication in Hanoi-Vinh section-Phase 2	2007-2020	VNR	64	ODA+State budget
	Improvement of railway line in Khe Net pass section	2007-2020	VNR	29	State budget
	Improvement of drainage system along HN-HCMC railway line	2007-2010	VNR	10	WB4
	Upgrade of Hanoi-Vinh railway section	2010-2020	VNR	147	State budget
	Upgrade of Nha Trang-Sai Gon railway section	2010-2020	VNR	145	State budget
CR02	Improvement in railway routes in the North	2001-2020	VNR	292	ODA + State budget
Components of CR02	Modernizing railway signals & communication in sections: Hanoi-Lao Cai, Hanoi-Dong Dang, Hanoi-Thai Nguyen, and Hanoi hub areas	2001-2020	VNR	68	ODA (China)+State Budget
	Modernizing Transport Operation Center	2007-2010	VNR	15	ODA(Germany)+State budget
	Urgent improvement of railway safety corridor	2001-2020	VNR	12	State budget
	Replacement of Da Phuc girder	2001-2010	VNR	2	State budget
	Rehabilitation & improvement of Kep-Ha Long section	2001-2020	VNR	34	State budget
	Rehabilitation & improvement of Dong Anh - Quan Trieu section	2001-2020	VNR	26	State budget
	Improvement and upgrading of Yen Vien-Lao Cai railway line	2009-2012	VNR	118	ADB+State budget
	Rehabilitation & improvement of Hanoi - Lang Son railway line	2001-2010	VNR	16	State budget
CR03	Construction of Yen Vien-Pha Lai railway line	2004-2010	VRA	118	State budget
CR04	Construction of new line between Ha Long and Cai Lan	2004-2010	VRA	59	State budget
CR05	Constrcution of new line between Chua Ve and DAP factory-Dinh Vu (Hai Phong)	2007-2010	VNR	68	State budget
Total Project Cost = 1,502 Mil USD					

Source: VITRANSS 2 Study Team

Table 6.6.2 shows proposed projects in Vitranss2, categorized as FII, SRI and SMI as mentioned previously. The total amount reaches about 46 billion US$ and it is impossible to implement all project with such high project cost in a short period. Therefore, prioritization of the projects is necessary.

Table 6.6.2 Proposed Projects

Type of Project	Project Code	Project Title	Project Description	Cost (Mil USD)
Improvement of existing line for capacity expansion	R01	Function-Improvement Items (Hanoi-Saigon Line)	To improve facilities (signal station, automatic level crossing & fence/barrier, depot, workshop etc) to provide 50 trains/day flequency of service on a single truck in Hanoi-Saigon Line.	2,465
	R02	Function-Improvement Items (Hanoi-Lao Cai Line)	To improve facilities (signal station, automatic level crossing & fence/barrier, depot, workshop etc) to provide 50 trains/day frequency of service on a single truck in Hanoi-Lao Cai Line	402
	R03	Function-Improvement Items (Hanoi-Dong Dang Line)	To improve facilities (signal station, automatic level crossing & fence/barrier, depot, workshop etc) to provide 50 trains/day frequency of service on a single truck in Hanoi-Dong Dang Line	116
	R04	System Reinforcement Items (Hanoi-Saigon Line)	To improve existing track to double track (meter gage) and system in some sections of Hanoi-Saigon Line (Hanoi – Nam Dinh (86.8 km), Hue – Da Nang (83.1km;including Hai Van Tunnel), Da Nang – Quang Ngai (136 km), Trang Bone – Saigon (48.7km))	6,748
	R05	System Reinforcement Items & System Modernization Items (Hanoi-Dong Dang Line)	To improve existing track to electrified double track (dual gage) to Hanoi and Dong Dang section (156km)	3,432
	R06	System Modernization Items (Hanoi-Saigon Line)	To improve extisting track to double track (meter gage) and system in overall section of Hanoi-Saigon Line (excluding sections upgraded as double track by R04)	18,509
Construction of new line	R07	Trang Bom – Vung Tau New Railway Construction (SRI & SMI)	To develop a new railway (standard gage double track) between Trang Bone and Vung Tau (71.3km)	1,849
	R08	Hanoi-Lao Cail New Railway Constrcution (SRI &SMI)	To develop a new railway (standard gage, double track) between Lao Cai and Hanoi (280km) besides exisiting railway line.	5,671
	R09	Hanoi-Hai Phong New Railway Constrcution (SRI &SMI)	To develop a new railway (standard gage, double track) between Hanoi and Hai Phong (112km) besides exsititng railway line.	1,893
	R10	HCMC – Loc Ninh New Railway Line Construction	To develop a new railway (dual gage, single track) between HCMC and Loc Ninh (134km)	670
	R11	HCMC – Can Tho New Railway Line Construction	To develop a new railway (standard gage, double track) between HCMC and Can Tho (146km)	3,796
Total				45,549

Source: VITRANSS 2 Study Team

6.7 Prioritization of Projects

The investment proposals coming from the railway sector will require around 47 billion USD, of which 1.5 billion USD is for committed/on-going projects, excluding the HSR Project. In comparison, a sustainable capital budget for the whole transport sector is USD65 billion for the period 2009-2020; with the budget envelope reaching USD91 billion, if Vietnam's economy sustains high growths without slow down over the next 12 years. To satisfy the capital requirement of the railway sub-sector, all other transport sub-sectors have to be given only little allocation from the State budget. Another reality check is the historical amount that rail managed to get in the past which is approximately USD 0.20 billion a year, equivalent to an average 2.0% share in the total transport investment program.

It is not possible to discuss prioritization of railway project on the context of only the railway sub-sector because there are trade-offs and coordination considerations with other sub-sectors, including roads, port & shipping, IWT, and aviation. The reader is referred to the main text of VITRANSS 2 for a more comprehensive discussion on transport project prioritization, including railway development. In the final analysis, around 5.8 billion USD was allocated to railway development projects, excluding Metros, for the period 2009-2020. Therefore only 4.3 billion worth of proposed projects can be accommodated after accounting for the around 1.5 billion USD already reserved for committed/on-going projects. This means that only around 10% of the proposed project amount can be implemented for the period 2009-2020.

To select from among the long list of projects to be developed during the period 2009-2020 as part of the VITRANSS 2 master plan, a multi-criteria analysis (MCA) was conducted. The use of MCA allows projects to be evaluated holistically, and seven items were considered as shown in Table 6.7.1.

Table 6.7.1 MCA for Project Evaluation

Criteria		Indicator	No. of Categories
1	Demand	(ton-km + pax-km)/km	5
2	Economic feasibility	EIRR	5
3	Financial feasibility	FIRR or Demand/Cost	5
4	Network Composition	5: Truck Line/ Main Corridor	5
		4-2: Semi-Truck Line/ Secondary Corridor	
		1: Local	
5	Natural Environmental Impact	% of Length passing Restricted Area	5
6	Maturity/Progress	9: DD (completed)	9
		8: DD (ongoing)	
		7: FS (completed)	
		6: FS(ongoing	
		5: Pre-FS (completed)	
		4: Pre-FS (ongoing)	
		3: MP	
		2: Idea	
		1: No Progress	
7	Consistency with Upper Plan or National Development Policy	3: Listed in Formal Plan	3
		2: Seemingly Consistent	
		1: Unknown/ Inconsistent	

Source: VITRANSS 2 Study Team

The methodology of evaluation scoring is as follows:

(i) Demand: By comparing demand volume, the projects with top 10% demand are given 5 points, 4 points to next the 20%, 3 points to the next 40%, 2 points to the next 20% and 1 point to the last 10%.

(ii) Economic Feasibility: In the same way as demand, each project is given point corresponding to the economic IRR.

(iii) Financial Feasibility: In the same way as economic feasibility, a point is given according to the financial IRR, or demand divided by cost as a substitute of FIRR. Point zero was given to non-income generating project.

(iv) Network Composition: Points are based on importance to the overall network structure.

(v) Natural Environmental Impact: Points are based on the potential impact to environmental.

(vi) Maturity/ Progress: In the order of (9) DD completed, (8) DD in Process, (7) FS completed, (6) FS in process, (5) Pre-FS completed, (4)Pre-FS in process, (3) Listed in Master Plan, (2) Still in concept stage, (1) No progress, each point was given.

(vii) Consistency Upper Plan or National Development Policy: (Refer to Table 6.7.1)

(viii) An overall score is then assessed by integrating all scores calculated. 20% of total score is based on Demand, 30% on Economic Feasibility and 10% on each of Network Composition, Natural Environmental Impact and Maturity/Progress. A score of 5 is attached projects with the highest rating, and 1 for projects with the lowest rating.

MCA was used only on the non-committed projects, while committed projects are assumed a part of the Master Plan already. For details of the evaluation methodology, including key assumptions on the calculation of economic benefits, the reader is referred to Chapter 8 of the Main Text of VITRANSS 2. Table 6.7.2 summarizes the results of the MCA. Based on the budget available for railway projects only the highest rated projects (5 score) can be accommodated during the period 2009-2020.

Table 6.7.2 Comprehensive Evaluation of Railway Projects

Project Code	Project	Cost (USD Mil.)	Demand	Economic	Financial	Network Composition	Natural Environment	Maturity of Plan	Gov't Policy	Overall Evaluation
Improvement of existing line for capacity expansion										
R01	Function-Improvement Items (Hanoi-Saigon Line)	2465.3	4	5	3	5	3	3	3	5
R02	Function-Improvement Items (Hanoi-Lao Cai Line)	401.9	3	3	4	4	2	3	3	3
R03	Function-Improvement Items (Hanoi-Dong Dang Line)	116.4	2	4	5	4	4	3	3	4
R04	System Reinforcement Items (Hanoi-Saigon Line)	6747.5	5	1	3	5	5	3	3	3
R05	System Reinforcement Items & System Modernization Items (Hanoi-Dong Dang Line)	3431.7	2	1	1	4	3	3	3	1
R06	System Modernization Items (Hanoi-Saigon Line)	18508.8	5	3	1	5	3	3	3	3
Construction of new line										
R07	Trang Bone – Vung Tau New Railway Construction (SRI & SMI)	1847.8	5	3	4	5	4	6	2	5

Project Code	Project	Cost (USD Mil.)	Demand	Economic	Financial	Network Composition	Natural Environment	Maturity of Plan	Gov't Policy	Overall Evaluation
R08	Hanoi-Lao Cail New Railway Constrcution (SRI &SMI)	5671.1	3	2	2	4	4	3	3	3
R09	Hanoi-Hai Phong New Railway Constrcution (SRI &SMI)	1892.8	4	2	3	5	5	3	3	3
R10	HCMC – Loc Ninh New Railway Line Construction	670.0	-	-	-	-	-	-	-	2*
R11	HCMC – Can Tho New Railway Line Construction	3,796.0	-	-	-	-	-	-	-	3*

Source: VITRANSS 2 Study Team

A realistic plan for railways will, therefore, have to be re-worked around a capital expenditure budget of USD5.8 billion for 2009-2020 to be allocated as follows:

(i) All committed projects including improvement & upgrading railway routes in the North-South and the North and some new lines amounting to US$1.50 billion;

(ii) Functional Improvement Items (FII) for Hanoi-Saigon line (R01), amounts to US$2.47 billion, which deserves the highest priority;

(iii) Construction of new line on Trang Bom - Vung Tau section (71.3km) (R07), amounts to US$1.85 billion.

The following projects can be considered as second priority for beyond 2020 (Score 4 or 3 Project):

(i) Functional Improvement Items (FII) for Hanoi–Lao Cai line (R02) and Hanoi–Dong Dang Line (R03), amounting US$ 0.52 billion;

(ii) System Re-enforcement Items (SRI) for Hanoi–Saigon Line (R04), amounting to US$ 6.75 billion;

(iii) System Modernization Items (SMI) for Hanoi – Saigon Line (R06), amounting to US$18.51 billion;

(iv) Construction of new lines on Hanoi-Lao Cai section (R08), Hanoi-Hai Phong Section (R09) and HCMC – Can Tho Section (R11), amounting to US$11.34 billion.

After the implementation of the projects above, the following project can be considered for development (Score 2 or 1 project).

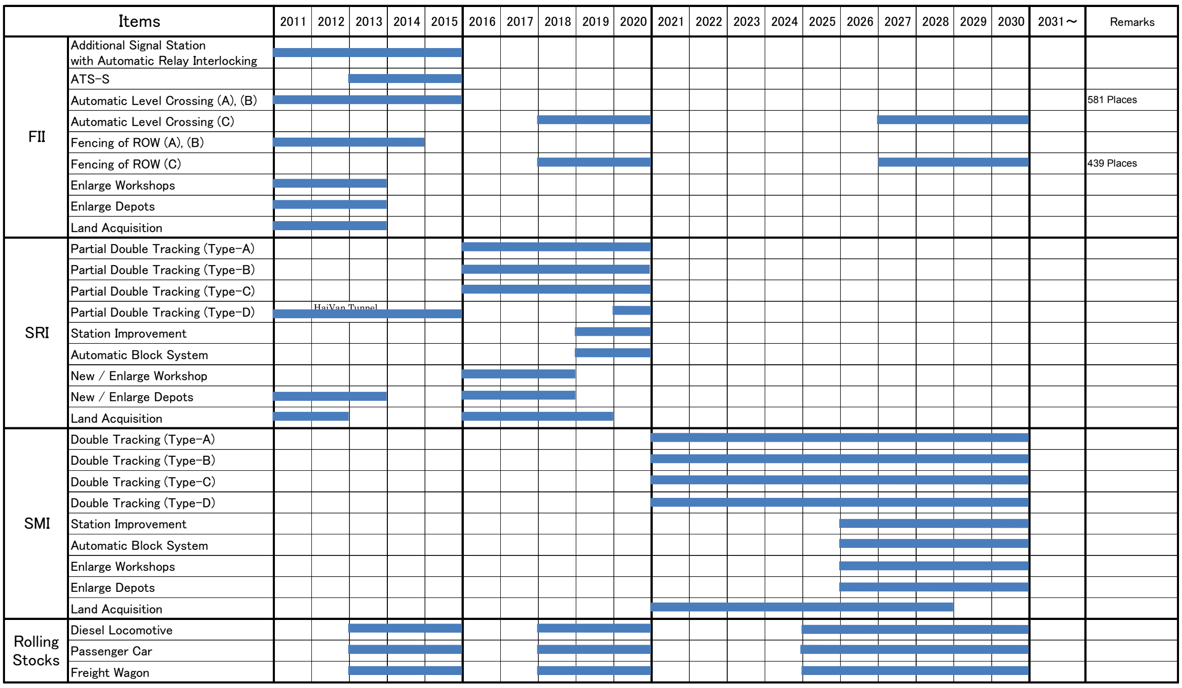
(i) System re-enforcement Items (SRI) & System Modernization Items (SMI) for Hanoi – Dong Dang Line (R05), amounting US$ 3.4 billion.

(ii) Construction of new lines on HCMC – Loc Ninh Section (R10) , amounting to US$ 0.67 billion.

6.8 Implementation Schedule

Indicative implementation schedules for the Hanoi-Saigon Line, Hanoi–Lao Cai Line and Hanoi-Dong Dang Line are shown on Figure 6.8.1 to 6.8.3, respectively. Except for Functional Improvement Items (FII) on Hanoi–Saigon line, implementation schedules are likely to be pushed back or deferred by a few years, based funding expectation.

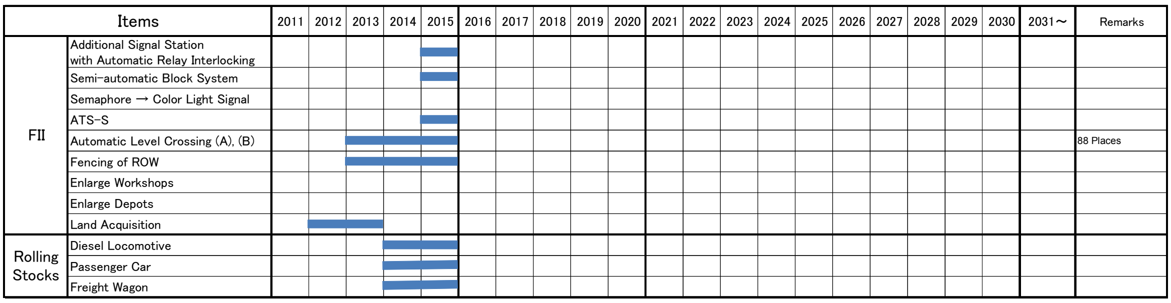
Figure 6.8.1 Indicative Implementation Timetable for Hanoi-Saigon Line



Note: FII: Function Improvement Items SRI: System Reinforcement Items SMI: System Modernization Items

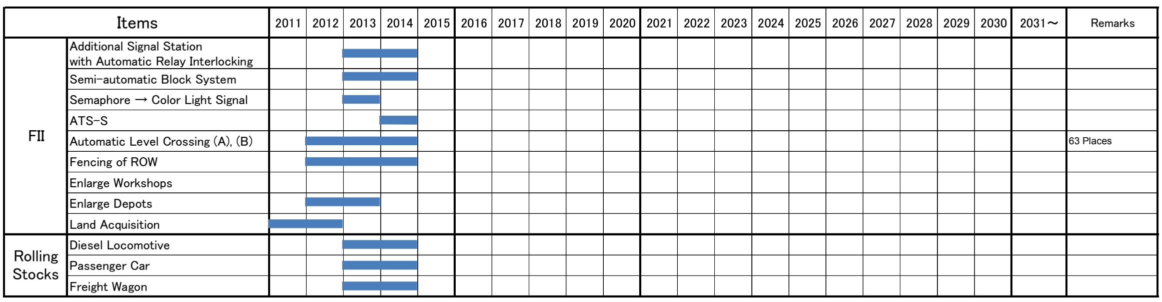
Source: VITRANSS 2 Study Team

Figure 6.8.2 Indicative Implementation for Hanoi–Lao Cai Line



Source: VITRANSS 2 Study Team

Figure 6.8.3 Indicative Implementation Timetable for Hanoi–Dong Dang Line



Source: VITRANSS 2 Study Team

6.9 Conclusions and recommendations

1) Key Findings

Among all the transport sectors, the railway sub-sector has probably the most number of projects in its pipeline which is worth more than USD47 billion. However it has also the distinction of having the most backlogs which includes projects that could not take off, delayed, or unimplemented. The reason is the funding gap. For the last seven years, the capital expenditures on rail projects averaged only about USD200 million, representing about 2% of the total investments in the transport sector of Vietnam.

Its market share in passengers and freight has declined. The network has not been completely rehabilitated from the ravages of war and yearly natural disasters. Hence, its level of service is falling below what the market requires or desires. Another factor for its poor performance is the vast expansion of the road network. These two factors, one internal and the other external, have reduced the role of railways in the corridors where it had traditionally been dominant.

The environment has changed, but the sector has not managed to keep up and be efficient and aggressive in marketing its services. Re-structuring has not resulted in significant tangible benefits, while the sub-sector searches for other options. The sub-sector has not been able to make the most of its existing rail assets, but at the same time it seeks to replace its assets with the latest and more advanced technologies, in terms of shift to electrification and standard gauge, or implementation of High Speed Railway on its longest line even longer than those built in many industrialized countries. Rail is losing in its traditional markets, but still pushes to expand into new markets with new lines or extensions of existing ones. But because of funding constraints the sub-sector is limited to what it can achieve.

The funding reality is such that new railway lines (such as HCMC–Loc Ninh) could only be considered after 2020. The HSR project carries a price of USD55 billion, and is virtually impossible to finance before 2020. It would take 10 years, at the very least, to complete. Deferring its implementation will improve its economic and financial viability, which are marginal under the current implementation scenario. Traffic is also very uncertain.

New railway lines are being constructed in HCMC and Hanoi. With a price of USD13.9 billion for 4 urban rail lines, they would compete for public funding and in the process and crowd out the railway sector in the competition for capital and human resource.

The positive financial results of VNR depict a contradictory picture to its sub-par performance in other indicators, such as in number of staff and throughput per km of track. At any rate, the inability of the sub-sector to attract private sector capital and the inadequacy of internal capacity to generate funding for backlog projects is indicative of the weak financial state of the sub-sector.

2) Recommendations for the Long Term

The most urgent task for the railway sector is to undertake its long-delayed institutional re-structuring. By their very nature, the transition is expected to be difficult and will take several years. Without an effective organization and clear directions, the sector will be unable to meet the challenges of a more competitive transport market and the implementation of a project portfolio 3 times bigger than it had previously handled. Unless this basic step is done, it cannot proceed with: (i) mobilizing private sector capital or resources for its development, (ii) training its officers and staff on the new tools and new roles, (iii) meeting the needs of a demanding customers.

There are 3 business models to choose from:

(i) The 'Euro model' – which would split VNR into two: one for track infrastructure and one for rolling stock operations;

(ii) The "JNR model – which would split VNR into four enterprises: a northern rail corporation (encompassing 4 Hanoi-oriented rail lines), a southern rail corporation (which is yet to emerge), a North-South rail corporation, and a rail-freight company.

(iii) Track Authority Concession model – which would place all assets under a rail authority who then parcels out separate management contracts for the 6 railway lines and 1 for the freight railway operations.

The sector should re-examine its priorities and downscale its plans by a ratio of 10 to 1. Instead of formulating a plan that will require USD47 billion, it should make do with USD5.8 billion capital investment program for the period 2009–2020. This program should focus on improving capacity on Hanoi - Saigon line. Unfortunately, the budget envelope does not have much room enough to develop many new railway lines.

The Hanoi-Saigon Line (or N-S Rail) will remain the most important and biggest (almost 70% of the network) segment of the railway sector in Vietnam. This is where demand is highest, and should therefore be accorded the highest priority in its 10-year investment program. To maximize capacity of this line, it needs double tracking and Automatic Block System for signaling. Estimated cost for this entire program is USD27.7 billion – an amount that exceeds the budget envelope to year 2030. Realizing its full potentials will stretch further into the future, in the event that HSR is pushed through before 2030.

Not unlike in other countries, the highest potential for private sector participation is in freight business. VNR should plan to privatize this part of its activities as soon as possible. Logistics is mostly private, and trucking is by and large in the hands of the private sector in Vietnam. Hence, government should not compete in the transport of goods. Moreover, bulk users who are the captive customers of rail need long-term assurance about transport means and are therefore willing to invest in freight wagons and locomotives to ensure their viability. For example, the fleet cost (for freight wagons and locomotives) up to 2020 is USD664 million. It is an amount that the State can avoid. Hence, if privatized, more money would become available for the 1st and 2nd priority projects in the railway sub-sector.

Because funding is the biggest obstacle to the realization of railway plans, the government should explore a long-term and stable source of funding for the railway sector. In many European countries, part of the levy on petrol goes into a rail subsidy. A promising option is to impose a carbon tax. The proceeds go to economic sectors that contribute to clean air and lower emissions. It has been reported that rail consumes the least energy of all modes of transport per unit transport demand.

APPENDIX 3A

Cost Estimation

APPENDIX 3A

Cost Estimation

1 Concept of Cost Estimation

Cost estimation is calculated as on the level of master plan under setting unit prices for each item which are planned in the Draft Master Plan. Therefore, it is calculated as a total amount and quantity itself is counted according to the items shown in the program such as per km or per place.

The base year of cost estimation is March 2008 when the unit price investigation was executed by VITRANSS 2. The latest price increase in Vietnam is remarkable, and they are very special since the inflation trends from the 2009 fiscal year were influenced by the world-wide economic crisis. It is hard to think that the price increase will advance at the same pace from now on, therefore, from this point of view, March 2008 will be adequate.

The key currency of cost estimation is US dollar (USD), and exchange rates against Japanese Yen (JPY) and Vietnamese Dong (VND) are as follows:

1USD=100JPY=17,000VND

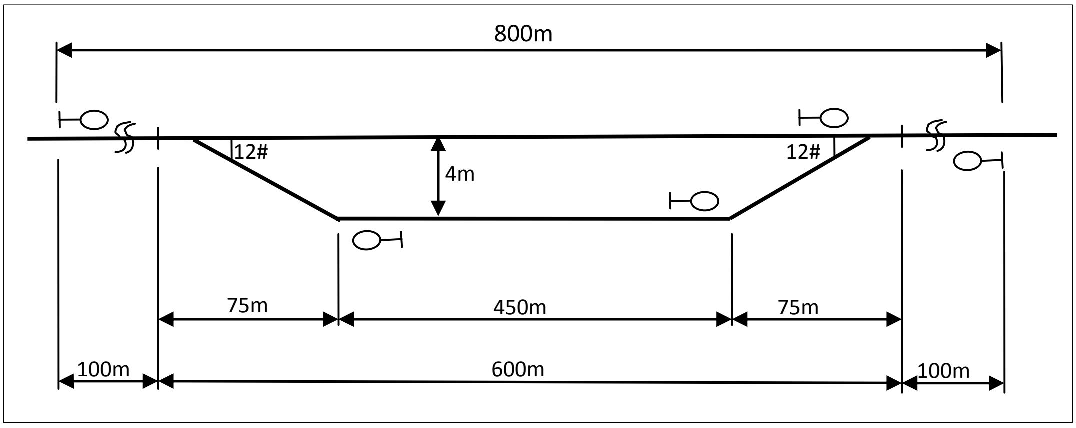
2 Unit Prices

Unit price is set under consideration with information obtained by investigation from rail-related organization such as MOT, VNR, VNRA, RPMU and TRICC through TDSI (the Counter Part), and from reports of similar projects undertaken in the past such as Hanoi UMRTs, HCMC UMRTs, Hai Van Tunnel, Hai Phong Line Improvement Plan, etc., and further from Japanese experts and organizations including cost estimations by Japanese Private Companies, etc.

(1) Additional Signal Station with Automatic Relay Interlocking

Schematic layout of additional signal station is shown below:

Figure 1 Schematic Layout of Additional Signal Station



Source: VITRANSS 2 Study Team

The unit price includes earthwork, track, staff building, signal device and automatic relay interlocking system. The unit price is USD1,469,000/station.

Land acquisition is assumed based on the existing ROW is 5m from the end of earthwork, therefore the required land will be additional width 4.0m x station length 550m + staff office & other space = 2,500 ㎡/ each station.

Unit price calculation:

(i) earthwork: as shown in (6), \$500/m x 600m=\$300,000.

(ii) track: same as above, \$900 x (600□2 x 30m)=\$486,000.

(iii) turnout: \$47,000 x 2set=\$94,000.

(iv) signal & automatic relay interlocking devices: \$580,000.

(v) staff building: \$300/m^2 x 30m^2= \$9,000.

(vi) total: \$1,469,000/station

(2) ATS-S (Automatic Train Stop–Stopper)

There are 2 kinds of device for ATS-S, one is called wayside coil which is set on the ground, and another is pick-up coil which is set on a locomotive car. ATS-S wayside devices will be provided at the same place of signals shown in Figure 2, therefore the ATS-S devices are 4 sets/each station. The unit price is USD30,000 x 4=USD120,000/ each station and it includes cable.

The pick-up coils will be counted separately, and its unit price is USD80,000/car.

(3) Automatic level crossing

Existing level crossings are classified into 3 types. In the FII, existing class-A & B level crossings will be changed to Automatic level crossing, and remaining class-C will be changed after double tracking completion. In this study, it is assumed that a 18.0m wide road is crossing railway as average of the class-A & B, and 6.0m wide road for class-C. The unit price includes level crossing alarm, barrier, control devices, electronic train detector and cable, and is USD200,000/place for class-A & B, and USD120,000/place for class-C.

(4) Fence/Barrier of ROW

To provide fence/barrier along side of railway ROW is required for safety of train operation with avoiding accidents when the numbers of train operation increase. According to introduce the automatic level crossings, to keep the ROW around the level crossings will be more important to prevent somebody invades against level crossing barrier.

On the other hand, there are some section where the fence/barrier is not necessary such as high embankment or deep cutting, tunnel and bridge sections. Therefore, cost estimation will be on the assumption that the section has to be provided fence/barrier will be at both sides of the existing level crossing of 200m for class-A & B, 100m for class-C. The length of fence/barrier is 200x2x2=800m at class A & B, 100x2x2=400m at class-C of each level crossing, and its unit price is USD60,000 /km.

(5) Enlarge Depots / Workshops

There are existing 3 workshops and 11 depots, however it seems difficult to divide for each line in their role, therefore all existing workshops and depots assumed to be enlarged 1.5 times according to the increased train numbers of about 1.5 times by adding signal stations, the unit price of enlarged part is USD 4,500,000/ha for workshop and USD 4,100,000/ha for depot.

Unit price calculation:

(i) 3 workshops are Gia Lam (20.8ha), Di An (24.0ha) and Hai Phong (2.5ha), and their total area is 47.3ha. Cost for existing workshop is USD100mil./place. Hai Phong is ignored because of its size, therefore 2x100mil./45ha = 4.5mil./ha

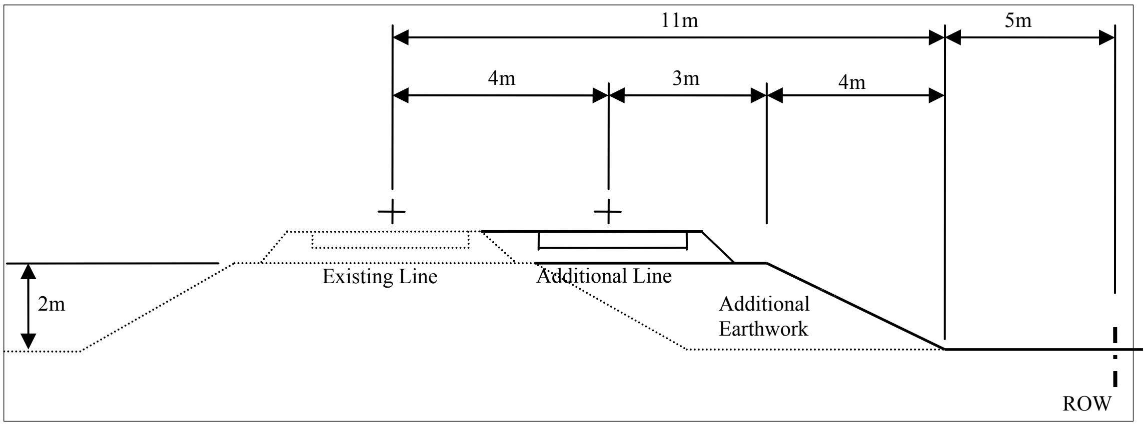
(ii) 11 depots are Yen Bien (4.9ha), Hanoi (4.1+1.1+3.0=8.2ha), Vinh (11.8+3.1=14.9ha), Da Nang (2.2+1.4=3.6ha) and Saigon (7.2+12.0+3.6=22.8ha), and their total area is 54.4ha. Cost for existing depot is USD 20mil./place, therefore 11x20mil./54.4ha= USD4.1mil./ha.

(6) Double Tracking (Type-A)

In section where existing line is good alignment the additional line is to be constructed in parallel. This is called 'Type-A' in this report and its conceptual layout is shown in Figure 2. The height of embankment shown in the figure is average value on the assumption. The unit price includes earthwork and track, and is USD1,400,000/km.

Land acquisition is assumed based on the existing ROW is 5m from the end of earthwork, therefore the required land will be additional width 4.0m/m.

Figure 2 Double Tracking (Type-A)



Source: VITRANSS 2 Study Team

Unit price calculation:

(i) earthwork: $500/m (the volume of this earthwork is about 1/3 of Type-B earthwork)

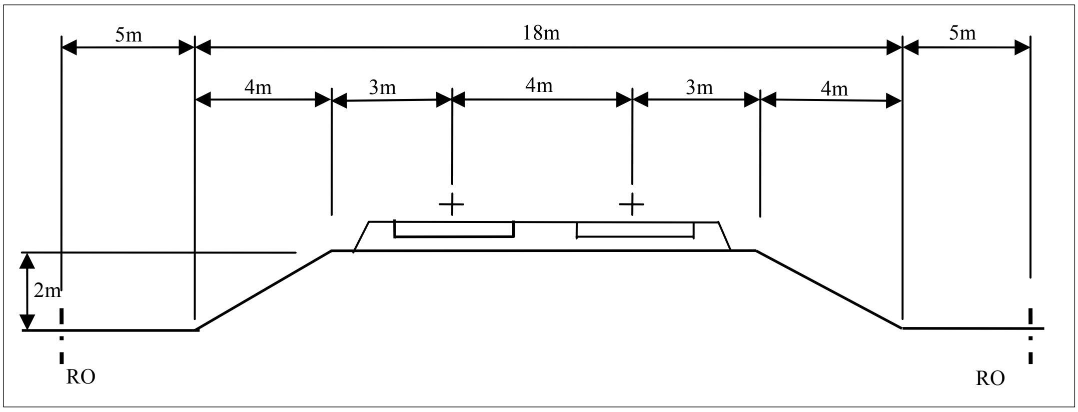
(ii) track: $900/m

(iii) total: $1,400/m

(7) Double Tracking (Type-B)

In section where existing line is bad alignment and it must be improved, new double track line is to be constructed apart from the existing line. This is called 'Type-B' in this report and its conceptual layout is shown in Figure 3. The unit price includes earthwork and track, and is USD3,300,000/km. Required land acquisition is 28m / m.

Figure 3 Double Tracking (Type B)



Source: VITRANSS 2 Study Team

Unit price calculation:

(i) earthwork: average price is about $1,500/m

(ii) track: $1,800/m (rail, sleeper, ballast, etc.)

(iii) total: $3,300/m

(8) Double Tracking (Type-C)

In section where existing line is the same as Type-B, however because of topographical feature or other conditional reasons, new double track line is not be able to adopt earthwork but bridge structure. This is called 'Type-C' in this report. The unit price is USD 23,000,000/ m including track. Required land acquisition width is 22m which is consisted of bridge width 12m plus 5m clearance for both side.

Unit price calculation:

bridge: average price is about $21,000/m

(i) track: $2,000/m (rail, sleeper, ballast, guard rail, etc.)

(ii) total: $23,000/m

(9) Double tracking (Type-D)

In section where existing line is the same as Type-B, however because of topographical feature or other conditional reasons, new double track line is not be able to adopt earthwork but tunnel structure. This is called 'Type-D' in this report. The unit price is USD 22,500,000/km including track.

Unit price calculation:

(i) tunnel: average price is about $19,500/m

(i) track: $3,000/m (rail, frame-type slab track, etc.)

(ii) total: $22,500/m

(10) Automatic Block System

Automatic block system will be introduced between stations every 1 km in double tracking sections. The formula of calculation for length of introducing this system is;

(i) L (km) = length of double tracking (km)–(Number of stations x 1.05)

(ii) The unit price includes signal devices, electronic train detector, cable and ATS-S wayside coil, and is USD130,000/km

Unit price calculation:

(i) automatic block system: $70,000/km

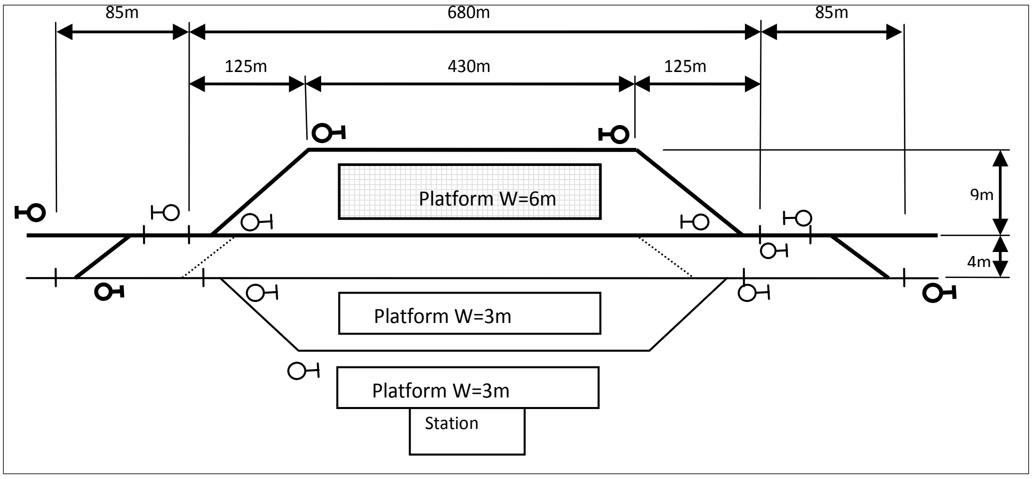
(ii) ATS-S wayside coil: $30,000x2 sets =$60,000/km

(iii) total: $130,000/km

(11) Station Improvement for double tracking section

Stations located within the section of double tracking have to be improved, and its schematic layout is shown in Figure 4.

Figure 4 Schematic Layout of Station Improvement



Source: VITRANSS 2 Study Team

The layouts of existing stations vary, but they can be roughly divided into 4 types and their compositions in the Hanoi-Saigon Line are as follows:

(i) 1 main line + 1 loop line 20%

(ii) 1 main line + 2 loop lines 60%

(iii) 1 main line + 3 loop lines 8%

(iv) 1 main line + 4 or more loop lines 12%

Therefore, the unit price is calculated based on the double tracking to the ‘1 main line + 2 loop lines’ as a representative type as shown in above figure.

The unit price includes earthwork, track, station building, signal device and automatic relay interlocking system. The unit price is USD3,136,000/station.

Land acquisition is assumed based on the existing ROW is 5m from the end of earthwork and land purchase for double tracking has been counted, therefore the required land will be additional width 9.0m x station length 680m + other additional space = 6,500m^2/ each station.

Unit price Calculation:

(i) earthwork: $1,000/m (the volume of this earthwork is about 65% of Type-B earthwork), therefore $1,000/mx680m=$680,000.

(ii) track: as shown in (6), $900x(680-2x30m)=$558,000.

(iii) turnout: \$47,000x6set=\$282,000.

(iv) signal & automatic relay interlocking devices: \$872,000.

(v) ATS-S wayside coil: \$30,000x13set=\$390,000.

(vi) station building enlargement: \$300/ m^2x60 m^2= \$18,000.

(vii) Platform: \$140/ m^2x6mx400m=\$336,000.

(viii) total: \$3,136,000/station

(12) New Depots and Workshops

New depots will be required at least 2 places near Nam Dinh and Tran Bone where the end side of partial double tracking, and a new workshop will be required at near Da Nang. The new workshop will be about 20ha as the same size of existing one, and the new depot will be about 5ha/each as on assumption for this cost estimation. The unit prices are same as enlargement described in (5), USD4.5 mil./ha for workshop, and USD4.1 mil./ha for depots.

(13) Rolling Stock

Required numbers of rolling stock for each stage are calculated based on the numbers of registered diesel locomotives (DL), passenger cars (PC) and freight wagons (FW) according to the progress of implementation of FII, SRI and SMI. The planned numbers of rolling stock are shown in Table 1. And additionally, the existing rolling stocks will have to be changed to new cars, therefore the numbers of renewal are counted as on the assumption of 1/3 by 2015, next 1/3 by 2020 and remaining 1/3 by 2030.

The unit prices for each type of rolling stock are assumed to be manufactured in Vietnam as in the Gia Lam Train Manufactory; Engines and their spare parts will be imported, others will be all made in Vietnam.

(i) DL: USD 1,420,000. plus ATS-S pick-up coil USD 80,000 = USD 1,500,000./each.

(ii) PC: USD 300,000./each

(iii) FW: USD 150,000./each

Table 1 Required Numbers of Rolling Stock

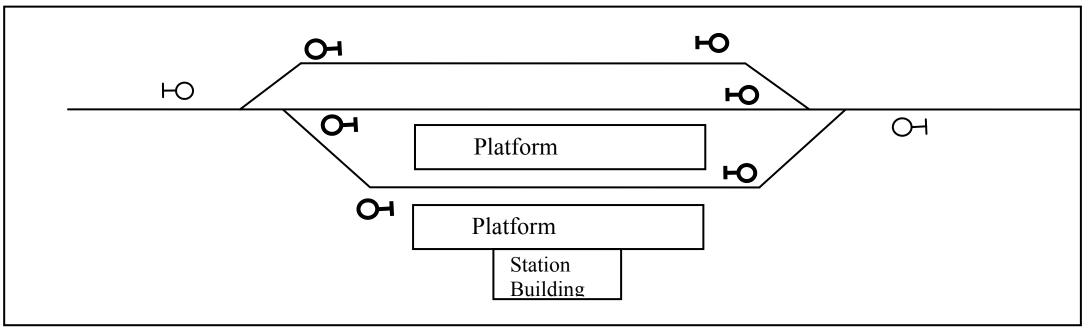
Time	Description		Hanoi-Saigon	Hanoi-LaoCai	Hanoi-Dong Dang	Total	Remark
Present	Present Numbers of DL	Passenger	90	5	3	98	The present rate of reserve =9%
		Freight	56	20	3	79	
		Total	146	25	6	177	
	Present Numbers of Car	Passenger	585	117	70	772	The present rate of reserve = 10%
		Freight	2,688	1,050	113	3,851	
		Total	3,273	1,167	183	4,623	
FII	Numbers of DL in 2015	Passenger	135	8	5	148	The planned rate of reserve will be 20%
		Freight	84	30	5	119	
		Total	219	38	10	267	
	Numbers of Car in 2015	Passenger	878	187	117	1,182	
		Freight	4,032	1,575	188	5,795	
		Total	4,910	1,672	305	6,977	
SRI	Numbers of DL in 2020	Passenger	179	8	5	192	The planned rate of reserve will be 20%
		Freight	84	30	5	119	
		Total	263	38	10	311	
	Numbers of Car in 2020	Passenger	1,736	187	117	2,040	
		Freight	4,032	1,575	188	5,795	
		Total	5,768	1,762	305	7,835	
SMI	Numbers of DL in 2030	Passenger	405	8	15	428	The planned rate of reserve will be 20%
		Freight	252	30	15	297	
		Total	657	38	30	725	
	Numbers of Car in 2030	Passenger	2,633	187	351	3,171	
		Freight	12,096	1,575	563	14,234	
		Total	14,729	1,762	914	17,405	

Source: VITRANSS 2 Study Team

(14) Semi-automatic Block System

This system has been adopted in Hanoi–Saigon Line. On the other hand, Hanoi–Lao Cai line, Hanoi–Dong Dang Line and other lines have been used token block system. At this opportunity that train operation numbers are going to be increased, token block system is to be changed to semi-automatic block system. The typical schematic layout is shown in Figure 5 below:

Figure 5 Schematic Layout for Semi-Automatic Block System



Source: VITRANSS2 Study Team

The unit price includes signal device and semi-automatic block system. The unit price is USD 248,000/station.

(15) Semaphore → Color Light Signal

There are remaining semaphores in Hanoi–Lao Cai Line, and as same as above, at this opportunity that train operation numbers are going to be increased, semaphores will be changed to color light signals.

The unit price is USD4,000/each

3 Cost Aggregations

The results of cost estimation for each project is summarized in Table 2, while the breakdowns and for each line is shown in Table 3 to 5.

The cost of new lines are calculated by their distance based on the recent F/S report of New Railway Line with consideration of geographical features for each line

This cost estimation shows direct cost only, and excludes price escalation, contingency, consulting services fee, administration cost, VAT and other taxes, interest during construction and commitment charge, etc.

Table 2 Summary of Cost Estimation (1,000 USD)

Existing Line Improvement	Distance (km)	FII	SRI	SMI	Total Amount
Hanoi-Saigon	1,726.2	1,896,396	5,210,874	14,237,553	21,344,822
Hanoi-LaoCai	293.5	309,175	0	0	309,175
Hanoi-Dong Dang	162.5	120,358	0	0	120,358
Sub Total		**2,325,929**	**5,210,874**	**14,237,553**	**21,774,355**
New Line Construction	**Distance (km)**	**FII**	**SRI**	**SMI**	**Total Amount**
Hanoi-Lao Cai	280.0	0	0	4,362,400	4,362,400
Hanoi-Hai Phong	112.0	0	0	1,456,000	1,456,000
Hanoi-Dong Dang	156.0	0	0	2,639,800	2,639,800
Trang Bom-Vung Tau	71.3	0	0	1,421,390	1,421,390
Sub Total		**0**	**0**	**9,879,590**	**9,879,590**
Grand Total		**2,325,929**	**5,210,874**	**24,117,143**	**31,653,945**

Source: VITRANSS 2 Study Team

Figure 3 Cost for Hanoi–Saigon Line by Type of Improvements

Item		Unit	Unit Price (1,000$)	Amount						Remarks
				Hanoi-Vinh	Vinh-Hue	Hue-DaNang	DaNang-NhaTrang	NhaTrang-SaiGon	Total	
FII	Additional Signal Station with Automatic Relay Interbcking	nos	1,469	7,345	11,752	0	27,911	20,566	67,574	
	ATS-S	nos	120	600	960	0	2,280	1,680	5,520	
	Automatic Level Crossing (1)	nos	200	30,400	19,200	10,200	30,600	25,800	116,200	Class-A&B of existing
	Automatic Level Crossing (2)	nos	120	12,360	10,800	3,240	14,040	12,240	52,680	Class-C of existing
	Fencing of ROW (1)	Km	60	7,296	4,608	2,448	7,344	6,192	27,888	Class-A&B of existing
	Fencing of ROW (2)	Km	60	2,472	2,160	648	2,808	2,448	10,536	Class-C of existing
	Enlarge Workshops	Ha	4,500	46,800	0	0	0	54,000	100,800	
	Enlarge Depots	Ha	4,100	16,810	30,750	0	0	46,740	94,300	
	Land Acquisition	Ha	10,006	257,120	68,993	0	3,165	240,070	569,348	Unit Price shows average
SRI	Partial Double Tracking (Type-A)	Km	1,400	98,000	0	39,900	163,800	28,000	329,700	
	Partial Double Tracking (Type-B)	Km	3,300	0	0	26,730	52,800	0	79,530	
	Partial Double Tracking (Type-C)	Km	23,000	391,000	0	552,000	46,000	667,000	1,656,000	
	Partial Double Tracking (Type-D)	km	22,500	0	0	506,250	45,000	0	551,250	
	Station Improvement	Nos	3,136	37,632	0	25,088	37,632	18,816	119,168	
	Automatic B bck System	Km	130	9,672	0	9,711	16,172	5,551	41,106	With ATS-S
	New/Enlarge Workshops	Ha	4,500	0	0	0	90,000	0	90,000	
	New/Enlarge Depots	Ha	4,100	20,500	0	51,660	0	20,500	92,660	
	Land Acquisition	Ha	11,815	293,594	0	353,977	395,070	528,269	1,570,910	
SMI	Partial Double Tracking (Type-A)	Km	1,400	169,400	207,200	57.260	344,400	364,000	1,142,260	
	Partial Double Tracking (Type-B)	Km	3,300	287,100	600,600	19,470	392,700	290,400	1,590,270	
	Partial Double Tracking (Type-C)	Km	23,000	92,000	138,000	0	207,000	184,000	621,000	
	Partial Double Tracking (Type-D)	km	22,500	450,000	742,500	195,750	292,500	135,000	1,815,750	
	Station Improvement	Nos	3,136	37,632	122,304	0	100,352	84,672	344,960	
	Automatic B bck System	Km	130	28,522	42,647	7,215	45,942	43,375	167,700	With ATS-S
	Enlarge Workshops	Ha	4,500	280,800	0	0	90,000	324,000	694,800	
	Enlarge Depots	Ha	4,100	100,860	184,500	0	0	321,440	606,800	
	Land Acquisition	Ha	6,549	1,664,518	780,0,151	50,763	496,972	1,486,609	4,479,013	
Rolling Stocks (RS)	**Phase of Introducing**			**FII**		**SRI**		**SMI**		**Rolling Stock Total**
	Diesel Locomotive	Car	1,500	235,500		159,000		787,500		1,182,000
	Passenger Car	Car	300	187,200		373,200		387,600		948,000
	Freight Wagon	car	150	428,850		148,350		1,599,900		2,177,100
Total Amount				**FII+RS**		**SRI+RS**		**SmI+RS**		**Grand Total**
				1,896,874		**5,210,847**		**14,237,553**		**21,344,822**

Source: VITRANSS2 Study Team

Table 4 Cost Estimation (Hanoi–Lao Cai Line)

Item		Unit	Unit Price (1,000$)	Amount (1,000 USD)			Remarks
				Hanoi-YenBai	YenBai-LaoCai	Total	
FII	Additional Signal Station with Automatic Relay Interbcking	nos	1,469	13,221	0	13,221	
	Semi –automatic Block System	nos	248	5,704	3,968	9,672	
	Semaphore -> Color Light Signal	nos	4	44	64	108	
	ATS-S	nos	120	1,080	0	1,080	
	Automatic Level Crossing	nos	200	6,000	6,600	12,600	Class-A&B of existing
	Fencing of ROW	Km	60	1,440	1,548	3,024	Class-A&B of existing
	Enlarge Workshops	Ha	4,500	0	0	0	
	Enlarge Depots	Ha	4,100	10,250	0	10,250	
	Land Acquisition	Ha	1,741	8,270	0	8,270	Unit price shows average
	Sub Total			**46,009**	**12,216**	**58,225**	
RS	Diesel Locomotive	Car	1,500		42,00	42,000	
	Passenger Car	Car	300		41,400	41,400	
	Freight Wagon	Car	150		167,550	167,550	
Total Amount						**309,175**	

Source: VITRANSS2 Study Team

Table 5 Cost Estimation (Hanoi–Dong Dang Line)

Item		Unit	Unit Price (1,000$)	Amount (1,000 USD)			Remarks
				Hanoi-Kep	Kep-Dong Dang	Total	
FII	Additional Signal Station with Automatic Relay Interbcking	nos	1,763	0	7,052	7,052	Dual Gauge = +20%
	Semi –automatic Block System	nos	248	0	1,448	1,448	
	Semaphore -> Color Light Signal	nos	4	0	0	0	
	ATS-S	nos	120	0	480	480	
	Automatic Level Crossing	nos	200	14,600	3,000	17,600	Class-A&B of existing
	Fencing of ROW	Km	60	3,504	720	4,224	Class-A&B of existing
	Enlarge Workshops	Ha	4,500	0	0	0	
	Enlarge Depots	Ha	4,100	0	0	0	
	Land Acquisition	Ha	10	0	10	10	Unit price shows average
	Sub Total			**18,104**	**12,750**	**30,854**	
	Diesel Locomotive	Car	1,500		10,500	10,500	
	Passenger Car	Car	300		26,700	26,700	
	Freight Wagon	Car	150		21,450	21,450	
Total Amount						**120,358**	

Source: VITRANSS2 Study Team

4 Cost Summary by Projects

It should be noted that the cost estimates were based only on direct cost items. When factored into a project budget, indirect costs items have to be added, e.g., price escalation, contingency, consulting services fee, administration cost, VAT/other taxes, interest during construction and other financial charges.

Although each project item usually differs in proportion to project size, foreign and local cost components, and timing of implementation, these had been ignored for purposes of budget estimation. Thus, the project costs factored in 13% of direct cost as the value for indirect cost. Table 6 shows the project cost for each Line broken down into such categories as FII, SRI and SMI. The year of expenditure is indicative, and would need to be changed after considering the relative priorities and the budget envelope.

Table 6 Project Cost by each Line

Existing Line Improvement	Distance (km)	Items	2011-2015	2016-2020	2021-2030	Total Amount (1,000$)
Hanoi-Saigon	1,726.2	FII	2,383,135	18,720	63,461	2,465,316
		SRI Total	1,057,254	5,690,233	0	6,747,486
		Hanoi-Nam Dinh (87km)	0	1,768,190	0	1,768,190
		Hue-Da Nang (83km)	1,057,254	1,042,375	0	2,099,629
		Da Nang-Quang Ngai (136km)	0	1,206,332	0	1,206,332
		Trang Bom-Sai Gon (50km)	0	1,673,335	0	1,673,335
		SMI	0	0	18,508,823	18,508,823
Hanoi-Lao Cai	293.5	FII	401,929	0	0	401,929
Hanoi-Dong Dang	162.5	FII	116,357	0	0	116,357
Sub Total			**3,958,674**	**5,708,953**	**18,572,284**	**28,239,910**
New Line Construction	**Distance (km)**	**Items**	**2011-2015**	**2016-2020**	**2021-2030**	**Total Amount (1,000$)**
Hanoi-Lao Cai	280.0	SMI	2,126,670	3,544,450	0	5,671,120
Hanoi-Hai Phong	112.0	SMI	0	946,400	946,400	1,892,800
Hanoi-Dong Dang	156.0	SMI	0	0	3,431,740	3,431,740
Trang Bom-Vung Tau	71.3	SMI	0	0	1,847,810	1,847,810
Sub Total			**2,126,670**	**4,490,850**	**6,225,950**	**12,843,470**
Grand Total			**6,085,344**	**10,199,803**	**24,798,233**	**41,083,380**

Source: VITRANSS2 Study Team

APPENDIX 3B

Japan's High Speed Railway, The Shinkansen

APPENDIX 3B

Japan's High Speed Railway, The Shinkansen

1 Introduction

The Tokaido Shinkansen went into operation as a genuine high-speed railway in 1964, the year the Tokyo Olympic Games were held. Since the commencement of operations, the Shinkansen has been highly praised for features in providing mass-transportation, high-speed service, and its safety record. As the main artery in Japan's transportation system, the Shinkansen has met the needs of business and tourism. Despite a one-time tendency for the public to think that railways are on the decline relative to highways and airline travel, railways have been reevaluated globally. The Shinkansen was a harbinger of an era of high-speed railway throughout the world.

Along with changes in social conditions in Japan, reforms have been vigorously carried out in a wide range of fields. Railway-related concerns now include speeding up service, environmental protection, safety measures, and cost reductions. Following the reform of the JNR (former Japanese National Railways) in 1987, plans were developed for constructing new Shinkansen. As JR (Japan Railway) group companies enlarged their railway networks, they developed new types of coaches and accelerated efforts to improve ground equipment and transportation services. In doing so, full consideration has been given to the characteristics of regions served and ways to enhance transportation features.

2 History of the Shinkansen

1) Birth of the Tokaido Shinkansen

The Tokaido Shinkansen went into operation in 1964 as the first high-speed train between Tokyo and Osaka in Japan. Planning of the new line was done against a background of extremely high transportation demand in the Tokaido region. Expansion of transportation capacity on the existing Tokaido Line had reached a limit. Therefore, the Shinkansen was initially seen as a track addition plan. As for gauge, various plans were considered, including standard gauge and narrow gauge. Finally, a standard 1,435mm gauge was adopted for the new line, and the aim became development of a revolutionary high-speed railway.

The 515.4km Tokaido Shinkansen provided a one-day journey connecting Tokyo and Osaka with a traveling time of 3 hours and 10 minutes, about half of the previous time of 6 and a half hours. The Tokaido Shinkansen was the first high-speed railway system in the world. It marked the beginning of a new era of high-speed railway systems and inspired the creation of high-speed railway networks in Europe.

2) Commencement of Sanyo Shinkansen

After the success of the Tokaido Shinkansen, the Sanyo Shinkansen was planned as a track addition project for conventional JNR lines. Construction between Shin-Osaka and Okayama began in 1967, and operation commenced in 1972. This was followed by construction of a new section between Okayama and Hakata that began in 1970. Operation began in March 1975. Almost half the length of (553.7km) the Sanyo Shinkansen is through tunnels. The undersea Shin-Kanmon Tunnel between Honshu, Japan's largest island and Kyushu Island was completed using new grouting and pipe-roof methods. A slab track structure was adopted for construction of the Sanyo Shinkansen with the aim of creating track that would be maintenance-free and afford reduced life cycle costs and strong track structures.

3) Shinkansen Construction Law and Start of Tohoku and Jyoetsu Lines

Shinkansen construction was included in the Nationwide Comprehensive Development Plan adopted by the Japanese Government in May 1969. A Nationwide Shinkansen Construction Law was promulgated in May 1970. These measures guided Japan's development strategy based on a Shinkansen high-speed railway network planned and built to achieve balanced progress and activation of outlying regions of the country. The Construction Law viewed the Shinkansen as a means of meeting the need for additional transportation capacity on the country's railway lines. Under the Law, a basic plan for five routes, the Tohoku, Hokkaido, Kyushu (Kagoshima), and Kyushu (Nagasaki) was decided on in 1972. The Shinkansen defined in the "Nationwide Shinkansen Construction Law" runs at high speeds of 200kph or through main sections.

Construction plans for three routes, for the Tohoku, Jyoetsu and Narita areas were adopted in April 1971. A Project Implementation Plan was approved in October 1971. Construction of the Tohoku Shinkansen (Tokyo-Morioka 496.5km) and Jyoetsu Shinkansen (Omiya-Niigata 269.5km) began in June 1982 for the former line and in November 1982 for the latter. However, with respect to the southern sections of Omiya, construction was delayed due to residents' opposition to construction because of widespread recognition of the need for environmental protection. Shinkansen operation between Omiya and Ueno began in March 1985. Operation between Ueno and Tokyo began in June much later, in 1991.

4) New Shinkansen Standards

Newly built routes were on the Hokuriku Shinkansen (Takasaki–Nagano 117.4km), the Tohoku Shinkansen (Morioka-Hachinohe 96.6km), and the Kyushu Shinkansen (Shin-Yatsushiro-Kagoshima-chuo 117.4km), totally 340.8km in length.

The Hokuriku Shinkansen is a 700km route that connects several cities, including Nagano City, Toyama City, and Kanazawa City. The Jyoetsu Shinkansen is commonly utilized for travel between Tokyo and Takasaki. Newly constructed sections also include routes extending from Takasaki to Osaka. Among the aims in the construction of the Hokuriku Shinkansen were holding down costs and shortening construction periods. Construction through Usui Pass at an altitude of 660 meters was a particular challenge. A new type of coach was developed for this line, and a steep gradient of 30% was adopted. A surface station was also adopted. High-speed turnouts and high-speed simple trolley wire were also utilized, and slab track was adopted on an earthen roadbed. The slab track had limited usage in tunnels and viaduct sections prior to this.

Operation of the Tohoku Shinkansen (Morioka–Hachinohe) began in December 2002. This was an expansion of Shinkansen service to the northern part of Japan Proper, 20 years after the commencement of operations between Omiya and Morioka in 1982. Tunnel sections occupy about 73% of the newly constructed line. Tunneling was executed using large-scale machinery and surface platforms in order to reduce construction costs.

The Kagoshima route on the Kyushu Shinkansen extends 257km from Hakata Station of the Sanyo Shinkansen to Kagoshima–Chuo with stops at Fukuoka, Kumamoto and Kagoshima Prefectures. Service began in sections on the route between Shin–Yatsushiro and Kagoshima–Chuo in March 2004. The commencement of Shinkansen service in Kyushu area came 29 years after the opening of the Sanyo Shinkansen. Tunnel portions occupy approximately 70% of the newly constructed sections in Kyushu. Cost savings were achieved with new technology developed for the sirasu (white sand consisting of fine pumice and volcanic ash) regions in Kyushu.

Table 1 Milestones in Shinkansen's Development

Month, Year	Main Items
Oct. 1964	Commencement of Tokaido Shinkansen (Tokyo–ShinOsaka)
Mar. 1972	Commencement of Sanyo Shinkansen(ShinOsaka–Okayama)
Mar. 1975	Commencement of Sanyo Shinkansen (Okayama–Hakata)
Jun. 1982	Commencement of Tohoku Shinkansen (Omiya–Morioka)
Nov. 1982	Commencement of Jyoetsu Shinkansen (Omiya–Niigata)
Mar. 1985	Commencement of Tohoku Shinkansen (Ueno–Omiya)
Mar. 1988	Commencement of Tsugaru Strait Line including Seikan Undersea Tunnel
Jun. 1991	Commencement of Tohoku Shinkansen (Tokyo–Ueno)
Oct. 1997	Commencement of Hokuriku Shinkansen (Takasaki–Nagano)
Dec. 2002	Commencement of Tohoku Shinkansen (Morioka–Hachinohe)
Mar. 2004	Commencement of Kyushu Shinkansen (Shin-Yatsushiro–Kagoshima-chuo)
Apr. 2005	Approval of Construction Implementation Plan of Hokkaido Shinkansen (Shin-Aomori–Shin–Hakodate(tentative)

3 Scheme of Shinkansen Construction

1) Construction Scheme

Nowadays, the main organization for infrastructure construction and management is the JRTT, the Japan Railway Construction, Transport and Technology Agency. The infrastructure is "loaned" to JR, the organization in charge of operations. This set-up is referred to as a "Separation of Operation and Infrastructure." With respect to Shinkansen construction, work is undertaken with due attention to profitability and cost-performance and confirmation of fundamental conditions such as agreements with municipal corporations and JR pertaining to separation of the management of conventional lines operating in parallel with the Shinkansen.

The organization for constructing the Shinkansen is shown in the following table:

Table 2 Example of Organization for Shinkansen Construction

Job Title	Managerial	Staff	Outsourcing	Total
Superintendent	1			1
Vice-superintendent	4			4
General Affair Div.	1	5		6
General Accounting Div.	1	5		6
Contract Div.	1	6		7
Right-of-way Div.	2	12		14
Planning Div.	1	10		11
Maintenance Management Div.	1	4		5
Technical Management Div.	1	8		9
Construction Div.	4	27		31
Construction Office	3	33	32	68
Total	20	110	32	162

Source: VITRANSS 2

According to Table 2, total management people are 20. Their ratio of administration, land and technology is 5:2:13. Staff ratio of that is 8:6:41. Total staff percentage in charge of land acquisition is approx. 9 %. (14÷162□8.6%) The staffs in charge of land acquisition who were less than 10% of whole staffs dealt with negotiations with 1,680 landholders in the construction section 80km in length and completed the land acquisition.

2) Scheme of Revenue for Construction

In the JNR era, Shinkansen operation was criticized for, in effect, restricting JNR management. Therefore, under the new scheme, JR revenue is strictly controlled handling is limited to loan at a limitation of benefit (revenue difference between With-construction of Shinkansen and Without-construction of it). There is no further direct charge of construction for JR companies.

As for annual project costs, the Japanese Government is obligated to pay two-thirds of the debt (public works-related expenses and a portion of the hand-over income of the four Shinkansen lines, the Tokaido, Sanyo, Tohoku and Jyoetsu Shinkansen lines) and municipal corporations bear the other one-third of the obligation.

3) Treatment of Conventional Lines in Parallel with Shinkansen

According to a consensus agreement reached by the Government and the Ruling Party, conventional lines running parallel to newly constructed Shinkansen sections are under management separate from JR companies subject to regional jurisdiction.

4) Environmental Considerations

The JRTT requires the submission of Environmental Impact Assessment reports and studies and evaluates the impact of Shinkansen construction on sensitive structures such as schools and hospitals and the environmental burden imposed by operations such as noise, vibration, and the impact on landscapes and flora and fauna. This is handled in accordance with the Environmental Assessment Law prior to construction.

4 Shinkansen Lines under Construction

As of February 2008, the following routes on Shinkansen lines were under construction:

(i) Hokkaido Shinkansen (Shin–Aomori–Shin–Hakodate(tentative))

(ii) Tohoku Shinkansen (Hachinohe–ShinAomori)

(iii) Hokuriku Shinkansen (Nagano–kanazawa and Fukui Station area)

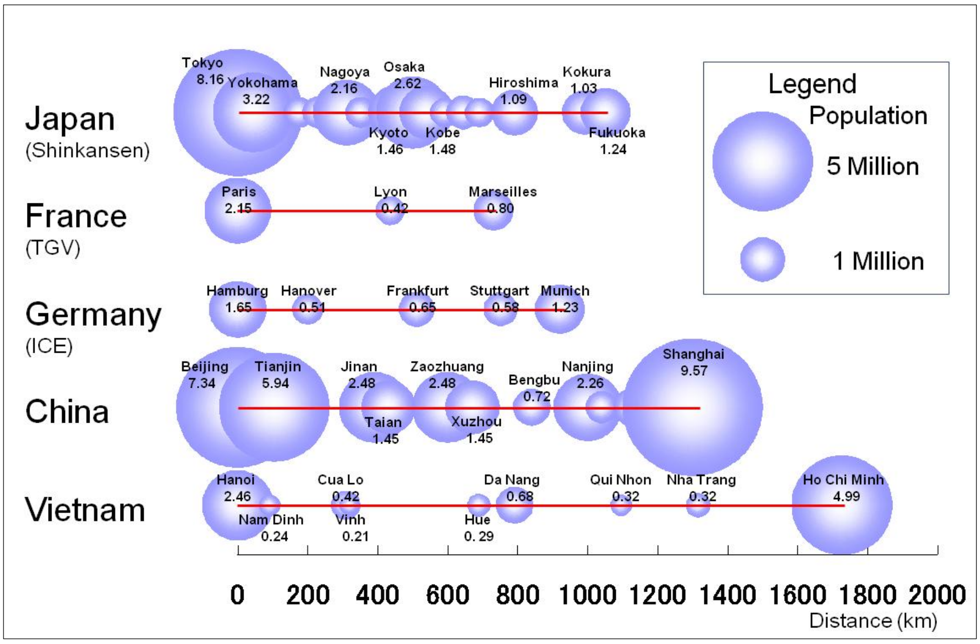
(iv) Kyushu Shinkansen (Hakata–Shin–Yatsushiro)

These are five sections on four routes approximately 590km in total length. The schedule calls for a 1,891-km Shinkansen corridor from Aomori at the northern end in Japan Proper linked to Kagoshima in Kyushu by the end of fiscal 2010, half a century after the commencement of Tokaido Shinkansen operations in 1964.

5 Country Context of HSR System

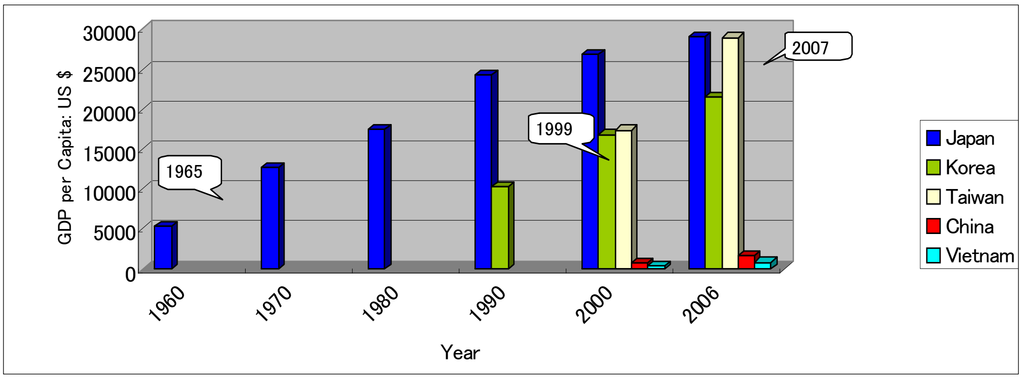
Figures 1 and 2 provide a comparative picture on the introduction of HSR in other countries.

Figure 1 Comparative Lengths and Hinterlands of HSR Systems



Source: MLIT, Japan

Figure 2 Commencement of HSR and GDP per Capita



Source: US Department of Labor (2007 July) and CIA World Fact Book

APPENDIX 3C

Magnetically Levitated Transport System

APPENDIX 3C

Magnetically Levitated Transport System

1 New High-Speed Railway Technology

Railway systems have made tremendous contributions to industry, economics and culture. A wide range of research and development activity was carried out to plan for faster train operation. One result was the development of the Shinkansen discussed above. This system was based on technologies created in Japan, which the country can justifiably take pride in. This effort has contributed significantly to economic progress in Japan.

Ultimately, there is a limit on the maximum velocity that can be achieved by conventional railway systems that rely upon the adhesive force between rail and wheel. Recognition of this fact led to a new concept of a super-high-speed railway. This was based on studies of super-conducting magnetically levitated railway (linear motor cars). Basic research on linear motor propulsion railway systems started at the Railway Technical Research Institute (the RTRI) in 1962 prior to the commencement of the Tokaido Shinkansen. Thereafter, ongoing research and testing has been conducted. Test tracks some 220m long were built by the RTRI, the Miyazaki Maglev Test Track and the Yamanashi Maglev Test Track. As of August 2007, the total distance covered in running tests since the start of development had exceeded 600,000km. A manned speed record of 581kph was achieved (a world speed record for railways) at the Yamanashi Maglev Test Track.

2 What is a Linear Motor Car?

Linear motor cars under development are for a “Superconducting Magnetically Levitated Railway.” A linear motor is one that relies on a magnetic levitation (hereinafter referred to as “Maglev”) system. Super-conducting magnets on-board the cars interact with rotors inside the rotary motor, propulsion coils on the ground, and stators outside. This is a ground-based system where propulsion coils are powered and propulsion force is controlled on the ground. By passing current through propulsion coils on the ground, a magnetic field is produced, to propel trains forward by the attractive force of opposite poles and the repulsive force of similar poles acting between the ground coils and the superconducting magnets built into the vehicles. The vehicles being propelled by a linear motor are called Linear Motor Cars. Super-conducting Magnetically Levitated Railway refers to railways that utilize superconductivity, are levitated, and run by magnetic force.

3 Linear Motor Cars as Next-Stage Transport Systems

Linear Motor Cars will go into commercial operation at maximum speeds of 500 kph. This is 1.7 times the maximum operational speed of a Shinkansen train. If this super high speed is realized, “people-to-people” communication over great distances will become possible. Business and tourism – all aspects of society–will be greatly affected in a very short period of time.

Instead of rails, Linear Motor Cars use U-shaped running corridors called guideways that cover the bottom and side faces of the vehicles. The vehicle trucks are firmly guarded by a condition of equal intervals between the trucks and magnets on the guideway. Therefore, the vehicles run in a very stable manner. Moreover, when the running speed increase to more than 100km/h, the vehicle is levitated by superconducting magnets and does not touch the surrounding walls. It is also possible to suppress yawing and vibration during super high-speed running. Therefore, Linear Motor Cars are the transportation of the near future, a super high-speed system providing great speed, safety and comfort."

4 Technology Development

1) Target of Technology Development

Principal technology development targets are:

(a) **Ultra-High Speeds:** To confirm stable running at the ultra-high speed of 550 km/h or more at the Test Track with the goal of revenue service at a maximum speed 500 km/h.

(b) **Greater Transport Capacity and On-Time Performance:** To establish on-time performance for one-way transportation of about 10,000 passengers per peak hour.

(c) **Economic Performance:** To establish system profitability with high productivity and lower construction and operating expenses.

2) Test Track Construction Plan

Construction of the 42,800m Yamanashi Test Track began in 1990. Running tests began in 1997. Construction work on an additional 24km section began in 2007.

3) Technical Standards

Tentative technical standard include the following:

(i) Minimum distance between main track centers is 5.8m.
(ii) Minimum main track curve radius is 8,000m, except for turnout curves.
(iii) Maximum main track gradient is 40%.

Principal Features

(a) **Maximum Speed:** To confirm sundry performance, infrastructure supports vehicle speed as high as 550kph or more.

(b) **Propulsion Method:** On-ground primary linear synchronous motor propulsion

(c) **Levitation and Guide System:** Sidewall levitation system by inductive repulsion, guidance by inductive repulsion and null-flux position adjustment

(d) **Operation Control:** Automatic operation system, control of double trains

4) Main Equipment

(1) Test Center

Principal Test Center functions:

(i) Equipment for monitoring entire test line
(ii) Description of test running schedule
(iii) Indications and orders to personnel
(iv) Control at electric power converting station
(v) Equipment for easy real-time analysis and estimation of results using data gathered by vehicle-horne and wayside measurements

Control equipment has functions for describing and executing test schedules, controlling indications and orders to personnel in order to carry out test runs, and ongoing maintenance work.

(2) Test Track Platform

A 3-meter-wide, 80meter-long platform is set up for sundry experiments on the linear platform. In addition, passenger devices are installed for safe rides and embarkation/disembarkation of passengers.

(3) Electric Power Feeding Station

This equipment functions to control train acceleration and deceleration by controlling the electric current fed to on-ground coils and to convert electric power received from the electric power company.

(4) Depot

The depot serves as a repair facility for ordinary maintenance and inspection of Linear Cars. It has functions to store and fill nitrogen used as an auxiliary freezing catalyst and to collect, refine and conduct re-liquefaction during liquefied helium grouting and filling of superconducting magnets.

5) Special Equipment and Devices

At the Yamanashi Test Track, performance is analyzed to ascertain energy efficiency, construction and operating expenses. Special equipment and devices are tested for the purpose of ultra-high-speed operation.

(a) **Adoption of U-shaped Guideway:** The guideways have two functions to support vehicles and to provide the motive power for vehicle propulsion. Several sorts of shapes were considered for this facility, but finally, the U-shaped type was adopted for the Yamanashi Test Track.

(b) **Two Types of Coils for Levitation and Guidance:** The function of the levitation and the guidance coils is equivalent to that of the rails of a conventional railway. The propulsion coils correspond to the statord of a rotary motor of conventional railways. Aluminum material is used for the wires as well as the levitation and guidance coils. The surface of the propulsion coils is coated with epoxy resin for of reliable insulation against high voltage.

(c) **Absolute Error within ±3mm:** Installation of the 5-mm coils had to be very precise to ensure riding quality equivalent to that of the Tokaido Shinkansen. This is in spite of the ultra-high running speed of 500kph at the Yamanashi Test Track. Strict accuracy was required to satisfy the above-mentioned requirements. On-ground coils were installed in the sidewalls. With respect to the direct installation method, to limit error within ±3mm, execution tests were carried out repeatedly. Unbelievable levels of accuracy control were achieved. Then, dowel concrete for installing on-ground coils was placed.

(d) **Train Location Detecting System to Ensure Safe Train Operation:** The speed of a Linear Motor Car is controlled by changing the electric current and frequency fed to coils in the guide way, using inverters at the feeding substation. To do this it is important to precisely detect train location and speed. In the Test Track, train location is detected with an accuracy of a few cm. This was achieved by adopting a Train Location Detecting System.

6) Variety of Tests

The following tests are conducted at the Yamanashi Test Track to attain higher levels of safety and amenities:

(a) **Confirmation of Stability at Ultra-High Speeds:** Performance at 500kph is confirmed by using revenue service-oriented vehicles.

(b) **Confirmation of Vehicle Reliability, Durability, and Performance of On-ground Equipment and Devices:** Repeated tests are conducted on the vehicles, on-ground equipment, superconducting magnets, guideways and electric power converting devices, to confirm high reliability.

(c) **Confirmation of Structural Standards (for curves, gradients, etc.):** Careful tests were conducted to confirm technical standards such as minimum curve radii and whether to some extent curvature can be handled by the vehicles at ultra-high speeds and to see what the steepest gradients are for safe stopping, etc.

(d) **Confirmation of Safety in High-Speed Passing Tests:** To confirm distances between main track centers to ensure operational stability when passing oncoming trains, especially when entering and passing through tunnels.

(e) **Confirmation of Safe Vehicle Performance in Tunnels:** To confirm capability at ultra-high speeds in tunnel areas and to confirm that the vehicle's body shell could endure alternation of atmospheric pressures when the vehicles run through tunnels.

(f) **Confirmation on Performance of Turnout Devices:** To confirm performance of high-speed-oriented turnouts, in addition to confirming that turnout devices with a weight of 100t could move smoothly

(g) **Establishment of Train Operation Control System:** To test and confirm control systems for several trains to maintain safe speeds and proper distances between vehicles when several trains are operated at the same time.

(h) **Establishment of Control System at Substation:** In order to establish substation control systems that supply the electric power for high-speed, stable running, and to confirm stability of the electric power system

(i) **Confirmation of Maintenance and Safety Systems:** To establish operational safety when trains are running and to confirm rational maintenance criteria required for safety of vehicles and on-ground equipment.

(j) **Investigation of Environmental Impact:** To investigate and measure environmental impact of noise, vibration, etc., owing to the high-speed running and to consider mitigation measures.

APPENDIX 6D

Profile of the Railway Projects

APPENDIX 6D

Profile of the Railway Projects

1. Master Plan Projects

A. Ongoing/Committed Railway Projects Profile (Master Plan)

Project Name:	Sector:
Improvement of North-South Railway Line	**CR01**

Project Background and Objective:

The present projects which are ongoing-committed projects aims rehabilitation, extension of track effective length in station yards for long formation of trains, and modernization of signaling system. However, such projects are mainly partial improvement on line, not directly touch to the reinforcement of track capacity.

Project Description:

Code	Project Description	Estimated Cost (2009) (Million US$)	Original Schedule	Financial Source	Implementing Agency
CSR01	Reinforcing main tunnels	44	2007-2020	ODA + GOV	VNR
CSR02	Enhancing bridge safety N-S railway line (44 bridges)	159	2007-2020	ODA + GOV	VNR
CSR03	Modernizing station signals in N-S line	20	2007-2020		VNR
CR04	Modernizing Vinh-Saigon signal &communication, N-S railway line(Phase 1)	64	2007-2020	ODA + GOV	VNR
CSR05	Replacing K1, K2 sleepers by pressed concrete sleeper, expanding station approach, installing additional track No.3 railway line	233	2007-2020	GOV	VNR
CSR06	Improvement of Nha Trang Station	38	2007-2020	GOV	VNR
CSR07	Relocation of Phan Triet Station	4	2007-2020	GOV	VNR
CSR08	Improvement and upgrading the remaining bridges in the N-S railway Line	9	2007-2020	ODA + GOV	VNR
CSR09	Modernizing Hanoi-Vinh signal & communication in Hanoi-Vinh section Phase 2	64	2007-2020	ODA + GOV	VNR
CSR10	Improvement of railway line in Ke Net pass section	29	2007-2020	GOV	VNR
CSR11	Improvement of drainage system along HN-HCMC railway Line	10	2007-2020	WB	VNR
CSR12	Upgrading Hanoi-Vinh railway section	147	2010-2020	GOV	VNR
CSR13	Upgrading Nha Trang –Saiogn railway section	145	2010-2020	GOV	VNR

Estimated Cost (2009):	Original Schedule:
US$ 965 million	2007-2020
Financial Source:	Implementing Agency:
GOV + ODA	VNR

Project Name: **Improvement in Railway Route in the North**	Sector: **CR02**

Project Background and Objective:

The deterioration of facilities is more serious in railway route in the North; ongoing-committed projects mainly cover rehabilitation or repair works. The modernization of signaling system is proceeding but progress is slow. The section of Yen Vien- Lao cai project is implementing by ADB finance, however potential transport demand is not cover by this project. An adding ballast is implementing for the one of improving method, however, track condition of still poor due to the shortage of tamping.

Project Description:

Code	Project Description	Estimated Cos (Million US$)	Original Schedule	Financial Source	Implementing Agency
CSR14	Modernizing railway signals & Communication in sections: Hanoi-Lao Cai, Hanoi- Dong Dang, Hanoi- Thai Nuguyen, and Hanoi hub areas	68	2001-2020	ODA + State Budget	VNR
CSR15	Modernizing Transport Operation center	15	2007-2010	ODA + State Budget	VNR
CSR16	Urgent improvement of railway safety corridor	12	2001-2020	State Budget	VNR
CSR17	Replacement of Da Phuc railway girder	2	2001-2010	State Budget	VNR
CSR18	Kep-Ha Long rehabilitation	34	2001-2020	State Budget	VNR
CSR19	Dong Anh-Quan Trieu	26	2001-2020	State Budget	VNR
CSR20	Improvement and upgrading of Yen Vien-Lao Cai Railway	118	2009-2012	ODA + State Budget	VNR
CSR21	Hanoi-Lang Son railway line	16	2001-2010	State Budget	VNR

Estimated Cost (2009): US$ 291 million	Original Schedule: 2001 – 2020
Financial Source: GOV + ODA	Implementing Agency: VNR

Project Name: **Yen Vien–Pha Lai Railway Line**	**Sector:** **CR03**

Project Background and Objective:

The main purpose of this new line is that connecting between the economic corridor of northeast and north –west area of Hanoi and Cai Lan Seaport. And also reflecting the agreement between Vietnam and China for the tow corridors one economic belt, creating transport service between the representative province Quang Tay and Van Lan in China and Cai Lan. The estimated transport is 3.64 million passengers and 7.4 million tons in 2020.

Project Description:

(i) Route Length: new line 35.2km, rehabilitation of existing line

(ii) Track structure: single track with dual gage system (passenger train:120km/h, cargo train:80km/h)

(iii) Maximum gradient: 6 ‰

(iv) No. of Stations: 2 station

Estimated Cost (2009): US$ 118 million	Original Schedule: 2004–2010
Financial Source: GOV	Implementing Agency: above VNRA

Project Name: **Ha Long – Cai Lan railway Line**	Sector: **CR04**
Project Background and Objective: This project is part of Yen Vien–Pha Lai Project, new railway line extend from Ha Long station to Cai Lan Sea Port. This section operates only fright transport purpose.	
Project Description: (i) Route lengh: new line 9.8km (ii) Second class track structure 60lm/h for fright ttain.	
Estimated Cost (2009): US$ 59 million	Original Schedule: 2004–2010
Financial Source: GOV	Implementing Agency: VNRA

Project Name: **Railway Line From Chua Ve to DAP factory (Dinh Vu) Railway Line**	Sector: **CR05**
Project Background and Objective: This project is also the two economic corridor one belt for the both countries Vietnam and China. This project is now suspended to construct new railway line by several reasons, financial reason of budget and/or waiting new international seaport. The reason is that Hai Phong has the international gateway port Lach Huyen, Dinh Vu seaport with more than 3,000m of berth; Hanoi – Haiphong expressway and some projects are on going constructed along the new railway line. Therefore, Vice Prime Minister said that it would be necessary to consider a practical alternative, based on the study of other competitive transport modes rather than railway mode. Deputy Prime Minister assigned Vietnam Chemical Corporation and Hai Phong City to consider and select a reasonable alternative in order to ensure the transportation of materials to DAP fertilizer plant.	
Project Description: (i) Extension of new railway line from Hai Phong existing railway line to Dinh Vu port for the transport of cargo	
Estimated Cost (2009): US$ 68 million	Original Schedule: 2007–2010
Financial Source: GOV	Implementing Agency: VNR

B. Proposed Railway Projects Profile (Master Plan)

- R01: Function-Improvement Items (Hanoi-Saigon Line)

Project Name: **(FII) Hanoi – Saigon Line** **Additional Signal Station with Automatic Relay Interlocking System & ATS-S**	Sector: **R01-1**
Project Background and Objective: The utmost of train operated between Hanoi- and Saigon is 33trains/day for both directions in average at present. Several rehabilitation projects is now implementing, however such projects not directly dissolve shortage of track capacity. The installation of new signal station is proposed in the location of bottle neck section of track capacity, capacity will increase to 50 trains, accordingly. This is almost 1.5 times from present track capacity.	
Project Description: The project includes the following works: a) Automatic Relay Interlocking: Hanoi – Vinh 5 stations, Vinh – Hue 8 stations, Da Nang – Nha Trang 19 stations, Nha Trang – Saigon 14 stations. b) ATS-S: Hanoi – Vinh 5 places, Vinh – Hue 8 places, Da Nang – Nha Trang 19 places, Nha Trang – Saigon 14 places.	
Estimated Cost (2009): US$ 95.02 million	Assumed Schedule: - 2020

Project Name: **(FII) Hanoi – Saigon Line** **Automatic Level Crossing & Fencing / Barrier of ROW**	Sector: **R01-2**
Project Background and Objective: No. of level crossing in this line is highest densities than other lines; such crossing obstructs safety train operation. All of train reduces their running speed avoiding accidents at level crossing, however can not avoid train accidents at crossing. Also illegal crossing are now increasing. Mechanical controlled automatic level crossing with installation of fence / barrier of ROW are proposed for reducing accidents and increasing train operating speed.	
Project Description: The project includes the following works: a) Automatic Level Crossing for Class (A), (B): Hanoi – Vinh 152 places, Vinh – Hue 96 places, Hue – Da Nang 51 places, Da Nang – Nha Trang 153 places, Nha Trang – Saigon 129 places. b) Automatic Level Crossing for Class (C): Hanoi – Vinh 103 places, Vinh – Hue 90 places, Hue – Da Nang 27 places, Da Nang – Nha Trang 117 places, Nha Trang – Saigon 102 places. c) Fencing / Barrier of ROW for Class (A), (B): Hanoi – Vinh 121.6 km, Vinh – Hue 76.8 km, Hue – Da Nang 40.8 km, Da Nang – Nha Trang 122.4 km, Nha Trang – Saigon 103.2 km d) Fencing / Barrier of ROW for Class (C): Hanoi – Vinh 41.2 km, Vinh – Hue 36.0 km, Hue – Da Nang 10.8 km, Da Nang – Nha Trang 46.8 km, Nha Trang – Saigon 40.8 km	
Estimated Cost (2009): US$ 269.50 million	Assumed Schedule: - 2020

Project Name: **(FII) Hanoi – Saigon Line** **Enlarge Workshops / Enlarge Depots in Hanoi - Saigon Line**	Sector: **R01-3**
Project Background and Objective: Enlargement of works shop and deport are proposed for increasing No. of train operations. Although further study requires exact location and proportion of it.	
Project Description: The project includes the following works: a) Enlarge Workshops: Hanoi – Vinh 10.4 ha, Nha Trang – Saigon 12.0 ha. b) Enlarge Depots: Hanoi – Vinh 4.1 ha, Vinh – Hue 7.5 ha, Nha Trang – Saigon 11.4 ha.	
Estimated Cost (2009): US$ 253.63 million	Assumed Schedule: - 2020

Project Name: (FII) Hanoi – Saigon Line **Land Acquisition**	Sector: **R01-4**
Project Background and Objective: The land purchases are estimated required area for the Enlargement of workshops/Deport.	
Project Description: a) Land Acquisition: Hanoi – Vinh 1.25 ha, Vinh – Hue 2 ha, Da Nang – Nha Trang 4.75 ha, Nha Trang – Saigon 3.5 ha.	
Estimated Cost (2009): US$ 740.15 million	Assumed Schedule: 2011 - 2013

Project Name: **(FII) Hanoi – Saigon Line Rolling Stock Procurements**	Sector: **R01-5**
Project Background and Objective: It is estimated to purchase rolling stock, due to increasing No. of train operation by improving track capacity with introducing additional signaling station.	
Project Description: The project includes the following works: a) Diesel Locomotive: 219 cars. b) Passenger Car: 878 cars. c) Freight Wagon: 4,032 wagons.	
Estimated Cost (2009): US$ 1,107.02 million	Assumed Schedule: - 2020

● R07: Trang Bone – Vung Tau New Railway Construction (SRI & SMI)

Project Name:	Sector:
(SRI & SMI) Hanoi – Saigon Line **New Railway Project between Trang Bone and Vung Tau by Standard Gauge (L=71.3 km)**	**R07**

Project Background and Objective:
The project aims to accomplish the improvement in distribution efficiency of increasing international containers. The double tracking between Trang Bone and Vung Tau line with new alignment, electrified standard gauge. This investment plan is introduced present plan, however is it better to review gauge and power supply system for through operation into existing line.

Project Description:
The project includes the following works: a) This new railway line will connect Cai Mep port, Long Binh ICD and Trang Bone ICD. b) The project between Thi Vai port and Vung Tau is implemented in next stage. c) Total length is 71.3 km.

Estimated Cost (2009):	Assumed Schedule:
US$ 1,847.81 million	- 2020

2. Other Proposed Railway Project (excluding Mater Plan Project)

- R02: Function-Improvement Items (Hanoi-Lao Cai Line)

Project Name: **(FII) Hanoi – Lao Cai Line** **Additional Signal Station with Automatic Relay Interlocking System & ATS-S**		Sector: **R02-1**
Project Background and Objective: Hanoi- Lao Cai located along Red River, the function of this line performs as international cargo from/to Kunming in China and also as life line of way side people. 35 trains per day of both directions are operating; this is highest traffic density than other line. This No. of train operation is mostly marginal condition under present track capacity. The rehabilitation of railway facilities is proceeding by the ADB financing, VITRANSS 2 also proposed additional signaling stations for obtaining 1.5 times from present track capacity with safety train control devices. .		
Project Description: The project includes the following works: a) Automatic Relay Interlocking: Hanoi – Yen Bai 9 stations. b) Semi-automatic Block System: Hanoi – Yen Bai 23 places, Yen Bai – Lao Cai 16 places. c) Semaphore ► Color Light Signal: Hanoi – Yen Bai 11 places, Yen Bai – Lao Cai 16 places. d) ATS-S: Hanoi – Yen Bai 9 places.		
Estimated Cost (2009): US$ 31.31 million	Assumed Schedule: - 2030	

Project Name: **(FII) Hanoi – Lao Cai Line** **Automatic Level Crossing & Fencing / Barrier of ROW**		Sector: **R02-2**
Project Background and Objective: The automatic level crossing is proposed in this line for safety train operation, due to the increasing No. of train operation by other investment program following transportation demand.		
Project Description: The project includes the following works: a) Automatic Level Crossing (A),(B): Hanoi – Yen Bai 30 places, Yen Bai – Lao Cai 33 places. b) Fencing / Barrier of ROW: Hanoi – Yen Bai 24.0 km, Yen Bai – Lao Cai 26.4 km.		
Estimated Cost (2009): US$ 20.31 million	Assumed Schedule: - 2030	

Project Name: **(FII) Hanoi – Lao Cai Line** **Enlarge Depot**		Sector: **R02-3**
Project Background and Objective: Enlargement of depot between Hanoi- Yen Bai		
Project Description: The project includes the following works: a) Enlarge Depot: Hanoi – Yen Bai 2.5 ha.		
Estimated Cost (2009): US$ 13.33 million	Assumed Schedule: - 2030	

Project Name: **(FII) Hanoi – Lao Cai Line** **Land Acquisition**	Sector: **R02-4**
Project Background and Objective: Land acquisition is estimated for enlargement of depot between Yen – Lao Cai, exact location and proportion is required.	
Project Description: The project includes the following works: Land Acquisition: Hanoi – Yen Bai 4.75 ha.	
Estimated Cost (2009): US$ 10.75 million	Assumed Schedule: - 2030

Project Name: **(FII) Hanoi – Lao Cai Line** **Rolling Stock Procurement**	Sector: **R02-5**
Project Background and Objective: The purchase of rolling stocks is proposed covering demand of this line. The required rolling stocks are mostly 1.5 times equivalent of present operation.	
Project Description: The project includes the following works: a) Diesel Locomotive: 38 cars. b) Passenger Car: 187 cars. c) Freight Wagon: 1,575 wagons.	
Estimated Cost (2009): US$ 326.24 million	Assumed Schedule: - 2030

- R03: Function-Improvement Items (Hanoi-Dong Dang Line)

Project Name: **(FII) Hanoi – Dong Dang Line** **Additional Signal Station with Automatic Relay Interlocking System & ATS-S**	Sector: **R03-1**
Project Background and Objective: The Dong Dang line has still enough capacity for transport demand at present. However, when transport demand is to increase by the international passenger and cargo transport from/to Nang Ning in China, The Additional Signal Station will install for the bottleneck of track capacity section, 1.5 times will increase the transport capacity than existing.	
Project Description: The project includes the following works: a) Automatic Relay Interlocking: Kep – Dong Dang 4 stations. b) Semi-automatic Block System: Kep – Dong Dang 6 places. c) ATS-S: Kep – Dong Dang 4 places.	
Estimated Cost (2009): US$ 11.73 million	Assumed Schedule: - 2030

Project Name: **(FII) Hanoi – Dong Dang Line** **Automatic Level Crossing & Fencing / Barrier of ROW**	Sector: **R03-2**
Project Background and Objective: The automatic level crossing project will be proposed for safety train running, because train operation in this line will increases 1.5 times from present operation.	
Project Description: The project includes the following works: a) Automatic Level Crossing (A), (B): Hanoi – Kep 73 places, Kep – Dong Dang 15 places. b) Fencing / Barrier of ROW: Hanoi – Kep 58.4 km, Kep – Dong Dang 12.0 km.	
Estimated Cost (2009): US$ 28.37 million	Assumed Schedule: - 2030

Project Name: **(FII) Hanoi – Dong Dang Line** **Land Acquisition**	Sector: **R03-3**
Project Background and Objective: The land acquisition is planned.	
Project Description: The project includes the following works: a) Land Acquisition: Kep – Dong Dang 1.0 ha	
Estimated Cost (2009): US$ 0.01 million	Assumed Schedule: - 2030

Project Name: **(FII) Hanoi – Dong Dang Line** **Rolling Stock Procurements**	Sector: **R03-4**
Project Background and Objective: It is proposed to purchase the rolling stock, due to increasing 1.5 times for the transport capacity.	
Project Description: The project includes the following works: a) Diesel Locomotive: 10 cars. b) Passenger Car: 117 cars. c) Freight Wagon: 188 wagons.	
Estimated Cost (2009): US$ 76.25 million	Assumed Schedule: - 2030

● R04: System Reinforcement Items (Hanoi-Saigon Line)

Project Name: **(SRI) Hanoi – Saigon Line Partial Double Tracking of Hanoi – Nam Dinh (L=86.8 km), Hue – Da Nang (L=83.1km;including Hai Van Tunnel), Da Nang – Quang Ngai (L=136 km), Trang Bone – Saigon (L=48.7km)**	Sector: **R04-1**

Project Background and Objective:

Partial double track is proposed for higher transport section, expecting No. of train operation are more than 50 trains/day.

Project Description:

The project includes the following works:

a) Partial Double Tracking of Hanoi – Nam Dinh (L=86.8 km).
b) Partial Double Tracking of Hue – Da Nang (L=83.1km;including Hai Van Tunnel).
c) Partial Double Tracking of Da Nang – Quang Ngai (L=136 km).
d) Partial Double Tracking of Trang Bone – Saigon (=48.7km)
e) Station Improvement: Hanoi – Vinh 12 stations, Hue – Da Nang 10 stations, Da Nang – Nha Trang 12 stations, Nha Trang – Saigon 6 stations
f) Automatic Block System: Hanoi – Vinh 74.4 km, Hue – Da Nang 128.1 km, Da Nang – Nha Trang 124.4 km, Nha Trang – Saigon 42.7 km.

Estimated Cost (2009): US$ 3,609.78 million	Assumed Schedule: - 2030

Project Name: **(SRI) Hanoi – Saigon Line New Deport and Workshops**	Sector: **R04-2**

Project Background and Objective:

Train operation will increase based on partial double track project. New depot and work shop propose for maintaining of rolling stock, detailed location and proposition may require further study.

Project Description:

The project includes the following works:

a) Enlarge Workshops: Da Nang – Nha Trang 20.0 ha.
b) Enlarge Depots: Hanoi – Vinh 5.0 ha, Hue – Da Nang 12.6 ha, Nha Trang – Saigon 5.0 ha.

Estimated Cost (2009): US$ 210.81 million	Assumed Schedule: - 2030

Project Name: **(SRI) Hanoi – Saigon Line Land Acquisition**	Sector: **R04-3**

Project Background and Objective:

Land acquisition is estimated for new depot / workshop also partial double track.

Project Description:

The project includes the following works:

a) Hanoi – Vinh 78.2 ha, Hue – Da Nang 17.89 ha, Da Nang – Nha Trang 27.9 ha, Nha Trang – Saigon 8.97 ha.

Estimated Cost (2009): US$ 2,042.18	Assumed Schedule: - 2030

Project Name: **(SRI) Hanoi – Saigon Line** **Rolling Stock Procurements**		Sector: **R04-4**
Project Background and Objective: No. of Rolling Stock will require by the partial double track between Hanoi- Nam Dinh, Hue-Da Nang- Quangai and rang Bone –Saigon based on future transport demand		
Project Description: The project includes the following works: a) Diesel Locomotive: 263 cars. b) Passenger Car: 1,736cars. c) Freight Wagon: 4,032 wagons.		
Estimated Cost (2009): US$ 884.72 million	Assumed Schedule: - 2030	

● R05: System Reinforcement Items & System Modernization Items
(Hanoi-Dong Dang Line)

Project Name: **(SRI & SMI) Hanoi – Dong Dang Line** **Improvement of Existing Line for Electrified Double Track (156.0 km)**	Sector: **R05**
Project Background and Objective: When No. of train operation are increasing more than 50 trains per day, double track project will required covering demand of operation. Section from Hanoi to Voi may propose parallel with existing line and Voi to Dong Dang propose to select new route because existing line is composed small curvature and high shape of gradients. This project is the double tracking between Hanoi and Dong Dang line by electrified dual gauge system.	
Project Description: The project includes the following works: a) The alignment between Haoi and Voi Xo (L=75.0 km) is planned by widening embankment. b) The alignment between Voi Xo and Dong Dang (L=81.0 km) is planned new route. a) Total length is 156.0 km.	
Estimated Cost (2009): US$3,431.74 million	Assumed Schedule: - 2030

- R06: System Modernization Items (Hanoi-Saigon Line)

Project Name: **(SMI) Hanoi – Saigon Line** **Double Tracking of Nam Dinh – Trang Bone (L=1,405.5 km)**	Sector: **R06-1**
Project Background and Objective: The whole section of double track between Hanoi – Saigon section will completed by this project, excluding partial double track section	
Project Description: The project includes the following works: a) Double Tracking of Nam Dinh – Vinh (L=232.0 km). b) Double Tracking of Vinh – Hue (L=369.0km). c) Double Tracking of Hue – Da Nang (L=55.5 km). d) Double Tracking of Da Nang – Nha Trang (L=387.0 km) e) Double Tracking of Nha Trang – Trang Bone (L=362.0 km) f) Station Improvement: Hanoi – Vinh 12 stations, Vinh- Hue 39 stations, Da Nang – Nha Trang 32 stations, Nha Trang – Saigon 27 stations g) Automatic Block System: Hanoi – Vinh 219.4 km, Vinh – Hue 328.05 km, Hue – Da Nang 55.5 km, Da Nang – Nha Trang 353.4 km, Nha Trang – Saigon 333.65 km.	
Estimated Cost (2009): US$ 7,386.52 million	Assumed Schedule: - 2030

Project Name: **(SMI) Hanoi – Saigon Line** **Enlarge Workshops and Enlarge Depots in Hanoi - Saigon Line**	Sector: **R06-2**
Project Background and Objective: Enlargement of workshop and depot are required by train operation by the double track.	
Project Description: The project includes the following works: a) Enlarge Workshops: Hanoi – Vinh 62.4 ha, Da Nang – Nha Trang 20.0 ha, Nha Trang – Saigon 72.0 ha. b) Enlarge Depots: Hanoi – Vinh 24.6 ha, Vinh – Hue 45.0 ha, Hue – Da Nang 12.6 ha, Nha Trang – Saigon 78.4 ha.	
Estimated Cost (2009): US$ 1,692.08 million	Assumed Schedule: - 2030

Project Name: **(SMI) Hanoi – Saigon Line** **Land Acquisition**	Sector: **R06-3**
Project Background and Objective: The Additional land purchase planned due to the enlargement of workshop and depot, also double track project.	
Project Description: The project includes the following works: a) Land Acquisition: Hanoi – Vinh 403.4 ha, Vinh – Hue 70.93 ha, Hue – Da Nang 0.03 ha, Da Nang – Nha Trang 41.25 ha, Nha Trang – Saigon 168.32 ha.	
Estimated Cost (2009): US$ 5,822.72 million	Assumed Schedule: - 2030

Project Name: (SMI) Hanoi – Saigon Line **Rolling Stock Procurement**	Sector: **R06-4**
Project Background and Objective: Some additional rolling stock procures for the progress of double tacking Project.	
Project Description: The project includes the following works: a) Diesel Locomotive: 132 cars. b) Passenger Car: 1,341 cars. c) Freight Wagon: 1,430 wagons.	
Estimated Cost (2009): US$ 601.25 million	Assumed Schedule: - 2030

Project Name: (SMI) Hanoi – Saigon Line **Rolling Stock Procurements**	Sector: **R06-5**
Project Background and Objective: Additional Rolling Stock requires for the operation of whole section between Hanoi-Saigon.	
Project Description: The project includes the following works: d) Diesel Locomotive: 525 cars. e) Passenger Car: 1,292 cars. f) Freight Wagon: 10,666 wagons.	
Estimated Cost (2009): US$3,006.25	Assumed Schedule: - 2030

- R08: Hanoi-Lao Cail New Railway Constrcution (SRI &SMI)

Project Name: **(SRI & SMI) Hanoi – Lao Cai Line** **New Railway Project Between Hanoi and Lao Cai (280 km)**	Sector: **R08**
Project Background and Objective: The new double track project is proposed in this section following transport demand and an agreement of the two corridor one belt railway system between China. Presently new double track project is under proceeding from Kunming to Lao Cai. The location of new railway line may locate parallel with existing line between Yen VIen and Yen Bai, and other section from Yen Bai and Lao Cai may located opposite site of Red River .	
Project Description: The project includes the following works: b) The double tracking between Hanoi and Lao Cai line with new alignment is planned by electrified standard gauge separating from the existing line.	
Estimated Cost (2009): US$ 5,671.12 million	Assumed Schedule: - 2030

- R09: Hanoi-Hai Phong New Railway Construction (SRI &SMI)

Project Name: **(SRI & SMI) Hanoi – Hai Phong Line** **Double Tracking Hanoi – Hai Phong by Standard Gauge (112.0 km)**	Sector: **R09**
Project Background and Objective: The present transport demand is lower than track capacity. When transport demand is exceeded that present transport capacity, the double tracking between Hanoi and Hai Phong will propose with electrified standard gauge connecting to Lao Cai.	
Project Description: The project includes the following works: a) The new route is paralleled to Hanoi expressway by Dinh Vu industrial zone. b) Total length is 112.0 km.	
Estimated Cost (2009): US$ 1,892.80 million	Assumed Schedule: - 2030

- R10: HCMC – Loc Ninh New Railway Line Construction

Project Name: **Construction of New Railway Line** **Sai Gon – Loc Ninh**	Sector: **R10**
roject Background and Objective: The Vietnam railway has relationship with ASEAN railway development projects for the revitalization of economic activities in Asian countries, the most of representative project is Singapore - Kunming railway link (SKRL), via Vietnam. The study on missing link between HCMC to Cambodia via Lock Ninh was implemented. (Feasibility Study on HCMC-Lock Ninh section by Vietnam, and Derailed Design study for Phnom Penh –Lock Ninh by ADB.)	
Project Description: The project includes the following works: a) Operation length from HCMC to Lock Ninh 134km b) Installation of single track and dual gage system c) Utilization of previously used Right of Way	
Estimated Cost: US$ 506 million (Information: VNR No. 1686QD-TTg)	Assumed Schedule: - 2030

- R11: HCMC – Can Tho New Railway Line Construction

<table>
<tr><td colspan="2">Project Name:
Construction of New Railway Line
HCMC – Can Tho</td><td>Sector:
R11</td></tr>
<tr><td colspan="3">Project Background and Objective:

New railway route from HCMC to Can Tho and Cau Mau are proposed by the Prime Minister’s Decision on the Approval of the Development Strategy of Vietnamese Railway Sector till 2020 and Vision till 2050 (No. 1686/QD-TTG November 20, 2008). This decision describe to connect North – South High Speed Railway (only passenger transport), this vision is suggested until 2050. The demand forecasting in this section in 2030, estimated 10,400~21,700 pax/day/2 direction, this estimating passenger volume is smaller than HSR project Hanoi - HCMC section. It is recommended implementing further study as the extension line when N-S High Speed railway is operated.

On other hand, the Vietnam Railway Transport Development Strategy up to 2020 and Vision 2050 transport (VNR September 2007), mentioned to introduce Asymptote High Speed Railway (both of passenger and freight transport), this projection is more realistic because of possibility of freight transport. However demand is not much as proposed new railway line in Sai Gon - Vung Tau corridor, most of cargo demanding railway transport may shift to that transport corridor due to development of sea port in that area.

Remaining cargo is agricultural goods from Mekong River Delta; however seasonal fluctuation may not accommodate for the construction of new railway line, it will recommend making study in referring of the new railway line in Sai Gon – Vung Tau corridor.</td></tr>
<tr><td colspan="3">Project Description:

The project includes the following works:
a) Asymptote high seed railway (but latest decision is HSR type)
b) Double track railway with electrified system
c) 1,435 mm standard gauge</td></tr>
<tr><td>Estimated Cost:
US$ 206
(Information: VNR No. 1686QD-TTg)</td><td colspan="2">Assumed Schedule:
- 2030</td></tr>
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