MINISTRY OF RAILWAYS
GOVERNMENT OF INDIA

NEEDS SURVEY
ON
HIGH SPEED RAILWAY TECHNOLOGY AND SKILLS
IN
INDIA

FINAL REPORT

March 2012

JAPAN INTERNATIONAL COOPERATION AGENCY

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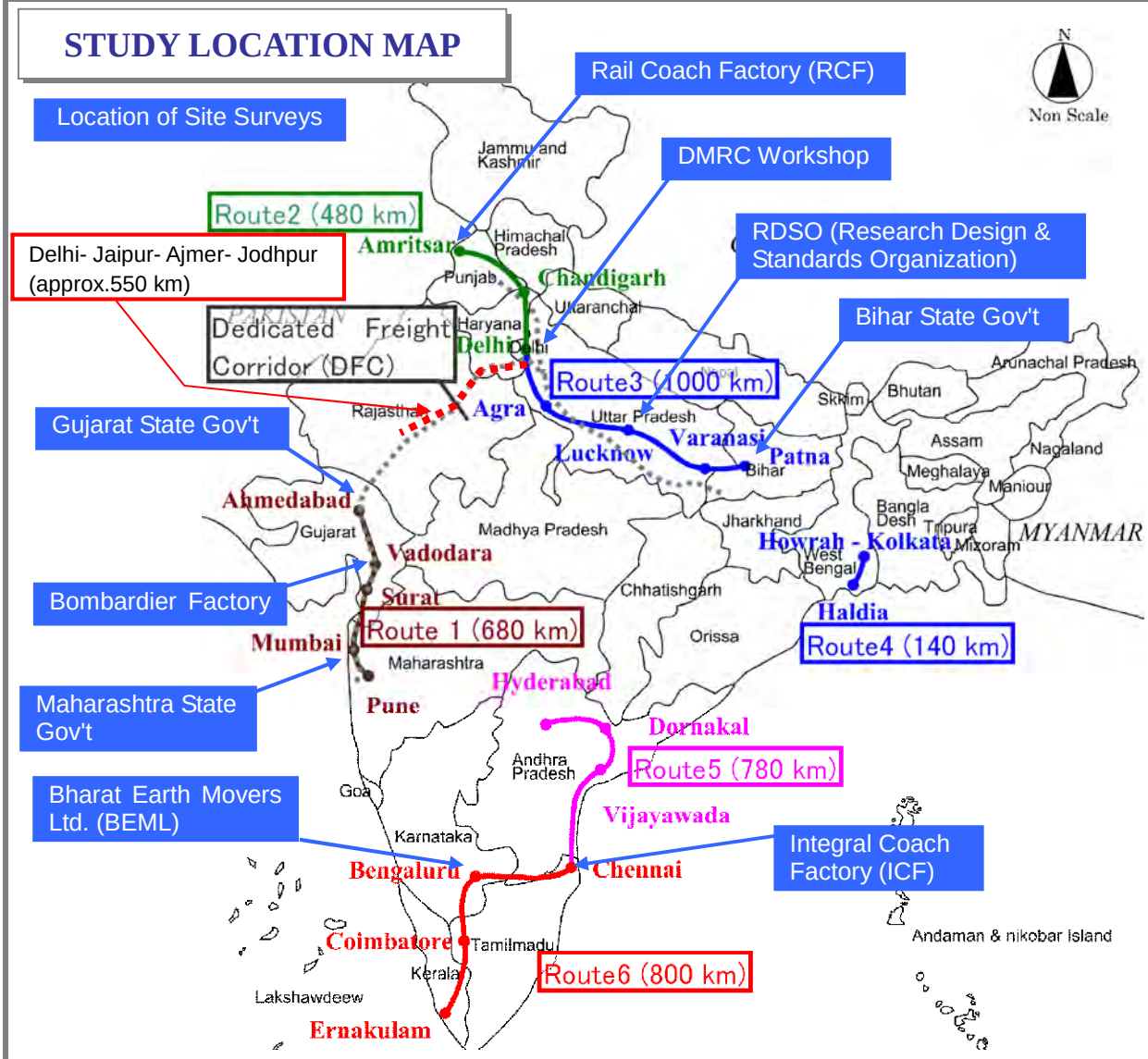
STUDY LOCATION MAP



Basic Data of India Source: Ministry of Foreign Affairs

- ■Area: 3.29 million km^2 (8.7 times area of Japan) (Gov't of India: incl. disputed area)
- ■Population: 1.2 billion*1
  Population Growth: 17.64% (2002/200) *1
- ■Capital: New Delhi (population: 300,000 ※2)
- ■Ethnic: Aryan Indian, Dravidian, Mongoloid, etc.
- ■Language: Hindi (Federal Official Language) & 21 State Languages
- ■Religion: Hindi (80%), Muslim (13%), Christian, Sikh, Buddhist, Jain *2
- ■Major Industry: Agriculture, Industry, Mining, IT industry
- ■GDP pre Capita: US$ 1,265 (IMF)
- ■GDP Growth: 8.5% (Gov't of India)
- ■Inflation Rate: 10.4% (CPI) 9.6% (WPI) (Gov't of India)

*1: Census 2011(Temporary)
*2: Census 2001
Other data are for the year 2010

- ■Total Amount of Trade (Gov't of India)
  (1) Exports: US$ 246 billion
  (2) Imports: US$ 351 billion
- ■Major Items of Trade
  (1) Exports: Machinery & Equipment, Petroleum Products, Chemical Products, Jewels
  (2) Imports: Crude Oil & Petroleum Products, Capital Goods, Gold, Silver
- ■Currency: Indian Rupee (Rs.) US$1 = 52.78Rs. (January 2012)
- ■ODA Performance of Japan (tentative)
  (1) Grant Aid: 48.0 billion yen (E/N basis)
  (2) Gov't Loan: 1.2 billion yen (E/N basis)
  (3) Technical Assistance:1.7 billion yen (JICA)

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ABBREVIATIONS

ATACS.....Advanced Train Administration and Communications System

ATC.....Automatic Train Control

BEML .....Bharat Earth Movers Limited

BOT .....Build, Operate and Transfer

CTC.....Centralized Traffic Control

DFC.....Dedicated Freight Corridor

DMIC.....Delhi- Mumbai Industrial Corridor

DMICDC .....Delhi Mumbai Industrial Corridor Development Corporation Limited

DMRC.....Delhi Metro Rail Corporation Limited

F/S.....Feasibility Study

GSM-R.....Global System for Mobile communications- Railway

ICF .....Integral Coach Factory

IR .....Indian Railways

IRR.....Internal Rate of Return

JBIC .....Japan Bank for International Cooperation

JICA.....Japan International Cooperation Agency

JORSA .....Japan Overseas Rolling Stock Association

JRTT .....Japan Railway Construction, Transport and Technology Agency

LCX .....Laky Coaxial Cable

METI.....Ministry of Economy, Trade and Industry of Japan

MIC.....Ministry of Internal Affaires and Communications of Japan

MLIT.....Ministry of Land, Infrastructure, Transport and Tourism of Japan

MOR .....Ministry of Railways

NHSRA.....National High Speed Rail Authority

NTDPC .....National Transportation Planning Committee

OCC .....Operation Control Center

ODA.....Official Development Assistance

PPP.....Public–Private Partnership

RCF.....Rail Coach Factory

RDSO.....Research, Designs & Standards Organization

RTRI .....Railway Technical Research Institute

SPV .....Special Purpose Vehicle

STEP .....Special Terms for Economic Partnership

UIC .....Union Internationale des Chemins de Fer (International Union of Railways)

VGF .....Viability Gap Funding

1. INTRODUCTION

1. INTRODUCTION

1.1 Background of the Study

At approximately 1.2 billion, India's population is the world's second largest after China and is expected to surpass it in the future. India is an emerging economy and has had a high real GDP growth exceeding 6% since 2003. The Government of India announced a target GDP growth of about 10% in its 12th Five-Year Plan (April 2012-March 2017) and high growth is expected to continue. The size and speed of economic growth in India leads economic growth in South Asia, and accounts for about 70% of the total growth in the region. To sustain this annual growth rate, infrastructure investment as great as US$1 trillion (including private funds) is said to be needed. However, to date, infrastructure development is slow due to a shortage of investment and the complexity of the systems involved.

Under these circumstances, in order to maintain strong economic growth, and to build an internationally competitive investment environment and solid economic foundation, development and improvement of infrastructure such as railways, roads, large airports, and ports has become an important task. Therefore, JICA considers "Assistance for Sustainable Economic Growth through Construction of Economic Infrastructure" one of the most important areas of support in its "FY2009 Country Assistance Implementation Policy for India". In this respect, it is willing to help with the development of India's transport infrastructure. In particular, it has been focusing on the railway sector, including metros in major cities and on a freight corridor connecting Delhi with Mumbai, which is known as the "Dedicated Freight Corridor" and is the first project in India to apply JICA's STEP (Special Terms for Economic Partnership) loan, in order that Japanese high technology, expertise and know-how can be fully utilized.

To address global environmental issues, railways, as an environmentally-friendly and efficient means of transportation, have attracted a great deal of attention worldwide. In December 2009, the Ministry of Railways of India (MOR) promulgated "Indian Railways Vision 2020," which designated six candidate routes in which high-speed railway (HSR) will be examined in pre-feasibility studies. These studies are now being carried out and will be completed by the end of 2012 for five of the six routes. Furthermore, the Minister of Railways announced in his budget speech on 14th March 2012 that a study on Delhi-Jaipur- Ajmer- Jodhpur as a possible seventh HSR route may also be carried out in fiscal year 2012.

The Government of Japan is willing to contribute to its bilateral relationship with India by contributing to social and economic development via the introduction of advanced railway technology and would now like to take this one more step forward by facilitating the implementation of HSR. In addition to Japan other countries, such as France, Germany, Italy and Spain, recognized as advanced countries in

high-speed rail will also become intent on entering the Indian market as it develops. Recently, Korea and China have also shown interest in entering the market. Given this background, the Japanese Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has taken the initiative and carried out a "Project Formulation Study on High-Speed Railway Commercialization in India" in fiscal year 2010 and a "Project Formulation Study on High-Speed Railway Commercialization in South India" in fiscal year 2011, which is expected to be completed in March 2012.

1.2 Objective of the Study

The objective of the Study is to gather and examine information on HSR to enable the formation of viable HSR projects in India utilizing JICA's assistance schemes (technical cooperation, dispatching of experts, training, yen loans, etc.). This includes the policies and project plans of the Government of India as well as that of the state governments. The objective of the Study is also to clarify the conditions and issues facing HSR development in India and the possible way forward.

1.3 Study Area

The study is strategic in nature and therefore considers the entirety of India.

1.4 Study Approach

1.4.1 Interviews of Japanese Organizations

The following Japanese organizations were interviewed in Japan to assess the strengths or weaknesses of Japanese companies, the possibility of HSR rail coach production in India, and the issues that should be addressed by Government of Japan to introduce the Shinkansen overseas.

[1] Japan Overseas Rolling Stock Association (JORSA)

[2] Mitsubishi Heavy Industries, Ltd.

[3] Social Infrastructure Systems Company, Toshiba Corporation

[4] Hitachi, Ltd.

[5] Railway Technical Research Institute (RTRI)

[6] Kawasaki Heavy Industries, Ltd.

[7] Sumitomo Metal Industries, Ltd.

[8] Mitsubishi Electric Corporation

1.4.2 Field Surveys

Field surveys were carried out as shown in Table1-1 to Table 1-3. The contents of the surveys are described below.

(1) Interviews of the Indian Ministry of Railways & Other Relevant Authorities

Interviews were carried out with the MOR and four other authorities (see below) to discuss the progress of government policies and business plans related to HSR, including the pre-F/Ss for the previously mentioned 6 HSR routes. Furthermore, in order to better assess the Indian Government's requirements to realize HSR in cooperation with the Japanese Government, detailed technical issues shall be taken up and clarified in a series of meetings with the MOR regarding civil engineering, rolling stock, signaling, power supply, and finance.

[1] Research Design & Standards Organization- RDSO (Lucknow, Uttar Pradesh)

[2] IRCON International Limited (New Delhi)

[3] Delhi Mumbai Industrial Corridor Development Corporation Limited (New Delhi)

[4] Planning Commission (New Delhi)

[5] National Transportation Planning Committee (New Delhi)

(2) Interviews of State Governments

Interviews of State Governments shown below were held with the intention of assessing the status of plans for facilitating the implementation of HSR (including financial resources, development plans, land acquisition etc).

[1] Government of Gujarat - Gujarat Infrastructure Development Board (Gandhinagar, Gujarat)

[2] Government of Bihar (Patna, Bihar)

[3] Government of Maharashtra (Mumbai, Maharashtra)

(3) Interviews of Private Japanese Corporations in India

Interviews of private Japanese manufacturers in India were carried out to assess problems in starting-up local companies, the characteristics and issues regarding local employment, based on the assumption of launching of a HSR coach factory in India.

[1] Toshiba India Private Limited (Gurgaon, Haryana)

[2] Kawasaki Heavy Industries, Ltd. Delhi Representative Office (New Delhi)

(4) Inspection of Coach Factories and Maintenance Shops

Inspections of the railway car factories listed below ((1) to (4)) were carried out to evaluate their technological capacity and capability and regarding possible future HSR car production in India. Inspection of DMRC railcar maintenance shop [5] was also done to evaluate the technical level of car maintenance in India.

[1] Rail Coach Factory (Kaputhala, Punjab)

[2] Integral Coach Factory (Chennai, Tamil Nadu)

[3] Bharat Earth Movers Limited (BEML) (Bangalore, Karnataka)

[4] Bombardier Transportation India Limited at Savli Site (Vadodara, Gujarat)

[5] Delhi Metro Rail Corporation Limited (New Delhi)

Table 1-1 Schedule for First Field Survey

Date		Program	City
10/30	Sun	NRT => Delhi	Delhi
10/31	Mon	MTG with JICA India Office - Confirmation on Scope of the Study and Discussions on Survey Methodology MTG with Embassy of Japan - Explanation of the Study and Request of Support from the Embassy MTG with RITES - Discussions on Survey Methodology & Collecting Data on HSR MTG with MOR - Confirmation on Scope of the Study, Discussions on Survey Methodology - Presentation on latest HSR technology	Delhi
11/1	Tue	MTG with MOR - Discussion & confirmation of thinking on the curriculum for the Seminar in Japan - Discussions on Survey Methodology, Collecting Data/Information on HSR Plans in India MTG with IRCON - Confirmation on Progress of Pre-FS Work	Delhi
11/2	Wed	MTG with MOR	Delhi
11/3	Thu	MTG with DMIC - Hearing about HSR and Regional Development along DMIC Delhi => Amritsar	Amritsar
11/4	Fri	Visit Rail Coach Factory - Collect information on capacity of rolling stock production Amritsar =>Delhi	Delhi
11/5	Sat	MTG with JICA INDIA OFFICE - Progress Report	Delhi
11/6	Sun	Team Meeting	Delhi
11/7 Holiday	Mon	Delhi => Lucknow	Lucknow
11/8	Tue	MTG with RDSO（India Railway Technology Institute) - Collecting Data on HSR in India - Explanation of latest HSR technology - Confirmation of Thinking on Indian Side Lucknow => Delhi	Delhi
11/9	Wed	MTG with MOR - Report on the results of the first survey - Finalization of curriculum for the Seminar in Japan	Delhi
11/10 Holiday	Thu	Team Meeting	Delhi
11/11	Fri	MTG with JICA India Office - Report on the results of the first survey	Delhi
11/12	Sat	DEL => NRT	In Transit
11/13	Sun	Arrive to Tokyo	

Table 1-2 Schedule for Second Field Survey

Date		Program	City
1/10	Tue	NRT => Delhi	Delhi
1/11	Wed	Visit JICA India Office - Confirmation of Scope for 2nd On-Site Visit & Study Progress Meeting with MOR - Confirmation of Scope for 2nd On-Site Visit & Study Progress	Delhi
1/12	Thu	Meeting with Mitsubishi Corp. - Collection of Information of Localization of Coach Production	Delhi
1/13	Fri	Attendance at MLIT Seminar in Delhi Meeting with Hitachi India	Delhi
1/14	Sat	Team Meeting	Delhi
1/15	Sun	Team Meeting	Delhi
1/16	Mon	Visit Planning Commission - Discussion of India's Strategy, Plans, etc. for Introducing HSR Meeting with MOR - Discussion of Technical Issues & Relevant Standards - Discussion on Study Team's Interim Report - Discussion on Workshop in India	Delhi
		(HSR Team) Delhi => Bangalore	Bangalore
1/17	Tue	Meeting with RITES - Discussion of Technical Issues & Relevant Standards Meeting with National Transportation Planning Commission	Delhi
		(HSR Team) Visit Bjarat Earth Movers Ltd. (BEML) in Bangalore Bangalore => Delhi	
1/18	Wed	Delhi => Gandhinagar	Gandhinagar
1/19	Thu	Meeting with Gujarat State Government - Confirmation of Budgetary Potential on expected HSR Project, Relevant Plans along the Route, Procedure for Land Acquisition, etc. Gandhinagar => Delhi	Delhi
1/20	Fri	Visit DMRC Workshop Visit Toshiba	Delhi
1/21	Sat	Team Meeting	Delhi
1/22	Sun	Team Meeting	Delhi
		(HSR Team) Delhi=>Chennai	Chennai
1/23	Mon	Meeting with RITES -Discussion on Technical Issue and Collection of Relevant Standards	Delhi
		Visit Integral Coach Factory (ICF) in Chennai Chennai=>Delhi	
1/24	Tue	Visit Delhi Office of Bombardier	Delhi
1/25	Wed	Visit Embassy of Japan & JICA India Office -Report on the Results of the Second Survey Meeting with MOR - Discussion on Results of 2nd Survey - Discussion on Workshop in India DEL => NRT	In Transit
1/26	Thu	Arrive to Tokyo	

Table 1-3 Schedule for Third Field Survey

Date		Program	City
2/14	Tue	NRT => Delhi	Delhi
2/15	Wed	Visit JICA India Office & Embassy of Japan - Discuss Scope of 3rd On-site Visit	Delhi
2/16	Thu	Meeting with Kawasaki Heavy Industries - Discussion on possible rolling stock localization, etc. Meeting with MOR - Civils Group Meeting on Requirements for Future JICA Workshop - Rolling Stock & Power Supply Group Meeting on Requirements for Future JICA Workshop Delhi => Ahmedabad	Ahmedabad
2/17	Fri	Visit Bombardier Factory Ahmedabad =>Delhi	Delhi
2/18	Sat	Team Meeting	Delhi
2/19	Sun	Team Meeting	Delhi
2/20 Holiday	Mon	Delhi => Patna	Patna
2/21	Tue	Meeting with Bihar State Government - Confirmation of Budgetary Potential for Expected HSR Project, Relevant Plans along Route, Procedure for Land Acquisition, etc. Patna =>Mumbai	Mumbai
2/22	Wed	Meeting with Maharastra State Government - Confirmation of Budgetary Potential on Expected HSR Project, Relevant Plans along the Route, Procedure for Land Acquisition, etc. Mumbai => Delhi	Delhi
2/23	Thu	Meeting with MOR - Signaling & Telecom. Group Meeting on Requirements for Future Workshop - Finance Group Meeting on Requirements for Future JICA Workshop	Delhi
2/24	Fri	Visit Embassy of Japan & JICA India Office - Report on Results of 3rd On-site Visit Meeting with RITES - Collection of Tech. Information & Specs.	Delhi
2/25	Sat	DEL => NRT	In Transit
2/26	Sun	Arrive to Tokyo	

1.4.3 Study Tour in Japan

A study tour was conducted in Japan, which included seminars and on-site inspections, for 12 Indian railway experts who represent the core of the staff responsible for India's future high-speed rail in MOR. The purpose of the study tour was to promote the understanding of the latest techniques on planning, construction, production, operation, management technology, theory and technology for HSR in Japan. The schedule of the study tour is as shown below.

Table 1-4 Schedule for Study Tour in Japan

Date			Activity
1	12/5	Mon	• Courtesy Visit to JICA • JICA : Lecture on “JICA’s Cooperation for Railway System Development” • JRTT : Lecture on "Funding for Railway Development/Construction Technology" • MLIT: Lecture on "Outline of High Speed Railway/ Policy Framework and Technical Standards in Japan"
2	12/6	Tue	• JR East: Lecture on "Fare Policy/Lifestyle Business" • JR East Shinkansen General Control Center • Tokyo Station (Shinkansen Operation, Ticketing, Reservation System, Platform Layouts, Commercial Facilities, etc.)
3	12/7	Wed	• JR East General Training Center in Fukushima (Safety, Staff Training, etc.)
4	12/8	Thu	• Construction Site of Hokkaido Shinkansen (JRTT) (Civil, Signal Team) • Shin-Sendai Sub-station (E&M Team) • Shinkansen General Rolling Stock Center (E&M Team)
5	12/9	Fri	• Aomori Dispatch, Morioka Shinkansen Rolling Stock Center
6	12/10	Sat	
7	12/11	Sun	
8	12/12	Mon	• Factory of Mitsubishi Electric Corporation • Factory of Kawasaki Heavy Industries, Ltd.
9	12/13	Tue	• Akashi-Kaikyo Bridge (Civil, Signal Team) • Factory of Hitachi Ltd. in Kasado (E&M Team)
10	12/14	Wed	• Steel Works of Nippon Steel Corporation (Civil Team) • Hitachi Ltd. Manufacturers in Mito (Signal) and in Omika (Operation Control Equipment) (Signal Team) • Factory of Toshiba Electric Service Corporation in Fuchu (E&M Team)
11	12/15	Thu	• RTRI: Lecture and Facility Tours (Introduction of Basic Research on HSR Technology, etc.)
12	12/16	Fri	• Kamata Station, Keikyu Corporation to Study Construction Site of Grade Separation • Exchange of Ideas with Private Companies • General Presentation by MOR Staff and Presentation by Private Companies followed by discussion
13	12/17	Sat	
14	12/18	Sun	
15	12/19	Mon	• Construction Site of Shinjuku Station • Lecture by JICA (JICA Support Program), • Detailed Presentation by MOR Staff & Conference with Japanese Government Agencies (MLIT,METI & JETRO) and JR East
16	12/20	Tue	• Departure from Tokyo

Note: JRTT: Japan Railway Construction, Transport and Technology Agency
MLIT: Ministry of Land, Infrastructure, Transport and Tourism
RTRI: Railway Technical Research Institute
METI: Ministry of Economy, Trade and Industry
JETRO: Japan External Trade Organization

2. PRESENT STATUS OF HSR IN INDIA

2. PRESENT STATUS OF HSR IN INDIA

2.1 Government HSR Policy

2.1.1 Expectations of Indian Officials about HSR

(1) Challenges in Transport

In the past decade, vehicle ownership has drastically grown in the major cities of India, resulting in serious traffic congestion and billions of man-hours lost. According to the population census, the urban population of the country reached 380 million in 2011, an increase of 1.3 times over the last decade from 290 million in 2001. It is estimated that this will reach 470 million in 2021.

In addition, rapid urbanization throughout the country has triggered the growth in demand for inter-city transport between metropolitan areas and second or third tier cities, with inter-city passenger air and car traffic increasing by 15 to 20%.

Source: MOR of India

Figure 2-1 Urban Population in India

(2) Need for HSR in India

The need to introduce high-speed railways (HSR) into India, which is an energy-efficient mass transit system, corresponds to the growth of demand for inter-city transportation and to the increased dependence on imported fossil fuel and the desire to reduce environmental impacts. The advantages of HSR, which are expected to contribute to economic growth of areas along its corridors, alleviate urban traffic congestion, and facilitate access to and from satellite cities, are described below.

- **Energy Efficient**

  The fuel consumption of HSR per passenger-km is about 1/5 that of aircrafts and 2/3 that of buses.

- **Minimal Land Acquisition**

  HSR requires approximately 15m of ROW, which is less than 1/2 of the space needed for a four-lane highway. Furthermore, HSR transport capacity can be up to 1.5 times that of a six-lane highway, and is highly cost-efficient as compared to road transport.

Table 2-1 Comparison of HSR & Motorway Capacity

High Speed Rail	Motorway
Double Track	2x3 Lanes
12 Trains per hour per Direction	4500 Cars per hour per direction
1000 Pax/Train	1.7 (Average) Passengers per car
Capacity = 12000 Passengers per hour	Capacity = 7650 Passenger per Hour

Source: MOR of India

(3) Key Issues for Introducing HSR

The key issues for developing HSR as recognized by MOR are listed below:

- Selection of a pilot project based on economic and financial viability.
- Emphasis on other alternative revenue sources such as real estate, carbon credits, cross-subsidies from road and air travel, etc.
- Technology improvements in HSR elements such as infrastructure, track, electrical installations, rolling stock, signaling and communications, train control, fare collection, etc.
- Consensus with project-affected residents and state governments regarding alignment requirements, taking into account rehabilitation needs or sensitive land issues.
- Proper project packaging to facilitate smooth execution.
- Introduction of a system integrator such as the NHSRA or a SPV.

Adequate revenue to cover the huge expenses needed to develop HSR is essential to operate at a high-frequency (e.g., intervals of 5 to 10 minutes). As it is difficult to earn sufficient revenue to cover all of the operating expenses, PPP and other schemes such as real estate development, financing by the central or state governments, VGF, etc. need to be considered.

Presently, the Government of India does not have a definite financial model for HSR. According to the MOR, it is likely to be funded using government funds (infrastructure development funds) as there is a large amount of risk involved. Additionally, there are expectations to obtain financial assistance from multilateral or bilateral funding agencies.

As of now, there are no plans to adopt a specific HSR system. Therefore, the system could be from any part of the world and would probably be selected as part of an international bidding process. Consideration is also being given to operating HSR via a PPP scheme, where the government would take responsibility at minimum for land acquisition and perhaps for funding the civil structures. Technical and financial support from the Japanese government would be welcomed by the MOR.

2.1.2 HSR in National Development Plans

(1) Outline of Indian Railways' Vision 2020

The long-term railway development plan described in Indian Railways' Vision 2020 was issued in December 2009 and its targets are as follows:

Table 2-2 Outline of Indian Railways' Vision 2020

Broad category	Short Term Target (2010-11-2011-2012)	Long- term Target (2012-2013-2019-20)	Total Target
Doubling (including DFC)	1000 kms	11000 kms	12,000kms
Gauge conversion	2500kms	9,500kms	12,000kms
New line	1000kms	24,000kms	25,000kms
Electrification	2000kms	12,000kms	14,000kms
Procurement of wagons	33909	255227	289136
Procurement of diesel locomotives	690	4644	5334
Procurement of electric locomotives	555	3726	4281
Procurement of passenger coaches	6912	43968	50,880

Source: MOR in India

Vision 2020 envisages the implementation of one HSR in each of the regions of the nation and plans for at least 8 corridors connecting commercial, tourist and pilgrimage hubs. The following 6 corridors have already been identified for pre-feasibility studies:

i) Pune-Mumbai-Ahmedabad (650 km approx.)
ii) Delhi-Chandigarh-Amritsar (450 km approx.)
iii) Delhi-Agra-Lucknow-Varanasi-Patna (991 km approx.)
iv) Howrah-Haldia (135 km approx.)
v) Hyderabad-Dornakal-Vijayawada-Chennai (664 km approx.)
vi) Chennai-Bangalore-Coimbatore-Ernakulam-Thiruvananthapuram (850 km approx.)

By 2020, at least four corridors of 2,000 km will be completed and development for 8 remaining corridors would be in different stages of progress. In the 12th Five Year Plan from 2012 to 2017, a provision of Rs. 200 billion has been set aside for mobilization through PPP for HSR corridors.

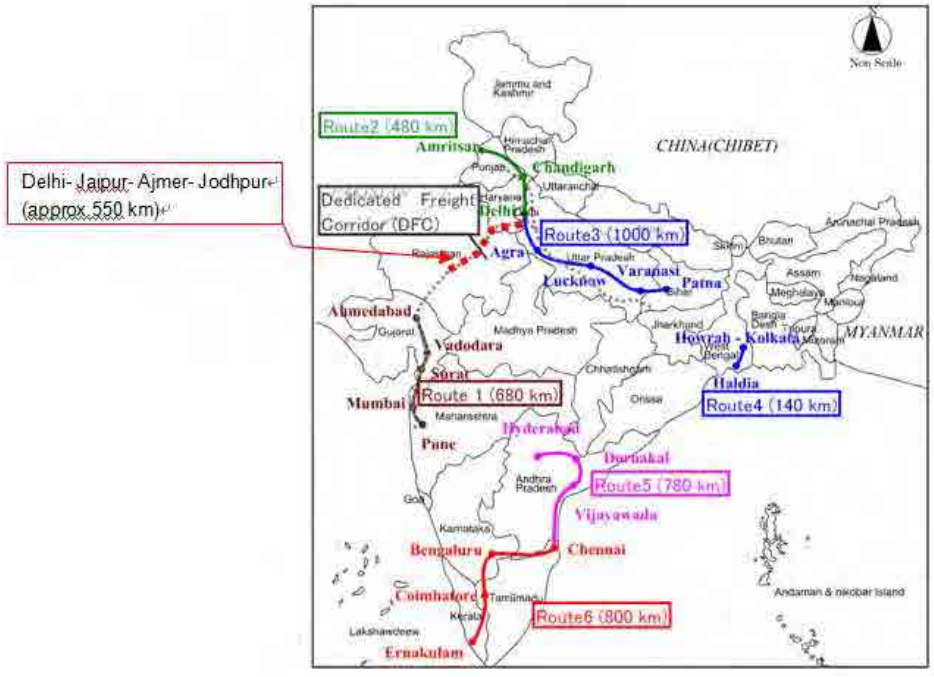
The pre-feasibility studies for the HSR corridors are being done with the involvement of the concerned state governments, and their development plans are being considered in deciding HSR alignments. The locations of stations within cities are also being discussed with the concerned city administrations.

(2) Status of HSR Pre-Feasibility Studies

The progress of the pre-feasibility studies for the 6 HSR corridors is indicated in Table 2-3. In addition, one more possible HSR route was announced in the budget speech of the Railway Minister on 14 March 2012 and would run from Delhi to Jodhpur via Jaipur and Agra. Further, the route from Trivandrum to Kasargod is also being mentioned as a possible HSR corridor.

Table 2-3 Status of HSR Pre-Feasibility Studies

No.	Section	Approx. Dist. (km)	Progress
1	Pune-Mumbai-Ahmedabad	680	Pre-F/S completed in December 2009 & finalization of financing in progress.
2	Delhi-Chandigarh-Amritsar	480	Consultant to be engaged.
3	Delhi-Agra-Lucknow-Varanasi-Patna	1,000	Consultant selected & study in progress.
4	Howrah-Haldia	140	Consultant selected & study in progress.
5	Hyderabad-Dornakal-Vijayawada-Chennai	780	Consultant selected & study in progress.
6	Chennai-Bengaluru-Coimbatore-Ernakulam	800	Consultant selected & study in progress.
	Delhi- Jaipur- Ajmer- Jodhpur	550	announced as another possible route in the budget speech in March 2012



(JICA Survey Team)

Figure 2-2 Status of HSR Pre-Feasibility Studies

2.1.3 HSR Plans of State Governments

(1) State of Gujarat

Gujarat has many advantages such as a business-friendly environment, good electricity and water supply, simplified procedures, availability of land, etc. It is keen on supporting HSR development that will connect its cities such as Ahmedabad with Mumbai to make itself an even more attractive destination. In this respect, it paid for 25% of the cost for the pre-F/S to promote the HSR corridor in Gujarat.

In addition to the Ahmedabad-Mumbai-Pune HSR corridor, Gujarat is also keen on developing an HSR to connect Ahmedabad with Dholera, which has been designated as a SIR (Special Investment Region).

Source: Gujarat Infrastructure Development Board

Figure 2-3 Locations of SIR, Industrial Area and SEZ in Gujarat

Gujarat has applied PPP schemes for several projects; however, it is yet to be decided whether a PPP scheme would be used to implement HSR in Gujarat, which hopes to have HSR stations at its major cities of Ahmedabad, Vadodara and Surat. Although HSR comes under the jurisdiction of the MOR, Gujarat is ready to provide support by assisting with land acquisition, utility relocation, etc., and would welcome support from the Japanese government to realize the implementation of HSR.

(2) State of Maharashtra

Maharashtra is highly motivated to see HSR implemented in its state, and would like to see it also extended to the city of Nagpur, which has a population of 2.4 million and is located in the eastern part of the state (see Figure 2-4). This would be in addition to the high priority route between Pune, Mumbai, and Ahmedabad.

Due to a lack of available land in Mumbai, Maharashtra would like to see the HSR station built in the suburbs, which is where the new airport and industrial parks are to be located. Accordingly, there are plans for Mumbai HSR station to be constructed in Panvel (see Figure 2-5).

Finally, Maharashtra believes that the foundation for HSR is in place (e.g., infrastructure backbone, potential ridership, etc.), but some concern has been expressed that some of its industry might migrate to Gujarat.

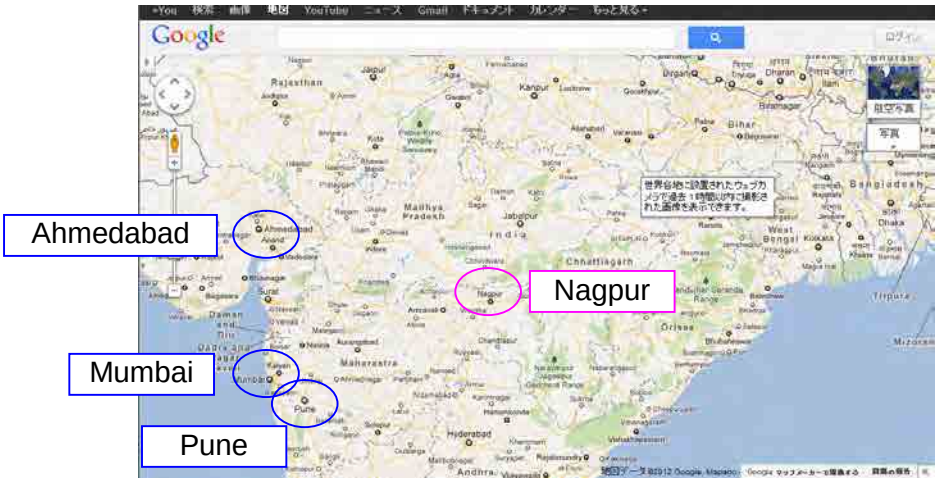


Figure 2-4 Locations of Mumbai, Pune and Nagpur

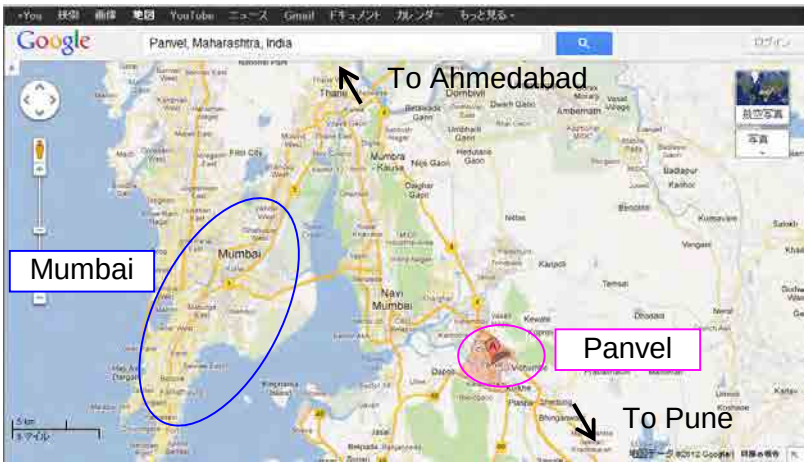


Figure 2-5 Location of Panvel

(3) State of Bihar

Bihar does not have any plans in place for the development of HSR and is waiting for the results of the F/S being done by the central government; although, development plans and related land acquisition is the responsibility of the state government. According to Bihar officials, land acquisition has been the biggest challenge in the past, and suggested that the combination of huge investments required for HSR as well as for an urban railway project, make the state government's budget and cooperation uncertain.

(4) Other States[1]

- **State of Tamil Nadu**

A large part of HSR Corridor 6 is Tamil Nadu. In 2006, the Government of Tamil Nadu prepared an HSR plan and made an official request to the Prime Minister in early 2007. Two alternative corridors were proposed: Chennai-Coimbatore and Chennai-Madurai. At present, the Chennai-Madurai section is the first priority.

1 Reference from Project Formulation Survey on the Route 5 and 6 by MLIT, March 2012

- **State of Karnataka**

Karnataka would like to have an HSR operate on the following routes: i) Bengaluru-Coimbatore, ii) Bengaluru-Mysore, and iii) Mysore-Calicut. Karnataka has a strong desire to also include the city of Mysore in an HSR plan. In October 2010, it requested the Minister of Railways to consider extending HSR from Bengaluru to Mysore.

- **State of Kerala**

Kerala established its own HSR entity known as Kerala High Speed Rail Corporation Ltd. (KHSRCL), and it is anticipated that it will be responsible for a 630km route linking Mangalore in Karnataka to the state capital of Kerala (i.e., Thiruvananthapuram) at an estimated cost of Rs. 770 billion, and would have intermediate stations at Kollam, Kottayam, Ernakulam, Thrissur, Kannur and Kozhikode. Also, as mentioned in 2.1.2(2), a HSR route from Thiruvananthapuram to Kasargod is being considered too. Finally, Kerala plans to utilize PPP schemes with state government and private sector companies cooperating with each other to achieve its project objectives.

2.1.4 Procedures & Key Personnel for Political Decisions on HSR

(1) MOR & NHSRA[2]

As per existing law, the Ministry of Railways (MOR) is responsible for Indian Railways, including planning, construction and operation of freight and passenger transport, safety management, train service, construction and maintenance of bridges/track, and asset management.

The operation of an HSR system, which is significantly different than that of the conventional railway system of Indian Railways, differs in terms of financial structuring, tariffs, technology, and safety parameters. That is, the mix of social and commercial principles that guide the policies of conventional railways will not be appropriate for HSR.

Given the preceding, the National High Speed Rail Authority (NHSRA), which has been planned as a dedicated HSR Authority, is expected to be established in 2012 and shall act as HSR facilitator and regulator and will raise resources through multiple sources to finance development and will adopt PPP schemes as appropriate on a case-by-case basis.

- **Outline of NHSRA**

NHSRA will be backed by national legislation and will be well suited to interact with state governments and other strategic partners to operate on sound commercial and economic principles. NHSRA is also envisaged to perform a regulatory role for the various HSR concessionaires.

2 Source: MOR

- **Roles of NHSRA**

The roles of the NHSRA are expected to be as follows:

- Planning of core infrastructures and identification of regions for HSR systems.
- Creating a platform for long-term HSR development plans in India.
- Identifying and specifying processes and technologies to be used in HSR.
- Inviting & awarding contracts/concessions for implementation of projects.
- Land acquisition for setting-up new stations and track.
- Overseeing implementation of projects & awarding contracts.
- Periodic monitoring of activities of concessionaires/SPVs.
- Interfacing between HSR and Indian Railway Units.
- Coordination between various HSR SPVs.
- Identifying sources of financing & assisting in achieving financial closure for projects.
- Developing additional revenue streams such as real estate.
- Optimization of input costs.
- Carrying out research activities relating to development, maintenance & management of HSR systems or any such facilities.
- Advising state & central government on matters relating to HSR systems.

(2) Ministry of Finance

The Ministry of Finance (MOF) is in charge of the financial management of the Government of India., and for allocating financial resources to state governments for adjusting the fiscal spending of the central government. The Ministry consists of five divisions: i) Department of Economic Affairs, ii) Department of Expenditure, iii) Department of Revenue, iv) Department of Disinvestment, and v) Department of Financial Services. Note that multilateral/bilateral funding for railway-related projects is routed through the MOR.

(3) Planning Commission[3]

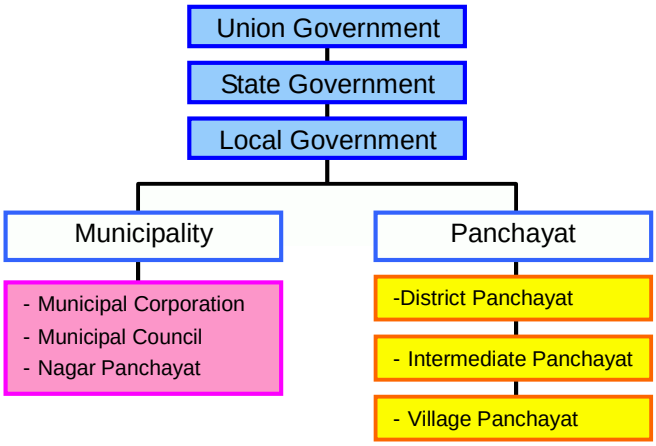
The Planning Commission is responsible for the execution and monitoring of the country's five-year plans. Working Groups are set up to assist with this and comprise the relevant ministries and agencies, academic experts, and representatives from relevant state government departments. In order to promote accurate planning, the Planning Commission monitors the status of the previous year's achievements and clarifies the issues necessary to satisfy planned targets based on this. Note that annual central government budget allocations to state governments are determined by this monitoring exercise.

3 Source: MLIT

(4) State Government

- **Rural Governance in India**[4]

The Indian Constitution stipulates that the country's administrative hierarchy consists of three levels of government: central, state and local. In addition, in urban and rural areas, different systems have been introduced and are comprised of a further three-layer structure. Currently, there are twenty-eight states and seven union territories. In addition, states are divided into districts and blocks.



Source: MLIT

Figure 2-6 Administrative Hierarchy Stipulated in Constitution of India

Defense, diplomacy, communications, currency, customs and infrastructure (railway, national highway, power supply and major ports) are the jurisdiction of the central government. The jurisdiction of the state government is to maintain public law and security, sewerage (water and sanitation), public health, education, regulations for agriculture, forestry/fisheries, transport infrastructure (state highways, non-major ports), etc. Legislative, economic/social planning, social security, trade, industry, and electric power fall under the jurisdiction of both the state and central governments.

- **HSR Project Cost & State Government**

The railways in states are operated by Indian Railways, while state are responsible for managing the urban metro systems. State governments, for the most part, have no concrete plans about supporting the HSR and are waiting for the completion of the F/Ss by the central government.

[4] Source: MLIT

- **Land Acquisition**

As mentioned earlier, land acquisition is the responsibility of state government. However, the specific locations of routes and railway stations will be as per the plan made by the central government, taking into account the wishes of state governments. Land acquisition, for example, can be minimized if the central and state governments plan for the needs of both HSR and conventional rail simultaneously.

- **Rural Development Plans**

State governments have their own plans for urban development, such as Special Economic Zones (SEZ) and industrial parks, and this should be considered by the central government in the HSR plans so that ridership can be maximized.

2.1.5 Expectations of Cooperation from Japan Regarding HSR Technology[5]

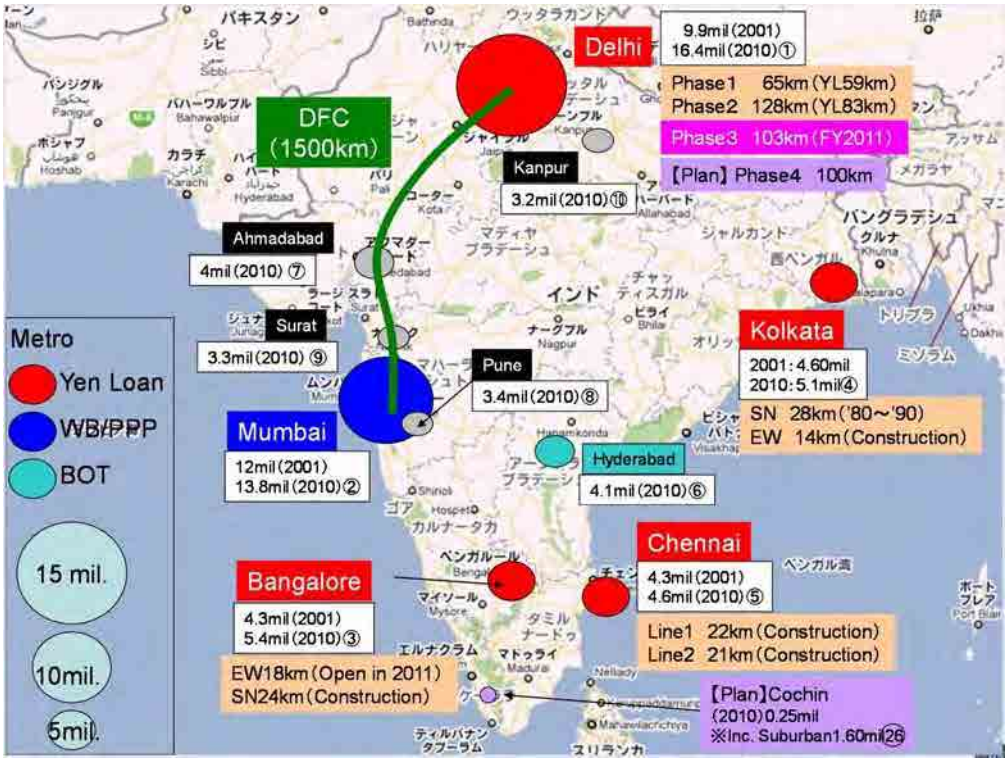
The reputation of Japan's HSR for safety, punctuality, passenger comfort, and customer service are well known. Its reputation for its skilled manpower is also highly regarded, with Japan's HSR placing great importance on staff training to ensure safe operation. Moreover, the level of technological research and development and the synergies achieved from the planning to the operation stage between the relevant government and private bodies are of the highest order. Therefore, it is expected that Japan's cooperation on HSR will include not only financial and technical support but also cooperation on capacity development.

2.2 Japan's Policy on Cooperation on HSR to India

2.2.1 International Assistance for Indian Railway Sector

Below, in Figure 2-7, the status of international assistance to the Indian railway sector is indicated.

5 Results of hearings of IR and RDSO participants at JICA Study Tour in Japan in December 2011



Source: JICA

Figure 2-7 Cooperation for Major Railway Projects in India

(1) Japan

The main objectives of Japanese assistance to India are: (1) promotion of economic growth (power, transportation, etc.), (2) reduction of poverty and environmental degradation, and (3) human resource development and interpersonal/intellectual exchanges.[6] The Japanese Ministry of Foreign Affairs (MOFA) has been focusing on the six major metropolitan areas of India regarding matters such as the promotion of local economic development and the environment via measures such as the alleviation of traffic congestion and air pollution, improvement of the urban environment via assistance with the implementation of mass rapid transit systems and ring roads, etc.

Moreover, MOFA has been also focusing on the industries of SEZs and economic corridors located between the six metropolitan areas (including the Delhi-Mumbai Industrial Corridor), with the aim of promoting regional development, efficient logistics, foreign capital to expand investment opportunities, and support for infrastructure development such as rail, arterial roads, large-scale airports and ports.[7]

6 Ministry of Foreign Affairs "Country Assistance Program for India", May 2006
7 Ministry of Foreign Affairs "Country Assistance Program for India", June 2011

(2) Asian Development Bank (ADB)

ADB decided to provide up to $500 million in multi-tranche financing (25 year repayment period, 5-year grace period) to support the US$ 1.1billion ”Railway Sector Investment Program” of MOR, which is a program to extend existing routes, carry out multi-tracking and electrification, and build new signaling systems. The Indian government is responsible for a further $440 million on top of the ADB investment.[8]

(3) World Bank

With the assistance of the World Bank, the Mumbai Urban Transport Project is an investment worth a total of 45.26 billion rupees (about $943 million) and aims to increase train frequency, carry out multi-tracking, increase speed and introduce new coaches to enhance transportation capacity and relieve congestion (the objective is to reduce the number of passengers in 9-car trains to less than 3,000). Moreover, the Indian Ministry of Finance announced on 27 October 2011 that the World Bank had signed an agreement to provide $975 million in funding for railway construction to be executed by the Dedicated Freight Corridor Corporation of India.[9]

2.2.2 Key Technical Cooperation Issues in the Railway Sector

(1) JICA’s Key Technical Cooperation Issues

“JICA Key Issues in the Railway Sector” was published in March 2010 and the objectives and measures given for the railway sector are as indicated in Table 2-4.

Table 2-4 Major Objectives & Measures for Railway Sector (National Transportation)

Sector	Objective	Interim Objectives	Sub Objectives	Major Measures
National Transportation	Balanced National Development	Improvement of Rail Transport	● Development of Trunk Railway Lines ● Strengthening of Maintenance Skills ● Establishment of Technical Specifications and Standard-ization ● Improvement of Business Management/ Privatization	● Formulation of National Transport M/P ● Development & Rehabilitation of Track and Maintenance Shop ● Provision of Rolling Stock ● Establishment of Technical Standards ● Technology Transfer related to Rationalization and Privatization of National Railway Management (dispatching experts, training in Japan, etc.)

Source: JICA

8 ADB: “$500 million in funding for Indian Railway Development”, September 2011
http://beta.adb.org/news/adb-500-million-loan-boost-indian-railways-jp

9 Compiled from various reports

(2) JICA's Assistance Schemes

JICA has the following tools and experience for providing assistance that can be leveraged for HSR projects in India. By combining the various tools and know-how, assistance both upstream and downstream for projects is possible and the full advantages of Japanese technology can therefore be realized.

i) Experience in every aspect of project execution, both upstream and downstream, including the formulation of master plans, design, construction, maintenance and management.

ii) Extensive project experience in both the hard and soft aspects of tracks, vehicle, systems, repair plant maintenance, transportation management/systems, operational guidance, personnel training, development of technical standards, etc.

iii) A variety of funding tools, including Grant Aid, ODA Loans, Private Investment Finance, etc.

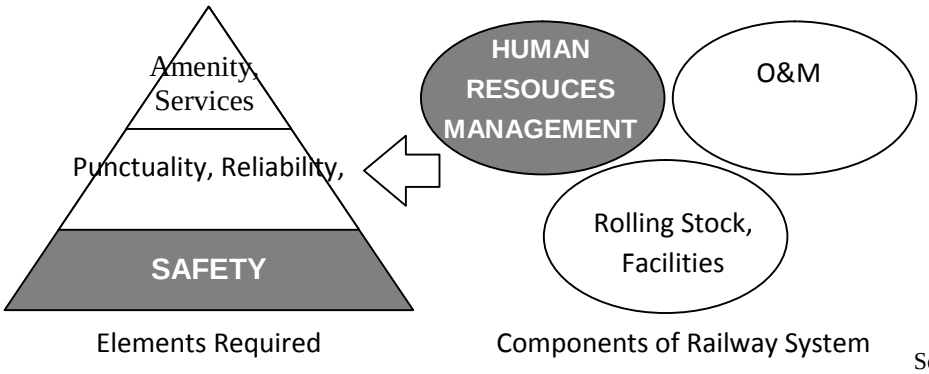
iv) Human resource development tools, such as the dispatch of experts for technical cooperation and training, including field visits to understand and appreciate the Japanese HSR system.

v) Connections with railway industry officials, including government agencies, financial institutions, business, manufacturers, trading companies, contractors and consultants.

2.2.3 Major Targets for Support of the Railway Sector

(1) Importance of Human Resource Development

Examining vehicle manufacturing plants with high production (technological) capabilities is important in order to better understand the possibilities for future technology transfers related to vehicle manufacturing in India. Organizational and human resource capabilities are also essential for effective technology transfer and as Figure 2-8 indicates, to make railway systems function safely and effectively.



Source: JICA

Figure 2-8 Importance of Human Resource Development

(2) Importance of Comprehensive Support

JICA assists countries to utilize a variety of capacity development tools in order to improve their organizational systems and human resource capabilities. Table 2-5 summarizes the expected benefits of JICA's comprehensive support which begins in the preliminary study phase of a project, and continues until the construction and smooth operation of the railway system.

Table 2-5 Examples of JICA's Comprehensive Cooperation Scheme

Stage	Scheme	Cooperation Program	Expected Benefits
Technical Cooperation	Formulation of M/P and F/S	Formulation of M/P & Long-Term Development Strategy Establishment of Technical Standards & System Specifications	Strengthening of Business Management Capacity Support on Establishment of O&M Companies Promotion of Introduction of Technical Standards
	Capacity Development, Improvement of Organization Structure	Dispatch of Experts to Attend Seminars & Training in Japan	Capacity Development of Local Railway Officials Establishment of Technical Training Programs Building of Training Facilities Utilization of Technology (Safety Management)
	Provision of Equipment	Provision of Rolling Stock, Provision of Training, Equipment, etc.	Promotion of Railway Systems Utilization of E&M Technology
Financial Cooperation	ODA Loan	Assistance on Design, Procurement and Bidding Construction Supervision	Civil Construction, Rail Development Utilization of Civil & Electrical Technology
		Export of Rolling Stock Assistance for Improvement of Rolling Stock Manufacturing Construction of Depot and Factory	Promotion of Railway Systems Utilization of E&M Technology

(JICA Survey Team)

2.3 Foreign Interest in HSR Development in India

Indian HSR plans will be a big object of interest for international HSR operators, consulting firms and governments where HSR is operated. Countries that have shown interest are Japan, China, Korea, Spain and France. However, no loan or credit arrangements have yet been finalized. The current status of international donors and relevant bodies, as well as funding of Indian HSR plans, could be the subject of a further survey.

3. TRENDS & FEATURES OF JAPANESE HSR TECHNOLOGY

3. TRENDS & FEATURES OF JAPANESE HSR TECHNOLOGY

3.1 Concepts & Key Technologies of Japanese Shinkansen

As indicated below, from a permanent way perspective, there are two kinds of high-speed rail (HSR) systems.

- Dedicated Line: Consists of building new exclusive lines for high speed rail, which is capable of meeting growing passenger demand, allowing for a transition of passenger traffic from conventional lines and the use of conventional lines for more cargo transportation, resulting in a dramatic increase in the capacity of passenger and freight transportation.
- Use of Conventional Line: Consists of making improvements to conventional line track so that high-speed operation is possible, resulting in a transfer from other means of transportation due to shorter travel times.

Dedicated Line

The Shinkansen system, which was the pioneer of HSR, is a dedicated-line system. In HSR, the top priority is to eliminate the collision of two trains or the collision of a train with another object, such as a road vehicle at a level crossing, as a tragic accident such as this would result in many people being killed and injured. The Shinkansen system is based on the concept of eliminating collisions by using grade-separated "dedicated track" for high-speed passenger service and an advanced "train protection system" known as ATC (Automatic Train Control system). In addition, unauthorized persons are prohibited from entering the track right-of-way by law. These key factors have enabled the Japan Shinkansen to continue its record of "zero" passenger fatalities since the start of its revenue service over 47 years ago.

Integration with Transport Network & Adjacent Areas

The following policies have also encouraged the expansion and successful development of the Shinkansen network in Japan:

- Integration with urban transportation networks to ensure that the Shinkansen is capable of providing riders with seamless connections that will bring them to there ultimate destination.
- Integration with surrounding areas that includes the development of Shinkansen stations and adjacent real estate to provide new services to riders and communities that also enhances the revenue and sustainability of the Shinkansen.

Shinkansen Technologies

The introduction of the "EMU", a lightweight wide-body railcar, has provided large transport capacity

to the Shinkansen and is robust in the event of a failure and is capable fast acceleration and deceleration. With the EMU's light axle load, it also contributes to the reduction of infrastructure costs. In conjunction with this, the following has been adopted to ensure high-density stable operation:

- Unification of train operation
- CTC (Centralized Train Control)
- The separation of operation & maintenance

Shinkansen Legacy

The Shinkansen system established a new concept for railway systems at the time of its inception by introducing the latest technologies and epoch-making concepts in realizing the world's first high-speed rail system. To this day, it proudly continues to be a world leader in HSR, providing the highest levels of safety, stability, transport efficiency and energy savings. The Shinakansen links people, services, and jobs over different regions and has stimulated economic development and synergy. Recently, dedicated-line and electric-railcar systems have been adopted in Europe, but Japan's system still has greater advantages owing to its greater experience and accumulation of knowhow.

3.2 Advantages of Shinkansen Systems

(1) High Safety/Stability

With its dedicated lines, high-performance safety systems, and separate operations and maintenance systems, Japan's Shinkansen is the world's safest (zero passenger fatalities in more than 45 years of operation) and most reliable (average of less than 1 minute delay per train) high-speed train.

2) Efficient Mass Transit

With its large capacity and high frequency operation (a 4-minute headway during peak times with a turnaround time of 12 minutes), the Japanese Shinkansen is unmatched in the world in providing efficient high-speed mass transit operation. Moreover, in order to further increase capacity, double-decker Shinkansens have also been put into operation.

3) Low-Cost Civil Infrastructure

Owing to the lighter axle load of carriages, it has been possible to reduce the cost for civil infrastructure. Moreover, due to the high acceleration and deceleration capabilities of the Shinkansen, as well as to its superior ability to negotiate curves, it has exceptional capability in dealing with sharp turns in city centers and up-and-down gradient changes. Also, with its unique fire prevention measures, tunnel diameters for double-tracked sections have been reduced resulting in lower construction costs.

4) Environmental Sustainability via Technological Innovation

By improving car-body structure and ground facilities, operation speeds have been increased while clearing Japan's strict environmental standards (noise, vibration etc.). The high-level technologies used to achieve this have also contributed to high-speed operation in cities and tunnels and lower construction costs.

5) Energy-Efficient & Eco-Friendly

Owing to the Shinkansen's light-weight carriages and superior traction circuit and regenerative braking system, its system has the lowest CO2 emissions and energy consumption in the world.

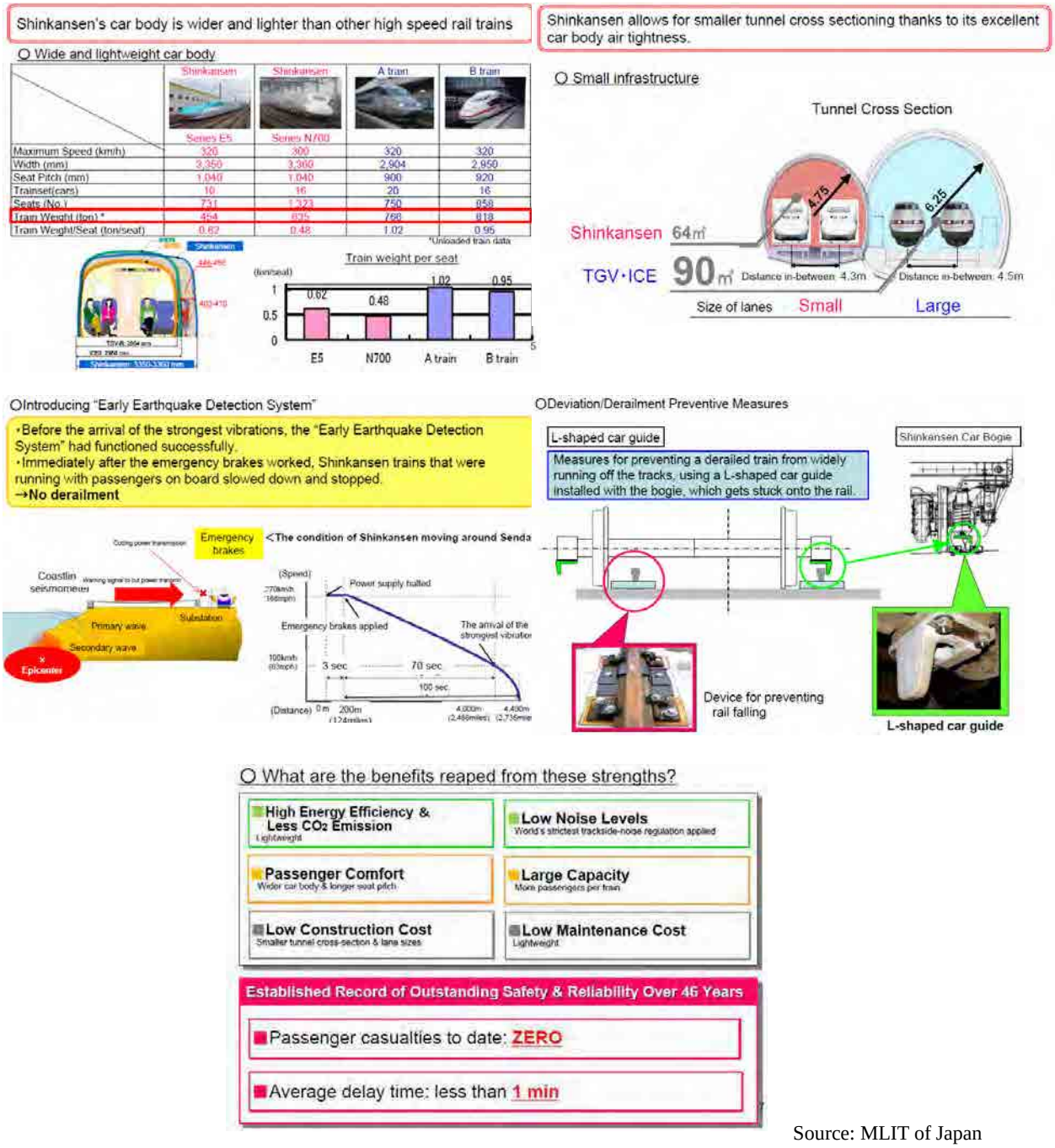
6) Service Quality

Owing to the Shinkansen's spacious wide body, there is ample room for passengers to relax and includes facilities such as reclining and rotating seats.

7) Technology for Use of Conventional Lines

The Shinkansen is basically a comprehensive transportation system designed to run on dedicated lines. However, it can run on conventional lines like the HSR trains in Europe and is a well-established technology in Japan.

Japan's MLIT has published the "Comparative Advantages of the Shinkansen", which indicates the strengths of the Shinkansen system, and is given below for reference.



Source: MLIT of Japan

Figure 3-1 Comparative Advantages of Japan's HSR Technologies

The Shinkansen's integrated system technologies are supported by superior elements and these are listed below.

- Civil Works/Track System: Slab track and an earthquake detection system with an emergency shut-down function.
- Rolling stock: Light-weight railcars that are airtight and environmentally friendly, with high driving performance capability on steep grades. They also have auto-rotating seats, coupling

and decoupling functions, and the capability of through-operation to conventional lines.

- Power/Signal/Communications System: AT power system, pattern control digital ATC system, train management system, and digital LCX.
- Ticketing: Auto-ticketing technology
- Maintenance and Command System: Separation of operations and maintenance functions, multi-purpose high-speed inspection trains, monitoring and OCC (Operation Control Center).

3.3 Current State of Railway Technology in India & the Need for HSR

3.3.1 Current State of Railway Technology in India

(1) Indian Railways

Indian Railways (IR) was established in 1853 and is currently one of the largest railways in the world with over 64,000 km of track and some 1.4 million employees. Furthermore, IR is planning to expand its transport capacity and currently is involved in numerous large-scale projects.

Unfortunately, much of IR's equipment is old. Currently, approximately 30 percent of its tracks are electrified, with most trains being pulled by electric or diesel locomotives. In regards to the train protection system, which is the most important element for safe train operation, there are trial installations of the Train Protection Warning System (TPWS). This is approximately the same level of equipment used for ATS-P, which is the main system used on conventional railways in Japan. However, only the major urban areas, such as Delhi, Mumbai and Kolkata, use automatic blocking systems based on track circuits, and the absolute blocking system, which blocks sections between stations, is the most commonly used on IR lines. Since there is not a sufficient amount of protection equipment, operation depends on the diligence of the station staff and train drivers. Because of this, large-scale train accidents are a common occurrence. In particular, there are many accidents at level crossings, and it is not rare for the window glass of express trains on conventional lines to be broken by flying stones. Such phenomena must be eradicated in the case of HSR as the consequences could be catastrophic.

Table 3-1 Train Accidents on Indian Railways

Year	Collision	Derailment	L-Xing accidents	Fire in train	Total	Incidence of accidents per million train kms.
1960-61	130	1415	181	405	2131	5.50
1970-71	59	648	121	12	840	1.80
1980-81	69	825	90	29	1013	2.00
1990-91	41	446	36	9	532	0.86
2000-01	20	350	84	17	473	0.65
2001-02	30	280	88	9	415	0.55
2002-03	16	218	96	14	351	0.44
2003-04	9	202	95	14	325	0.41
2004-05	13	138	70	10	234	0.29
2005-06	9	131	75	15	234	0.28
2006-07	8	96	79	4	195	0.22
2007-08	8	100	77	5	194	0.21
2008-09	13	85	69	3	177	0.20

Note: *The total also includes accidents under the miscellaneous category apart from the four categories shown in the table.*

Source: VISION 2020

(JICA Survey Team)

Figure 3-2 Express in Operation with Window Broken by Flying Stones

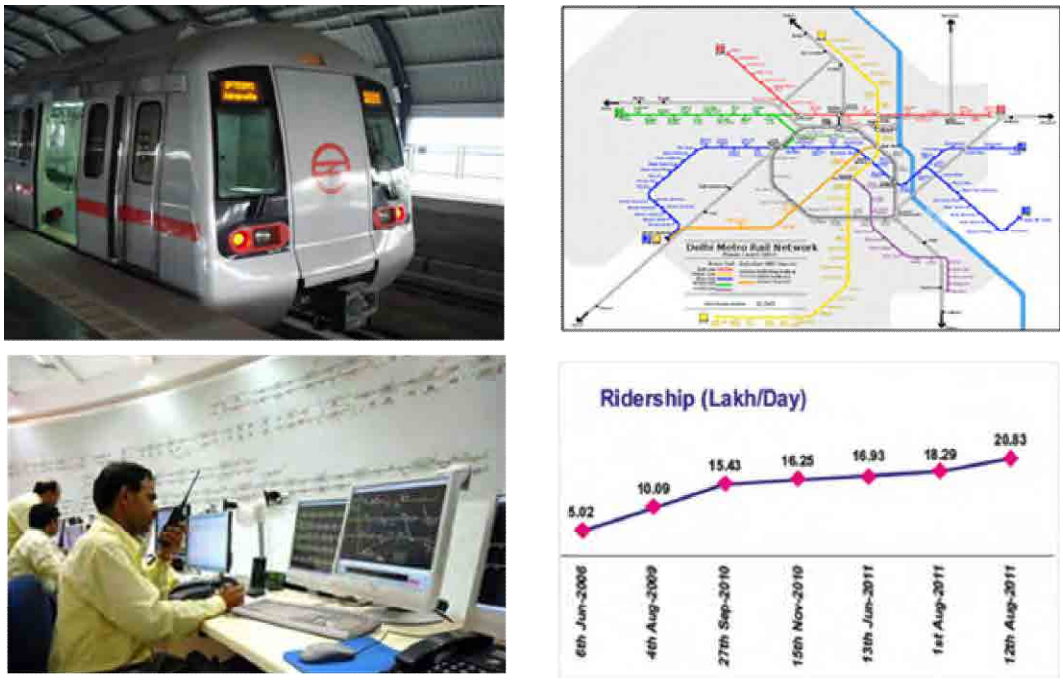
(2) Metro Systems in India

In order to establish a public mass transit infrastructure that can help relieve road congestion in India's major cities, metro projects are currently underway in such cities as Delhi, Mumbai, Chennai, and Bangalore. As of February 2012, there are operating metro systems in Delhi, Kolkata and Bangalore. In particular, the Delhi Metro system is often cited as an example of success within India in that the number of passengers is increasing and the network is expanding. This is having a major positive effect on projects in other cities.

Construction of the Delhi Metro started in 1998. The Delhi Metro Rail Corporation (DMRC) was established and after a smooth construction period this system opened for revenue service in 2002. In

addition, it surpassed the technological level of conventional lines in IR by introducing the latest railway technologies such as EMU, ATC systems and OCC (Operation Control Center). These technologies enabled the current level of stable operation that offers high-density 3-minute headway during peak demand hours.

In regards to track gauge, there was some discussion about whether the Delhi metro should operate on conventional track and as a result the initial operation (Phase 1 -- Line1, 2 and 3) began with broad gauge (1676 mm) track. However, after various discussions, the conclusion was that Phase 2 would use standard gauge (1435 mm) track. In addition, standard gauge track would be used in future by the metro systems in the other major cities of India.



Source : Delhi Metro H.P.

Figure 3-3 Outline of Delhi Metro

(3) Rolling Stock Manufacturing Technology

There are five factories in India related to the manufacture of rolling stock, such as RCF (Rail Coach Factories) under the auspices of the Ministry of Railways. In addition, the manufacture of metro rolling stock is also being performed at BEML (Bharat Earth Movers Limited) under the auspices of the Ministry of Defense.

On-site investigations of RCF, BEML and ICF (Integrated Coach Factory) were conducted. Most of the rolling stock currently used for IR passenger cars and metro rolling stock are made from thick sheets of

stainless steel and, with the exception of some freight cars, aluminum (the material assumed to be used for HSR) is not used.

RCF is the main factory for manufacturing the thick-plated stainless steel passenger cars for IR. It has very little experience in handling specialized electric components and electrical wiring used in the manufacturing of electric railcars. In addition, there are major technological issues, such as large amounts of distortion when the stainless steel is welded.

ICF and BEML manufacture metro rolling stock and have the technological know-how for manufacturing EMU, including the handling of electrical components and wiring. In addition, the technology for welding the thick stainless steel plates appears to be to a specific standard.

If these factories were to be used for manufacturing HSR rolling stock, there would first be a need to improve the accuracy of electrical wiring and bogie fabrication by building on the experience gained from the manufacturing of electric rolling stock for metro applications, as well as a need to learn skills that would contribute to quality. Furthermore, there would be a need to clear the even bigger hurdle of acquiring manufacturing skills needed for welding aluminum, which is more difficult than welding stainless steel, and fabricating high-precision high-speed bogies.

3.3.2 The Need for Indian HSR

India continues to experience one of the most rapid levels of economic growth in the world, and demand for railway transportation is expected to increase significantly, both in terms of passengers and freight. In addition, under the “India Railway Vision 2020”, railways have been positioned as “a vehicle of inclusive development and national integration”, and in order to meet the expected increases in transportation demand, it is believed that there will need to be a separation of passenger and cargo, along with an expansion of the rail network and increases in transport capacity. This vision also includes the following key issues.

- Network Expansion
- Capacity Creation
- Train Safety– Zero Tolerance for Accidents
- Reducing IR’s Carbon Footprint

In respect to high speed rail, the following has been noted:

- Increase in speed of regular passenger trains to 160-200kmph on segregated routes.

- Construction of at least 4 HSR lines to provide bullet train service at 250-350kmph, with plans for at least 8 more corridors. Six corridors have already been identified for pre-feasibility studies.
- Construction and operation of high speed lines is, however, very expensive and would require capital infusion and passenger patronage of a very high order. Massive capital investment would necessitate running of trains at frequent intervals of 5-10 minutes with sufficient load factors.

Based on the above statements and survey findings, India is headed in the direction of developing dedicated track for HSR passenger service with the characteristics of being safe, eco-friendly, and supporting mass transit, which is believed to be a direction for which the advantages of Japan's Shinkansen systems will be demonstrably superior.

3.4 Selection Process for HSR Systems

At the present, Indian Railways is proceeding with pre-F/Ss for 6 HSR corridors. The NHSRA, which will act as the promoter of Indian HSR projects and formulate its technical standards, is planned to be established in the near future. In addition to these 6 corridors, the Minister of Rail in his budget speech on 14th March 2012 proposed that another corridor (i.e., the Delhi-Jaipur-Ajmer-Jodhpur corridor) be taken up and that a study on this executed within the year. Moreover, the budget for HSR Line 1 is in the finalization stage.

In the first field survey by the JICA Survey Team, the Team obtained useful information that the technical standards for HSR have not yet been decided and NHSRA will decide them in consultation with the RDSO upon a review of the pre F/S reports for the 6 HSR corridors.

Thus, the most important thing is that the strengths of the Japanese Shinkansen system should be well appreciated by NHSRA and RDSO from the pre-F/S reports so as to enable NHSRA to adopt the best technology for the HSR system in India.

3.5 Shinkansen Best Solution for Indian HSR

3.5.1 Technical Innovation

As stated earlier, there are two types of HSR: one using "dedicated track" and one using "conventional track." From the standpoint of safety, the top priority for HSR, the major assumption when using conventional track is that its level of safety is sufficient for high-speed operation. However, based on the current conditions in IR, it cannot be said that its conventional track satisfies this level of safety.

When constructing a new HSR, the maximum effect should be achieved by introducing the latest proven technological systems. Establishing a system that is independent of technology used for conventional lines is the best way of achieving this. For example, one of the most important factors behind the successful development of the Delhi Metro was that it was not bound to the technological levels of the conventional lines and was free to introduce new and effective systems. "Innovation and leapfrogging" from outmoded conventional railway technologies are imperatives when planning a HSR system. That is the reason a “dedicated line” is essential for HSR in India.

3.5.2 The Priorities of the Shinkansen System

(1) Safety– Zero Tolerance for Accidents

The most important point of the Shinkansen system is that it is the safest HSR system in the world. This has been achieved by applying the basic concepts of having its track separate from that of conventional lines and eliminating all level crossings, as well as applying key technologies such as advanced "train protection systems." No system in any other country can approach the safety record of the Shinkansen and its “zero” fatality record since its start of revenue service over 47 years ago.

(2) Network Expansion

The Shinkansen network has been steadily expanding in Japan. It started in 1964 with a 515 km section between Tokyo and Osaka and now has a total network length of 2,388 km. In addition, technology has also been developed that enables high-speed trains to travel on conventional sections of track (at a maximum speed of 130 km/h). This was introduced for approximately 150 km of track in Yamagata in 1992 and for approximately 130 km of track in Akita in 1997.

(3) Capacity Creation

The Shinkansen uses a wide-body EMU that enables it to carry large numbers of passengers. When combined with the maximum 4-minute headway, it provides a transportation capacity that cannot be seen anywhere else in the world. This high train operation efficiency will also contribute to lower operation costs.

(4) Reducing Carbon Footprint of Indian Railways

In addition to the large transport capacity and lightweight railcars of the Shinkansen, its propulsion and regenerative braking system also give it the best energy-saving performance in the world.

(5) Technology for Withstanding Earthquakes

India, and in particular northern India, has frequent earthquakes. It is important that any HSR that

makes safety its top priority be able to take countermeasures to deal with earthquakes. The Shinkansen system has established systems for the early detection of earthquakes at the wayside and developed technology to help prevent trains from derailing. The effectiveness of these systems has been proven even when there have been major earthquake disasters.

Based on the preceding, it is clear that the Shinkansen system would be the best technical solution for India's HSR. However, in order to propose the best application of Japanese Shinkansen technology, more information will need to be gathered and examined.

3.5.3 Comparison of World's HSR Technology

A comparison of Japanese, French, Italian, Spanish, and Chinese HSR technologies are given in Table 3-2. As the table indicates, the weight of the Shinkansen, which utilizes light-weight EMUs, is significantly less than the weight of other HSRs and is therefore more efficient. That is, the lighter Shinkansen results in lesser loads on civil engineering structures and therefore contributes to reductions in infrastructure costs as well as to lower operating expenses. For reference, the maximum axle loads for Japan and Europe as are follows:

■ Maximum Axle Load

Japan: About 13t Europe: 17t is a standard usually applied

In addition, the wider railcar of the Shinkansen enables greater transport capacity and its air-tight sealing and superior aero-dynamic technology enables the distance between the centers of track and the cross-sectional areas of tunnels to be relatively small as indicated below.

■ Distance between centers of tracks

In Japan: 4.3m is the standard In Europe: 4.5m～4.8m is widely used

■ Cross sectional areas of tunnels

In Japan: 63.5m^2 is the standard In Europe: 80m^2～100m^2 is widely used

Finally, the Shinkansen consumes significantly less energy than its competitors, as can be seem from the power per seat, and is due to factors such as lighter rolling stock, the shape of the rolling stock, and differences in the performance of the propulsion and brake systems. In recent years, HSRs in other countries have been making the transition to light-weight aluminum, but the Japanese Shinkansen system has maintained its superiority due to its long experience and accumulated knowhow.

Table 3-2 Efficiency of Typical High-Speed Trains

Series		N700	E5	E4	TGV-R	TGV-D	AGV11	Velaro E	Velaro CHR3	Zefiro V300	Zefiro 380
Country		Japan	Japan	Japan	France	France	Italy	Spain	China	Italy	China
Supplier		Hitachi/ Kawasaki/ Nippon Sharyo			Alstom			Siemens		Bombardier	
Max. Op. Speed (km/h)		300	320	240	320	320	300	300	350	300	350
Train length(m)		404.7	253.0	201.4	200	200	200	200	200	202.0	215.3
Train width(mm)		3360	3350	3380	2904	2896	2900	2950	3260	2924	3328
Formation		14M2T	8M2T	4M4T	2L8T	2L8T	6M5T	4M4T	4M4T	4M4T	4M4T
Type		EMU	EMU	EMU	Loco	Loco	EMU	EMU	EMU	EMU	EMU
Single / Double-deck		Single	Single	Double	Single	Single	Double	Single	Single	Single	Single
Passenger Capacity	1st & Business	200	55	54	120	197	97	141	66	N.A	N.A
	Economy	1123	658	763	257	348	349	264	491	N.A	N.A
	Total	1323	731	817	377	545	446	406	557	600	664
Train weight :Tare (ton)		635	452	428	383	380	384	439	447	500	462
Max. Axle load (loaded)		11.2	13.1	15.9	17.0	17.0	17.0	17.0	17.0	17.0	17.0
Power : Train (kW)		17000	9600	6720	8800	8800	9400	8800	8800	8800	9800
Train length/seat (m/seat)		0.306	0.346	0.246	0.522	0.367	0.448	0.493	0.359	0.337	0.323
Train weight/ seat(ton/seat)		0.480	0.618	0.523	1.016	0.697	0.861	1.081	0.802	0.833	0.695
Power / seat (kW/seat)		12.85	13.13	8.23	23.34	16.15	21.08	21.67	15.80	14.66	14.83

(JICA Survey Team)

3.5.4 Conditions for Introducing the Shinkansen System

(1) Utilization of a Wide Railcar

The Shinkansen uses a wide railcar that is 3400 mm in width. The E5 series Shinkansen has a seat width of 440 mm in a 5-seat-per-row configuration and an aisle width of 570 mm. European standards for rolling stock make a 5-seat-per-row arrangement impossible. Note that it is the Shinkansen's wide railcar that gives it overwhelming superiority in transport capacity.

Rolling stock clearance for conventional lines in Indian Railways is 3250 mm, which is even narrower than the Shinkansen itself. Here, a 5-seat-per-row arrangement is being considered, but if the same seating arrangement as that of the E5 series is used, the aisle width would become 470 mm. On the other hand, the LHB coach used on the conventional lines of Indian Railways has an aisle width of 451 mm, so the seating arrangement of the E5 series could be used if minor modifications are made. However, if in the future a 6-seat-per-row configuration like that of the Shinkansen's E4 series, which operates double-decker cars and was developed in Japan for high-speed and high-volume commuter travel, is to be used then it would be desirable to have a rolling stock clearance of 3400 mm. This means operation on conventional track is not possible.

(2) Disadvantages of Broad Gauge Track (1676mm)

Standard gauge track (1435 mm) is commonly used for HSR and broad gauge track (1676 mm) is not in service anywhere in the world. If broad gauge track is used, it would be necessary to develop a new type of high-speed bogie. Using wider track gauge means that wheel-sets would also have to be wider, which would require that the wheel-set and bogie frame be dramatically strengthened. This, in turn, would require that the entire bogie design be re-evaluated. While conventional knowhow could be used in this new wide bogie design, extensive amounts of time would be required for validation testing of the dynamic functions and durability strength of the new design. Furthermore, new facilities would have to be built for the high-speed testing of this new bogie design. When these factors are considered, the introduction of a broad gauge bogie would create issues in that a lengthy development period together with its accompanying costs would be required.

(3) Crashworthiness

The Shinkansen system eliminates the potential for collision by using dedicated high-speed track without any grade crossings together with highly reliable train protection systems. When the potential for collision is eliminated, collision countermeasures for railcars can be minimized.

On the other hand, if collision safety needs to be considered, crushable zones must be established in the

cars along with a design that enables the coupler and draft gear to absorb the impact of a collision. In addition, creating a survival zone requires a structure that cannot collapse. A railcar strong enough to withstand a collision results in a heavier and less energy-efficient structure.

The use of the Shinkansen concept, which eliminates the potential for collision, provides high energy efficiency that contributes to lower operating costs and enables a compact infrastructure that will reduce construction costs.

(4) Regulation of Train Protection System

The digital ATC system is the main type of train protection system used in the Shinkansen system today. In contrast, the protection system used for existing HSR in Europe differs from country to country. Currently, progress is being made in the introduction of a European Train Control System (ETCS), which would be a common system to enable interoperability. The following three levels have been prepared to help make the introduction of ETCS easier.

Level 1: Trains are detected with existing track circuits and existing signaling equipment remains. Ground coils, called "Euro Balise", verify speed that corresponds to the current display on the signal.

Level 2: Trains are detected with existing track circuits and information relating to the current signal display is transmitted from the wayside to trains by a Global System for Mobile communications - Railway (GSM-R).

Level 3: There are no wayside signals, track circuits or other such equipment. Trains are detected by high-speed transmitters and GSM-R conveys this information to the wayside, which is the basis for train control. This arrangement reduces wayside equipment and enables moving block train control.

In practice, Level 2 is currently being used. From a functional standpoint, this system is nearly the same as the digital ATC in Japan. However, one major difference is that digital ATC uses track circuits for passing information between the wayside and trains while the ETCS Level 2 uses GSM-R, a dedicated railway radio. When using a broadband radio such as GSM-R, new technologies for encryption and confirming integrity are necessary. From this point, local radios such as track circuits and transponders offer higher levels of safety and reliability, which has enabled the Shinkansen to provide safe and stable transport under high-density operation. The Advanced Train Administration & Communication System (ATACS) developed by JR East in Japan is the equivalent of ETCS Level 3, and a 400 MHz radio wave is utilized for this system and has seen use under actual conditions.

Based on the preceding, Japanese manufacturers are in no way inferior to those in Europe. Therefore, Indian Railways should not limit applicable standards, but rather should encourage competition from a wide range of systems and take a decision taking into account actual performance specifications.

3.5.5 Management Technology & Human Resource Development

To realize an integrated high-speed rail system a wide range of areas, from planning (system and route selection) to design, construction and operation/maintenance, including human resource development, financial planning, etc., must be considered. In the previous section the main required hardware was summarized. However, the success of a system depends mostly on the operating and maintenance elements that come after construction. On this point, the excellence of Japan's Shinkansen system can be judged by its incomparable safety record of "zero passenger fatalities since operations began", and its reliability with "intervals between trains being as little as 4 minutes with an average delay of less than 1 minute". That is, the operational expertise of railway companies and their human resources, together with technology transfers, are vital keys to the success of any HSR system. However, software-based technologies cannot stand on their own absent quality hardware. Japan's HSR is successful owing to its ability to effectively combine both the software and hardware aspects of its system.

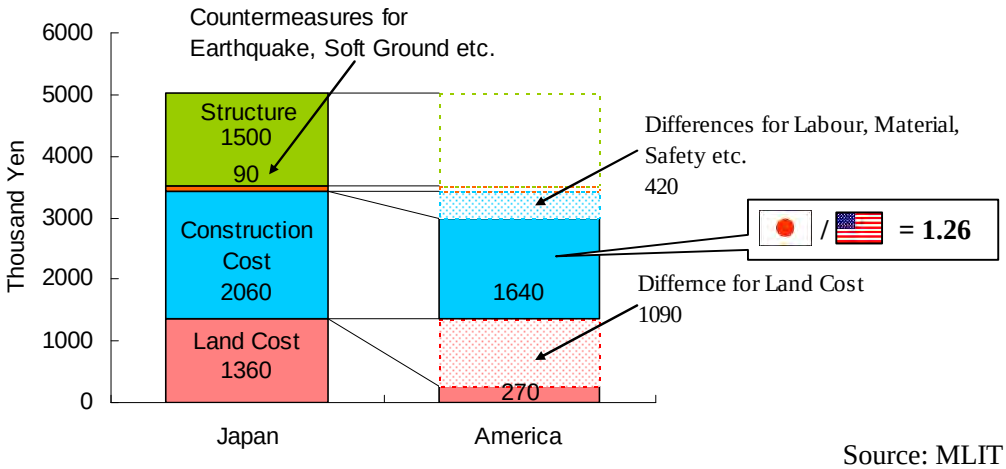
3.5.6 Advantages of Dedicated HSR as Compared to Semi-HSR on Conventional Lines

When the technological factors for semi high-speed service of about 200 km/h on conventional track and those for high-speed service on a dedicated track are considered, there is no major difference in the E&M systems. Factors affecting speed would be the minimum curve radius of the track alignment and the amount of distance between the centers of track. In particular, when it is assumed that level crossings will have to be removed for safety as part of the improvements for the conventional track, there are going to be substantial costs. While there is no need to acquire right-of-way, construction costs using existing conventional track will be quite large as there will be difficulties during construction as revenue service will need to continue. Moreover, when other factors are taken into consideration, such as construction standards, maintenance and restrictions on operating diagrams that all will arise because of the differences in the performance and weights of the trains, the use of conventional lines for semi-high-speed service is not beneficial from the standpoint of cost performance. Based on the needs of IR, which are increasing transport capacity and expanding its network, introducing dedicated HSR should be given a higher priority.

3.5.7 Comparison of the Cost for Civil & Structural Works

The civil structures of the Japanese Shinkansen system are cost competitive and this is due to features such as the light-weight body, shape of the lead-car's nose, etc. of rolling stock operating on dedicated

track. On the other hand, there is a general perception that Japanese construction costs are some of the most expensive in the world. This is due to the fact that a large part of Japan's project cost is comprised of high land-acquisition costs and costs for countermeasures to deal with earthquakes, soft ground, etc. This, and differences in costs for materials and labor, result in higher Japanese construction costs. However, as shown in the figure below, if these differences (which are local-based) are accounted for, the construction costs of Japan are the same as those of the US and Europe.[1]

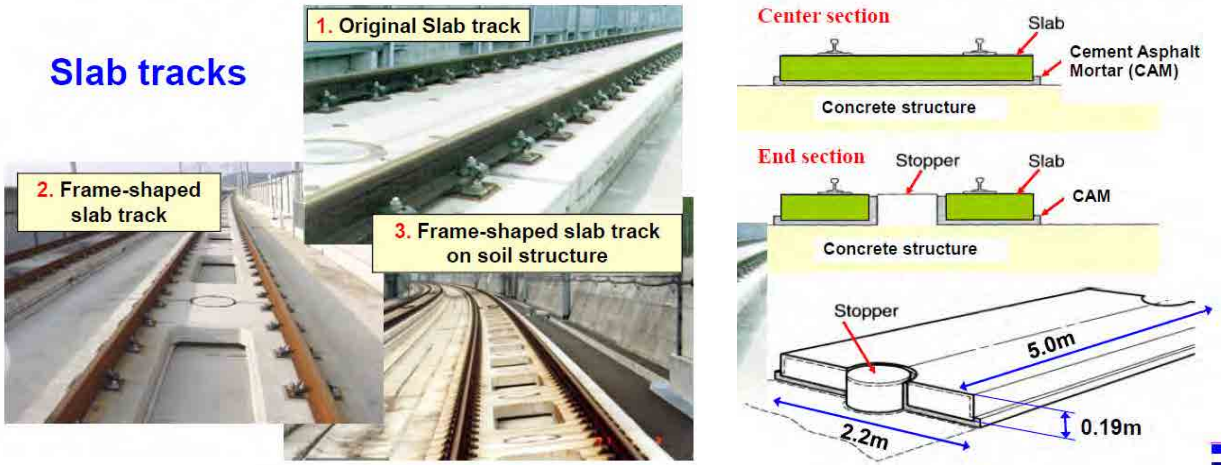


Source: MLIT

Figure 3-4 Breakdown of Construction Costs for Japan & US

3.5.8 Advantages of Slab Track

Slab track has been adopted for HSR in Japan (see Figure 3-5). Although its construction cost is higher, its maintenance cost is about 1/4 of that for ballast track. In addition, it also has excellent durability and therefore contributes to reducing the life-cycle costs of the HSR system.



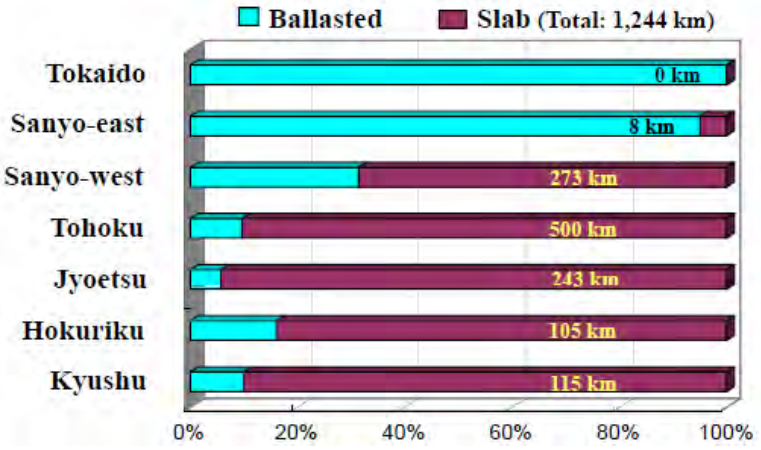
Source: RTRI

Figure 3-5 Outline of Slab Track

1 Source: MLIT

(1) Adoption of Slab Track by the Shinkansen

Slab track was adopted in 1972 (with the Sanyo Shinkansen Line) in earnest. Including the frame-type slab, it accounts for about 90% of newly constructed HSR lines at the present. Its service life is more than 30 years and there have been no reports of damage from cyclic loading of trains. However, there have been some reports of deterioration due to salt or frost damage in the harsher environments. Therefore, instead of a steel reinforcement bar, development of organic short fiber reinforced concrete is in progress.



Source: RTRI

Figure 3-6 Composition of HSR Track Structure in Japan

(2) Comparison of Ballast & Slab Track

1) Advantages of Ballast Track

The advantages of ballast track are low vibration and low noise due to the dispersion of load from the sleepers to the embankment. Note that the ballast structure has good drainage and low construction costs. In addition, compared to slab track, ballast track is easy to repair if damaged. That is, if there is large-scale damage caused by a natural disaster or the aging of the cushioning material, it takes much time to reconstruct the concrete structure. However, ballast track is much easier to repair. Furthermore, with the introduction of automated tamping machines in recent years, ballast track is even easier to maintain. In the case of the newest tamping machine, 2 to 3 people are needed for its operation and 1 to 2 people for monitoring, and 100m of conventional track can be completed in about 10 to 15 minutes.

Figure 3-7 MATISA ” B241” Tamping Machine

2) Disadvantages of Ballast Track

(a) Increase in Daily Maintenance

Ballast track is prone to displacement and in the case of HSR there is a problem that frequent maintenance would be required. There is thinking that the Tokaido Shinkansen, which runs along Japan’s most important economic corridor, should use slab track. However, this would require suspension of operation over a long period of time and is therefore not possible. Moreover, with recent innovations in automated track inspection and maintenance, the benefits of ballast track, which include noise reduction, are being re-considered so much so that the newest Shinkansen in Kyushu that opened in 2004 adopted ballast track on some of its sections.

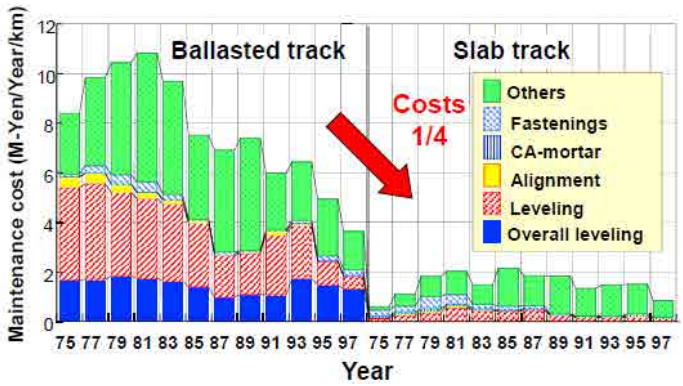
(b) Anti-Ice/ Snow

The undercarriage of a train is prone to icing in the snowy regions and ballast is sometimes kicked up by the falling ice that then causes damage to windows and car bodies. This was a frequent problem on the Tokaido Shinkansen until ballast shatterproof sheeting was laid. This problem does not occur in the case of slab track.

3) Advantages of Slab Track

(a) Less Maintenance

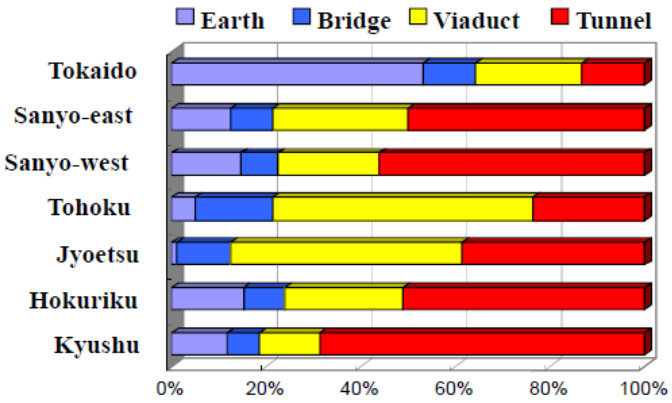
Ballast track requires frequent maintenance due to track deviation from the weight and vibration of the trains. Slab track, on the other hand, deviates less owing to its concrete slab; thereby, greatly reducing maintenance. In addition, because slab track is light weight, it is possible to reduce the dead load in the case of a viaduct.



Source: RTRI

Figure 3-8 Comparison of Maintenance Cost for Ballasted Track & Slab Track

For metros, tunnel structures occupy a large portion of the route, and therefore fastened track and slab track are often adopted to reduce maintenance and inspection. In the case of Shinkansen lines with large numbers of tunneling sections, slab track has also been adopted.



Source: RTRI

Figure 3-9 Composition by Type of Shinkansen Structure

(b) Anti-Ice/ Snow

In the case of snowy regions slab track is much preferred and the Sanyo, Tohoku and Joetsu Shinkansens have adopted it. Note that the track is also equipped with hot water sprinklers to aid in the melting of snow.

4) Disadvantages of Slab Track

(a) Difficulty of Large-Scale Repair

The construction cost of slab track is higher than that of ballast truck. Also, in the case of large-scale damage by natural disasters for example, the time and cost for operation recovery is much larger than that for ballast track. On the other hand, slab track requires almost no daily maintenance and depending on train operation frequency, labor, machinery and material cost for maintenance, structural conditions etc. its superiority as compared to ballast track will vary.

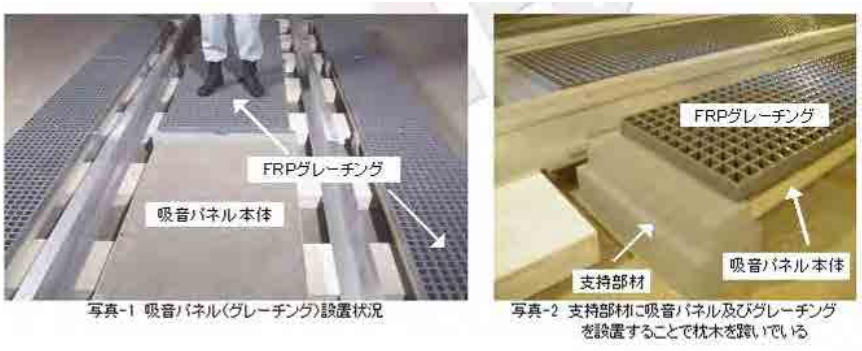
(b) Countermeasures for Noise

Unlike ballast track, there is no gap between the rails and roadbed to reduce vibration. Furthermore, noise is also bounced back and train noise and vibration increases both inside and outside of the train. Therefore, for noise reduction purposes, ballast track is sometimes laid in urban areas instead of slab track. There are cases on elevated conventional lines of elastic ballast track or a floating ladder track being adopted. Elastic ballast track mounts elastic material on the underside of pre-casted sleepers to reduce noise from viaducts. A floating ladder track is a longitudinal sleeper supported by a low-elasticity spring.

Source: JR Kyushu

Figure 3-10 Example of Anti-Noise Method (1)

In recent years, there have been noise-dampening improvements more effective than ballast.



Source: Tobishima Construction Corp.

Figure 3-11 Example of Anti- Noise Method (2)

(3) Conclusion

Slab track is a disadvantage in terms of initial costs but is excellent over the long term for maintenance cost savings. On the other hand, in the case of track being badly damaged, slab track is inferior to ballast track in terms of recovery time. Therefore, in order to determine which type of track is more suitable, it is necessary to consider a number of factors that include train operation frequency, maintenance cost, and natural conditions.

Table 3-3 Predominance of Slab Track

Item	Ballast	Slab
Construction Cost		Expensive
Construction Speed		Same
Durability	Poor, daily maintenance required	
Maintenance Cost	Daily maintenance required	Basically maintenance- free
Vulnerability for Disaster	Vulnerable to flooding	
Vulnerability for Ice & Snow	Special countermeasures required for ballast stability	
Disaster Recovery in case of Demolition		Long period required
Easiness of Reconstruction		Long period required

3.5.9 Seismic Reinforcement Technology

Japan, which is an earthquake-prone country, has long experience with seismic retrofit technology for existing structures, as well as with the seismic design of civil engineering structures. The design of civil engineering structures of the Japanese Shinkansen is based on railway facilities damaged by the Great Hanshin-Awaji Earthquake in 1995 and by the Mid-Niigata Prefecture Earthquake in 2004.

(1) Strengthening of Seismic Design Criteria

The Sanyo Shinkansen viaduct suffered serious damage in the Great Hanshin-Awaji Earthquake of January 1995. As a result, earthquake resistance standards for civil engineering structures were improved. The new seismic criteria after the Hanshin-Awaji Earthquake were set as follows:

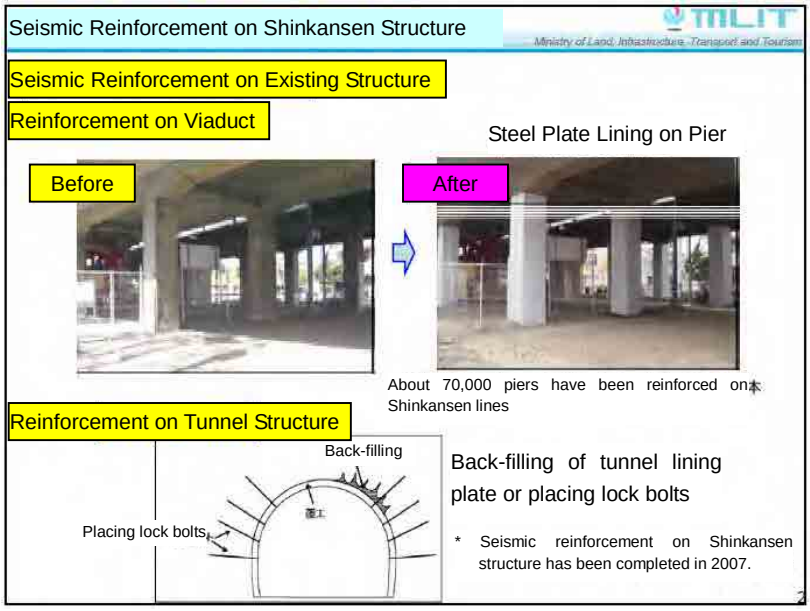
- For an earthquake of intensity 5 (moderate earthquake): No damage to structure
- For an earthquake of intensity 6-7 (large earthquake): Minor damage where quick functional recovery is possible

Source: MLIT

Figure 3-12 Damage to Sanyo Shinkansen Viaduct from Hanshin-Awaji Earthquake in 1995

(2) Seismic Reinforcement on Existing Structure

For civil structures on the Tokaido, Sanyo, Tohoku and Joetsu Shinkansen, which were built before the Hanshin-Awaji Earthquake, seismic reinforcement of the steel lining on viaduct pillars was carried out. In addition, reinforcement by back-filling of tunnel lining plates, or placing lock bolts, has also been carried out for tunnel structures.



Source: MLIT

Figure 3-13 Seismic Reinforcement on Existing Shinkansen Structure

(3) Damage to Civil Structures in the Great Eastern Japan Earthquake

As a result of the above new design criteria, the Great Eastern Japan Earthquake that occurred on 11 March 2011, which had magnitude of 9.0 and is the largest earthquake ever observed in Japan, did not cause serious damage to the bridges, viaducts, stations, and tunnels of the Tohoku Shinkansen and no Shinkansen was derailed.

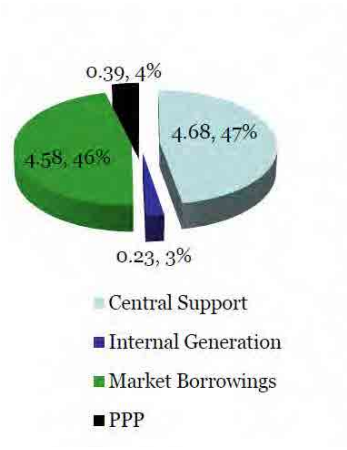
4. EXPECTED BUDGET, FINANCIAL RESOURCES & FUNDING

4. EXPECTED BUDGET, FINANCIAL RESOURCES & FUNDING

4.1 Overall Financial Situation & Funding Conditions

4.1.1 MOR's Budget

MOR's annual budget for fiscal year 2011 was US$12.81 Billion, 47% of which was financed by the central government and 46% by borrowing from the market. Out of the total budget approximately 24% (US$3.07 billion) is allocated for the production and renewal of rolling stock, 17% (US$2.12 billion) for the construction of new lines, and 11% (US$1.20 billion) for track doubling.



Plan Heads	Allocation
Rolling Stock	3.07
New Lines	2.12
Metro Transport	1.44
Doubling	1.20
Track Renewals	0.81
Lease Payment	0.77
Investment in PSUs	0.56
Gauge Conversion	0.55
Electrification	0.22
Road Safety	0.44
Workshops incldg. PUs	0.37
Passenger Amenities	0.24
Signalling & Tele	0.24
Traffic facilities	0.23
Others	0.54
Grand Total	12.81

Unit: Billion US$

Source: Indian MOR

Figure 4-1 MOR Resource Allocation (Annual 2011 Plan)

4.1.2 Budget for 11th Five Year Development Plan

The infrastructure budget is comprised of funds from the central government, state governments and private sector. Of the total budget for fiscal year 2011, 37% came from the central government, 32% from state governments and 31% from the private sector. In regards to the budget for the railway sector, the central government's funding accounted for 78% of the total, while that of state government accounted for no more than 3%.

In the case of the central and state governments, government expenditures are financed in three ways: 1) from the central/state budget, 2) from internal resources, and 3) by borrowing. As for the private sector financing is carried out in two ways: 1) from internal resources and 2) by borrowing. Note that the central/state budgets account for no more than 31% of the total expenditure required for infrastructure and that the majority of funding comes from internal/external borrowing. In the case of external borrowing, private direct investment and direct investment from PPP schemes are also included.

4.1.3 Transport Investment Plan for Next Five Years

The Railways XXII Plan (2012-17) has been established with a view to minimizing economic losses

and road traffic congestion, together with reducing environmental impacts, traffic accidents, and dependence on imported fossil fuels. Improving the operating speeds of freight and passengers in a safe manner is of importance here. The investment is to be about 1 trillion US dollars, of which US$659 billion is to be allocated for rail, US$120 billion for roads, and US$14.7 billion for airports. As for the HSR, it is anticipated that 600 to 800 billion rupees will be invested by the government and private sector through loans.[1]

4.2 PPP for HSR Projects

4.2.1 General Overview of PPP Schemes

Private business plays a major role in the railway sector throughout the world and many PPP schemes consist of obtaining a return on investment via revenues from rider fares, with the premises that there are sufficient demand and ridership capacity-to-pay. PPP schemes have become widespread and can be applied when it is difficult for government to bear the investment risk of a project on its own. In this case, the project would usually consist of three components: 1) policy formulation, 2) policy enforcement (i.e., laws & regulations), and 3) execution of services. The private sector would of course be responsible for the third component while government would handle the first and second components.

PPP projects are classified from a procurement perspective as shown in Table 4-1. In the case of a BOT scheme, business plan preparation, design work, construction, and operation would all be carried out by a private-sector firm until it recovers its investment. This means that the concessionaire for a railway BOT must not only be technically capable but also have good operational knowhow. This is especially true of HSR as it is a large-scale business, and, given that countries introducing HSR do not initially possess the necessary competencies to manage it, it is becoming more common that HSR is being tendered out as on a PPP basis as a BOT scheme. For example, Brazil has been trying to have the private sector under a BOT contract construct, operate, and maintain HSR service between Rio de Janeiro and Sao Paulo. In the United States, consideration is being given to procuring the private sector to carry out the operation and maintenance of HSR in California.

1 Based on interview of RITES in November 2011

Table 4-1 Types of Railway PPP Projects from a Procurement Perspective

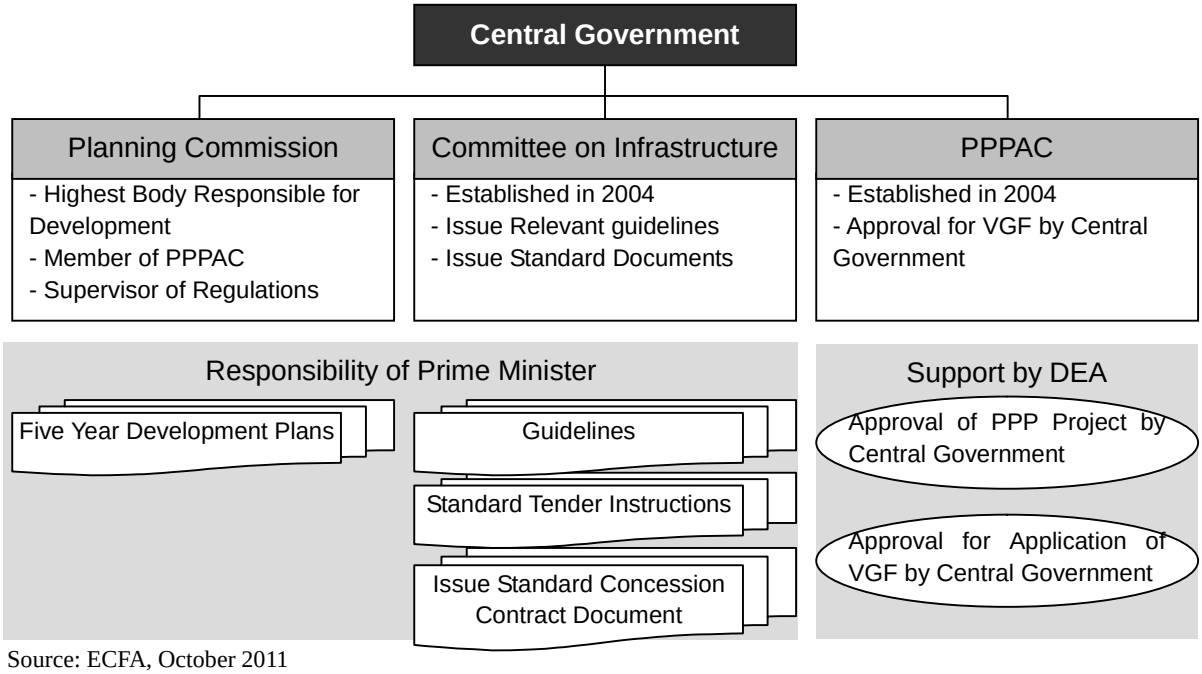
Goods and/or Services Procured	Type of Entity	Example	
Car Parts	Manufacturer	Numerous examples	
Car Parts + Maintenance	Manufacturer (Operator)	- CTRL-DS (UK) - Dubai Metro, etc.	
Car Parts + Maintenance + Operations	Manufacturer Operator	- Taiwan High-speed Railway	
Construction + Car Parts + Maintenance + Operations	Consultant Manufacturer Operator	-Ongoing HSR Projects: Brazil, California, Viet Nam, etc.	- Metros: Indonesia (Jakarta) Viet Nam (Hanoi, Ho Chi Minh), etc.

Source: Japanese Ministry of Land, Infrastructure, Transport & Tourism

4.2.2 PPP System in India

(1) Outline of PPP System

In India, PPP schemes for infrastructure projects come under the ambit of the Planning Commission, Committee on Infrastructure, and the PPP Approval Committee (PPPAC), which is a part of the Department of Economic Affairs (DEA) of the Ministry of Finance (see chart below).



Source: ECFA, October 2011

Figure 4-2 PPP Promotion System in India

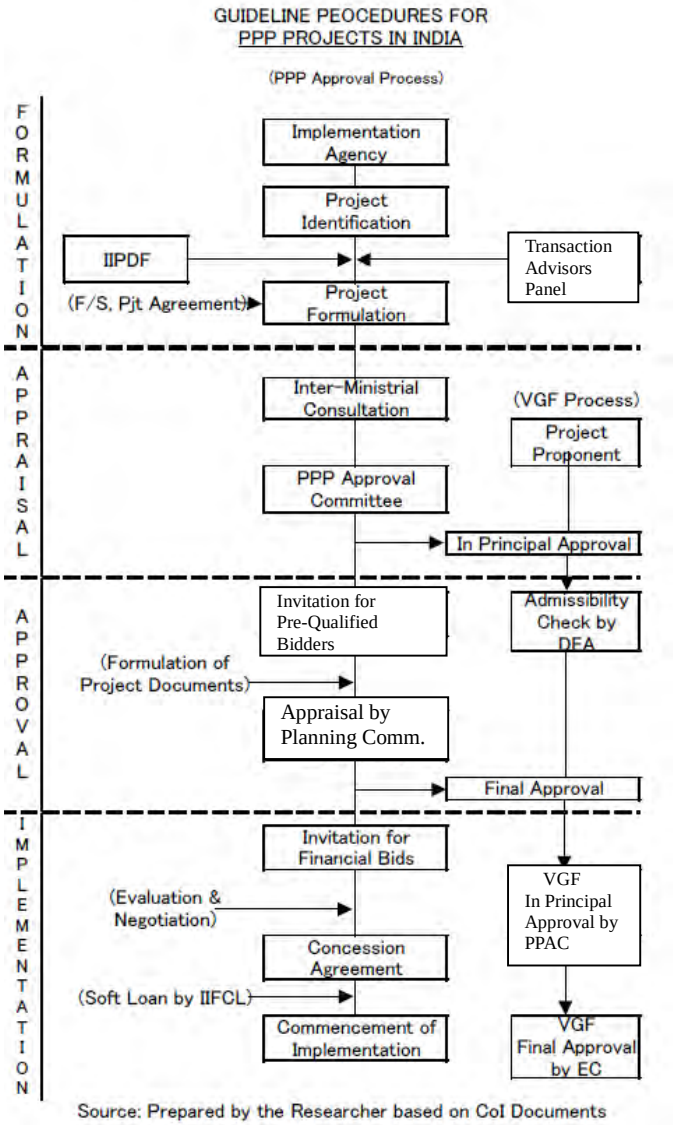
(2) PPP Project Implementation Process

In India, infrastructure development via PPP is subjected to review and approval by PPPAC. For

approval of PPP projects, there is an "In-Principal Approval" and "Final Approval". Forty projects totaling about 270 billion rupees had been approved by the PPPAC by March 2008.

(3) Overview of Government Support for PPP Projects

In the case that the profitability of an approved PPP project is low, there is a provision for applying to the government for a subsidy, which is known as viability gap funding (VGF). The government also established the India Infrastructure Fund Company Limited (IIFCL) to provide long-term, low-interest loans to PPP projects. Moreover, in order to facilitate the formation of PPP projects, the Ministry of Finance has formulated a system to dispatch experts (such as legal and financial experts) and to provide access to funding.



Source: ECFA, 2008

Figure 4-3 PPP Project Implementation Process in India

4.2.3 Examples of PPP Projects in Foreign Countries

PPP has played an important role in the construction and operation of HSR in foreign countries including Taiwan, Netherlands, and Portugal. A description of these examples is given below.[2]

(1) Taiwan

Taiwan's HSR, which links the island nation from north to south, has been a success in many respects. Between 2006 and 2009, after the launch of the HSR, the number of passenger-miles traveled by train in Taiwan increased by 56%, while the number of passengers on domestic air service dropped by 53%. By 2009, the high ridership on its densely populated routes allowed the company that built the line to start earning an operating profit.

On the other hand, the Taiwanese government's efforts to pursue a fully private-sector built and financed high-speed rail line fell apart despite rising ridership, with the company running into difficulty after the Asian financial crisis in the late 1990s, when it was forced to take out loans with high interest rates in order to pay for the project. The high-interest debt soon became financially unsustainable with more than three-fifths of the company's net income used to pay off these loans. As late as 2009, the company was still paying a high 8 percent interest rate on some of its loans. As result, the private company responsible for building the line faced a financial crisis caused by its reliance on high cost debt, forcing the Taiwanese government to ultimately step in to bail out the company and to refinance its debt, resulting in the government having to pay for 40% of the investment.

(2) Netherlands

At the time HSL-Zuid in Netherlands was commissioned, it was the largest PPP rail project in Europe. In fact, it was referred to as the "European PPP Deal of the Year" in 2001 in Project Finance magazine and was highly evaluated. The project was divided into three components: 1) substructure, 2) superstructure, and 3) operations. The contractor for the substructure was procured via conventional bidding, while two PPP schemes were to carry out the superstructure and operations components, respectively.

However, due to the above structuring, problems immediately occurred. That is, the parties were unable to coordinate their efforts effectively, contributing partly to a 2-year delay and an increase in costs by 55%. Moreover, the Dutch government, which wanted to induce lower bids, took on much of the financial risks that were supposed to be borne by the private-sector concessionaires, resulting in it

[2]"High-Speed Rail: Public, Private or Both? Assessing the Prospects, Promise and Pitfalls of Public-Private Partnerships", U.S.PIRG Education Fund, Summer 2011

ultimately bearing 86% of the cost of a project that was supposed to be a high-profile PPP scheme. It can be said that inappropriate planning and the lack of proper risk management resulted in significant losses for the Dutch.

(3) Portugal

Portugal is situated next to one of the world's HSR leaders, Spain. Yet, nearly two decades after the completion of Spain's first high-speed rail line in 1992, Portugal remains without high-speed rail service. Over the past decade, Portugal has developed a plan to build HSR, which would link its major cities with the Spanish network. The plan consists of 6 PPP schemes, with 5 of the schemes for the 5 sections to be constructed and maintained and 1 scheme for the building and maintaining of the signaling/telecommunications network. In developing its approach to the project, Portugal consciously sought to avoid many of the pitfalls of earlier rail PPPs and established a special purpose vehicle to operate the HSR.

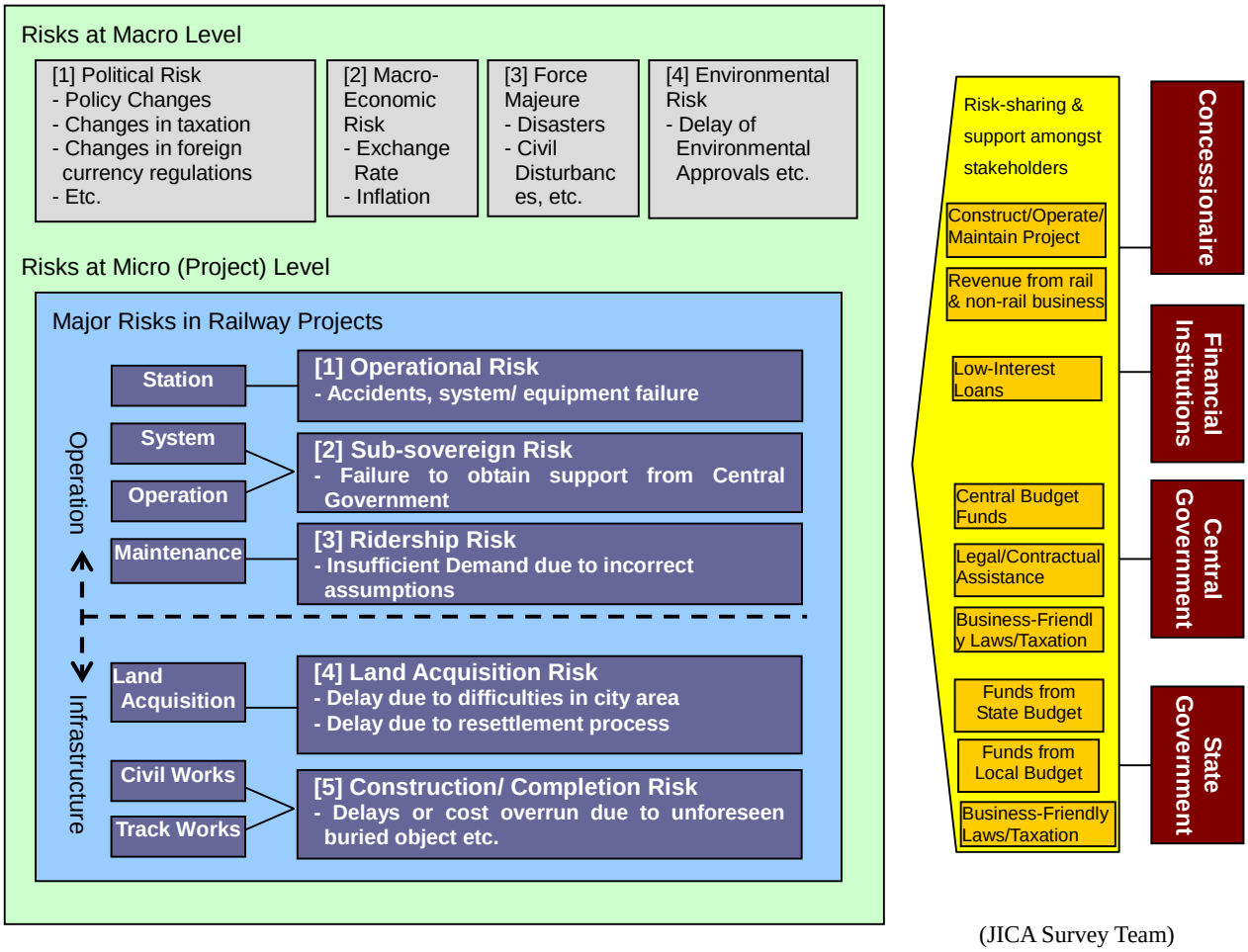
However, ultimately, the Portuguese government had to assume responsibility for 55% of the total cost of the HSR. Moreover, in order to satisfy the demands of the banks, the government had to also take responsibility for the risk of interest rate fluctuation, something that the private sector should usually does. Finally, with the Euro crisis, the project was put on hold as Portugal was in financial turmoil. On the other hand, if Portugal does not proceed with the HSR, it could face claims from the private sector for hundreds of millions of Euros and its relations with Spain, which has extended its HSR network to the Portuguese border, could be damaged.

(4) Evaluation of PPP in Foreign Countries for HSR

As illustrated by the above, even though it had been planned that either a vast majority or 100% of the cost for HSR was to be borne by PPP schemes, various factors such as inadequate planning, inappropriate division of risk and contract structuring, poor risk management, unforeseen changes in the cost of capital, etc. resulted in the public sector losing substantial sums of money. The preceding seems to bear out the fact that no modern HSR has ever been built with only private capital and that the public sector needs to be closely involved in realizing HSR, and that even well thought out plans such as that of Portugal can go awry.

4.2.4 Risks Relating to PPP

In order to operate sustainable PPP projects, the proper allocation of risk amongst the stakeholders and timely measures to minimize risk at each stage of project implementation is crucial. The risks that are faced by PPP schemes for railway projects are as shown in Figure 4-4. As the figure indicates, risk can be divided in those at the macro and micro (project) levels. In the former, such risk will include changes in government policy, taxation, currency regulations, exchange rate fluctuations, inflation, force majeure, and obtaining environmental clearances in a timely manner. As for the latter, risk will entail the construction of the infrastructure and then its operation and maintenance. The allocation of risk amongst the stakeholders is indicated by the side-bar, which usually includes the concessionaire, financial institutions, central government, and state government. Note that access to low-interest capital and the existence of business-friendly laws at both the national and state government levels are important for PPP schemes to be successful. For railway projects, the concessionaire should also try to earn revenue from non-rail business that can be developed in connection with its concession in order to increase both revenue and the success of the project.



(JICA Survey Team)

Figure 4-4 Project Risks in Railway PPP Projects

Risks must be carefully considered from the beginning stages of a project, which is usually at the feasibility stage. In order to implement a PPP scheme, it is necessary to construct a financial model that clearly describes the risks involved and how they are to be managed and allocated amongst the relevant stakeholders. Some of the issues and measures that may need to be considered at the F/S stage are indicated in Table 4-2. Moreover, a sample of the types of risks and the entities responsible for assuming those risks are shown in Table 4-3.

Table 4-2 PPP Implementation Issues & Measures at the F/S Stage

Issue	Measure
• Business operating environment • Country risk • Risk-sharing • Framework for supplementing revenues from related businesses • Ridership • Business models	• Analyze global & domestic political/economic conditions in India. • Prepare possible workarounds. • Configure contract to allot efficiently & fairly risks amongst private and government entities. • Account for legal requirements to ensure operation of PPP scheme will be successful. • Coordinate with relevant state government regarding transit routes, associated development plans, beneficiaries, etc. • Consider measures business model to increase ridership

(JICA Survey Team)

Table 4-3 Types of Risks & Assignment of Burden

Project Phase	Type of Risk	Example of Risk	Burden of Risk		
			Central/ State Gov't	Private	
				Operator	Financial Institution
Whole Project	Political	Termination of contract due political needs, etc.	●		
	Macro-economic	Adverse interest & exchange rate fluctuations		○	○
	Force Majeure	Disasters, civil conflicts, etc.	○		○
	Environmental	Delay in environmental clearances		○	
Planning Design Construction Stage	Funding	Delinquent investment		●	
	Project Completion	Land acquisition, resettlement	●		
		Cost overrun		●	
		Completion delay		●	
		Termination of construction		●	
Operation & Maintenance Stage	Sub-Sovereign	Breach in Gov't support	●		
	Operation/ Maintenance	Lack of project profitability	●		
		Breach in maintenance contract		●	
	Demand Risk	Failure of demand/ income	○	○	

(JICA Survey Team)

4.3 Funding for HSR Projects and the Agenda for Success & Profitability

The development of HSR corridors via PPP was proposed in the railway budget speech of the Minister of Railways for fiscal year 2010. NHSRA will act as the facilitator and regulator of project funds through public and private financial resources (including PPP schemes). Funding support for NHSRA for PPP schemes is expected to come from a separate fund, the application of VGF (Viability Gap Funding), and from multilateral or bilateral loans guaranteed by the central government. As for non-PPP projects they will be directly funded by the central government. Other sources of funds could include revenue sharing from concessionaires, contributions from state governments, real-estate development fees, etc. The issues that need to be addressed by India and the agenda for realizing a successful HSR, together with ensuring profitability, are described in 4.3.1, 4.3.2, and 4.3.3 below.

4.3.1 Issues Needing Resolution

- Gaps in development policies and the rules and regulations of sectors.
- Lack of long-term funds and funds for capital investment and borrowing (maturities of more than 10 years).
- The need to strengthen the capacity of Government of India officials and administrative organizations to manage the PPP project.
- Insufficient human resources in the private sector to promote the smooth implementation of PPP projects.
- The need for enhanced ability to form PPP project to provide attractive investment opportunities for the private sector.
- The need to promote the public understanding of PPP projects.

4.3.2 Agenda for Success of HSR Projects using PPP Schemes

(1) Sustainable Plan for Long-Term Operation & Maintenance

- Strong consensus with the realization of long-term goals contained in VISION2020.
- Budgetary assurance for the following five-year plans for HSR projects.
- Assurance of budgetary and organizational sustainability for the operation of the HSR execution agency (NHSRA).

(2) Assurance of Project Profitability

- Appropriate project structuring.
- Seconding PPP experts in the fields of financial planning and management to NHSRA for capacity-building purposes.

- Formulation of public financial support in case project financials become unacceptable (via for example ridership guarantee, VGF, etc.).

(3) Assuring Stability of Operation

- Improving the investment environment via business-friendly laws and regulations.

(4) Promote Private Sector Firms with Ability to Accomplish PPP Projects

- Disclosure of information, promotion of communication and exchanges between private and public sectors.
- Prevention of unfair competition, securing appropriate pricing, formation of a fare-competitive environment, and procurement monitoring by government.

(5) Other Elements for Stable Execution of PPP Schemes for HSR Projects

- Division of projects into appropriate components from the viewpoint of minimizing contract and completion risk and to assure effective coordination and control of all said components.
- Selection of viable projects that can be operated by private bodies with technical support from JICA.
- Adoption of maintenance-minimization technologies to reduce maintenance costs with technical support from JICA.

4.3.3 Challenges to Improve Profitability

Ensuring the profitability of an HSR line is not an easy task whether it is in Japan or India. Below in Table 4-4 are some examples of the measures that could be applied to achieve and improve profitability.

Table 4-4 Examples of Measures to Improve HSR Profitability

Issue	Measure
Low Ridership	> Execute punctual and high-frequency service. > Ensure reliable signaling. > Promote service via branding and advertising.
Non-rail Business	> Introduce commercial and real estate management knowhow. > Adjust laws & regulations to encourage operation of non-rail business by HSR operators to increase profitability.
Competitive Fare Setting	> Improve accuracy of forecasting profits based on fare settings. > Reform legal system to allow flexible pricing.
Viability Gap Support by Central/Local Government	> Appropriate application of VGF related laws and regulations. > Examine possibility of budget support for project by state governments.

(JICA Survey Team)

5. SUPPORT POLICY FOR IMPLEMENTATION OF HSR IN INDIA

5. SUPPORT POLICY FOR IMPLEMENTATION OF HSR IN INDIA

5.1. Methods for HSR Technology Transfer

In order to provide HSR technology to the key persons in positions of authority, to persons in charge of policy making, and to practitioners from the Indian side, effective and useful information could be made available in the ways described below.

(1) Hearings of Personnel Responsible for HSR Project

Further concrete discussions of experts and staff that will actually be in charge of the Indian HSR should be carried out. These hearings should consider the following themes:

- Matching up of the technical knowhow required by India with available Japanese knowhow.
- Analysis of the costs of Japanese HSR technology to satisfy Indian specifications & concrete measures for accomplishing this.
- Concrete understanding of the business plan (including by state gov't) for commercial HSR operation.
- Clarification by the Indian side of the issues involved in realizing the HSR and the direction and support expected from Japan.

(2) Capacity Development Schemes

It is recommended that technology transfer to India's NHSRA and to other relevant organizations and personnel be carried out with the aim of building capacity by utilizing Japanese training schemes, which can provide the following opportunities:

- Associate expert programs to enhance the abilities of young experts.
- Long-term overseas & domestic training programs to build capacity in specialized fields
- Individual-based training for highly specialized development
- JICA internship program (open recruitment) to broaden the base of personnel capable of participating in international cooperation

Note that the above training schemes would be carried out in cooperation with the relevant Japanese agencies, private companies and railway operators who are involved with HSR technology and who would introduce the concepts and methodologies regarding construction, operation, maintenance, etc. These entities would consist of organizations such as JETRO (Japan External Trade Organization), JARTS (Japan Railway Technical Service), JTCA (Japan Transport Cooperation Association), OCAJI

(Overseas Construction Association of Japan), and IDCJ (International Development Center of Japan).

(3) Promotion of the Exchange of Personnel

By inviting NHSRA officials to participate in a study tour similar to that of this survey, it is possible for Indian experts to quickly experience and see first-hand Japan's latest HSR technology, construction, operation, maintenance, etc. Such a study tour would focus on the following:

- Introduction of the results of the latest HSR research and the current state of HSR in Japan.
- Experience Japan's railway system via inspection and on-site visits to facilities such as the control center, construction sites, etc.
- Introduction via seminars of the legal and financial framework and business models applied in Japan.

5.2. JICA's Assistance Policy

5.2.1. Utilization of JICA's Various Assistance Schemes

JICA possesses an array of tools and experience listed below that can provide assistance to leverage HSR projects in developing countries, and is the only organization in Japan capable of providing this kind of comprehensive support. Moreover, based on its vast experience, JICA possesses an extensive network that encompasses central and state governments, private enterprise, and related development agencies. By combining these various tools and knowhow, as well as tapping into its broad support network, it is possible for JICA to provide assistance that is highly effective (see table 5-1).

- Experience in every aspect of project execution, both upstream and downstream, including the formulation of master plans, design, construction, maintenance and management.
- Extensive project experience in both the hard and soft aspects of track, vehicles, systems, repair plant maintenance, transportation management/systems, operational guidance, personnel training, the development of technical standards, etc.
- Human resource development tools such as the dispatch of experts for technical cooperation and training.

Table 5-1 JICA's Assistance Schemes

Scheme	Outline of Scheme	Examples
Tech. Cooperation for Development Planning Preparatory Surveys	• Assistance to prepare M/P on HSR development, relevant urban transport systems, regional development, etc. • F/S for high priority projects	• National Transport M/P • Urban Transport M/P • F/S on specific plans
Preparatory Surveys on PPP Infra. Projects	• F/S that considers PPP and possibility of Japanese private corporations being involved in public works projects under yen-loan schemes	• Disclosure of information to & exchange with private sector • Assistance with formulation of project implementation plans
Human Resource Training	• Technology transfer to working-level personnel in the NHSRA & MOR • Project formulation by dispatching experts, institutional strengthening, legal system building, training of staff support and guidance • Provision of equipment • Build support for policy and business contract system of PPP, strengthen capacity of personnel working in NHSRA, business monitoring • Assist with establishing technical specifications/standards for HSR	• Invitation to seminars & site visits • JICA's internship program & coordination with private sector programs • On-the-job training • Dispatch of short- & long-term advisors • Cooperation for training programs of relevant organizations
ODA Loan	• Financial assistance with easy-repayment conditions (e.g., low interest)	• Construction, improvement of civil & track works
Grant Aid	• Financial cooperation for projects with no obligation for repayment	• Construction, improvement of civil & track works • Construction, improvement of maintenance shops, stations, and other facilities

(JICA Survey Team)

5.2.2. Cooperation by Type of Assistance

(1) Technical Assistance

1） Technical Studies

2） Preparatory Surveys

◆ Assistance for preparation of HSR business plan, related development plans for urban/regional transportation networks, for roadside development, etc.

◆ Technical assistance and technology transfer related to the design of civil engineering structures/track, various facilities, construction, and the operation and maintenance of high-speed rail.

3） Preparatory Survey for PPP Projects

◆ Planning for rail and related businesses and operation.

◆ Institutional building, contract management capacity building, etc. for PPP.

4） Surveys for Basic Information Collection

- Collection of information and technical criteria/standards regarding HSR from the relevant Indian public and private organizations as was done in this survey and an analysis of said information and data.
- Provision of information to Indian HSR officials and state governments via the execution of seminars and workshops, etc.
- Establishment of a network of India contacts via the above activities.

(2) Financial Support

1） ODA Loans

- Funding for civil engineering facilities, track, E&M systems, and construction of related facilities.
- Assistance with detailed design & procurement.

2） Grant Aid

- Export of rolling stock, electrical systems, etc.
- Construction and rehabilitation of rolling stock factories & maintenance shops

3） Investment for Special Purpose Vehicles (SPV)

- Provision of financing and investment to (railway) SPV

(3) Dispatch of Experts

1） Long-term Experts

- Cooperation with India government officials involved in project formulation as well as with Japanese diplomatic missions.
- Technology transfer related to railway technology.
- Cooperation with RDSO on establishing HSR technical specifications & standards.
- Assessment of the developments and trends of Indian government agencies.
- Execution of adjustments for the application of STEP loan.

2） Short-term Experts

- Provision of stage-by-stage technical guidance: a) Assistance with building legal, financial, and contractual systems; b) Assistance with building management system for HSR and related business models; c) Assistance with establishment of organization for HSR operation.
- Training of drivers, operations staff, etc.

- Technology transfer for HSR operation, which includes inspection and diagnostic technologies, operations management, delay recovery knowhow, etc.
- Technical support to establish HSR technical standards & specifications.

(4) Human Resource Development

1) Training Schemes

- Technology transfer to HSR working-level staff and to young engineers under JICA's training schemes.
- Cooperation with related Japanese public and private organizations in execution of JICA's training schemes.
- Capacity building for RDSO staff regarding technical specifications & standards for HSR

2) Promotion of Expert Exchanges to Japan

- Execution of expert and dignitary exchanges to Japan for HSR similar to the study tour carried out in this survey.
- Exchange of information regarding technical specifications & standards.

3) Implementation of OJT

- On-the-job training for HSR working-level staff and young engineers regarding design, construction, operation, maintenance.

5.3. JICA's Support Roadmap for Implementing HSR in India

The roadmaps shown in Figure 5-1 and Figure 5-2 indicate the process for implementing HSR in India and the support that could be provided by JICA at each stage of the project, with the first figure representing the Base Case and the second figure an Alternative Case. Below, the content of both cases are briefly summarized and it is assumed that the Japanese Shinkansen system would be considered for adoption in either case.

(1) Base Case

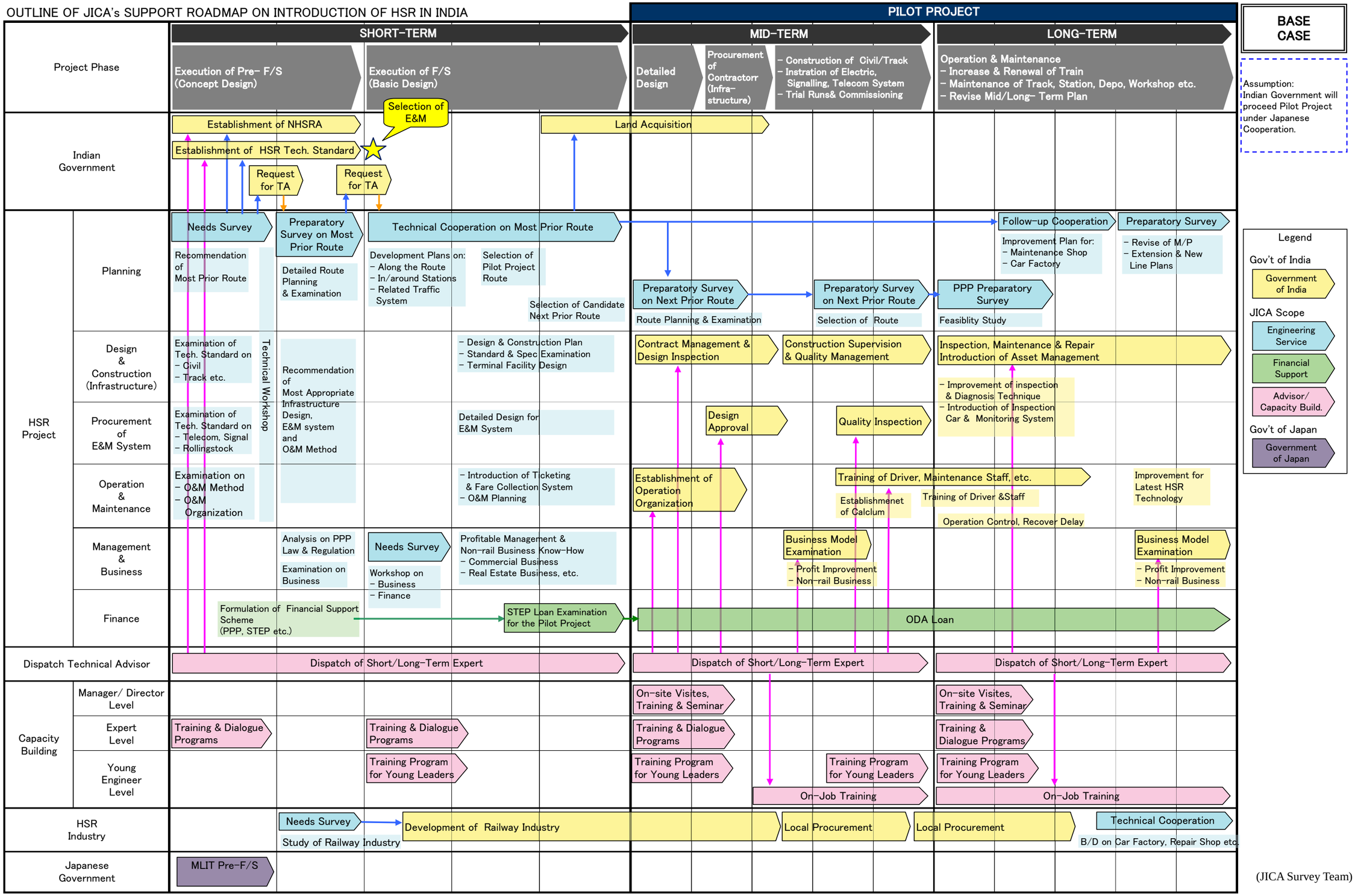
In this case, the Government of India would carry out the HSR project with a Japanese ODA loan and would give serious consideration to adopting the Japanese Shinkansen system, which would consist of implementing civil works, track, rolling stock and E&M per Japanese Shinkansen standards. However, in the case of the Japanese Shinkansen system being adopted for implementation, it is necessary for the Indian government to fully understand the comparative advantages of Shinkansen technology, sustainability and profitability. Therefore, it is necessary to illustrate the advantages of the Shinkansen

system as compared to other HSR systems via Needs Surveys, Preparatory Surveys, etc. for possible HSR candidate routes.

(2) Alternative Case

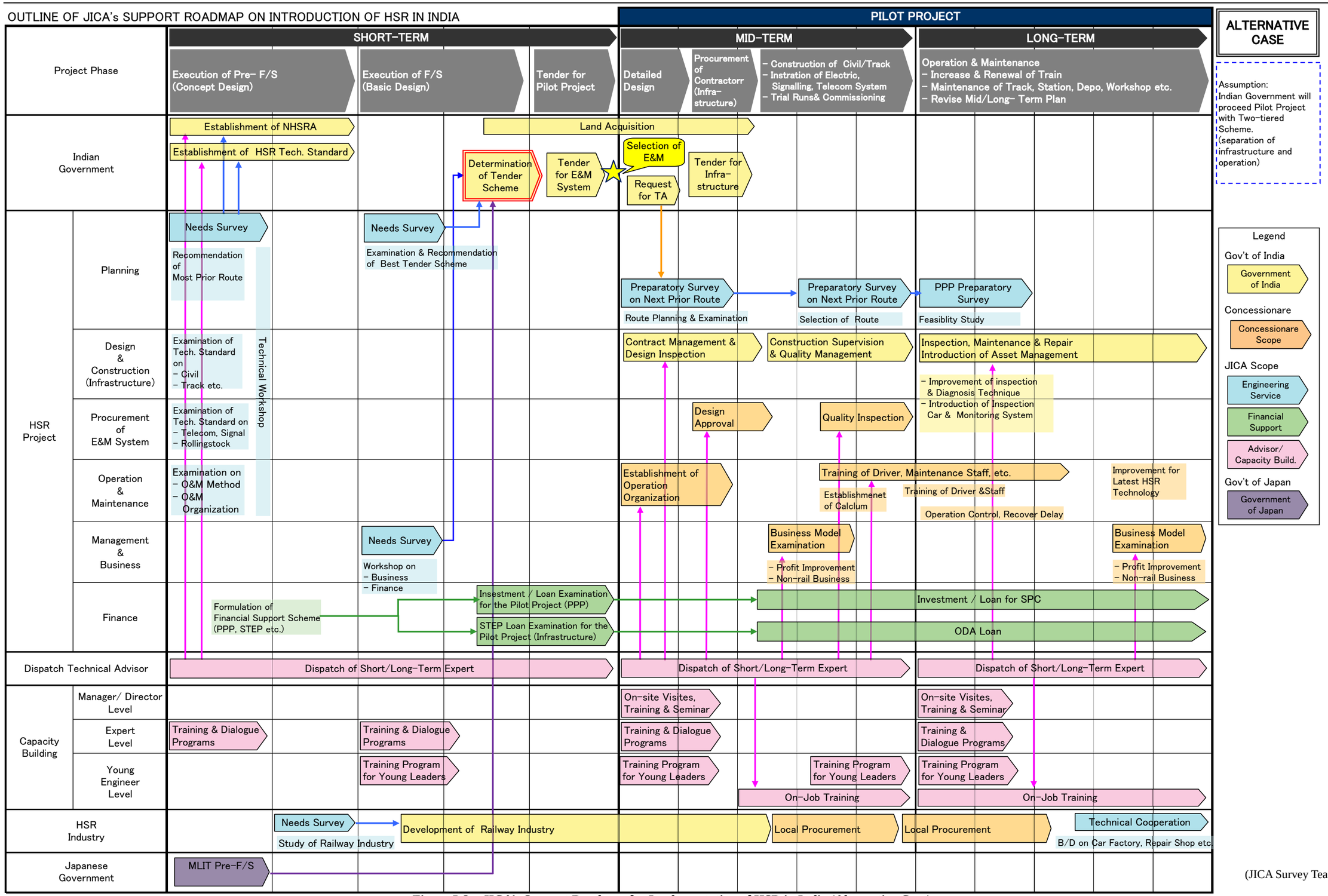
It is assumed that the HSR project would be divided into essentially two components. One component would consist of civil and track work being carried out by the Indian government and the other component would have a private sector SPV in charge of rolling stock, E&M works, and operations and maintenance. A Japanese ODA loan would be provided for the civil and track works, and Japan could also assist with the investment and financing for the rolling stock and E&M systems. In the case of the Shinkansen being adopted, it would be necessary that the civil works and track be designed according to its specifications.

Finally, in the case of Japan providing funding for a SPV, it is recommended that a rail organization possessing Shinkansen technological knowhow such as JR participate. This would be the same for the Base Case as well. However, there could be problems with private sector participation when issues such as profitability, exchange risk, the stability of capital flows, difficult market penetration, etc. are considered. Therefore, it is necessary to examine support measures for the private sector that will enable the participation of a rail organization in the SPV. In the case that a company such as JR is unable to be involved in an SPV, it is important that there at least be a mechanism so that it can provide advice and inputs to the entity operating the HSR.



(JICA Survey Team)

Figure 5-1 JICA's Support Roadmap for Implementation of HSR in India (Base Case)



(JICA Survey Team)

Figure 5-2 JICA's Support Roadmap for Implementation of HSR in India (Alternative Case)

6. OUTLINE OF STUDY TOUR IN JAPAN

6. OUTLINE OF STUDY TOUR IN JAPAN

A study tour, which included on-site visits and seminars in Japan, were conducted for railway experts from the Government of India (i.e., the Ministry of Railways, RDSO, and state government) to enhance their understanding of modern railway technologies and service management methodologies.

6.1 Outline of Study Tour

(1) Duration

From 5th December 2011 to 20th December 2011

(2) List of Participants

Participants from the Indian side are listed in Table 6-1, and in order for the tour to be more effective the participants were segregated into three groups: 1) civil engineering and track, 2) signaling and telecommunications, and 3) rolling stock and power supply.

Table 6-1 List of Participants

Group	Name of Officer	Designation	Specialization
Civil	Mr. Surinder Pal	Executive Director (Civil Engineering-Planning)/Railway Board	Civil
	Mr. Vinay Kumar Singh	Executive Director (PSU)/Railway Board	Planning
	Mr. Jagmohan Gupta	Executive Director (Finance-Budget)/ Indian Railways	Finance
	Mr. Sunil Kumar Gupta	Director (Urban Transport and High Speed-Civil)/ RDSO	Civil
	Mr. Vinayak Rao Kakatkar	Executive Director (Finance-Expenditure)/Railway Board	Finance
Signaling & Telecom.	Mr. Sanjay Bajpai	Secretary to General Manager (Deputy General Manager)/Northern Railway	Traffic
	Mr. Niraj Kumar	Executive Director (Perspective Planning), Railway Board	Traffic
	Mr. Pradeep Kumar	Executive Director (Signal Projects)/ Railway Board	Signal
Power Supply & Rolling Stock	Mr. Nihar Ranjan Dash	Director (Electrical Engineering-Development)/Railway Board	Electrical
	Mr. Sanjiv Swarup	Executive Director (Standards Electrical)/ RDSO	Electrical
	Mr. Mukund Kumar Sinha	Director (Planning-Mechanical)/ Railway Board	Mechanical
	Ms. Archana Mittal	Director (Mechanical Engineer (Freight)/ Railway Board	Mechanical

(3) Schedule & Contents of Study Tour

The schedule for the study tour is as shown in Table 6-2 and the contents of the tour are as described below.

1) JICA's Role & Expertise

- JICA's Expertise in the Railway Sector
- JICA's Assistance Schemes

2) Seminars & Site Visits

HSR Technology

- Construction Technology on Civil and Track
- Technical Research on High-speed Rail

Relevant Laws, Regulations & Technical Standards

- Legal Framework of Japan's Shinkansen Project, Technical Standards

Operation, Control, Safety Management/Training, Rail & Non-rail Business

- Operation and Control
- Safety Management/Training
- Railway Station Facilities & Non-rail Business

Site Visits to Construction Site, Railcar Factory, Wayside Facilities

- Construction Site of Hokkaido Shinkansen
- Rolling Stock Factory, Maintenance Depot, Rail Factory, Substations
- Akashi Channel Suspension Bridge
- Continuous Grade-Separated Crossing Project near Keikyu Kamata Station
- Terminal Facility Construction Project at Shinjuku Station

3) Exchange of Views with Japanese Private Corporations

- Presentation by MOR Officials: Overview of Indian Railways, Proposal for HSR in India, HSR Japan- The Study Tour Perspective, Way Forward
- Presentation by Private Corporations: Sumitomo Metal, Nabtesco, Nippon Signal and Kawasaki
- Q&A Session

4) Exchange of View with Japanese Government Officials

- Lecture by JICA on JICA's Support Program
- Presentation by MOR Officials: Indian Transport Scenario, Need of High Speed Railway in India, National High Speed Rail Authority (NHSRA), Key Issues and Challenges, Implementation Structure
- Conference with MLIT, METI, JETRO and JR East

Table 6-2 Schedule for Study Tour in Japan

	Date	Day		Region	Group A: Civil Engineering & Track	Accomodation	Region	Group B: Signalling & Tele-communications	Accomodation	Region	Group C: Power Supply & Rolling Stock	Accomodation
1	12/5	Mon	AM	Tokyo	Arrival (07:10)	Tokyo	Tokyo	Arrival (07:10)	Tokyo	Tokyo	Arrival (07:10)	Tokyo
			PM		13:00 Courtesy Visit to JICA 14:00 JRTT* : Lecture on " Funding for Railway Development/Construction Technology" 16:00 MLIT**: Lecture on " Outline of High Speed Railway/ Policy Framework and Technical Standards in Japan" at JICA HQ in Kojimachi, 6F			13:00 Courtesy Visit to JICA 14:00 JRTT* HQ: Lecture on " Funding for Railway Development/Construction Technology" 16:00 MLIT**: Lecture on " Outline of High Speed Railway/ Policy Framework and Technical Standards in Japan" at JICA HQ in Kojimachi, 6F			13:00 Courtesy Visit to JICA 14:00 JRTT* HQ: Lecture on " Funding for Railway Development/Construction Technology" 16:00 MLIT**: Lecture on " Outline of High Speed Railway/ Policy Framework and Technical Standards in Japan" at JICA HQ in Kojimachi, 6F	
2	12/6	Tue	AM	Tokyo	10:00-11:30 JR East: Lecture on "Fare Policy/Lifestyle Business"at JICA HQ in Kojimachi, Rm 113	Tokyo	Tokyo	10:00-11:30 JR East: Lecture on "Fare Policy/Lifestyle Business"at JICA HQ in Kojimachi, Rm 113	Tokyo	Tokyo	10:00-11:30 JR East: Lecture on "Fare Policy/Lifestyle Business"at JICA HQ in Kojimachi, Rm 113	Tokyo
			PM		13:30-15:00 JR East Shinkansen General Control Center (90 min) 15:10-16:10 Tokyo Station (Shinkansen Operation, Ticketing, Reservation System, Platform Layouts, Commercial Facilities, etc.) (60 min)			13:30-15:00 JR East Shinkansen General Control Center (90 min) 15:10-16:10 Tokyo Station (Inspect Operational Aspects, including Ticketing, Reservation System, Platform Layouts, Commercial Facilities, etc.) (60 min)			13:30-15:00 JR East Shinkansen General Control Center (90 min) 15:10-16:10 Tokyo Station (Inspect Operational Aspects, including Ticketing, Reservation System, Platform Layouts, Commercial Facilities, etc.) (60 min)	
3	12/7	Wed	AM	Travel	Tokyo (10:20) to Shin-Shirakawa (11:50) by Nasuno No. 255	Sendai	Travel	Tokyo (10:20) to Shin-Shirakawa (11:50) by Nasuno No. 255	Sendai	Travel	Tokyo (10:20) to Shin-Shirakawa (11:50) by Nasuno No. 255	Sendai
			PM	Shin-shirakawa	12:00-13:00 Lunch => Move by Shuttle bus (15 min) 13:20-16:20 JR East General Training Center in Fukushima (Safety, Staff Training, etc.) => Move by Taxi (15 min) Shin-Shirakawa (16:50) to Koriyama (17:03) by Nasuno No. 261 Koriyama (17:31) to Sendai (18:17) by Max Yamabiko No. 145		Shin-Shirakawa	12:00-13:00 Lunch => Move by Shuttle bus (15 min) 13:20-16:20 JR East General Training Center in Fukushima (Safety, Staff Training, etc.) => Move by Taxi (15 min) Shin-Shirakawa (16:50) to Koriyama (17:03) by Nasuno No. 261 Koriyama (17:31) to Sendai (18:17) by Max Yamabiko No. 145		Shin-Shirakawa	12:00-13:00 Lunch => Move by Shuttle bus (15 min) 13:20-16:20 JR East General Training Center in Fukushima (Safety, Staff Training, etc.) => Move by Taxi (15 min) Shin-Shirakawa (16:50) to Koriyama (17:03) by Nasuno No. 261 Koriyama (17:31) to Sendai (18:17) by Max Yamabiko No. 145	
4	12/8	Thu	AM	Travel	<Construction Site of Hokkaido Shinkansen (JRTT)> Sendai (09:50) to Shin-Aomori (11:22) by Hayabusa No. 1 (Series E5) 11:32 Shin-Aomori to 11:40 Kogintei (Lunch) *Car provided all day	Aomori	Travel	<Construction Site of Hokkaido Shinkansen (JRTT)> Sendai (09:50) to Shin-Aomori (11:22) by Hayabusa No. 1 (Series E5) 11:32 Shin-Aomori to 11:40 Kogintei (Lunch) *Car provided all day	Aomori	Sendai	Sendai (09:36) to Natori (09:51) Taxi from Natori Sta. (10 min) 10:10-10:40 Shin-Sendai Substaion (30 min) Taxi to Natori Sta. (10 min) Natori (11:09) to Sendai (11:23)	Aomori
			PM	Aomori	12:40 Kogintei to 13:20 Sotogahama Railway Construction Office (Change clothes) 13:40 Sotogahama Railway Construction Office to 13:55 The 2nd Sotokuroyama Tunnel 14:55 The 2nd Sotokuroyama Tunnel to 15:20 Ushirogata Viaduct 15:50 Ushirogata Viaduct to 16:20 Aomori Railway Construction Office (Change Clothes) 16:40 Aomori Railway Construction Office to 16:55 Richmond Hotel		Aomori	12:40 Kogintei to 13:20 Sotogahama Railway Construction Office (Change clothes) 13:40 Sotogahama Railway Construction Office to 13:55 The 2nd Sotokuroyama Tunnel 14:55 The 2nd Sotokuroyama Tunnel to 15:20 Ushirogata Viaduct 15:50 Ushirogata Viaduct to 16:20 Aomori Railway Construction Office (Change Clothes) 16:40 Aomori Railway Construction Office to 16:55 Richmond Hotel			Lunch Sendai (13:00) to Iwakiri (13:08) Pick-up Bus from Iwakiri Sta. (15 min) 13:30 - 15:00 Shinkansen General Rolling Stock Center (90 min) Pick-up Bus to Iwakiri Sta. (15 min) Iwakiri (15:27) to Sendai (15:37) Sendai (16:38) to Shin-Aomori (18:33) by Hayate No. 31	
5	12/9	Fri	AM	Aomori	9:10 Bus from Hotel 09:30 -11:00 Aomori Dispatch, Morioka Shinkansen Rolling Stock Center (90 min) Bus to Lunch	Osaka1	Aomori	9:10 Bus from Hotel 09:30 -11:00 Aomori Dispatch, Morioka Shinkansen Rolling Stock Center (90 min) Bus to Lunch	Osaka1	Aomori	9:10 Bus from Hotel 09:30 -11:00 Aomori Dispatch, Morioka Shinkansen Rolling Stock Center (90 min) Bus to Lunch	Osaka1
			PM	Travel	Lunch Shin-Aomori (12:28) to Sendai (14:25) by Hayate No. 26 Sendai (15:07) to Sendai Airport Sta. (14:46) by Airport Access Line Sendai Airport (16:55) to Itami Airport (18:30) by ANA Flight 1668		Travel	Lunch Shin-aomori (12:28) to Sendai (14:25) by Hayate No. 26 Sendai (15:07) to Sendai Airport Sta. (14:46) by Airport Access Line Sendai Airport (16:55) to Itami Airport (18:30) by ANA Flight 1668		Travel	Lunch Shin-Aomori (15:42) to Sendai (17:24) by Hayate No. 32 (Series E5) Sendai (17:57) to Sendai Airport Sta. (18:22) by Airport Access Line Sendai Airport (19:10) to Itami Airport (20:30) by ANA Flight 740	
6	12/10	Sat	AM PM	Osaka	6:00 Lobby (Kyoto 1-day tour)	Osaka1	Osaka	6:00 Lobby (Kyoto 1-day tour)	Osaka1	Osaka	6:00 Lobby (Kyoto 1-day tour)	Osaka1
7	12/11	Sun	AM PM	Osaka	9:45 Lobby (Osaka, Afternoon tour)	Osaka2	Osaka	9:45 Lobby (Osaka, Afternoon tour)	Osaka2	Osaka	9:45 Lobby (Osaka, Afternoon tour)	Osaka2
8	12/12	Mon	AM	Amagasaki	8:45 Hotel to 9:30 Mitsubishi Electric Corporation 9:30 - 11:30 Factory of Mitsubishi Electric Corporation	Osaka2	Amagasaki	8:45 Hotel to 9:30 Mitsubishi Electric Corporation 9:30 - 11:30 Factory of Mitsubishi Electric Corporation	Osaka2	Amagasaki	8:45 Hotel to 9:30 Mitsubishi Electric Corporation 9:30 - 11:30 Factory of Mitsubishi Electric Corporation	Osaka2
			PM	Kobe	12:30 Mitsubishi Electric Corporation to 13:30 Kawasaki Heavy Industries, Ltd. 13:30 - 17:00 Factory of Kawasaki Heavy Industries, Ltd. 17:00 Kawasaki Heavy Industries, Ltd. to 18:00 Hotel		Kobe	12:30 Mitsubishi Electric Corporation to 13:30 Kawasaki Heavy Industries, Ltd. 13:30 - 17:00 Factory of Kawasaki Heavy Industries, Ltd. 17:00 Kawasaki Heavy Industries, Ltd. to 18:00 Hotel		Kobe	12:30 Mitsubishi Electric Corporation to 13:30 Kawasaki Heavy Industries, Ltd. 13:30 - 17:00 Factory of Kawasaki Heavy Industries, Ltd. 17:00 Kawasaki Heavy Industries, Ltd. to 18:00 Hotel	
9	12/13	Tue	AM	Kobe	8:30 Lobby Akashi-Kaikyo Bridge	Kokura	Kobe	8:30 Lobby Akashi-Kaikyo Bridge	Tokyo	Travel	Shin-Osaka (10:09) to Tokuyama (11:56)	Hiroshima
			PM	Travel	Shin-Kobe(13:13) to Kokura (15:21) by Sakura No. 557 19:00-19:15: Hotel to Restaurant		Travel	Shin-Kobe (13:22) to Tokyo (16:13) by Nozomi No. 26		Kasado	Factory of Hitachi Ltd. in Kasado Tokuyama (16:54) to Hiroshima (17:28) by Kodama No. 752	
10	12/14	Wed	AM	Kitakyushu	8:30 Leave Hotel 8:45-15:30 Steel Works of Nippon Steel Corporation	Tokyo	Ibaraki	Ueno (7:30) to Omika (9:09) by Fresh Hitachi No. 5 Hitachi Ltd. Manufacturers in Mito (Signal) and in Omika (Operation Control Equipment) Katsuta (16:46) to Ueno (18:07) by Fresh Hitachi No. 48	Tokyo	Travel	Hiroshima (8:10) to Tokyo (12:13) by Nozomi No. 8	Tokyo
			PM	Travel	15:45 Leave for Kitakyushu Airport (16:30) Kita-Kyushu Airport (17:00) to Haneda Airport (18:25)					Tokyo	Factory of Toshiba Electric Service Corporation in Fuchu	
11	12/15	Thu	AM PM	Tokyo	8:15 Lobby 10:00-16:30 RTRI***: Lecture and Facility Tours (Introduction of Basic Research on HSR Technology, etc.)	Tokyo	Tokyo	8:15 Lobby 10:00-16:30 RTRI***: Lecture and Facility Tours (Introduction of Basic Research on HSR Technology, etc.)	Tokyo	Tokyo	8:15 Lobby 10:00-16:30 RTRI***: Lecture and Facility Tours (Introduction of Basic Research on HSR Technology, etc.)	Tokyo
12	12/16	Fri	AM	Tokyo	8:15 Lobby 10:00 - 12:00 Kamata Station, Keikyu Corporation to Study Construction Site of Grade Separation	Tokyo	Tokyo	8:15 Lobby 10:00 - 12:00 Kamata Station, Keikyu Corporation to Study Construction Site of Grade Separation	Tokyo	Tokyo	8:15 Lobby 10:00 - 12:00 Kamata Station, Keikyu Corporation to Study Construction Site of Grade Separation	Tokyo
			PM		14:00 - 17:00 Exchange of Ideas with Private Companies General Presentation by MOR Staff and Presentation by Private Companies followed by discussion 17:00 - 18:30 Party @JICA Tokyo in Hatagaya			14:00 - 17:00 Exchange of Ideas with Private Companies General Presentation by MOR Staff and Presentation by Private Companies followed by discussion 17:00 - 18:30 Party @JICA Tokyo in Hatagaya			14:00 - 17:00 Exchange of Ideas with Private Companies General Presentation by MOR Staff and Presentation by Private Companies followed by discussion 17:00 - 18:30 Party @JICA Tokyo in Hatagaya	
13	12/17	Sat	AM PM	Tokyo	Free	Tokyo	Tokyo	Free	Tokyo	Tokyo	Free	Tokyo
14	12/18	Sun	AM PM	Tokyo	Free	Tokyo	Tokyo	Free	Tokyo	Tokyo	Free	Tokyo
15	12/19	Mon	AM	Tokyo	Construction Site of Shinjuku Station (90 min) 9:00 Lobby 10:00 Entrance of JR East Shinjuku Bldg. (next to HQ Bldg.) 10:00-10:50 Briefing by JR East 10:50-11:10 Q & A 11:10-11:50 Site Survey and Q&A	Tokyo	Tokyo	Construction Site of Shinjuku Station (90 min) 9:00 Lobby 10:00 Entrance of JR East Shinjuku Bldg. (next to HQ Bldg.) 10:00-10:50 Briefing by JR East 10:50-11:10 Q & A 11:10-11:50 Site Survey and Q&A	Tokyo	Tokyo	Construction Site of Shinjuku Station (90 min) 9:00 Lobby 10:00 Entrance of JR East Shinjuku Bldg. (next to HQ Bldg.) 10:00-10:50 Briefing by JR East 10:50-11:10 Q & A 11:10-11:50 Site Survey and Q&A	Tokyo
			PM		14:00 - 15:00 Lecture by JICA (JICA Support Program), at JICA HQ in Kojimachi, 6F 16:00 -18:00 Detailed Presentation by MOR Staff & Conference with Japanese Government Agencies (MLIT,METI**** & JETRO*****) and JR East at JICA HQ in Kojimachi, Rm 113			14:00 - 15:00 Lecture by JICA (JICA Support Program), at JICA HQ in Kojimachi, 6F 16:00 -18:00 Detailed Presentation by MOR Staff & Conference with Japanese Government Agencies (MLIT,METI**** & JETRO*****) and JR East at JICA HQ in Kojimachi, Rm 113			14:00 - 15:00 Lecture by JICA (JICA Support Program), at JICA HQ in Kojimachi, 6F 16:00 -18:00 Detailed Presentation by MOR Staff & Conference with Japanese Government Agencies (MLIT,METI**** & JETRO*****) and JR East at JICA HQ in Kojimachi, Rm 113	
16	12/20	Tue	AM	Narita	Departure (11:25) (JL749)		Narita	Departure (11:25) (JL749)		Narita	Departure (11:25) (JL749)	
			PM	Delhi	Arrival (18:20)		Delhi	Arrival (18:20)		Delhi	Arrival (18:20)	
Mr. V.K. Singh & Mr. Jagmohan Gupta												
16 (B)	12/20	Tue	AM	Travel	Tokyo (9:36) to Sendai (11:12) by Hayabusa No. 3 (Series E5)							
			PM	Sendai	Lunch Sendai (13:22) to Iwakiri (13:30) Iwakiri (13:39) to Rifu (13:46), taxi to 14:00 - 15:20 Shinkansen General Rolling Stock Center (study Series E6) taxi to Iwakiri Station Iwakiri (15:49) to Sendai (15:59) Sendai (16:13) to Tokyo (18:44) by Yamabiko No. 218 (Series E4)							
17 (B)	12/20	Tue	AM	Narita	Departure (11:25) (JL749)							
			PM	Delhi	Arrival (18:20)							

Note :
* : JRTT: Japan Railway Construction, Transport and Technology
** : MLIT: Ministry of Land, Infrastructure, Transport and Tourism
*** : RTRI: Railway Technical Research Institute
**** : METI: Ministry of Economy, Traide and Industry
***** : JETRO: Japan External Trade Organization

6.2 Contents of Study Tour

6.2.1 Seminars & Site Visits

(1) Seminar on JICA's Expertise in the Railway Sector

Date & Time: 05/Dec. (Mon) 13:00-14:00

Lecturer: JICA

Contents:

- JICA's Assistance Scheme
- Importance of Training in the Railway Field
- JICA's Training Assistance

(2) Seminar on Construction Technology of Shinkansen

Date & Time: 05/Dec. (Mon) 14:00-16:00

Lecturer: JRTT

Contents:

- Introduction of JRTT
- Electric System of Shinkansen
- Slab Track in Japan

(3) Seminars on Policy & Tech. Standards of Shinkansen

Date & Time: 05/Dec. (Mon) 16:00-18:00

Lecturer: MLIT

Contents:

i) HSR in Japan

- Japan's Current HSR Network
- The Development of the Construction of Shinkansen
- The Earthquake-proof Shinkansen

ii) Technical Standards System of Japan

(4) Seminars & Site Visits on Operation, Control, Safety Management/Training, Rail & Non-rail Business of Shinkansen

Date &Time: 06/Dec. (Tue)

Lecturer: JR East

Contents:

i) Outline of Shinkansen

- Outline of JR East
- Overview of JR East Shinkansen
- Anti-noise Measures & Aseismic System

ii) The Fare Charging System

iii) Overview of JR East's Life-Style Business

- Future Prospects of JR East's Life-Style Business
- Sales & Profit
- Overview of Business

(5) Inspection of Tokyo Station and Shopping Facilities

Date & Time: 06/Dec. (Tue)

Lecturer: JR East

Contents:

i) JR East Shinkansen General Control Center

ii) Inspection of Tokyo Station

- Operation of Shinkansen
- Ticketing & Reservation System
- Platform Layouts
- Shopping Facilities etc.

(6) Visit to JR East General Education Center in Fukushima

Date & Time: 07/Dec. (Wed)

Lecturer: JR East

Contents:

- Outline of JR East General Education Center in Fukushima
- Shinkansen Crew Training Simulation System
- Museum of Railway Accident History

(7) Construction Site Visit - Hokkaido Shinkansen (Civil Engineering & Track/ Signaling & Telecom Groups)

Date & Time: 08/Dec. (Thu)

Lecturer: JRTT

Contents:

- Project Outline of Hokkaido Shinkansen Construction
- Construction Method and Procedure
- Site Visit & Inspection

(8) Site Visit to Shin-Sendai Substation (Power Supply & Rolling Stock Group)

Date & Time: 08/Dec. (Thu)

Lecturer: JR East

Contents:

(9) Site Visit to Shinkansen Rolling Stock Center (Power Supply & Rolling Stock Group)

Date & Time: 08/Dec. (Thu)

Lecturer: JR East

Contents:

(10) Site Visit to Aomori Dispatch, Morioka Shinkansen Rolling Stock Center

Date & Time: 09/Dec. (Fri)

Lecturer: JR East

Contents:

- Inspection of Shinkansen Cars
- Categories of JR East Shinkansen Cars
- Site Visit & Inspection

(11) Visit to Mitsubishi Electric Corporation

Date & Time: 12/Dec. (Mon) 9:30 -11:30

Lecturer: Mitsubishi Electric Corporation

Contents:

- Mitsubishi Transportation Systems
- Outline of Mitsubishi Itami Works
- Site Visit & Inspection

(12) Visit to Kawasaki Heavy Industries Hyogo Works

Date & Time: 12/Dec. (Mon) 13:30 -17:00

Lecturer: Kawasaki Heavy Industries

Contents:

- Outline of Kawasaki Heavy Industries
- Introduction of Rolling Stock Company and Hyogo Works
- Factory Tour

(13) Visit to Akashi Suspension Bridge (Civil Eng. & Track/Signaling & Telecom. Group)

Date & Time: 13/Dec. (Tue)

- Visit Bridge Museum and Bridge Site

(14) Visit to Hitachi Ltd. Kasado Factory (Power Supply & Rolling Stock Group)

Date & Time: 13/Dec. (Tue)

Lecturer: Hitachi Ltd.

Contents:

- Introduction of Hitachi Rail Systems & Kasado Works
- A-Train, the New Basic
- Factory Tour

(15) Visit to Nippon Steel Corp. Rail & Shape Mill, Yawata Works (Civil Eng. & Track Group)

Date & Time: 14/Dec. (Wed)

Lecturer: Nippon Steel Corporation

Contents:

- Outline of Nippon Steel Corporation
- Outline of Yawata Works
- Outline of Rail and Shape Mil
- Outline of Yawata R&D Laboratory
- Factory Tour

(16) Visit to Hitachi Ltd. Omika Works & Mito Transportation System Product Division (Signaling & Telecom. Group)

Date & Time: 14/Dec. (Wed)

Lecturer: Hitachi Ltd.

Contents:

- Outline of Mito Transportation System Product Division
- Outline of Information and Control Systems Company
- Outline of Hitachi Ltd. Transportation Systems
- Factory Tour

(17) Visit to Toshiba Corporation Fuchu Complex (Power Supply & Rolling Stock Group)

Date & Time: 14/Dec. (Wed)

Lecturer: Toshiba

Contents:

- Introduction of Toshiba Railway Systems Business, Rolling Stock Systems, Power Supply Systems
- Outline of Taiwan High Speed Rail System
- Outline of Toshiba Corporation Fuchu Complex
- Factory Tour

(18) Lecture & Laboratory Visit on Basic Research of HSR Technology at RTRI

Date & Time: 15/Dec. (Thu)

Lecturer: RIRT

Contents:

i) Lecture

- Outline of RTRI
- Shinkansen- Bolsterless Bogie, Improving Running Performance and Riding Comfort
- Noise Problemx of High-speed Train in Japan: Development of Noise Reduction Technologies
- Recent Technologies of Train Control Systems in Japan
- Track Technology for High Speed Lines of Japanese Railways

ii) Laboratory Tour

- Ride Comfort Simulator
- In the-Loop Simulation System
- Large-Scale Shaking Table
- Rolling Stock Test Plant

(19) Site Visit to Continuous Grade-Separated Crossing Project near Keikyu-Kamata Station

Date & Time: 16/Dec. (Fri) 10:00-12:00

Lecturer: Tokyo Metropolitan Government,, Keikyu Corporation, Keikyu Kamata JV

Contents:

- Project Outline of Continuous Grade- Separated Crossing near Keikyu-Kamata Station
- Introduction of Direct Elevation Method
- Introduction of Works on VTR
- Site Visit & Inspection

(20) Site Visit to Terminal Building Construction Project at Shinjuku Station

Date & Time: 19/Dec. (Mon) 10:00-12:00

Lecturer:

Contents:

- Introduction of Outline of the Project
- Site Visit & Inspection

6.2.2 Exchange of Views with Private Companies

Date & Time: 16/Dec. (Fri) 14:00-17:00

Contents:

i) Presentation by MOR Officials: ”Study Tour of HSR in Japan”

- Overview of Indian Railways
- Proposal of HSR in India
- HSR Japan- The Study Tour Perspective
- Way Forward

ii) Presentations by Private Japanese Corporations

- Sumitomo Metal: Sumitomo Railway Products
- Nabtesco Corporation: Railroad Products Company
- Nippon Signal: Signaling System for High Speed Rail
- Kawasaki: Technical Introduction of Kawasaki's High Speed EMU Trains

(Minutes of Discussion attached at the end of this chapter.)

6.2.3 Exchange of Views with Japanese Government Agencies & JR East

(MLIT, METI, JETRO, JR East)

Date & Time: 19/Dec. (Mon) 14:00-18:00

Contents:

i) Lecture by JICA: JICA’s Support Program

ii) Presentation by MOR Officials: ”Indian Perspective and Policy Initiatives”

- Indian Transport Scenario
- Need of High Speed Railway in India
- National High Speed Rail Authority (NHSRA)
- Key Issues and Challenges
- Implementation Structure

(Minutes of Discussion attached at the end of this chapter.)

6.3 Meeting on HSR between Indian Experts & Japanese Companies

A meeting was held on 16th December 2011 at JICA's Hatagaya office between the Indian experts and Japanese private companies regarding HSR. At the meeting five presentations were given, with one by the Indian side and four by private Japanese companies. A summary of the meeting is given below.

6.3.1 Main Points of Discussion on MOR Presentation

- In regards to technical cooperation for HSR, MOR is only cooperating with Japan at present and has not asked for cooperation from any other country.
- Although India is using broad gauge for its conventional lines, the government of India has decided to utilize standard gauge for HSR.
- MOR is intending to have its HSR designed for speeds of 350 km/h but actual running speeds will vary.
- MOR started working seriously on HSR about one and a half years back. After completion of the pre-feasibility studies for the 6 HSR corridors under consideration, MOR will take up 2 to 3 corridors for a feasibility study, as all the corridors cannot be taken up simultaneously due to the high capital costs. That is, one corridor will be initially constructed and, depending on the success of that corridor, other corridors will be considered. The process will consist of a National High Speed Rail Authority being established by June 2012 and then the execution of the feasibility studies.
- As for the 6 HSR corridors no priority has yet been assigned. However, financial viability will come out from the pre-feasibility studies and feasibility studies. Then, based on that, MOR will select one corridor.

6.3.2 Main Points of Discussion on Sumitomo Metals Presentation

- MOR mentioned that Sumitomo had supplied large numbers of wheels to India in the past, which is now not the case. Sumitomo noted that after 1960 India established its own wheel manufacturing plants and this is the reason for the decrease in supply from Sumitomo. Sumitomo hopes that with the introduction of HSR in India it may have the chance again to make give more supplies.
- Sumitomo manufactures both corrugated and noise-damped wheels. Corrugated wheels are used in conventional trains and sold in accordance with requests from operators. As for noise-damped wheels, they contain rubber inside the steel of the wheel and this is the secret behind their noise-reduction capability.
- It was noted that noise-damped wheels are not intended for HSR and are a solution for conventional trains where there are sharp curves that result in wheel-generated noise. In the

case of the Shinkansen, it is not just the wheel but many other larger factors that contribute to noise.

- Corrugated wheels are used everywhere in Japan and are also exported to the New York metro. It is popular with customers as the wheel is light but strong.
- It was mentioned by Sumitomo that its main competitors in wheel manufacturing are the Europeans, as they have both the history and technology in this field. Sumitomo was not concerned by the Chinese as the technology has been developed by the Japanese and Europeans. In other words, the Chinese do not have experience in HSR and do not possess technology at the level of the Europeans, who are Japan's real rivals.
- Sumitomo stated that most (80-90%) of the wheels that it exports to the US are for freight (trailer) cars. It was mentioned by Sumitomo that wheels for passenger coaches, especially HSR, require higher specifications, and it is the company's strategy to pursue and to be competitive in this market.

6.3.3 Main Points of Discussion on Nabtesco Presentation

- Other than China where it sells it products directly, Nabtesco sells its products to Japanese railcar producers such as Kawasaki and Hitachi.
- In the case of China, it is carrying out a direct technology transfer for HSR as mandated by its contract.

6.3.4 Main Points of Discussion on Nippon Signal Presentation

- Nippon Signal was requested by MOR to send more information about its landslide and rock-fall detection systems and Nippon Signal agreed to email such.
- MOR queried whether digital axle counters are used for the Shinkansen. Nippon Signal replied that digital axle counters are being utilized on the many different Shinkansen lines but as a fall-back system.
- MOR then wanted to know if the intermittent brake pattern is applied by the Shinkansen or conventional lines. Nippon Signal replied that the continuous brake pattern is the most advanced type of braking and has already been adopted for both the Shinkansen and some conventional lines. However, the older conventional and Shinkansen lines are still using the intermittent brake pattern. In the case of India, the continuous brake pattern could be provided for its HSR system.

6.3.5 Main Points of Discussion on Kawasaki Presentation

- MOR expressed its concern on how the cost of the train sets can be reduced. Kawasaki

replied that it does not have a clear idea about what the cost-reduction items for India's HSR would be at the present time, but that it is willing to cooperate with MOR to achieve an optimum solution.

- Kawasaki introduced to MOR its advanced HSR the "efset", which is compliant with international standards. MOR queried whether this could be produced in a timely manner as there is no physical prototype. Kawasaki responded that it is possible as a large number of tests have been carried out using highly advanced simulation equipment and that the relationship with their suppliers is good.
- MOR queried whether the same speeds and acceleration could be maintained with Japan's present HSR technology if coaches were manufactured per European or US standards. The reasoning behind this question is that India's railway standards, which are based on European and US ones, might be difficult to change without adversely affecting safety.
- Kawasaki responded by saying that it is has great respect for European standards and it is competing against them. On the other hand, if you apply US standards, the trains would be heavier and more expensive. Kawasaki noted that if India's HSR is fully dedicated with a sophisticated signaling system, there is no chance of a collision occurring and therefore no need to have a heavy railcar body. **That is the Shinkansen concept.** However, if you want to have through operation with conventional lines without a sophisticated signaling system, than you have to consider the possibility of collisions occurring maybe at level crossings or with other trains, meaning you may have to consider heavier and stronger railcar bodies. So, it depends on your concept.
- MOR agreed that the Shinkansen is without doubt very safe and well proven. However, it mentioned that changing India's standards might not be easy without affecting safety. Therefore, if you have to deal with European or American standards, which India follows, would Japan's HSR be able to maintain the same performance parameters for things such as speed and acceleration?
- Kawasaki responded saying that is why the "efset" was developed, as it expects that a client may request some standards different from those of Japan, which Kawasaki must comply with if it is to export its technology. For example, in the case of Taiwan, standards different from those of Japan were requested. In response, Kawasaki incorporated different standards that included European ones. Therefore the Taiwan Shinkansen, which looks very similar to the Japanese Shinkansen, is actually different.
- Regarding power for railcars, according to Kawasaki, two-car units are used to increase the power of car operation up to 350 km/h. It was noted that studies on utilizing 4-car units, with one transformer and 3 to 4 motorcars, were also carried out. However, in this case, the

transformer under the floor became too big and could not be accommodated. Therefore, Kawasaki gave up on that idea and decided to adhere to the two-car unit concept. In the case of the two-car unit concept, if one unit fails there is another remaining and is a sufficient redundancy to ensure operational speed can be maintained at acceptable levels.

- MOR queried about the maximum number of cars that can be accommodated by HSR without compromising speed and acceleration. Kawasaki stated that from its experience the maximum is 16 cars.
- MOR stated that in India there are many 24-coach trains and would like to know if it possible for HSR to handle this number of cars and requested that Kawasaki try to respond to this at a later time.
- MOR noted that Shinkansen cars are wider than European HSR cars and wanted to know the reason for this. Kawasaki responded by saying that in the case of Europe through-operation of HSR and conventional lines started from the beginning and is universal. Therefore, the car size for HSR had to be the same as that conventional rail and is therefore smaller than that of the Shinkansen. In the case of Japan, as the gauge for the Shinkansen is different from that of its conventional rail, the best configuration could be realized.
- MOR mentioned that in India there is high temperatures and humidity and wanted to know if a different maintenance periodicity would be required than what is applied in Japan. Kawasaki stated that in the case of Taiwan it had experienced a number of issues, including higher temperatures and humidity than that of Japan. In the case of India, conditions may be even more severe than Taiwan so that may have to be explicitly considered.

6.4 Meeting on HSR between Indian Experts & Japanese Government Officials/JR East

A meeting, which included a presentation by Mr. V.K. Singh, was held at JICA headquarters in Kojimachi on 19th December 2011 between the Indian experts and Japanese government officials in order that ideas and opinions on HSR could be exchanged. A summary of the meeting is described below.

- The Japanese side queried the Indian side on what they thought where the most interesting sites during their visit to Japan. The Indian side replied that the site visit to Aomori was quite impressive, including both the general site and viaduct. In particular, the new kind of slab-track with the opening in the middle, which not only reduces cost but snow accumulation as well, was interesting. Another interesting thing in Japan was that when you bore a tunnel you construct the base of the track in parallel.
- The Japanese side queried whether snow was an issue in India. The Indian side stated that it would not be an issue for HSR lines, but that for conventional trains it is an issue in the Jammu-Kashmir region, where India is undertaking the construction of railway in a big way. In that region India is already running trains at a speed of 120km/h and the terrain is very difficult and similar to that of Aomori, where technologies for viaducts and bridges are required. The snow season lasts for 3 months and everything is closed down during that period.
- The Japanese side wished to confirm whether India would be using standard gauge for its HSR. The Indian side replied that it would be doing so. Although it has been Indian policy to follow a uni-gauge policy for railway till now, where meter gauge was converted to broad gauge, broad gauge will only be used for conventional rail. However, note that some of the narrow gauge on conventional lines will not be removed due to historical reasons.
- The Japanese side expressed an interest in knowing the public opinion in India about HSR, as some people have been saying it is expensive and a high-end mode of transport only for the rich. On the other hand, the Indian government has a policy of inclusive development.
- The Indian side responded by saying that initially there was pressure on politicians not to announce the HSR and they thought there would be public protests. However, it has fortunately been well received, but there are still a few who think that the HSR is for the elite class and not for the masses.
- On the other hand, the Indian side mentioned that Indian Railways is currently facing serious capacity concerns and is unable to provide tickets to all those who want to travel. For example, the reservation system allows for a two-month prior booking but all the tickets sell out on the very first day before 10am. With economic development, young people want to spend money on comfortable, reliable and speedy transport, with demand

for AC coaches going up over the last 5 to 7 years. That is, there is a distinct class of traveler moving to a higher level and in the next 10 years with 6-7% economic growth this segment will want to move to the HSR. This is something that should be kept in mind.

- The Japanese side said that it is willing to contribute to the realization of HSR in India and that it has the technology required for operation and maintenance as well. In this respect, the Japanese side wanted to know if India has any ideas about funding assistance from Japan.
- The Indian side replied that it has yet to decide on funding, as it first must consider in more detail the corridors where it would want HSR and their viability. After the feasibility studies, the design would be understood and therefore the costs and requirements for funding. Until the two important issues of corridor selection and costing are finalized, the Indian side is unable to comment on the funding issue.
- The Japanese side stated that it could provide assistance with the feasibility studies and to which the Indian side expressed its appreciation.
- The Japanese side mentioned that in an Indian budget speech it was clearly mentioned that PPP would be applied for HSR. On the other hand, in today's presentation by the Indian side it was indicated that some of the HSR schemes may be non-PPP. It was then queried on whether, for example, the first HSR line could be government funded.
- The Indian side replied that as a general tool projects will be PPP. However, the National High Speed Rail Authority (NHSRA) will be in place for a long period of time and it will provide funds for projects of national importance under a legal framework. This will enable the possibility of G-to-G funding and is an option that has been kept open.
- The Japanese side asked whether the NHSRA is to be established within the MOR or outside of it. The Indian side stated that all public companies/corporations and authorities come under some government ministry. In the case of the NHSRA, it will come under the MOR. However, its management will be established by an act of Parliament and will therefore be much more powerful than a regular public company or authority.
- According to the presentation by the Indian side NHSRA has four goals. The Japanese side queried whether these have been officially approved and whether they will be mentioned in the next budget speech. The Indian side stated that these goals have already been given to the NHSRA and serve as a roadmap.
- In the presentation implementation strategies were also given. The Japanese side stated that it thought that Option 1 (DBFOT) would be very difficult, as has been shown by the case of the Brazilian HSR. In fact, Brazil is now re-evaluating its implementation scheme. The Indian side also said that it would like to avoid DBFOT, as HSR projects are too large for it

and the private sector may not have the risk-taking or funding appetite especially for the first corridor. Therefore, unbundling infrastructure and operations into B&T and DFOT, respectively, seems to be the best way forward, as the size then becomes manageable. The physical infrastructure, which is the most expensive part, will require government funding or support or guarantees. Especially, in the case of the first and second corridors. Depending on the success of those corridors, we can then think of DBFOT for the third to fifth corridors, which may be 20 years in the future.

- The Japanese side queried who approved the roadmap for NHSRA as shown in the presentation and to which the Indian side responded that it was the MOR.
- The Japanese side mentioned that capacity development for railway staff is important for HSR and wanted to know what efforts have been made by MOR in this regard. The Indian side replied that as far as conventional lines are concerned India has a very good system of training for engineers that is time-tested. On the other hand, there is still no system for HSR. Regarding construction, this should not be a problem as India has been completing good tunnel and viaduct projects for elevated railways/metros. During construction, India could incorporate the necessary knowhow for operation/maintenance, which is what has been done for metros in India.
- The Japanese side stated that their impression of Indian Railways is that of a large and successful operation. Therefore, if you introduce HSR system step-by-step, India should be able to operate it. Although the current system is old, with the introduction of a new system your employees will be motivated and proud in doing their work.
- The Indian side queried whether JR East makes a profit from the Shinkansen. To this the Japanese side responded by saying that 30% of JR East's revenue is from non-railway businesses and 70% from rail-related businesses and that the company is profitable overall. Further, it was noted that JR East's business base is the Tokyo metropolitan area, with most of its business being the transportation of commutation trips and is one of the world's largest in those terms.
- The Japanese side noted that in some local areas, for example villages in Aomori, revenue from the HSR is insufficient to cover the construction costs of the Shinkansen. On the other hand, it was mentioned that in the case of the HSR, construction is taken care of by the central government and operation by JR. Its JR's responsibility to make sure that the operation is profitable.
- It was further stated by the Japanese side that JR was privatized 20 years back and the biggest change is JR East's knowhow about making profits based on the services it provides to customers. Some of them use HSR, some of them use conventional lines for

commuting, and some go shopping in station buildings. The thinking is that this business model has huge potential.

- The Indian side stated that it was very impressed with Japanese technology and the automatic control machines used for quality control. However, they noted that the Indian operational and climatic conditions are quite different, such as high temperatures and extremely dusty conditions, and therefore design changes may be required and that this should be kept in mind for operation control.
- The Japanese side queried the kind of cooperation India is expecting. For example, construction companies actually build the infrastructure; therefore, is cooperation on a construction basis or technical assistance transfer basis? The Indian side replied that it would need to have technical transfer and this is usually part of the specifications in the bidding documents. It is only then that collaboration with private companies can take place. That is, first there is knowhow, technical transfer, bidding and then an interface with the private companies.
- The Indian side mentioned that it found from a purely urban transportation viewpoint that there is lot of synergy between the various transportation organizations in Japan. For example, Japan has rail stations, subways, buses, etc. interfacing smoothly with each other. Where does this integrated and holistic approach come from? Which agency takes care of the interests of the stakeholders and comes up with a plan for everyone. How do you do that in Japan?
- The Japanese side stated that it is very difficult to answer, as private companies come up with what they think is effective for managing transport and they recognize that interfacing with each other is important and in everybody's interest. National and local governments work together instead of there being one person or body. That is, in Japan, the respective bodies are able to work and come up with the major output that is required via consensus.
- Japan also has a long-term transportation plan that is developed by the country and which serves as a strategic guideline. In the case of stations and the areas around them, this is dealt with by the local governments. For example, in the case of Shinjuku Station, the bus terminal being built there is being funded by the national government but is being carried out by local government and related entities.
- Moreover, the Japanese private sector also works together. SUICA, which is an IC multi-modal card, is used by JR, buses, taxis, and for shopping.
- In the case of Tokyo Metro and JR, there is joint cooperation and this sort of concept could be introduced into India for example between Indian Railways and Delhi Metro.

6.5 Comments on Japan's HSR Technology

In order to assess the significance and effectiveness of the study tour, a questionnaire survey was conducted on 10 of the Indian experts, as 2 of the 12 experts could not come until the last couple of days. Of these 10 respondents, nine answered that the content of the tour was very useful, with one respondent stating that it was useful. Nobody gave a reply that it was not useful. Moreover, nine experts stated that the seminars were just right in terms of length, while one expert thought they were too short. Finally, five of the Indian experts responded that the information and/or knowhow obtained from the study tour could be applied in India, while four thought there may be some applicability. Only one replied that he was not sure about the tour's applicability to India.

Below, the types of Japanese knowhow thought to be applicable to India, the perceived strengths and weakness of Japanese HSR, the major issues facing Indian HSR, and the cooperation expected from Japan is listed below and is based on the answers of the experts to the abovementioned questionnaire.

1) Knowhow Applicable to India

- Operational knowhow of Japan's HSR
- Manufacturing and maintenance of rolling stock
- Construction technology without disruption of train traffic
- Signaling system
- Level of customer care
- Development of HSR brand
- Soft- skills such as punctuality, commitments, following the safety rules
- Signage, vehicle guidance boards
- Proliferation of ticket vending machines
- Quality improvement in existing passenger carrying rolling stock for moving towards higher operating speed, in comfort and with reliability
- Integration of new technology

2) Strengths of Japan's HSR

- Safety
- Punctuality, reliability
- Passenger comfort, amenities
- Skilled staffs and capacity and skill development
- Quality of production
- Environmentally friendly system

- Capacity
- Customer services
- Light-weight, highly efficient rolling stock
- Elevated track
- Continuous noise barrier
- Highly sophisticated signaling system
- High- level research and development, especially on simulation technology
- Integrated design, planning, execution and operation
- Operation speed
- Synergy in planning between relevant government and private bodies
- Emphasis on timely completion of works

3) Weaknesses of Japan's HSR

- Seems difficult to sustain as a stand-alone system
- Lack of railcar strength in case of a collision
- Lack of Adaptability to UIC standards
- Cost unless the non- railway business proves successful
- Lack of flexibility of the rolling stock on different system
- Insufficient guidance for foreigners at stations

4) Major Issues for Implementing HSR in India

- Financial resources
- Land Acquisition
- Identification of the highest priority HSR section in India
- Development of business model, secure profitability
- Climatic conditions different from those of Japan
- Construction cost for dedicated elevated or underground track
- Consensus and establishment of roles towards the realization of HSR development plan
- Review of relevant laws and regulations
- Enlightenment of passengers regarding manners and rules
- Concrete HSR implementation plan

5) Cooperation Expected from Government of Japan

- Financial support
- Technical support on technical and operational knowhow

- Capacity building and skill development and training of staff
- Techno-economic surveys, implementation of F/S
- Provision of technical standards
- Knowhow on recovering from delays, disasters, etc.

6.6 Overall Results of Study Tour

The study tour in Japan allowed its Indian experts to see and experience both the hardware and software technologies that enable the Japanese Shinkansen to operate at the highest levels of efficiency, safety and reliability. In particular, the tour provided the opportunity for these experts to visit Shinkansen facilities, R&D facilities, and construction sites not open to the public and to obtain details from manufacturers and factories. The valuable information that the Indian experts obtained is something that can only be provided by a tour such as this.

In addition, the Indian experts were able to experience the Shinkansen brand at its stations by seeing the advanced guidance, ticketing, and customer service facilities, as well as the punctual and safe operation of it trains, indicating an overall quality that goes beyond the application of just high-tech hardware.

Through the study tour, it is believed that the advantages of introducing Japanese HSR technology to India were made clear. On the other hand, the Indian side has requested that the additional information listed below be made available via some future Japanese technical cooperation and/or human resource development scheme in order for them to continue towards the goal of realizing HSR in India.

(1) Civil & Track

- Information on cooperation between the Shinkansen and conventional rail (for example Tokyo Metro and JR) that could serve as an example for Indian Railways and Delhi Metro.
- The details of the technology and cost involved in track maintenance.
- Maintenance management system & its organizational structure.
- Details of standards for electrical power facilities and track.

(2) Signaling & Communications

- Maintenance management system for signaling and telecommunications technologies and countermeasures for system failure.

(3) Rolling Stock System

- Details of standards for electro-mechanical systems and vehicles.
- Information on frequency of vehicle failure and details of failures.
- Details on vehicle maintenance.
- Details on maintenance management system for electrical power facilities.
- Layout of rolling stock depots.

(4) Finance

- Detailed balance sheet for the Shinkansen as a stand-alone operation.
- Method for financially evaluating an HSR in the planning stages.

7. CONCLUSIONS & RECOMMENDATIONS FOR IMPLEMENTATION OF HSR IN INDIA

7. CONCLUSIONS & RECOMMENDATIONS FOR IMPLEMENTATION OF HSR IN INDIA

Taking into consideration the survey results, the issues and challenges in India, and keeping in view the support of Japan for the implementation of HSR via utilization of its latest technologies, the conclusions and recommendations of this survey are given below.

7.1. Conclusions

(1) Key to Success of HSR in India

To realize HSR in India, the success of the first pilot project is essential. This success will hinge on the selection of the most viable route, the introduction of reliable systems, sufficient budget allocation and smooth land acquisition.

Interviews with state officials in Gujarat and Maharashtra, through which HSR Corridor 1 will pass and which most likely be the most viable route, indicate that these states are very keen to see HSR implemented. It was confirmed that these states anticipate sufficient demand for HSR based on their plans for regional development and for attracting industry to their areas. The states are positive about acquiring the necessary land for HSR and providing some financial support as well. To ensure the success of the HSR the central government should consider the following when dealing with states:

- Some of India's state governments have their own ideas regarding development in conjunction with HSR and envision seeing high-speed routes to provincial cities and special economic zones as well. The central government may want to consider accommodating these concepts if viable, and should in any case closely coordinate with states to ensure the successful integration of HSR with state urban planning and transport networks to ensure sufficient ridership.
- The cooperation of state governments, especially in regards to land acquisition, will be a key issue for smooth project execution. If possible, some funding from states should be considered as this would provide them with a greater sense of ownership and provide a broader funding base.
- As HSR routes will cross states, coordination between states including development plans along corridors may need to be considered.

On the other hand according to information from MOR, even in the case of Corridor 1 (i.e., Pune – Mumbai – Ahmedabad), where the populations of Mumbai and Ahmedabad are comparable with those of Tokyo and Osaka, the economic internal rate of return in the pre-F/S was only around 13 to 14% and

is not that high. Therefore, revenue other than that from HSR should also be considered in order to ensure stable profits and business sustainability, such as station and real estate development. Also, it is therefore recommended that the legislation for establishing the NHSRA contain provisions so that it may be able to manage and operate related non-rail businesses and commercial facilities, as well as to have a certain amount of flexibility in setting prices. These measures will create an environment for the successful operation of HSR.

(2) Japan's Expertise in HSR Business

During the study tour in Japan and in discussions in India with MOR's financial expert, it was mentioned that the Shinkansen in Japan does not seem to be very profitable. For example, out of the 7 JR group companies, only 3 (JR East, JR Central and JR West) are profitable. The profitability of these 3 companies, however, is due in part to their expertise in developing new sources of revenue from non-rail businesses such as real estate, commercial facilities, etc, as well as to the expert management of their conventional lines. Another important factor is that these companies work under a flexible pricing system, which requires a rail company to only notify the relevant ministry of fare changes as along as it is within the predetermined ceiling. This Japanese expertise and pricing system, has helped to make rail (including the Shinkansen) a success and should be considered for application in India.

Ultimately, however, the most important thing to ensure successful HSR operation is to have highly punctual, reliable, and frequent service. For this reason, it is important to operate HSR on a dedicated line and to equip it with sophisticated and reliable control systems like those of Japan's Shinkansen.

(3) Issues with PPP Schemes & Countermeasures

In MOR's opinion, HSR in India may be implemented via government funding and PPP, with the former to fund the construction of the civil infrastructure/track and the latter to carry out the HSR operation and maintenance. On the other hand, as described in Chapter 4, the application of PPP overseas for HSR has experienced a myriad of problems that has resulted in the public sector having to bear a large portion or most of the cost for HSR. In order to help ensure the success of a PPP scheme in the case of HSR, it is important that in addition to improving its profitability that policy tools be enhanced and/or new ones developed so public sector funding can be utilized as required, together with developing related non-rail businesses.

Based on the preceding, in order to realize HSR in India with PPP, it is necessary to promote further capacity building of officials in charge of the legal and financial aspects of NHSRA; especially, in regards to the formation of projects with PPP schemes, business planning, and project structuring.

(4) Japan's Policy for HSR Assistance

It is thought that Japanese assistance, which will include financial support, will be required in the areas of contract management and technology transfer, technical assistance related to civil engineering, track, and operation and maintenance. Provision of non-rail related business know-how, which should part of the HSR business model, will also be necessary. The dispatch of foreign experts to MOR to facilitate the introduction of this knowhow would be useful. Furthermore, technology transfer via training programs in Japan for working-level personnel, persons in charge of establishing technical criteria/standards, and for legal and finance professionals involved in PPP business would be useful. Based on the preceding, the following matters should be considered regarding future Japanese assistance:

- Cooperation with RDSO regarding the examination and establishment of technical specifications and standards through the dispatch of JICA experts to RDSO and/or the invitation of RDSO personnel to seminars in Japan.
- Proposal of new construction methods and technologies to reduce HSR life-cycle cost.
- Dispatch of JICA experts to assist in improving the laws and regulations to realize a more efficient and effective system for PPP implementation, and in the development of a road map for mid-and long-term project plans, business development, technical cooperation and the development of policy tools.
- Seminars in Japan to promote technology transfer on PPP project formulation, business planning, project structuring, and examination of PPP schemes in foreign countries.

In addition to the preceding, the domestic production of high-speed trains should be considered. With the appreciation of the Japanese yen in recent years and the complex tax system and high tariffs in India, importing HSR rolling stock may be difficult. Thus, there is an urgent need for both Japanese government and private companies to address and resolve this issue.

7.2. Recommendations

(1) Demonstration of the Superiority of the Japanese Shinkansen

At present, MOR is assuming that the HSR project would consist of public sector and private sector managed components. In this case, if the Japanese Shinkansen system is to be adopted, it is necessary to demonstrate its superiority from both technical and cost viewpoints, and the following should be carried out to achieve this:

- Detailed comparison of the features, costs, and advantages of the Shinkansen system as compared with the HSR systems of other countries so that MOR can choose the best HSR.
- Detailed explanation on the advanced hardware that supports Shinkansen maintenance, which in turn ensures its unparalleled operational reliability and safety.
- Detailed explanation on the methods of education and training for human resources that enables the Shinkansen to carry out high frequency and high-speed operation in a safe and reliable manner.

(2) Further Collection & Analysis of Tech. Information & Determination of Best Solutions

Based on the social and environmental conditions of an HSR route, the optimum mode and content of execution needs to be decided. Assuming that the management of HSR will be via a PPP scheme, a construction method that minimizes life-cycle costs and an optimal maintenance plan are essential for finding the best HSR solution. Moreover, since HSR criteria do not exist in India, it is necessary to further collect and analyze the relevant related technical data for design criteria, seismic criteria, etc., and to carry out additional analysis on technical standards for managing the maintenance of structures.

(3) Monitoring of the NHSRA

It is expected that the NHSRA Act will come into force during 2012. However, since NHSRA has no experience in managing an HSR, and since it is still unknown how much political and technical influence it will have in securing a sufficient budget and in preparing and executing it business plans, it is necessary that information concerning NHSRA's organizational structure, budget, and project implementation capacity be followed up. Furthermore, taking into account the business cycle of high-speed rail by PPP, there is a need to continue to gather information on the financial situation of the India, its political stability in the medium- to long-term, national economic conditions, and rail-related development.

(4) Facilitating HSR Investment

There are still many unknowns about the future of India's economic development and it is therefore necessary to keep track of and forecast possible developments. Given this, it is suggested that the following be carried out to facilitate investment in India's HSR:

- Preparation of a long-term investment plan based on the financial analysis of the HSR long-term plan in Vision 2020.
- Analysis and preparation of a business model for introducing the Japanese Shinkansen to India.
- Preparation of a long-term plan based on the utilization of support and financing schemes from financial institutions such as JICA, JBIC, etc.

(5) Framework to Promote Participation of Japanese Rail Company

In order to realize the smooth introduction of the Japanese Shinkansen if it is adopted, it is crucial that a rail organization possessing a vast amount of HSR operational knowhow such as JR be involved. On the other hand, there are obstacles to the participation of the private sector listed below and a framework of support measures will need to be considered to ameliorate them so as to obtain the involvement of an entity like JR.

- Profitability & allocation of risks such as exchange risk
- Stability of capital flows to finance the implementation of HSR

In the case that a company such as JR is unable to be involved in the abovementioned enterprise, it is important that there at least be a mechanism for it to provide advice and inputs to the entity operating the Indian HSR.

APPENDICES

APPENDIX 1 - LIST OF STAKEHOLDERS INVOLVED IN STUDY

Appendix 1 List of Stakeholders Involved in Study

Name	Position
AUTHORITIES, ORGANIZATIONS & CORPORATIONS IN INDIA	
Embassy of Japan, New Delhi	
Mr. Mamori Fukada	First Secretary
JICA India Office, New Delhi	
Mr. Hiroshi Suzuki	Senior Representative
Mr. Taro Okawa	Representative
Mr. Yuichiro Sano	Representative
Mr. Sanjeev Moholkar	Lead Development Specialist
Ministry of Railways, New Delhi	
Mr. Vinay Kumar Singh, IRSE	Executive Director, PSU
Mr. Jagmohan Gupta	Executive Director Finance (Budget)
Mr. B.N.Rajasekhar	Adviser (Planning)
Mr. Surinder Pal, IRSE	Executive Director, Civil Engineering (Planning)
Mr. K. Vinayak Rao	Executive Director, Finance (Expenditure)
Mr. Niraj Kumar	Executive Director (Perspective Planning)
Mr. Pradeep Kumar	Executive Director (Signal Project)
Mr. Nihar Ranjan Dash	Director, Electrical Engineering (Development)
Mr. Mukund Kumar Sinha	Director, Planning Mechanical Engineer
Ms. Archana Mittal	Director, Mechanical Engineer (Freight)
Mr. Sanjay Bajpai	Secretary to General Manager, Deputy General Manager, Northern Railway
RITES Limited, Gurgaon, Haryana	
Mr. Jatin Sarkar	General Manager Special Projects
Mr. P.K. Gupta	General Manager (Track & Survey)
Mr. Sanjay Mishra	C.T.P.M, Eastern Railway
Mr. Pradeep Kapoor	Jt. General Manager (Transport Economist)
Mr. Sumit Sinha	Director (Technical)
Mr. Rajeev Mehrotra	Managing Director
Mr. M.K.Sharma	AM (T&E)
IRCON International Limited, New Delhi	
Mr. Deepak Sabhlok	Director (Projects)
Delhi Mumbai Industrial Corridor Development Corporation Limited (DMICDC) , New Delhi	
Mr. Amitabh Kant, IAS	CEO & MD
Mr. R.K. Bansal	Advisor- Railways
Mr. Abhishek Chaudhary	Company Secretary
Rail Coach Factory(Ministry of Railways), Amritsar, Punjab	
Mr. Rajnish Bansal, IRSME	Secretary to General Manager
Mr. Prakash Butani	Chef Planning Engineer
Research Design & Standards Organisation- RDSO (Ministry of Railways), Lucknow, Uttar Pradesh	
Mr. Rajesh Kumar	Executive Director, Urban Transport & High Speed
Mr. Aniruddh Gautam	Executive Director, Industrial Development
Mr. Harsh Khare	Director (Electrical), Urban Transport & High Speed
Mr. Sunil Kumar Gupta	Director (Civil)
Mr. Kaushal Kumar	Director Signalling
Mr. B.K. Shrivastava	Director Laboratory
Mr. Sanjiv Swarup, IRSEE	Executive Director/Standards Electrical
Mitsubishi Corporation New Delhi Branch	
Mr. Koichi Hattori	General Manager, New Delhi Branch
Mr. Shinji Hikasa	General Manager, Transportation Systems Unit Ship, Aerospace & Transportation Systems Division

Planning Commission, New Delhi	
Dr. Manoj Singh	Advisor (Transport)
National Transportation Planning Committee, New Delhi	
Mr. B.N.Puri	Member Secretary
Bjarat Earth Movers Limited, Bangalore, Karnataka	
Mr. Ashokan	Chief General Manager
Mr. Manjunathan	General Manager
Gujarat Infrastructure Development Board Gandhinagar, Gujarat	
Mr. A.K. Sharma, IAS	Chief Executive Officer
Mr. Shardul Thakore	Senior Manager
Delhi Metro Rail Corporation Limited, New Delhi	
Mr. P.K.Pathak	Deputy General Manager/ Operation
Mr. Mukesh Kumar	Vice Principal/ Manager/ Training/ RS
Toshiba India Private Limited, Gurgaon, Haryana	
Mr. Norio Koishikawa	General Manager, Railway Systems, Special Infrastructure Systems Division
Integral Coach Factory, Chennai, Tamil Nadu	
Mr. Abhay Kumar Khanna	General Manager
Dr. S.Ram Prakash	Chief Medical Superintendent
Mr. Hemant Kumar	Chief Mechanical Engineer
Mr. S.C.Parhi	Chief Security Commissioner
Mr. M.Salvaraj	Chief Engineer
Mr. JSP Singh	Chief Electrical Engineer
Mr. Vijay P Meshram	Controller of Store
Ms. Meera Nageswaran	Financial Advisor & Chief Account Officer
Mr. L.N. Prasad	Chief Design Engineer (Electrical)
Mr. S.Srinivas	Chief Design Engineer (Mechanical)
Bombardier Transportation India Limited, New Delhi	
Mr. Sriram Raju	Director- Sales
Kawasaki Heavy Industries, Ltd. Delhi Representative Office, New Delhi	
Mr. Takao Suto	Chef Representative, Delhi Representative Office
Mr. Akira Kimura	Representative, Delhi Representative Office
Bombardier Transportation India Limited, Savil Site, Vadodara, Gujarat	
Mr. Amit Yadav	Director, Production
Mr. Richard Melanson	Director, Purchasing
Mr. Vivek Trivedi	Head, Technical Services
Government of Bihar, Patna,	
Mr. Navin Kumar	Chief Secretary
Government of Maharashtra, Mumbai	
Mr. Ratanakar Gaikward	Chief Secretary
Dr. Shailesh Kumar Sharma	Principal Secretary for Transport
Mr. Thomas C. Benjamin	Principal Secretary, Urban Development Department

APPENDIX 2 - MINUTES OF MEETING

1. Introduction

A team of experts from the Japan International Cooperation Agency (hereafter referred to as the Team) arrived in New Delhi on 31st October 2011 to begin the collection of information and data over a period of twelve days for the first field visit of the "Needs Survey on High Speed Railway and Skills in India". This memorandum contains a summary of the hearings and interviews with government officials and organizations in New Delhi, Kapurthala and Lucknow, together with a description of on-site activities, and will form part of the Team's reporting.

2. Activities for 31st October 2011

On this date, meetings were held with JICA and the Embassy of Japan at 9:00am and 11:00am, respectively, to kick-off the first field visit. Subsequently, meetings were held respectively with RITES and the Indian Ministry of Railways at 12:00pm and 4:00pm, and which are summarized below.

Location: RITES, Gurgaon
Time: 12:30 to 13:30
Present: RITES- Jatin Sarkar (GM-Special Projects), P.K. Gupta (GM-Civil)
JICA Survey Team- Shinya Nakamura (TL/Infrastructure Business), William Hayes (Deputy TL), Mitsuyuki Osawa (HSR Systems Expert), Masaaki Hara (HSR Rolling Stock Expert), Atsushi Kamiyama (Project Financing Expert), Rajesh Bhatt (Sr. Project Asst.), Naresh Kumar (Project Asst.)
Record: The Team introduced its members and described the purpose of the JICA Survey. After that, the following discussion took place:

- The Team queried RITES on the possible sources of information regarding the status of proposals/plans for High Speed Rail (HSR) in India and whether any official or white papers are available on this. According to RITES, as this is a relatively new topic, there is still relatively little concrete information in existence.
- However, RITES stated that the Indian Government is serious about HSR and the concept of HSR corridors has been accepted. In fact, it was stated that pre-feasibility studies for the following routes have been completed:
  - Ahmedabad-Mumbai-Pune
  - Howrah-Haldia
  - Delhi-Patna
- As a result, it is expected that INR 600 to 800 billion is to be recommended for HSR in the 12th Five-Year Plan, which should be available within a month or two. Funds would come from government, the private sector, and loans.
- Instead of MOR/IR, there may be a new entity to carry out the execution and operation of HSR trains in a setup similar to that of the Dedicated Freight Corridor Corporation.
- It was agreed that it is important to introduce HSR technology suitable for India and that training arrangements, facilities and technology transfer need to be made available.
- RITES suggested the Team meet Mr. Ranjan Jain (Advisor Infrastructure) of the Railway Board to exchange and collect more information about HSR planning.
- RITES also recommended that the Team talk with the Planning Commission of India, as they and not MOR are ultimately responsible for transport planning. It is suggested that the Team meet with Mr. Manoj Singh (Advisor Transport) at the Planning Commission.
- At the Team's request, RITES will assist in providing information for the preparation of documentation regarding HSR in India. As Mr. Sarkar is a member of a government sub-committee dealing with this issue, he is willing to introduce the Team to B.N. Puri of the National Transportation Development Planning Committee.
- Finally, RITES requested that some of its engineers be allowed to participate in the training and seminars sponsored by JICA that are to be held in Japan in Dec. 2011.

Location: Ministry of Railways (Railway Board), New Delhi
Time: 16:00 to 17:00
Present: Railway Board- B.N. Rajshekhar (Advisor Planning), V.K. Singh (Exec. Director-Public Sector Undertakings)

JICA- Hiroshi Suzuki (Sr. Representative- Delhi Office), Keisuke Fukui (Asst. Director- South Asia Dept.), Nobuhiro Kurose (Deputy Director- Economic Infrastructure Dept.), Yuichiro Sano (Representative- Delhi Office), Taro Okawa (Representative- Delhi Office), Sanjeev Moholkar (Lead Development Specialist- Delhi Office)
JICA Survey Team- Shinya Nakamura (TL/Infrastructure Business), William Hayes (Deputy TL), Mitsuyuki Osawa (HSR Systems Expert), Masaaki Hara (HSR Rolling Stock Expert), Atsushi Kamiyama (Project Financing Expert), Rajesh Bhatt (Sr. Project Asst.), Naresh Kumar (Project Asst.)

Record: The Team introduced its members and described the purpose of the JICA Survey. After that, discussions focused on the following issues:

- The collection of information on the status of HSR in India, including the 12th Five-Year Plan and any official or white papers that may be available.
- The holding of HSR training and seminars in Japan for about two weeks in December 2011 for 10 to 20 Indian experts to be nominated by MOR.
- The holding of a HSR workshop in India either in January or February 2012 for two days for about 100 participants to be nominated by MOR.
- JICA stated that Japan is interested in supporting Indian HSR and would like to cooperate in developing a roadmap for this purpose.
- Therefore, JICA's Team would like to explore possibilities for Indian and Japanese collaboration as part of its survey, with the intention of clarifying the needs of India for HSR technology that would take into consideration not only hardware but also software issues such as management structure and finance.
- To achieve the preceding, JICA's Team would like to hold discussions and collect inputs and opinions from various organizations and expressed its desire to visit IRCON, the Kapurthala rail coach factory, and RDSO in Lucknow.
- MOR agreed to provide a letter so the Team could visit the abovementioned organizations and sites.
- MOR stated that it has just started working on HSR and is still examining the various technical and financial aspects, and that it intends to form a core team of experts to engage the Japanese side. JICA agreed that this is a good idea and would like to establish a long-term interface to hopefully realize the successful implementation of HSR.
- As for the training and seminars in Japan, the Team and MOR will hold discussions to finalize the details for this.

3. Activities for 1st November 2011

On this date, meetings were held with the Railway Board and IRCON. Below is a record of these activities.

Location: Ministry of Railways (Railway Board), New Delhi

Time: 11:00 to 12:30
Present: Railway Board-V.K. Singh (Exec. Director-Public Sector Undertakings)
JICA Survey Team- Shinya Nakamura (TL/Infrastructure Business), William Hayes (Deputy TL), Mitsuyuki Osawa (HSR Systems Expert), Masaaki Hara (HSR Rolling Stock Expert), Atsushi Kamiyama (Project Financing Expert), Rajesh Bhatt (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)
Record:

- The Railway Board handed the Team an official letter enabling them to visit the organizations and sites it wishes to see.
- The Team then gave the Railway Board a detailed program for the Training and Seminar Program in Japan.
- After examining the above program, Mr. Singh stated that he would like it to address the following:
  - The policy framework & institutional mechanisms for HSR in Japan
  - Legislation implemented and changes over time
  - The history of Japanese HSR
  - Lessons learnt by Japan and improvements to the HSR system
  - Organizational structure
- Mr. Singh also suggested that the following locations be visited during the proposed Training and Seminar Program:
  - Control room in Tokyo
  - Tokyo Station to see platform layouts, commercial development around station, ticketing, and to obtain information about mobile phone and train service interfaces
  - Akashi Bridge
  - Electrical sub-station
  - Train maintenance depot
- It was decided that the Indian experts going to Japan should be divided into two groups:
  - One group would consist of 2 civil engineers, 2 finance experts, 1 signal engineer and 1 telecoms engineer.
  - The other group would consist of 2 electrical engineers, 2 mechanical engineers and 2 operation experts.

Location: IRCON, New Delhi
Time: 17:30 to 18:30
Present: IRCON- Dilip Sabhlok (Director-Projects)
JICA Survey Team- Shinya Nakamura (TL/Infrastructure Business), William Hayes (Deputy TL), Mitsuyuki Osawa (HSR Systems Expert), Masaaki Hara (HSR Rolling Stock Expert), Atsushi Kamiyama (Project Financing Expert), Rajesh Bhatt (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)
Record: The Team introduced its members and described the purpose of the JICA Survey and the training, seminars, and workshop that will be held by it. Mr. Sabhlok then introduced IRCON and explained that it is essentially a general contractor owned by the Indian government and that they work not only on rail projects but on highway and airport projects as well. After that, the following points were made from the subsequent discussion that took place:

- Six HSR corridors for which pre-feasibility studies (Pre-FS) are being carried out under the MOR and they are as listed below, with IRCON doing the Pre-FS for the first four corridors and MOR the Pre-FS for the last two corridors.
  - Delhi –Patna (inception report 1 completed)
  - Howrah-Haldia (draft final report completed)
  - Hydrabad –Chennai (consultant being selected)
  - Chennai –Trivandrum (consultant being selected)
  - Pune –Mumbai –Ahmedabad (completed)
  - Delhi –Amritsar (completed)
- All Pre-FS work, which consists of preparing two inception reports, a draft final report, and a final report, should be completed around the end of next year at latest and it is expected that PPP will be applied in implementing these projects.

- Mr. Sabhlok stated that all of the final Pre-FS reports for the six corridors will receive a comprehensive review and the most suitable HSR technology selected.
- Projects costing more than INR 500 million require Planning Commission approval.
- As for the manufacturing of HSR coaches, technology transfer will be needed; although, these coaches will need to be imported initially for a certain amount of time (perhaps a decade).
- As for HSR track, it has been essentially decided to go with standard gauge, as it is being used by all HSRs throughout the world and has a proven safety record. That is, trying to apply broad gauge would require extensive testing and trails and is expected to be ruled out for India's HSR. In fact, reporting for the Howrah-Haldia Line was revised to have standard gauge as the required type of track.
- It was noted that some state governments, such as Kerala and Karnataka, are planning HSR on their own, with a plan for HSR to run from Trivandrum to Mangalore.
- In addition to HSR, India is also trying to upgrade existing track so it can operate at speeds up to 150 km/h. In this regard the following comments were made by IRCON:
  - The average speed on 75% of turnouts for existing Indian railway track is only 30km/h, with the remainder of turnouts having speeds of 50 km/h and 75 km/h.
  - Increasing speeds on existing line to more than 130 km/h is not possible many times due to the large number of level crossings and to the fact that fencing is ineffective as it is torn down by residents.
  - It was noted that the maximum speed of a freight train is 75 km/h, but will increase to 110 km/h with the Dedicated Freight Corridor.
- Mr. Sabhlok stated that HSR and overall higher operating railway speeds is necessary for India's development.

4. Activities for 2nd November 2011

Location: Ministry of Railways (Railway Board), New Delhi
Time: 17:30 to 18:30
Present: Railway Board- V.K. Singh (Exec. Director-Public Sector Undertakings)
JICA Survey Team- Shinya Nakamura (TL/Infrastructure Business), William Hayes (Deputy TL), Mitsuyuki Osawa (HSR Systems Expert), Masaaki Hara (HSR Rolling Stock Expert), Atsushi Kamiyama (Project Financing Expert), Rajesh Bhatt (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)

Record:

- The Team submitted a revised Training and Seminar Program to MOR for discussion.
- MOR suggested that the Team divide the Indian experts into three groups (Civil Engineering & Track, Signaling & Telecommunications, and Power Supply & Rolling

Stock) in order to cater to their needs more suitably, and which was agreed upon by the Team.

- The MOR also requested that the Team consider whether or not it was possible to leave on 3rd December 2011 instead of 4th December 2011 for the Training and Seminar Program in Japan.
- The Team handed a questionnaire consisting of six queries to the MOR to answer in order to facilitate the progress of the JICA survey.
- Mr. Singh stated that he would try to have replies to the questionnaire ready by November 9th.

5. Activities for 3rd November 2011

On this date, a meeting was held with DMICDC and then the Team flew to Amritsar to prepare for a visit with officials of the rail coach factory in Kapurthala on the following day.

Location: Delhi Mumbai Industrial Corridor Development Corporation (DMICDC), New Delhi
Time: 11:15 to 12:30
Present: DMICDC- Amitabh Kant (CEO/MD), R.K. Bansal (Advisor- Railways), Abhishek Chaudhary (Company Secretary)
JICA Survey Team- Shinya Nakamura (TL/Infrastructure Business), William Hayes (Deputy TL), Mitsuyuki Osawa (HSR Systems Expert), Masaaki Hara (HSR Rolling Stock Expert), Atsushi Kamiyama (Project Financing Expert), Rajesh Bhatt (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)
Record: The Team introduced its members and described the purpose of the JICA Survey and the training, seminars, and workshop that will be held by it. After that, the following points were made from the subsequent discussion that took place:

- DMICDC suggested that financial agreements for HSR should not be PPP based. That is, to overcome market risk, financial agreements should be in the form of an annuity-based Engineering Turn-Key Project.
- DMICDC also suggested the Team meet the Deputy Chairman of the Planning Commission (Mr. Ahluwalia), so as to push the HSR concept to the level of the prime minister. This was recommended as the Japanese prime minster is visiting India next month on an official visit.
- DMICDC indicated that a HSR line connecting Delhi–Mumbai via Ahmedabad would be the most valuable and therefore important.
- It was recommended by DMICDC that there be a separate HSR authority, as the operation of HSR is entirely different from that of conventional rail.
- DMICDC stated that it would like for the Indian side to be informed of the different HSR technologies (e.g., Japanese, French, & German).
- Mr. Bansal suggested that the Team meet with the former chairman of the Railway Board (Mr. Batra), as he is a member of a high-level committee for HSR.

6. Activities for 4th November 2011

Location: Rail Coach Factory (RCF), Kapurthala
Time: 10:30 to 14:30
Present: RCF- Rajnesh Bansal (Secretary to GM), Prakash Bhutani (Chief Planning Eng.)
JICA Survey Team- Shinya Nakamura (TL/Infrastructure Business), William Hayes (Deputy TL), Mitsuyuki Osawa (HSR Systems Expert), Masaaki Hara (HSR Rolling Stock Expert), Atsushi Kamiyama (Project Financing Expert), Rajesh Bhatt (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)
Record: The Team introduced its members and described the purpose of the JICA Survey and the training, seminars, and workshop that will be held by it. After that, the following points were made from the subsequent discussion that took place:

- There are two large rail coach factories in India, with RCF in Kapurthala being one and the other the Integral Coach Factory (ICF) in Chennai. ICF was established in 1961 and its ICF design accounts for 90% of IR's coaches, which have maximum speed 110 km/h.

- RCF was established in 1987 and the first coach was produced in 1988. In 1998 RCF, in a technology transfer agreement with Linkman-Hoffe-Buche (LHB), built LHB coaches with the help of ALSTOM. The LHB coaches are fit to run at 200 km/h, but due to Indian Railway track conditions they are certified for 160 km/h operation only.
- It was noted that RCF is well equipped and that it manufactures 97% of the parts of the LHB coaches, with the remaining 3% of the parts being imported from Europe. The transfer of technology required six years and RCF is now capable of independent production.
- RCF manufactures 1600 coaches annually and of these 500 coaches are the modern LHB. It is expected that 800 LHB coaches will be produced next year.
- Another factory in Raibrelli, which is in Uttar-Pradesh, produces 5 LHB coaches per month. The total capacity of this factory at full utilization will be 1000 coaches per year.
- RCF can tests coaches for speeds of up to 200 km/h and these coaches are outfitted with disk brakes.
- In RCF, steel for production comes from the east of India.
- The government established the RCF in Kapurthala to stimulate employment and development in the area. The total number of employees at RCF is 8000, and facilities include residential accommodation, schools, a hospital, and playgrounds. There are 160 officers and of these 100 are engineers. RCF has 100 to 150 supervisors.
- Regarding the safety of items, RDSO is the controlling authority and purchases can only be done only after their certification.
- Quality is handled by a quality manager. Note that all designs must be approved by the Commissioner of Railway Safety.
- RCF took the Team on a tour of its factory, which basically consists of the following five shops:
  - Sheet metal fabrication shop (for sheet cutting, laser cutting)
  - Assemble shop (for welding of side walls, roofs, floors etc.)
  - Print shop
  - Furnishing shop
  - Bogie shop

- After the tour, the RCF gave the Team gave an audio-visual presentation of its factory and presented a CD of said presentation, together with a brochure, for its use.

7. Activities for 8th November 2011

Location: Research Design & Standards Organization (RDSO), Lucknow
Time: 10:30 to 14:30
Present: RDSO- Rajesh Kumar (Exec. Director- Urban Transport & High Speed), Aniruddh Gautam (Exe. Director- Industrial Development), Harsh Khare (Director Electrical), S.K. Gupta (Director Civil), Kaushal Kumar (Director Signaling), B.K. Shrivastava (Director Lab.)
JICA Survey Team- William Hayes (Deputy TL), Mitsuyuki Osawa (HSR Systems Expert), Atsushi Kamiyama (Project Financing Expert), Rajesh Bhatt (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)
Record: The Team introduced itself and described the purpose of the JICA Survey and the training, seminars, and workshop that will be held by it. After that, the following points were made from the subsequent discussion that took place:

- The Team inquired about the questionnaire it sent to RDSO prior to its visit. RDSO informed the Team that most of this information is available on its website, but gave a quick overview of itself.
- RDSO has 3000 employees and 30 directorates and it is the only research organization of Indian Railways and therefore plays an important role. It has inspection offices throughout the country to carry out certification.
- There are also sixty to sixty-five core groups in RDSO that carry out all kinds of research and inspection of products used in railways.
- It is the responsibility of RDSO to examine how HSR or other new technologies can be implemented in India. In fact, it was stated by RDSO that they are essentially the "keepers of railway technical knowledge" for the Indian government.
- It was noted that although Metros are under the jurisdiction of the Ministry of Urban Development, their safety is under the purview of RDSO.
- RDSO mentioned that a seminar to exchange information with HSR manufacturers was held on 16th September 2011 and included Kawasaki, Siemens, Bombardier, and Alstom.
- The issue of interoperability was discussed and Director Civil is of the opinion that the HSR should be broad gauge. The Team stated that from the viewpoint of safety it would be wise not to have conventional rail and HSR operating on the same track.
- RDSO stated that signaling and telecommunications, as well as rolling stock, technologies are portable but that civil engineering is not and that RDSO therefore does not have as much knowledge about civil standards as it would like.
- RDSO requested the Team to provide it with Japanese standards and specifications for civil works for HSR as they expect this to account for about 75% of its cost. There was interest in ballasted and non-ballasted track technology, bridges and tunnels, as well as in the system of construction and maintenance methodology. The Team said it would consider the request but that much of the documentation may be in Japanese.
- RDSO mentioned that at present it basically follows European standards.
- The Team noted that HSR civil engineering standards for India may not need to be as high as Japan, as Japan is an earthquake-prone country and has difficult geo-technical conditions.
- RDSO inquired about the certifying authority for Rolling Stock in Japan. The Team responded that this is the responsibility of the manufacturer and is done in the presence of the operating agency and there is no agency similar to that of RDSO or the Commissioner of Railway Safety in India.
- Finally, RDSO took the Team on a tour of some its facilities that included its Engine Development Lab (which included the creation of alternative fuels such as CNG and bio-diesel), Brake Testing Lab., etc.




8. Activities for 9th November 2011

Location: Ministry of Railways (Railway Board), New Delhi
Time: 12:30 to 13:15
Present: Railway Board- V.K. Singh (Exec. Director- Public Sector Undertakings)
JICA Survey Team- William Hayes (Deputy TL), Mitsuyuki Osawa (HSR Systems Expert), Atsushi Kamiyama (Project Financing Expert), Rajesh Bhatt (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)

Record:

- The final version of the Training and Seminar Program in Japan was explained by the Team and agreed to by Mr. Singh.
- The Team requested that MOR email the bio-data forms, together with scanned copies of passports, for the Indian experts participating in the Program by 15th November 2011.
- The Team also requested that MOR provide it with the specifications for India's railway system. Mr. Singh said he would but that he would like a list of the particular specifications the Team wishes to have.
- The Team queried whether it has been decided that standard gauge will be used for India's HSR, and the response was that standard gauge has been selected.

- The Team also inquired as to whether there are any quotas on the percentage of foreign versus Indian components for the HSR. Mr. Singh said that no such restriction exists.
- Finally, Mr. Singh stated that he would provide answers to our questionnaire by November 25th instead of today.

JICA Survey Log
January 11th – January 25th, 2012

1. Introduction

A Team of experts from the Japan International Cooperation Agency (hereafter referred to as the Team) arrived in New Delhi on 10th January 2012 to begin the collection of information and data over a period of fifteen days for the second field visit of the "Needs Survey on High Speed Railway and Skills in India". This memorandum contains a summary of the hearings and interviews with government officials and organizations in New Delhi, Bangalore, Chennai and Ahmedabad, together with a description of on-site activities, and will form part of the Team's reporting.

2. Activities for 11th January 2012

On this date, meetings were held with JICA, at 11:30 am, and MOR, at 3:00 pm, to kick-off the second field survey. A summary of the MOR meeting is provided below:

Location: MOR, Delhi
Time: 15:00
Present: MOR- V.K. Singh (Exec. Director-PSU), Archna Mittal (Director Mechanical-Freight), and other senior officials of the Mechanical Department
JICA Survey Team-Shinya Nakamura (TL), William Hayes (Deputy TL), Atsushi Kamiyama (Project Financing Expert), Mitsuyuki Osawa (HSR Systems Expert), Masaaki Hara (Mechanical Engineer) S.K. Mallik (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)

Record:

- The Team queried the MOR about a possible JICA workshop, which is tentatively scheduled for February 2012, and also stated that it wanted to visit factory shops in Gujarat and Chennai.
- MOR suggested a visit to the Kapurthala Rail Coach Factory to meet with Mr. Raj Shekhar (Head).
- The Team requested also a visit to the Integral Coach Factory in Chennai.
- MOR suggested a meeting with Rajeev Malhotra, Managing Director of RITES, and suggested a visit to the wheel and axel plant of Indian Railways.
- The Team advised that would like to meet with BEML, a coach factory in Bangalore, to discuss technical issues.
- The Team requested to hold a discussion about the Interim Report on 17th January 2012 and agreed to submit the report on Friday (13-01-2012) for MOR's examination.
- The Team was keen to know about HSR information required by MOR for the proposed workshop.
- MOR suggested that the Team give a presentation on HSR during the proposed workshop.
- The Team requested a presentation about the Japan study tour attended by MOR also be given.
- Mr. Singh informed that MOR would like to discuss technical issues in more detail and country-to-country cooperation at the workshop.
- The Team requested to invite the Chairman of MOR.
- MOR advised that they will request him to come and informed them about his busy schedule at this time due to budget session and suggested the dates (16th or 17th February) as an appropriate time for the workshop.
- The Team accepted 17th February 2012 tentatively and requested preparation of a presentation on the seminar, which was held in Japan.
- MOR informed that they will prepare this presentation.
- The Team stated that it would like to discuss HSR financing.
- MOR advised to contact Mr. Jagmohan Gupta regarding finance.
- The Team requested the next five-year plan.

- MOR informed that officially it has not been issued. However, the approach paper is available with the Planning Commission.

3. Activities for 12th January 2012

The Team met with officials of Mitsubishi to collect information about the localization of coach production.

4. Activities for 13th January 2012

On this date, a seminar was organized by MLIT Japan on HSR.

Location: Lalit Hotel, New Delhi
Time: 10:00
Present: TTILIT, MOFA, METI, JITI, CGPR, JETRO, JICA and CII
Minister of Railways and other officials from railway and railway-associated departments, including DMRC
Record: On this date, speeches were given by various dignitaries from Japan and India. Below is a summary of these speeches.

Mr. Takashi Kitamura (Vice-Minister of MLIT)

- There is a desire by India's MOR to realize HSR by 2020.
- HSR can cater to the growth in Indian passenger travel in a safe and stable manner and operate at the required high frequency.
- India is considering development of HSR on six corridors.
- The Shinkansen can play a great role in the development of India's HSR and thereby its society and economy.
- The Shinkansen is safe and stable and can operate at a high frequency.
- Japan is willing to support and cooperate on HSR with India.

Mr. Satoshi Seino
President and CEO East Japan Railway Company (JR East)

Acting Chairman
Council of Global Promotion of Railway

- HSR is needed due to the large amount of traffic congestion.
- JR East built the first HSR in 1960.
- India is a large country with a huge population and good economic growth.
- Indian Railways network is more than 3,000 km.
- HSR will play an important role in our relations with India.

Mr. Makoto Washizu
Vice Chairman, Institution for Transport Policy Studies (ITPS)
President, Japan International Transport Institute (JITI)

- India is one of the leading countries in the world.
- India has 8 times the land area of Japan and 10 times its population with an annual GDP growth of 8-9% in recent years.
- It is also well known to all that information technology will continue to play an important role in India's economy.
- India's economy will also play a vital role along with the economies of the US and China in the near future. Taking into consideration the rapid increase in population and economic growth, it is important to provide appropriate transportation and infrastructure network.
- In order to ensure a comfortable lifestyle as well as smooth mobility, HSR should be implemented quickly for the people of India, as it is necessary to provide quality intercity transportation in a manner that is energy efficient and considers global warming problems.
- According to estimates from TERI, road and rail transport will be 70% larger than the current level by the year 2020. Also, air traffic will increase by 110%, indicating a need for HSR.
- Road and air transport is fully dependent upon oil and it is estimated that India will need to import 90% of its oil in 2030.
- India should focus on other means of transportation that consumes less oil such as the HSR.
- India is planning six HSR corridors; however, more corridors need to be planned, given its economic and population growth.

Shri Dinesh Trivedi, Minister of Railways, Government of India

- Mentioned the 68th year of Indo-Japanese diplomatic relations, which are becoming stronger and stronger.
- There is no doubt that HSR is going to be a new and strong chapter in Indian Railways history.
- Exciting time as far as the railway system is concerned and as far as Indian growth is concerned. The world is getting a little flat in terms of economic growth but India's growth is robust.
- India cannot grow without the railways system growing and is the engine of Indian growth. Therefore, indirectly, Indian Railways is going to be the engine of growth of the world at large. The organization is one of the best in the world and has more than 4 million employees. Right from the gagman to the members of the board, Indian Railways people are very professional. Just like an army, you give them a task and they will deliver.
- Indian Railways is absolutely competent to take any kind of task forward.

- The presence of Mr. Kitamura, Vice Minister for MLIT Japan and the distinguish guests clearly underline the keen interest taken by Japan on development of HSR in India.
- Indian Railways is the third largest railway system in the world, with about 64,000 km of routes, 7 billion passengers-km and more than 900 million tons of freight traffic. It, however, accounts just for little more than 10% of the total passenger traffic in the country and about 30-35% of the freight traffic.
- In this respect, the Dedicated Freight Corridor, which is receiving substantial support from Japan, is a step towards rectifying this situation and measures are also being taken to increase the speed of passenger trains to about 200 km/h. It may not sound very encouraging when compared with Japan's HSR, but we have to make a beginning somewhere. We are still at an exploratory stage as far as HSR is concerned, which is an important mode of transport for linking major cities and business centers in an environmentally friendly manner. We are looking forward to taking the initiative for HSR and would be dependent on the front runners for this, which include Japan, China, Spain, Taiwan, and Germany, with Japan being at the top.
- We have heard how safe and efficient the Japanese HSR is. It is a great milestone that there has not been a single major incidence in its 47 years of operation. In this respect, I have formed a Committee of experts for safety. In the 12th Five Year Plan of India investment of one trillion USD is envisaged, and a major portion of this will be going to Indian Railways so initiatives such as the HSR can be taken.
- I was thinking who could be the best people to understand safety protocol and my answer was those people who deal with nuclear science and those people who deal with space technology, because their protocol is of zero tolerance. I was fortunate to get acquainted with Dr Anil Kakodkar, who is one of the best nuclear scientists perhaps in the world, to head the Committee. I must tell you that I have also another committee comprised of Mr. Sam Petroda, Mr. Deepak Parik, and Mr. E. Sridharan, who are pioneers in Indian Railways, and they are going to tell us how to take Indian Railways forward.
- Both of these committees are to give us significant inputs and I am sure that these kinds of inputs are going to take Indian Railways to the 4th or next generation.
- A comprehensive modernization program of Indian Railways is being launched. This program will include provisioning of modern track, signaling systems and rolling stock on high traffic density and other important routes.
- Passenger trains will run at higher speeds and freight trains will carry heavier loads faster, and there will be large-scale upgrading of both passenger stations and modern freight logistics to enable real-time operation.
- World class indigenous research facilities will be established to promote railway-related technology.
- More dedicated freight corridors will be built to segregate freight and passenger train operations and high-speed passenger corridors having the potential to run at 300 km/h will be built.
- Also, there will be a separate authority to mange railway stations.
- Investment of 1 trillion USD will help Indian Railways shift traffic from road to rail, which will be good for passengers using both road and rail.
- As we know that the world is becoming environmental friendly we should consider issues related to carbon credits.
- The whole world is aware that Japan is a pioneer in introducing the first HSR as far back as 1964, known as the bullet train or Shinkansen between Tokyo and Osaka. Japan's HSR symbolizes the highest standards of safety, punctuality, efficiency and compliance with environmental norms. We are therefore, extremely happy to note that the Government of Japan has shown a keen interest to associate with us.

- Vision 2020 of Indian Railways envisages a target of completing four HSR corridors totaling 2,000 km, and plans for the development of another 8 corridors with target completion dates set for 2019-20.
- At present, three pre-feasibility studies out of a total of six for identified HSR corridors are on-going. One study is being undertaken by a Japanese consortium, while a national HSR authority for planning, implementing and monitoring HSR projects is also and under formation.
- The Shinkansen has continuously innovated to achieve cutting-edge technology in the sphere of HSR. For example, trains now run at an axle load of 12 tons whereas in the recent past this was 16-17 tons.
- Fuel efficient technology would be crucial for a country like India where we need to carry more passengers at reasonable tariffs, which would be served by making provisions for high-capacity coaches and making axle loads fuel efficient.
- Issues like heat and humidity, adaptability of technology to Indian conditions, funding requirements, socioeconomic conditions, etc. would also need to be addressed to arrive at a functional business model for HSR.

Mr. Naresh Aggarwal
Vice Chairman CII Railway Equipment Division
Chairman, Sun star overseas limited, Delhi
Co-Chairman cum Managing Director, VAEVKN private limited

- CII has a very long association with Indian Railways.
- The railway sector, after a century of service, is very important for this country and a lifeline to the people of this nation.
- Tentatively, it has been estimated that the investment requirement for rail development is around 264 billion USD for the next 10 years. To address this need the quantum of PPP schemes has to be considerably expanded.
- The Union Railways are planning to have HSR operate at 250 km/hr on dedicated track.
- HSR will result in environmental benefits, as it much more fuel efficient than road transport. Also, much less land is needed to serve the same number of passengers as road transport.
- HSR will reduce travel time and allow people to commute from further distances and thereby providing greater flexibility regarding home and work.
- Indian Railways initially ventured into high-speed trains with the introduction of the Rajdhani in 1970 and then the Shatabdi trains that run at 140-150 km/hr.
- Due to its high cost, HSR will require funding from the central government, apart from PPP schemes, which will lead to innovative techniques for highly capital intensive projects such as HSR.
- It is hoped that the initiative of establishing a High Speed Rail Transport Authority will result in HSR being constructed in a timely manner that will alleviate congestion and pollution on the roads as well as in a speedier transport network, which can be achieved with an HSR system capable of running at speeds 350 km/hr.
- Finally, the HSR corridors are also expected to catalyze development of towns along their routes and perhaps reduce migration to metropolitan cities.

After the above address, presentations were given by the following experts:

1. Mr. Akihiko Tamura, Department General, Railway Bureau, Ministry of Land, Infrastructure, Transport and Tourism

Salient Features:
- Japan's current High Speed Rail Network
- The main features and advantages of the Shinkansen
- Towards the introduction of High Speed Rail in India
  - India: Country with high potential for HSR
  - Construction scheme of the Shinkansen
  - The benefits brought by the Shinkansen

2. Mr. Satoshi Seino, President and CEO of East Japan Railway Company

Salient Features:
- Outline of JR East
- Features of Shinkansen HSR
- Economic effects
- Conclusion

3. Mr. Tsutomu Morimura, Senior Executive Director, Central Japan Railway Company

Salient Features:
- Overview of Central Japan Railway and Tokaido Shinkansen
  - Safety & Punctuality
  - Dedicated line with no level crossing
  - Automatic Train Control (ATC)
  - Shinkansen control centre
- Introduction of the N700-I Bullet
  - Explanation of N700-I Bullet
  - Rolling stock specifications
  - Low-energy consumption
  - Mass transport
  - Optimum seat capacity

4. Mr. Masashi Ishizuka, Associate Officer, Kawasaki Heavy Industries Ltd.

Salient Features:
- Company profiles and products
- Record of High Speed Train Protection
- Important factors for planning HSR
- Total system safety and low operation costs

5. Mrs. Akshima T. Gate, Fellow, Centre for Research & Sustainable Urban Development and Transport Systems, Sustainable Habitat Division, Energy & Resources Institute (TERI)

Salient Features:
- Passenger transport sector in India
- Growth in passenger sector in India
- Dominance of road sector
- Slow growth of rail infrastructure
- Passenger transport growth tendencies
- BAU trends expected to continue in future
- Energy consumption level to increase in the future

- Energy efficient options
- HSR benefits, key requirements, investment requirements, impacts and challenges

6. Mr. Yosuke Takada, Director of International Affairs Office, Japan International Transport Institute (JITI), Institute for Transport Policy Studies (ITPS), Japan

Salient Features:

- Benefits brought by the introduction of HSR
- Criteria to assess suitable country or area for HSR, taking these benefits into account
- Future vision of HSR network in India

5. Activities for 16th January 2012

On this date, the meeting was held with the Planning Commission in the morning and with MOR in the afternoon.

Location: Planning Commission, New Delhi
Timing: 11:00
Present: Planning Commission- Dr. Manoj Singh, Advisor Transport
JICA Survey Team- Shinya Nakamura (TL), William Hayes (Deputy TL), Atsushi Kamiyama (Project Financing Expert, Mitsuyuki Osawa (HSR Systems Expert, JICA, Mr. Masaaki Hara, Mechanical Engineer, JICA, Mr. S.K. Mallik, Senior Coordinator, JICA, Mr. Naresh Kumar, Junior Coordinator, JICA

Record:

- The Team expressed their support for HSR in India. A seminar was held in Japan in December 2011, wherein twelve officials from MOR visited railway companies and private companies. The signaling system, rolling stock and maintenance of HSR in Japan were shown to MOR officials.
- The Team suggested that there will probably be another workshop in Delhi on 17th February 2012 with railway and other related transport departments.
- The Team inquired about the Planning Commission's 12th Five Year Plan.

- The Planning Commission stated that at present only the approach documents are available on its website.
- The Team wanted to know the allotment of funds for HSR in the next 12th Five Year Plan.
- The Planning Commission stated that funding allotment is not indicated in its plan but only the total budget.
- The Team mentioned that funding could also be available from the Japanese Government.
- The Team inquired about the contribution of funds from the central and private sector. The Team also wanted to know if the HSR Project would be PPP based or non-PPP based and also wanted to know if the Indian government will consider Japanese funding for this project.
- The Planning Commission replied that it is keen for PPP schemes to be used but that other methods of funding could also be considered if appropriate. PPP schemes for railways are contained in the 12th Five Year Plan.
- Planning Commission inquired about the business models in Japan for HSR.
- The Team explained about the funding structure in Japan, whereas the Japanese government contributes about 80% of the funding for civil works. Also, recently, private companies pay a fee to use the civil structures.
- The Planning Commission also inquired about the procurement of rolling stock in Japan.
- The Team explained that rolling stock is procured and maintained by private companies. The private companies also generate revenue from non-rail businesses like shops, hotels and office buildings.
- The Team inquired whether HSR is a high priority for India.
- The Planning Commission stated that it is high on their list of priorities, but depends on the budget of the Union Government of the India.
- The Team wanted to know about the budget for HSR.
- The Planning Commission stated that MOR would be in a better position to discuss that.
- The Team also wanted to know about the viability of HSR between Pune-Ahmedabad and Delhi-Amritsar.
- The Planning Commission stated that the pre-feasibility study was done by MOR and that it would know.
- The Planning Commission also wanted to know about the nature of the survey study, whether it is an engineering study or economic study.
- The Team explained the nature and purpose of the survey and mentioned that JICA is ready to provide both technical and financial support for HSR in India.
- The Team wanted to know if Planning Commission has plans to discuss with the State Government about the 6 corridors.
- The Planning Commission stated that MOR is responsible for this. Railways are operated by the central government and if state governments want they can meet with the central government. After that, it comes to the Planning Commission.
- The Team wanted to know about the land acquisition.
- Planning Commission stated that land acquisition is a state government issue. Acquiring land depends upon the farmer-owner negotiations by the state government. The cost of such land will depend on the priced fixed by the owners of the land and state government.
- The Planning Commission expressed interest in technology transfer for the HSR. The Team gave an example about DMRC, where JICA experts and Tokyo Metro provided the necessary knowhow.
- The Team explained about the seminar held in Lalit Hotel, Delhi on 13th January 2012. MOR was very positive about Japanese willingness to work together.
- The Planning Commission wanted to know whether JICA had assisted China's HSR.
- The Team explained that Japan assisted the Chinese on their railway projects regarding rolling stock. Especially, JICA and the JR Group assisted China with technology transfer.

The Kawasaki factory was established in China through a joint venture. On the other hand, the signaling system, which caused the crash, was not from Japan.

- The Team explained that although the Chinese system is cheaper nobody really wants it.
- Planning Commission wanted to know about future plans of HSR in Japan.
- The Team explained that Japan is trying to extend its network up to 3,000 km or more.
- The Planning Commission wanted to know the per km cost of construction for HSR in Japan.
- The Team replied that it was 16 billion yen per km in Japan, but it would be cheaper in India, since in Japan there are multiple issues such as rough mountainous terrain and frequent earthquakes.
- The Planning Commission wanted to know about rolling stock.
- The Team suggested that it should be eventually localized.
- The Planning Commission wanted to know about the workshop to be held on 17th February 2012, as it may want to attend.
- The Team explained that they will discuss with JICA and revert back. The workshop itself will deal with technical issues, operations, maintenance, rolling stock and financial schemes.

Location: MOR, New Delhi
Time: 15:00
Present: MOR- V.K. Singh (Exec. Director-PSU), Archna Mittal (Director Mechanical), Mukund Sinha (Director Planning (ME)) and other high officials of MOR
JICA Survey Team- Shinya Nakamura (TL), William Hayes (Deputy TL), Atsushi Kamiyama (Project Financing Expert), Mitsuyuki Osawa (HSR Systems Expert), Masaaki Hara (Mechanical Engineer), S.K. Mallik (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)
Record:

- The Team discussed the agenda of the workshop and wanted to discuss technical issues and relevant standards as well as discuss about the study Team's Interim Report and the workshop in India.
- The Team suggested that the workshop be in February 2012 and that technical issues be discussed in the first half and soft issues (i.e., finance) and maintenance in the second half.

- MOR advised inviting state ministers to discuss state issues and to invite the BEA & MEA Planning Commissions to discuss financial issues.
- MOR also stated that they would like to cover the presentation on technical issues and financial issues and MOR would like to have detailed information on track issues, especially on the power side.
- MOR further stated that they are considering the organizational structure.
- The Team suggested that MOR invite the Chairman of the Railway Board to the workshop.
- MOR advised to also include the GM, while they will try to include the Chairman of Railway Board.
- The Team wanted to know whether it would be better invite Indian Companies.
- MOR advised inclusion of Indian Companies as per the MLIT list and Secretary/Principal Secretary Transport.
- The Team requested the guidance of MOR for invitation of people to the workshop.
- MOR also suggested inviting private Japanese companies to the workshop.
- MOR further suggested inviting ministries, RDSO, financial institutions, state governments, urban transportation institutions, TERI, IIM Ahmedabad and Educational Training Institute.
- The Team requested to discuss this with JICA.
- The Team further requested a meeting on 24th January 2012 to discuss this in more detail.
- MOR stated that they wanted to see an audio visual presentation about HSR in Japan.
- The Team member explained the Interim Report, which included the first field survey carried out in the month of November 2011.
- MOR suggested deleting Annexure 3.1.2 of the Interim Report, as it was not correct.

6. Activities for 17th January 2012

Location: NTDPC, New Delhi
Timing 15:30
Present: NTDPC- B.N. Puri (Member Secretary)
JICA Survey Team- Shinya Nakamura (TL), William Hayes (Deputy TL), S.K. Mallik, (Sr. Project Coordinator)
Record:

- The Team explained the survey it is carrying out using the Interim Report it had prepared in December and handed over one copy to NTDPC for its reference.
- The Team explained about the seminar held at Lalit Hotel in New Delhi on HSR on 13th January 2012, which was attended by the Minister of Railway, along with the Chairman of the Indian Railway Board and other high officials of Indian Railways, and by high officials of other ministries and CII.
- NTDPC wanted to know about the objectives of the present JICA study.
- The Team explained the objective was to determine the needs of India in introducing HSR to its country.
- NTDPC expressed concern about whether it would be viable to introduce HSR in the present Indian context.
- The Team explained the need for establishing faster rail transport to satisfy the social and economic needs of the country, as illustrated by the large numbers of air travelers.
- NTDPC wanted to know the view of the Planning Commission on the JICA Team visit.
- The Team stated that the Planning Commission was giving HSR high priority and ad cooperated with the Team in its survey.
- NTDPC expressed concern about the affordability of HSR, stating that HSR for a 500 km stretch would require approximately INR 30 billion, which is equal to the total annual railway budget.
- NTDPC suggested if JICA could provide funding, then the Indian Government may be able to provide supplementary funding.
- NTDPC wanted to know how viable HSR is in relation to air and road transportation, its total cost and financing mode. NTDPC also wanted to know RDSO's view on HSR technology.
- NTDPC stated that the Prime Minister desires HSR on a long term basis, subject to the decisions of the Planning Commission.
- NTDPC state that the real usage cost of passengers in India will be much higher than Japan.
- It is not feasible to introduce HSR on a short term basis (i.e., during the 12th Five Year Plan).
- The Prime Minister has set up a committee for HSR in the Planning Commission and it will decide the future policy of HSR. The PMO is monitoring the Planning Commission for the same and accordingly we have started working in July 2009.
- NTDPC wanted to know whether there are any PPP schemes being considered by JICA for HSR, as Indian Railways has hardly any PPP experience.
- The Indian Prime Minister is very keen on HSR and the dedicated freight corridor system and his thinking is similar to that of Tokyo.
- NTDPC further stated that new freight corridors are more important in the present railway system and the same has also been opined by Dr. E. Sridharan (former MD of DMRC).
- Ultimately we will be requiring HSR, but depending upon two things:
  1. Funding
  2. Viability

Location: BEML, Bangalore
Timing 12:00
Present: BEML- Ashokan- (Chief General Manager/), Manjunathan (General Manager)
JICA Survey Team- Mitsuyuki Osawa (HSR Systems Expert), Masaaki Hara (Mechanical Engineer, Naresh Kumar (Project Coordinator)
Record:

- The Team explained the purpose of the visit to inquire about BEML's interest in manufacturing railway coaches for high speed trains, and if required to do technological transfers from Japan.

Introduction of BEML

BEML (Bharat Earth Movers Limited) governed under the Ministry of Defense; is mainly divided into to three segments:

- Mining equipment (technical collaboration with Komatsu-Japan), both domestic and export markets such as Indonesia, the Middle East, Malaysia and Africa.
- Defense products-Trucks, floating bridges, etc.
- Rolling stock (suburban & metro trains)

BEML, established in 1964, started manufacturing conventional railway coaches and EMU for Indian Railways, now most of the conventional railway coaches being built are transferred to the Integral Coach Factory (ICF) and Rail Coach Factory (RCF), both are governed by the MOR. BEML started building metro rail coaches in 2004 after securing orders from Delhi Metro.

Presentation on BEML
Rail Products:

Electric Multiple Unit Metro Car-Broad Gauge (DMRC-RS1 Project)
Electric Multiple Unit Metro Car-Standard Gauge (DMRC-RS3 Project)
Rail Coach
Rail Bus
AC EMU
SS AC EMU
Wheeler OHE Inspection Car
4 Wheeler OHE Inspection Car
Utility Track Vehicle
BOBRNAL Wagon
METRO CARM-Standard Gauge (BMRC Project)
Track Laying Equipment
Spoil Disposal Unit
Catenaries Maintenance Vehicle
Sky Bus Coaches

- The Team wanted to know the year in which BEML started manufacturing rail cars
- BEML stated that they started manufacturing metro coaches in 2004 and conventional coaches in 1964.
- The Team wanted to know when BEML's factory was established.
- BEML replied in year 1964.

- The Team learned that BEML works under the Ministry of Defense, not the Indian Railway, so inquired why BEML started manufacturing rail coaches.
- BEML explained that initially they manufactured defense equipment. In order to grow BEML, it started working with Indian Railway later on.
- The Team wanted to know who the major customers of BEML are in India and outside India.
- BEML explained that regarding metro BEML has no customers outside of the country. It is only for the wiring and construction that BEML has customers outside India.
- The Team wanted to know to which companies BEML started to export to outside India.
- The BEML explained that they have exported to Europe, South Africa and the Middle East.
- The Team wanted to know about the products that are manufactured in their factories.
- BEML explained that here BEML manufactures only rail and metro coaches. BEML has two other units: one in Kolar Gold Fields (KGF), Karnataka, and another in Mysore. At KGF BEML manufactures mining equipment and engines & dump trucks at the Mysore plant. Recently, BEML has decided to start an aerospace business in Mysore.
- The Team wanted to know the number of employees working in the BEML factory.
- BEML replied that there are 3,500 employees.
- The Team wanted to know how many are engineers and how many are workers.
- BEML stated that there are 1,500 officers (engineers) and the rest are workers.
- The Team wanted to know how many cars are manufactured per year.
- BEML answered 12-14 metro coaches and 40-50 conventional coaches per month at Bangalore and 30 conventional coaches per month at KGF. For metro coaches, if more need to be manufactured, BEML can use its Palakkad unit, which has just has started business. Therefore, infrastructure with large capacity is available.
- The Team wanted to about know the products manufactured in this factory.
- BEML stated that it manufactures only car bodies and the bogies come from Rotem and propulsion parts are imported and assembled here.
- The Team wanted to know the total time it takes to build a metro complete car.
- BEML stated that for one car it takes 6 months.
- The Team wanted to know about the body materials used for metro cars.
- BEML stated that they use stainless steel.
- The Team wanted to know the materials used for conventional cars.
- BEML stated that they use cotton steel.
- The Team wanted to know whether the BEML made any coaches with aluminum and if so where.
- BEML stated that only wagons (freight) are made by aluminum in this factory.
- The Team wanted to know about the tie-up of BEML with other countries for metros.
- BEML stated Rotem from Korea and propulsion systems from Mitsubishi in Japan.
- The Team wanted to know about the good points of Japanese manufacturers.
- BEML stated that they are good in quality and are transparent.
- The Team wanted to know how BEML get orders for manufacturing rolling stock from operational companies.
- BEML stated that it is through a bidding system.
- The Team wanted to know about the procurement of equipment needed for rolling stock. For example, power supply, car bodies and brake systems.
- BEML stated that the customer will specify which item is to be bought from whom. They specify everything in the tender.
- The Team wanted to know who designed first metro car.
- BEML stated that it was Rotem.
- The Team wanted to know who designed the BEML cars.

- BEML stated that the original design came from Rotem.
- In the case of DMRC, the Team wanted to know who designed the cars.
- BEML stated that Rotem designed the cars as part of a consortium. The design party is Rotem, while some DMRC cars were designed by BEML.
- The Team wanted to know who negotiates prices for purchasing the material from other companies.
- BEML stated that they do it themselves.
- The Team wanted to know the purpose of BEML in manufacturing rolling stock, but not maintenance.
- BEML stated that, it is a consortium and there are three other partners: Rotem, Milko (for marketing), Mitsubishi (for electric) and BEML.
- The Team wanted to know the latest product of BEML.
- BEML stated that for Jaipur Metro, BEML is going to supply 40 cars to them by April 2013.
- The Team wanted to know the consortium in the case of Jaipur Metro.
- BEML stated no one.
- The Team wanted to know who designed the car body of Jaipur Metro?
- BEML stated that they designed the cars themselves.
- The Team wanted to know the cost per car.
- BEML stated that their marketing people would know that the answer.
- The Team wanted to know about the design engineers working with BEML.
- BEML stated that there are around 60-70 design engineers.
- The Team wanted to know the design specifications of the rolling stock for Jaipur Metro.
- BEML stated that the specifications were given by the customer in the tender documents.
- The Team wanted to know the number of R&D people in BEML.
- BEML stated that there are about 60-70 design engineers (Design and R&D Department is combined).
- The Team wanted to know about the quality control method used.
- BEML stated that it is ISO 9001, 2008.
- The Team wanted to know about the work schedule of BEML.
- BEML stated that it has only two shifts. One is 7:00 am to 3:00 pm and the second is 3:00 pm to 11:30 pm. In some critical situations, BEML may have a night shift. BEML works 5 days a week, while Sunday is off.
- The Team wanted to know about the training centre and what type of training is provided for employees.
- BEML stated that BEML provides training for welders, fitters, sheet workers and turners. For metro everybody was trained in Korea.
- The Team wanted to know about the ability to manufacture HSR coaches at BEML.
- BEML stated that BEML is already manufacturing metro coaches, so it will be easy for them to switch to HSR. Compared to conventional trains, HSR starts from 200 km/hr, which will be easy to catch up.
- The Team wanted to know the total area of the factory.
- BEML stated that it is around 700 acres.
- The Team wanted to know if TOT for HSR coaches can be possible at BEML.
- BEML stated that in the Mysore plant, they can start, since they have a lot of space there.

Factory Visit

Conventional car bodies manufacturing unit
Bangalore Metro manufacturing unit
- Bogies are imported from Korea

- Primary and secondary suspension (Korea obtains from Japan).
- Couplers from Germany.
- Inverter boxes from Mitsubishi.
- Doors from Spain.
- Interconnection gauges from Austria.

7. Activities for 19th January 2012

On this date, a meeting was held with Gujarat State Government in the morning to discuss about: confirmation of budgetary potential on the expected HSR Project, relevant plans along the route, procedures for land acquisition, etc.

Location: Gujarat State Government
Timing 11:30
Present: Gujarat Govt. - A.K. Sharma (Sec. to Chief Minister), Shardul Thakare (Senior Manager, Gujarat Infrastructure Development Board (GIDB))
JICA Survey Team- Shinya Nakamura, (TL), William Hayes (Deputy TL), Mr. Mitsuyuki Osawa (HSR Systems Expert), Atsushi Kamiyama (Project Financing Expert), Masaaki Hara (Mechanical Engineer), Naresh Kumar (Project Coordinator), S.K. Mallik (Sr. Project Coordinator)
Record:

Presentation session on GIDB

Salient Features:

- 565 km of the Dedicated Freight Corridor DFC (38%) falls in Gujarat. That means 169,000 square km of industrial corridor.
- Special Investment Region (SIR) at Dholera.
- Early bird projects.
- Mega industrial parks: the heart of the SIR.
- Dholera SIR: New International Airport.
- SEZs in Gujarat.

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- The Team queried about the formation of GIDB.
- GIDB explained that in 1996 it was formed as a society and later on in 1999 it converted to a board. It provides advisory services to the Government of Gujarat. It supports the Gujarat Industrial Development (GID) Act to facilitate other departments on various projects on the fast track mode.
- GIDB explained that it comes under the Gujarat Ministry of Industries; the Chairman of the board is the Chief Minister. GIDB has a transport plan and considers DMIDC: BIG 2020-Blueprint of infrastructure of Gujarat. It includes rail, metro activities, etc.
- GIDB stated its keen desire to build world-class infrastructure for Gujarat, including HSR. GIDB mentioned that in addition to the Ahmedabad-Mumbai HSR, it would like to connect Ahmedabad with Dholera, which will have an international airport and is a Special Investment Region.
- The Team asked about the importance of the Dholera route.

- GIDB explained that right now there is no potential, but GIDC is working on developing future potential.
- The Team queried about the exchange of ideas between GIDC and MOR.
- GIDB stated that MOR would not be involved in the Ahmedabad-Dholera line and would only give principal approval. It was noted that the line may even go further south-west to a place called Bhav Nagar, which is a port city. Therefore, a fast train would connect Ahmedabad, Dholera and Bhav Nagar.
- The Team queried about funding for the extension, as the central government will fund the Ahmedabad-Mumbai-Pune corridor.
- GIDB explained that there would be separate funding by the Government of Gujarat and it would be part of the DFC & DMICDC projects.
- The Team explained the purpose of its survey and the study tour held in Japan, together with the seminar sponsored by the Japanese government on 13th January 2012 in Delhi.
- GIDB stated that the Gujarat government is keen about HSR and contributed 25% of the cost of the HSR pre-feasibility study. The Gujarat government would like to see the HSR project begin immediately and considers it to be of great importance, as many people travel between Ahmedabad and Mumbai.
- GIDB further explained that airfare is still expensive and that if HSR is cheaper it would fill a very important role.
- The Team stated that in Japan the HSR fare from Tokyo to Osaka is almost same as air, but HSR is faster and lot of people switch to that.
- The Team stated that in Japan, HSR is preferred over air travel for distances of 500km to 700km.
- GIDB stated that although it has not yet made an arrangements for the Ahmedabad-Mumbai HSR, as this is mainly the job of the central government, it will do what it can to cooperate (including land acquisition and funding).
- The Team queried about the percentage of funding to be contributed by the Government of Gujarat.
- GIDB stated that it has not been worked out.
- The Team asked which cities the HSR will pass throughin Gujarat.
- GIDB stated that they are Ahmedabad, Vadodara, Surat.
- The Team queried about GIDB's help to integrate the station.
- GIDB stated that it would work together with MOR to integrate HSR with it development plans.
- The Team queried about the major issue of land acquisition.
- GIDB stated that for Gujarat land acquisition is not a problem. Fresh land acquisition is very minimal, as MOR has already acquired 65-70% of the land. The rest of the land will be managed by us.
- GIDB stated that it is ready for the Ahmedabad-Mumbai-Pune project and that it only has to be implemented.


8. Activities for 20th January 2012

On this date, a meeting was held with DMRC, Shastri Park Depot in the morning

Location: DMRC, Shastri Park Depot
Timing 11:00
Present: DMRC- P.K. Pathak (Deputy General Manager Operations), Mukesh Kumar (Mechanical Eng. & Vice Principal of DMRC Training Institute)
JICA Survey Team- Shinya Nakamura (TL), Atsushi Kamiyama (Project Financing Expert), Mitsuyuki Osawa (HSR Systems Expert), Masaaki Hara (Mechanical Engineer), S.K. Mallik (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)

Record:

- The Team explained that the purpose of their visit was to see the DMRC workshop to understand its system of operation in relation to the forthcoming HSR project by MOR.
- DMRC explained the operational structure of Delhi Metro and also mentioned that trains run from 60 km/h to 90 km/h on some of its lines.
- The Team queried that if one track fails could DMRC run its trains.
- DMRC stated that its trains can operate on a single track but punctuality would be lost. DMRC said this type of occurrence is very rare.
- The Team queried about derailment.
- DMRC stated that there was only one at the Yamuna Bank two years ago due to a problem with the track.
- The Team queried about rail operation monitoring.
- DMRC explained that DMRC has a CBTC (Computer Bases Track Circuit) now. However, in Phase 3, DMRC is going to apply a radio-based CBTC used in China in order to realize minimal headway.
- The Team stated that CBTC has not been proven yet and asked about the maximum capacity of trains per hour.
- DMRC explained that in peak hours it depends on the line. Line 2 & 3 are the busiest lines. DMRC has headways of around 3 minutes depending upon the requirements for a particular line.
- The Team queried that if the DMRC control system fails how are trains operated.
- DMRC explained that in that case, it would hand over control to the local station, as they have an automatic local control system.
- The Team queried about operation related to safety.

- DMRC explained that it cares about its customers and staff and gives priority to safety and checks all its equipment during non-working hours. From midnight to 6am DMRC carries out its maintenance..
- The Team queried about the transfer of train data.
- DMRC stated that this is done through the Automatic Train Control System (ATC System). That is, from track to train, the DMRC signaling system is controlled via ATC.
- The Team queried about the suppliers of the ATC system.
- DMRC explained that for Lines 1 and 2 the signaling system is provided by Alston, for Lines 3 and 4 by Siemens, and for Lines 5 and 6 by Bombardier.
- The Team queried about the purchase of metro cars from BEML.
- DMRC stated that they were initially purchased from Rotem, but after that they have been purchased from BEML directly.
- The Team queried about the number of control centres.
- DMRC explained that they have only two control centres. One is near Shastri Park and the other is near Metro Bhawan, Connaught Place. Lines 1&2 are controlled by Shastri Park, while the rest of lines are controlled by Metro Bhawan and the Airport Line is controlled by Reliance.
- DMRC has seven depots for rolling stock maintenance. For Line 1 maintenance, there is a depot at Shastri Park. For Line 2 there are two depots: one at Sultanpur and the other at Khaberpas. Then, for Lines 3&4, there are again two depots: one at Najafgarh and one at Yamuna Bank. For Line 5 there is a depot at Mundaka and for Line 6 a depot at Sarita Vihar.
- All depots are responsible for the maintenance of rolling stock (even heavy maintenance). Only materials are supplied by the central depots.
- The Team queried about the DMRC maintenance standards for rolling stock.
- DMRC explained that we have categories, such as the following:
  A check: after 5,000 km
  B1 check: after 15,000 km
  B4 check: after 60,000 km
  B8 check: after 120,000 km
  C1 check: after 400,000 km
  C2 check: after 800,000 km
- The Team queried about the total kilometers run per train per day.
- DMRC stated that it is approximately 450 km per train per day.

Workshop Visit:

Certificate

DMRC, train maintenance depot, Shastri Park, Delhi-53 has established and applies a quality management system for scheduled cleaning and maintenance of trains. ISO9001: 2008.

1. It has capacity to repair 27 trains, 24 4-car consists and 3 6-car consists, which in the future will increase to 52 trains.
2. A check after 5,000 km
   B1 check after 15,000 km
   B4 check after 60,000 km
   B8 check after 120,000 km
   C1 check after 400,000 km
   C2 check after 800,000 km
3. It contains 6 lines, 12 trains can be repaired at a time.
4. The total staff in all 7 depots is around 1,200.
5. The total number of cars is 450.

6. Standard gauge extension is not possible, but broad gauge can be extended up to 8 cars.
7. Maintenance of bogies.
8. AC repair section.
9. RRM – 1,500 (Rail cum Remote Controlled Shuttering Vehicle).
10. Training school of DMRC.

9. Activities for 23rd January 2012

On this date, a meeting was held with ICF, Chennai.

Location: ICF, Chennai
Timing 9:00am
Present: ICF- Abhay Kumar Khanna (General Manager), Dr. S. Ram Prakash (CMS), Hemant Kumar (CME), S.C. Parhi, (CSC), M. Salvaraj (CE), JSP Singh (CEE), Vijay P Meshram (COS), Meera Nageswaran (FA), L.N. Prasad (CDE/Elec), S. Srinivas, (CDE/Mech)
JICA Survey Team- Mitsuyuki Osawa (HSR Systems Expert), Masaaki Hara (Mechanical Engineer), Naresh Kumar (Project Coordinator)
Record:

Questionnaire session

1. When was ICF established?
   1955, ICF is a part of Indian Railways.

2. When did ICF start to manufacture EMU?
   1960, AC EMUs in 1970
   DC EMU (for Mumbai) now using AC
   25 KVA-incoming voltage, 3-phase transmission

3. What companies/organizations have you supplied rolling stock?
   Indian Railways, African Countries, Asian Countries.
   1981 to Kolkata Metro

4. How do you obtain the contract of manufacturing rolling stock?
   We do not do direct exporting, it is routed through RITES.

5. Have you formulated any consortium with any foreign company?
   Yes, with a Swiss car manufacturer.

6. What type of rolling stock does ICF manufacture?
   Coaches and EMU

   What type of car body material: steel, stainless steel or aluminum alloy?
   Steel and stainless steel

7. How much rolling stock can you manufacture per year?
   1,503 coaches-last year
   1,510 coaches-this year
   1,700 coaches-in net 2-3 years time

8. How many employees and engineers do you employ?
   Approximately-12,000
   Engineers-7,500-8,000
   Design Engineers-150

9. Who decides the main specifications of rolling stock, regarding IR and metro?
   RDSO does, but the coaches are designed by us.

10. Who is responsible for designing?
    We are responsible for designing coaches.

11. How many designers do you employ?
    150 engineers

12. We like to know what type of machinery is equipped.
    EMUs are from BEL (Bharat Electrical Limited)

Presentation on ICF

- Factory started in 1955
- Number of designs evolved so far-more than 250
- Annual turnover in 2010-11-Rs. 2,500 cr.
- Quality assurance: ISO9001, ISO14001 and BS OHSAS 18001
- ICF-100% Green energy
- 1955-56-first coach
- 1960-AC EMU
- The total factory area is 189.5 acres (767,100 sq m.)
- Total 11,826 employees
- The total coaches manufactures until December 31, 2011 is 44,190
- Aerodynamic HHP DEMU (2204)
- DEMU for Jammu & Kashmir, there is a heat unit to melt the ice
- DMU for Sri Lanka

- M/s Medha (Hyderabad)
- 3 phase technology BHEL
- 3-phase AC EMUs are energy-efficient, from total energy 30% energy is regenerated
- 300 fully stainless steel coaches
- 300 coaches set of FIAT bodies

Factory Visit

- Programmed cutter machine, the thickness of steel it cuts is 1.6/2 mm
- Laser cutting and welding machines
- Hydraulic press machines-800 tone of load
- Stainless steel roof of the caches
- AC duct roof
- Country steel width is 3.1 mm and the roof is 1.6 mm
- Kolkata Metro cars
- Construction work started in March 1952
- The first shell turned out in October 1955
- The total area is 26.67 hectares
- Covered area is 21.24 hectares
- The total supervisors are 517, 3720 Artisans and 1,224 group D staff
- DMU for Sri Lanka
- Kolkata under frame assembly
- Bogie section
- Air spring suspension
- Load test section for 100-300 passengers
- Robotic welding
- Paint shed, fitting shed
- The main rectifier from Hind Rectifier Ltd

The Design & Development Centre

- The software used is Solid Works, for 3D works
- Electric/CADD section
- Master control to traction control system
- DEMU's
- Testing section
- Stress & Strain investigation on 1600 HP Stainless Steel DMU/TC/V shell

Operation training centre for operation CNC trainer and CBT Lab

Meditation Hall

Supervisor development plan

Advanced welding training institute

- Spot welding machine

10. Activities for 24th January 2012

On this date, a meeting was held with Bombardier, New Delhi at noon and MOR, New Delhi in the after noon.

Location: Bombardier, New Delhi
Timing 12:00
Present: Bombardier- Sri Ram Raju (Director Sales)
JICA Survey Team- Shinya Nakamura (TL), William Hayes (Deputy TL), Atsushi Kamiyama (Project Financing Expert), Mitsuyuki Osawa (HSR Systems Expert), Masaaki Hara (Mechanical Engineer), S.K. Mallik (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)
Record:

Introduction:

Bombardier Transportation of India came into force in 2001. Before that it was part of ABB. Nowadays, Bombardier has businesses in Europe and Asia. Around 2006, Bombardier got an opportunity to bid for Delhi Metro coaches and won an initial contract for 340 stainless steel cars and this has now grown to 640 cars because of network expansion. Therefore, Bombardier set up this factory at Salvi for manufacturing stainless cars mainly for Delhi Metro for the Indian market. At present, Bombardier is concentrating on the Indian market, but might manufacture equipment for export.

The JICA Team focused on some of the relevant important issues and the answers given by the Bombardier Team are noted below.

- The Team queried about the construction of DMRC cars, if Bombardier made the whole car, just bogies or everything.
- Bombardier explained that designs come from Europe but that manufacturing is done in India. Some components still come from Germany.
- The Team queried about where the design is being done.
- Bombardier stated that design is done by European counterparts by a core company in German.
- The Team queried about who decides the design.
- Bombardier stated that we have to undergo design review from DMRC.
- The Team queried about the design part, who designed what, Bombardier or another company.
- Bombardier stated that the Group Company Bombardier Germany was doing the designs.
- The Team queried about HSR trains produced by Bombardier
- Bombardier stated that they have HSR trains called ZEFIRO that go up to 380 km/h and received an order from China for 380 trains.
- The Team queried about the production location of HSR.
- Bombardier stated they are produced in China. ZEFIRO has not gone elsewhere yet.
- The Team queried if for example India has to construct HSR and Bombardier is interested in bidding, would those cars come from China.
- Bombardier stated that it tries to localize but this is dependent on quantity, configuration, etc.
- The Team queried about Indian customers.
- Bombardier stated that it has only two customers in India: Indian Railways and Delhi Metro.

- The Team queried about where its employees, workers and engineers come from (for example, Indian Railways).
- Bombardier stated that very few of its people come from Indian Railways or the rail industry and that it has to take time to train and groom its staff.
- The Team queried about the number of its employees in India.
- Bombardier stated that it has around 1,000 staff, with about 200 being engineers.
- The Team queried about the next metro project for Bombardier.
- Bombardier stated that it is looking forward to Delhi Metro Phase 3 and to the Hyderabad metro.
- The Team queried about the possibility of forming consortia in India.
- Bombardier stated that in India it does not at present intend to form consortia. Outside of India, it has formed consortia with Alstom and Siemens, but this will depend on the project.
- Bombardier stated that basically 20-30 staff is from Europe and are mostly involved in expert work.
- The Team queried about its two manufacturing sites.
- Bombardier stated that car body and propulsion manufacturing units are both located in Baroda: one in Salvi and the other is in Baneja.
- The Team queried about work at its engineering centre in Hyderabad.
- Bombardier stated that the Hyderabad is an engineering centre where people do not perform work for just India but for outside India as well. The work consists mainly of design conversion from 2D to 3D and modeling of schematics.
- The Team queried about the production of propulsion and the quality level of every product.
- Bombardier stated that lot of components come from abroad, which consist of high-end electronics ICP, PCB, etc.
- The Team queried about the components they produce in Vadodara.
- Bombardier stated that these are mainly propulsion components.
- The Team queried about other electronics equipment purchased from abroad.
- Bombardier mentioned vacuum circuit breakers.
- The Team queried about the education given to technicians and if some were trained in Europe.
- Bombardier stated if a new product is manufactured abroad, we have a processer in Bombardier, who is solely trained on the job.
- The Team queried about the training provided for both technicians and engineers.
- Bombardier stated both engineers and technicians are trained.
- The Team queried about the difficulty of technology transfer.
- Bombardier stated that it depends on the type of technology. Quality management was mentioned as a problem in India. Also, many suppliers do not have the capacity to design.
- Bombardier said there have many changes to the European metro design due to requests from DMRC and that it is very particular.
- The Team queried about the width of car bodies.
- Bombardier stated that the width is 2.9 m.
- The Team queried about who approves its designs.
- Bombardier stated that basic design comes from the Indian customer.
- The Team queried whether dust is a problem in Delhi and asked if DMRC told them about the dust and temperature.
- Bombardier stated that they had in the design stage and filters were added in the basic design.
- The Team queried about who design the DMRC workshop.
- Bombardier stated that DMRC has their own workshop.

- The Team queried about warranties.
- Bombardier stated that:
  - Design for 35 years, but the warranty is only for 2 years.
  - The bearing life is only for 10 years.
  - The body warranty is 30 years, but now customers want 35 years.
  - Car body life is 25 years.
  - Components have to be replaced after some time.
- The Team advised that for HSR rolling stock the body be made of aluminum.
- Bombardier stated:
  - Yes
  - Difficult to get aluminum in India.
  - It depends upon the quantity in India.
  - Bombardier has both aluminum and stainless steel.
- The Team queried if given a chance to produce HSR coaches, can they produce them in India using aluminum?
- Bombardier stated that it can but it depends on the quantity.
- The Team queried if they can manufacture HSR bogies in India using aluminum.
- Bombardier stated that yes it can do so.
- The Team queried about the production of aluminum cars by Bombardier in other counties.
- Bombardier stated that they produce aluminum cars in Europe.
- The Team queried why they decided to locate a workshop in India.
- Bombardier stated that because it is the right time to concentrate on the Indian market. Many projects are here.
- The Team queried about who its main competitors are.
- Bombardier stated that its main competitors are BEML, ROTEM, ALSTOM, and ICF/RCF/BEML.
- The Team queried how many days they work per week.
- Bombardier stated that they work five days a week in two shifts.
- The Team advised that they want to visit their factory to see the propulsion units and control centre, next month.
- Bombardier agreed.
- The Team advised that would it could visit between 22nd February-24th February 2012, and asked Bombardier to let them know which day is best.
- Bombardier stated that they would like to know the purpose of the visit.
- The Team stated that they want to see the layout of the factory and have discussions with the supervisors.

11. Activities for 24th January 2012

On this date, a meeting was held with MOR, New Delhi in the afternoon.

Location: MOR, New Delhi
Timing 15:00
Present: MOR- V.K. Singh (Exec. Director- PSU)
JICA Survey Team- Shinya Nakamura (TL), William Hayes (Deputy TL), Atsushi Kamiyama (Project Financing Expert), Mitsuyuki Osawa (HSR Systems Expert), Masaaki Hara (Mechanical Engineer), S.K. Mallik (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)

Record:

- MOR gave a list of people for the proposed workshop in February.
- In regards to rolling stock, MOR stated ICF produces EMUs like those in Japan but that RCF, which focuses on locomotives, does not.
- The Team mentioned that aluminum bodies are not manufactured and that this is important for light-weight cars for HSR.
- The Team also mentioned that the quality of bogies is insufficient and, as HSR bogies are very delicate, this could cause a major accident.
- MOR stated that JICA would have to go for high-end technology.
- The Team advised that Indian technicians are good at performing their work; therefore, technological upgrade should be easy.
- MOR emphasized the upgrading of technology.
- The Team advised that Bombardier is an acceptable choice for manufacturing HSR rolling stock.
- MOR thought that BEML might be acceptable and inquired about ICF and RCF.
- The Team stated the difference between BEML and ICF is machinery, with the former being better equipped and that RCF would have great difficulty manufacturing HSR coaches.
- MOR queried about the Team's visit to Gujarat.
- The Team said that Gujarat was keen about HSR and would also like to see a line go to Dholera as well.
- MOR queried about the possibility of a branch line to Dholera.

- The Team replied that at present there is little development in Dholera and that it will take several more years. The Team stated that Gujarat wants to move fast and that land acquisition is not an issue for them.
- MOR advised that it is considering funding civil infrastructure, while maintenance and operation can be done by private organizations under a PPP scheme.
- The Team advised that PPP schemes can executed in many ways but that HSR will require positive government support.
- MOR expressed interest in obtaining a stand-alone balance sheet for Japan's Shinkansen as a reference for determining fares.
- The Team said that it would try to obtain this from JR East but that it may not be easy as it is not in the public forum.
- MOR also showed interest in station development and would like to know to what extent this will be necessary to make HSR a viable enterprise.
- MOR asked about a realistic commissioning schedule for HSR.
- The Team replied that it would address this issue.

12. Activities for 25th January 2012

On this date, a meeting was held with the Embassy of Japan to explain the results of the second field survey and the plans for the third and final field survey in February.

JICA Survey Log
February 15th – February 24th, 2012

1. Introduction

The JICA Survey Team arrived in New Delhi on 14th February 2012 to carry out its third and final field visit of the survey till 24th February 2012. This memorandum contains a summary of the hearings and interviews with government officials and organizations in New Delhi, Vadodara, Patna, and Mumbai, together with a description of on-site activities, and will form part of the Team's reporting.

2. Activities for 15th February 2012

On this date, meetings were held with JICA and Embassy of Japan officials to discuss the overall progress of the survey and its final expected outputs, which will be contained in the Final Report to be prepared and submitted by the Team in March 2012.

3. Activities for 16th February 2012

Meetings were held with MOR in the forenoon and afternoon regarding civil engineering and rolling stock issues for HSR that MOR would like to see addressed in a future JICA workshop. Below is a record of these activities.

Location: Ministry of Rail
Time: 11:00 – 13:00
Present: MOR- V.K. Singh (Exec. Director-PSU), Surinder Pal (Exec. Director-Civil Eng.)
JICA Survey Team- Shinya Nakamura (TL), William Hayes (Deputy TL), Atsushi Kamiyama (Project Financing Expert), Mitsuyuki Osawa (HSR System Expert), Rajesh Bhatt (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)

Record:

- MOR asked about soil treatment and actions to prevent settlement that may cause damage to non-ballasted track on earthen embankments. They enquired about the structural changes required, since in the case of any differential settlement in soil non-ballasted track will crack and requires much time to repair.
- MOR further stated that due to the liquefaction of soil when there is an earthquake, for example, an entire embankment can collapse. MOR would, therefore, like to have detailed information about the countermeasures applied in Japan for settlement and liquefaction in terms of case studies and design parameters.
- MOR stated that viaducts are probably more cost-effective than embankments as no fencing is required, land acquisition is less, and the construction of road over-bridges is unnecessary. It further added that the use of non-ballasted track will be more appropriate in this case as ballasted track results in greater loads on the structure and its maintenance would thereby require more inputs.
- The Team agreed that viaducts would usually be better than embankments in the case of India.
- MOR also wants to know more about Japanese soft-ground improvement techniques in terms of case studies, specifications, and costs.
- MOR also wants to know more about track maintenance practices in Japan (i.e., standards, specifications, & maintenance scheduling). Queries were made about limits/tolerance and methods to measure the deterioration of track and alignment.
- MOR stated that the life of their sleepers is 50 years but the life of fixtures and other equipment is less (about 10 years). Hence, component-wise maintenance is carried out.
- IR uses thermit welding for its tracks and the life of this type of welding is approximately 10 years, with some failures after only 2 to 3 years. Some of the premature failures are due to track corrosion caused by urea from train toilets. IR is now trying to introduce discharge-less toilets. The failure of weld joints is also due to flaws in the welding process due to poor workmanship.
- In IR there is a thermit weld every 260m, as this is the length of the track being produced by the Steel Authority of India.

- MOR wants to know the life-cycle cost for slab track. That is, is it less expensive than non-ballasted track?
- MOR also wanted to know what work Japan carried out on conventional lines for the operation of the Mini-Shinkansen. The Team stated that Japan simply changed the track from meter gauge to standard gauge, and because it operates at a much lower speed than the normal Shinkansen it is not completely fenced off.
- MOR also wanted to know what the per-km cost for HSR might be in India. As MOR has to weigh this against the potential benefits in order to decide whether or not to execute the project.
- The Team stated that a preliminary figure regarding cost should be available within 6 months, as some Japanese firms are working on HSR pre-feasibility studies for the Indian agency IRCON.
- It was agreed the design and maintenance for HSR will be totally different from that of the conventional line, and that a dedicated line is necessary to prevent people, animals, and obstacles from appearing on the track; otherwise, safety would be compromised and the consequences could be horrendous.

Location: Ministry of Railways
Time: 14:00 – 16:00
Present: MOR- V.K. Singh (Exec. Director-PSU), N. R. Dash (Exec. Director-Elec. Eng. Dev.), Archana Mittal (Director-Mech. Eng. (Freight)), Sanjeev Sawroop (Exec. Director-Standards Elec.), Mukund Sinha (Director-Planning for Mech. Eng.)
JICA Survey Team- Shinya Nakamura (TL), William Hayes (Deputy TL), Atsushi Kamiyama (Project Financing Expert), Mitsuyuki Osawa (HSR Systems Expert), Rajesh Bhatt (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)
Record:

- Mr. Osawa explained the Shinkansen concept, system, and key technologies and how it would be the best solution for HSR in India. He also mentioned that a dedicated line is essential for operational safety reasons.
- The Team stated that the light-weight body, big capacity, efficient propulsion system and regenerative braking technology of Japanese HSR, can contribute to reducing Indian Railway's carbon footprint. The Team also stated that these characteristics also enable the Japanese HSR (i.e., Shinkansen) to run at commercial speeds of up to 300 km/h and to operate 301 trains per day, which far exceeds that of any other country operating HSR. It was noted that a fully active control system is used in the N700, E5, E6 & latest series of trains.
- The Team stated that the JICA workshop would address in more detail the features of the Shinkansen system, rolling stock technologies, and train protection system.
- MOR wanted to know the maximum test and operating speeds, as well as the maximum acceleration of the Shinkansen. The Team stated that at present the maximum test speed is about 445 km/h, the maximum operating speed 300 km/h, and the maximum starting acceleration speed 2.6 km/h/s.
- MOR suggested that the following topics be addressed:
  - Vehicle dynamics with specific attention to the standards that Japan and MOR follow, together with the minimum and maximum vertical force for rolling stock.
  - The type of investment required for manufacturing rolling stock and its maintenance. For example, whether ICF, RCF, BEML or Bombardier are capable of manufacturing HSR coaches in India.
  - A description of routine HSR maintenance problems encountered in Japan.
  - More detailed information about power supply & rolling stock.
- The Team stated that the abovementioned topics can be covered in the JICA workshop with the help of Hitachi and Kawasaki.

- MOR stated that National High Speed Rail Authority of India is in the process of being formed. MOR then enquired about the inter-operability of the HSR with conventional rail and other modes of transport. The Team stated that, even though the Shinkansen operates on dedicated line, it and the other modes of transport in Japan are well integrated with each other. MOR stated that conventional rail is old and not standard gauge so it could not be physically inter-linked with HSR in India. The Team mentioned that in any case this would not be advisable from a safety viewpoint given the large differences in technological and operational characteristics.
- MOR requested that data from Japan about HSR failures such as wheel defects and other equipment failure be made available. The Team said it will try to obtain it from the operating companies.
- MOR asked about milestones for manufacturing, maintenance, training and project management in regards to the Shinkansen.
- MOR suggested also that the JICA workshop include the following:
  - Maintenance routines and periodicity.
  - Power supply arrangements.
  - Vehicle dynamics (broad parameters).
  - Effects of lateral & vertical forces.
  - Cost of rolling stock.
  - Organization.

4. Activities for 17th February 2012

The Team traveled to Vadodara to meet with the staff of Bombardier factory on this day in order to carry out a site visit. Below is a record of these activities.

Location: Bombardier Factory, Vadodara (Savli), Gujarat State
Time: 10:15 – 13:30
Present: BOMBARDIER- Sriram Raju (Director- Sales), Vivek Trivedi (Head- Technical Services), Richard Melanson (Director- Purchasing), Amit Yadev (Director- Production)
JICA Survey Team- Shinya Nakamura (TL), William Hayes (Deputy TL), Atsushi Kamiyama (Project Financing Expert), Mitsuyuki Osawa (HSR Systems Expert), Rajesh Bhatt (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)

Record:

- Presentation by Mr. Raju on Bombardier covered the following topics:
  - The Savli site was established in July 2007and was a green-field factory.

  - The first order for rolling stock came from DMRC and was for 340 cars.
  - The first metro car was delivered in May 2009.
  - Thirty-three million euro was invested to build the factory.
  - The number of directly employed staff is at present 558, and another 3000 jobs are generated indirectly. Note that the number of factory employees would expand to 1000 when the factory is in full operation.
  - Robotic machines
  - Site certification includes: IRIS certification, EN ISO9001:2008, OHSAS 18001:2007, EN ISO14001, ISO 3834-2:2005
- Bombardier described its bogie production, car body production, and final assembly/test hall.
- Bombardier stated that it manufactures everything here at Savli, expect for a few components. Bombardier has its propulsion unit in Baroda.
- Bombardier stated it has the capacity to produce 32 cars per month with the work week consisting of 6 days and 2 shifts per day, which can be ramped up to a maximum of 40 cars. It has 140 certified welders, 262 fitters and 4 robos.
- Bombardier stated that it is capable of testing 2 to 6 cars, including initial voltage tests on DT cars and water tests. Bombardier has welding courses to train welders.
- Bombardier stated that it delivers coaches to the client via road transport, as it is difficult to obtain permission from Indian Railways to use rail transport. The company it uses is PROCAM.
- Bombardier stated that it trains people in its processes and makes efforts to motivate its workforce.
- Bombardier stated that it trains people both abroad (especially in Sweden and Germany) and here in India. At present, it has 40 engineers and expects to increase this to 60 this year.
- Bombardier stated that it imports axles from Bonatrans of Germany and Sifang of China.
- Bombardier located its factory in Gujarat because it was able to obtain clearance easily and because it has excellent power supply. The Government of Gujarat was also very supportive of Bombardier and is pro-business. In fact, according to Bombardier, Gujarat's response was faster than that of China. Manpower in Gujarat is also qualified and the life style is good.
- Bombardier stated that it is capable of building HSR coaches, but that the quantity would need to be sufficiently large to justify the introduction of a new manufacturing line.
- Bombardier also stated that the total time to retool for HSR manufacturing would require a minimum of 6 to 8 months.
- Bombardier stated that at present it only has one client (i.e., DMRC) and is hoping to obtain more work to ensure a steady stream of work.
- Bombardier stated that RDSO is not working with DMRC, but that DMRC intends to involve them in future.
- The Team toured the Bombardier factory and encountered the following:
  - Bombardier works under a team concept and for 1191 days had not experienced an accident.
  - Radiographic testing is done in-house.
  - Monitoring indicates in 97% RFT (right-first-time).
  - Measurement checker unit, testing of spring and break pipes.
  - Welding and robo-spot welding.
  - Leakage test done with software called TICO.
  - High voltage testing area – Bombardier does test with 55KV first and then moves to 23-36 KV. Results are examined with software called Monas.

- After voltage testing of individual cars, they are coupled in 4, 6, and 8-car consists and tested again. When this is completed, the cars dimensions are checked and water leakage tests executed.
- Mr. Fazan Khan (Testing Manager) explained the entire testing routine executed by Bombardier.
- All parts and tests are checked by DMRC. AGM/GM-level staff from DMRC is available 24-hours a day at Bombardier.

5. Activities for 21st February 2012

On this date, a meeting was held with the Chief Secretary of the Government of Bihar. Below is a record of these activities.

Location: Chief Secretary's Office, Patna, Bihar
Time: 13:15 – 14:30
Present: Government of Bihar - Navin Kumar (Chief Secretary)
JICA Survey Team- Shinya Nakamura (Team Leader), William Hayes (Deputy Team Leader), Atsushi Kamiyama (Project Financing Expert), Mitsuyuki Osawa (HSR Systems Expert), Rajesh Bhatt (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)

Record:

- The Team asked about the Government of Bihar's view on the HSR, as Delhi– Patna is a relatively high priority corridor.
- The Chief Secretary stated that they are very keen to see the HSR implemented, but that MOR is responsible for its execution as it is a national transportation project.
- The Chief Secretary stated that he thought that the Delhi–Patna corridor, which is about 1000 km long, would be very competitive with air travel if appropriately priced.
- The population of Patna is approximately 2 million and most people travel by train as it is the cheapest mode of travel to Delhi. Note that Patna airport is small and large aircraft cannot land and a new airport is needed.
- The Bihar government would assist MOR with land acquisition, which should not be a big problem for HSR as the amount of right-of-way required is relatively small.
- Moreover, the Chief Secretary mentioned that the state government has raised compensation for land acquisition and pays 240% instead of 100% of the land value to the owner and reiterated that there should be no problem.

- On the other hand, the Bihar government does not intend to provide any money for HSR infrastructure and is expecting the central government to be responsible for all funding in that regard.
- The Chief Secretary stated that there are basically two kinds of funding models for rail-based projects, with one being a joint venture between the central and state governments and the second a PPP scheme. However, in the case of long-distance railway projects, Indian Railways alone is usually responsible.
- The Chief Secretary stated that he has had little interaction with MOR, as he assumed his post only in September 2011.
- The Chief Secretary confirmed that Bihar has an infrastructure development board and that it would be involved in the integration of HSR stations with its urban areas and existing transport.
- The Team mentioned that the Gujarat government contributed 25% of the total cost of the pre-feasibility studies.
- The Chief Secretary stated that the Bihar government did not contribute financially to the pre-feasibility study for its corridor.
- The Chief Secretary stated that the Indian Government needs funding for the HSR project and a scheme similar to the one provided by JICA for the Delhi Metro would be good.
- The Team mentioned that JICA is at present assisting with the training of Indian Railway experts in Japan for the HSR.
- The Chief Secretary mentioned that Patna is in the process of procuring consultants for a feasibility study for a metro in Patna and if it is viable may also request JICA's assistance.
- Finally, the Chief Secretary suggested that the HSR be extended to Kolkata, as it is only about 500 km from Patna.

6. Activities for 22nd February 2012

On this date, a meeting was held with the Chief Secretary of the Government of Maharashtra in the afternoon. Below is a record of these activities.

Location: Chief Secretary's Office, Mumbai, Maharashtra State
Time: 13:30 – 15:00
Present: Government of Maharashtra- Ratnakar Gaikward (Chief Secretary), Dr. Sailesh Kumar Sharma (Principal Secretary- Transport), Thomas Benjamin (Principal Secretary- Urban Development Department)

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JICA Survey Team- Shinya Nakamura (Team Leader), William Hayes (Deputy Team Leader), Atsushi Kamiyama (Project Financing Expert), Mitsuyuki Osawa (HSR Systems Expert), Rajesh Bhatt (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)

Record:

- Regarding JICA projects in Maharashtra, the Team mentioned that JICA is currently providing assistance to the DFC (dedicated freight corridor) project and to a light-rail study in Pune, which was requested by the Pune Municipal Corporation.
- The Principal Secretary stated the Government of Maharashtra is also interested in building a fully-elevated metro in Pune, which has a population of 2.5 million. The total cost for this project would be about INR 25 billion and is highly viable. He noted that RITES had produced the DPR and that they are interested in perhaps obtaining JICA funding. He mentioned further that in Pune Line 1 is planned to run from Kothrud to Vadgaon Sheri and Line 2 from Pimpri to the heart of Pune.
- The Team then mentioned that MMRDA (Mumbai Metropolitan Region Development Authority) has approached JICA for its Metro Line 3 project (the Colaba-Bandra-SEEPZ line), which is completely underground and 33.5 km in length.
- The Principal Secretary added to this by saying that there is a serious need for a metro system in Mumbai as the population is 35 million and the current modes of transport are unable to cater to the demand. He also stated that Line 3 is anticipated to cost about INR 10.24 billion, with JICA expected to contribute 52%, the Maharashtra Government 19%, and the Central Government 15% of the cost.
- The Team then went on to say that JICA is keen to finance HSR between Ahmadabad – Mumbai – Pune, which is a high priority HSR corridor that has had a pre-feasibility study carried out by the Central Government.
- The Principal Secretary replied that the Government of Maharashtra is keen as well to implement the HSR project. He also mentioned that they are interested in connecting Mumbai and Nagpur, as Nagpur is the second capital of Maharashtra with a population of approximately 1 million and a transport hub. Connecting Nasik, which is about 200km from Mumbai, was discussed as well and would form a triangle between Mumbai, Pune and Nasik.
- The Principal Secretary further stated that Maharashtra has no problem to connect with Ahmadabad, but they want to connect to other areas of Maharashtra as well.
- The Principal Secretary mentioned that they do not have any budget plan for the HSR, and the Chief Secretary stated that although they have met with MOR they have not discussed the HSR and therefore he does not have an idea about its viability.
- The Principal Secretary stated that in Maharashtra there is coordination committee that interacts with the state and MOR and works under the Chief Secretary and that the HSR project would be decided by that committee.
- The Chief Secretary stated that they will consider related development plans for the HSR when the MOR approaches them about it.
- The Principal Secretary stated that Maharashtra is ready to contribute for the HSR project but wants to know the cost of the project.
- The Principal Secretary suggested that the HSR station for Mumbai be in the Panvel area in Navi Mumbai as there is a lack of space inside Mumbai city. It was noted that there is also a plan to build a new International Airport in Panvel.
- The Principal Secretary mentioned that they are planning to build a 22km trans-harbor bridge connecting Navi Mumbai with Mumbai to improve connectivity.
- The Principal Secretary said that Maharashtra would be able to help in providing infrastructure for the manufacturing of HSR rolling stock, as it is the most industrial state in the country.
- The Principal Secretary stated that MIDC is responsible for issues related to land, power, water, and industrial development, while MMRDA was in charge of developing the

public transport network. Further, MRVC (Mumbai Railway Vikas Corporation Ltd.) is responsible for the improvement of the infrastructure of the Mumbai suburban railway system.

- The Principal Secretary stated for the Team's reference that the World Bank MUTP1 (Mumbai Urban Transport Project-1) contributed INR 50 billion to Mumbai to reduce congestion in trains by 14%. With MUTP2, they have increased the number of trains, the frequency of train operation, train consist length, improved station conditions and improved the physical internal conditions of trains as well, resulting in crush load being reduced from 5000 people per train to 3000.

7. Activities 23rd February 2012

On this date, the meeting was held with MOR forenoon and afternoon. Below is a record of these activities.

Location: MOR
Time: 11:00 – 13:00
Present: MOR- V.K. Singh (Exec. Director-PSU), V.R. Kakatkar (Exec. Director-Finance)
JICA Survey Team- Shinya Nakamura (TL), William Hayes (Deputy TL), Atsushi Kamiyama (Project Financing Expert), Mitsuyuki Osawa (HSR Systems Expert), Tamio Okutani (Signaling Expert), Rajesh Bhatt (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)

Record:

- MOR asked about the cost difference of dedicated track for 200 km/h and 350 km/h operation and the advantages of increasing train speed from 200 km/h to 350 km/h.
- The Team replied that for dedicated track for 200 km/h and 300 km/h operation there is essentially no difference in cost with the difference being only about 5%.
- On the other hand, the Team stated that higher speeds will encourage more travel and thereby increase business opportunities and stimulate economic growth. For non-dedicated track, the maximum operating speed would be 160 km/h and, if there are level crossings, this would be reduced to 130 km/h due to safety concerns.
- MOR wanted to know more about the signaling system for a 200 km/h system.
- The Team noted that in Japan ATS (Automatic Train Stop) is common but for HSR ATC (Automatic Train Control) is applied. In Japan, the same type of track is used for 130 km/h and 200 km/h operation. However, for 300 km/h operation slab track is recommended.

- The Team suggested that Europeans are upgrading speeds on conventional rail to 160 km/h but not to 200 km/h.
- MOR stated that one level crossing per km is the average number in India for a conventional line, so it a big issue when train speed is increased.
- Regarding HSR and PPP, the Team stated that it will be very difficult for a private company to earn profit in Japan unless the civil structures are funded by the government. The private sector would be responsible for the systems and rolling stock.
- MOR stated that if you outsource maintenance the risk of the private sector could be reduced. In any case, there has to be an assurance of sufficient revenue generation.
- MOR prepared a presentation on its perception of the business model and fare charging system for the Shinkansen and which was as follows:
  - JR East: Largest Japanese railway company
  - Network: 7,512 km
  - Passengers carried per day: 17 million
  - Operating revenue of JR East group: US$ 32 billion (US$ 22 billion from transport & US$ 10 billion from non-rail businesses)
  - Non-railway business: US$16 billion from conventional line; US$6 billion from Shinkansen

  Business Model
  - Data from Tokaido Shinkansen suggested O&M cost per train km is approx. US$91.8.
  - Based on this figure, JR East's O&M cost should be in the range of US$ 17 billion, where as the income from Shinkansen is around $ 6 billion.
  - The overall profitability of JR East is possible because of non-rail business (Real state, hotels, shopping malls, resorts etc)

  Fare Charging System for Shinkansen
  - The charge for Shinkansen travels consists of "Fare" and "Charges".
  - Fare: amount payable for transport services.
  - Charges: surcharge for additional services.
  - Additional service comprises high-speed service; high-grade service; sleeping-car service.
  - Both fares and charges follow telescopic pattern.
- Presentation from the Team's Atsushi Kamiyama covered the following topics:
  - History of the Construction of the Shinkansen.
    - Construction period
    - Construction cost
  - Management of the Shinkansen
    - Passenger increases
    - Business conditions of JR companies
    - Structure of business income and performance of 3 JR Companies
    - Characteristics of operation of each company
    - Population distribution on corridors – comparison with foreign countries
    - Related businesses
  - Outline of government regulation for railway fares and charges.
- The Team suggested that in India the construction cost for HSR would be 3-4 billion Japanese yen per km. In Japan it is more, because there are frequent earthquakes and Japan has also invested much money to reduce noise.
- MOR queried how is the gap between the Shinkansen's O&M cost of US$ 17 billion and income of US$ 6 billion estimated by it covered.

- The Team replied that it would have to check the MOR's estimates and could respond by email.

Location: MOR
Time: 14:00 – 16:00
Present: MOR- V.K. Singh (Exec. Director-PSU)
JICA Survey Team- Shinya Nakamura (TL), William Hayes (Deputy TL), Atsushi Kamiyama (Project Financing Expert), Mitsuyuki Osawa (HSR Systems Expert), Tamio Okutani (Signaling Expert), Rajesh Bhatt (Sr. Project Coordinator), Naresh Kumar (Project Coordinator)

Record:

- The Team's Tamio Okutani gave a presentation on signaling systems for HSR and covered the following topics:
  - Outline of signaling systems
  - Outline of train detection
  - Outline of ATC system
  - Outline of breaking pattern
  - Outline of signaling & traffic control systems
  - Signaling & traffic control center
  - Electric equipment (open)
  - Electric equipment (tunnel)
  - LCX: Leaky Coaxial Cable
  - Disaster warning system
- The Team stated that in Japan a track circuit is approx. 1km long and the distance between two trains is measured by a tachometer and the speed a train moves along a track circuit. There is a transponder every 14km and is used for calibration.
- The Team suggested that for communication between a control center operator and train driver and between a control center operator and maintenance staff telephones located in boxes be used.
- MOR stated that in India they have only the sockets and not the phones and that the phones are hand carried. However, in the case of the HSR it is possible.
- MOR asked about GPS for train location in Japan.
- The Team stated that there is no GPS for trains in Japan; although, Europe does use GSMR. The Team mentioned that the Shinkansen signaling system is more reliable.
- MOR commented that the Japanese signaling system is excellent and would like to know more about the cost and the redundancies of the system.
- MOR also wanted to know if it is possible to reduce the 3-layers system of ERTMS3.
- The Team noted that ERTMS3 is used in Europe and that on conventional lines in Japan ATACS is applied, which is a moving block system. Recently, in Japan, a digital ATC system is being utilized.
- The Team stated that signaling costs beyond 300 km/h would be the same all over the country, whether it is South or North India, and recommended that detailed discussions on the ATC signaling system be held in future.
- Finally, the Team informed MOR that the CTC system can be switched over to another control system in case of an emergency.

8. Activities 24th February 2012

On this date, meetings were held with JICA and Embassy of Japan officials to discuss the final results of the three field surveys and the closing out of the survey and its final expected outputs, which will be contained in a final report to be prepared and submitted by the Team in March 2012.