JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

VIETNAM RAILWAYS (VR)

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

FINAL REPORT

TECHNICAL REPORT 6

QUESTIONS AND ANSWERS TO COMMENTS

June 2013

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

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

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

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

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

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

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

June 2013

Kazuki Miura
Director, Economic Infrastructure Department
Japan International Cooperation Agency

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ABBREVIATIONS

ATC	Automatic Train Control
CTC	Centralized Traffic Control
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMU	Electric Multiple Unit
EVN	Vietnam Electricity
GDP	Gross Domestic Product
HCMC	Ho Chi Minh City
HSR	High Speed Railway
JICA	Japan International Cooperation Agency
LCC	Low-Cost-Carriers
MOT	Ministry of Transport
NSHSR	North-South High Speed Railway Project
OCC	Operation Control Centre
RPF	Rehabilitation Policy Framework
UMRT	Urban Mass Rapid Transit
VITRANSS2	The Comprehensive Study on the Sustainable Development of Transport System in Vietnam

1 Need for Investment and Development Orientations

1) Why is HSR needed? What are the benefits, and who will be the beneficiaries?

1.1 Analysis on traffic demand in the future have presented that the future transportation demand along the north-south corridor is significant for both passenger and freight services. For example, passenger transport will increase by 3.0 times in terms of the number of passengers between 2010 and 2030, and by 3.9 times in terms of passenger-km. Likewise, freight transport will increase by 2.7 times in terms of weight (ton) and by 3.1 times in terms of ton-km.

1.2 It is difficult to meet this high level of demand for passenger and freight only with roads, air and coastal shipping, it is important for the railway to play much more significant role in both passenger and freight transport. Existing single track railway will be unable to satisfy the demand around 2030, even if roads, expressways, and air transport are expanded in accordance with current plans. With regard to passenger transport along the north-south corridor, the railway is required to provide with higher speed services competitive to air and expressway. Mere improvement of existing railway is unable to meet the needs.

1.3 As Vietnam's economy grows, income and time value of the people increase and the demand for higher travel speed services increase. HSR is a competitive mode to satisfy the needs. When inter-city passenger travel demand is met by HSR, the existing railway can share local passenger and freight transport services.

1.4 HSR is necessary to meet the future demand both in terms of quantity and quality. The expected benefits from HSR development are as follows:

(i) Satisfy large passenger transport demand along the north–south corridor which is estimated to increase by 4-5 times between 2010 and 2030. It is difficult to satisfy the future demand without an HSR, even if national roads, existing railways, expressways, and air transport are improved/ developed.

(ii) Satisfy increasing needs for high-speed services as time value of the people increase.

(iii) Promote urban expansion of Hanoi and HCMC in organized manner, integrated and balanced development along the HSR routes including urban, industrial and tourism development, as well as to strengthen the connectivity of cities.

1.5 The above implies that not only potential passengers along the alignment but also those living in the vicinities of the stations. Analysis has proven that HSR is competitive with the fare level which is half of air fare and double of bus transport, which is rather affordable.

1.6 For more information, refer to Volume I Chapter 3 and 4 in the Main Report.

2) How should the HSR be developed in relation to other modes of transport? In what ways is the HSR more advantageous compared to other modes of transport?

1.7 The current transport system for passenger and freight in this corridor comprises of the National Highway (2-4 lanes), existing railway and air transport, and coastal waterway for freight. As this cannot meet the demands in 2030, the Government is planning the expansion of the National Highway, construction of the Expressway, expansion of air transport capacity, improvement of the existing railway, and the construction of the new railway lines. While it is not realistic to assume all of these improvements are expected to be completed by 2030, in this study, future improvement was assumed based on the discussions made during VITRANSS2 study as follows: completion of the expansion of National Highway (4 lane roads), completion of the expressway, and completion of the expansion of air transport capacity. The results based on this presupposition are as follows:

(i) While the north-south traffic demand is generally met by 2030 including the improvement of the existing railway, the traffic demand will exceed the capacity after 2030.

(ii) While the capacity of the existing single-track railway is insufficient in 2020-2025, the capacity of double-track railway is excessive when improvements of other modes are completed.

(iii) Given the assumption that there is a high-speed railway in 2030, the demand for high-speed railway is high, and a shift in demand from both roads and air is expected.

1.8 Therefore it can be said that the issue for north-south corridor is on the one hand how to increase traffic demand as a whole, and on the other hand how to meet the demands for high-speed transport. If the railway cannot meet the demands for high-speed transport, there will be a great burden on road and air transport. Therefore, there will be adverse impact from social, economic, and environmental aspects, and will suffocate the realization of sustainable transport development which is the target of the current transport sector plan of the Government.

1.9 For more information, refer to Volume I Chapter 3 and 4 in the Main Report.

3) Can't the existing railway be used to provide high-speed purposes?

1.10 The answer is "NO". Although you may consider three alternatives for upgrading existing railways, all alternatives are not recommended. Each alternative and reason of objection is described as below:

1.11 **Conversion of existing railway to dual gauge:** Conversion of the entire existing line to dual gauge is not advisable because firstly, high speed operation is impossible on dual gauge. For example, Akita Shinkansen in Japan which operates on dual gauge has a maximum speed of only 130 km/h and average speed of 85 km/h. In addition, most bridges have to be reconstructed due to the shift of load center, and many station spatial layouts have to be remodelled due to the shift of construction gauge. Regarding maintenance cost, this will increase largely for dual gauge tracks. Train operation also has to be suspended during the construction period, and direct operation between Hanoi and HCMC becomes impossible for a long period. It is also noted that there are no cases in the world that dual gauge is applied for such a long route.

1.12 **Upgrading the existing railway for train operation at maximum speed of 200 km/h:** Many adjustments to the infrastructure will be needed. Most curved sections need to be upgraded to those with 2,000 meter radius at more than 1,500 locations, level crossings at roads need to be grade separated at more than 2,000 locations, and the renewal of electric, signalling-safety facilities, rolling stock is necessary. Maximum speed for narrow gauge is limited at 160 km/h. This option will also require suspension in operation of existing railway due to construction work for a long time. Hence double-tracking, standard gauge and electrification requires almost the same level of investment as new line construction.

1.13 **Mixed operation of passenger and freight trains at maximum speed of 200 km/h:** There is technological difficulty of freight train operation at more than 120 km/h, and there are also problems related to the safety and the train operation diagram. Although there are several cases in the world which has mixed operation of passenger and freight railway transport, in all cases, in order to prevent accidents upon trains pass one another, decline of overall transport capacity and speed, various measures are taken. This is quite disadvantageous given that the full operation from Hanoi to HCMC in the future is very long distance at 1,500km. HSR would reduce competitiveness among other transport modes if the speed shall be reduced.

1.14 For more information, refer to Volume I Chapter 3 and 4 in the Main Report.

4) Why does the HSR need to maintain maximum speed of over 300km/h?

1.15 In order for HSR to have competitiveness among other transport modes, especially air transport on the 1,500km long distance from Hanoi to HCMC, maintaining a maximum speed of over 300km/h is essential. Even given the fact that access to stations/ terminals is easier for HSR than air transport (in which according to a survey done in 2011, average access time from the city center to Noi Bai Airport and Tan Son Nhat Airport are 60 and 40 minutes, respectively, and domestic flight requests passengers to check-in 60 minutes prior to departure), air transport can connect both cities in 2 hours. Hence, the HSR can only become competitive at a speed of over 300km/h in which connects both cities in 5.7 hours.

5) What is the demarcation of roles among HSR and the existing railway? How about freight transport?

1.16 From the demand analysis conducted in the study, it is concluded that the railways along the north-south corridor are expected to play following roles;

(i) HSR can meet the demand for higher speed transport services which will increase further as income level of the people increase. A reason why HSR demand is high in the analysis is partly due to relatively low level of fare (1/2 of air fare) and easier access to the stations/terminals than air (generally speaking, access to airport takes longer time than other modes; based on a survey in 2011, average access times to Noi Bai Airport and Tan Son Nhat Airport are 60 minutes and 40 minutes, respectively; furthermore, domestic flight requests passengers to check-in 60 minutes before departure).

(ii) Existing railway has relatively high potential demand for freight transport services. The estimated freight traffic volume is unable to be met by single track railway. If the freight traffic demand to be attended fully, there are no more capacities left for passenger traffic. Double tracking increases the capacities by 3 to 4 times of the existing railway (from 50 trains/day to 170 trains/day) which is excessive compared to estimated demand.

(iii) While traffic demand analysis in this study is made for up to 2030, farther increase in along the north-south corridor beyond 2030 is highly likely considering potential growth of socio-economy and urbanization trend. Under these circumstances the requirement for rail transport services will become noteworthy because construction of additional expressways will be much more difficult and expensive than the railway.

1.17 Potential roles of railway development along the north-south corridor are obviously seen and summarized as follows;

(i) Increasing demand for higher speed and quality services along the north-south corridor can be met by HSR in the most appropriate manner. Capacities of air transport services are limited and still expensive for public and expressways are unable to compete with HSR for medium and long distances.

(ii) Existing railway has two main roles. One is to meet freight transport demand which is estimated to be about 50 to 60 trains/day in 2030. Another is to meet various types of passenger demand including those of medium distance travel and feeder to HSR. Local transport demand around main cities located in the north-south corridor may also be a market for existing railway though the analysis is not made in the study.

(iii) As the land to spare for transport infrastructure is limited along the north-south corridor, provision of high quality mass-transit transport is considered important for sustainable growth and development of the corridor beyond 2030.

1.18 For more information, refer to Volume I Chapter 3 and 4 in the Main Report.

6) What is the basis for selecting the priority sections in Hanoi – Vinh and HCMC – Nha Trang?

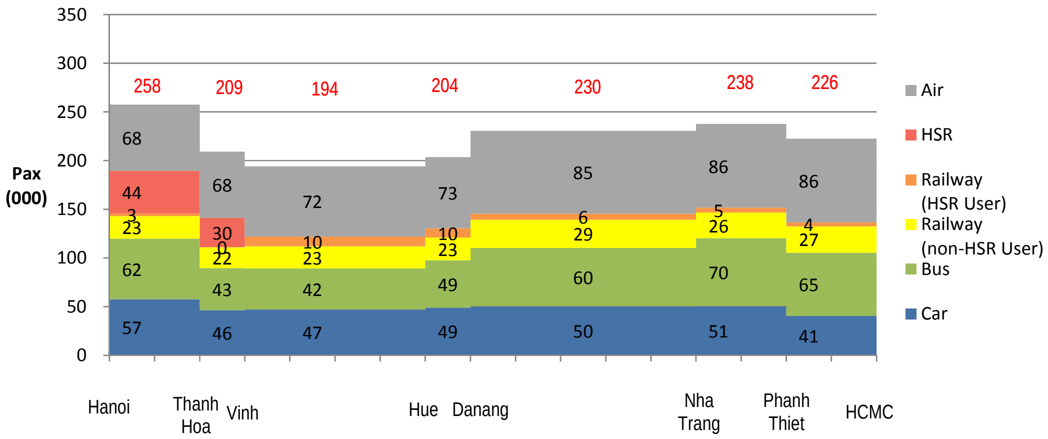
1.19 The priority section was selected by JICA, based on the results of traffic demand analysis in VITRANSS2 and the Pre F/S conducted by MOT. While there is a clear demand and relatively high economic viability on the sections which includes Hanoi and HCMC, the other two ends are both significant regional urban centers at Class I City level.

7) Wouldn't the effect of HSR be very limited if Hanoi and HCMC is not connected during the operation of priority sections only?

1.20 Traffic demand on the north-south corridor, connecting Hanoi and HCMC, is expected to increase by 4-5 times during 2012-2030. Such demand on the corridor includes not only long distance trips such as one from Hanoi to HCMC but also shorter trips such as ones from Hanoi to Vinh, from Hanoi to Nam Dinh, from HCMC to Nha Trang among others; for example, the estimated travel demand moving Hanoi – HCMC (both-direction) in 2030 is about 28,000 passenger/day, which accounts only for 10-15% of cross-sectional traffic demand.

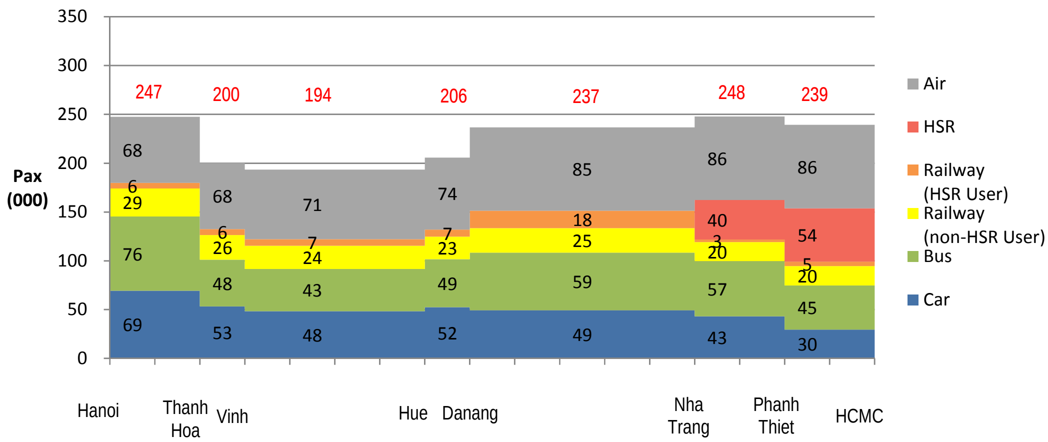
1.21 Figure 1.1 and 1.2 show the cross-sectional demand of the north-south corridor in 2030, in case either of north or south HSR priority section is developed. The figures clearly indicate the potentially high HSR ridership for priority sections, accounting for around 15-20% of cross-sectional demand or around 30-40 thousands of cross-sectional traffic per day (both-direction).

1.22 For more information, refer to Volume II Chapter 3 in the Main Report.



Source: JICA Study Team

Figure 1.1 Cross Sectional Traffic in North-South Corridor (Hanoi-Vinh under operation for HSR, 2030)



Source: JICA Study Team

Figure 1.2 Cross Sectional Traffic in North-South Corridor (HCMC-Nha Trang under operation for HSR, 2030)

8) What is the appropriate timing to develop the HSR?

1.23 The construction of the entire section of HSR can only become economically viable around middle of 2030s[1]. Comparison of investments to HSR from macro-economic viewpoint (% of investment cost for first HSR project to GDP at the time of investment) indicates that they are roughly 2-4% in the case of Japan, Korea, and Taiwan. Assuming that Vietnam's GDP will grow at average rate of 6%/year, the timing when the indicator for HSR in Vietnam fall below 4% is around 2030 for a partial section such as Hanoi – Vinh and HCMC – Nha Trang. This implies that a strategy to develop HSR step by step in accordance with economic growth is necessary. Implementing HSR project by forming subsections and implementing by phase is one effective way for development.

1.24 For more information, refer to Volume I Chapter 4 and 6, and Volume II Chapter 3, 7, and 10 in the Main Report.

[1] Project benefits are composed of savings in vehicle operating cost and travel time of passengers. It is also assumed that fare of HSR is a half of air fare and other improvement projects for national roads, expressways, existing railways (A2 level) and airports are completed in 2030. Economic Internal Rate of Return (EIRR) of 12% is applied to determine economic viability of the project.

9) The investment for HSR is huge. How is this justified when there are many other sectors in urgent need for investment?

1.25 Intermodal relationship along the north-south corridor has been analysed to determine the timing of HSR development by section in integration with the development of the existing railway. Based on that, improvement of national highways, development of expressways, and expansion of air transport are given priority.

10) How are the alternative scenarios discussed in the National Assembly considered and analysed in this study?

1.26 Initial set of alternative scenario on the development of the North-South railway development discussed in National Assembly in 2010 were reviewed and reorganized for more comprehensive study to provide a rational basis to formulate optimum strategy on the North-South railway development. The approach to this work is composed of three steps (See Table 1.1);

(i) Step 1: Review of initial alternative Scenario

(ii) Step 2: Identification of opportunities and constraints to upgrading existing railway

(iii) Step 3: Identification of options for improvement of existing railway and development of new railway

Table 1.1 Steps for Review and Reorganization of Alternative Scenario

Step 1 Initial Alternative Scenario

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

Step 2 Possibility of Upgrading of Existing Railway

- Possibility of converting to dual gauge for entire section of existing railway (1,700 km)
- Possibility of upgrading of existing railway infrastructure to accommodate train operation at maximum speed of 200 km/h.
- Possibility of mixed operation of passenger and freight trains at maximum speed of 200 km/h

Step 3 Options for Improvement of Existing Railway

	Options for Improvement of Existing Railway
A1	• Minimal improvement to ensure safe operation (ongoing and committed projects) • Maximum Operating Speed: 60 km/h (Travel Time: 29.1 h (Hanoi-HCMC) • Capacity: 32 trains/day/both-direction
A2	• Maximization of existing single track transportation capacity • Maximum Operating Speed: 70 km/h (Travel Time: 25.4h (Hanoi-HCMC) • Capacity: 50 trains/day/both-direction
B1	• Double tracking with meter gauge • Maximum Operating Speed: 110 km/h (Travel Time: 15.6 h (Hanoi-HCMC) • Capacity: 170 trains/day/both-direction
B2	• Double tracking with standard gauge • Maximum Operating Speed: 135 km/h (Travel Time: 12.7 h (Hanoi-HCMC) • Capacity: 170 trains/day/both-direction

Options for New HSR

New Line
• Maximum Operating speed: 280 km/h (Maximum Design Speed: 320 km/h)

Source: JICA Study Team.

1.27 For more information, refer to Volume I Chapter 4 in the Main Report.

11) Various options on the new construction of HSR track gauge 1,435mm on the north-south corridor shall be considered.

(1) Option 1: new construction of HSR track gauge 1,435mm, electrification, and maximum speed of 320km/h for passenger service.

(2) Option 2: new construction of a HSR track gauge 1,435 mm, electrification, maximum speed < 200 km/h.

(3) Option 3: new construction of normal railway track gauge 1,435mm, electrification, for both passenger and freight services.

1.28 As explained in 3), mixed operation of passenger and freight trains at high speed is not recommended (see also Main Text Part I Chapter 3 for details). While this study is mainly done based on Option 1, Option 2 and 3 will be considered in a separate study for initial sections, namely Hanoi – Phu Ly, HCMC – Long Thanh, Hanoi – Hai Phong, HCMC – Vung Tau, and Hanoi – Noi Bai.

1.29 For Option 3, in order to realize mixed operation of passenger and freight services, there will be issues on safety and in addition the speed must also be reduced. However, slower speed will reduce the competitiveness of HSR upon full opening. Hence mixed operation of passenger and freight services is not advisable. However, this may be possible for a certain section, if accepting the fact that the overall speed will slightly decrease. Japan's Seikan Tunnel is an example of such a case. But even so, results of this study reveal that mixed operation of passenger and freight services is not recommended for full operation from Hanoi to HCMC. Therefore, there is a possibility for adopting Option 3 for initial sections, in which passenger trains are relatively few, and also under conditions that the maximum speed is accepted to be reduced.

12) What are the differences of New Line Construction at 160-200km/h and over 300km/h?

(a) Cost

1.30 The long-term goal for HSR development in Vietnam is the construction of an HSR system of over 300km/h since the distance from Hanoi to HCMC is as long as 1,500km and high speed is indispensable for the HSR to be competitive to other transport modes. However, there are arguments that reducing the speed will reduce the overall initial cost. Therefore, in this section, the new line construction at 160-200km/h (which will be capable to increase speed to over 300km/h in the long-term) and the new line construction at over 300km/h from the initial stage are compared.

1.31 Items which cause a difference between the two options are i) substations and ii) rolling stocks as shown in Table 1.2. This is due to the reason that the cost for rolling stocks for slower operation speed is cheaper. The difference in the power consumption of rolling stocks leads to the difference in the number of substations.

1.32 Items which do not show any differences between the two options are i) roadbed structure, ii) signal and telecommunications, and iii) other costs such as land acquisition, consulting services, reserves, etc. These items are subject to the precondition explained above, and hence the same cost will be needed for both cases. As for signaling system for train speed over 160km/h, operational safety cannot be secured by such systems as ATS-P or ETCS Level 1 which depend on driver's vigilance. In the case of over 160km/h train operation, therefore, same level of signaling system or ATC will be needed as 300km/h case.

1.33 The results of cost comparison are shown in Table 1.2 to 1.4. The difference in cost between 160km/h and 300km/h is around 875 USD million or around 5% for both north and south sections combined.

Table 1.2 Cost Comparison (Ngoc Hoi – Vinh Northern Section)

Northern Section	160 km/h	300 km/h	Notes
Roadbed Structure	4,979	4,979	Including track, maintenance depots and workshops
Electricity	1,325	1397	Number of substations: 7 for 300km/h, 5 for 160 km/h
Signal and Telecommunications	646	646	ATC signaling system
Rolling Stocks	719	1,093	Smaller unit cost for 160km/h
Others	1,678	1,678	Land acquisition cost, consulting services, reserves, etc.
Total	9,347	9,793	Difference: 446 USD million

Source: JICA Study Team.

Table 1.3 Cost Comparison (Thu Thiem – Nha Trang Southern Section)

Southern Section	160 km/h	300 km/h	Notes
Roadbed Structure	4,680	4,680	Including track, maintenance depots and workshops
Electricity	1,580	1,652	Number of substations: 8 for 300km/h, 6 for 160 km/h
Signal and Telecommunications	756	756	ATC system adopted for 300km/h
Rolling Stocks	688	1,045	Smaller unit cost for 160km/h
Others	1,616	1,616	Land acquisition cost, consulting services, reserves, etc.
Total	9,320	9,749	Difference: 429 USD million

Source: JICA Study Team.

Table 1.4 Cost Comparison (North and South Priority Sections combined)

North and South Priority Sections	160 km/h	300 km/h	Notes
Roadbed Structure	9,659	9,659	Including track, maintenance depots and workshops
Electricity	2,905	3,049	Number of substations: 15 for 300km/h, 11 for 160 km/h
Signal and Telecommunications	1,402	1,402	ATC system adopted for 300km/h
Rolling Stocks	1,407	2,138	Smaller unit cost for 160km/h
Others	3,294	3,294	Land acquisition cost, consulting services, reserves, etc.
Total	18,667	19,542	Difference: 875 USD million

Source: JICA Study Team.

1.34 A different result is shown in the comparison carried out in KOICA Feasibility Study for Ngoc Hoi - Ha Tinh section reported in December 2007. The cost of Alternative 2 (Roadbed 350km/h, System 200km/h) is 9% lower than that of Alternative 3 (Roadbed 300km/h, System 350km/h) as shown in Table 1.5. This is due to the fundamental difference in the applied signaling system for the option of 160-200km/h, i.e. JICA applies ATC to the option of 160km/h while KOICA applies ATP (Auto Train Protection) to Alternative 2 or an option of system 200km/h. Although ATP is lower than ATC in cost as shown in Table 1.6., ATP signaling system being equivalent to ETCS Level 1 is not considered to be appropriate to introduce into the construction of a new line with train speed over 160km/h due to less capability than ATC. Once ATP is introduced into a new line it will be highly difficult and costly to upgrade it to ATC in future.

Table 1.5 KOICA's Comparison of Different Alternatives (Ngoc Hoi– Ha Tinh: 334km)

<table>
<tr><th colspan="2" rowspan="2">Cost of Each Type</th><th>Alternative 1
Roadbed 200km/h
System 200km/h</th><th>Alternative 2
Roadbed 350km/h
System 200km/h</th><th>Alternative 3
Roadbed 350km/h
System 350km/h</th></tr>
<tr><th>Mill USD</th><th>Mill USD</th><th>Mill USD</th></tr>
<tr><td rowspan="3">1. Construction</td><td>Roadbed</td><td>4,997</td><td>6,114</td><td>6,114</td></tr>
<tr><td>System</td><td>3,840</td><td>3,840</td><td>4,538</td></tr>
<tr><td>Total</td><td>8,837</td><td>9,954</td><td>10,652</td></tr>
<tr><td colspan="2">2. Incidental Expense</td><td>815</td><td>916</td><td>1,025</td></tr>
<tr><td colspan="2">3. Rolling Stock Purchase</td><td>282</td><td>282</td><td>517</td></tr>
<tr><td colspan="2">4. Land Compensation</td><td>510</td><td>550</td><td>550</td></tr>
<tr><td colspan="2">5. Total</td><td>1,044</td><td>11,702</td><td>12,744</td></tr>
<tr><td colspan="2">6. Contingency</td><td>1,044</td><td>1,170</td><td>12,74</td></tr>
<tr><td colspan="2" rowspan="2">Total</td><td>11,488</td><td>12,872</td><td>14,019</td></tr>
<tr><td>89.2%</td><td>100.0%</td><td>108.9%</td></tr>
</table>

Source: Feasibility Study for Building and Electrifying the New 1,435mm Double Track Gauge from Hanoi to Vinh on the North-South Trunk Line, KOICA, 2007.

Table 1.6 KOICA's Comparison of System Construction Costs

(unit : mill USD)

Cost for Each Type	200 km/h	350 km/h	Change
1. Track, Architecture, Inspection	1,048.3	1,048.3	-
2. Electric Facility, Architecture	1,519.1	1,815	(+) 295.9
3. Communication Facility	955.9	955.9	
4. Signal Facility	316.8	718.3	(+) 401.5
5. Vehicle Purchase	282	517	(+) 235
Total	4,122.1	5,054.5	(+) 932.4

Source: Feasibility Study for Building and Electrifying the New 1,435mm Double Track Gauge from Hanoi to Vinh on the North-South Trunk Line, KOICA, 2007.

(b) Travel Time

1.35 The difference in travel time for north and south priority sections are shown in Table 1.7 and 1.8. Comparing the operation of 320km/h and 160km/h in the northern section, there is a difference of 53 minutes for express trains and 52 minutes for local trains. Likewise, for the southern section, there is a difference of 1 hour and 7 minutes for express trains, and 1 hour and 6 minutes for local trains. This indeed indicates nearly a two times increase in travel time.

Table 1.7 Travel Time Comparison (Ngoc Hoi – Vinh Northern Section)

E2 Type (10 cars)						Hakutaka Type (9 cars)	
320km/h		300km/h		200km/h		160km/h	
Express	Local	Express	Local	Express	Local	Express	Local
0:59:00	1:15:30	1:01:00	1:16:15	1:29:15	1:38:45	1:52:00	2:07:30

Source: JICA Study Team.
Note: "Express" means nonstop (stopping only at terminal stations of Ngoc Hoi and Vinh), and "Local" means stopping at all stations.

Table 1.8 Travel Time Comparison (Thu Thiem – Nha Trang Southern Section)

E2 Type (10 cars)						Hakutaka Type (9 cars)	
320km/h		300km/h		200km/h		160km/h	
Express	Local	Express	Local	Express	Local	Express	Local
1:13:30	1:29:30	1:17:15	1:33:00	1:53:00	2:03:00	2:21:00	2:35:15

Source: JICA Study Team.
Note: "Express" means nonstop (stopping only at terminal stations of Ngoc Hoi and Vinh), and "Local" means stopping at all stations.

13) Why are constructions of initial sections needed?

1.36 In order to develop HSR which is a significant and long-term national project in the most effective and appropriate manner, it is expected that an initial section (which refers to the first segment of HSR priority sections) is constructed and operated with following objectives:

- To provide an effective base for human resource development necessary for construction, operation and management of HSR based on actual system through the initial section.
- To commence actual high-speed operation at early stage not only for training but also commercial purpose for experiences of the people and promoting social consensus on the HSR.
- To provide inputs for preparation of necessary institutions such as regulations, technical norms and standards and other matters related to effective development of

HSR.

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

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

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

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

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

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

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

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

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

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

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

1.38 In Japan, initial sections as test tracks had been utilized for around two years before the operation. However, since HSR technologies are far different from ones currently applied in Vietnam, it would take a longer period mainly for human resource development, preparation of maintenance manuals, and testing of the HSR system to allow appropriate introduction of the HSR to Vietnam.

2 Consistency with Existing Plans

1) Is the HSR consistent with existing plans such as the Socio-Economic Development Plans, Construction Plans, Sector Plans, etc.?

2.1 The latest regional and urban plans were collected in order to reflect the latest plans to HSR development. These plans include the Socio-Economic Development Plan, Construction Plan, Land Use Plan, Transport Development Plan, and other sectorial plans. In addition, development plans and situation of area in vicinity of the station was carefully studied.

2.2 The Study Team has also conducted a series of consultation meetings, stakeholder meetings, and follow-up meetings in the 11 provinces along the alignment to ensure consistency with existing plans of the localities. In these meetings, detailed information of individual projects on-going, committed, or in plan was also shared with the JICA Study Team. The comments given in these meetings were reflected accordingly to the alignment and station location.

2.3 For more information, refer to Volume I Part A and B Chapter 4 Planning of HSR Routes in the Main Report.

3 Traffic Demand Analysis and Fare Level of HSR

1) The methodology and results of the traffic demand analysis needs to be clarified in a more explicit manner.

3.1 The methodology and the result of the demand forecast are comprehensively explained in Technical Report No.2 Demand Forecast & Transportation Cost. In the following paragraphs, the approach, methodology and the result of the demand forecast are briefly explained.

3.2 For the purpose of traffic demand analysis of the HSR, the model developed in VITRANSS2 (JICA, 2010) was modified based on the latest traffic data, socio-economic data, and the data of transportation available. Four steps method model was applied for the demand forecast. Four-step method is the one of the most traditional methodology of demand forecast including the following four analytical steps, (i) trip generation/attraction, (ii) trip distribution, (iii) modal split, and (iv) traffic assignment.

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

Table 3.1 Population and Urbanization Projection by Region

Region	2005		2009		2020		2030		AGR for Pop. (%)		
	Pop. (000)	Urban (%)	Pop. (000)	Urban (%)	Pop. (000)	Urban (%)	Pop. (000)	Urban (%)	05 - 09	09 - 20	20 - 30
Red River Delta	19,084	25.6	19,584	29.3	21,709	39.3	22,992	47.1	0.6	0.9	0.6
Northern midlands and mountain areas	10,799	15.3	11,054	15.9	12,327	17.8	13,225	20.0	0.6	1.0	0.7
North Central and Central coastal areas	18,609	22.0	18,835	24.0	20,222	30.4	21,436	37.7	0.3	0.6	0.6
Central Highlands	4,768	27.4	5,115	28.2	6,035	41.2	6,783	51.7	1.8	1.5	1.2
South East	12,381	55.9	14,068	57.2	17,379	61.3	19,300	68.8	3.2	1.9	1.1
Mekong River Delta	16,859	20.4	17,191	22.8	18,487	30.6	19,419	38.6	0.5	0.7	0.5
Vietnam Total	82,499	27.0	85,847	29.6	96,159	37.1	103,155	44.4	1.0	1.0	0.7

Source: JICA Study Team

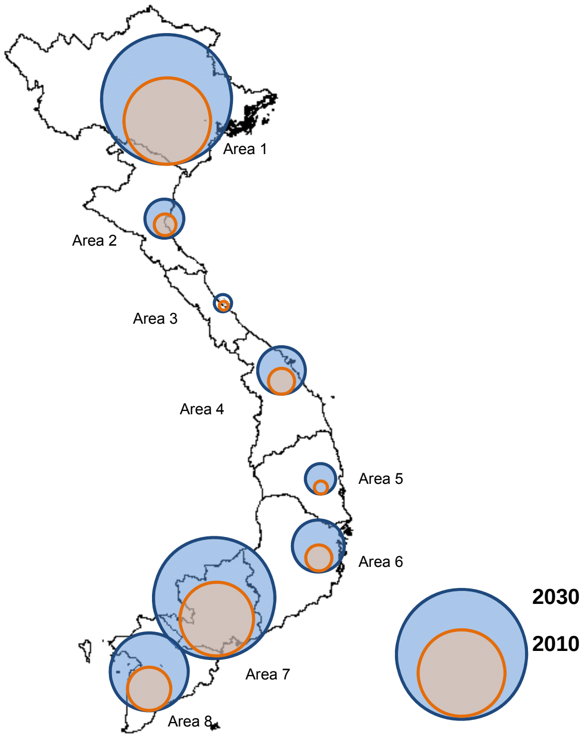
Table 3.2 Projected GRDP by Region

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

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

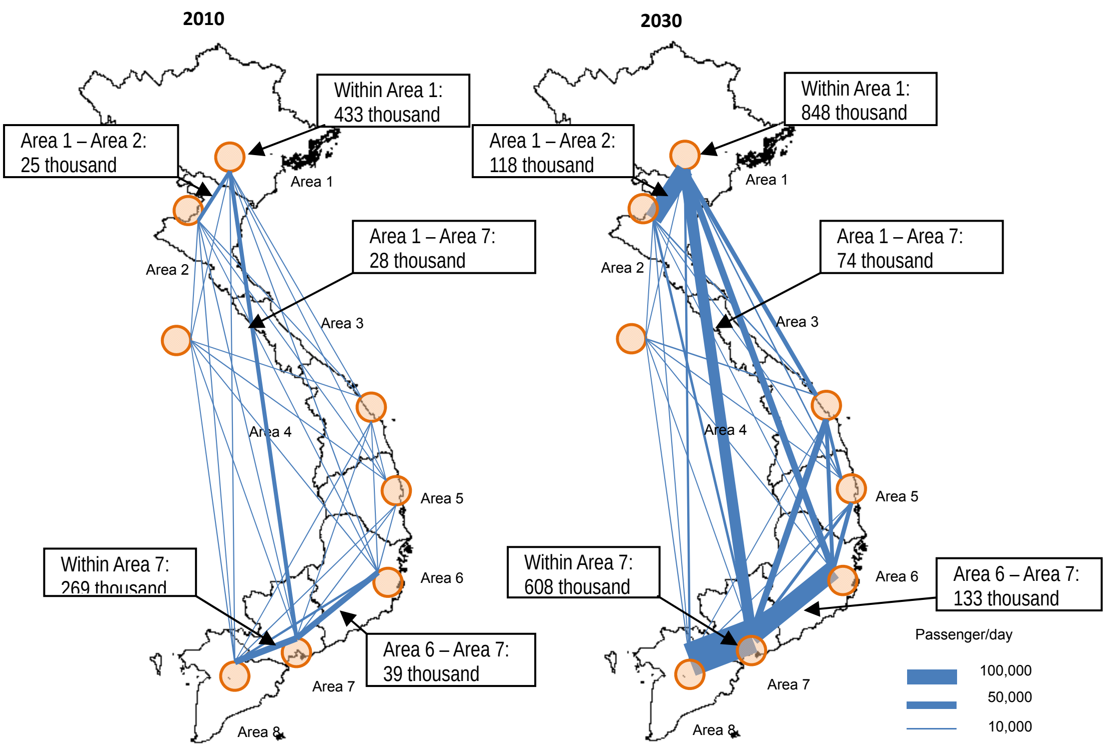
3.4 Figure 3.1 and Figure 3.2 shows trip generation/attraction and trip distribution respectively. During 2010-2020, the total number of inter-provincial trip will increase by 2.7 times and the number of passengers who travel between the north (Area 1) and the south (Area 7) will increase 2.6 times The travel demand moving between neighboring areas will also increase significantly.

Area	Generation/Attraction (000)	
	2010	2030
1	469	1,003
2	29	100
3	6	15
4	39	132
5	9	49
6	44	169
7	335	879
8	102	381
Total	1,032	2,728



Source: Study Team

Figure 3.1 Trip Generation/Attraction per day (inter-provincial) (2010 & 2030)



Source: JICA Study Team

Figure 3.2 Passenger Traffic Demand Distribution, (inter-provincial) (2010 & 2030)

3.5 Model split model was applied assuming operating condition by mode as shown in Table 3.3 and the result of analysis for the base cases under which HSR is operated for Hanoi-HCMC, Hanoi-Vinh, and HCMC-Nha Trang are shown in Table 3.4. Daily passenger demand on HSR is 85 thousands and 68 thousands for Hanoi-Vinh and HCMC-Nha Trang sections, respectively, which account for 3.1% and 2.5% of all interprovincial trips.

Table 3.3 Assumed Operating Condition by Mode

Mode			PCU/Veh Ratio	Average Occupancy [1]	Fare/Cost (VND/Pax-km	Travel Speed (km/h)	Time at terminal (waiting time) (min)
Road	Road	Car	1	3.2	527	40	0
		Bus	2.5	20.5	525	32	20
	Expressway	Car	1	3.2	855	80	0
		Bus	2.5	20.5	653	64	20
Railway	Existing Railway		-	-	584	60/70/110 /135[2]	20
	High Speed Railway [3]		-	-	873	280	20
Air Transport			-	-	1,745	600	60

Source: JICA Study Team

Note: 1) Based on traffic survey (2011) (The same condition is assumed for the future), 2) Depending on the level of improvement of existing railway (A1, A2, B1, B2) 3) For base case

Table 3.4 Demand Analysis Result by Mode

Year	Assumed HSR Section Under Operation	Unit	Representative Mode of Transport					TOTAL
			Car	Bus	Railway (CR)[1]	HSR	Air	
2010 (Base Year)	-	No.of pax/day (000)	304	675	30	-	25	1034
		Modal Share (pax, %)	29.4	65.3	2.9	-	2.4	100.0
		Average Trip Length (km)[2]	118	183	407	-	932	188
2030	Hanoi-HCMC	No.of pax/day (000)	733	1558	89	275	74	2728
		Modal Share (pax, %)	26.9	57.1	3.2	10.1	2.7	100.0
		Average Trip Length (km) [2]	191	164	454	667	1250	261
	Hanoi-Vinh	No.of pax/day (000)	787	1647	92	85	116	2728
		Modal Share (pax, %)	28.9	60.4	3.4	3.1	4.3	100.0
		Average Trip Length (km) [2]	220	183	502	400	1238	256
	Nha Trang -HCMC	No.of pax/day (000)	790	1663	92	68	114	2728
		Modal Share (pax, %)	29.0	61.0	3.4	2.5	4.2	100.0
		Average Trip Length (km) [2]	214	178	532	627	1290	258

Source: JICA Study Team
Note: 1) In case service level of railway is A2, 2) Distance from final origin to final destination.

3.6 The summary of demand analysis for HSR is shown in Table 3.5. Since cities are located closely to each other in Hanoi-Vinh section, the average trip length of HSR users of Hanoi-Vinh section is shorter than that of Nha Trang-HCMC section. Thus, while the number of passenger is higher in the north section (85 thousands at 50% of air fare) than in the south (68 thousands at 50% of air fare), passenger-km is higher in the south (12 million in the north and 17 million in the south at 50% of air fare).

Table 3.5 Results of High-Speed Railway Traffic Demand Analysis

Item		North (Hanoi-Vinh)		South (HCMC-Nha Trang)	
Passengers (day)	@1/2 airfare	84,912		67,903	
	@3/4 airfare	38,602		32,923	
Passenger-kms (000/day)	@1/2 airfare	12,034		16,972	
	@3/4 airfare	5,523		9,044	
Traffic Demand of Main Cross-Sections (1/2 airfare)	000/day	Hanoi – Thanh Hoa	43.0	HCMC – Phan Thiet	49.0
		Thanh Hoa - Vinh	30.0	Phan Thiet – Nha Trang	40.0
	Share of HSR (%, excluding air)	Hanoi – Thanh Hoa	22.5	HCMC – Phan Thiet	32.7
		Thanh Hoa - Vinh	21.1	Phan Thiet – Nha Trang	24.5

Source: JICA Study Team

3.7 Cross sectional traffic and modal share from the terminal cities in case Hanoi-Vinh and HCMC-Nha Trang sections are developed are shown in Figures 3.3 and 3.4, respectively. Besides the passengers from/to cities along the alignment, transferring passenger are also observable. 30% of passenger moving from Hanoi to Vinh uses HSR, while 60% of passenger moving from HCMC to Nha Trang does.

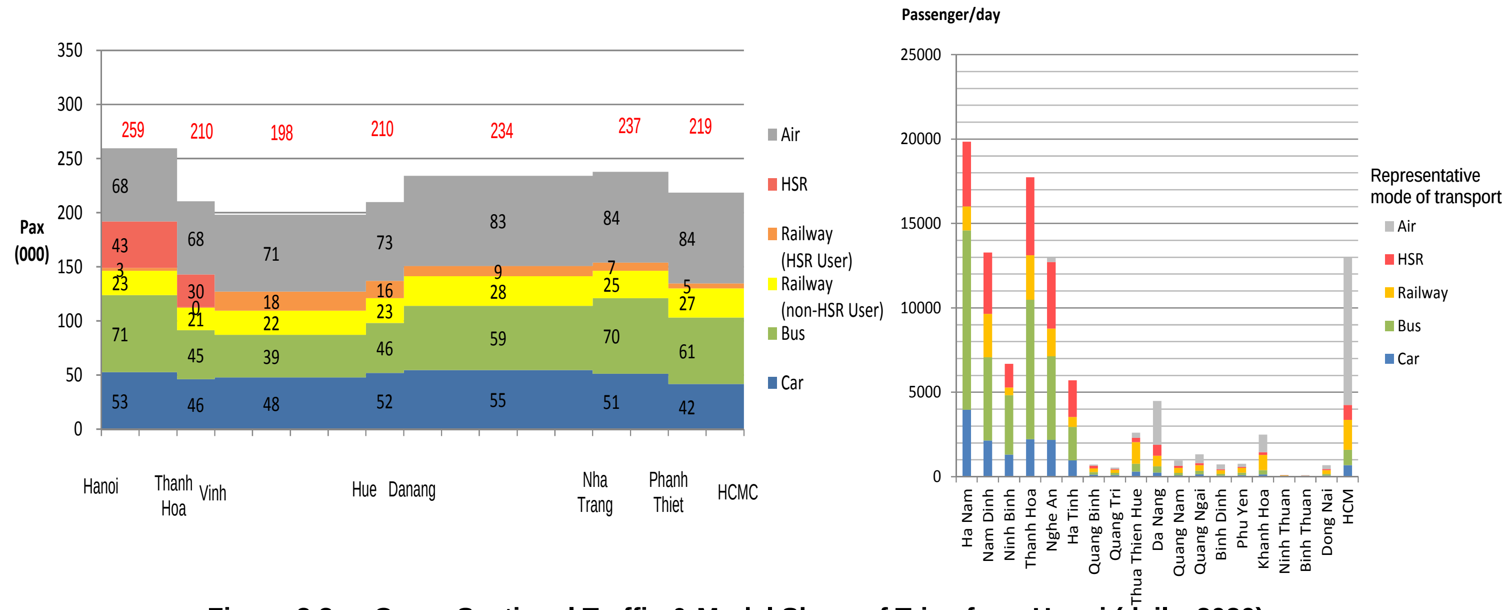


Figure 3.3 Cross Sectional Traffic & Modal Share of Trips from Hanoi (daily, 2030) (Hanoi-Vinh Section is under operation)

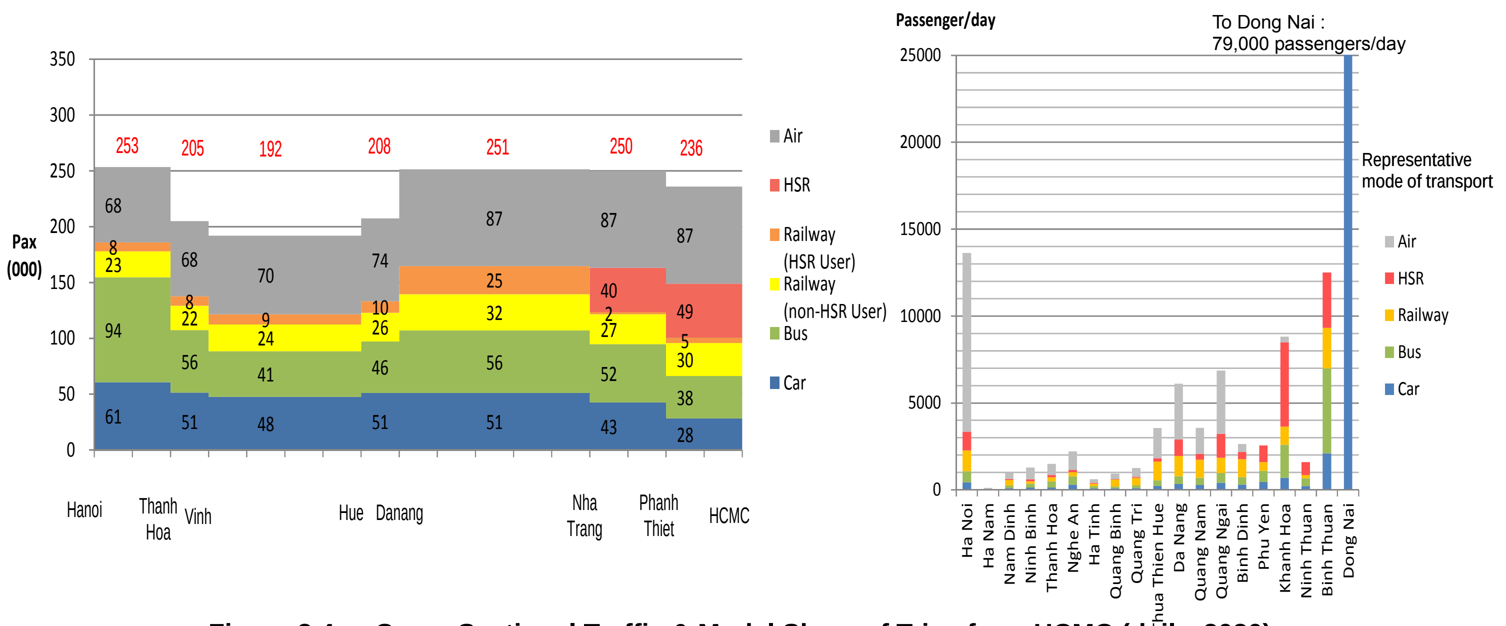


Figure 3.4 Cross Sectional Traffic & Modal Share of Trips from HCMC (daily, 2030) (HCMC-Nha Trang Section is under operation

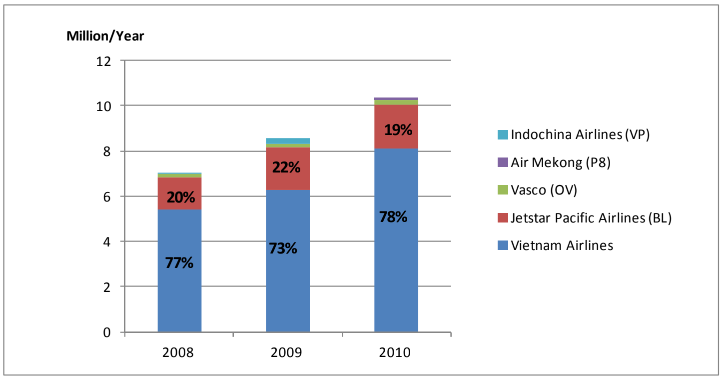
2) What are the effects of the emerging LCC (low-cost-carriers) market to the development of the HSR?

3.8 The raise of low-cost-carriers (LCC) is the world-wide trend in recent years and it is also true in Vietnam; LCC, such as Jet-Star Airline and Air Mekong operate domestic flights with reasonable fare settings compared to Vietnamese flag carrier, Vietnam Airlines. Vietnamese HSR supposedly has to face to the competition with this new style of air transport service. While it is not easy to foresee the future situation of transportation market in Vietnam clearly, it could be affirmed that HSR will play an important role in the market of transportation in Vietnam with competition and supplementation with other transportation modes including LCC. The followings are insights on the role of HSR in the future transport market in Vietnam.

3.9 **HSR's Role on priority sections (Hanoi-Vinh and HCMC-Nha Trang):** the advantage of HSR over other modes for the priority sections is quite obvious. HSR can offer services with travel time of around 70 minutes for either of Hanoi-Vinh (284 km) or HCMC-Nha Trang (362 km) sections while air transport demands 60 minutes only for waiting at airports and, in addition, requires more access travel time than railway transport (Noi Bai International Airport (NBIA) in Hanoi is about 45 km away from Hoan Kiem district and the planned Long Thanh International Airport (LTIA) will be about 40 km away from District 1 in HCMC). Total travel time would be 2-3 times compared to HSR. Even if LCC set quite cheap fare level, it is almost impossible to compete with HSR service for such sections.

3.10 **Limited Capacity of Airports:** To cater to the increase of traffic demand in the North-south corridor, which will be 4-5 times for 2010-2030, the expansion of the capacity of transportation infrastructure is indispensable. The limitation of the capacity of airports is already a serious issue in Vietnam. NBIA in Hanoi has handling capacity of 6 million passengers per annum (mppa), which is short to the actual volume of 9.5 mppa as of 2010 while Tan Son Nhat International Airport (TSN) in HCMC has a passenger handling capacity of 15 mppa, which is already short to the actual volume handled of 17 mppa in 2011. The expansion of airports' capacities is on-going; in NBIA, Terminal 2 (T2), which will add additional capacity of 10 mppa, is now under construction (as of August 2012) and expected to be completed in 2015; in HCMC, new LTIA is under planning for starting operation in 2020 with the capacity of 25 mppa. These expansions are, however, obviously not enough to cater to the huge increase of traffic demand in the North-south corridor. Either LCC offers services with reasonable fares or not, airport transport cannot deal with the volume on its own. HSR is, therefore, expected to offer addition transportation capacity with high-speed service.

3.11 Past Trend of LCC: The number of annual domestic air passenger by operating company is shown in Figure 3.5 below. Both Vietnam Airlines and the low cost carriers (i.e., Jet Star Pacific, VASCO, Air Mekong, and Indochina Airlines) have been increasing their passenger volumes over the last three years. The share of LCC remains on the level of around 20% without significant increase, which indicates that, while LCC play some role on air transportation market, it is not yet considered a dominating force. However, this situation may change in the near future. Therefore, high speed operation of HSR will be needed even more in the future. (see Chapter 1 item 4))



Source: Civil Aviation Administration of Vietnam

Figure 3.5 No. of Annual Domestic Air Passenger by Operating Company

3) The fare level presumed in the Pre F/S at 3/4 of the air fare is too high for common people, and a more appropriate fare shall be set.

3.12 For setting the fare level, there are generally two major things to be concerned; financial sustainability of HSR operation and people's accessibility to HSR service. While it is necessary to maximize the financial profitability of HSR operation from the operational point of view, the fare level is expected to keep at a reasonable standard in consideration of the project's economic benefit.

3.13 In the study, four cases of the fare level have been tested (see Table 3.6) and case 2 (base case, half of air fare) is considered most appropriate since it is financially most preferable and attract large number of passengers enough to justify the economic benefit of the project. It is expected that Vietnamese GDP per capita in 2030 will be 2.83 times higher than the one in 2010 and, in such case, fare level of case 2 (half of air fare) accounts for 0.131% of GDP per Capita, which is lower than one of Japan when the first Shinkansen line started operation (0.160%), while it is still higher than the ratio of fare level to GDP per capita in some other countries (see Table 3.6). Since the economic growth in Vietnam is considered to continue even after 2030, the fare level to GDP per capita ratio will further decrease, which means more people can easily access to HSR service, and even it would be possible to increase the fare level in the future.

Table 3.6 Results of High-Speed Railway Traffic Demand Analysis

	Case 1	Case 2 (Base Case)	Case 3	Case 4
Fare level per km (VND)	436.5	873	1309.5	1746
Fare level per km (US$)	0.021	0.042	0.062	0.083
Fare level per 100 km/ GDP per Capita per km in 2030 (%)	0.066%	0.131%	0.197%	0.262%
Note	Quarter of Air Fare	Half of Air Fare	3/4 of Air Fare	Equal to Air Fare

Source: JICA Study Team

Table 3.7 HSR Fare in the World

	Japan (1964)	Japan (2010)	Taiwan (2007)	Taiwan (2010)	Korea (2004)	Korea (2010)	France (2010)	Germany (2010)	Spain (2010)
Fare level per km (Constant 2010 US$)	0.055	0.311	0.136	0.136	0.095	0.117	0.277	0.340	0.227
Fare level per 100 km/ GDP per Capita per km in 2030 (%)	0.160%	0.073%	0.077%	0.074%	0.054%	0.056%	0.070%	0.085%	0.074%

Source: JICA Study Team

3.14 For more information, refer to Volume I Chapter 2 and 4, Volume II Chapter 2 and 3 in the Main Report.

4 HSR System

1) What is the best HSR system for Vietnam given the comparison among various technologies in the world, and why?

4.1 Since the distance from Hanoi to HCMC is long, speed is an important factor for deciding the HSR system in Vietnam. However, on the other hand, high speed can lead to very devastating results once an accident occurs. In addition, given that it will be the first time for Vietnam to introduce HSR technology, the system should be as simple which can avoid mistakes as much as possible. It is best if this can be realized at a low cost.

4.2 Comparing the push-pull power concentrated technology adopted by European countries and the EMU (Electric Multiple-Unit) technology of Japan, the advantage of a push-pull power concentrated technology has been said to be the passenger's comfort and longer lives of rolling stocks owing to the fact that locomotives are not loaded on passenger cars. However, due to the development of technology, such differences have become negligible. On the other hand, EMU technology has many advantages such as speed increase/ decrease capability, lighter rolling stocks, safer operation, number of seats per length of rolling stocks, etc. Therefore, although both systems were competing with one another in the past, due to the increase in operation speed, most countries now select EMU technology. This recent adoption of EMU technology in China has united the world's trend towards EMU technology.

4.3 Another large difference between the HSR of Japan and other countries is whether it adopts single track single-directional or single track bi-directional operation. Single track bi-directional operation is that by bi-directionally operating on one track on a double-track railway, the other track will be available for maintenance or use in sudden accidents. While this is convenient, the actual operation becomes complicated, and many rules and measures have to be applied to ensure safety (e.g. how to maintenance one single track during train operation of another single track).

4.4 Japan adopts single track single-directional operation and for this operation, Japan adopts the method to separate the time for maintenance and operation. In addition, operation never stops in tunnels even when there is a fire, which simplifies the system. Hence, given these methods and concepts to ensure safety, fatal accidents in Japan are at 0 persons ever since 1964. Not only safety, but such measures enable more compact infrastructure for HSR hence leading to relatively lower costs.

4.5 From this viewpoint, the HSR system to be adopted in Vietnam will as follows: (1) EMU technology and (2) Single-track single-directional operation by separating operation and maintenance time.

4.6 For more information, refer to Volume I Chapter 5 in the Main Report.

2) How will the introduction of HSR affect the electricity system in Vietnam?

4.7 The electric power company (EVN) in Vietnam will supply sufficient electric power to satisfy the demand. Necessary measures will be taken so that the electrification of the railway does not affect the electricity system or general consumers in Vietnam.

4.8 For more information, refer to Volume I Chapter 5, Volume II Chapter 6 in the Main Report.

5 Urban Development and Integrated Development

1) How will the provinces and cities along the alignment benefit from HSR development?

5.1 Expected benefits due to HSR development should not be limited to the transportation sector alone but should be felt for overall socio-economic activities in provinces and cities along the alignment. The major benefits from HSR development to provinces and cities along the alignment include the following: i) passenger's effects such as time reduction, increase safety and convenience, ii) operator's effect such as profit increase, iii) presence effect such as improvement of symbolic value and formulation of urban core, iv) economic effect, v) land use effect, vi) modal shift effect. For urban areas, station development is one of the most important aspects of HSR in relation to urban development. (see Table 5.1) For more information, refer to Volume I Chapter 2, Volume II Chapter 2, 4, and 5 in the Main Report.

Table 5.1 Potential Benefits of HSR Station Development

Category	Potential Benefits of HSR Station Development	
	Direct	Indirect
Economic	• Increase of visitors (business, tourism, etc.) to the city • Expansion of urban activity including new businesses, commercial market activities, etc.	• Commercial development • Promotion of industrial activities • Increase in job opportunities • Increase in tax revenue
Social	• Enhancement of city image • Expansion of daily milieu • Promote urban living with comfort and convenience through public transport	• Formation of urban core • Promote social integration of old city center and new development areas.
Environment	• Decrease GHG emission • Promote urban living in harmony with natural environment • Increase importance of historical and cultural resources	• Increase awareness for environmental protection • Natural preservation area, agricultural area and green area
Infrastructure	• Urban renewal, area infrastructure and utilities improvement • Regional connectivity • Reduction in travel time • Increased transport safety and convenience • Enhance intermodal connection	• Modal shift towards public transport use

Source: JICA Study Team

2) What kinds of measures are needed to ensure swift land acquisition especially in urban areas?

5.2 Land acquisition is a serious issue for many infrastructure development projects in Vietnam. There are two main aspects which make this difficult, one legislative and the other institutional. These issues coupled with needed measures are described as follows.

(a) Securing Land for Development

5.3 In the new Urban Planning Law (Article 18 and 23) and Decree No. 37 (Article 14), the roles and contents of the General Plan (1/10,000 scale), Zone Plan (1/2,000 scale) and the Detailed Plan (1/500 scale) are clarified. According to the current legislation in Vietnam, the plan which has force of law is mainly the Detailed Plan only, including site clearance based on the plan (Article 62 of Law) and management principle of construction

(Article 69 of Law). Though right-of-way of main facilities and roads are shown both in the General Plan and Zone Plan, the land cannot be reserved based on these plans. However, it takes large inputs of time and money to formulate this Detailed Plan for the whole city (and therefore not administered in most cases). Hence the reality is that land is not reserved effectively for infrastructure development.

5.4 In order to combat this issue, there will be a need for a legislation reform. To control actual urban development and construction activities in compliance with the General Plan, at least a zoning map[2], key urban facility map[3], and special purpose zones[4] shall be indicated in the Zone Plan at 1/2,000 which covers the whole city hence enabling to reserve land for future infrastructure development.

5.5 Although this legislative reform has been proposed in a former JICA study in cooperation with MOC, this still has a long way towards its realization.

5.6 However, there are cases already in the cities along the alignment which make efforts to reserve land for the development of HSR. One good practice is in Phu Ly City in Ha Nam Province. Although facing legislative difficulties as explained, the city takes initiative by restricting the issuance of development permission in the areas reserved for HSR based on the General Plan. Hence land can be reserved for the future before its construction, minimizing the adverse effects if otherwise. This is a very good example to be noted in which other cities and provinces along the alignment are suggested to follow.

(b) Need for Transparent Land Management

5.7 Actual practices in land management in Vietnam can be quite controversial as several current policies make corruption related to land unusually profitable[5]. Compulsory land acquisitions create large uncontested profits for certain people, especially when prices are set below market values. An independent mechanism for determining land prices are needed to bring them in line with the actual market price. Hence this will provide fairer conditions for those dispossessed of their land, and enable to reduce the people's complaints and concerns towards compensation. For this, building accountability of officials is also important, as such rules mechanisms can be effective only if they are well implemented.

5.8 For more information, refer to Volume I Chapter 2, Volume II Chapter 2, 4, and 5 in the Main Report.

3) Does the study consider how to ensure smooth access to the HSR station in urbanized areas?

5.9 Connectivity of HSR with other transport modes is also important, as HSR will face the competition against air and road soon after its operation. Therefore, HSR should maximize the advantageous points of HSR (e.g. short access time, punctuality, high frequency of operation, etc.) by considering a strategic station location.

5.10 Successful urban development has been achieved with feeder railway network (that is to say, if there is better connectivity, the ridership will increase and thus promote

[2] Indication of use zones, floor area ratio, building coverage ratio, maximum building height.

[3] Indication of location, size, boundary of key urban facilities.

[4] Indication of location, size, boundary of zones for special purposes.

[5] "Recognizing and Reducing Corruption Risks in Land Management in Vietnam", "Survey Report on Information Disclosure of Land Management Regulations", World Bank, 2012.

economic viability). Without convenient railway connection, many cities have failed in integrated development (e.g. in Japan, Taiwan, Korea, etc.)

5.11 Hence the station location has been evaluated and selected with regards to the following factors assessing the convenience of the people:

(i) Connectivity with other transportation modes

(ii) Distance from main urban centers

(iii) Availability of land for integrated development

5.12 For more information, refer to Volume I Chapter 2, Volume II Chapter 2, 4, and 5 in the Main Report.

6 Alignment Planning

1) What are the criteria for setting the alignment and station location?

6.1 The criteria for setting the alignment are as follows:

(i) HSR route must ensure high-speed train operation at maximum speed of 350 km/h

(ii) HSR route must maximize socio-economic benefits due to HSR by locating stations in integration with future urban pans. Connectivity with existing railway and other transportation modes is also important to ensure good accessibility to HSR.

(iii) HSR route must minimize negative impact on social and environmental aspects in the areas along the routes.

(iv) HSR route and related structures must be planned and designed in a way that they meet technical standards for HSR and contribute to reduce construction and maintenance costs.

6.2 As basic concept for station locations selection along the HSR alignment, JICA Study Team has set the station in areas which meet one or more of the following criteria. For each station location, more detail alternative locations are considered and evaluated to find out the most appropriate one.

(i) Provincial Capitals, if alignment allows.

(ii) Larger towns (ex. class III) along the alignment.

(iii) Special location for passengers' convenience

(iv) Other stations may be developed later if there is 1) enough demand with 2) potential of integrated development.

6.3 For more information, refer to Volume II Chapter 4 and Volume III Chapter 3 in the Main Report.

2) Is connectivity with the existing north-south railway and urban railways in Hanoi and HCMC ensured for HSR?

6.4 Upon setting the station location, the connectivity of HSR with the existing railway and urban railways were viewed as one of the most critical points. This is because the convenience of passengers will be the key for the success of HSR. If the HSR is connected with the existing railway and urban railways, they can serve as a feeder service for the HSR. This is also based on the assumption that the existing railway will also be upgraded to provide safer operation and higher speed with more frequent trains.

6.5 For more information, refer to Volume II Chapter 4 and Volume III Chapter 3 in the Main Report.

3) What are the criteria in selecting the structure type for HSR, such as embankment, viaduct, etc.?

6.6 In order to determine the structure type for HSR, JICA Study Team has studied the basic conditions such as the geological data, topographic data obtained from the site investigation, boring survey, under-going project and the satellite-based map of 1/10000 scale. Embankment and viaduct structures are planned to minimize not only the social environment impact but also the construction cost of the whole section. Viaduct is used when meeting the following criteria while embankment is basically applied in the other cases.

(i) Populated area such as urban area where may cause significant impacts on existing buildings, road, railway and other facilities.

(ii) Soft Ground with the N value of less than 5 for more than 20m depth where the residual settlement of embankment is supposed to be large

6.7 For more information, refer to Volume II Chapter 4 and Volume III Chapter 3 in the Main Report.

4) In embankment sections, flooding and segmentation of urban areas is concerned. How does the HSR plan avoid such issues?

6.8 In case of embankment, it is suggested to plan box culverts for passing road (for peoples' mobility and integrity of community) and surface water way in case of flood. For the passing road, 2 boxes of 6m width are planned per 1 km of embankment. For the surface waterway, by carrying out the hydrological calculation based on the rainfall and topography condition along HSR alignment, inserting box culverts of 2.0m x 2.0m at 4 locations per km shall be enough for avoiding flooding situation by the embankment.

6.9 For more information, refer to Volume II Chapter 4 and Volume III Chapter 3 in the Main Report.

7 Construction Cost

1) How does the construction cost per km calculated in this study compare with other cases in the world?

7.1 The matter that greatly influences the construction cost is the ratio of the civil structures (soil structure, bridge, and elevated bridge), country 's labor cost and various non-personnel expenses (concrete, reinforced concrete, construction material, overhead wiring, signal communication, product related to the electricity such as electric powers, vehicle, and land). Non-personnel expenses include goods that need to be imported and those that can be procured in Vietnam. For more information, refer to Volume II Chapter 7 in the Main Report.

7.2 The construction cost estimated in this project is around half that of Japan. For more information, refer to Volume II Chapter 7 in the Main Report.

2) Does the study consider the escalation of construction cost in the future? If so, how much escalation is expected?

7.3 The escalation rate of Vietnam currency is estimated at 7.4% and the escalation of the foreign currency is estimated at 1.6% annually. For more information, refer to Volume II Chapter 7 in the Main Report.

8 Funding Options

1) How should the enormous cost for the development of HSR be funded? Is it possible for Vietnam to fund on its own? If not, what kinds of assistance will be needed?

8.1 In other countries, the development of high speed railway was started when the project cost is around 2 - 4% of GDP. In Vietnam, the project cost of one section (either Hanoi-Vinh or HCMC – Nha Trang) is 2 - 3% of GDP in 2030, given that Vietnam achieved economic growth at 6%. In order to open the priority section in 2030 fully in the most effective manner, it is necessary to establish stage development plan and commence various preparatory activities including detailed planning and design, land acquisition, human resource development, among others which require substantial length of time. (see Volume I Chapter 6 Figure 6.1.1 Preliminary Roadmap for High-Speed Railway Development.)

8.2 In general, high speed railway is developed under the strong initiative of the government, as most of the projects under private initiatives have ended up with failures and take-over by the government. Therefore, it is generally pointed out that majority of the total project investment costs or responsibilities should be taken by the government. In the preceding cases, governments allocated funds for the construction of high speed railway projects through state budgets, or by providing finances. In order to mitigate the government financial burden and also to achieve operational efficiencies, private involvement to the remaining part is recommended.

8.3 Part of the costs covered by the Vietnamese government could be financed by the soft loans of international donor organizations.

8.4 For more information, refer to Volume I Chapter 6 and Volume II Chapter 10 in the Main Report.

2) Why does the government has to be responsible for funding?

8.5 In general, high speed railway is developed under the strong initiative of the government, as most of the projects under private initiatives have ended up with failures and take-over by the government. Therefore, it is generally pointed out that more than 80% of the total project investment costs or responsibilities should be taken by the government.

8.6 The government can consider introducing private loans and equity for the remaining 20%, but private financial institutions and investors can join the HSR project, only when they can expect sufficient profits with low risks. Then, it is important for the government to secure the profitability of the privates by several guarantee mechanisms (e.g. guarantee for foreign exchange risks, or ridership guarantee).

3) Given the limitation of Government budget, how should private sector funds be introduced in a way that there is enough incentive for the private sector?

8.7 As the total project cost of the high speed railway project is huge, introduction of private financing and investments should be considered.

8.8 In order to introduce private financing and investments, it is necessary to separate a part of the project which can generate revenues and profits from others. Operations of HSR and rolling stocks are such candidates, as it can expect certain revenues and profits from ridership. In contrast, infrastructure which does not generate revenues could not be privately financed.

8.9 In order to attract private investors or financial institutions, it is important to ensure that they can secure sufficient profits and also let them avoid huge risks. Private sector is not willing to join HSR project, if they expect low profitability and high risks. Therefore, the government would have to provide necessary support, by providing guarantees for minimum profits or risk mitigation measures.

8.10 For more information, refer to Volume I Chapter 6 and Volume II Chapter 10 in the Main Report.

4) How will the investment for HSR development affect the financial situation of Vietnam?

8.11 In other countries, the development of high speed railway was started when the project cost is around 2 - 4% of GDP. In Vietnam, the project cost of one section (either Hanoi-Vinh or HCMC – Nha Trang) is 2- 4 % of GDP in 2030, given that Vietnam achieved economic growth at 6%.

8.12 The project cost of one section is equivalent to 30% of annual budget. This is almost same level as Korea when it decided the development of HSR in 1993.

8.13 The ratio of outstanding debt to GDP is 27% as of 2009, and this is expected to decrease according to the economic growth, given that the government does not increase the amount of debts for other reasons. As the construction cost of one section of HSR is 2-4 % of GDP, HSR project would not cause serious debt problems, if the government successfully manage public debt in general.

5) Will the ticket price increase if the HSR is operated by private sector? Will safety of HSR be ensured if operated by private sector?

8.14 In some countries including Japan and Taiwan, high speed railway is operated by private, but the private operation has not been a reason for expensive rail ticket prices or low safety. No matter if the HSR is operated by private, the ticket price will be determined based on the competitions with other modality such as airplanes.

8.15 If a private HSR Company covers both operations and infrastructure development, and also if construction companies are the shareholders of HSR Company, they might try to increase the construction prices of the infrastructure. However, this problem will not happen in Vietnam, as private will be responsible only for operations and rolling stocks and the infrastructure is under the responsibility of the government. Safety will also be ensured under the responsibility of both the government and the HSR Company.

6) Will the private sector provide all the investment and financing for the HSR project?

8.16 Private sector and the government will share the costs and responsibilities of the project. In PPP framework, private sector will be generally responsible only for a revenue generating or profitable part, while the government covers non-profitable parts.

8.17 From the international experiences, it is pointed out that more than 80% of the total project investment costs or responsibilities of HSR project should be covered by the government. This is due to the fact that firstly, traffic demand will be relatively smaller upon partial operation compared to full operation, and secondly, long periods for construction will be needed and the investment costs will be enormous. It is difficult and risky for the private sector to undertake this. In addition, bearing in mind the compatibility of the project as a whole and the possibility of future extension to other areas, the government shall take initiative of the project. Without full commitment from the government, the realization of HSR is impossible.

9 Operation Organization and Human Resource Development

1) It is understood that the development of high quality human resources are indispensable for the success of HSR development. How should this be realized?

9.1 **Promote understanding of HSR:** In order to develop high quality human resources for the operation of HSR, it is needed to consider Vietnam's current level of railway technology, and through the analysis of the issues it is facing, the needed training shall be proposed in detail. However, there is a great gap between the current level of railway technology in Vietnam and the technology needed to operate the HSR. Hence, the first step is for those involved in HSR development in Vietnam to understand what HSR is, and why and how Shinkansen has operated for decades with safety ensured, without any major accidents. For more information, refer to Volume I Chapter 6 and Volume II Chapter 8 in the Main Report.

9.2 **Human resource development through existing railway and urban railway:** The modernization of the existing railways and construction of urban railway (UMRT) will become good opportunities for human resource development for HSR. It is needed to nurture good staff for each technical aspect, who can also train others to increase the number of staff who can undertake HSR operation in the future. The below indicates step-by-step acquirement of technology:

(i) Existing north-south railway line (single track, ballast track, non-electrified)

(ii) Modernization of existing north-south railway

(iii) Urban railway (double track, electricity tied directly to connecting track, electrified, OCC, train operation control system)

(iv) HSR (high speed exceeding 300 km/h, double track, slab and ballast track, electrified, OCC, train operation control system (ATC & CTD), etc.

9.3 For more information, refer to Volume I Chapter 6 and Volume II Chapter 8 in the Main Report.

9.4 **Human resource development through initial section:** In order to raise the level of railway technology to operate the HSR, a long period of time is needed. Hence to utilize the urban railway is important as described above, however upon actual operation of the HSR, acquirement of specific technologies relating to high-speed operation is essential. From this aspect, an initial section shall be constructed as soon as possible. After the operation of the initial section, the related training facilities shall be used as an HSR training center with facilities for training. For more information, refer to Volume I Chapter 6 and Volume II Chapter 8 in the Main Report.

2) What kinds of technical transfer will be needed, and in what way will this be realized?

9.5 **Technical transfer for HSR construction:** Technical transfer for HSR construction most ideally should be done upon the construction of the initial section. Although basic technology for civil structures has also been introduced and practiced in Vietnam for road construction etc., technology relating to tracks, signal and telecommunications, electricity etc. are areas in which Vietnam lacks experience. Therefore, such technology shall be acquired during the process of constructing urban railway and initial section for HSR, assigning key staff to attain these technologies. It is important that these key staff are trained from the stage of design and construction supervision, so that they can not only be useful for HSR construction but also for the operation and management after the completion of HSR.

9.6 **Technical transfer for operation and maintenance:** The following are the technologies needed for HSR operation and maintenance:

(i) **Train Operation and Facility Management:** (1) ATC (automatic train control) and CTC (centralized traffic control) to ensure safe train operation, (2) train operation control system and facility management system based on IT

(ii) **Rolling Stocks:** (1) ATC for rolling stocks, (2) rolling stocks capable of high-speed operation over 300 km/h and maintenance technology

(iii) **Electricity:** (1) electricity and substations, (2) ATC and CTC, (3) railway radio and maintenance technology

(iv) **Tracks and Civil Structures:** (1) tracks for high-speed operation, (2) large-scale maintenance facilities for tracks, (3) civil structures for HSR and maintenance technology

9.7 For more information, refer to Volume I Chapter 6 and Volume II Chapter 8 in the Main Report.

3) What kinds of operation organization are proposed for HSR development and operation?

9.8 The operation organization for HSR shall be independent from that of the existing railway, and should be stand-alone. The Vietnamese HSR Managing Company should manage all activities including site operations as well.

9.9 The head office of the Vietnamese HSR managing company shall have the following business segments, divisions, and offices with their respective assignments:

(i) Management Planning Division (management policies and investment planning);

(ii) Safety and Disaster Management Office (company-wide safety and disaster countermeasures);

(iii) Education and Training Office (education planning for employees and work related to the training center);

(iv) General and Personnel Affairs Division (general affairs and personnel management);

(v) Financial Affairs and Materials Division (financial affairs and materials);

(vi) Railway Operations Headquarters (comprehensive coordination of railway management matters; some work of each division such as marketing, transportation, rolling stock, equipment/facilities, and electricity related to HSR operation); and

(vii) Information System Office (systems on train operation control and company-wide office IT).

9.10 Branch offices will be established in Hanoi and HCMC, with staff as follows: 170 staff in the Head Office, 2,400 staff in Hanoi Branch, 2,700 staff in HCMC branch, a total of 5,300 staff.

9.11 The major considerations upon proposing this organizational structure are (1) safety, (2) disaster management, (3) training for human resource development, (4) IT system, and (5) material procurement.

9.12 Since it takes a long period for construction, it is difficult to expect the HSR managing company to undertake this role. Therefore, the preparatory board for HSR construction shall be situated within the government, preferably under MOT. In addition, since technical transfer and human resource development takes a long period of time, the initial section shall be established prior to the construction of HSR sections commercial operation. Therefore, an operational organization for the initial section will be needed as well.

9.13 For the partial operation based on initial section, the organization can be adjusted accordingly to the length of the track. For example, if the initial section is about 50 km long, the needed staff is estimated at around 500 including those for the Head Office.

9.14 For more information, refer to Volume I Chapter 6 and Volume II Chapter 8 in the Main Report.

10 Environmental and Social Considerations

1) It is required to select the best alternative which has minimum effect to the environment/ landscape/ natural environment/ climate change/ agricultural area.

10.1 In this study, the optimal alternative (alignment and station location) has been selected through a comparison exercise of alternatives considering the best integration of four important aspects, i.e. 1) convenience and integrated development, 2) environmental and social considerations, 3) high speed serviceability, and 4) economic efficiency. For the environmental and social considerations aspects, impacts on natural environment, living environment (pollution) and social environment were assessed by overlaying proposed HSR alignments and stations and environmental sensitivity maps. The environmental and social impact by the selected optimal alternative wer evaluated to be the minimum among the alternatives.

10.2 For more information, refer to Volume III Chapter 3 in the Main Report.

2) Impacts on social infrastructures and services, and local communities should be avoided or minimized by the HSR projects.

10.3 In this study, the alignment was planned with due considerations to minimize the impact on land acquisition and resettlement through a comparison exercise of alternatives as mentioned above which also contribute to minimize the impacts on social infrastructures and service as well as local communities.

10.4 In addition, the sections where embankment structures will be adopted will be designed installing appropriate number of box culverts and/or other equivalent facilities in order to secure peoples mobility and minimize impacts on community integrity. The installed box culverts are also expected to play important roles for smooth water flow and animals movement in the area.

Source: JICA Study Team.

Figure 10.1 Image of Embankment with a Box Culvert

10.5 For more information, refer to Volume III Chapter 3 in the Main Report.

3) EIA is necessary for the HSR projects.

10.6 In accordance with Law on Environmental Protection on November 29, 2005, and Decree No 29/2011/ND-CP on Provisions of Strategic Environmental Assessment, Environmental Impact Assessment and Environmental Protection Commitment on April 18, 2011, EIA is required for the HSR projects. In addition, if the HSR projects will strive to receive funds or any other supports from funding agencies and organizations, a detail and comprehensive environmental and social considerations study including preparation of an EIA report will be essential.

10.7 In this study, provisional scoping for EIA was conducted on the selected optimal alternative, which includes the proposal on technical requirements of the EIA. It is necessary that the scoping and scope of EIA study should be finalized based on the updated and elaborated projects plan. Based on the results of scoping, a full scale EIA study shall be conducted.

10.8 For more information, refer to Volume III Chapter 4 in the Main Report.

4) What are environmental impacts peculiar to high-speed train operation? What kinds of measures are needed to mitigate these impacts?

10.9 Railway noise and vibration are considered to be major environmental impacts by high-speed train operation. The past various researches and surveys revealed that railway noise and vibration levels are considered to be increased as the running speed of trains is faster. However, various mitigation measures can be adopted at sources, in propagation paths and at receiving points. Actually, mitigation measures at sources has been developed and incorporated in various places in rolling stocks such as pantographs and seams of cars, and tracks including its proper maintenance. In case of railway noise, if it is required, soundproof walls shall be established.

Improved Pantograph

Cover at Seam of Cars

Source: JICA Study Team.

Figure 10.2 Examples of Mitigation Measures for Noise at Sources (at Car)

10.10 In addition, by high-speed train operation, there is a possibility to cause interference of radio wave reception and some disturbances on electromagnetic waves especially around the facilities where AC feeding is adopted such as substations. If these problems are identified, sufficient compensation needs to be considered.

10.11 When a train entering a tunnel at high speed, an impact sound as “Don”, called as tunnel sonic boom, is generated around the other side of the entrance of tunnel, and there would be some shaking happening at windows of houses in the vicinity of the entrance.

This impact is caused by the micro-presser wave produced by released pressed air, which is pushed by the high-speed operating train, at the entrance of tunnel. In order to mitigate the impact of tunnel sonic boom, improvement of shape of train head as a long-nose head and establishment of tunnel entrance hood has been adopted.

Long-nose Head

Tunnel Entrance Hood

Source: JICA Study Team.

Figure 10.3 Examples of Mitigation Measures for Micro-Pressure Wave at Tunnel

10.12 For more information, refer to Volume III Chapter 5 in the Main Report.

5) What are positive environmental impacts excepted by the HSR projects?

10.13 By the HSR projects, modal shift of the passengers is expected from car and bus, air, existing train to the HSR. The per person-km emission of GHGs and air pollutants is much smaller in the HSR compared with other transportation modes. It is expected that total emission of GHGs and air pollutants is decreased by the modal sift. Consequently, the HSR projects would contribute to mitigate global warming/climate change and reduction of air pollution.

10.14 For more information, refer to Volume III Chapter 6 in the Main Report.

6) Resettlement and rehabilitation issues need to be studied carefully.

10.15 In this study, the alignment was planned with due considerations to minimize the impact on land acquisition and resettlement through the comparison of alternatives as mentioned above. The selected optimal alternative has been considered based on the latest topographic map so that the alignment will avoid number of affected buildings as long as the alignment plan allows. The area of the land to be acquired is also minimized by adopting the minimum distance between track centers.

10.16 In addition, the resettlement and rehabilitation policy framework (RRPF) has been drafted up containing basic idea and direction for resettlement and rehabilitation, which will be able to be utilized when the project proponent is going to prepare resettlement action plan (RAP) and/or Compensation, Support and Resettlement (CSR) Plan in the future stage of the projects. In the course of preparation of RRPF, number of affected buildings was counted and the market survey was conducted to know the actual replacement cost in accordance with JICA Guidelines. Detail study on resettlement will be conducted once the projects are officially materialized in accordance with relating law and regulations in Vietnam and/or requirements of the expected funding agencies or institutions.

10.17 For more information, refer to Volume III Chapter 7 in the Main Report.

11 International Practices of Development of HSR

11.1 Experience of Japan's Shinkansen Development

1) Brief History

(a) Planning and Decisions on Shinkansen Development

11.1 **General:** The Shinkansen is a network of high-speed railway lines in Japan operated by four Japan Railways Group Companies. Since the initial Tokaido Shinkansen opened in 1964, the world's only high-speed railway at that time, Shinkansen network has expanded to 6 routes and 2,387 km that links most of major cities on the islands of Honshu and Kyushu. The development of Shinkansen network has supported to improve national economy, to expand living area of people and to promote regional development. In 2006, it carried about 305 million passengers per year or 835 thousand passengers a day in 2006. At this moment, extension of Tohoku Shinkansen, Hokuriku Shinkansen, and Kyusyu Shinkansen are in progress.

11.2 **Definition:** The Shinkansen is defined as "a regular commercial train or railway system with maximum speed of more than 200 km/h" according to the Nationwide Shinkansen Railway Development Act established in 1970. The word of "Shinkansen" is generally regarded as synonymous with "High-speed Train or Railway System" in the world, because today's world high-speed railway is modeled after the development of Shinkansen.

11.3 **Technical Features:** As Shinkansen operates with high-speed more than 200 km/h, it is completely different railway system from existing railways in terms of railway facilities and equipment, railway vehicles, safety standard, operation service, riding comfort, etc. Major technical features and unique aspects are as follows:

11.4 Gauge of Shinkansen is 1,435 mm, while existing railway in Japan is narrow 1,067 mm. So it is impossible to run through train from Shinkansen to other railway, and carriage of Shinkansen (loading gauge with 3.4 m width) is larger than conventional cars (loading gauge with 3.0 m width).

11.5 The minimum curve radius of Shinkansen is basically 4,000 m (except for 2,500 m of Tokaido and Sanyo Shinkansen (Shin Osaka-Okayama Section), and some sections in the vicinity of major stations and urban area), while 800 m in existing railways.

11.6 In order to operate high-speed trains safely, Shinkansen track are all grade-separated, guarded by fences and strictly prohibited to enter into track.

11.7 Unlike exisiting railways in which different type of trains such as limited express, local train, freight train run same track irregularly, train schedule of Shinkansen was quite simple. Long distance trains run frequently and regularly like urban commuter train (such as every hour or every thirty minutes). It became quite convenient for travelers and industry, business activity and tourism along Shinkansen route.

11.8 Shinkansen adapted innovative train operating system, ATC (Automatic traffic control system). There are no wayside signals along Shinkansen track, and the speed restriction is displayed in the monitor of the driver's cab. Depending on the speed signal, train speed is automatically controlled.

11.9 **Basis of Shinkansen Train:** The existing Tokaido Line was all electrified from

Tokyo to Osaka in 1956 and new electric multiple units (EMUs) train, limited express 'Kodama (meaning Echo)' began to run in 1958. Before the introduction of type 20, long distance train in Japan are mostly pulled by locomotive. Type 20 was quite innovative, run from Tokyo to Osaka in 6 hours and 30 minutes, one hour shorter than former locomotive train, and also equipped with air cushion and air condition of all cars which was quite rare in Japan at that era. 'Kodama' got quite successful and attracted many passengers because of its fast and comfortable journey. Now nearly all trains in Japan including Shinkansen are EMUs style, which is unique aspect in the world railways realizing high acceleration and deceleration, but the successful 'Kodama' was the origin of long distance limited express EMU train, and became the basis of Shinkansen.

11.10 A part of the Tokaido Shinkansen in Kamonomiya in Kanagawa Prefecture opened in 1962 and experimental Shinkansen train began to run. It was opened to public through test drive and enhanced understanding of high-speed railways to many people. It also revealed the problem of sudden change of air pressure when high-speed train enters into tunnel, which shocks ears of passengers. This experience was reflected to practical train of air proof structure.

11.11 Major development milestones of Shinkansen are listed in Table 11.1 and described as follows:

Table 11.1 Major Chronology of Shinkansen Development

Year	Major Development
1958	Approval of Construction Plan for TOKAIDO Shinkansen
1959	Commencement of construction of TOKAIDO Shinkansen
1961	Loan from the World Bank (US$ 80 million, redeemed in 1981)
1962	Construction of test section (31.8km)
1964	Inauguration of TOKAIDO Shinkansen (515.4 km: Tokyo-Shin Osaka), Tokyo Olympic
1970	Establishment of Nationwide Shinkansen Railway Development Act (7,000 km network)
1972	Inauguration of SANYO Shinkansen (160.9 km: Shin Osaka-Okayama)
1975	Extension of SANYO Shinkansen (392.8 km: Okayama-Hakata)
1982	Inauguration of JOETSU Shinkansen (269.5 km: Omiya-Nigata)
	Inauguration of TOHOKU Shinkansen (465.2 km: Omiya-Morioka)
1985	Extension of TOHOKU/JOETSU Shinkansen (27.7 km: Ueno-Omiya)
1987	Privatization of Japan National Railway (JNR) to Japan Railway Companies (JRs)
1991	Extension of TOHOKU Shinkansen (3.6 km: Tokyo-Ueno)
1997	Inauguration of HOKURIKU Shinkansen (117.4 km: Takasaki-Nagano)
2002	Extension of TOHOKU Shinkansen (96.6 km: Morioka-Hachinohe)
2004	Inauguration of Kyushu Shinkansen (126.8 km: Yatsushiro-Kagoshima Chuo)
2010	Extension of TOHOKU Shinkansen (81.8km: Hachinohe-Aomori)
2011	Extension of KYUSHU Shinkansen (130.0km: Hakata-Yatsushiro)

Source: JICA Study Team (culled from various information sources).

11.12 **Bullet Train Plan:** The first plan to build new high-speed railway called Dangan Ressha (the Bullet Train) from Tokyo to Shimonoseki dates back to 1939. Construction began in 1941 and it was planned to complete in 1954. Its maximum speed was to be 150 km/h, and 200 km/h in the future. Journey time was 4 hours from Tokyo to Osaka, and 9 hours from Tokyo to Shimonoseki. At that time, it took 8 hours between Tokyo and Osaka by the fastest limited express 'Tsubame' by steam locomotive, maximum speed 95 km/h. They started to buy land and build some of the long tunnels, but due to the start of Pacific War, construction was stopped. However, those land and tunnels are used for Shinkansen after years.

11.13 **Decision of Developing Tokaido Shinkansen:** After the defeat of war and severe situation all over the country, Japanese economy began to recover. Traffic of existing Tokaido line between to the two largest cities of Tokyo and Osaka, began to increase rapidly and nearly reached to full capacity in mid 1950s. At that time, the idea of high-speed railway was considered to be fantasy by many people. Practical idea at that time was four-tracking of existing Tokaido line, but the President of JNR insisted the building of new high-speed railway, and Government finally approved the project.

11.14 If simple four-tracking had been adapted, existing Tokaido line of old railway system taking at least 6 hours between Tokyo and Osaka would have been completely defeated by air and highway which grew rapidly after 1960s. It could be said that one decision at that time changed the future of high-speed railway in Japan and many other countries.

11.15 High-speed train named Tokaido Shinkansen was began to be built in 1959 with the estimated cost of 380 billion JPY. In 1961, JNR got a loan from World Bank at 800 thousand USD (29 billion JPY. It was paid-off by 1981). Then, 515.4 km new line was completed in 1964, only five years. Tokyo Olympic game was to be held in October 1964, so they planned to complete Tokaido Shinkansen before that and hurried the construction.

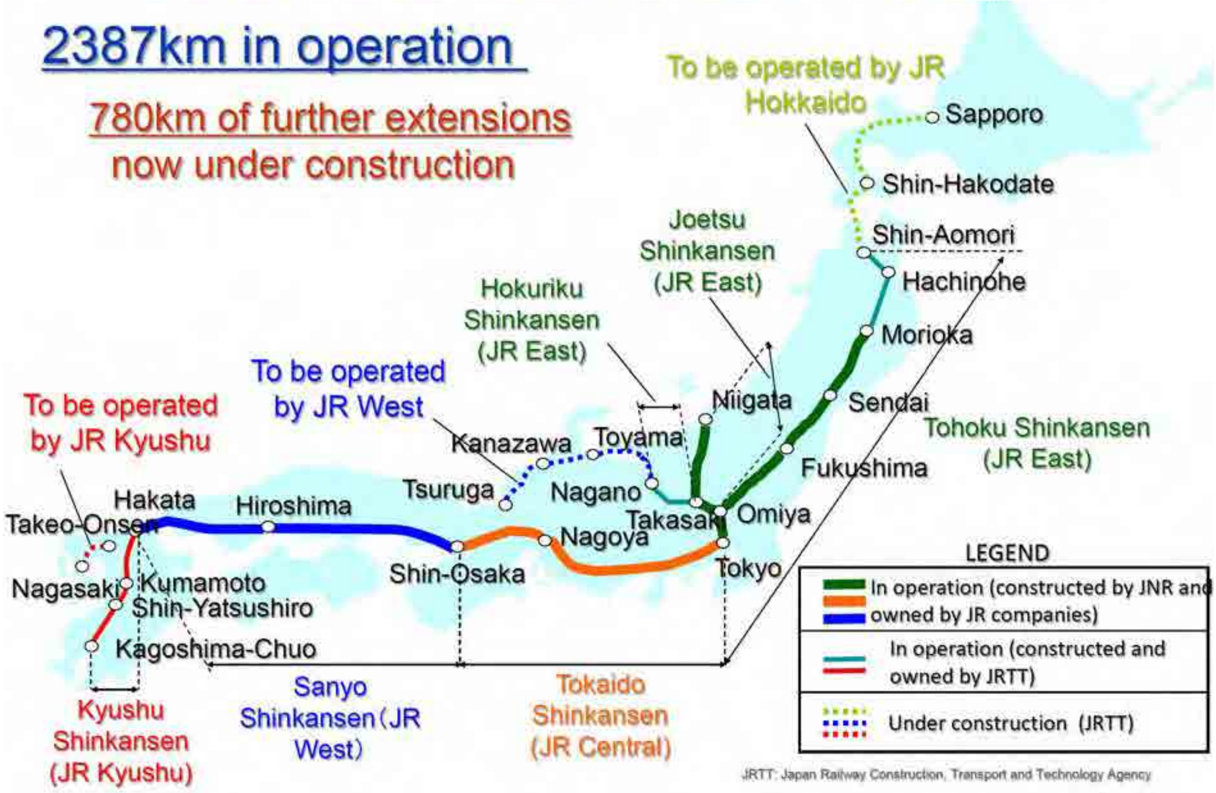
11.16 **Inauguration of Tokaido Shinkansen:** After rush construction, Tokaido Shinkansen finally opened in October 1964, 10 days prior to the opening ceremony of Tokyo Olympic game. At that time, one fast ‘Hikari’ express took 4 hours from Tokyo to Shin Osaka and one ‘Kodama’ express which stops all the station took 5 hours. Maximum speed was 210 km/h but there were many temporary speed restricted sections at first. In 1965, those restrictions were removed and trains got much faster, ‘Hikari’ was 3 hours and 10 minutes, ‘Kodama’ was 4 hours. Train was called ‘Type 0’ with unique bonnet style like airplane. Train set was composed of 12 cars (later, 16 cars), two of them were first class cars (later called ‘Green car’) and other ten were second class cars.

(b) Network Development

11.17 **Network Expansion:** The Nationwide Shinkansen Railway Development Act was established in 1970 and 7,000 km nationwide Shinkansen network plan was decided. Tokaido and Sanyo Shinkansens were also incorporated in this plan, though they were already opened or under construction. Sanyo Shinkansen was opened from Shin Osaka to Okayama In 1972, and extended to Hakata in Kyushu Island in 1975. After Sanyo Shinkansen, due to the lack of expense and other problems, construction was delayed from the planned schedule. However, Tohoku and Joetsu Shinkansens opened in 1982 and Hokuriku Shinkansen in 1997 and Kyushu Shinkansen in 2004 due to the act. Although, the planned network is not completed yet, due to the fast and convenient service, Shinkansen got quite popular transport in Japan. The follow-on Shinkansen routes have fewer passengers than Tokaido Shinkansen but they contributed to the growth of industry and tourism along the route.

11.18 **Shinkansen Network:** Since the first Tokaido Shinkansen was opened with 515 km in 1964, Shinkansen network was expanded to six routes with total route length of 2,387km. Currently Shinkansen network carries more than 300 million passengers a year. The network covers so far major part of Honshu and Kyushu and to be expended to other areas and Hokkaido Island. Average station interval is about 32 km. As Shinkansen network is expanded and its vehicle and operating system are further improved, the time distance between major cities along the Shinkansen routes was extensively shortened and become more convenient for passengers. The location and profile of the current

Shinkansen network are shown in Figure 11.1 and Table 11.2. Increase of Shinkansen route length is presented in Figure 11.2.



Source: Dr. Toshiji Takatsu, Executive Vice President, Japan International Consultants for Transportation Co., Ltd. (JIC)

Figure 11.1 Current Shinkansen Network in Japan

Table 11.2 Profile of Shinkansen by Route

Route	Route	Distance (km)	Inaugural Year by Section	No. of Stations	Average Station Interval (km)
Tokaido	Tokyo - Shin Osaka	515.4	1964 (Tokyo-Shin Osaka 515.4km)	17	32.2
Sanyo	Shin Osaka - Hakata	553.7	1972 (Shin Osaka-Okayama, 180km) 1975 (Okayama-Hakata, 464km)	19	30.8
Tohoku	Tokyo - Aomori	674.9	1982 (Omiya-Morioka, 505km) 1985 (Ueno-Omiya, 27.7km) 1991 (Tokyo-Ueno, 3.6km) 2002 (Morioka-Hachinohe, 96.6km) 2010 (Hachinohe-Aomori, 81.8km)	24	28.1
Joetsu	Omiya - Nigata	269.5	1982 (Omiya-Nigata, 269.5km)	10	29.9
Hokuriku	Takasaki - Nagano	117.4	1997 (Takasaki-Nagano 117.4km)	6	23.5
Kyusyu	Hakata - Kagoshima Chuo	256.8	2004 (Shin Yatsushiro-Kagoshima Chuo, 126.8km) 2011 (Hakata-Yatsushiro, 81.8km)	12	23.3
Total		2,282.0	-	68	38.5

Source: JICA Study Team (culled from various information sources).

(c) Management

11.19 Following the privatization and division of Japan National Railways (JNR), part of the Nationwide Shinkansen Railway Development Law was amended to give Japan Railway Construction, Transport and Technology Agency (JRTT) responsibility for overseeing construction of all Shinkansen lines. A two-tier system was established with infrastructure owned by JIRTT and leased to the operators. To avoid a recurrence of the debts incurred by JNR, the cost and profitability of any new Shinkansen line must be thoroughly examined before construction approval can be given. Other basic conditions include obtaining consent from local municipalities and concerned JR operators regarding the impact on and management of existing lines running parallel to the new Shinkansen.

11.20 In the JNR era, most funding for new Shinkanasen lines came from loans, and it raised public criticism about how JNR was responsible for its worsening finances. As an example, the Joetsu Shinkansen was almost exclusively financed by the Fiscal Loan Fund and other loans. Under the new leasing scheme, the operator pays track usage fees based on the operating profits accrued from the new Shinkansen, but bears no other direct construction costs. The central government bears two-thirds of the direct construction costs (as subsidy to JRTT, and some profits from the sale of existing Shinkansen) and local municipalities bear the remaining one-third.

(Source of above section: Dr. Toshiji Takatsu, Executive Vice President, Japan International Consultants for Transportation Co., Ltd. (JIC))

2) The Case of Tokaido (Tokyo-Osaka) Line

(a) Location of the Route and Socio-economic Characteristics

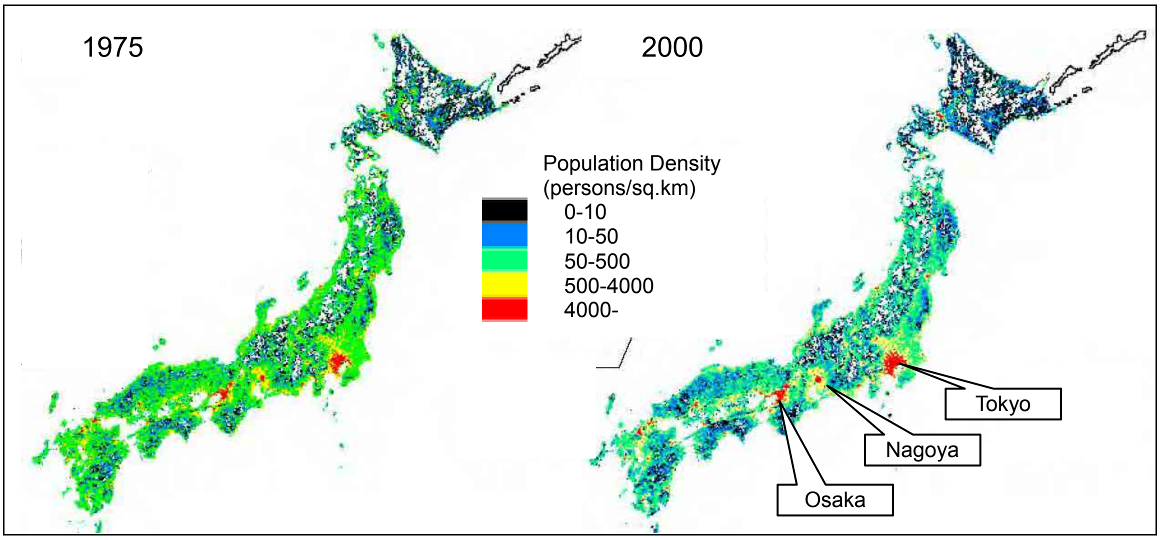
11.21 **Population and Industries:** The Tokaido Shinkansen connects the Tokaido Corridor (including Tokyo, Chukyo, and Kansai metropolitan areas) which its population and industrial activities are the most significant in Japan. Along the corridor, ordinance-designated cities (major cities designated by the Central Government) and other large cities of over 0.5 million each are located. The population along this corridor was 43% to the national toal at the point of opening of the Tokaido Shinkansen, and currently totals to 50%. (refer to Table 11.3).

11.22 Reflecting on the change of population from 1975 and 2000, the high-dense areas of the three major metropolitan areas (Tokyo, Chukyo, Kanasai) have increased, and on the other hand, low-dense areas of rural areas have increased as well, indicating the fact that the socio-economic activities along the Tokaido Corridor has become active. (refer to Figure 11.2).

Table 11.3 Population of Three Metropolitan Areas along Tokaido Shinkansen

Area	1965	1970	1975	1980	1985	1990	1995	2000	2005
Population (million)									
- Tokyo	21	24	27	29	30	32	33	33	34
- Chukyo	8	9	9	10	10	11	11	11	11
- Kansai	14	15	17	17	18	18	18	18	18
3 Areas Total	43	48	53	56	58	60	62	63	64
Japan Total	99	105	112	117	121	124	126	127	128
% to Japan Total									
- Tokyo	21	23	24	25	25	26	26	26	27
- Chukyo	8	8	8	8	8	9	9	9	9
- Kansai	14	15	15	15	15	15	15	15	14
3 Areas Total	43	46	48	48	48	49	49	50	50

Source: Statistical Yearbook of Japan
Note: Tokyo Metropolitan Area (Tokyo, Kanagawa, Saitama, Chiba), Chukyo Metropolitan Area (Aichi, Gifu Mie), Kansai Metropolitan (Osaka, Kyoto, Nara, Hyogo)



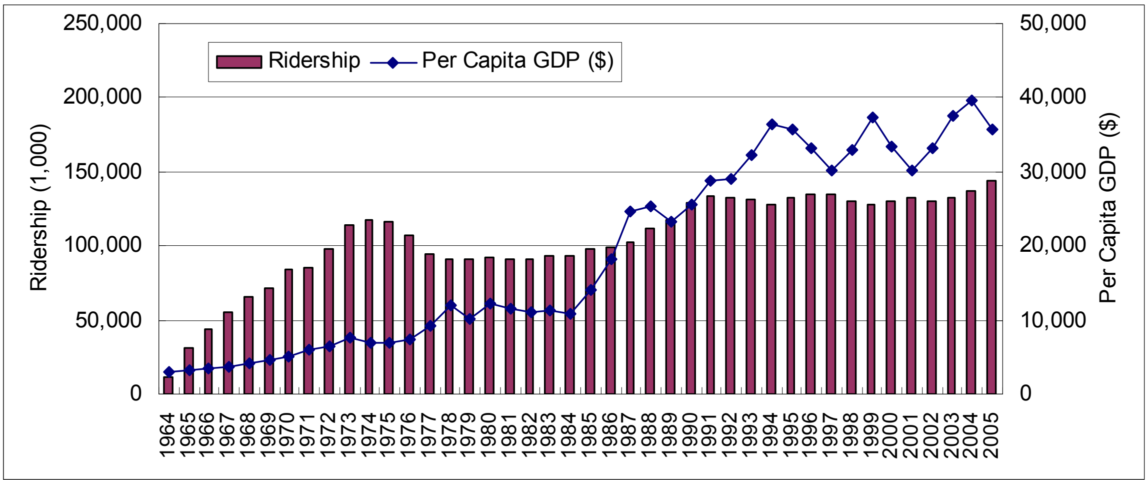
Source: Ministry of Land, Infrastructure and Transport

Figure 11.2 Distribution of Population Density (1975 and 2000)

11.23 **National Economy:** The national GDP of Japan has been growing over the years, and as of 2005, the GDP in real terms has reached 537 JPY trillion (4.6 USD trillion, 1USD=111 JPY), and the GDP per capita at 4.2 JPY million (35,751 USD, 1USD=117 JPY). At the opening of the Tokaido Shinkansen, the GDP in real terms was 105 JPY trillion (0.3 USD trillion, 1 USD=360 JPY), and the GDP per capita at 1.1 JPY million (3,010 USD, 1 USD=360 JPY).

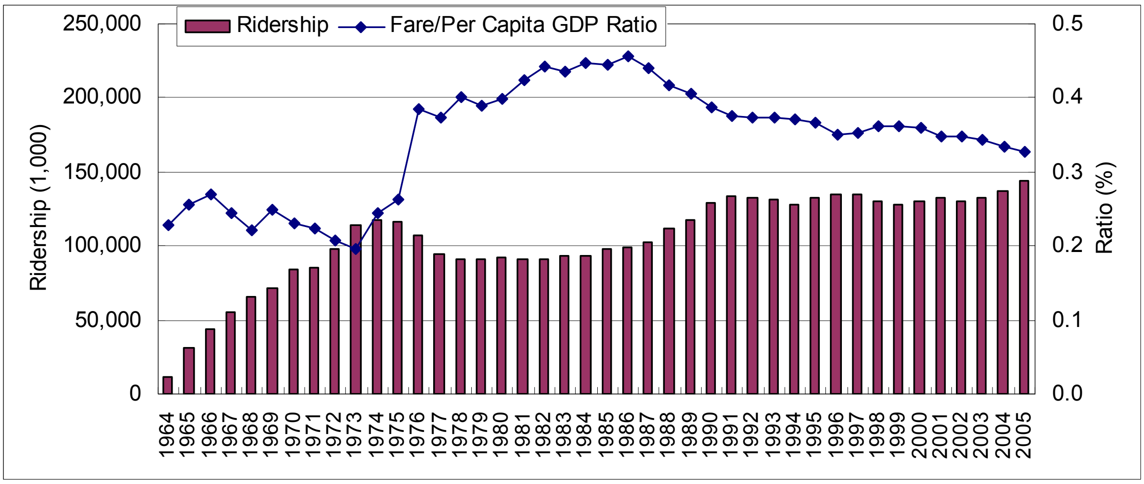
11.24 Comparing the relation between the per capita GDP and the ridership of Tokaido Shinkansen, although a strong relation cannot be seen in the initial stages after operation, after the 1990s, the ridership has grown along with the growth of economy. (refer to Figure 11.3).

11.25 In order to look into the relation between the ridership and fare level, the ratio of fare to the per capita GDP was compared. Although it is understood that no absolute relation is seen and will be dependent on the competition with other modes of transport, it can be said that ridership will decrease when the fare becomes relatively high, and vice versa. (refer to Figure 11.4)



Source: JICA Study Team (culled from various information sources)

Figure 11.3 Per Capita GDP and Ridership of Tokaido Shinkansen



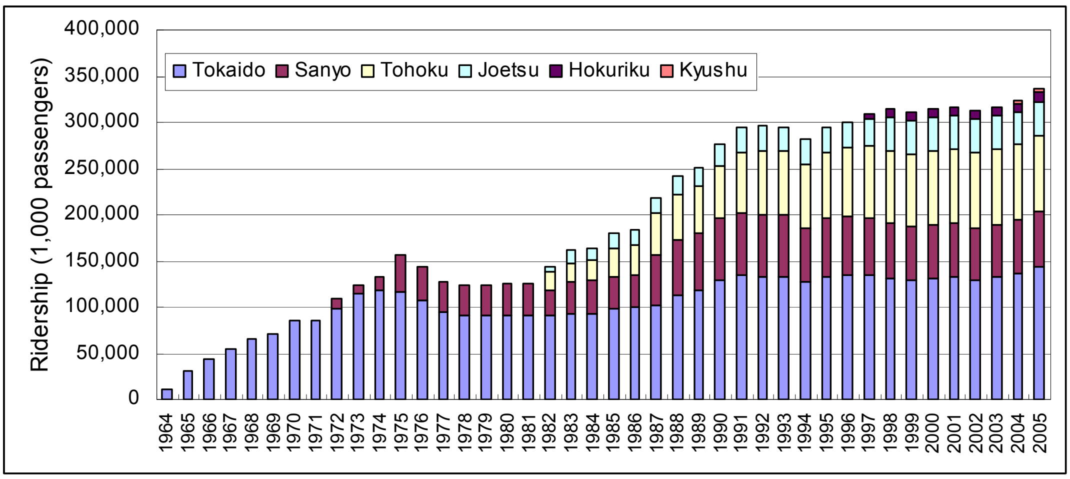
Source: JICA Study Team (culled from various information sources)

Figure 11.4 Fare/Per Capita GDP Ratio and Ridership of Tokaido Shinkansen

(b) Ridership

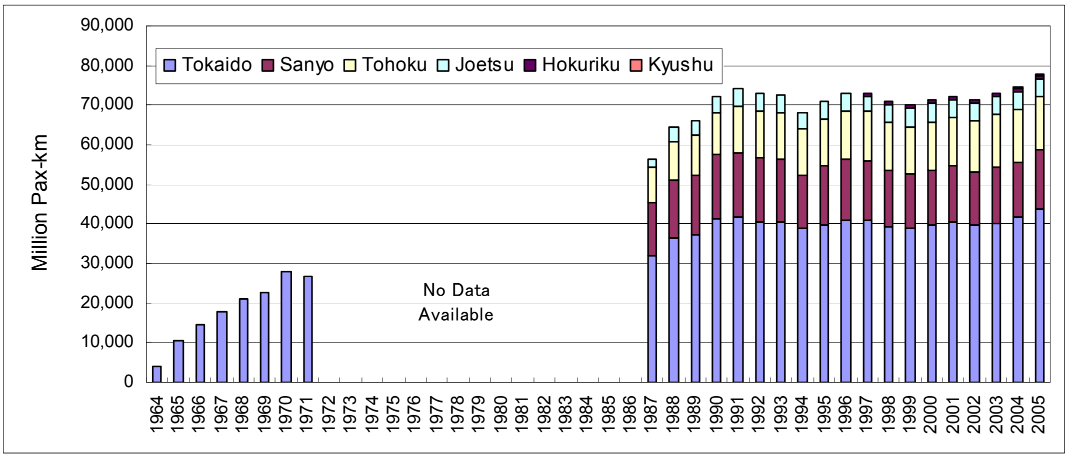
11.26 **Shinkansen Ridership:** Due to the fast and convenient service of Shinkansen, its service got quite popular transport in Japan. As of 2006, the Shinkansen network composed of 6 routes with length of 2,387 km carried about 305 million passengers per year or 835 thousand passengers a day. The number of passengers carried by Tokaido Shinkansen was 11 thousand in the opening year of 1964 (3 months). It grew at surprising paces, marking 20 or 30% increase every year in 1960s. The ridership was has been increasing year by year and reached to 145 million a year or 400 thousand a day in 2006, although there is a decreasing period in late 1970s and beginning of 1980s. (refer to Figure 11.5)

11.27 **Shinkansen Traffic:** In 2006, the Shinkansen network transported about 80 billion passenger-km as a whole. Average trip length of passengers was 260 km. As for Tokaido Shinkansen, it transported 44.5 billion passenger-km and average trip length was 305 km per passenger. Fluctuation tendency of total passenger-km is almost same as that of ridership. Average trip length of Tokaido Shinkansen in 1970 was about 330 km per passenger. It is observed that the average trip length has been decreased due to increase of commuting passengers (refer to Figure 11.6)



Source: JICA Study Team (culled from various information sources)

Figure 11.5 Changes in Ridership of Shinkansen by Route



Source: JICA Study Team (culled from various information sources)

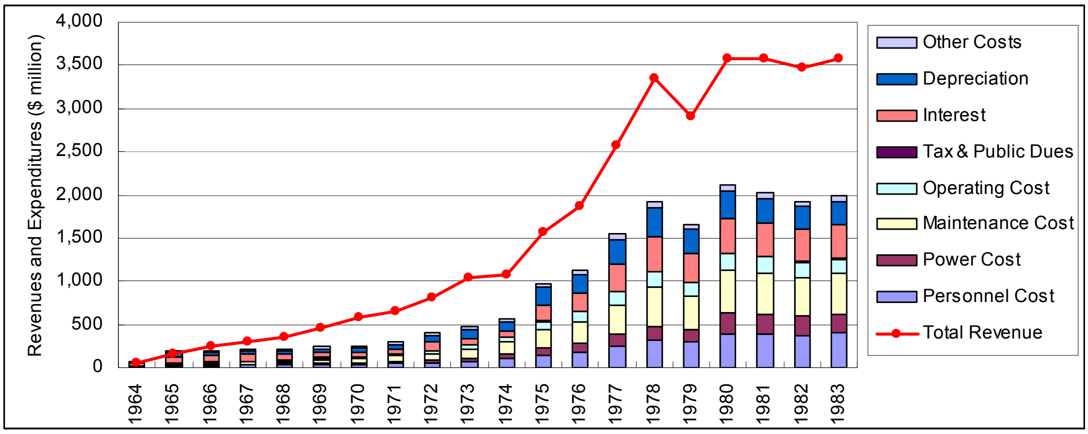
Figure 11.6 Changes in Transport Demand of Shinkansen by Route

(c) Revenue and Expenditure

11.28 **Revenue:** Tokaido Shinkansen operates regularly 305 trains a day in 2007. In average, it carried about 400 thousand passengers a day (145 million passengers a year) and earning annual are revenue of 1,043 billion JPY (8.7 USD billion, 1 USD=119 JPY) in 2006. Currently, fare revenue of Tokaido Shinkansen shares 85% of total revenue of JR Central.

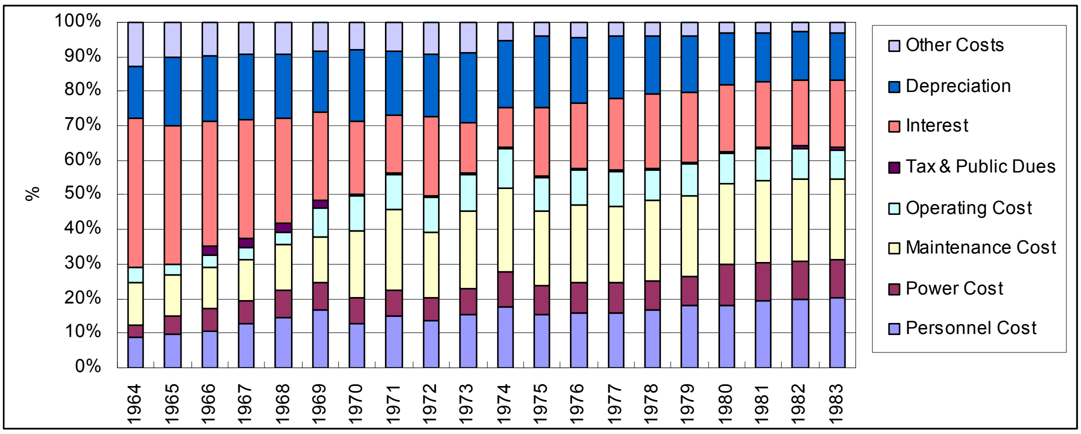
11.29 **Balance of Revenues and Expenditures:** Figure 11.8 shows the revenues and expenditures of Shinkansen (Tokaido and Sanyo) from 1964 to 1983 (JNR period). In the beginning two years after Tokaido Shinkansen opened, it shows the deficit balance due to huge amount of interests. However, it tuned to favorable balance since 1966 and amount of surplus reached to 461 JPY billion (2.0 USD billion, 1 USD=232 JPY) in 1983. Apparently, Shinkansen operation itself seems profitable but Shinkansen operators, formally JNR and currently JR Companies, are also managing existing railway system which is not profitable.

11.30 **Cost Structure:** As mentioned above, major part of expenditures was by interest (over 40%) in the initial period, but it reduced less than 20% and shifted to maintenance cost (23%) and personnel cost (20%) in early 1980s. (refer to Figure 11.8)



Source: JNR, 20-Year History of Tokaido-Sanyo Shinkansen (1985)
Note: Including Shinkansen Routes of Tokaido (after 1964) and Sanyo (after 1972)

Figure 11.7 Changes in Revenues and Expenditures of Shinkansen Operation



Source: JNR, 20-Year History of Tokaido-Sanyo Shinkansen (1985)
Note: Including Shinkansen Routes of Tokaido (after 1964) and Sanyo (after 1972)

Figure 11.8 Changes in Cost Structure of Shinkansen Operation

3) Main Characteristics of Shinkansen System

(a) Future Network Development Plan

11.31 In 1992, Yamagata Line between Fukushima and Yamagata was opened for Shinkansen. This section was not newly constructed, but the gauge of existing line was widened from 1,067 mm to 1,435 mm, and Shinkansen can go direct from Tokyo to Yamagata, which is called 'Mini Shinkansen'. Smaller Shinkansen vehicle was introduced to adapt to the standard of existing railway. 'Mini Shinkansen' connects Tokyo and country city which does not have large traffic enough to build new Shinkansen directly with relatively small cost. In 1997, the second 'Mini Shinkansen' was opened between Morioka and Akita. And Yamagata Line extended to Shinjo in 1999.

11.32 **Future of Shinkansen:** Shinkansen will be faster in the future using new vehicle. In Tokaido and Sanyo Shinkansen, new type N700 vehicle is in service in 2007. Maximum speed of type N700 is 300 km/h, realized by adopting tilting system even in the curve of 2,500 meters radius of Tokaido Shinkansen. Acceleration rate is also improved from 1.6 km/h/s to 2.6 km/h/s. Speed-up is also considered in Tohoku Shinkansen. In 2010, it was extended to Shin Aomori, and in order to connect Tokyo and Aomori within 3 hours to win competition with air services, JR East raised maximum speed to 320 km/h from 2013.

11.33 As the route map shows, Shinkansen network is extending further. Tohoku Shinkansen to Aomori, Kyushu Shinkansen to Hakata, and Hokuriku Shinkansen from Nagano to Kanazawa will complete in 2014. Shinkansen might be further extend to other cities by introduction of 'Mini Shinkansen' or the development of "free-gauge train" currently under experiment which can change gauge and go direct from Shinkansen to existing railway line.

11.34 Another future project is the development of linear motor car, more than 500 km/h maximum speed between Tokyo and Osaka by way of Chuo Shinkansen route. Part of experimental linear motor car line was completed in Yamanashi in 1997, and it is said to be possible to use as practical transport despite some problems such as cost and durability remain.

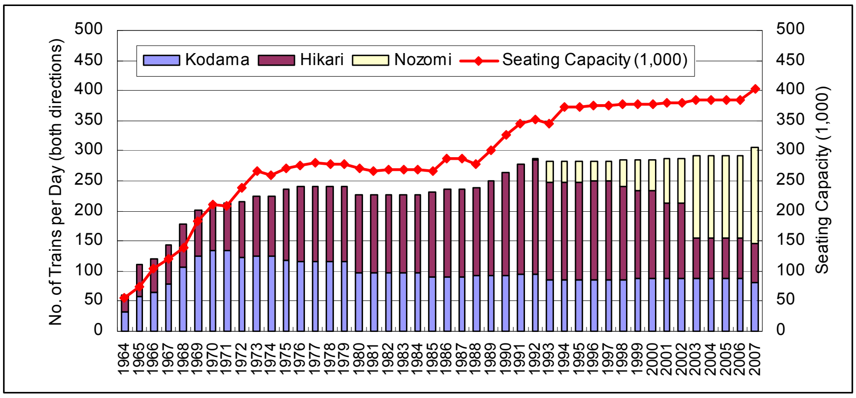
(b) Operational Conditions

11.35 **Service Frequency and Transport Capacity:** In Tokaido Shinkansen, 60 trains are operated regularly a day (both directions) in 1964. Train schedule was consequently improved. It was '1-1' pattern (one Hikari and one Kodama every hour) in 1964, '2-2' pattern in 1965, '3-3' pattern in 1967. Service frequency has been increased rapidly in 1960s and reached over 200 by 1970. Then, it has been increased to 305 by 2007. Three types of trains are operated such as Kodama, Hikari and Nozomi (introduced in 1992). Travel time between Tokyo and Shin Osaka is now about 2 hours 25 minutes by Nozomi, 3 hours by Hikari and 4 hours by Kodama. Kodama stops all stations. Along with Tokaido Shinkansen, there are 17 stations and an average station interval is about 35 km. In the beginning, the number of Kodama trains was more than Hikari trains, but it is inverted in 1976. After Nozomi was introduce, the number of Nozomi trains increased rapidly. The composition of three types of train in 2007 is 160 of Nozomi, 64 of Hikari and 80 Kodama. (refer to Figure 11.9)

11.36 As its frequency increased, the seating capacity of Tokaido Shinkansen is also increased from 56 thousands in 1964 to 404 thousands (daily between Tokyo and Osaka, both directions). In the beginning period, Tokaido Shinkansen started to operate a 12-car train but it was unified in 1989 to a 16-car train and fixed a capacity at 1,323 seats a train. (refer to Figure 11.9)

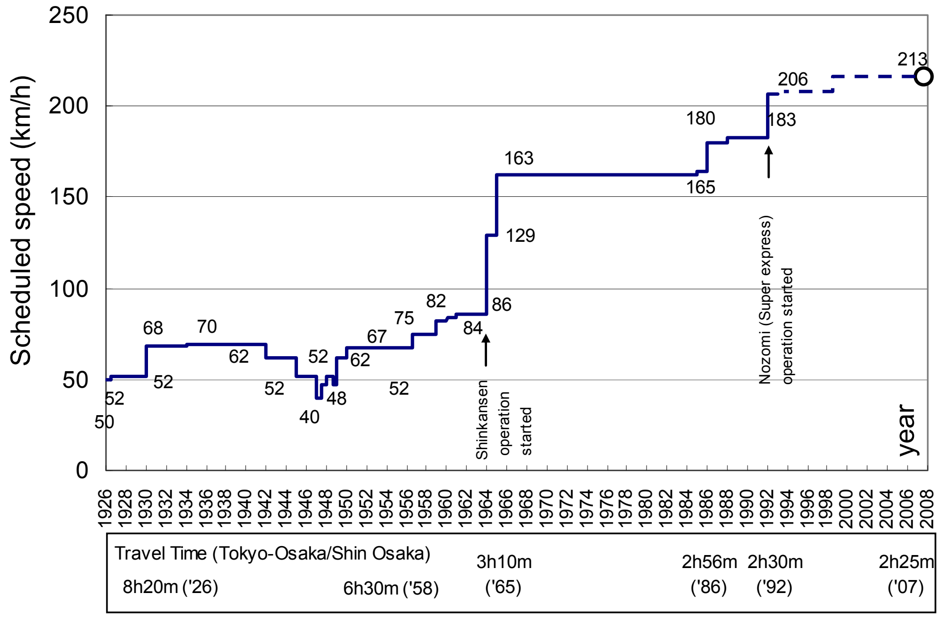
11.37 **Travel Time and Speed:** Before Tokaido Shinkansen was opened, the existing Tokaido Line required 6 hours and 30 minutes between Tokyo and Osaka by the improved limited express. After Tokaido Shinkansen is opened, the travel time between Tokyo and Osaka was dramatically shortened. In the beginning period, travel time between Tokyo and Shin Osaka was 3 hours and 10 minutes by Hikari train (maximum speed is 210 km/h and scheduled speed 163 km/h). Then, it was being reduced gradually and reached 2 hours and 25 minutes by "Nozomi" (maximum speed is 270 km/h and scheduled speed 213 km/h) in 2007. (refer to Figure 11.10)

11.38 **Fare Level:** When Tokaido Shinkansen opened in 1964, the fare between Tokyo and Shin Osaka was 2,480 JPY (7 USD, 1 USD=360 JPY), equivalent to about 12 % of the initial monthly salary for college graduates at that time (21,200 JPY=59 USD). The fare was increased moderately during after that 10 years, but it was increased rapidly during late 1970s and beginning of 1980s due to rising prices and loss making operation of JNR. However, since late 1980s, it is kept at same level. The present fare as of 2013 is 14,050 JPY (180 USD, 1 USD=78 JPY), equivalent to about 7% of the initial monthly salary for college graduates (198,800 JPY=1,757 USD). The Shinkansen fare is getting relatively cheaper in comparison with general rising prices. (refer to Figure 11.11)



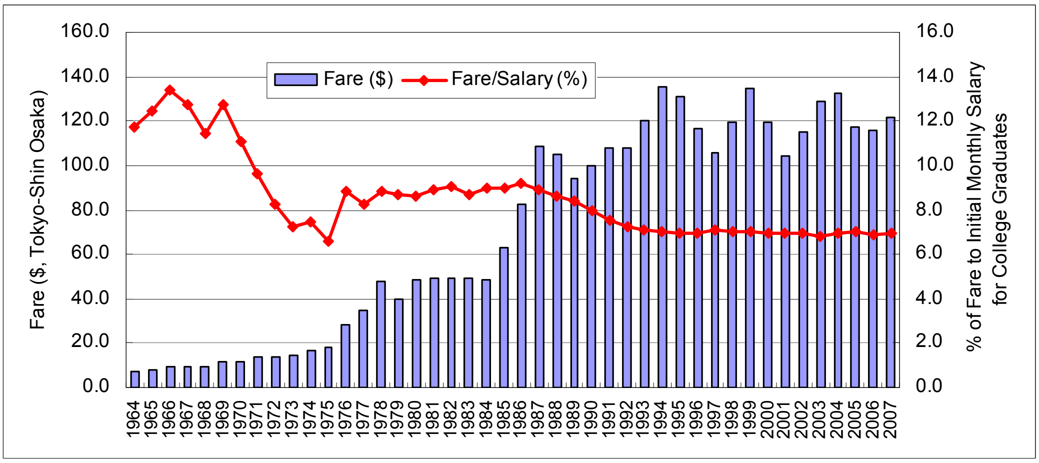
Source: JICA Study Team (culled from various information sources)

Figure 11.9 Changes in Frequency and Transport Capacity of Tokaido Shinkansen



Source: JICA Study Team (culled from various information sources)

Figure 11.10 Changes in Scheduled Speed and Travel Time of Tokaido Shinkansen

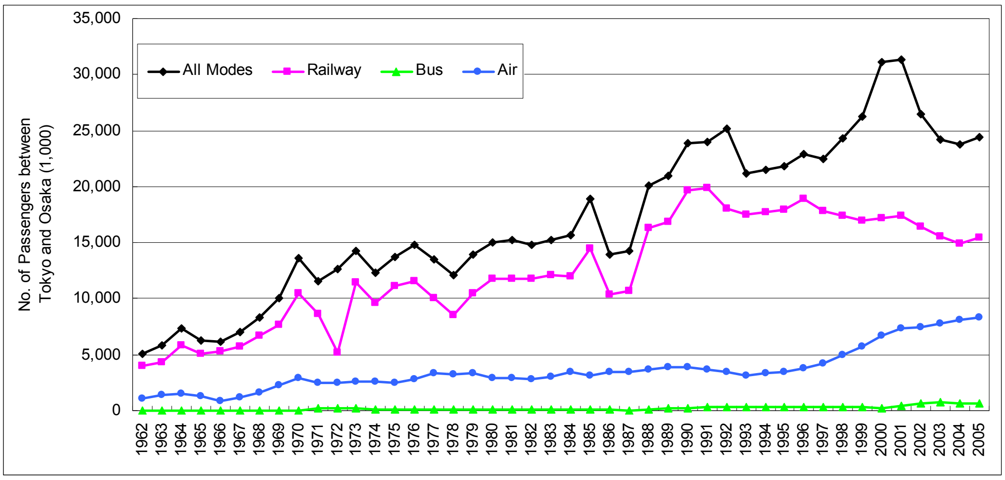


Source: JICA Study Team (culled from various information sources)

Figure 11.11 Changes in Fare Level of Tokaido Shinkansen

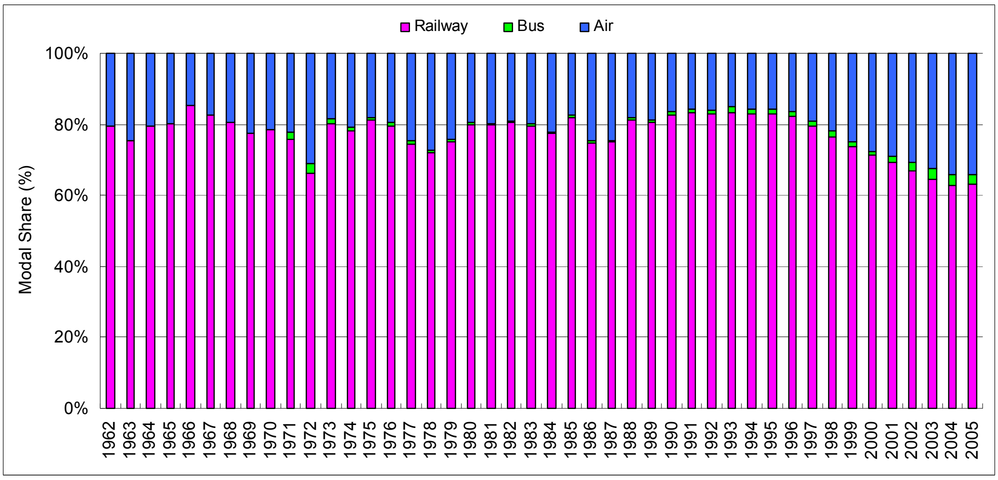
(c) Competitiveness of Shinkansen

11.39 Although Shinkansen made remarkable success during 1960s with increasing passengers, demand turned to decrease in late 70's. It was mainly due to the development of air and road transport and heavy deficit of Japanese National Railway. In Japan, improvement of air and road had been slow compared with U.S and Western Europe, and railway had kept the **most** important position in transport system until 1960s. But due to the introduction of large jet and improvement of airport, air travel became relatively cheaper and frequent services were introduced to many cities. Also highway and new bypass road had been constantly extended and people came to do commuting, shopping and all other tasks by driving their car especially in rural area. Shinkansen extended to western Japan in 1970s, but from Tokyo to Hiroshima or Fukuoka, air is faster than Shinkansen, so especially in west Okayama - Hakata section, passengers got much fewer than eastern part. Besides, because of the development of other transport, inefficient management, tendency to be affected by rights of politics and other reasons, JNR suffered from serious deficit, and they raised train fare almost every year during late 70s and early 80s, which leaded to decrease of passengers. In addition, deficit and lack of investment stopped improvement of Shinkansen service. Nearly same type 0 train had been produced since 1964 to 1985, and train speed had been same during that period, either.



Source: Regional Traffic Survey for Passenger and Freight

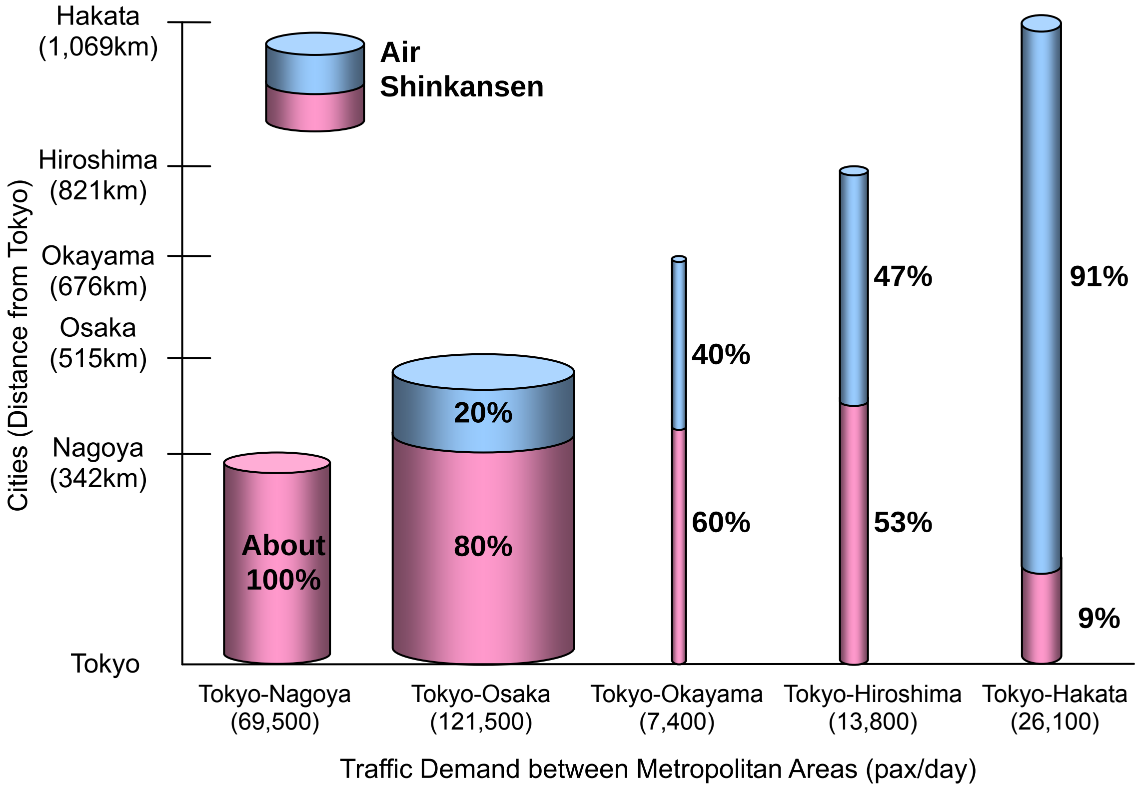
Figure 11.12 Passenger Traffic between Tokyo and Osaka



Source: Regional Traffic Survey for Passenger and Freight

Figure 11.13 Modal Share of Passenger Traffic between Tokyo and Osaka

11.40 **Modal Share by Trip Distance:** Looking into the modal share by trip distance, it is clear that air transport is competitive for long-distance travel. For travel from Tokyo – Nagoya (342km), Shinkansen is used at almost 100%, and this is 80% for Tokyo – Osaka (515km). (refer to Figure 11.14)



Source: Regional Traffic Survey for Passenger and Freight.

Figure 11.14 Modal Shares between Shikansen and Air Transport by Distance (2005)

(d) Socio-economic Impacts of Shinkansen

11.41 Construction of new Shinkansen lines brings a range of benefits to passengers and the railway operator. Not only shorter travel times, which allow passengers to travel further and stay longer at their destination, Shinkansen also offers enhanced safety, comfort and reliability. There are also several considerable knock-on benefits for areas along the line, such as enhancing the location of companies, promoting tourism and social interactions.

11.42 By allowing some manufacturers to locate their plants throughout the country, the development of Japan's nationwide high-speed transport network has also played a role in helping solve the over-centralization of people and resources in major cities, which causes regional disparities in employment opportunities and income.

11.43 As an example, what has been the impact of the March 2004 opening of the Kyushu Shinkansen between Shin-Yatsushiro and Kagoshima-Chuo?

11.44 Unlike Shinkansen links to Tokyo, the Kyushu Shinkansen trackside population is relatively low. As a result, the local regions undertook a number of initiatives in the run-up to the opening. For example, JR Kyushu helped redevelop the area around the Kagoshima-Chuo Station terminus building with entertainment facilities, shops, restaurants, and cinemas.

11.45 In particular, the large-scale investments were developed around Shinkansen stations. The areas around other Shinkansen stations were also made more appealing. Station plazas have been developed for better inter-modal connections with other transport modes, such as buses and taxis, and an active south Kyushu tourism promotion campaign was also conducted by local authorities and private companies.

11.46 According to a survey by the Kagoshima Regional Economic Research Institute, 53% of Kyushu Shinkansen passengers in the year immediately after it opened came from outside Kagoshima Prefecture. The Institute estimates that the increased consumption in Kagoshima Prefecture as a result of the extra visitors totaled ¥9.6billion and that the total knock-on effect was worth ¥16.6 billion.

11.47 The Kagoshima success story is thought to be attributable to the strategic initiatives taken to maximize the effect of the Shinkansen through cooperation between local government and private companies and provides a shining example for new Shinkansen lines in the future.

11.48 Thus accessibility to high speed railway station would be very important. In Tokyo metropolitan area high speed line, medium distance suburban railway line, short distance urban railway lines were operating parallel in the same corridor. Therefore, land acquisition for the long term development plan would be quite important to future hierarchical railway network by strategic railway network planning.

(Source of above section: Dr. Toshiji Takatsu, Executive Vice President, Japan International Consultants for Transportation Co., Ltd. (JIC))

4) Related Institutions to Shinkansen Development

(a) Railway Development

11.49 **Railway Establishment Act:** In 1892, this act was enacted. By this act, railway construction plans under the government's duty became concrete. This act assigned 33 railway sections and appointed 9 especially important railway sections as "First Generation" railway sections that were to be constructed within 12 years after enactment. Though construction costs were primarily covered by railway bonds, later they were disbursed from general account budget alike. The significance of this act was the fact that government driven railway construction was acknowledged legally for the first time.

11.50 **Special Act for Penalty regarding the Obstruction of Safe Railway Service:** In 1964, this special act was enacted. This act defined "a public arterial railway owned by the JNR connecting Tokyo and Osaka which its tracks are 1.435 m" as a Shinkansen, namely the Tokaido-Shinkansen which began its operation in the same year. The act prescribes punishment for any action hindering safe railway service (e.g. damaging facilities, laying objects on railway tracks). This was applied to other Shinkansen lines alike after the National Shinkansen Maintenance Act in 1970.

11.51 **Nationwide Shinkansen Railway Development Act:** This is the law which specifically regulates the Shinkansen development enacted in 1970. Article 2 defines "an arterial railway which travel the main section of the railway line at the speed over 200 km/h" as a Shinkansen. The purpose of this act was to construct a synthetic national Shinkansen network. The background of this act was the fact that the politicians and bureaucrats which were initially against the construction of the Tokaido-Shinkansen changed their attitude after experiencing the unforeseen achievements of the Tokaido-Shinkansen, now seeking for the Shinkansen's economic effect. The significance of this act was that the Shinkansen became independent of other railways legally as well.

11.52 This act provided that railway construction schedules should to be determined by the Minister of Land, Infrastructure, Transport and Tourism, and the Minister should fix and announce the basic plan of the Shinkansen lines which its construction should be commenced (Article 4), and after a survey (Article 5), determine a maintenance plan (Article 7), and assign construction (Article 8). The difference of this process comparing a normal railway line and a Shinkansen line is that the former requires the enterprise to fix the plan and apply for permission from the Minister, and in turn the Minister grants the permission. But the latter requires the Minister to fix the plan and assign the enterprises to construct them. This is called a presumed permission, which guarantees consistency with the Railway Business Act enacted in 1986.

11.53 According to Article 13, construction costs should be borne by the government and benefiting prefectures. In addition, prefectures can demand its municipalities which also benefit from the Shinkansen construction to share the burden to the extent of its benefits. The act also provides that the amount of costs that municipalities are responsible for must be determined after consultation with the applicable municipalities and resolved by the prefectural congress. The act further regulates that municipalities should make efforts to act as an intercessor in attaining land and other needed measures.

11.54 **Railway Business Act:** In 1986, this act was enacted accompanied by the privatization of the Japanese National Railways. Before the act, JNR Act regulated the national railways, and Regional Railways Act regulated the private railways, but after the act, the operations of all railway enterprises were regulated with this unified law.

(b) Other Related Laws and Regulations

11.55 Other important laws and regulations related to the Shinkansen include the **Land Condemnation Act** enacted in 1951. This act is a basic law which regulates the requirements, procedures, effects, and compensations regarding land condemnation. Though Article 29 Section 1 of the Constitution of Japan guarantees private property rights meaning that land purchase is voluntary, Article 1 of this act provides that “the aim of this act is to regulate requirements, procedures, effects, and compensations regarding condemnation of land in need for public welfare, to make adjustments between the furtherance of public welfare and private property, and as a result, to contribute to a fair and rational utilization of land“. Consequently, a compulsory condemnation of land for public welfare regardless to the owner’s will became possible.

11.56 The act appoints the Shinkansen as a “specific public enterprise” based on the **Special Measurement Act on Acquisition of Public Land** enacted in 1961. Therefore, even in the case that the examination of the compensation amount is yet to be finished, by meeting the conditions; paying a tentative compensation or a deposit, a division of privilege acquisition and delivery of land becomes possible. In other words, Shinkansen construction is legally dealt as an enterprise which its land acquisition is relatively easy.

11.57 **Construction Plans of the Shinkansen:** After the practice of the Tokaido Shinkansen, there was a growing tendency to establish more Shinkansen lines. Reflecting the prosperity of those days, the government made a cabinet decision of the New National Synthetic Development Plan which included the construction of 7,200km extension of the Shinkansen lines. This included not only the constructing lines such as Sanyo, Tohoku, and Joetsu, but also planned lines such as Hokkaido, Chuo, and so on, all planned to be completed by 1985, the target year of the New National Synthetic Development Plan. Moreover, in 1970 when the National Shinkansen Maintenance Act was enacted, the planned Shinkansen lines increased to a total of 9,000km extension. In 1973, the basic planned 5 lines (Hokkaido, Tohoku (north of Morioka), Hokuriku, Kyushu (Kagoshima Route), Kyushu (Nagasaki Route)) were promoted as maintenance Shinkansen lines meaning its construction preparation was about to begin, and the basic plans of the other 12 lines (about 3,500km extension) were determined, which resulted in a solidification of the 7,000km extension of the Shinkansen network. However, after the oil shock in 1972, these plans were passed up and the plans were frozen. Before the establishment of Japan Railway in 1987, a cabinet decision was made to revitalize the construction plans of 3 Shinkansen lines; the Tohoku (north of Morioka), Hokuriku, Kyushu (Kagoshima Route), unfreezing the plan again. In 2006, according to the Ministry of Land, Infrastructure, Transport and Tourism's latest statistics, the construction of 2,387km extension of the Shinkansen lines are finished and are operating, and construction will likely continue in the future alike.

11.2 Experience of France's HSR Development

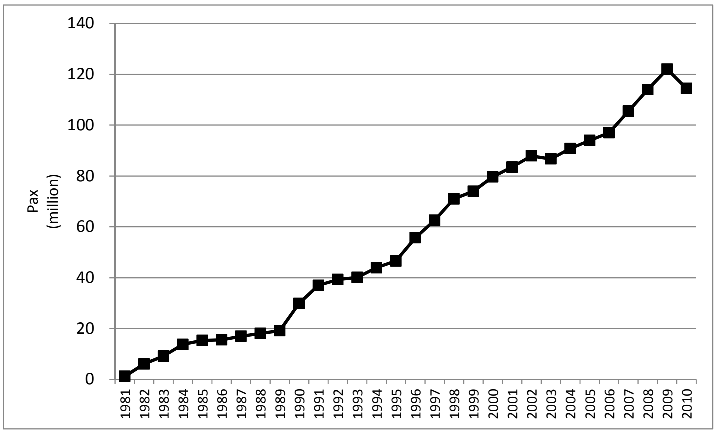
1) Brief History

11.58 The idea of France's high-speed train, the TGV (*Train à* Grande *Vitesse*) was first proposed in the 1960s, after Japan had begun construction of the Shinkansen in 1959. It was developed during the 1970s by GEC-Alsthom (now Alstom) and SNCF (national rail operator). The inaugural operation commenced in 1981 between Paris and Lyon, and since then, the TGV network centred in Paris has expanded to connect cities not only across France but also to adjacent countries as well.

2) Main Characteristics of TGV

(a) Ridership

11.59 On 28 November 2003, the TGV system carried its one billionth passenger, and excluding international traffic, the TGV system carried 98 million passengers during 2008, an increase of 8 million (9.1%) on the previous year.

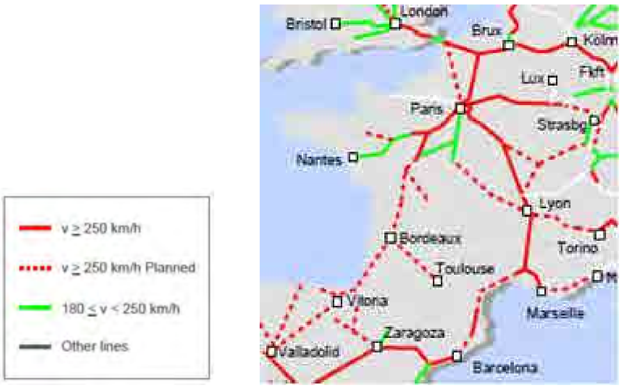


Source: Pepy, G., 25 Years of the TGV, Modern Railways, 2006.

Figure 11.15 Ridership of TGV

(b) Network Development

11.60 France has a total of 1,768 km of high-speed railway network with six lines operating. The current lines and those under construction can be grouped into four routes radiating from Paris: southwest (LGV Atlantique to Tours and Le Mans), north (LGV Nord and High Speed 1 to London, with a branch towards Brussels), east (LGV Est to Strasbourg), and southeast (LGV Sud-Est, LGV Rhone-Alpes and LGV Mediterranee to Marseille, plus LGV Rhin-Rhone and LGV Perpignan-Figueres).



Source: UIC, 2011.

Figure 11.16 High-Speed Railway Network in France

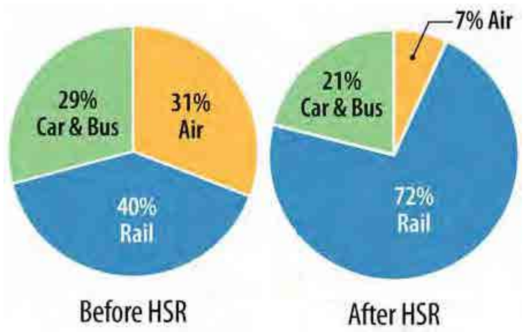
(c) Revenue and Competitiveness

11.61 In terms of passenger-km and commercial revenue, TGV traffic comprises about 75% of total SNCF main-line traffic. Operation of TGV trains in France and in neighbouring countries (including Eurostar and Thalys services) is a main profit center for SNCF. Experience shows an immediate reaction by the public after a new TGV is opened. Sources of increased traffic are passengers changing from air to road transport due to the value added by the TGV in terms of shorter trip times, frequent services, high comfort and competitive fares. The impact of high-speed rail on air travel is unquestionable; air routes in competition with the TGVs have all seen similar drops in volume, especially on journeys with a trip time of less than 3 hours. The impact on road transport is also clear – indices for traffic show that motorways in competition with TGVs experience a decrease in traffic growth. As an added benefit, the drop in air and road traffic decreases the negative impact of pollution, etc., on the environment due to the environment friendly nature of the TGV.

(Source of above section: Jean-Pierre Arduin and Jincheng Ni, French TGV Network Development, 2005.)

11.62 Introduction of high-speed railway has resulted in modal shifts from air and car to high-speed railway, creating a more balanced and efficient transportation system. As shown in Figure 11.7, France provides good examples of travellers shifting to HSR from other travel modes once high-speed railway becomes an option.

(Source of above section: California High-Speed Rail Program Draft 2012 Business Plan, 2011.)



Source: California High-Speed Rail Program Draft 2012 Business Plan, 2011.

Figure 11.17 Mode of Travel before and after HSR Operation in France (TGV Sud-Est)

11.63 See Volume I Chapter 5.1 for technical features for system and technology for HSR in France and other countries.

11.3 Experience of China's HSR Development

1) Brief History

11.64 High-speed railway development in China is being initiated by the Ministry of Railways (MORC). MORC has for three decades been challenging to meet the rapidly growing demand for passenger and freight demand, and prevent railways from becoming a bottleneck on the nation's development. A drastic improvement was required in the railway system and the construction of new high-speed passenger dedicated lines was announced in the 10th five-year plan (2001-2005) to expand the cargo transportation on the existing lines, which became the basis for today's HSR development in China.

2) Main Characteristics of China's HSR

(a) Ridership

11.65 The average ridership of China's HSR is around 20 to 30 million passengers per year, and is increasing year by year.

(b) Network Development

11.66 The currently opened routes with the initial design speed of 350 km/hour are 3,625 km in total. The Chinese Ministry of Railways reviewed the operation speed on June 13, 2011 prior to the start of operation of the Beijing - Shanghai High-Speed Railway and announced that the operation speed will be reduced from 350 km/h to 300 km/h from the start of operation. Furthermore, the operation speed for three routes including the route between Wuhan - Guangzhou that were opened and operated at the running speed of 350 km/h was reduced to 300 km/h according to the train schedule revised in July in the same year. On July 23 in the same year, a devastating high-speed train collision occurred in Wenzhou, which made people keenly aware of the importance and difficulty of ensuring safety during operation.

Source: JICA Study Team

Figure 11.18 High-Speed Railway Network in China

(c) Funding, Revenue and Competitiveness

11.67 Funding for China's high-speed railway network is difficult to isolate from the sources of overall investment in the railway sector. In 2007, nearly half of railway investment was funded from domestic bank loans and bonds, about 16% from provincial governments and public enterprises (through use of the joint venture model), and about 15% from a construction surcharge on freight. Since 2007 the overall program has expanded substantially, there has been a 10% increase in the construction surcharge, and other funding sources have been developed; so 2007 may not constitute an accurate picture of the final outturn.

(Source of above section: Pau Amos et al., High-Speed Rail: The Fast Track to Economic Development?, World Bank, 2010)

11.68 On the cost side, China has realized comparatively low unit rates of construction on many components and processes due to the scale of the program, continuous working with few delays and wage levels lower than in other countries where high-speed rail is being introduced.

11.69 The three-hour high-speed rail journey between Wuhan and Guangzhou costs the equivalent of USD 72 (around 0.07 USD/km), against USD 21 on a conventional train that takes about ten hours. As might be expected, many passengers still prefer the slower, cheaper alternative, but transfer to high-speed is expected to increase steadily as incomes increase and more people try the new service for the first time. Recognizing that virtually all major transport projects, including the original Shinkansen, involve significant demand ramp-up periods, MOCR believes that with the expected rise in China's income levels over the next five to ten years it will have no problem in filling its seats. Certainly China's airlines agree, and have expressed grave concerns for the future of short-haul air travel. Nevertheless, as the present fare levels, whilst HSR will be a major competitor for the higher end of the market in China will find travel by high-speed train as expensive proposition. It seems likely that yield management techniques will be need to be introduced to attract passengers who can fill seats at less busy times and at fares less than the full-premium price.

(Source of above section: Pau Amos et al., High-Speed Rail: The Fast Track to Economic Development?, World Bank, 2010)

11.70 See Volume I Chapter 5.1 for technical features for system and technology for HSR in China and other countries.