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16. Abstract

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HIGH SPEED RAIL: A STUDY OF INTERNATIONAL BEST PRACTICES AND IDENTIFICATION OF OPPORTUNITIES IN THE U.S.

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ABSTRACT

In the United States, passenger rail has always been less competitive than in other parts of the world due to a number of factors. Many argue that in order for a passenger rail network to be successful major changes in service improvement have to be implemented to make it more desirable to the user. High-speed rail can offer such service improvement.

With the current administration's allocation of $8 billion in its stimulus package for the development of high-speed rail corridors and a number of regions being interested in venturing into such projects it is important that we understand the factors and regulatory structure that needs to exist in order for passenger railroad to be successful. This study aims to review how foreign countries have developed and their railroad systems to identify key factors that have contributed to its successful implementation. An evaluation of the factors, such as organization structure, operation, administration, development and type of funding, that are common to each of these projects will used as performance measures to identify potential locations and opportunities for high speed rail projects in the U.S. Southwest region.

EXECUTIVE SUMMARY

In the United States, passenger rail has always been less competitive than in other parts of the world due to a number of factors. Many argue that in order for a passenger rail network to be successful major changes in service improvement have to be implemented to make it more desirable to the user. High-speed rail can offer such service improvement.

With the current administration's allocation of $8 billion in its stimulus package for the development of high-speed rail corridors and a number of regions being interested in venturing into such projects it is important that we understand the factors and regulatory structure that needs to exist in order for passenger railroad to be successful.

This research study aimed to review how foreign countries have developed and reorganized their railroad systems to identify key factors that have contributed to its successful implementation. The study team looked at factors such as organization structure, operation, administration, development and type of funding, socio-economic characteristics, demographics, financial capacity, institutional capacity, financial models, private sector involvement, and competition with other modes. These factors were then used as performance measures to identify potential locations and opportunities for high speed rail projects in the U.S. Southwest region.

WHY ARE OTHER COUNTRIES INVESTING IN HIGH-SPEED RAIL?

High-speed rail should not be regarded as an element but as a complex system that includes infrastructure, rolling stock, signaling systems, maintenance systems, stations, operation management, financing and legal aspects, among other components. It is not a unique system and its implementation has to be adapted to take into account the different circumstances in each location such as geographical, commercial and operational aspects.

While there are many technical differences between conventional and high-speed trains that go beyond the speed in which it travels, these two types of railways systems can coexist in the same network depending on how the infrastructure and the market are organized. Different countries used different exploitation models between these two types of passenger train operations. In Japan for example high-speed rail runs exclusive tracks. In France, high-speed rail uses upgraded conventional tracks for final approaches in to city centers; Spain's high-speed rail infrastructure, on the other hand, allows for conventional trains to use high-speed rail tracks. Other models, like the one used in Germany, allowed for freight trains to use spare capacity of the high-speed tracks during nighttime slots.

The model chosen will determine the service that is to be provided by the high-speed trains and the traffic restrictions it will encounter, and will ultimately affect the overall construction and operating costs and the benefits received from the operations of such services. In any case, the decision to implement high-speed rail service or of choosing one exploitation model over another should not be solely based on cost. The decision is based on whether the economic and social benefits gained from such a system are high enough to compensate its infrastructure and operating costs.

ECONOMIC AND SOCIAL BENEFITS

The direct benefits of a high-speed rail system are: passenger time savings, increase in comfort, reduction in congestion and delays in roads and airports, reduction in accidents, reduction in environmental externalities. Time saving benefits will depend on the current door to door travel times for the available modes compared to the difference achieved through high-speed rail. It will also depend on how high time is valued by the traveler, be it for work-related or leisure trips. In addition to shorter travel times, high-speed rail can offer passengers a greater level of comfort than other modes like conventional rail, air or bus travel. These additional comforts are in terms of space, noise, accelerations and any number of services that can be provided by operators of high-speed trains such as catering services, wet bars, unlimited use of electronic devices and, in some cases, even a nursery for children.

FINANCING HIGH-SPEED RAIL

As with any other transport infrastructure project, when a government entity is looking into the possibility of developing a high-speed rail corridor it needs to evaluate which financing mechanism it will use. There are several business models that can be used for the development of high-speed rail corridors. These range from purely public, public-private partnerships, to purely private; although the literature suggests that the latter is highly unlikely due to specific characteristics of transport infrastructure projects that will always require the involvement of the public sector whose interests go beyond financial gain to take into account social-economic benefits.

Developing high-speed passenger rail corridors can involve a relatively large long-term investment. A high initial investment cost and long construction period are combined with a slow ramp-up period for increasing revenues, which all yields to a rather low cash flow at a 'normal' discount rate, as depicted in. This cash flow situation makes it less attractive for private investors and motivates the need of some kind of public sector participation.

Recent research conducted concerning high-speed rail developments have suggested that financing for these types of projects cannot be funded solely on private investments; its long-term return of investment and the great risks that are common to infrastructure projects does not make them attractive for the private sector. In order for an infrastructure project, e.g. high-speed rail, to be attractive to a private investor it will always need to have some sort of participation from the public sector, such as a public-private partnership

The public-private partnerships schemes used can vary from project to project depending on the specific characteristics and the legal framework followed by the region for such partnerships. Some of the key requirements necessary for the successful implementation of PPP can be summarize as:

- Strong government commitments
- Regulatory and legal framework that facilitates such structures
- A fair allocation of the risks involved
- Well prepared model tailored for the specific project
- Clear and transparent tender process

CASE STUDY EVALUATION

The different international corridors were evaluated in terms of organizational structure, operations, service level, development, type of funding, financial models, private sector involvement, and competition with other modes, as well as socio-economic characteristics, demographics, the following overall conclusions were observed.

In terms of organizational structures, all of the cases evaluated had separated agencies for the infrastructure and operations of railways with the idea of promoting competiveness and efficiency and in some cases competition but at the same time maintaining tight regulations in terms of rail development.

Identification of priority corridors has been a key factor in the successful development of high-speed rail in the different nations evaluated. This success has been measured in terms of passenger demand, revenue and economic development. Since the 1990s the EU Commission adopted the Trans-European Transport Networks (TEN-T), a plan envisioning the integration and interoperability of all of its member states through coordinated improvements to primary roads, railways, inland waterways, airports, seaports, inland ports and traffic management systems. This approach is very similar to the one being followed by the U.S. federal government with the FRA's designated high-speed rail corridors. In the case of the Japanese Shinkansen, the oldest high-speed rail network in operation, plans for the development of the HSR lines have existed since its implementation in the 1960's. Consequently, recent project assessments have focused on which line to prioritize rather than whether to build the line or not. The major driving forces behind the development of the Shinkansen network has been the benefits it has brought to the regional and national economy and that local communities are expected to contribute a proportion of the funding.

All of the international corridors studied have had a previous passenger rail system already in place. The decision has been mainly to upgrade the technology. These have been driven by the national governments and the already established agencies in charge of the rail infrastructure and passenger operation. The main drivers are the national governments who receive support from regional and local governments since they have seen the benefits and economic development possibilities a HSR station can bring to their area. In more recent projects more funding has been coming from the regional and local governments.

Strong government policies and regulations have been an important part of the success of high-speed rail over other modes of transport. For example, high landing fees due to airport capacity constraints and tight airline regulation have been able to make high-speed rail a more competitive mode to users. Airlines are also taking a more direct participation in passenger rail operations. Government participation varies from country to country but for the most part it is very direct as is evident in the infrastructure systems in place. In the European railway framework, infrastructure costs, including maintenance, are covered by both the Government and the Infrastructure Manager (IM) through infrastructure charges that the operator pays for running services on the infrastructure. Although variations in charges can be caused by conditions applicable to a specific corridor it is likely that a greater part of it is caused by the differences in the level of subsidies the governments are willing to provide.

HIGH-SPEED RAIL IN TEXAS

The comparison of the international cases evaluated showed that a corridor connecting the state's four largest metropolitan areas, Houston, Dallas/Fort Worth, San Antonio and Austin has the potential of developing high-speed rail as a significant mode of transport between these cities. The distances between city pairs, the number of potential stops and the demographics obtained for these cities fits with the averages obtained from the comparison of the case studies evaluated. A much more comprehensive study of travel patterns and future developments in the area is required in order to truly assess the impact of such development.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1. WHY HIGH-SPEED RAIL?

1.1 INTRODUCTION

After World War II, when Japan and European countries emphasized rebuilding their railways, the United States' primary focus was on improvements to roadways and airports. Due to a lower population density and a more automobile-oriented culture promoted by its easier access, passenger rail is not as competitive in the United States than in other parts of the world. Many argue that in order for a passenger rail network to be successful major changes in service improvement have to be implemented to make it more desirable to the user. High-speed rail can offer such service improvement.

With the current administration's allocation of $8 billion in the 2009 American Recovery and Reinvestment Act (ARRA) stimulus package for the development of high-speed rail corridors and a number of states being interested in venturing into such projects it is important that we understand the factors and regulatory structure that needs to exist in order for passenger railroad to be successful. This study has aimed to review how foreign countries have developed their railroad systems to identify key factors that have contributed to its successful implementation, such as, organization structure, operation, administration, development and type of funding, demographics, financial capacity, financial models, private sector involvement, and competition with other modes. These factors are to be use a performance measure to identify potential locations and opportunities for high speed rail projects in the U.S. Southwest region.

1.2 WHY ARE OTHER COUNTRIES INVESTING IN HIGH-SPEED RAIL?

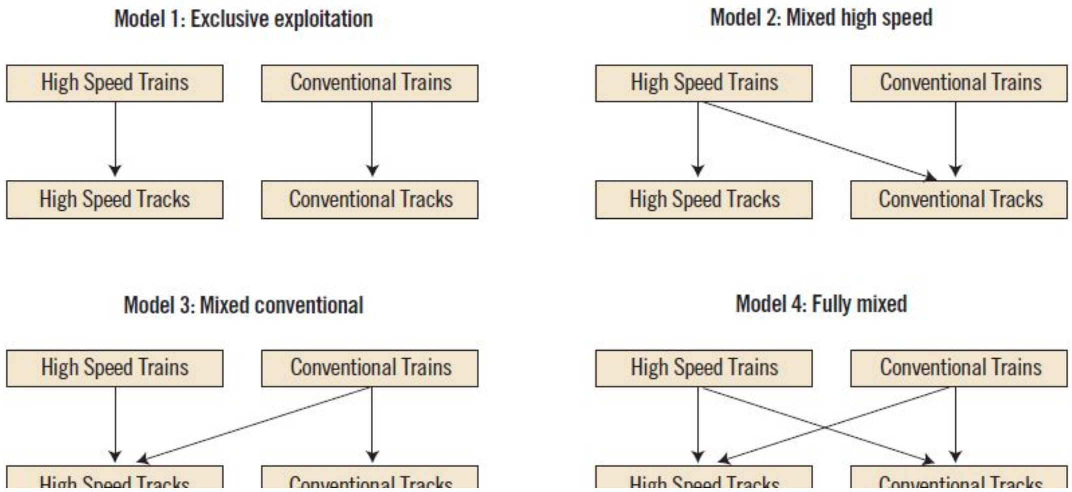
High-speed rail should not be regarded as an element but as a complex system that includes infrastructure, rolling stock, signaling systems, maintenance systems, stations, operation management, financing and legal aspects, among other components. It is not a unique system and its implementation has to be adapted to take into account the different circumstances in each location such as geographical, commercial and operational aspects.

Although high-speed rail share the same basic principles as conventional rail several distinctions that can be made between the two systems. The most evident difference is the commercial speed in which each system operates, high-speed trains operate at speed above 125 mph and has been tested up to 320 mph. These high speeds require trains to operate in tracks with special geometrical characteristics such as curve radius as well as the use of rolling stock that allows reaching those higher speeds. Another significant difference between conventional and high-speed rail is their signaling systems. Traffic on conventional tracks is controlled by external electronic signals together with automated signaling systems, whereas signaling between high-speed trains and blocks of tracks is usually fully in-cab integrated, eliminating the need for drivers to see line-side signals (de Rus, 2009). There also exists a difference in the electrification of the lines; high-speed lines require at least 25,000 volts to achieve enough power, while conventional lines may operate at lower voltages.

While there are many technical differences between conventional and high-speed trains that go beyond the speed in which it travels, these two types of railways systems can coexist in the same network depending on how the infrastructure and the market are organized.

1.2.1 Exploitation Models

On a report compiled for the BBVA Foundation, de Rus differentiates between four types of exploitation models that can be identified from the different high-speed rail systems that are currently operating around the world and its relationship to conventional rail systems. Figure 1.1 shows the four exploitation models identified by the author.



Source: de Rus, 2009

Figure 1.1: High-Speed Rail Models According to the Relationship with Conventional Services

The first one, the exclusive exploitation model is characterized by its complete separation from conventional services. This model is used in Japan where the main reason for the development of a high-speed rail system was because the conventional lines had reached its capacity limits. The second model defined on the figure is the mixed high-speed model, in which high-speed train can operate on specifically built new lines or on upgraded segments of conventional lines, reducing construction costs. This model is followed by the French TGV system where high-speed trains mostly operate on new tracks but used upgraded conventional tracks for approaches to city centers. A third exploitation model, the mixed conventional model, adopted by the Spanish railway system, allows for some conventional trains to run on high-speed rail tracks. Advantages from this model come from the reduction in rolling stock acquisition and maintenance costs, and option of offering intermediated high-speed services for certain routes. The fourth model, the fully mixed model, allows for both high-speed and conventional trains to operate on each other's infrastructure. This model is used for the German ICE system where high-speed trains use upgraded conventional tracks and freight trains use the spare capacity during the night. Although this model may reduce construction costs upfront, maintenance costs are significantly higher and can cause a decrease in line capacity due to trains operating at significantly different speeds.

The model chosen will determine the service that is to be provided by the high-speed trains and the traffic restrictions it will encounter, and will ultimately affect the overall construction and operating costs and the benefits received from the operations of such services. In any case, the decision to implement high-speed rail service or of choosing one exploitation model over another should not be solely based on cost. The decision is based on whether the economic and social benefits gained from such a system are high enough to compensate its infrastructure and operating costs.

1.2.2 Economic and Social Benefits

The direct benefits of a high-speed rail system are: passenger time savings, increase in comfort, reduction in congestion and delays in roads and airports, reduction in accidents, reduction in environmental externalities. Time saving benefits will depend on the current door to door travel times for the available modes compared to the difference achieved through high-speed rail. It will also depend on how high time is valued by the traveler, be it for work-related or leisure trips. In addition to shorter travel times, high-speed rail can offer passengers a greater level of comfort than other modes like conventional rail, air or bus travel. These additional comforts are in terms of space, noise, accelerations and any number of services that can be provided by operators of high-speed trains such as catering services, wet bars, unlimited use of electronic devices and, in some cases, even a nursery for children.

Benefits received from additional capacity are only relevant if the demand is exceeding the capacity of the existing modes but evidence also suggests that running rail infrastructure less close to capacity benefits reliability (de Rus, 2009). Studies conducted for the British railways suggests that about 50% of the traffic on a new high-speed rail line will be diverted from other modes, mainly car and air, with the remaining being totally new trips (Atkins, 2003). This diversion would lead to a reduction in congestion and delays in roads and airports since high-speed rail offers a higher capacity of transport, about 400,000 passengers per day (UIC, 2009).

In terms of safety, high-speed rail is regarded as the safest transportation mode, in terms of passenger fatalities per billion passenger-kilometers, that is currently available. There has been a very small amount of accidents involving high-speed trains and few of these have reported fatalities. High-speed rail is generally acknowledged to be a less pollutant mode when compared with its competing alternatives. But the quantity of polluting gases generated to power a high-speed train will depend on the amount of energy consumed and the air pollution generated from the electricity plant that produce such energy (de Rus, 2009). In terms of land take, evidence suggests that the number of passengers transported per hour per meter of infrastructure is on average 45 times higher for rail than for cars (Fitch Ratings, 2010) favoring rail over roadways.

Other indirect benefits achieved with such system are wider economic benefits such as regional development. The literature also points out that the implementation of a high-speed rail line has a centralizing effect in the cities it is connecting, meaning that there is a tendency towards the concentration of economic activity towards the major cities connected through high-speed rail (de Rus, 2009). Such systems can also promote a more logical territorial structure and help contain urban sprawl.

1.3 USA HIGH-SPEED RAIL VISION

After more than 50 years of investing on its extensive highway and aviation systems, the United States is now moving towards a new transportation vision for the nation, one that responds to the economic and environmental challenges the world is facing today. President Obama's administration has proposed the integration of a high-speed rail system to the current transportation network as a way to address current and future passenger and freight demands. In 2009 federal government pledged its long-term commitment to the development of a high-speed passenger rail network by assigning $8 billion in the American Recovery and Reinvestment Act (ARRA) to serve as a down payment for different high-speed or intercity passenger rail projects and by allocating $1 billion per year in the administration fiscal budget to fund a high-speed rail grant program.

Federal funds available for high-speed rail development are divided into types: 1) *Projects*, which are grants to complete individual projects that have already completed preliminary engineering and environmental work; 2) C*orridor programs*, a cooperative agreement to develop an entire segment of phase of a corridor program, projects that are eligible are those with completed corridor plans and environmental documentation and have a prioritized list of projects to meet the corridor objectives; projects that receive this type of funding required additional oversight from the Federal government; 3) *Planning*, cooperative agreements for planning activities such as development of corridor plans and State Rail Plans; funds used for these projects do not fall under the ARRA appropriation funds.

High-speed rail services have been defined somewhat differently than how the International Union of Railways (*Union Internationale des Chemins de fer*, UIC) defines it. According to the UIC, a high-speed rail is any type of passenger rail transportation that operates at the speed of 125 mph or faster. In the United States it has been divided into three categories: *Express*, *Regional* and *Emerging* high-speed rail. High-speed rail *Express* are defined as services between major population centers that are 200 to 600 miles apart, running frequently with few stops along the way, at top speeds of at least 150 mph on completely grade separated, dedicated tracks. This type of service is intended to relieve air and high-way capacity constraints. High-speed rail *Regional* services are define as a frequent service between major and moderate population centers 100 to 500 miles apart, running at top speeds of 110 to 150 mph and making some intermediate stops along the way, using grade separated right-of-way with some dedicated and some shared tracks and having. This service is intended to relieve highway constraints and some air capacity constraints. *Emerging* high-speed rail are those services that run in 100 to 500 miles long corridor at top speed of 90 to 110 mph on primarily shared track and advance grade crossing protection or separation. These services do not fall under the category of “true” high-speed but are thought to have strong potential for future Regional or Express service (Federal Railroad Administration, 2009).

Although having different definitions, the intent is the same: provide intercity passengers with a superior transportation system that at the same times fulfills the current economic and environmental needs. In a time were congestion, pollution and oil dependency can compromise a country’s economic competiveness it is important that to invest in infrastructure that will further encourage a country’s development and economic stability. Reviewing what other countries have done with these types of rail systems in terms of organizational structure, administrative policies, operations, service level, funding, fare integration and intermodal connectivity can serve as a basis for the United States when trying to identify possible corridors.

CHAPTER 2. INTERNATIONAL CASE STUDIES

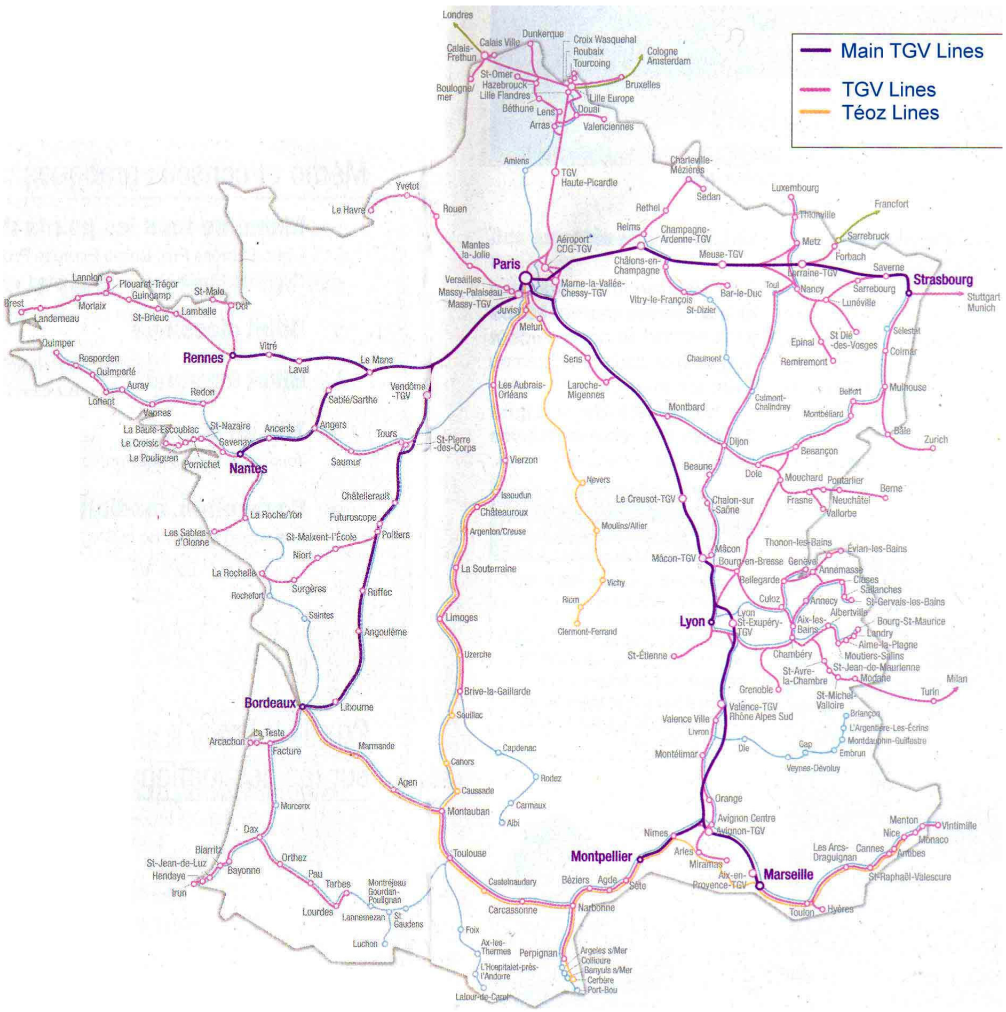
2.1 INTRODUCTION

High-speed rail (HSR) has been developed in a number of countries, including Taiwan, Korea, China, Japan, France, Germany, and Spain. In Europe, the European Commission deemed the expansion and interconnectivity of Europe's HSR lines as one of its top priorities, allocating significant amounts of funding for HSR development (Campos, 2009). Although HSR is seen as a more environmental friendly mode of transportation that generates substantial social benefits, building, maintaining, and operating HSR systems requires a significant financial investment.

The current Administration's allocation of $8 billion in stimulus funding for the development of HSR corridors in the U.S. has sparked a renewed interest in the implementation of HSR services. This document reviews international examples in an effort to gain insight into how HSR has been developed in these countries and to understand the impact of HSR on transportation mode shares in the HSR corridors.

2.2 FRANCE

France, the largest member state of the European Union at 211,209 square miles, was the first European country to construct a high speed rail (HSR) line. The first HSR rail line – with the à grande vitesse (TGV) train – opened in 1981 and connected Paris and Lyon (249 miles apart). This first line, the TGV Sud Est, was first conceived in the 1970's primarily for political and strategic reasons, but also because of capacity constraints that were experienced on the existing passenger rail line between Paris, Dijon, and Lyon. This line has been extremely successful since its opening, securing enough revenues to re-pay its infrastructure debt within a decade. The success of this line thus led to the expansion of the country's HSR network, with new lines built in the south, west, north, and east of the country (see Figure 2.1 for a map of the current TGV lines) (La Vie du Rail, nd).



Source: http://www.projectmapping.co.uk/Europe%20World/Resources/tgv_map.jpg

Figure 2.1: French Passenger Rail System

From Table 2.1 it is evident that there are currently seven HSR lines in operation, representing a network of 1,163 miles. In addition, there are 186 miles under construction and 1,625 miles in the planning stages (International Union of Railways, nd). As can be seen from Figure 2.1 and Table 2.1, all the routes commence in Paris, thereby providing a radial network connecting to the capital. In 2008, the French government announced that they will provide citizens with a true national HSR network by diverting away from the Paris centered radial routes (Railway Technology, nd).

Table 2.1: French TGV lines

Line	Length (miles)	Year Opened	Top Speed (mph)
TGV Sud-Est (Paris-Lyon)	260	1981	186
TGV Atlantique (Paris-Le Mans and Tours)	181	1990	186
TGV Rhône-Alpes (Lyon-Valence)	75	1992	186
TGV Nord (Paris-Lille/Channel Tunnel)	215	1993	186
TGVInterconnexion IDF (Paris Bypass)	65	1994	186
TGV Méditerranée (Valence-Marseille)	161	2001	199
TGV Est (Paris-Baudrecourt)	206	2007	199

Source: International Union of Railways (UIC), nd

2.2.1 Organizational Structure

Societe Nationale des Chemins de Fer de France (SCNF), a state owned company, is the operator of almost all passenger rail services in France. International long distance HSR services are operated by different consortia, such as Eurostar and Thalys, in partnership with SCNF. For example, for the rail service between from Paris and Brussels SCNF has partnered with Thalys.

The rail infrastructure is owned by Reseau Ferre de France (RFF), a state owned company, which was formed to comply with the EU legislation on the separation of infrastructure and operations. RFF acts as the owner of the infrastructure but contracts the operation and maintenance of safety systems to SNCF. All transportation policy decisions fall under the Ministry of Transport and Tourism. Figure 2.2 shows a diagram of the French railway organization structure.

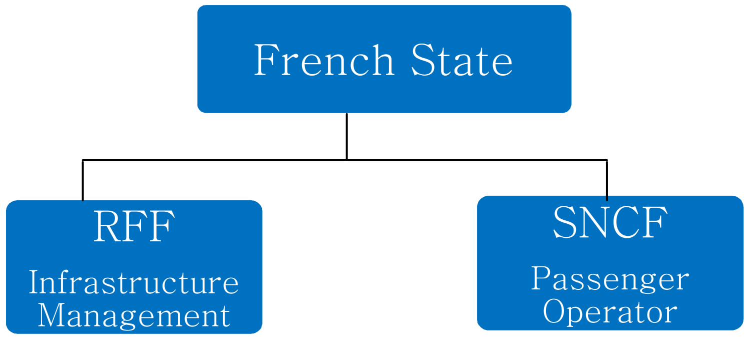


Figure 2.2: French Railway Organization Diagram

2.2.2 Funding

Before 1997 most of the funding for HSR lines came from the national government through SNCF - mainly from bank borrowings. Rolling stock was also financed by bank borrowing and, whenever possible, SNCF utilized leaseback arrangements for rail cars upon delivery. Recent funds for HSR construction in France has been derived from a variety of sources, including the national government, regional governments, RFF, SNCF, and the European Union.

RFF, as the infrastructure provider, can borrow money in the international markets to undertake major projects, such as the construction of new HSR lines. The funding borrowed is guaranteed by the government and the amount is restricted to what RFF can repay from the access fees. RFF typically does not borrow to fund a specific project, but rather to meet its overall financial needs. In addition to borrowings, the TGV lines have also been developed with grant funding from local sources, such as a city, county council, district council and regional council. Grant funding is dependent on local government support, which is partly influenced by the redevelopment and regeneration that a new TGV line is anticipated to deliver. In projects that have involved funding from local authorities, these have come from bond issuing through specialized commercial banks. The amounts of contribution have been fixed and dependent on travel time decrease benefits to Paris. Having local authorities involved in the development of a TGV line has increased the number of stakeholders involved and need to be properly managed by RFF to not incur on project delays.

A recent French law has allowed RFF to enter into public-private partnerships to finance and deliver new infrastructure projects. The tow models currently being used are: a concession model, in which rail operators pay an access charge to the concessionaire based on their actual use of the infrastructure; and a partnership contract, were RFF pays availability fee to the private sector partner based on the performance agreement and regardless of the actual usage of the infrastructure. These models are discussed further in Chapter 3.

The TGV rolling stock is procured by SNCF and is funded through lease commitments.

2.2.3 Infrastructure and Operation

As infrastructure manager, RFF is in charge of providing the rail infrastructure. Engineering works required for the developments of new lines contracts is contracted out, as well as the maintenance of new and existing infrastructure. Contracts for new infrastructure are allocated on a section by section basis with specialist contractors in order to mitigate the risks of defaulting of a single contractor. Infrastructure is provided to SNCF on an availability basis.

The TGV lines were developed within the context of the wider SNCF rail operations. All TGV trains are thus electrified at 25KV ac and 1,500V dc to enable the use of all types of rail lines in the SNCF network. In other words, although the HSR lines are completely separate, the TGV trains are designed so they can use the existing rail routes on the final approaches into previously established rail stations. Top commercial speeds for the TGV lines are 199 mph, but under test runs, top speeds up to 320 mph have been reached (Railway Technologies, nd).

2.2.4 Ridership and Fares

The TGV lines are so popular amongst travelers in France that SNCF had to adapt the train carts from “singles” to “double-decks” on the most popular HSR lines, for example the Paris-Lyon line. These double-deck carts can carry up to 1,000 passengers. The TGV’s most popular routes are shown in Table 2.2. As can be seen, the travel time on the longest route, the 482 miles between Paris and Marseille, is 3 hours and 10 minutes. Some of the most popular destinations within the TGV network are: Paris, Rennes, Nantes, Bordeaux, Montpellier, Marseille, Lyon, and Strasbourg (Rail Europe, nd).

Table 2.2: Travel Information for Popular TGV Destinations

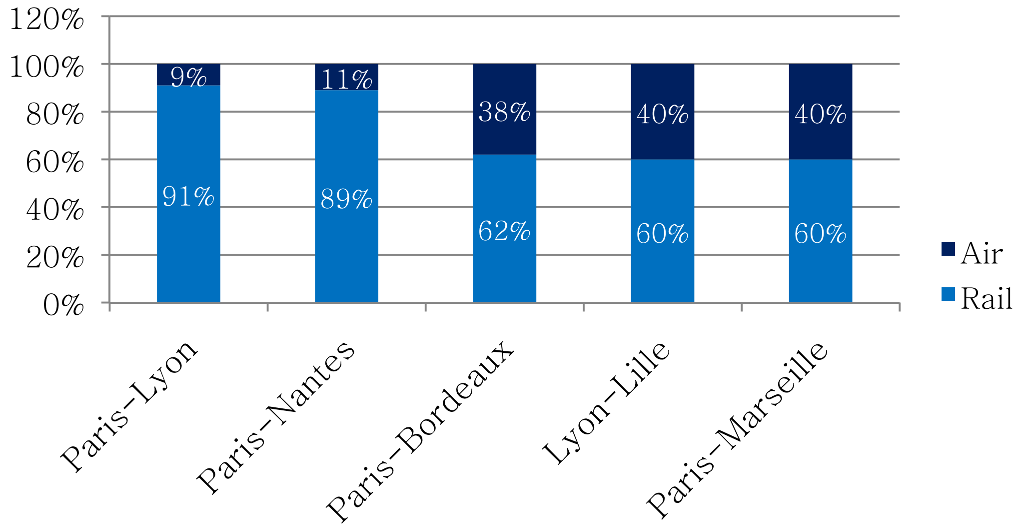
Route	Distance (miles)	Travel Time (hrs)	Fare (US$)
Paris-Lyon	287	1:55	120.98
Paris-Nantes	238	2:00	83.20
Paris-Bordeaux	346	3:00	100.70
Lyon-Lille	423	3:30	145.32
Paris-Marseille	482	3:10	118.92

Note: Exchange Rate Used: $1 = €1.42 (source: www.xe.com/ucc, December 2009)
Source: www.voyages-sncf.com, nd

2.2.5 Market Share

TGV's main competitor is the airline Air France, which is also owned by the French government. Air travel has been impacted since the opening of the first TGV line. To compete with air, rail fares have traditionally been much lower than air fares to compensate for the time advantage air has over rail. TGV fares have been only slightly higher than conventional rail fares in France for political and social reasons (Steer Davies & Gleave, 2003). Numerous governmental constraints on airlines have also hindered the market for low cost airlines. In addition, high gas prices and tolls on inter-city routes make traveling by car over long distances undesirable. Figure 2.3 illustrates the rail share[1] of the rail-air market in specific TGV corridors. As can be seen from the figure, in the Paris-Lyon and Paris-Nantes corridor HSR dominated the market. This high usage of the rail mode has caused the airline provider, Air France, to cease certain flight destinations and for some routes, such as Paris-Brussels, entered into a partnership with Thalys, a cross-border rail operator.

[1] The rail market share for all passenger transportation is 9.6% (2004); 18% for distances of 250 to 370 miles.



Source: Steer Davies & Gleave, 2003

Figure 2.3: Rail-Air Market Share

2.2.6 Project Development

In 1982, the French government passed the *Loi d'Organisation sur les Transports Interieurs* (LOTI) legislation, which states that all large infrastructure projects have to be appraised using the same criteria and that construction costs, direct and indirect social costs, and environmental costs be accounted for. The LOTI legislative framework includes the *Circulaire relative aux modalities d'elaboration des grands projects d'infrastructure ferroviair*[2]*,* which was established in 2000 and describes the process for developing rail infrastructure. Under this process, the infrastructure owner, RFF, is required to conduct the economic evaluation of proposed rail projects (Steer Davies & Gleave, 2003).

The development of a rail project includes the following stages:

- consultation with local governments, businesses, chambers of commerce, etc.;
- preliminary studies to define the main characteristics of the project and evaluates potential alternatives;

[2] The *Circulaire relative aux modalities d'elaboration des grands projects d'infrastructure ferroviair* requires that a project assessment be conducted. The guidelines for a project's assessment are defined in the *Circulaire Idrac*, the official project assessment document for all public projects, and in the *Boiteux* report, an updated general guidance specific to transport projects.

- pre-project summary, an in-depth study on the traffic, environmental and economic aspects of the selected alternative;
- assessment of the public utility. At this stage a funding plan is developed and an assessment of the public benefit is conducted by the region's Prefect. At the conclusion of this stage, the Ministry of Transportation issues a Statement of Public Utility, which includes a socio-economic analysis of the potential impact of the proposed rail project, as well as an outline of the approved funding plan;
- detailed pre-project stage, which includes additional studies to finalize the project's detailed characteristics and financing options[3]; and
- finally, the official agreement is signed and approved by the Ministry of Transportation, permitting the RFF to commence the development of the rail project (Steer Davies & Gleave, 2003).

In France, the implementation of infrastructure projects, such as HSR lines, is simplified by the fact that once the Statement of Public Utility is issued, property is expropriated automatically and land owners have no right to appeal. And although the authorization process involves extensive analysis and consultations with local and regional governments, it usually takes up to one month for medium sized projects and up to 3 months for major projects, such as the TGV Est (Steer Davies & Gleave, 2003).

2.3 ITALY

Italy's first HSR line from Rome to Florence opened in 1991 as a response to the poor conditions on the conventional rail route. Currently, there are five HSR lines in operation in Italy, connecting most of the country's major cities, such as Rome, Florence, Milan, Naples, Bologna, and Turin (see Figure 2.4). Although Italy's elongated shape perhaps makes it easier to provide connectivity between cities, its population is very disperse - i.e., Italy's population density is 517 inhabitants per square mile – resulting in frequent train stops and a reduction in the average high-speed train speed (Steer Davies & Gleave, 2003).

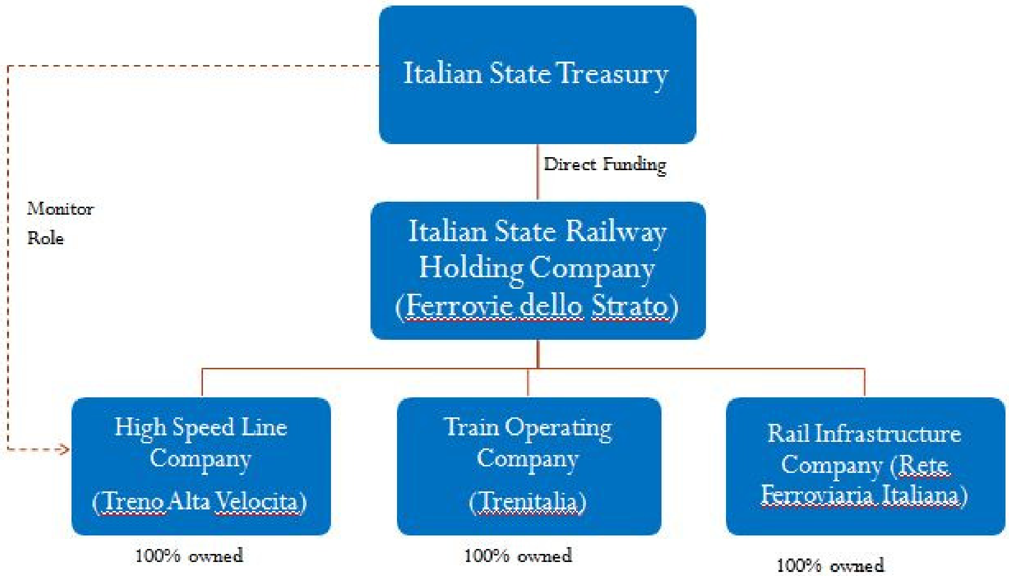
[3] The cost-benefit analysis of a HSR project considers: the net financial outcome of the project; passenger time savings; mode shifts; net losses of other transportation mode operators; impact on tax revenues; and social and economic impacts. Important decision criteria are also the rate of return of the proposed investment - a minimum of 8% is required - and political considerations (Steer Davies & Gleave, 2003).

Source: www.italianrail.com

Figure 2.4: Italian High-Speed Rail Network

2.3.1 Organizational Structure

In 1992, the State railway, *Ferrovie dello Stato* (FS), was converted into a private company with the Ministry of Economy and Finance as the sole shareholder. In accordance with the 1997 EU directive, rail infrastructure and operation was separated into different divisions under the FS Group: *Rete Ferroviaria* (RFI), which manages the existing rail infrastructure, including tracks, stations and installations, and *Trenitalia*, the operating company of both freight and passenger services. Figure 2.5 shows a diagram of the Italian railway organizational structure.



Source: Adapted from Ernst & Young, 2009

Figure 2.5: Organizational Structure

2.3.2 Funding

In 1991, the FS had awarded a 50-year concession to *Treno Alta Velocita* (TAV) - a public (40%) - private (60%) consortium at the time. The concession was to develop, design, finance, and construct a series of HSR lines throughout Italy. In addition, FS awarded construction contracts to general contractors for sections of individual HSR lines. In 1997, FS bought out the private sector shareholders in TAV, resulting in a publicly owned HSR company. Today, TAV is 60% funded through interest free loans from FS and 40% through capital market issues underwritten by explicit government guarantees. Upon completion of the projects, ownership is transferred to RFI, although TAV retains the right to charge a usage fee. RFI in turn charges Trentalia or other train operating companies who use the HSR infrastructure.

According to a report by Standard and Poor, project costs have been estimated at 35 billion euros and in 2004 18 billion euros had been financed as follows: 28% by state funding, 44% by state guaranteed debt and 28% from loan notes. Bonds were issued by Infrastrutture SpA, a financial intermediary created to provide long-term lending to infrastructure projects. Additional funding from the EU was available since the lines are part of the trans-European transport projects.

Revenue sources for high-speed rail projects come from track access charges, rental of commercial space in stations, and state subsidies.

2.3.3 Infrastructure and Operation

In order to minimize land acquisition and environmental costs, the Italian high-speed lines are constructed along existing motorway right-of-way. For some projects this has led to an increase in costs since it has required the additional civil works in the existing highways, accounting to 30% of the project costs.

Rail infrastructure in Italy is fully mixes, meaning that both high-speed and conventional passenger trains, as well as freight trains, can use all rail lines. This type of set-up allows for high-speed trains to use existing conventional tracks to make the final approaches into city centers and allows freight train to use the spare capacity during the night. In order to have access to the infrastructure, train operators enter into contracts with RFI that usually lasts for one year, but longer term contracts are also in place. The track access charges paid by the operators to RFI are forecasted after deducting operating, financing and tax expenses and are recalculated every five years and adjusted for inflation. Any shortfalls due to a reduction in service by an operator would be covered by the state, although the operator is usually subjected to a penalty per contract agreements (Ernst & Young, 2009).

Two types of high-speed trains are used in Italy: tilting and non-tilting. Tilting train technology allows high speed trains to operate on non-straight tracks minimizing the need to build new rail infrastructure and allowing trains to operate at high speeds on existing tracks. When approaching a curve the train tilts to reduce centrifugal force on passengers while being able to maintain its high speed (Memagazine, nd). In Italy, tilting trains were designed to operate on the sinuous route along the coastal area and the mountainous area of the Alpine system (Railway Technology, nd). Table 2.3 provides summary information about the length (distance) and travel time of the various HSR destinations in Italy.

Table 2.3: Distance and Travel Time for Italian HSR Destinations

Line	Length (miles)	Duration
Turin-Milan	93	1 hr
Milan-Bologna	113	1 hr 5 min
Bologna-Florence	48	35 min
Florence-Rome	154	1 hr 20 min
Milan-Rome (non-stop)	315	2 hr 45 min
Milan-Rome	315	3 hr
Rome-Naples	137	1 hr 10 min

Source: Ferrovie dello Stato, nd

2.3.4 Market Share

The market share of HSR in Italy is only 5%. This is largely attributable to the fact that conventional passenger rail on parallel tracks provide a good service at a lower fare than the HSR. The travel time difference between the conventional rail lines and HSR lines is approximately 20 to 30% lower for HSR (Steer Davies & Gleave, 2003). HSR is becoming more competitive as capacity constraints on the conventional lines will shift passengers to the new lines, especially for long distance travel. On the other hand, the emergence of low cost airlines has resulted in competition between rail and air modes.

A new HSR competitor is expected to emerge in 2011 when a new privately owned high-speed train, the Italo, begins operation. Amongst the investors in this billion euro project are the head of Fiat and Ferrari and the French Rail company, SNCF. The company, *Nuovo Transporto Viaggiatori*, is producing a new line of trains, known as *Automotrice Grande Vitesse* (AGV) - an updated version of the French TGV. The fleet of 25 Italo trains will be used on three main lines: Turin-Salerno (with stops in Milan, Bologna, Florence, Rome, and Naples); Venice-Rome (with stops in Padova, Bologna, and Florence); and the Rome-Bari line. The Italo will be mostly constructed from recyclable materials and will consume 15% less energy than current high-speed trains. Fares are anticipated to be competitive with those of Trenitalia (Nuovo Transporto Viaggiatori, nd).

2.3.5 Project Development

The Italian government produces a general transportation plan every five to ten years. This plan, called *Piano Generale dei Transporti e della Logistica* (PGT), sets the guidelines for planning a transportation infrastructure project and lists which projects are to be implemented. If a project is not included in the PGT, it cannot be undertaken. However, the inclusion of a project does not necessarily mean it will be constructed within the plans timeframe. A more detailed plan, specific to rail infrastructure, is also developed by the RFI. This plan, the *Piano Prioritario degli Investimenti* (PPI), includes an evaluation of all rail infrastructure projects, as well as a prioritized list of rail projects. Again, a project's inclusion in this plan, which usually encompasses a period of 5 years, does not automatically guarantee its construction. The implementation of all rail projects is subject to available funding (Steer Davies & Gleave, 2003).

The following guidelines are used to prioritize rail infrastructure[4] projects:

- compliance with safety and legal requirements,
- improve overall efficiency and productivity,
- resolve capacity constraints,
- provide better quality of service,
- benefit the development of the freight network, and
- benefit the underdeveloped southern regions (Steer Davies & Gleave, 2003).

The PGT requires the RFI to consider as many of these criteria as possible. In addition, the RFI also evaluates the financial viability of the proposed rail project and assesses the effects on the overall rail network. It should also be noted that the land expropriation process in Italy is very complicated due to laws that date back to 1865 (Steer Davies & Gleave, 2003).

In 2001 the government passed an Objective Law, which fast-tracks certain infrastructure projects included in the PGT, including HSR projects. This accelerated process allows for a

[4] The Interdepartmental Committee for Economic Planning (CIPE), comprising representatives from the regional governments, conducts an annual review of the PPI and may ask the RFI to perform an economic evaluation of a particular rail project. When requested, the RFI will conduct a cost benefit analysis following the guidelines established by the World Bank, but the appraisal criterion varies from project-to-project (Steer Davies, 2003).

project to be approved, e.g. environmental clearing, route plans and designs, within a period of 15 months. The final approval for an infrastructure project is issued by the Interdepartmental Committee for Economic Planning (CIPE) (Steer Davies & Gleave, 2003).

2.4 KOREA

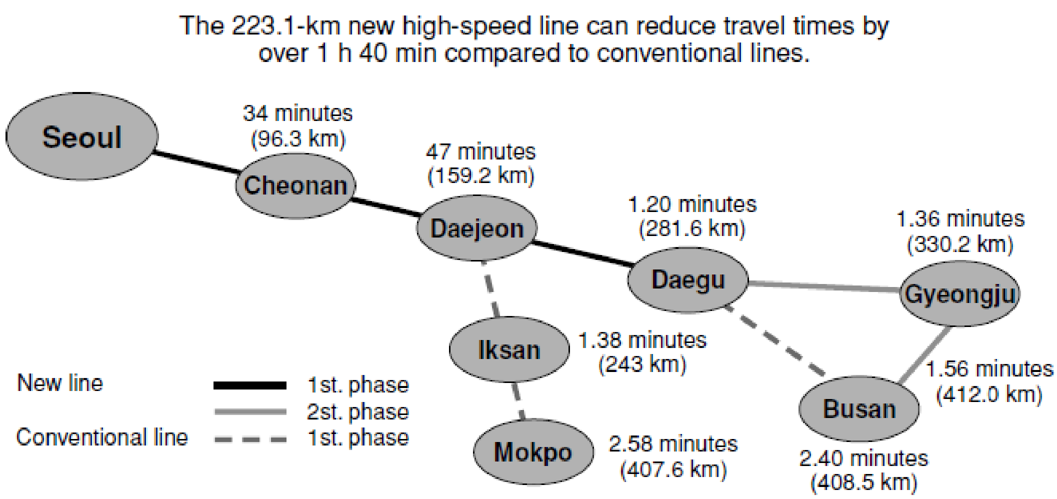
The Republic of Korea or South Korea is located in East Asia and comprises a total area of 37,421 square miles of mostly mountainous topography. The majority of South Korea's 48 million people live near the capital city of Seoul (about 45%), making Seoul one of the most densely populated cities in the world (CIA World Factbook, nd).

Korea's highway network extends 53,997 miles and the railway network encompasses 1,941 miles (see Figure 2.6 for a map of the Korean transportation corridors). The country's two main transportation corridors are the Seoul-Busan corridor, extending southeast from Seoul, and the Seoul-Mokpo corridor, extending southwest from Seoul. Most of the development has occurred and 70% of the population resides in the Seoul-Busan corridor, while the Seoul-Mokpo corridor comprises mainly farming areas.

Source: http://www.lib.utexas.edu/maps/middle_east_and_asia/s_korea_pol_95.jpg

Figure 2.6: Korea's Transportation Corridors

The Korean government began evaluating the feasibility of an HSR line in 1973 in an effort to relieve chronic bottlenecks on the country's highway and railway corridors and to encourage a more even distribution of the population. However, it was not until the early 1990's after the Ministry of Construction and Transport (MOCT) established a special task force to advance the Seoul-Busan HSR line, in cooperation and coordination with other government agencies that a business plan and funding options for the Korean Train Express (KTX) first appeared. An economic downturn in 1997 resulted in the government having to revise its plan by constructing the line between Seoul and Busan using electrified and upgraded conventional lines between Daegu and Busan and a completely new line between Seoul and Daegu - instead of building an entire new HSR line between Seoul and Busan. The revised plan was to be constructed in two phases. The first phase included the electrification of the existing links and constructing new links. The second phase, scheduled for completion by 2010, involves the construction of an entirely new line between Daegu, Gyeongju, and Busan (see Figure 2.7 for a schematic of the KTX route). To maximize the impact of this new HSR line the government decided to include the electrification of the Honam Line (i.e., Daejeon-Mokpo) along the west side of the peninsula in the Phase 1 project, thereby connecting all of the country's main corridors (Shin, 2005).



Source: Chun-Hwan, 2005

Figure 2.7: KTX Route

2.4.1 Organizational Structure

In 2004, following a reform of the railway sector, the Korean National Railway (KNR) was split into two government agencies, separating the infrastructure development of the railways from the operation of the rail lines as a way to promote competiveness and efficiency while securing management accountability. The Korea Rail Network Authority (KR), a government owned corporation, is in charge of the construction and maintenance of the rail infrastructure. The operation and management of commercial services offered to passengers by the KTX and conventional railways were assigned to the Korea Railroad Corporation (KORAIL) - also a government owned corporation. Both of these agencies fall under the MOCT (Shin, 2005).

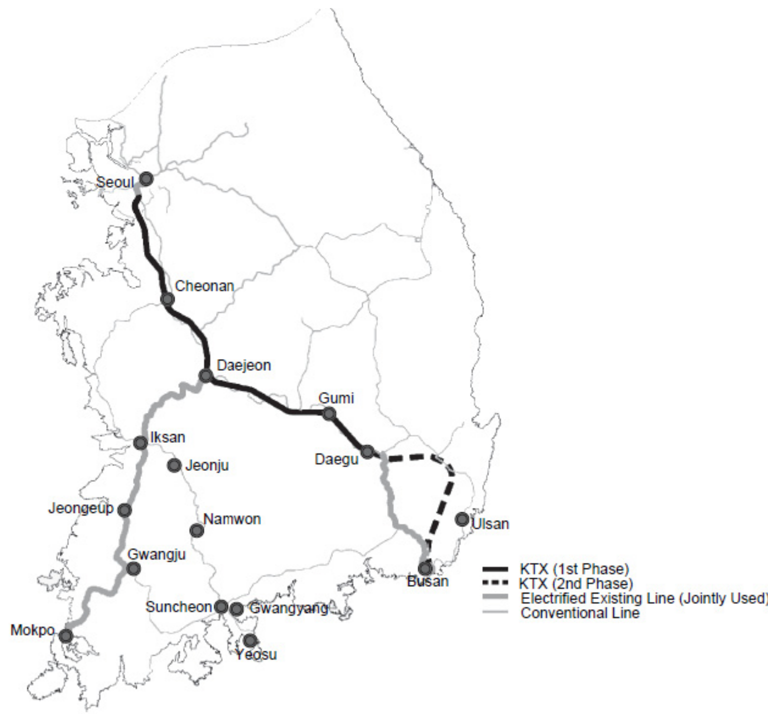
2.4.2 Funding

The costs for developing the first phase of the network were initially estimated at $11 billion, but the actual costs ($17 billion) exceeded the original estimate. The funding for the current network came from two main sources: 45% were obtained from the government (35% contributions and 10% guaranteed loans) and 55% came from the Korea High Speed Rail Construction Authority (KHRC) (24% foreign loans, 29% bonds, and 2% private capital). Loans incurred by the KHRC will be repaid with operating revenues. Funding for the electrification of the Honam Line came entirely from the government (Chun-Hwan, 2005).

2.4.3 Infrastructure and Operation

The KTX began operation in 2004 on the country's two main corridors: Gyeongju (Seoul-Busan) and Honam (Seoul-Mokpo/Yeosu) (see Figure 2.8 below). Due to the country's mountainous terrain, 46% of the Seoul-Busan line was built as tunnels and 26% as bridges. The Seoul-Busan corridor is 255 miles of completely grade-separated rail lines and includes 10 stations. The first three stations are in the Seoul Metropolitan Area and the average distance between stations is 36.6 miles (Shin, 2005).

The Seoul-Mokpo corridor is 253 miles and has 11 stations spaced on average 36 miles apart. This line includes the same stations as the Seoul-Busan line up to Daejon, from where it separates to include the stations in Westdaejon and continues onto Seodaejon, Iksan, Songjongri, Gwangju, and Mokpo stations. This line currently operates on an existing electrified line, but there are plans to build a completely new line in the corridor because of capacity and speed limitations (top speed is only 99-105 mph) on the existing line (Shin, 2005).



Source: Lee and Chang, 2006

Figure 2.8: South Korea's HSR network

All the KTX stations were designed as multi-purpose nodes, comprising two- to eight-story high buildings, with underground and above ground floors. Fully automated systems for reservations, ticket purchasing, and ticket issuing are available at all stations. Travel information centers, providing travel information on all transportation modes, are also available (Chun-Hwan, 2005).

The KTX technology is similar to the French a Grande Vitesse (TGV) technology. The Korea TGV Consortium (KTGVC) was established under the direction of Eurkorail (a partner of Alstom), whose participation in the project consisted of the integration of the rolling stock systems, maintenance, and the electrification of the rail lines. The train sets were built under a technology transfer agreement with Alstom. The first 12 train sets were built in France, while the remaining 46 train sets were built in Korea[5] by Rotem, the local developer (Tome Ariz, 2007).

Each train is 1,270 feet long and has 20 carriages, including two motor cars, two powered passenger carriages, and 16 passenger cars. Each train can carry up to 935 passengers per trip. The train sets include advance safety features, such as triple friction, regenerative and rheostatic braking, and an integral fire alarm system. The maximum operational speed is 185 mph, which can be achieved in 6 minutes and 8 seconds. The average speed traveled between Seoul and Busan is 118 mph. Another innovative feature of the KTX system is the heating of the overhead catenary wires to prevent the formation of ice. The latter is a major cause of service disruption in other HSR systems around the world (Railway Technology, nd).

2.4.4 Ridership and Fares

Tables 2.4 and 2.5 compare the travel time and fares of the Gyeongbu and Honam lines, respectively, with the two conventional rail lines. On average, the KTX fare is 1.3 times that of the conventional express trains, but travel time savings range from 45 minutes to 2 hours and 45 minutes.

Table 2.4: Gyeongbu Line: Comparison between KTX and Conventional Rail

		KTX			Saemaul			Mugunghwa		
			Fares (US$)			Fares (US$)			Fares (US$)	
Depart	Arrive	Travel Time	Week-days	Week-ends	Travel Time	Week-days	Week-ends	Travel Time	Week-days	Week-ends
Seoul	Cheonanasan	0:39	11.00	11.78	-	-	-	-	-	-
Seoul	Daejeon	1:00	18.53	19.83	1:47	12.90	13.42	2:10	8.66	9.09
Seoul	Dongdaegu	1:50	33.26	35.60	3:34	25.20	26.33	4:10	16.97	17.75
Seoul	Miryang	2:21	37.24	39.84	4:08	29.45	30.75	4:52	19.75	20.70
Seoul	Busan	3:00	41.48	44.34	4:48	34.04	35.60	5:45	22.95	23.99

Source: Korea Public Transportation Guide, 2009

[5] A new prototype of HSR vehicle is currently being tested in Korea for stability and reliability. This new design, named KTX-II, reaches a maximum speed of 217 mph. The latter is because of the 15% less drag compared to the KTX due to its aerodynamic train nose design and the use of aluminum alloy to reduce weight. With the KTX-II, Korea will be the fourth country, after Japan, France, and Germany, to have its own technology to build a high-speed train with a maximum operational speed of 205 mph (Chin, 2005).

Table 2.5: Honam Line: Comparison between KTX and Conventional Rail

Depart	Arrive	KTX			Saemaul			Mugunghwa		
		Travel Time	Fares (US$)		Travel Time	Fares (US$)		Travel Time	Fares (US$)	
			Week-days	Week-ends		Week-days	Week-ends		Week-days	Week-ends
Yongsan	Seodaejeon	1:00	18.36	19.66	1:46	12.73	13.25	2:12	8.49	8.92
Yongsan	Iksan	1:56	23.99	25.64	2:51	19.05	19.92	3:18	12.82	13.42
Yongsan	Songjeongri	2:48	30.31	32.48	3:48	26.59	27.80	4:27	17.84	18.62
Yongsan	Gwangju	3:07	31.09	33.26	4:07	27.45	28.67	4:35	18.53	19.31
Yongsan	Mokpo	3:27	35.08	37.50	4:38	31.70	33.17	5:29	21.31	22.26

Source: Korea Public Transportation Guide, 2009

The KTX fares were based on market studies conducted and considered public opinions expressed during public hearings. The fare structure favors long distance travel with decreasing rates given increasing distance. In contrast, the fare for conventional rail service is proportional to the distance traveled. The KTX fares are approximately 62% of the competing airfares. Table 2.6 provides a comparison between the KTX fares and airfares (Chun-Hwan, 2005).

Table 2.6: Comparison Between KTX fares and Airfares(US$)

Section	KTX		Air	Ratio (%)
	Business	Economy		
Seoul-Daegu	42.08	30.03	53.36	56%
Seoul-Busan	54.23	38.73	60.67	64%
Seoul-Gwangju	44.06	31.50	53.79	58%
Seoul-Mokpo	50.08	35.63	58.43	61%

Source: Chun-Hwan, 2005.

In an attempt to attract more passengers, KORAIL has implemented several discount programs, such as pass discounts of up to 60% for a 30 day pass, reservation discounts from 3.5% to 20%; commuter pass discounts of 15% to 30%, and group discounts of up to 10% for groups of 10 people or more (Chun Hwan, 2005).

On average 70,000 passengers were using the KTX per day after the first three months of operation. Although this number is 46.4% lower than the ridership forecasted by the Korea Transport Institute, ridership has been steadily rising. After the first year of operation, the daily passenger ridership increased to 105,000 passengers per day. Lee and Chang (2006) concluded that this increase in ridership was mainly due to adjustments in the operational schedule, increased service frequency, and a reduction in KTX fares on existing rail links.

Corridor statistics show that more than 80% of the passengers travel on the Seoul-Busan corridor, which concurs with the development in the corridor. On the other hand, the land use surrounding the Seoul-Mokpo corridor constitutes mainly farm land. In addition, the latter corridor has a more competitive highway bus system that provides service parallel to the KTX. Although the KTX accounts for 34% of the total passengers using the national mainline rail network, its revenues account for 66% of the total income. To date, the KTX has earned $3.35 billion in revenue (Seo, 2009).

The users of the KTX lines are mainly company workers (74%) and self-employed (13.2%) workers. Most of the KTX passengers are young professional males with a high educational background. Weekday travels are mostly for business purposes (58.3%) and weekend trips are mostly for private purposes (67.7%). More than 50% of the KTX passengers were previous conventional rail passengers, 19% were previous air travelers, 13% used their private vehicles before, and 12.9% used the intercity express bus service before. Passengers reach the KTX stations via subway (49.6%), bus (13.9%), taxi (21.1%), and private vehicle (12.7%) (Shin, 2005).

The opening of the KTX has reduced travel times significantly and now 70% of the nation is within a 3 hour distance of the rest of the country. The KTX has also extended the commuting radius around Seoul to around 93 to 124 miles, because it only takes 34 minutes to travel from Seoul to Cheonan and 49 minutes to Daejeon (Chul, 2007).

2.4.5 Market Shares

The mode shares for passenger travel in Korea is divided between roads (55.9%), railway (20.6%), subway (17.4%), air (5.6%), and maritime (0.4%). As for freight movement the total cargo transport (in tons) is divided between roads (70.7%), maritime (21.8%) railway (7.4%), and air (0.1%).

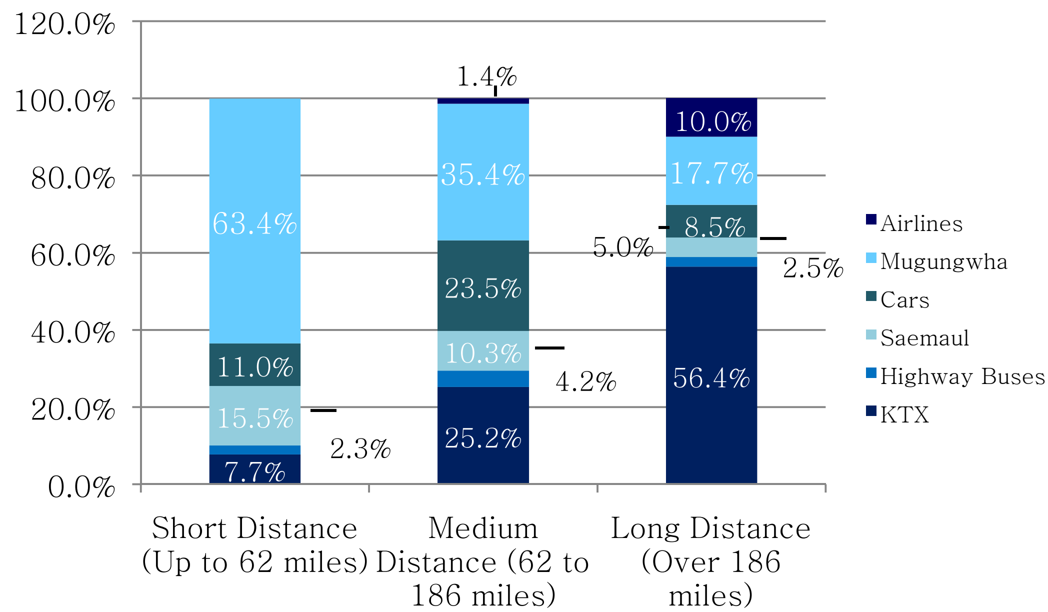
The KTX has significantly increased the transportation capacity in Korea and is serving an increasing share of the nation's medium- and long-distance traffic market. The latter has negatively impacted other transportation modes, such as air, express bus, and conventional rail. In anticipation of a reduction in travelers, the airlines reduced flight frequencies between the cities of Seoul and Busan, Daegu, Mokpo, and Gwangju. According to Chun-Hwan (2005), the daily number of airline passengers on the KTX corridor dropped from 21,341 before the opening of the KTX to 10,934 passengers after the opening of the KTX. Express bus services also saw a decline in its long distance passenger market with passenger decreases of 20% to 30%. However, short distance passengers increased by about 20% (Lee and Chang, 2006). Table 2.7 provides the modal market share in the Seoul-Busan corridor.

Table 2.7: Modal Share Between Seoul and Busan

Section	Classification	Car	Bus	Air	Rail				Total
					Total	KTX	Saemaul	Mugungwha	
Seoul-Busan	Passengers	3,082	1,912	6,837	22,666	20,768	814	1,084	34,497
	Share (%)	8.9	5.5	19.8	65.7	60.2	2.4	3.1	100

Source: Chul, 2007

Overall, demand for KTX has increased 39% on the Seoul-Busan corridor and 12% on the Seoul-Mokpo corridor. Figure 2.9 illustrates the modal market shares as a function of the distances traveled. HSR has proven to be more competitive for medium (i.e., 60 to 185 miles) to long (i.e., more than 185 miles) distance trips. For short distances (i.e., less than 60 miles) the dominant modes are private vehicles, express buses, and conventional rail (Lee and Chang, 2006).



Source: Chul, 2007.

Figure 2.9: Mode Share by Distance Traveled

2.4.6 Concerns

Initially the KTX experienced minor delays and technical difficulties mainly due to the fact that it operates on some sections of conventional rail lines. This was quickly corrected with an adjustment to the train timetable. In addition, the most frequently raised concerns by passengers include the fixed reverse-direction seating and insufficient legroom in economy class. A newer model of the KTX train will have rotational seats. Finally, passengers have also raised concerns about the difficulty to access the KTX stations and inconvenient connections between KTX stations and other transportation terminals. In general though, passengers viewed the KTX as a satisfactory transportation mode with a 97% record of punctuality defined as service within 10 minutes of on-time service (Chun-Hwan, 2005).

2.4.7 Future of KTX

Korea is continuing to expand its HSR system with the construction of the second phase of the Gyeongbu line, which will result in the complete separation of the KTX from conventional lines. When completed, passenger transportation capacity is expected to increase 3.4 times the original projections for 2003. Currently more than 90% of the freight moved in the Seoul-Busan corridor is by truck. The completion of phase two will thus also increase rail cargo capacity substantially (Shin, 2005).

The KR has also recently begun the construction of the new southwest line linking Osong and Mokpo. The government is investing $9.8 billion in this new KTX line with the objective to promote development in this region. The first 113 miles to Gwangju is scheduled to open in 2014 and the second section between Gwangju and Mokpo is scheduled for completion in 2017 (Asiaone, 2007).

2.5 SPAIN

Located in the Iberian Peninsula, Spain occupies an area of 195,364 square miles, (approximately 75% of the size of Texas) and has a population of about 46.7 million (almost double the Texas population of 24.3 million). Spain's terrain is largely dominated by mountain ranges, high plateaus, and rivers. Spain is connected by an extensive road system of which more than 2,485 miles are tolled. Madrid, the capital city, is located in the center of Spain. It is the country's largest city with a population of 6.3 million in the greater metropolitan area. Other major cities, such as Barcelona and Seville, are located approximately 250 to 375 miles from Madrid - an attractive distance for HSR services. These major cities are all densely populated with very low population densities between the major cities. The latter makes HSR construction easier, although the terrain is very mountainous (Steer Davies & Gleave, 2003).

The first HSR line in Spain, or AVE as it is commonly known, opened in 1992 connecting the capital city of Madrid to the southern city of Seville. The Spanish government chose this route over the most obvious one - connecting Madrid and the second largest Spanish city, Barcelona - because Seville was hosting the World Expo in 1992. According to a study by Steer Davies and Gleave (2003), there is no evidence that an economic appraisal was done to justify this decision as has been the case for newer projects. The Madrid-Seville HSR line has, however, been successful since it opened for service. Travel times were reduced by 60% from the conventional rail line and 99.8% of the trains arrive within three minutes of the scheduled arrival time (Steer Davies & Gleave, 2003).

Figure 2.10 illustrates the current HSR network in Spain as well as the lines that are currently under construction and in the planning stages. The Spanish government plans to increase its network from its current 988 miles to 6,125 miles by 2020 (RENFE, 2010). The 293 mile line from Madrid to Seville also provides services to Ciudad Real, Puerto Llano, and Cordoba. This has greatly influenced the development of these small to medium size cities. In the case of Ciudad Real, the smallest of the three Spanish cities, there are 10 daily HSR train stops each way. This has resulted in Ciudad Real's population increasing by 15% due to its now closer proximity to Madrid. An HSR trip by AVE to Madrid takes less than 50 minutes, making Ciudad Real practically another borough of Madrid (Roncero, 2009).

Source: RENFE, 2010

Figure 2.10: Spain's Rail Network

2.5.1 Organizational Structure

Red Nacional de los Ferrocarriles Españoles (RENFE), a state-owned company, is the national rail passenger operator and the main freight operator. *Administrador de Infraestructuras Ferroviarias* (ADIF), another state-owned company, is in charge of the construction and maintenance of the rail infrastructure. Prior to the EU legislation that required that rail infrastructure and operations be separated, RENFE was also responsible for the construction and maintenance of the rail infrastructure. A third state-owned company, *Gestor de Infraestructuras Ferroviarias* (GIF), is responsible for the development of the HSR lines, but once the new rail infrastructure is constructed, responsibility is passed to ADIF (Steer Davies and Gleave, 2003).

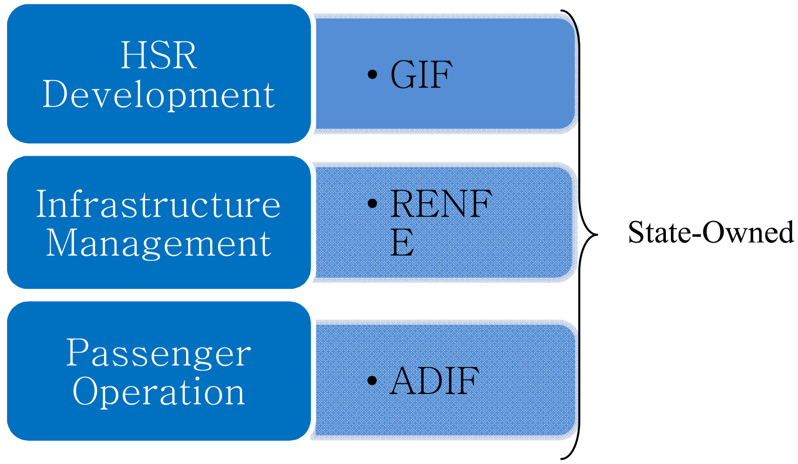
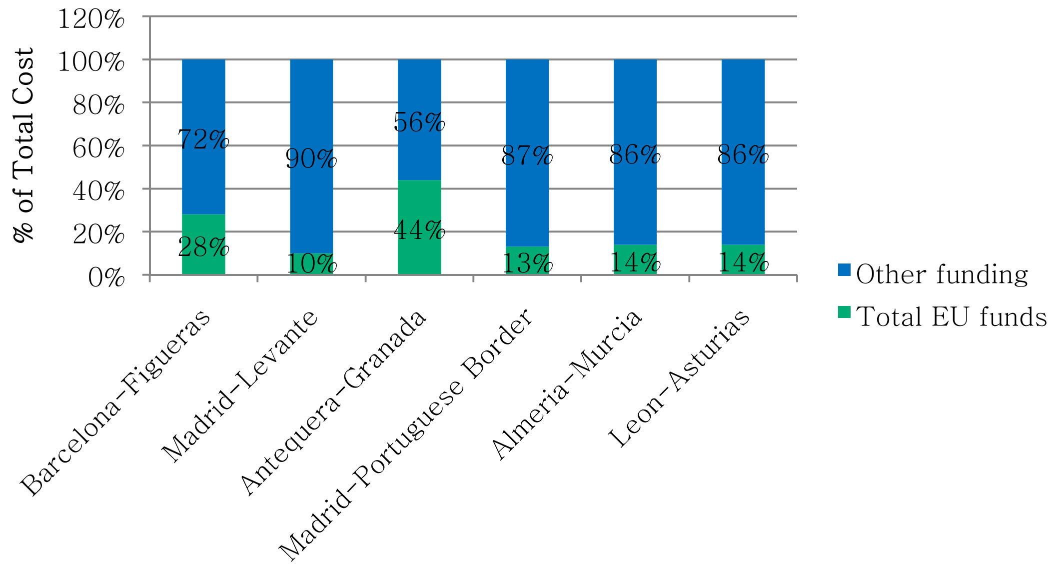


Figure 2.11: Spain's HSR Rail Organizational Structure

2.5.2 Funding

The majority of the funds for the development of high-speed lines in Spain have from the national government and the European. There is great support at both the national and regional government levels for the development of HSR in Spain, up to 2008 the investment committed was approximately $32 billion for the 988 miles of HSR in operation and 820 miles under construction; this amount does not take into account the investment on the Madrid-Seville line. A significant portion of this investment has come from various sources of EU funding, such as the Trans-European Network (TEN-T) funds, Cohesion funds and European Regional Development Funds (ERDF) (Ernst & Young, 2009). A detailed explanation of these funding sources is covered in Chapter 3. In addition, the EIB granted a $265 billion loan to help construct the Madrid-Barcelona line. It is planned that funding for future expansions will come from the national government, local governments, ADIF, and loans from the European Investment Bank (EIB). Funding for international HSR networks could potentially come from the European Union (GAO, 2009).

Figure 2.12 shows the percentage of EU funding received for specific HSR projects in Spain. The Spanish government's commitment to the expansion of its HSR network on its long term plan is demonstrated by its allocation of $160 billion of its 330 billion 2020 budget plan to rail. According to RENFE this accounts for an investment in transport infrastructure of 1.8% of the GDP per year until the year 2020 (RENFE, 2010).



Source: Ernst & Young, 2009

Figure 2.12: Funding sources distribution for specific Spanish HSR projects

2.5.3 Infrastructure and Operation

The conventional railways in Spain use an Iberian standard gauge (1.688mm), and to allow for the usage of available rolling stock technology and to connect to the wider European rail network, the Spanish railway authority decided to construct the new HSR line in the standard gauge (1.434mm) (Railway Technology, nd).

Initially, the rolling stock technology adopted was that of the French Alstom TGV, but currently Siemens Velaro ICE (Germany) trains and trains produced from a joint venture between Bombardier (France) and CAF and Talgo (both from Spain) are also used. RENFE requires that the width of the train wheel can be altered to operate on Iberian standard gauge.

Table 2.8 provides the length, the year it opened, and the top speeds of the Spanish HSR lines currently in operation. RENFE offers three types of services: long-distance (AVE), long-distance/dual gauge (ALVIA) and, medium-distance (AVANT). The average distance covered by the AVE services is 345 miles at speeds between 186 and 218 mph. These are commercial services, run only on high-speed infrastructure and do not receive government subsidies. The ALVIA services operate in dual gauge, using the new high-speed tracks and conventional lines being able to cover longer distances (average distance 354 miles) than the AVE because of its used of the conventional lines. ALVIA trains travel at a speed slightly lower than AVE trains, from 124 to 155 mph and offers services to 64 cities; at present, AVE trains serve 19 cities. These are also commercial services but not all are profitable having the need for 'temporary' government subsidies until all lines are completely connected to high-speed; as a whole they are profitable. AVANT services are public services that are subsidized by the government and are mostly used as a commuter rail with an average trip distance of 96 miles at a speed of 155 mph. The average amount of subsidies per year is $40 million (RENFE, 2010).

Table 2.8: Characteristics of Spanish HSR lines

HSR Line	Length (Miles)	Year Opened	Top Speed (mph)
Madrid – Seville	259	1992	168
Madrid – Lleida	322	2003	186
Zaragoza – Huesca	49	2003	124
Madrid (La Sagra) – Toledo	13	2005	155
Córdoba – Antequera	62	2006	186
Lleida – Camp de Tarragona	51	2006	186
Madrid – Segovia – Valladolid	111	2007	186
Antequera – Málaga	34	2007	186
Camp de Tarragona – Barcelona	55	2008	186
Bypass Madrid	3	2009	124

Source: International Union of Railways, 2009

The Spanish government is committed to provide HSR connections to all regional capitals within four hours of Madrid and six hours of Barcelona, thereby potentially reducing travel times by up to 70% compared to the existing rail travel times. In 2007, ADIF proposed in its strategic plan that by the year 2020 it would build almost 5,600 miles of new HSR lines, putting 90% of Spain's population within 31 miles of a station (Railway Technology, nd) and 50% with a high-speed station in their city; currently only 40% of the population is within 31 miles of a high-speed station (RENFE, 2010).

2.5.4 Ridership and Fares

According to an article by *Comunicaciones Ferroviarias* (2009), RENFE reported that the Madrid-Barcelona HSR line transported 2.3 million passengers in its first year of service - a 206% increase in rail passengers when compared to the number of passengers transported by conventional rail before the AVE initiated operation. The complete corridor, which also includes stops in Zaragoza, Lerida and Tarragona in addition to Madrid and Barcelona, transported a total of 5.8 million passengers in 2008. On average, the occupancy rate of the AVE trains was 63% in 2008 and 89.5% in the most saturated routes (Diario Cordoba, 2009). For the complete AVE and long distance network, RENFE reported transporting 23.13 million passengers in 2009, a 0.6% decrease than in 2008 (Revista 80 dias).

Table 2.9 illustrates the different destination services provided by the AVE and travel time. For example, a passenger traveling from Madrid to Barcelona can choose a more direct service, only stopping in Zaragoza, for a total trip time of less than 3 hours or a service that takes 3 hours and 24 minutes with multiples stops.

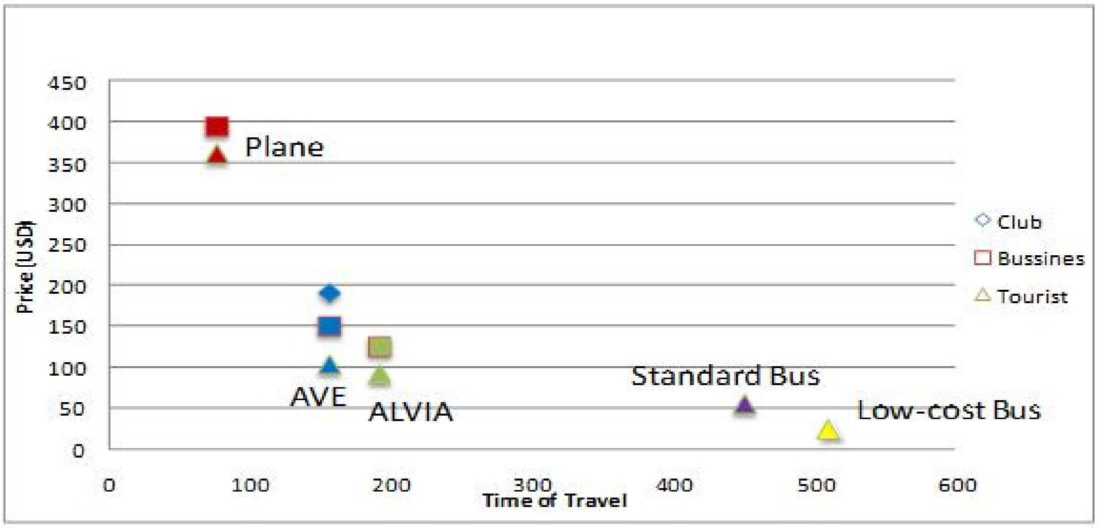
Table 2.9: AVE Time Travel Information

HSR Line/Stops	Total Trip Time
Madrid – Zaragoza – Barcelona	2 hr 57 min
Madrid – Calatayud – Zaragoza – Lleida – Camp Tarragona - Barcelona	3 hr 24 min
Madrid – Ciudad Real – Puerto Llano – Cordoba – Sevilla	2 hr 35 min
Madrid – Ciudad Real – Puerto Llano – Cordoba – Puente Genil Herrera – Antequera Sta Ana – Malaga	2 hr 55 min
Madrid – Segovia – Valladolid	1 hr 10 min
Madrid (Atocha) – Guadalajara Yebes – Calatayud – Zaragoza Delicias – Tardiente – Huesca	2 hr 15 min
Barcelona – Camp Tarragona – Lleida – Zaragoza Delicias – Ciudad Real – Puerto Llano – Cordoba Central – Sevilla	5 hr 37 min
Barcelona – Camp Tarragona – Lleida – Zaragoza Delicias – Cordoba Central – Puente Genil-Herrera – Antequera Sta Ana – Malaga	5 hr 45 min

Source: RENFE, 2009

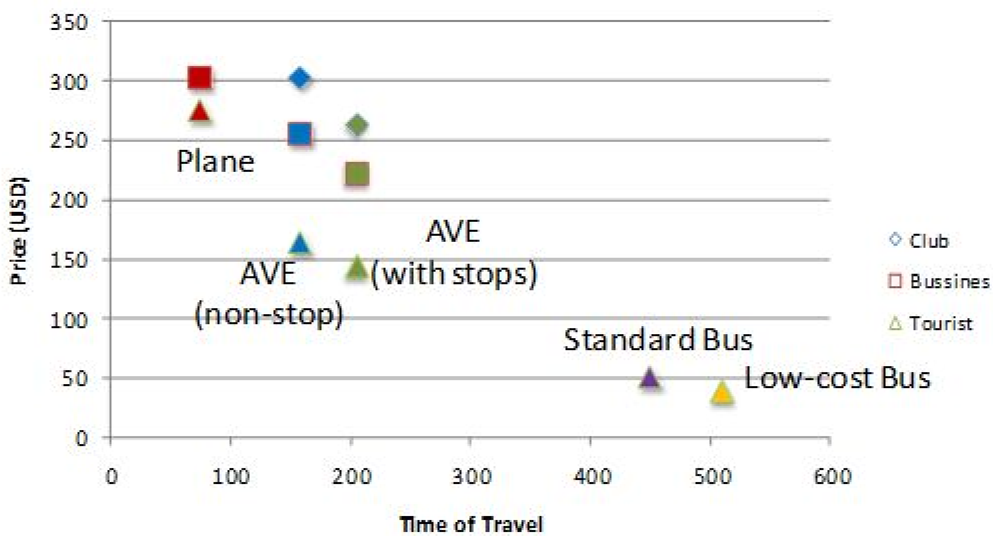
Figure 2.13 shows a comparison of the average prices and the travel times for each mode for a one-way trip from Madrid to Seville, 293 miles apart. From the figure it can be seen that for the Madrid-Seville trip the AVE is very competitive with the airplane in terms of prices offering a Club ticket, the highest class, for half the price of an airline business class the time of travel difference between these modes is 80 minutes, but it should be noted that the AVE provides services from city center to city center. On the other hand, airports in Spain are miles away from the city and require that passengers be at the airport at least one hour before flight departure.

Figure 2.14 shows the same comparison for a trip from Madrid to Barcelona, 390 miles apart. For this trip the prices for an airline ticket and an AVE ticket are closer together for the higher class AVE services. For the basic tourist class both the services with stops and non-stop for the AVE are much more competitive. The travel time difference between the two modes is 83 minutes for the case of non-stop travel on the AVE and 128 minutes for the services with additional stops. Again, it should be noted that AVE trips are from city center to city center unlike airplane trips which require additional travel times to get to and from the airport.



Source: RENFE, 2010

Figure 2.13: Price Comparison between modes for Madrid-Seville trip



Source: RENFE, 2010

Figure 2.14: Price Comparison between modes for Madrid-Barcelona trip

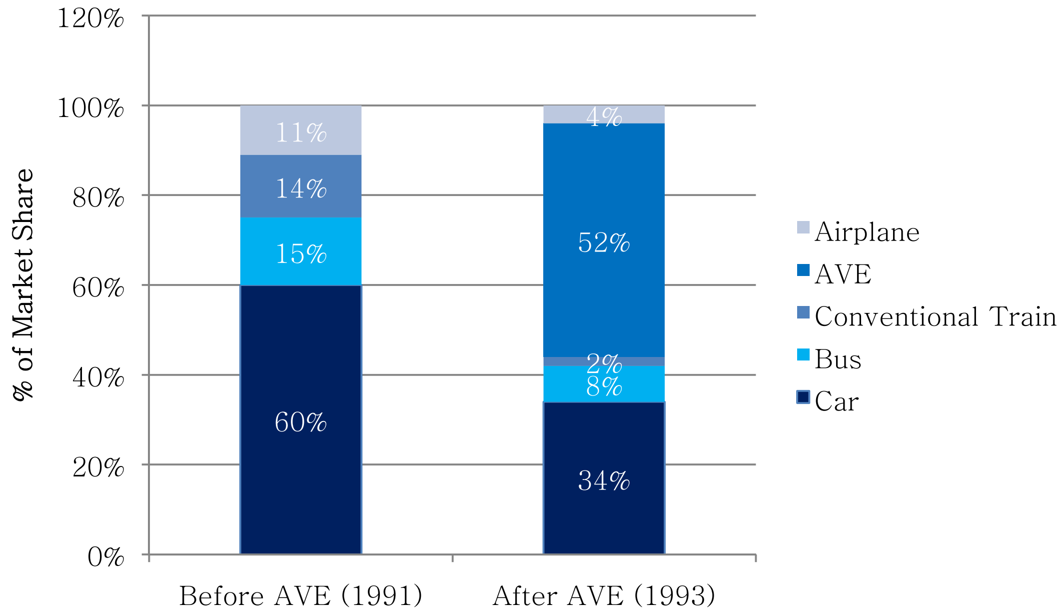
In an effort to provide more competitive fares, RENFE announced in 2009 a new discount fare program where passengers would be able to purchase HSR train tickets at a 50% discount when bought 24 hours prior to the trip. Also, travelers can obtain up to 60% discount on regular HSR fares and 40% discount on premium HSR fares when bought through the internet (Diario Cordoba).

2.5.5 Market Share

Historically, Spain's rail market share has been lower than in most EU member states, largely because of the poor quality of its conventional rail network. Before HSR, conventional rail only accounted for 4.8% of domestic trips and 5.2% of domestic passenger kilometers, while bus service was more than twice this level and sometimes provided better travel times than rail. For example, a trip from Madrid to Barcelona 387 miles away used to take 7 hours by the conventional train compared to 8 hours by bus (ALSA, nd). An extensive long distance bus system and well-developed domestic air network thus compete with rail services. Currently, the modal market share[6] is 65% private vehicles, 32% rail (i.e., both HSR and conventional rail), and 3% domestic air travel (INE, 2009)

When the Madrid-Seville line open in 1992 the Spanish airline, Iberia, was under state control. This allowed RENFE to enter into a competition agreement with the airline taking a significant amount of its market share for that route (Ernst and Young, 2009). This HSR dominance over the Madrid-Seville market is shown in Figure 2.15, where it can be seen that a year after the AVE line opened it completely dominated the market gaining more than half of the shares. It is calculated that, within a year, airlines lost a fifth of their domestic passengers and long-distance rail gained almost one third; however this may change now that the airlines have been deregulated and competition from low cost airlines will be possible (Ernst & Young, 2009).

[6] The Spanish National Statistics Bureau, INE, did not report modal market share information for buses.



Source: RENFE, 2010

Figure 2.15: Mode Share after opening of Madrid-Seville AVE line

2.5.6 Project Development

The development of an HSR line starts with an analysis by the *Ministerio de Fomento* (Public Works) to determine where the investment will yield the highest value. This is followed by a more detailed study by the *Ministerio de Fomento* and GIF on how the operations should be delivered. An economic analysis is also conducted for each project. This analysis follows the guidelines established by the European Commission Directorate General for Regional Policy since a large share of the funding is typically EU regional development funds. Value of time is not specified in the guidelines and can vary between projects. HSR project assessments also include financial and multi-criteria analyses (Steer Davies and Gleave, 2003). According to the Steer Davies and Gleave study (2003), shadow prices and conversion factors are used extensively in the project assessments, following the guidance of the European Commission. However, economic assessments are only conducted as a means to prioritize projects rather than to determine if the project should be implemented.

2.6 GERMANY

Germany, located in Central Europe, comprises an area of 137,847 square miles and has a population density of 596 people per square mile. Germany's topography ranges from very mountainous in the south to the plains of the north (CIA World Factbook, nd).

The German high-speed train, known as ICE, operates mostly on conventional rail infrastructure. It provides services in Switzerland, Belgium, and the Netherlands. The French Thalys also operates in Germany, but not on HSR infrastructure. The German HSR lines were first included in the country's federal transportation plans, i.e., *Bundesverkehrswegeplan* (BVWP), in 1973 in response to the increasing congestion levels on the then existing rail network. By the next BVWP in 1985, the objective changed to making rail competitive with other modes. This was not only to be achieved with an increase in speed, but the government also wanted to improve the quality of rail service (Steer Davies and Gleave, 2003).

The first HSR lines were constructed to accommodate conventional trains, as well as freight trains. This increased construction costs because gradients had to be limited and passing lines constructed. For these reasons, the HSR lines were also designed for a lower speed than what is typical for other European HSR lines. Newer HSR lines have, however, been constructed exclusively for the use of HSR trains operating at speeds up to 186 mph. Another factor that contributed to the higher costs of implementing HSR in Germany was the fact that more extensive environmental mitigation measures have been adopted (Steer Davies and Gleave, 2003).

2.6.1 Organizational Structure

The operation of passenger and freight trains and the maintenance of the rail infrastructure are headed by the *Deutsch Bahn* (DB), a private joint stock company, established in 1994 by joining the state owned *Deutsch Bundesbahn* of West Germany and *Deutsch Rieschbahn* of East Germany. Within the DB, various divisions – i.e., *DB Bahn*, *DB Netze*, and *DB Schenker* – are in charge of different rail service aspects. DB Bahn manages rail passenger travel within Germany, including ticketing, servicing, and running all German intercity rail travel and international rail travel services. DB Netze is responsible for the rail infrastructure, including construction and maintenance. DB Schenker is the freight division. Some private operators have concessions to provide local and regional freight services (Deutsch Bahn, nd). Figure 2.16 shows a schematic of the German railway organizational structure. In 2008 the DB was supposed to change from private joint stock to public stock but this was been delayed due to the market conditions. At present the DB still remains under state control (Ernst & Young, 2009).

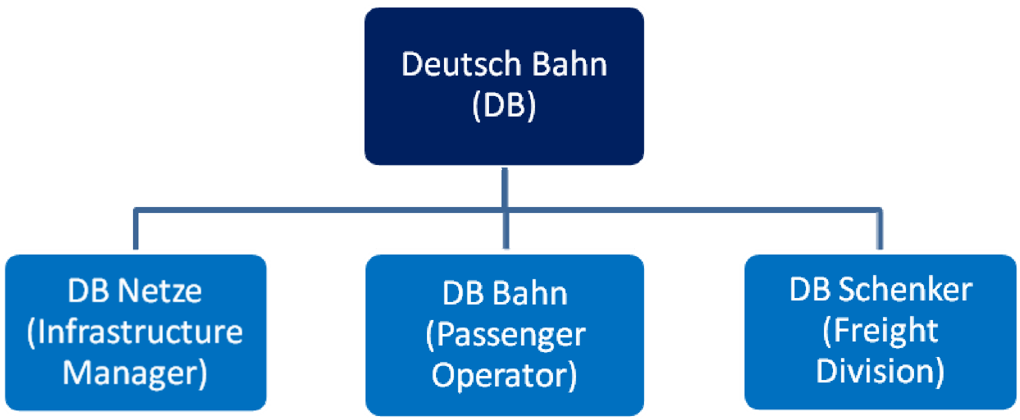


Figure 2.16: Germany's Railway Organizational Structure

2.6.2 Infrastructure and Operations

When development of the ICE system started Germany decided to establish a fully integrated system where high-speed and conventional trains, as well as freight trains would run on the same track and new ICE lines would maintaining the same speed standards, voltage capacity and signaling as conventional lines, unlike in the rest of Europe. The reason for doing this was because of Germany's low population density and separating high-speed lines would increase the construction costs since too many new lines would have to be constructed in order to provide good connectivity between its dispersed regions.

Although complete integration of rail services may have reduced construction costs mixing traffic has proofed to be difficult since there are large speed differences between freight and passenger services requiring. Time slotting has also been very challenging since the night time slots for freight traffic cannot always be allocated since high-speed services required high level of maintenance on the tracks that can only be conducted at night to not disrupt services. There are currently 10 ICE lines in operation that operates at speeds varying from 99mph to 186mph (see Figure 2.17). It should be noted that HSR lines typically do not enter city centers (Railway Technology, nd).

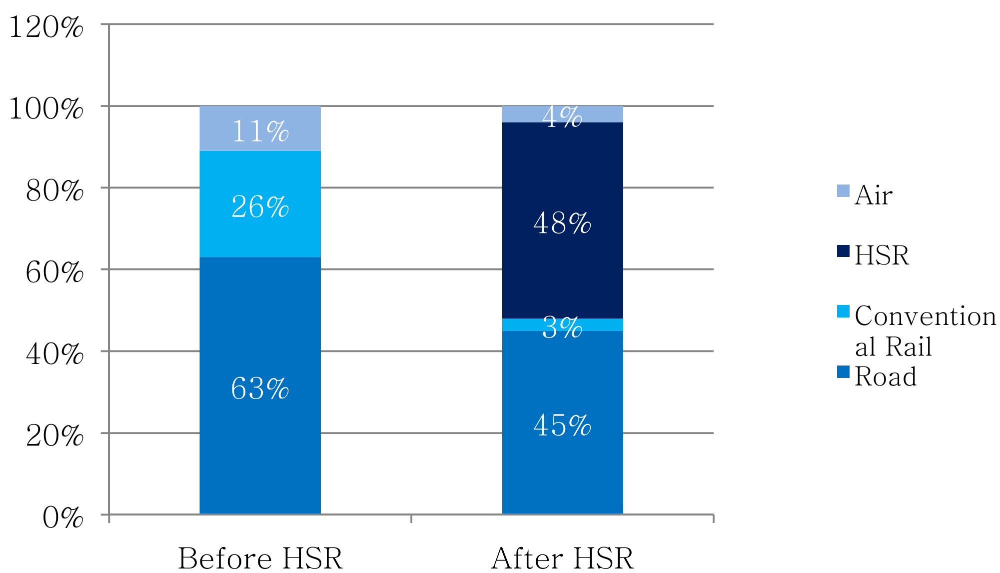
Note: Lines shown in purple operate at high speeds.
Source:http://international.uiowa.edu/studybroad/students/prospective/destination/germany/travel.asp

Figure 2.17: Germany's ICE lines

Although Germany is very populated, German cities tend to be small. Only Berlin has a population of over 3 million people, followed by Hamburg with 1.7 million people, and Munich with 1.3 million people. The German population is thus dispersed, necessitating rail passenger services to make frequent stops. On average, a train going from Hamburg to Munich makes at least seven stops along the way. Trains going from Frankfurt to Berlin, 343 miles away, typically make eight stops along the way for a total trip time of 4 hours and 8 minutes at a cost of US$166. A trip from Hamburg to Frankfurt, 496 miles away, will take 3 hours and 36 minutes with three stops along the way and cost US$160. On average, there are seven stops along each line (Deutsch Bahn, nd).

2.6.3 Market Share

Conventional rail lines offer a good, reliable service but disperse populations and a mountainous terrain requires frequent stops and trains to operate at lower speeds, resulting in longer travel times and passengers choosing other types of transport modes. The ICE has been successful in diverting passengers from other modes. Figure 2.18 shows an example of the ICE's success on the Frankfurt-Hamburg corridor, where the mode shifts caused by its inception is highly noticeable. From the figure it can be seen that when high-speed services were introduced in this corridors it gain passengers from all modes not only conventional rail, which it almost eliminated. In regards to air and rail competition, the ICE has been very successful in some corridors as is exemplified in the cancellation of Lufthansa's domestic route between Frankfurt and Cologne (Ernst & Young, 2009). The DB reported transporting 1.7 billion rail passengers in 2004 (Sang Lee, 2007).



Source: BBVA Report, 2009

Figure 2.18: Germany's ICE Market Shares for the Frankfurt-Hamburg corridor

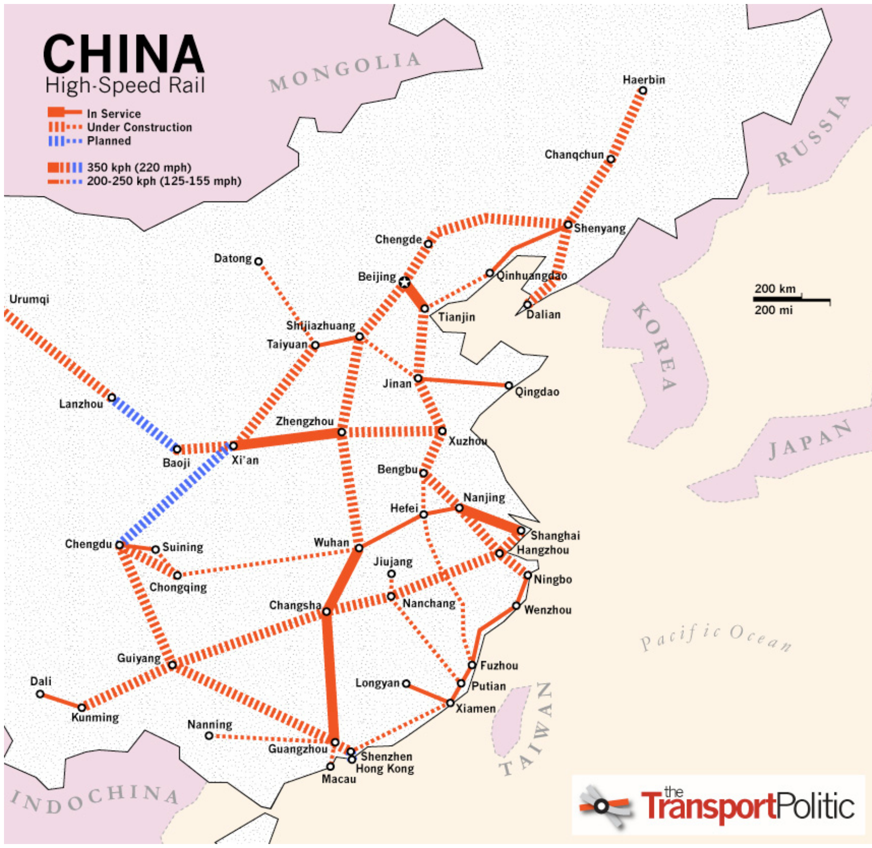
2.6.4 Project Development

Once an infrastructure project is included in the BVWP, and after consultation with the regional and local governments, the project needs to be included in the *Bundesschienenausbaugesetz,* the Federal Construction Plan Law. Following the approval of this law, the DB proceeds to apply for planning and construction permission from the *Eisenbahnbundesamt* (EBA), the federal railway office and rail regulator, who also determines whether the financial agreement between the government and DB is reasonable. At this stage, opponents to the project can appeal it in the courts (Steer Davies and Gleave, 2003).

The development of the BVWP, a process that can take up to 10 years, requires that a feasibility study be conducted. The latter includes a cost-benefit analysis, an environmental risk assessment, and a spatial impact assessment. Following government guidelines, an explicit weighting is applied to the results of the spatial impact assessment, which usually includes factors that cannot be given a monetary value, to ensure that these factors are considered in the cost-benefit analysis (Steer Davies and Gleave, 2003).

2.7 CHINA

China, the world's most populous nation, has joined other countries in the development of high-speed rail and will soon become the country with the most miles of high-speed rail tracks. With an existing conventional rail network of 53,438 miles reaching its operating capacity due to an expansive growth in the last decade, the Chinese government has sought the opportunity to expand and upgrade the network with a very ambitious plan that is to be completed by 2020. Currently there are a total of 4,300 miles of high-speed rail lines in operation that are to be increased to 8,000 miles by 2012 and 10,000 miles by 2020 (China Daily, 2010). Figure 2.19 shows a map of the proposed Chinese network for the year 2020.



Source: Transport Politics, 2009

Figure 2.19: Proposed Chinese Railway Network

2.7.1 Organizational Structure

After the establishment of the People's Republic of China in 1949, railways were nationalized and the integration of the network, linking all provincial capital cities to Beijing, was highly prioritized by the new government (Garatt, 2010). Both railways and rolling stocks are owned and operated by the Ministry of Railways. China Railways is a division under the Ministry that is in charge of passenger rail operations. In 2007 the Ministry of Railways established China Railways High Speed (CRH), a division of China Railways, for the development and operation of the country's first high-speed rail systems.

2.7.2 Infrastructure and Operation

China currently has 1,550 miles dedicated high-speed rail lines and when the railway development program is completed by 2020 the country will have more high-speed rail track miles than the total length all of the high-speed tracks in the world (Kang, 2010). A total investment of $118 billion USD will be invested by 2012 (Zhao, 2010).

In order to qualify for the bidding of the high-speed rail program the Chinese government required that foreign companies be willing to pair-up with local companies and share their technology. Currently both Japanese and German technology has been used for the development of the Chinese high-speed rail and with this exchange of technology the Chinese have develop their own technology and is now looking to export it to many countries such as the United States, Russia, Brazil and Saudi Arabia (Xin, 2010).

The average operating speed for the Chinese high-speed lines is 163 mph with a maximum speed of 217 mph. In some cases travel time has been cut in half, as is the case of the Beijing-Shanghai Express Railway which links China's biggest economic and population centers. This 819 mile corridor runs in a north-south direction connecting these two cities in 5 hours, provides a 64% travel time reduction and is expected that its annual ridership exceeds 160 million passengers. As with other developments of high-speed rail in China there has been active participation of the private sector in the financing of the line through private pension funds, insurance and investment companies. Investors also participate as stockholders sharing both risks and dividends. High expectations and confidence exists amongst the investors that the system will generate enough revenue to repay loans and costs (Chen, 2009).

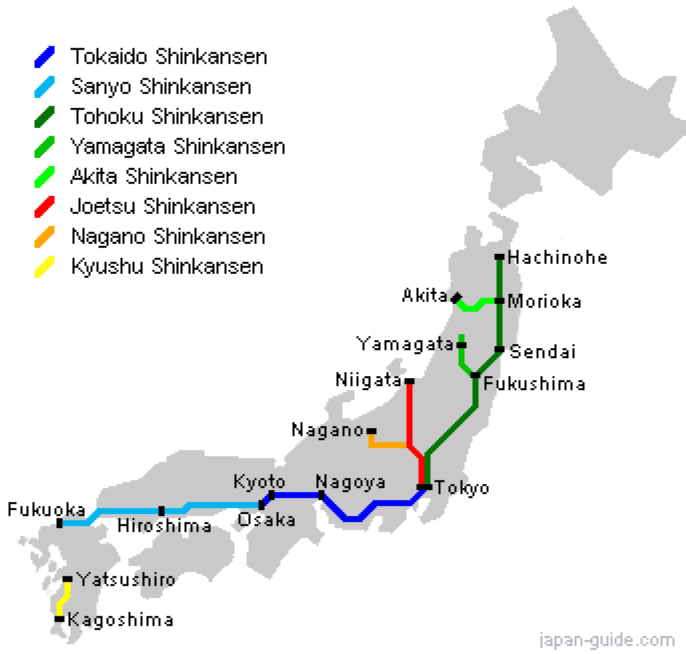
Shortly after starting operations the Chinese high-speed rail has already taken and important role in the mode share market. China's Southern Airline reported that a third of its national routes now suffer direct competition from the railways (Garett, 2010). Table 2.10 shows a list of the Chinese high-speed lines that are currently operational and those that are under construction. Additional lines are currently on the planning phase.

Table 2.10: List of Chinese High-Speed Rail Lines published by the UIC

	Line	Year Opened (Projected)	Length (miles)	Top Speed (mph)
Operational	Jinan – Qingdao	2008	225	124
	Beijing – Tianjing	2008	75	217
	Nanjing – Hefei	2008	103	155
	Hefei – Wuhan	2008	221	124
	Shijiazhuang – Taiyuan	2009	118	124
	Zhengzhou – Xi'an	2009	285	217
	Wuhan – Guangzhou	2009	601	217
	Ningbo – Wenzhou– Fuzhou	2009	349	155
	Fuzhou – Xiamen	2009	171	124
Under Construction	Guangzhou – ShenZhen	(2010)	65	217
	Nanchang – Jiujiang	(2010)	57	124
	Changchun – Jilin	(2010)	60	124
	Guangzhou – Zhuhai	(2010)	88	124
	Hainan east circle	(2010)	191	124
	Chengdu – Dujiangyan	(2010)	45	124
	Shanghai – Nanjing	(2010)	186	186
	Wuhan – Yichang	(2011)	182	186
	Beijing – Shanghai	(2011)	819	217
	Tianjin – Qinhuangdao	(2011)	162	217
	Nanjing – Hangzhou	(2011)	155	217
	Shanghai – Hangzhou– Ningbo	(2011)	186	186
	Hefei – Bengbu	(2011)	81	186
	Mianyang – Chengdu– Leshan	(2012)	196	155
	Xiamen – Shenzhen	(2012)	312	124
	Beijing – Wuhan	(2012)	697	217
	Haerbin – Dalian	(2012)	562	217
	Nanjing – An'qing	(2012)	160	124

2.8 JAPAN

Japan, the first country to develop a high speed train network, began operation of its first Shinkansen train in 1964, connecting Tokyo to Osaka. Currently, there are over 1,550 miles of HSR lines connecting cities on eight different Shinkansen lines (see Figure 2.19 for a map of Japan's HSR lines). Japan has 127 million inhabitants in an area of 145,883 square miles, yielding a very high population density of 874.4 people per square mile. This together with the country's topography and economic geography creates the need for high capacity corridors between the major cities (Steer Davies and Gleave, 2003).



Source: Japan-guide website, nd

Figure 2.20: Japan's HSR Lines (Shinkansen Lines)

Partly because of its mountainous topography, most of Japan's population resides along the coastal areas, concentrating in city centers and the areas surrounding the major cities. Although this has provided access to HSR services for the majority of the population, it has also raised the construction costs of newer lines[7], because these lines had to be built almost entirely on viaduct or in tunnels (Steer Davies and Gleave, 2003).

Japan has a very long history of providing passenger rail service since the 19th century. As mentioned before, Japan first ventured into high speed trains in 1964. The objective was to relief the capacity constraints on the existing conventional rail system. Capacity, as well as speed, remains a key benefit of the Shinkansen lines. Trains operate at very high frequencies - on some lines every 10 minutes - and provide a capacity of over 1,600 seats per train (Campos and Rus, 2009).

[7] Land constraints have also impacted airport expansions, resulting in very high landing charges for airplanes.

In 1969 the Japanese government passed the Second National Land Comprehensive Development Law, to promote a more balanced development of the country and avoid overpopulated cities, as was the case at that time. To reinforce this law, the government passed the National Shinkansen Network Development Law in 1970 to develop the HSR network (Steer Davies and Gleave, 2003).

2.8.1 Funding

Before 1987, the construction of HSR in Japan was funded through debt incurred by the national government and Japan National Railways (JNR) – although the World Bank contributed a minor percentage of the funding. Following the successful introduction of this system, the Japan Railway Construction Public Corporation (JRCC) was established to procure future HSR services on behalf of the state. Historically, the funding model for the development of the Japanese HSR network was thus to use JNR funds provided by the Japanese state (66.7%) and local governments (33.3%) (Ernst & Young, 2009).

In 1987, the Japan National Railways (JNR) was divided into seven companies. Six of these were privatized and were tasked to develop the infrastructure and operate the passenger rail lines. These companies are known as the Japanese Railways (JR Group). The seventh company is the national freight operator. Although the companies comprising the JR Group are private, the government still holds some of the shares through the Japan Railway Construction Corporation (JRCC). Figure 2.21 shows a schematic of the organizational structure of the Japanese railway; all six railway companies are independent having no capital tie with each other.

Following privatization, the state progressively reduced funding for the JNR, which resulted in the requirement for increasing private funding in successive projects. Upon privatization of the heavily indebted JNR, the new entity, JR Group bought the existing four HSR lines from the national government in 1991. The JR Group companies pay an annual fee to the national government for 60 years (GAO, 2009).

For the lines constructed following privatization, the JRCC has been in charge of the construction of the rail infrastructure. Upon completion, the JR companies pay a lease to the government for using the infrastructure. The JR companies also maintain the infrastructure and serve as the train operators. The lease payments are based on projected ridership. The national government does not provide operating subsidies to the JR companies (GAO, 2009).

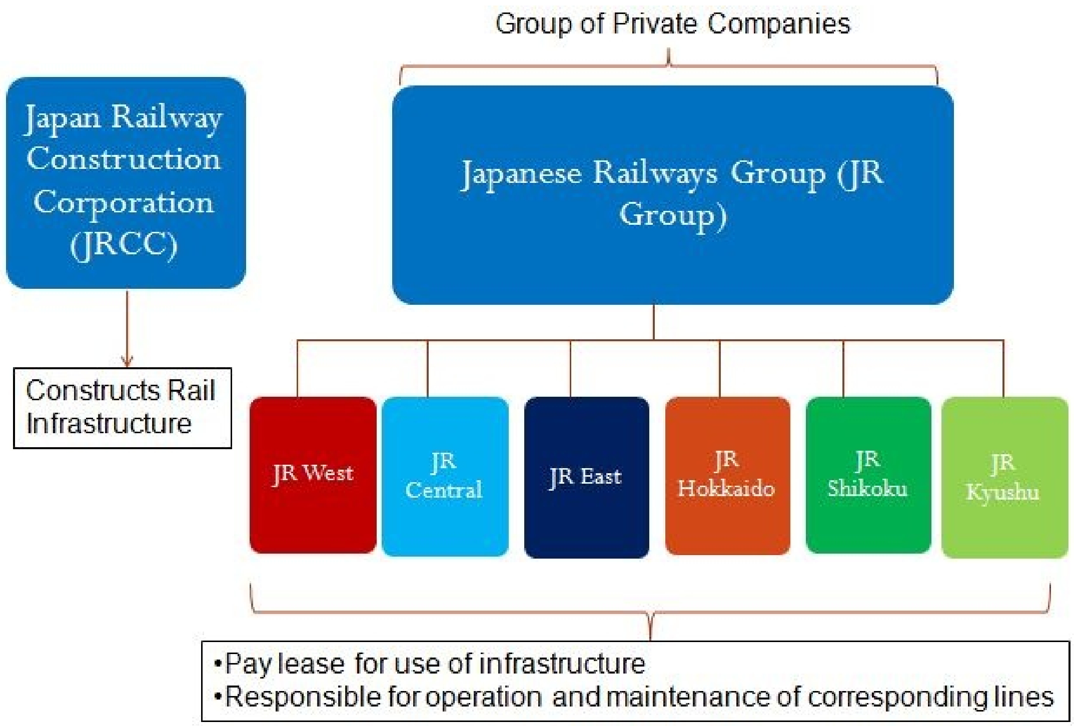


Figure 2.21: Japan Railway Organizational Structure

2.8.2 Infrastructure and Operation

One of the main reasons for the development of the Shinkansen network was the positive impact this was expected to have on the regional and national economy. This vast network has provided its passengers with significant reduction in travel times, increased transport capacity, job creations and environmental benefits (Ernst & Young, 2009). The average distance between stations is 53 miles and trains operate at speeds up to 186 mph. All trains operate on dedicated HSR track, but conventional railway lines provide links to the Shinkansen stations, facilitating access to city centers (Sang Lee, 2007). JR Group also encourages the development of stations for retail and office use; almost 15% of its revenues are gained through the leasing of space for shopping centers and office buildings (Ernst & Young, 2009).

2.8.3 Ridership and Fares

The Japanese Shinkansen trains have a very high passenger ridership. For example, the JR Central, which operates one of the most popular routes, the Tokaido Shinkansen, carried over 151 million passengers in 2008 (Central Japan Railway Company website, nd). Table 2.11 provides information about the number of stations, average distance between stations, length of the corridor, and the fares charged on the different Shinkansen HSR lines. As is evident from the table, fares are a function of the distance traveled.

Table 2.11: Summary of Japanese Shinkansen Lines

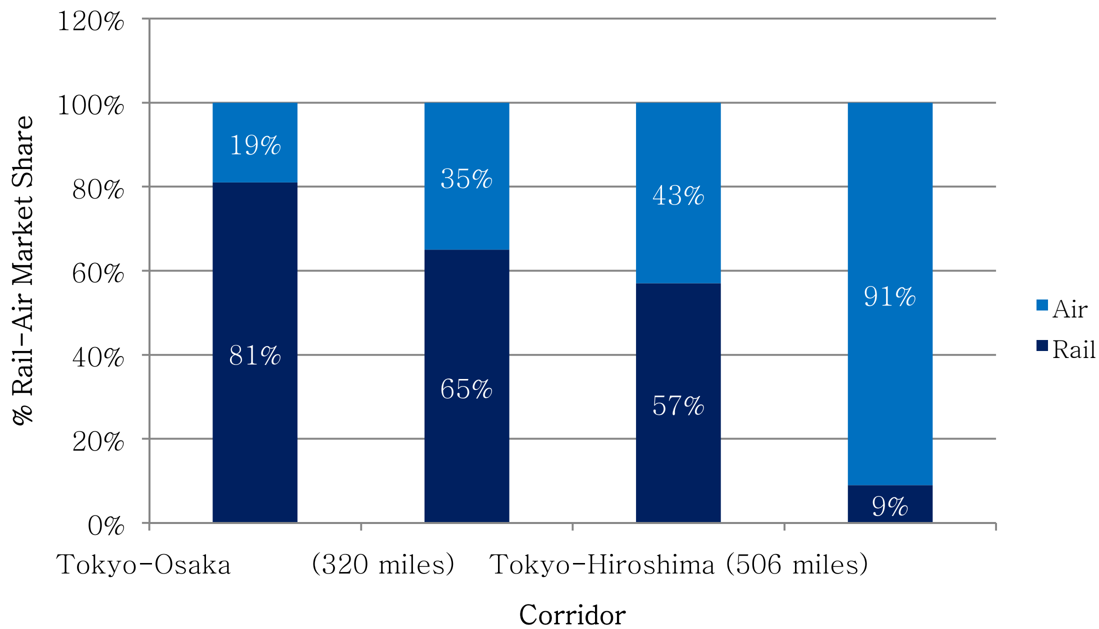
HSR Line	Number of Stations	Average Distance Between Stations (miles)	Length of Line (miles)	Fare (US$)
Tokaido Shinkansen	4	114.46	343	148
Sanyo Shinkansen	7	64.45	387	158
Kyushu Shinkansen	6	35.90	180	105
Tohoku/Akita Shinkansen	9	51.47	412	188
Joetsu Shinkansen	7	34.58	207	115
Yamagata Shinkansen	7	43.64	262	140
Nagano Shinkansen	7	23.03	138	89

Source: Japan Railways Group, nd

2.8.4 Market Share

Even before HSR came into service, the conventional rail mode share has been very significant in Japan. Conventional passenger trains are still seen as very reliable with only a 30 second delay per train on average (Steer Davies and Gleave, 2003). In 2007, Japan's HSR mode share was 30% of the overall passenger kilometers traveled; 67% for trips between 310 and 435 miles. Most of Japan's major cities, such as Osaka, Nagoya, Kobe, and Kyoto, are located within 186 to 373 miles from Tokyo, which are ideal distances for HSR rail service. For distances above 435 miles, HSR has an 11% market share. Up to 23% of the passenger traffic on the Shinkansen lines is induced traffic (Sang Lee, 2007).

High-speed trains' main competition has come from the three main airlines, but air services had been constrained until recently when added capacity at the major airports provided more landing slots. Road transportation (i.e., buses and private vehicles) has never competed with rail due to the long distances between cities, road congestion, and high tolls (almost US$68 per 100 miles) (Steer Davies and Gleave, 2003). Figure 2.2 shows the market share between the HSR and air modes for several destinations originating in Tokyo. As is evident from the figure, the HSR market share is reduced as travel distance increases.



Source: Central Japan Railway Company website, nd

Figure 2.22: Rail-Air Market Shares

2.8.5 Project Development

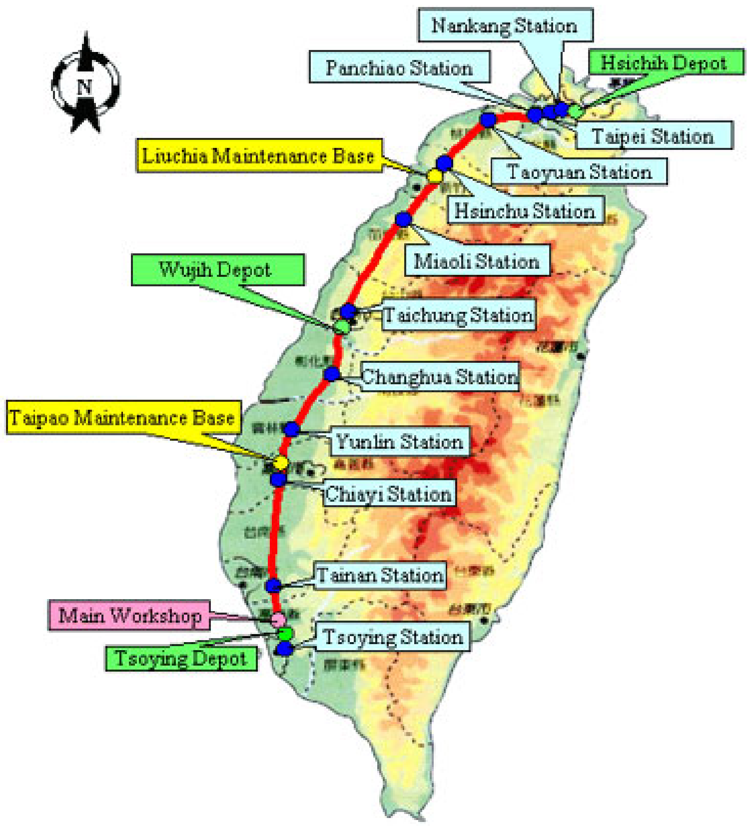
Plans for the development of the HSR lines have existed since before the National Shinkansen Network Development Law. Consequently, recent project assessments have focused on which line to prioritize rather than whether to build the line or not. Decisions on project priorities are guided by two agreements made between the government and the main political parties in 1987 and in 1996. Factors considered include: demand forecasts, construction costs, prospects of profitability and the impact on the JR companies, and the condition of alternative modes available. Other factors considered are the amount of the lease payments the JR companies foresees to make to the JRCC, and whether there is consent from the local governments and from the JR Group companies (Steer Davies and Gleave, 2003). A regional economic impact analysis is also conducted in the assessment of project priorities. The regional economic impact analysis compares the gross regional product in both the build and no build scenarios. Although this analysis includes the potential travel time savings to be incurred by passengers, no value is attached to this or any other benefits as would be the case when conducting a traditional cost benefit analysis (Japan Railways Group, nd).

2.9 TAIWAN

Taiwan, located off the southeast coast of China, has an area of 13,822 square miles. It is bordered by the East China Sea in the north, the Philippine Sea to the east, the South China Sea to the south and the Taiwan Strait in the west. Almost two thirds of the island's terrain is covered mountains in the east coast and plains in the west coast were 70% of its 23 million population resides (CIA World Factbook, nd).

In response to growing vehicle traffic congestion along the western corridor during the 1970s the idea of developing a HSR in Taiwan was first conceived. The initial Taiwan HSR Project was planned to be built as a public sector project with government bearing full responsibility. However, due to increased public fiscal burdens, the Taiwanese Congress decided to withdraw the budget that had been allocated to the HSR Project and subsequently decided to have the HSR Project built by the private sector through a Build-Operate-Transfer (BOT) model, stating that the private sector would run the project more efficiently than a government agency (Cheng, 2009). The Korean government issued a tender for the private construction and operation of the Taiwan HSR Project on October 29, 1996.

Figure 2.23 shows a map of the 214 miles of Taiwanese HSR that run along the western coast from Taipei to Zuoying, making 10 stops along the way. Eight of the twelve stations are currently in operation and only the stations in Taipei, Taiching, and Zuoying are located in city centers, creating the need for feeder routes to serve the HSR lines. The rail line comprises 148 miles of bridges and 28 miles of tunnels (Via Libre).



Source: THSRC website, nd.

Figure 2.23: Taiwan's HSR Lines

2.9.1 Organizational Structure

Taiwan HSR Consortium (THSRC) was formed in 1996 to bid on the HSR BOT Project. The THSRC was selected in May 1998 as the concessionaire to build and operate the HSR service. In 1998, the agreements were signed between the Ministry of Transport and Communications (MOTC), representing the Taiwanese Government, and the THSRC that granted THSRC a concession to finance, construct, and operate the HSR System for a period of 35 years and a concession for HSR station area development for a period of 50 years. The project was constructed based on THSRC's own plans rather than under the government's budgeting process (Cheng, 2009). Figure 2.24 shows an organizational chart of the Taiwanese HSR business model.

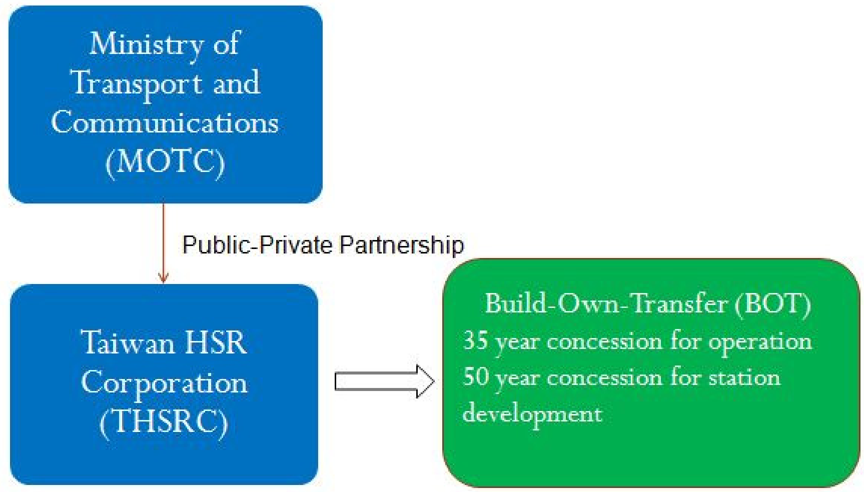


Figure 2.24: Taiwan's HSR Business Model

2.9.2 Funding

The construction costs were estimated at $18 billion and it was originally envisioned that the private sector would build and finance the project without any government assistance, through the sale of preferred shares to institutional investors. The THSRC was selected because its proposal did not include any request for government support. However, lenders to THSRC demanded and eventually received a wide range of government guarantees in the event that the THSRC could not meet its financial obligations.

Thus, although approximately 70% - 80% of the total project cost was funded through bank debt, a significant proportion of the funds were guaranteed by the government. In 2000 the government raised $10 billion from the nation's postal savings account for debt guarantee for the first part of the project, and it step in again in 2005 to buy securities worth $237 million (Ernst & Young, 2009). In the end, public funding came up to be approximately 20.6% of the total project costs. This was use to fund land acquisition, planning, design, supervision and civil work for below-the-ground structures in specific section in Taipei. The 79.4% of private investment financed civil works, stations, track work, electrical and mechanical systems, maintenance bases and financial costs (Ernst & Young, 2009).

The project has incurred in costs overruns due to delays caused by financing and contractual issues and safety testing, its inability to come up with the forecasted ridership, and high interests (Ernst & Young, 2009).

2.9.3 Infrastructure and Operation

The BOT contract stated that the government would be in charge of land acquisition, financial loan acquirement, environmental mitigations, and integration with local transportation systems (Cheng, 2009). This integration with local transportation has been somewhat delayed and has resulted in poor feeder services to certain HSR stations. This has resulted in the THSRC providing free bus shuttles from city centers to remote HSR stations to improve the access concerns (Cheng, 2009).

The HSR line was at first specified to use European train-sets but after much controversy the Japanese Shinkansen bullet train system were chosen instead. This change in specifications caused delays in the starting of service due to problems with adjustment of the Japanese system to the infrastructure that had already been built to European specifications. Changes to the signaling and electrification, as well as training the drivers had to be conducted (Ernst & Young, 2009).

In the two years since opening, the HSR project has incurred losses equivalent to two-thirds of its equity capital. Both the government and THSRC have blamed an unreasonable financial structure, i.e., high interest rates and a depreciation period set at 26.5 years, which is much shorter than the service life of the infrastructure, for these losses (Taipei Times, 2009). On July 13, 2009 the MOTC announced that it had signed a memorandum of understanding with THSRC and the Bank of Taiwan, laying the groundwork for refinancing the THSRC project by the end of the year. In September of 2009, the company was reorganized and the government took majority control of the company (Taipei Times, 2009).

2.9.4 Ridership and Fares

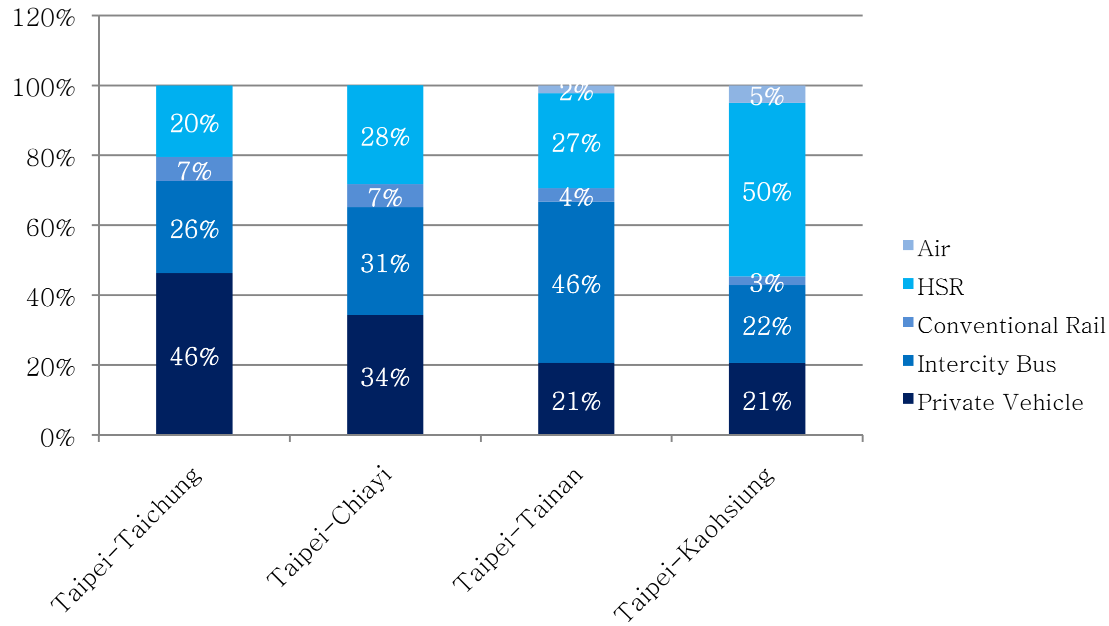
The THSRC launched operation in January 2007 with a 50% fare discount for the first month as a marketing strategy to introduce passengers to the service. It currently operates 140 trips per day and has a capacity of 15 trains per hour per direction. The trains operate from 6:30AM to 11:30PM. The THSRC offers discounts (a) on tickets for non-reserved seats purchased on the day of travel, (b) 50% off for seniors, children, disabled persons, and one companion to a disabled person, and (c) 10% off for groups comprising of 11 or more adults. Passengers can only take advantage of one discount offer (THRSC, nd).

The ridership forecasts predicted that over 200,000 daily passengers would use the HSR in its initial stage of operation and that this number would increase to 336,000 passengers per day by 2033. This has not materialized. After 20 months of operation, only 84,000 passengers on average have used the HSR service per day, about 30% of its long-term daily ridership forcast (Kao, 2009). This ridership level resulted from the THSRC initiating a discount program that offered a 20% discount on trips from Monday to Thursday. Before this program was initiated, the daily passenger volumes were only 74,574 (Cheng, 2009).

The Ministry of Transport and Communications (MOTC) conducted a survey in 2007 to characterize the HSR users based on their trip characteristics. Based on this survey, business trips constitute 40% of the passenger traffic, tourist trips 30%, family visits 22%, and 8% of the trips are induced demand (new trips) brought about by the introduction of the HSR service.

2.9.5 Market Share

Figure 2.25 illustrates the market share of each mode for several HSR corridors. The shortest distance from Taipei is Taichung at 103 miles. As can be seen from the figure, this HSR corridor has a very high private vehicle mode share. However, each subsequent HSR corridor is longer – i.e., 156, 195, and 221 miles respectively from Taipei – so that it is evident that the HSR mode share increases as the distance increases.



Source: Lin et. al (2008)

Figure 2.25: Mode Share in HSR Corridors

Table 2.12 compares these same destinations in terms of travel time duration and fare prices. From Table 2.12, it is evident that both standard and business HSR fares are substantially higher than the competing modes.

Table 2.12: Travel Time Durations and Fare Prices by Mode

Trip	Conventional Rail		HSR			Bus		Air	
	Travel Time	Fare Price ($USD)	Travel Time	Fare Price ($USD) Business	Fare Price ($USD) Standard	Travel Time	Fare Price ($USD)	Travel Time	Fare Price ($USD)
Taipei-Taichung	2hr 15min	11	53 min (direct)	30	21	2 hr	12	-	-
Taipei-Chiayi	3hr 30min	18	1hr 34min	44	33	3hr	10	-	-
Taipei-Tainan	4hr 14min	22	1hr 55min	54	41	4hr	18	55 min	41
Taipei-Zuoying	4hr 40min	25	1hr 34min (direct)	59	45	-	-	-	-
Taipei-Kaohsiung	4hr 50min	26	-	-	-	5hr	22	50 min	52

Source: Lin et. al (2008)

2.10 THE NETHERLANDS

The HSL-Zuid (HSL-South) is a 78 mile high-speed rail line that runs on dedicated track and connects the countries of The Netherlands and Belgium via the cities of Amsterdam, Schipol, Rotterdam, The Hague and Breda and then goes on to connect to the HSL-4 in Belgium with stops in Antwerpen and Brussels. Running through one of Europe's most densely populated area, the HSL-Zuid corridor services up to 40% of The Netherlands population. Figure 2.26 shows a map of the HSL-Zuid line, which was scheduled to open in 2009.

Source: Ministry of Transport, Public Works and Water Management, 2006

Figure 2.26: Map of HSL-Zuid, The Netherlands

2.10.1 Organizational Structure

The HSL-Zuid project falls under the Dutch's government Ministry of Transport, Public Works and Water Management direction. It was procured with two separate public-private partnership (PPP) for the infrastructure and operation of the line, led by Infraspeed and HAS, respectively. The Dutch government acts as the contract manager and is responsible for the traffic management, safety and integration of the system, this falls under Pro-Rail (Ernst & Young, 2009). Figure 2.27 shows a schematic of the organizational structure of the Dutch HSR line.

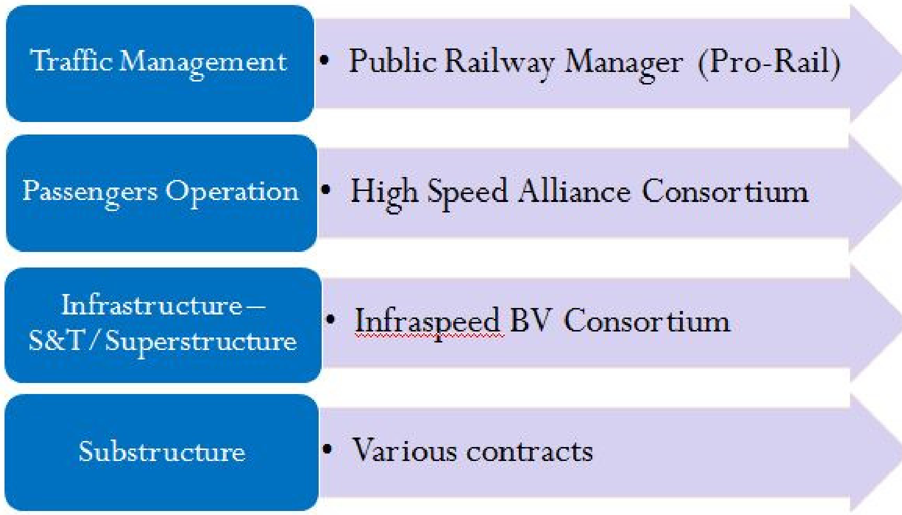


Figure 2.27: Organizational Structure of HSL-Zuid

2.10.2 Funding

As was mentioned above, the line was financed through two PPPs. The first one, led by the Infraspeed BV consortium, is set up as an availability contract, whereas the Dutch government pays an annual performance fee for the availability of the infrastructure. The amount paid will depend on the percentage of availability; full payment fee is $396 thousand per day or approximately $145 million per year for 98.5% of availability (Ministry of Transport, Public Works and Water Management, 2010). The contract follows a DBFM model for a period of 30 years, including a five year construction period and 25 years of operation and maintenance. After the 30 year period ownership of the railway infrastructure will be passed to the state (Railway People).

Infraspeed consists of Fluor Daniel, in charge of the project management, BAM/NBM, responsible for the track work, buildings and noise control, Siemens, responsible for the signaling and electrifications, and Innisfree and Charterhouse Project Equity Investment. Apart for the capital investment provided by these companies, a financing consortium between 24 banks was formed to provide credit funding. This consortium is led by Hypovereinsbank, ING, KBC, KfW, Dexia Public Finance and Rabobank. (Railway People, Railway Technology). The project was financed using private funds and bank loans.

The second PPP is led by the Royal DutchAirlines (KLM) and Dutch Railways (NS) under the High-Speed Alliance (HSA) consortium have a 15 year agreement with the Dutch government to pay for the exclusive right to operate trains in the HSL Zuid line. The annual payment amounts to $195 million per year (Ministry of Transport, Public Works and Water Management, 2010). A separate contract for the network connections was awarded to a separate design-build contractor and is finananced by the Dutch government (Ernst & Young, 2009).

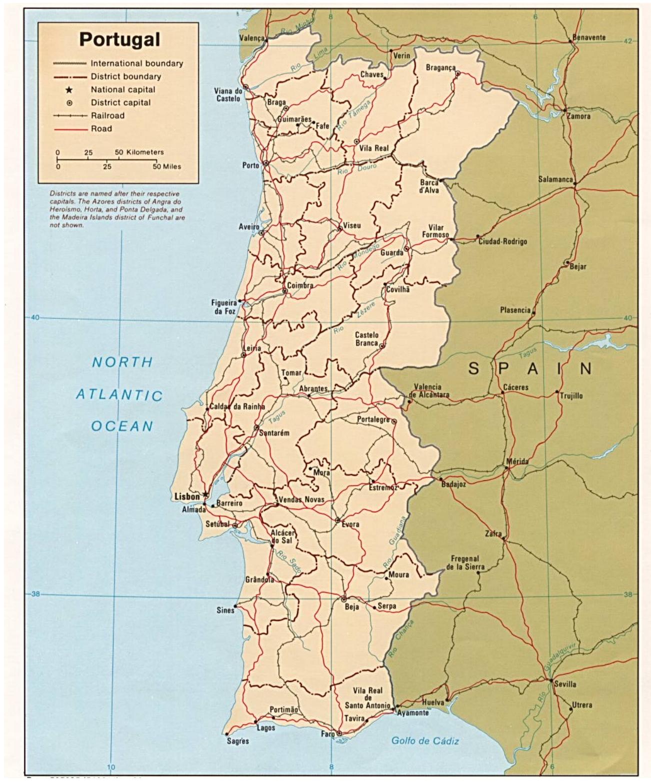
2.10.3 Operation

The delivery of the project infrastructure was done according to schedule but delays caused by modifications to the European Rail Traffic Management System (ERTMS) due to a change in EU protocol. Others delays such as the late delivery of the train sets, the upgrading of the signaling system and late delivery of testing equipment for the ERTMS has cause cost overruns (Ernst & Young, 2009). According to a report from the Dutch Audit Commission, these delays will result in a total loss of $293 million paid by the government in access charges even though the trains are still not running on the tracks. HSA has also demanded a reduction in its yearly payments to compensate for under-estimation of the running times through Belgium where it will need to share conventional tracks in some sections (Ernst & Young, 2009).

2.11 PORTUGAL

Located on the western side of the Iberian Peninsula, Portugal comprises an area of 35,645 square miles. Bordered by Spain to the east and north and the Atlantic Ocean to the south and west, Portugal's economy has historically been dominated by sea trade. Of its 10.7 million inhabitants, 75% lives on the Atlantic coastline, with more than 40% residing in the two largest cities, i.e., Lisbon, the capital, and Porto (Margarido Tão, 2004).

Passenger surface transportation occurs mainly on the three toll roads (i.e., A-1, A-2, and A-3) comprising 248 miles that run along the Atlantic coastline from Braga to Setubal passing through Porto and Lisbon. These toll roads provide travel times of just below 4 hours and 30 minutes, under normal flow conditions, between Braga and Lisbon. Two other east-west toll roads (i.e., A-6 and A-12) connect to the *Autovia de Extramadura* in Spain on route to Madrid, which is approximately 404 miles away. Various east-west non-tolled roads also link Portugal to the Spanish border. Figure 2.28 provides a map of the Portuguese transportation network.



Source: www.vmapas.com

Figure 2.28: Portugal's Transportation Network

For longer distance travel (e.g., outside Portugal), air travel is the most competitive mode, with flights providing connections to major European cities, such as Paris and Brussels, within two hours. The airports in Lisbon and Porto are, however, extremely congested. On the other hand, the passenger rail mode has been completely neglected over the years. Most of the rail network comprises single-track lines, operating on a phone-block system[8], and only 22% of the network is electrified. The average train speed is below 62 mph, compared to 75mph on roadways, presenting a very unfavorable scenario for passenger travel. The Portuguese government has started to upgrade existing rail tracks, but with very few benefits, because the higher speeds can

[8] A signaling measure that dates back to the 19th century that allows for proper spacing between trains and to avoid collisions (Signal Box, nd)

only be achieved on very short sections of the network and because the track is shared with freight rail (Margarido Tão, 2004).

In an effort to revive rail efficiency, and promote rail competitiveness and sustainability, the European Union (EU) envisioned with the development of the Trans-European Transportation Network, the construction of 20,000 km of HSR by the year 2020. Given this vision, it became necessary to develop rail services and infrastructure in Portugal that offers users cost and time savings, reliability and comfort, and integrates with the European rail network (Margarido Tão, 2004). Figure 2.29 shows a map of the proposed Portuguese HSR lines.

Source: RAVE, 2010

Figure 2.29: Map of proposed Portuguese HSR lines

2.11.1 Organizational Structure

The Portuguese government entered into a partnership with *Rede Ferroviaria Nacional, E.P.E.* (REFER), the national railway infrastructure administrator, and created the *Rede Ferroviária de Alta Velocidade* (RAVE) in 2000 as a public limited company. The government held 60% of the company's shares and REFER held 40%. RAVE was provided public funding to conduct all studies needed to provide information regarding the planning, financing, construction, and operation of the HSR network in Portugal. RAVE also holds 50% of the shares of *Alta Velocidade Espanha-Portugal* (AVEP), a group created to conduct market research studies, define routes and other technical aspects, and coordinate the applications and procedures for obtaining EU funding. The other 50% of AVEP is owned by ADIF, the Spanish Railway Infrastructure Management company (RAVE, nd).

In 2007, RAVE proposed a business model for the implementation of the Portuguese HSR Network. The model proposed five public-private-partnerships (PPPs) for the design, construction, financing, and maintenance of the railway infrastructure and superstructure for the three priority lines (i.e., Lisbon to Porto, Lisbon to Madrid, and Porto to Vigo) for a period of 40 years. A single PPP was also proposed for the design, supply, installation, financing, and maintenance of the signaling and telecommunications systems for all three lines for a period of 20 years. REFER will be in charge of the infrastructure management capacity management, route allocation and traffic management and the Portuguese government will acquire the needed rolling stock that will later be transferred to the future operator. The operational model is set to be defined in 2010(RAVE, nd). Figure 2.30 shows a schematic of the Portuguese organizational structure.

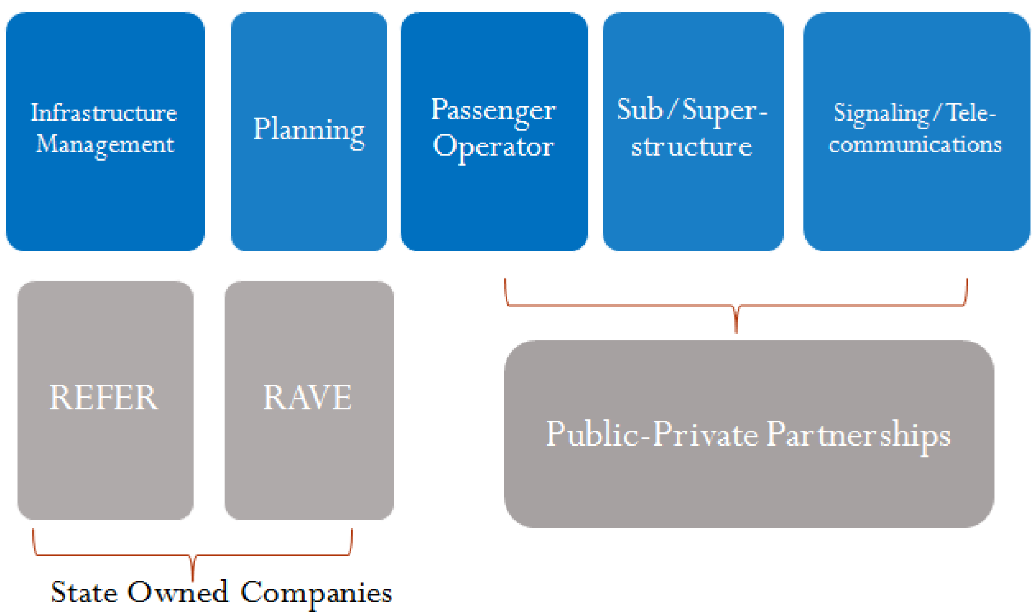


Figure 2.30: Organizational Structure of proposed Portuguese HSR lines

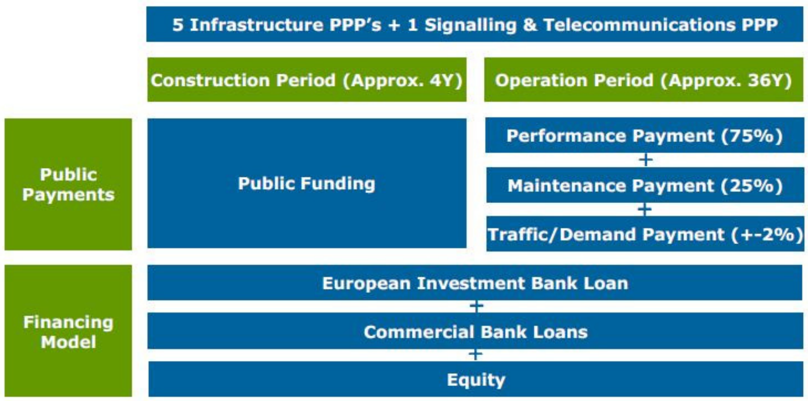
2.11.2 Funding

In 2006 the EU granted Portugal "Cohesion Funds" to begin construction of the standard gauge railway routes dedicated to passenger traffic. Cohesion Funds are a financial instrument established in 1994 by the EU to help member states reduce economic and social disparities, and to stabilize their economies. This type of EU funding mechanism is explained in greater detailed in Chapter 3.

The three projects identified and accepted by the EU and classified as a *"Priority Scheme"* and eligible to receive funding were:

1. The Madrid-Lisbon line - a 128-mile route (on the Portuguese side), which will provide an HSR service link of less than three hours between Madrid and Lisbon with trains traveling at speeds of up to 217 mph. This line is being funded by the EU (Cohesion Funds), by the Spanish and Portuguese governments and by private investments.
2. A new Lisbon-Porto line – a 180-mile line, connecting the metropolitan cities in less than 1 hour and 30 minutes. The passenger trains on the new line will be traveling at speeds up to 186 mph. The existing Lisbon-Porto rail line will be used for freight and regional passenger services.
3. The first phase of the Porto–Valencia line, which requires a 34-mile extension of the North-South corridor from Porto to Vigo in Portugal. This line will be built in the Iberian broad-gauge (1,668 mm) on dual-gauge sleepers to enable a fast conversion when the line is eventually connected to the "Atlantic Axis" (Vigo-Santiago-Coruña). The design speed for this line is 155 mph (Margarido Tão, 2004).

The project will be built in several phases and the public funds that are needed to finance subsequent phases are expected to be raised with the operating revenues with the phases that are implemented first. For example, 42% of the public funding for the Lisbon-Madrid and 52% of the public funding for the Lisbon-Porto line will be raised this way (Ernst & Young, 2009). By using a phase approach and separating the each section into different PPPs the private investment required for each section is reduced, approximately $1.9 to $2.8 billion for the super and sub-structures and $700 million for Signaling and Telecommunications (RAVE, 2010). This makes the investment more attractive to the private sector. Figure 2.31 shows a schematic of the financial structure of the Portuguese HSR PPP model.

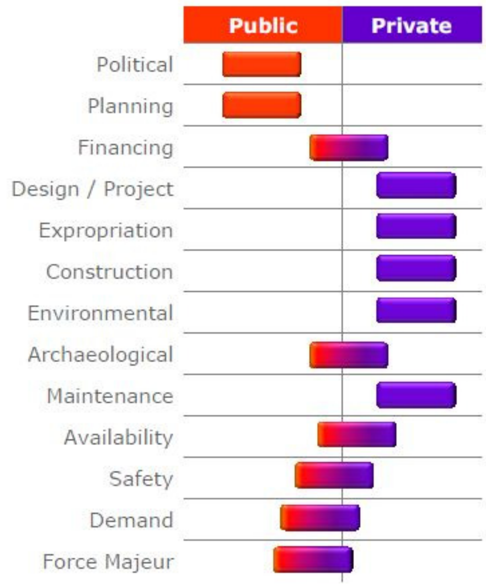


Source: Rave, 2010

Figure 2.31: Financial Structure for Infrastructures

Under this model payments to the concessionaires are made on the basis of performance, maintenance and demand, fomenting the full line availability during a complete operation day. Payment deductions are made for non-availability of the infrastructure and for not maintaining assets in good condition (RAVE, 2010). At present only one tender has been awarded for the Poceirão-Caia line, a 103 miles section that is to be part of the Lisbon-Madrid line. The final tender came to be for $1.9 billion, a 40% reduction in cost after the first public session in 2005 (RAVE, 2010). Construction is expected to begin by 2010 and the complete Lisbon-Madrid HSR line is expected to be in full operation by 2013 (Project Finance, 2009). A second tender was launched in March 2009 for the Lisbon- Poceirão line for $2.7 billion and bids were received in August 2009; at this moment tender has not been awarded. The bidding for the signaling and telecommunications PPP was to be open for tender in February 2010 (RAVE, 2010).

According to RAVE their PPP models have been successful in sharing the risks of the projects, making it more affordable to the private partners. Figure 2.31 shows a risk matrix of the PPP model.



Source: Rave, 2010

Figure 2.32: Risk Matrix

2.11.3 Market Share

Table 2.13 lists the proposed HSR lines. Plans for the last three lines have not been finalized and no completion dates have been determined.

Table 2.13: Proposed HSR lines

Line	Length (miles)	Point-to-Point Travel Time	Design Speed (mph)	Demand (100,000) pass/ year)	Expected Completion
Lisbon – Caia (Madrid)	128	2hr 45min	217	5.3	2013
Porto – Vigo (Valencia) Phase 1	34	40min	155	2.1	2013
Lisbon – Porto	180	1hr	186	13.5	2015
Porto – Valencia (Vigo) Phase 2	28		155		
Aveiro – Almeida (Salamanca)	106	2hr 45min	155	1.8	
Evora – Faro – Vila Real de SA (Huelva)	149	1hr 50min	155	1.6	

Source: Margarido Tão, 2004

Tables 2.14 and 2.15 compare the current modal splits (without HSR service) and the anticipated modal split after the completion of the Portuguese HSR network for business and leisure travel. The anticipated modal split estimates were obtained from binomial and multinomial Logit models, using utility functions estimated from revealed and stated preference survey data.

The current passenger rail service available between Lisbon and Madrid is a 10 hour night service. This is not a viable option for business trips, hence the 0% market share for the current rail mode. Personal vehicle travel is also not a feasible option for business travelers, because the six hour journey does not allow for a return trip on the same day. For business trips, a rail market share of 96.66% is thus anticipated with the implementation of HSR on the Lisbon to Madrid corridor. For leisure trips, the impact on mode shift is not expected to be as drastic, but still significant in that rail market share is anticipated to increase from 2.16% to 40.39% with the implementation of HSR. It is furthermore anticipated that a total of 4.18 million new trips – compared to the 5.8 million current trips - will be induced by the introduction of HSR. These numbers are comparable to the Paris-Lyon TGV, where induced traffic was more than double the number of trips diverted from other modes (Margarido Tão, 2004).

Table 2.14: Modal Slit Before and After Lisbon-Madrid HSR Line

Line		Type of Trip	Market Share (%)		
			Rail	Air	Road
Lisbon-Madrid	Before HSR	Business	0	100	0
	After HSR		96.66	3.34	0
	Before HSR	Leisure	2.16	2.11	95.73
	After HSR		40.39	1.29	58.32

Source: Margarido Tão, 2004

Table 2.15 compares the current and anticipated travel time, cost, and rail market share before and after the implementation of the HSR line between Lisbon and Porto. From Table 13, it is clear that it is anticipated that the business rail market share would be slightly more than 50%. It is anticipated that road travel's business market share will reduce significantly with the introduction of HSR (i.e., from 84.97 to 44.36%), even though the trip from city center to city center is via a continuous roadway and only takes 2 hours and 30 minutes. A similar modal shift is expected for leisure trips with rail's market share estimated at almost 50% with the introduction of HSR (Margarido Tão, 2004).

Table 2.15 Modal Split Before and After Lisbon-Porto HSR Line

Line		Type of Trip	Travel Time (min)			Cost (€)			Market Share (%)		
			Rail	Air	Road	Rail	Air	Road	Rail	Air	Road
Lisbon-Porto	Before HSR	Business	190	120	150	29.5	75	18.75	6.23	8.80	84.97
	After HSR		75	120	150	50	75	18.75	51.05	4.59	44.36
	Before HSR	Leisure	190	120	150	17.5	75	18.75	10.77	0	89.23
	After HSR		75	120	150	33	75	18.75	49.53	0.15	50.32

Source: Margarido Tão, 2004

2.12 CONCLUDING REMARKS

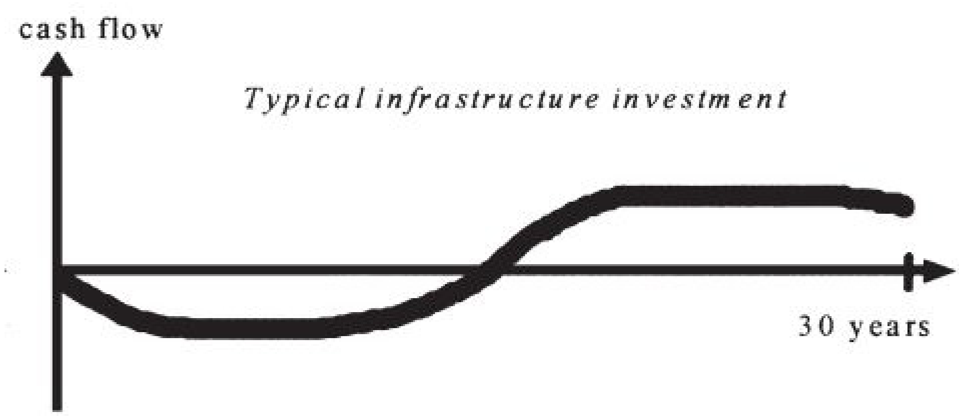
This chapter described the development of several HSR services in the world. Although cultural and political differences prevail, in all cases it is clear that mode shares are substantially impacted by the implementation of an HSR service. For example, all the successful HSR services have impacted the air travel mode partly because it seems that HSR becomes increasingly competitive at distances between 125 and 400 miles. It is also important to note that all the HSR systems included in this report received significant financial support or guarantees from the government. This clearly demonstrates that for HSR to be successful, public funding will be required.

CHAPTER 3. FINANCING HIGH-SPEED RAIL

3.1 INTRODUCTION

As with any other transport infrastructure project, when a government entity is looking into the possibility of developing a high-speed rail corridor it needs to evaluate which financing mechanism it will use. There are several business models that can be used for the development of high-speed rail corridors. These range from purely public, public-private partnerships, to purely private; although the literature suggests that the latter is highly unlikely due to specific characteristics of transport infrastructure projects that will always require the involvement of the public sector whose interests go beyond financial gain to take into account social-economic benefits.

Developing high-speed passenger rail corridors can involve a relatively large long-term investment. A high initial investment cost and long construction period are combined with a slow ramp-up period for increasing revenues, which all yields to a rather low cash flow at a 'normal' discount rate, as depicted in. This cash flow situation makes it less attractive for private investors and motivates the need of some kind of public sector participation.



Source: Adapted from Roll & Verbeke, 1998

Figure 3.1: Cash flows during the life cycle of an infrastructure investment

In their paper, Roll and Verbeke discuss that the implementation process of a project is divided into 3 phases: promotion and preparation phase, construction phase, operating phase; and every phase has specifics risks and uncertainties associated with it. During the promotion and preparation phase, feasibility studies are conducted and funds are allocated. In this phase there is a high risk that the project will not be conducted, making it very unattractive to private investors since investing in costly studies may not lead to any kind of future remuneration. The second phase is the construction phase where a project may encounter political and commercial risks due to construction and completion delays and cost changes. Since the construction period can extend through several years political contexts may change during this phase and cause further delays on the project. The third and last phase is the operation, which involves mainly technical risks if the facility does not work properly, market risks if forecasts were too optimistic, and regulatory risks if government changes regulations such as adopting a policy that would require any change in the original project context.

Fitch Ratings also recognizes the different phases of the development of large infrastructure projects that can span for over 15 years, and the risks involved in each phase for a private investor in the case of a concession contract. The first phase, the initiation, is covered from the point of conception of the project to its final decision. This phase usually involves only the public sector, but in cases where a private investor is involved this is seem as highly risky by the rating company. During this phase the project scope is first materialized and can change radically along its development. Having the private sector already involve in such a preliminary stage can mean substantial cost overruns and delays to the investors due to changes in the scope or unforeseen events that do not materialize until later on in the process, such as lack of political support which might lead to an abandonment of the project.

The second phase in the conditioning phase which consists of land acquisition, zoning adaptations, permit procurement, relocation of existing utilities, contract design, risk assessment, and call for tenders, among others. During this phase the concession company starts getting involve in the project, involvement may be on a higher or lower degree depending on the specific project. Costs associated with this phase can be very uncertain, especially if land that needs to be acquired is around a very densely populated area, in which case costs would be much higher and there are higher risks of cost overruns and delays due to land disputes. The third and last phase is the realization of the project in which the sole responsibility is in the hands of the concession company. This phase involves cost estimation, contract management, project supervision, project control and cost control, among other activities.

Based on the reality and conditions of the development of transportation infrastructure for both the public and private sector a partnership between both parts can bring an attractive and flexible solution to the deliverance of the project. Depending on how this partnership is set up it can minimize the investment risks of the project and make it more attractive to the private sector. At the same time it gives the government added capacity to distribute the available funding amongst other public interest projects since it does not have to commit excessive amounts of funding to one particular project, such as high-speed rail.

Figure 3.2 gives an overview of the public and private sector involvement in each of the Case Studies reviewed in Chapter 2. From that discussion we can observe that there has been a recent trend amongst new HSR projects to involve the private sector in a more direct way than it was involved in previous projects.

		France	Spain	Germany	Korea	Italy	The Netherlands	Portugal	Japan	Taiwan
		TGV	AVE	ICE	KTX	TAV	HSL-Zuid	RAVE	Shinkansen	THSR
Specification		State	State	State	State	State	State	State	State	State
Substructure	Design, Build	RFF	ADIF	DB Netze	KR	RFI	State	PPP	JRCC	THSRC
	Operate, Maintain								JR Group	
Superstructure	Design, Build						PPP		JRCC	
	Operate, Maintain								JR Group	
Rolling Stock	Supply	SNCF	RENFE	DB Bahn	KORAIL	NTV	Dutch Railways (NS)	State	JR Group	
	Maintain					Trenitalia				
Operations						Trenitalia	PPP	PPP		
Financing	A mix of options involving private sector funding, bank debt and capital market financing raised directly by the project vehicle of IM with strong public sector support									

Increasing Involvement of the Private Sector

Source: Adapted from Ernst & Young, 2009

Figure 3.2: Public and Private sector involvement in development of HSR

3.2 PUBLIC-PRIVATE PARTNERSHIPS

Due to lack of funding resources many public entities have been promoting the use of public-private partnerships (PPP) as a way to develop infrastructure projects. Private investors can participate in infrastructure projects in various ways, for example, as shareholders, creditors, holder of bonds. The public sector's role can be to only serve as a regulator or it can have more participation in the investment by providing public grants, loans and guarantees for a percentage of the investment in order to lower the risks and make it more attractive for the private sector to invest the remaining portion. In most cases, the government also provides the necessary right-of-way and additional investments needed for the project to function properly, such as feeder routes and roadways and is responsible for obtaining the required permits and regulatory requirements. The ultimate benefit of a PPP is the sharing of the business and commercial risks involved in each project.

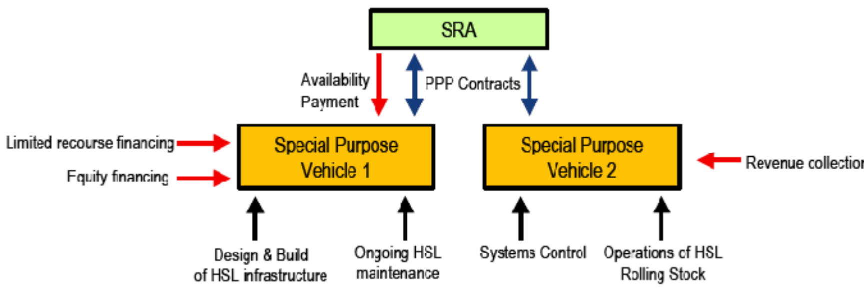
Some examples of the business models that have been used in recent projects that have been developed though public-private partnerships are discussed in the following section.

3.2.1 Availability-Based Models

An availability-based model is one where the delivery of the infrastructure is completely separated from its operation. In this type of model the entity acting as the infrastructure manager is paid solely on the basis of making the infrastructure available for the entity providing the passenger operations; this is also known as a design, build, finance and maintain with separation of operations (DBFM&O) model. A percentage of the infrastructure that needs to be available at all times is established beforehand on the project's contract and failure to provide it would result in penalties paid by the infrastructure manager to the contracting agency, usually the government. As a result maintenance schedules need to be aptly planned so as to not incur in penalties. This type of model eliminates any direct impact of traffic risks to the investor since the infrastructure manager is always guaranteed a payment for making the infrastructure available regardless of the amount of traffic that passes through it. But although it can eliminate direct traffic risks, indirectly it will be affected since the wear and tear of the infrastructure will depend of the traffic volumes that pass through it, of which the provider has no control over. Availability based models work well in cases where the public sector wants to attract private investors to provide the costly infrastructure and make it more attractive to them by absorbing all the traffic risks.

This structure also allows for a phased development of the HSR service as phases of the infrastructure can be let as separate DBFM concessions, while the existing operator would be allowed to provide services over the extended network (Ernst & Young, 2003). This approach is currently being used in the development of the Portuguese HSR.

Figure 3.3 shows a diagram of the components of and availability-based model. Such projects could also involve a separate contract with the private sector for the operation of passenger services, as is the case for the HSL Zuid in The Netherlands.



Source: Ernst & Young, 2003

Figure 3.3: Availability-based model

Examples of Availability-Based Models.

<u>HSL Zuid</u>. The HSL Zuid is a 78 mile high-speed rail line that runs on dedicated track and connects the countries of The Netherlands and Belgium. The line was developed through two separate PPPs, one for the infrastructure and one for the operation. The infrastructure PPP, between the Infraspeed BV consortium and the Dutch government, follows an availability-based model in which the Dutch government pays an annual performance fee for the availability of the infrastructure for 25 years; the amount paid depends on the percentage of availability. The second PPP is led by the Royal DutchAirlines (KLM) and Dutch Railways (NS) under the High-Speed Alliance (HSA) consortium have a 15 year agreement with the Dutch government to pay for the exclusive right to operate trains in the HSL Zuid line. The payments made by the operating company to the Government are used to pay the infrastructure company for the availability of the line.

Portuguese HSL. The Portuguese government has developed their PPP model for developing HSR using and availability-based approach. The model proposed five PPPs for the design, construction, financing, and maintenance of the railway infrastructure and superstructure for a period of 40 years and a single PPP for the design, supply, installation, financing, and maintenance of the signaling and telecommunications systems for all lines for a period of 20 years. Under this model payments to the concessionaires providing the infrastructure are made on the basis of availability of service, performance, maintenance and demand. Payments made to the signaling and telecommunications systems provider are made on the basis of availability of service. Payment deductions are made for non-compliance with pre-established availability. At this time these lines are not operational and only one PPP has been awarded.

Perpignan-Figueras Link. The Perpignan-Figueras link is the 28 mile international section of a high-speed rail line that will connect France and Spain mostly through a tunnel under the Pyrenees, reducing travel times between Barcelona and Toulousse by more than 2 hours. The line will carry both passenger and freight traffic. The bi-national project was sponsored the French and Spanish government and involved private sector participation through a PPP for the building, financing, operation and maintenance of the infrastructure (Scott Wilson website, nd). The 50 year concession was awarded to TP Ferro consortium, a 50-50 joint venture between Eiffage of France and Spain's ACS-Dragados, who was required to build and finance the infrastructure at its own risk, receiving a subsidy for the construction. Operation and management of the infrastructure also falls under the concession scheme acting as the infrastructure management and having the right to collect access charges on passenger operating companies, from both the French and Spanish side, as well as from freight operators.

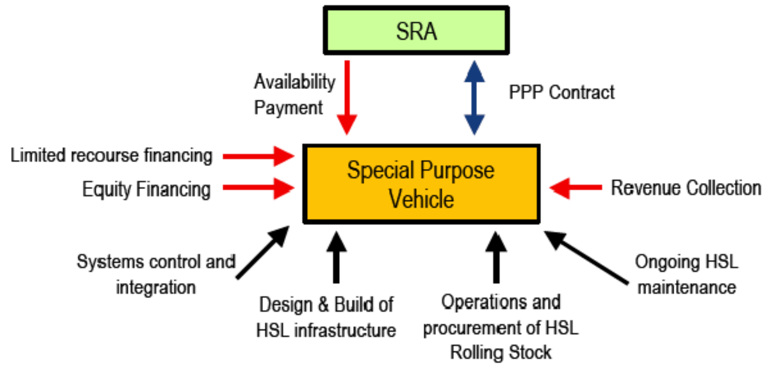
3.2.2 Demand-Based Models

Demand-based models can be divided into two main types depending on the scope of the project. The first type is for those projects that are fully integrated, meaning that the same entity that provides the infrastructure will also be in charge of the passenger operation services; it is also know as a design, build, finance and operate (DBFO) model. These types of projects are greatly exposed to traffic volume risks since the main source of revenue is coming from the actual passenger throughput. Fully integrated projects can be carried out both by solely public means or with participation from the private sector. When carried out as a PPP this model involves a single contract with the private sector to provide the financing for the project in addition to designing, building, maintaining the infrastructure asset, and operating the service. This structure usually exposes the private sector to the majority of the risks associated with the project. Financing of the project is normally provided by third party debt providers on a limited recourse basis over the construction phase with additional risk or equity capital from the main contractors (Ernst & Young, 2003).

Since ridership forecasts for any type of transportation development can have a high number of uncertainties this type of structure will have high risks for the operating company if full revenue risks are transferred. According to Ernst & Young, it is unlikely that the fare box revenues generated from the project would be sufficient to meet the debt service obligations of the Special Purpose Vehicle (SPV). In this case, the public sector could pay a fixed fee to the private sector during the operational phase to cover the funding deficit. This fixed fee is usually based on performance to provide the private sector operator with an incentive to provide the desired levels of service (Ernst & Young, 2003).

Since this model is employed by a contract between the public sector and a single operator it does not have the most efficient structure if the rail network is to be implemented in phases. If the project is decided to be carried out in phases it would require the termination of the DBFO concession, which could involve significant compensation costs to the existing concession company if the contract is breached (Ernst & Young, 2003).

Figure 3.4 shows a diagram of such model. One recent example of its implementation is the Taiwan High-Speed Rail running from Taipei to Tsoying that was developed by means of a concession.



Source: Ernst & Young, 2003

Figure 3.4: Demand-based model

A second type of demand-based model is projects where, like the availability-based model, only the infrastructure is to be provided. But, unlike the availability model, its revenue will be directly affected by the traffic volume since they are based on the track access charges the passenger operator is required to pay the infrastructure manager for access to the corridor. These track access charges can be in the form of booked capacity, where the operator enters into an agreement with the infrastructure manager to use future available capacity on the network; or, by actual throughput, that can be measured as the number of trains, the weight and length of the trains, the train capacity (e.g. number of seats), or the number of passengers transported. This type of financing mechanism is more or less the traditional way high-speed rail projects have been implemented in Europe, where, by decree of the European Commission, two separate entities are required for the rail infrastructure and the passenger operation, even if these two entities are owned or manage by its corresponding government.

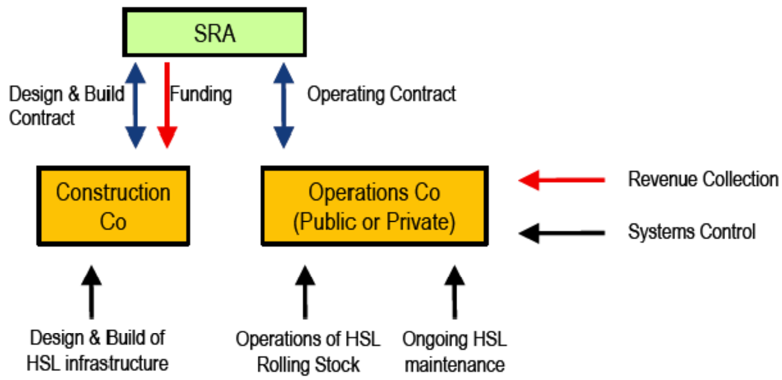
Examples of Demand-Based Models.

Taiwan High-Speed Rail. The Taiwan High Speed Rail was the first high-speed rail corridor that used a PPP model for its development. The model use was a build-operate-transfer, where the concessionaire was required to build, finance, operate and maintain the high-speed line and then transfer it back to the government at the end of the 35 year term. Revenues collected by the concessionaire are exclusively from passenger fares and revenues obtained from station developments. The project was awarded to the Taiwan High-Speed Rail Company which was selected because its proposal did not include any request for government support. However, lenders to THSRC demanded and eventually received a wide range of government guarantees in the event that the THSRC could not meet its financial obligations. In the two years since opening, the HSR project has incurred losses equivalent to two-thirds of its equity capital. Both the government and THSRC have blamed an unreasonable financial structure, i.e., high interest rates and a depreciation period set at 26.5 years, which is much shorter than the service life of the infrastructure, and a passenger ridership lower than what was predicted as the cause of these losses (Taipei Times, 2009). On July 13, 2009 the MOTC announced that it had signed a memorandum of understanding with THSRC and the Bank of Taiwan, laying the groundwork for refinancing the THSRC project by the end of the year. In September of 2009, the company was reorganized and the government took majority control of the company (Taipei Times, 2009).

3.2.3 Other Structures

Design & Build with Separation of Operations (DB&O). The DB&O model is the traditional structure for the procurement of infrastructure projects where separate contracts for the construction and operations are used. Construction risks are transferred to the private sector through the design and build contract but, since payments are made throughout the construction phase of the project the public sector is still retaining some part of the risks (Ernst & Young, 2003).

The operating phase is carried out by an operator that can be either from the private or public sector. The operator is usually responsible for the maintenance of the infrastructure in addition to the procurement of the rolling stock, the operation, and maintenance of the rolling stock, and the collection and retention of fare box revenue (Ernst & Young, 2003). This structure can be used in combination with other structures when the construction site conditions are deem to have to many risks and transferring them to the private sector would make the project an unattractive investment. This was the case of the HSL Zuid, where the construction of the substructure was delivered through various design and build contracts. Figure 3.5 shows a diagram of the DB&O model.



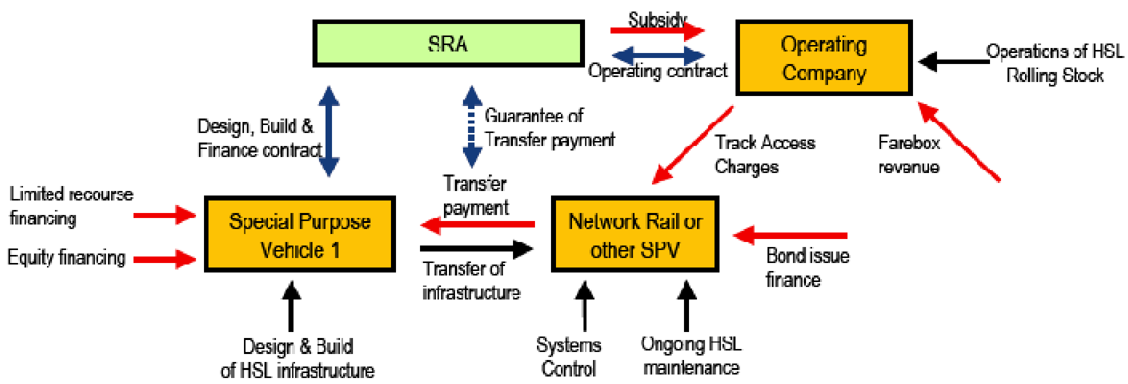
Source: Ernst & Young, 2003

Figure 3.5: DB&O model

Design, Build, Finance & Transfer with Separation of Operations (DBFT&O). Under a DBFT&O structure the financing and construction the HSR infrastructure would be carried out by the private sector and, upon its completion, transfer it to the rail infrastructure owner and operator from the public sector who under contract would be required to purchase the asset for a pre-established price, subject to the assets meeting certain technical and safety criteria (Ernst & Young, 2003). Depending on the expected ridership levels, all of the funding for the purchase of the infrastructure can be secured through the track access charges the infrastructure owner will levy on the operating companies.

This type of structure facilitates the development of a HSR system using a phased approach since infrastructure is transferred to a "rail infrastructure owner and operator" upon satisfactory completion and commissioning of the asset (Ernst & Young, 2003). The operation of the HSR services can be provided by the private sector under a separate contract. This operator would collect revenues from the fare box and pay the infrastructure owner an access fee for its use but it is highly likely that an operating subsidy would be required from the government (Ernst & Young, 2003).

Figure 3.6 shows a diagram of the DBFT&O model. This type of structure has still not been used in any of the existing rail infrastructure projects but according to Ernst & Young, could be relevant for both segregated or integrated projects.



Source: Ernst & Young, 2003

Figure 3.6: DBFT&O model

3.3 STRUCTURE OF ACCESS CHARGES

An access charge is a payment made by the train operator (TO) to the Infrastructure Manager (IM) for the access to the railway infrastructure. In the European railway framework, infrastructure costs, including maintenance, are covered by both the Government and the Infrastructure Manager (IM) through infrastructure charges that the operator pays them for running services on the infrastructure. These infrastructure charges can vary from country to country and range from less than 0.5 euro per train-km to up to 4 euro per train-km. Although variations can be caused by conditions applicable to a specific corridor, such as speed of travel and route congestion, it is likely that a greater part of it is caused by the differences in the level of subsidies the governments are willing to provide (Sánchez-Borrás, 2009).

In a study conducted by Sánchez-Borrás and Lopez-Pita (2009), they characterized different access charging system implemented in HSR in Europe and analyzed the level of charges applied to these lines in order to quantify the mark-ups above marginal cost that are charged to high speed services. The countries evaluated where France, Spain, Germany, Italy and Belgium. In the case of France and Spain, their study identified that both countries apply a marginal cost plus mark-ups principle, consisting of applying mark-ups above marginal costs in order to raise cost recovery and their pricing structure follows a two-part tariff[9] principle. For Germany, Italy and Belgium the difference between state compensation and the full financial cost is already set in

[9] A two-part tariff is a pricing technique typical of monopolistic markets where the consumer is charged a surplus as a cover charge in addition to a per unit charge that covers the marginal cost of the unit.

the level of charges collected. Both Germany and Belgium based there pricing structure on a linear tariff[10] principle; Italy uses a two-part tariff pricing structure (Sánchez-Borrás, 2009).

The infrastructure charging systems applied by each country are set to cover specific costs that have been incurred or are part of the operation of the infrastructure. Table 3.1 shows the different costs covered by these charging systems for the countries covered in the study. As can be seen, in the majority of cases costs are only partly covered by the charging systems. The researchers also observed that in the case of investment costs the costs that are covered are only for HSR indicating how users are willing to make a financial contribution to cover part of the cost of the very high investments required to develop such lines (Sánchez-Borrás, 2009).

Table 3.1: Costs covered by rail infrastructure charges

	France			Spain			Germany			Italy		
	Covered	Partially Covered	Not Covered	Covered	Partially Covered	Not Covered	Covered	Partially Covered	Not Covered	Covered	Partially Covered	Not Covered
Investment Costs		X			X			X				X
Finance Costs					X							
Maintenance Costs		X			X		X					X
Renewal Costs		X						X				X
Traffic Management Costs		X			X		X				X	

Source: Sánchez-Borrás, 2009

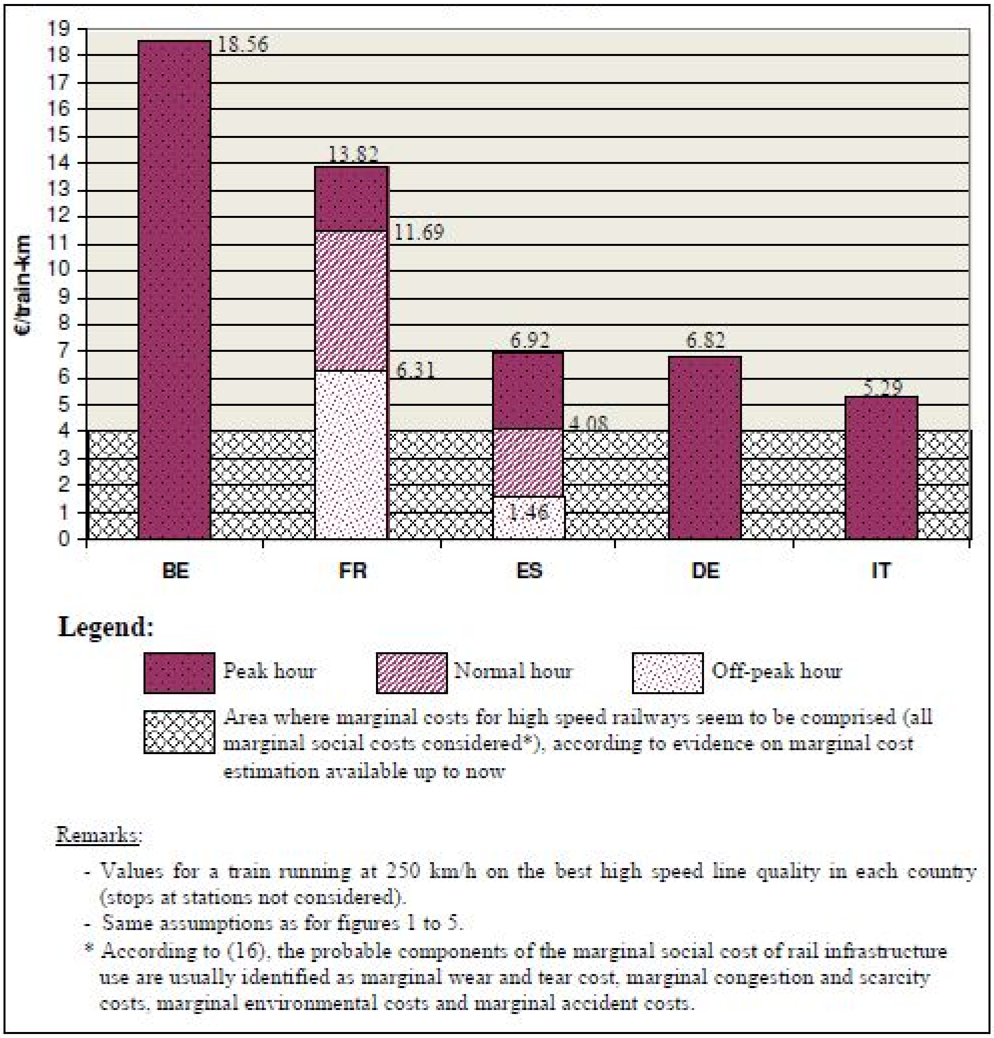
According to the study there seem to be a tendency to apply higher charges, higher mark-ups over marginal costs, to HSR systems in all of the countries evaluated. These higher charges in HSR systems cause by mark-ups to social marginal cost result from the application of Ramsey-Boiteux[11] pricing, differentiate the high-speed service from other rail services by the broad category of passenger train, location and time of day (Sánchez-Borrás, 2009). Their results, shown in Figure 3.7, present the unit values charged to high speed services running at 155 mph

[10] In a linear tariff structure the consumer is charged a single price for the service.

[11] Ramsey Pricing or the inverse elasticity rule, raises individual prices above marginal cost in according to each service's price elasticity of demand which under certain circumstances can maximize welfare.

(250 kph) on the best high speed line quality for each country included in the study. From the figure it can be observed that the mark ups for high speed services are be well above marginal social costs and that the level of mark ups for high speed lines differ from one country to another. This could be due to differences in the level of subsidies in each country, as well as to different applications of price discrimination (Sánchez-Borrás, 2009).

According to the researchers, it is not very clear how the mark-ups are implemented in practice or how they are calculated, but from their characterization of the pricing systems for these countries they could at least distinguish the concepts to which the mark-ups seem to be applied. These are based on wear and tear costs, mark ups to recover part of the investment costs or mark-ups set at a level that the market can bear, taking into consideration the commercial position of HSR (Sánchez-Borrás, 2009). The study concluded that infrastructure charges for HSR systems seemed to be a mix of recovery of the capital cost with a mark-up on what the market could bear (Sánchez-Borrás, 2009).



Source: Sánchez-Borrás, 2009

Figure 3.7: Unit values charged to high speed services

3.4 EUROPEAN UNION FUNDING MECHANISMS

As has been discussed above, the development of HSR cannot depend on private investment alone, funding by the public sector will be needed in most cases in order to make the investment more feasible to the private sector. The following section reviews several funding mechanisms implemented by the European Commission to help fund HSR projects.

3.4.1 TEN-T Budget Line

Adopted in 1996, the Trans-European Transport Network (TEN-T) was established as a way to promote interoperability and social cohesion between European countries. In order for a project to be identified as part of the TEN-T it needs to provide a system of open and competitive markets and promote the interconnections and interoperability of national networks; projects that provide access to these networks can also qualify as TEN-T projects (Maastricht Treaty, Article 129b, 1992). Member States can apply and receive grants from the TEN-T budget line to finance studies conducted at the early stages of a project, such as feasibility studies, environmental studies, comprehensive technical studies and geological explorations.

The TEN-T budget line is currently under review and it is being considered to add to its qualifications that all projects be subjected to a commonly recognized cost-benefit analysis that take into account geographical disparities between benefits and the financial costs of investments. Allowing for a more objective comparison between projects when evaluating grants applications. This type of funding also offers loan guarantees as a way to help finance TEN-T projects (European Commission, 2009).

3.4.2 Cohesion Funds

Cohesion Fund is a financial instrument established in 1994 by the EU to help member states reduce economic and social disparities, and to stabilize their economies. These funds can be used to finance up to 85% of eligible expenditures on major environmental and transport infrastructure projects in the least prosperous EU member states, i.e., whose gross national income (GNI) per capita is below 90% of the EU-average (European Commission website, nd).

In 2004 the EU allocated $15.9 billion euros for the Cohesion Fund to be used between 2004 and 2006; more than half of this amount was reserved for new Member States. Countries that are eligible for this type of funding for the 2007-2013 period are: Bulgaria, Cyprus, the Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, and Slovenia. Spain is eligible to a phase-out fund only as its GNI per inhabitant is less than the average of the EU-15 (European Commission website, nd).

To qualify for Cohesion Funds, a project needs to be either an environmental project that helps achieve the objectives of the European Commission treaty; or a transportation infrastructure project that was identified in the TEN-T guidelines. A proper funding balance must be achieved between environment and transport infrastructure projects (European Commission website, nd).

In order to apply for these funds qualifying Member States submit their proposal applications for financing to the European Commission. Proposals must include information of the particulars of a specific project, its feasibility and financing, and its impact in socio-economic and environmental terms. Projects must comply with the EU legislation currently in force, such as the rules on competition, and the environmental and public procurements. Once the application is submitted the Commission will analyze the project to see if all conditions are met, such as, economic and social benefits in the medium term; its contribution to achieving the Community objectives for the environment and the eTen; its compliance with the Member State set priorities; and, its compatibility with other Community policies. Decisions are usually made within three months.

The total amount of combined assistance (e.g. Cohesion Fund and other source of EU funding) cannot exceed 90% of the total cost of the project; although this is subject to some exceptions where the Commission may finance up to 100% of the total cost of preliminary studies and technical support measures. In the case of projects that generate revenue the amount of support is calculated taking into account the forecasted revenue (European Commission website, nd). Once a project receives funding from the Commission the project sponsor (e.i. Member State) is responsible for its implementation, management of the funds, meeting timetables and following the financing plan. All projects are subject to regular check-ups and monitoring from the Commission and can be suspended of funding support for not complying with its measures.

3.4.3 European Investment Bank loans

The European Investment Bank (EIB) is the European Union's long-term lending bank. It is an autonomous institution that raises funds in capital markets to lend in favorable terms to EU projects; its activity is constantly adapted to be in accordance with EU policies. The EIB is able to finance up to 50% of the cost of a project at very attractive rates. Following EIB principles, loans are only given to projects that are economically, financially and technically viable.

3.4.4 European Investment Fund

The European Investment Fund (EIF) is owned by the EIB, the EU Commission and other financial institutions. The EIF can provide guarantees for the TEN-T projects to facilitate the granting of private capital at lower interest rates by taking over part of the project's risks. Since guarantees are rarely expected to be called upon it carries less of a burden on the EU budget than the provision of direct funding (Roll and Verbeke, 1998).

3.4.5 Loan Guarantee Instrument for Trans-European Transport Network Projects

The Guarantee Instrument for Trans-European Transport Network Projects (LGTT) is a financial mechanism implemented by the European Commission and the European Investment Bank (EIB) to attract a larger participation of private investors in the financing of TEN-T projects whose financial viability is based on revenues from tolls or user-charges. The purpose of the program is to partially cover the risks involved in infrastructure investments so as to improve the financial viability of the projects improving the borrower's ability to service senior debt during the initial ramp-up period (EU Commission website, nd).

The LGTT is financed with a capital contribution of 1 billion Euros (divided 50-50 between the EU Commission and the EIB) that is intended to support up to 20 billion Euros of senior loans. It normally does not exceed 10% of the total senior debt, although some exceptions are made for cases with high traffic volatility during the initial stages of the project, in which case it can go up to 20%. The amount of the guarantee is limited to 200 million Euros per project in accordance with the EIB Structured Finance Facility rules (EU Commission website, nd).

3.4.6 Other sources of funding

Additional sources of funding available include the European Regional Development Fund under the Structural Funds that provide resources to co-finance infrastructure projects, among other things, in regions that need assistance to resolve structural economic and social problems (European Commission website, nd). The European Coal and Steel Community (ECSC) provides loans and loans guarantees to projects that promote the use of steel. The amount of the loan will depend on the amount of steel use for the project. Table 3.2 presents a summary of these funding measures and the regions to which it can be applied to.

Table 3.2: European Funding Measures for the Trans-European Transport Networks

Major European funding measure	Region of application	Forms of intervention
TEN-T budget line	EU	Feasibility studies, loan guarantees, interest subsidies, general subsidies
Cohesion Fund	Spain, Portugal, Greece, Ireland	Subsidies for the less developed EU member states
Structural Funds	Specific Regions	Subsidies for the development of regions with lower welfare or special difficulties
EIB loans	Europe	Loans for transport projects
EIF	EU	Loans guarantees
ECSC loans	EU	Loans, loan guarantees linked to steel use for HSR
LGTT	EU	Loan guarantees

Source: Adapted from Roll and Verbeke, 1998

3.5 CONCLUDING REMARKS

As in evidenced from above, financing for infrastructure projects cannot be funded solely on private investments, its long-term return of investment and the great risks that are common to infrastructure projects does not make them attractive for the private sector. In order for an infrastructure project, e.g. high-speed rail, to be attractive to a private investor it will always need to have some sort of participation from the public sector, such as a public-private partnership

The PPP schemes used can vary from project to project depending on the specific characteristics and the legal framework followed by the region for such partnerships. Some of the key requirements necessary for the successful implementation of PPP can be summarize as:

- Strong government commitments
- Regulatory and legal framework that facilitates such structures
- A fair allocation of the risks involved
- Well prepared model tailored for the specific project
- Clear and transparent tender process

CHAPTER 4. HIGH-SPEED RAIL IN TEXAS

4.1 INTRODUCTION

In recent years high-speed rail service has become a very desirable mode of transportation in Europe and Asia. High-speed rail is seen as an environmentally-favorable mode of transport that can help reduce congestion on roads and in air travel, whilst offering the traveler safety and comfort with a high-quality service. The United States has not been an exception to this trend with many politicians and interest groups advocating for its implementation around the country. But high-speed rail is not a new technology and in some countries it has been a very popular mode of transport for decades. This study aims to analyze these high-speed rail systems to determine potential opportunities for its implementation in the state of Texas.

4.2 METHODOLOGY

Chapter two reviewed the nine countries that are currently running or implementing a high-speed rail system. Factors that were evaluated include organizational structure, operation, administration, development, funding mechanisms, private sector involvement, demographics and market shares. . Information gathered from each of the systems analyzed was tabulated in order to identify common characteristics between them. These characteristics were later used to evaluate locations in the state of Texas where a high-speed rail system would be more favorable using two of the already proposed high-speed corridors: the Texas Triangle corridor and the T-bone corridor. Finally, a cost evaluation was conducted following cost evaluation principles identified from the literature review.

4.3 CASE STUDY EVALUATION

When performing the nine case studies of the international high-speed rail networks several factors were selected in order to find certain similarities, if any, between them with the intent of projecting those factors to the Texas region. Those factors included organizational structure, operation, administration, development, funding mechanisms, private sector involvement and market shares, as well as quantitative factors, such as demographics and population density, total miles of network, annual ridership, number and length of lines, number of stations, average distance between stations and speed. A summary of these quantitative characteristics is presented in Table 4.1.

Table 4.1: Summary of chart of quantitative characteristics of the corridors evaluated

	South Korea	Taiwan	France	Spain
Area (sq mi)	38,023	13,973	211,208	195,364
Population density (per sq mi)	1273	1557	287	239
Total miles of HSR network	411	212	1163	994
Annual Ridership (million)	31	30	100	23
Number of Lines	2 operational	1 operational	7 operational	10 operational 12 construction 10 planned
Length of Lines (mi)	Seoul-Busan – 256 Seoul-Mokpo - 253	212	TGV Sud-Est – 260 TGV Atlantique – 181 TGV Rhône-Alpes – 75 TGV Nord – 215 TGV Interconnexion – 65 TGV Méditerranée – 161 TGV Est - 206	Madrid – Seville – 259 Madrid – Lleida – 322 Zaragoza – Huesca – 49 (Madrid -) La Sagra – Toledo -13 Córdoba – Antequera – 62 Lleida – Camp de Tarragona – 51 Madrid – Segovia – Valladolid – 111 Antequera – Málaga – 34 Camp de Tarragona – Barcelona – 55 By pass Madrid - 3
Number of stations	Seoul-Busan - 9 Seoul-Mokpo - 9	current - 8 future - 12	TGV Sud-Est - 4 TGV Atlantique - 4 TGV Rhône-Alpes - 2 TGV Nord - 4 TGV Interconnexion - 2 TGV Méditerranée - 4 TGV Est - 5	Madrid – Seville - 4 Madrid – Lleida - 4 Zaragoza – Huesca - 1 (Madrid -) La Sagra – Toledo -1 Córdoba – Antequera - 1 Lleida – Camp de Tarragona - 1 Madrid – Segovia – Valladolid - 2 Antequera – Málaga - 1 Camp de Tarragona – Barcelona - 1
Avg. distance between stations (mi)	Seoul-Busan - 36.6 Seoul-Mokpo - 36.1	current – 30 future - 19.5		
Speed (mph)	186	186	186-199	124-186

Table 4.1 (Continued): Summary of chart of quantitative characteristics of the corridors evaluated

	Germany	Italy	Portugal
Area (sq mi)	137,810	116,304	35,672
Population density (per sq mi)	598	500	296
Total miles of HSR network	798 mi	462 mi	625 mi
Annual Ridership (million)	not available	not available	N/A
Number of Lines	10 operational 3 construction 6 planned	6 operational 2 construction 2 planned	6 planned
Length of Lines (mi)	Fulda – Würzburg – 56 Hannover – Fulda – 154 Mannheim – Stuttgart – 68 Hannover (Wolfsburg) – Berlin – 117 Köln – Frankfurt – 122 Köln – Düren – 26 (Karlsruhe -) Rastatt – Offenburg – 27 Leipzig – Gröbers (- Erfurt) – 15 Hamburg – Berlin – 157 Nürenberg – Ingolstadt – 55	Rome – Florence – 154 Rome – Naples – 137 Milan – Novara – 93 Milan – Bologna – 113 Florence – Bologna – 48 Turin-Milan – 93	Lisbon – Caia - 128 Porto – Valence first phase – 34 Lisboa – Porto – 180 Porto – Valencia second phase – 28 Aveiro – Almeida – 106 Évora – Faro – Vila Real de SA – 149
Number of stations	Fulda – Würzburg - 7 Hannover – Fulda - 9 Mannheim – Stuttgart - 8 Hannover (Wolfsburg) – Berlin - 11 Köln – Frankfurt - 10 Köln – Düren - 8 (Karlsruhe -) Rastatt – Offenburg - 10 Leipzig – Gröbers (- Erfurt) - 9 Hamburg – Berlin - 10 Nürenberg – Ingolstadt -		11
Avg. distance between stations (mi)	41		
Speed (mph)	143-186	155-186	155-217

Table 4.1(Continued): Summary of chart of quantitative characteristics of the corridors evaluated

	Japan	Netherlands	Average
Area (sq mi)	145,902	16,485	97,799
Population density (per sq mi)	873	1023	948
Total miles of HSR network	1524	78	801
Annual Ridership (million)	352	not available	696
Number of Lines	13 operational 4 construction 3 planned	1 operational	
Length of Lines (mi)	Tokyo – Osaka (Tokaido) – 320 Osaka – Okayama (San-yo) – 100 Okayama – Hakata (San-yo) – 244 Omiya – Morioka (Tohoku) – 289 Omiya – Niigata (Joetsu) – 168 Ueno – Omiya – 17 Tokyo – Ueno – 2 [Fukushima – Yamagata – 54 [Morioka – Akita – 79 Takasaki – Nagano (Hokuriku) – 73 [Yamagata – Shinjo – 39 Morioka – Hachinohe (Tohoku) – 60 Yatsuhiro – Kagoshima Chuo (Kyushu) - 79	78	116
Number of stations	Tokaido Shinkansen - 4 Sanyo Shinkansen - 7 Kyushu Shinkansen - 6 Tohoku/Akita Shinkansen - 9 Joetsu Shinkansen - 7 Yamagata Shinkansen - 7 Nagano Shinkansen - 7	4	7
Avg. distance between stations (mi)		30.8	
Speed (mph)	186		176

In terms of land area, the average square mileage of the countries evaluated was 97,799 square miles, about two fifths the area of Texas (261,797 square miles). The average population density was 948 inhabitants per square mile and although this average is slightly skewed due to the high density in South Korea and Taiwan, all of the countries evaluated had a population density more than double that of the 79.6 inhabitants per square mile in the United States and Texas. The higher population density in these countries can have two repercussions: on the one hand it is easier to serve a higher percentage of the population with fewer stations and corridors since travel distance for the users would be shorter; on the other hand, it could mean higher construction costs since the corridors would be crossing these populated areas. Although stations are usually located in city centers, newer developments are sometimes being located outside the cities in order to promote developments in those areas. Japan is one clear example where cities have restructured around the stations.

The average length of the high speed rail lines evaluated was 127 miles with a maximum length of 322 miles and a minimum length of 26 miles; shorter corridors were identified but were disregarded since these were mainly by-passes or extensions to already existing corridors. The literature suggests that high-speed rail is more competitive on distances between 100 and 300 miles. The distances between Texas' largest metropolitan areas are all within these ranges: Dallas/Fort Worth to San Antonio (267 miles), Houston to Dallas/Fort Worth (252 miles), San Antonio to Houston (199 miles) and Austin to Houston (163 miles). On average, there are seven stations per line; the corridors that have been proposed for Texas have been proposed to have an average of seven stations to serve the metropolitan areas and medium sized cities along the route.

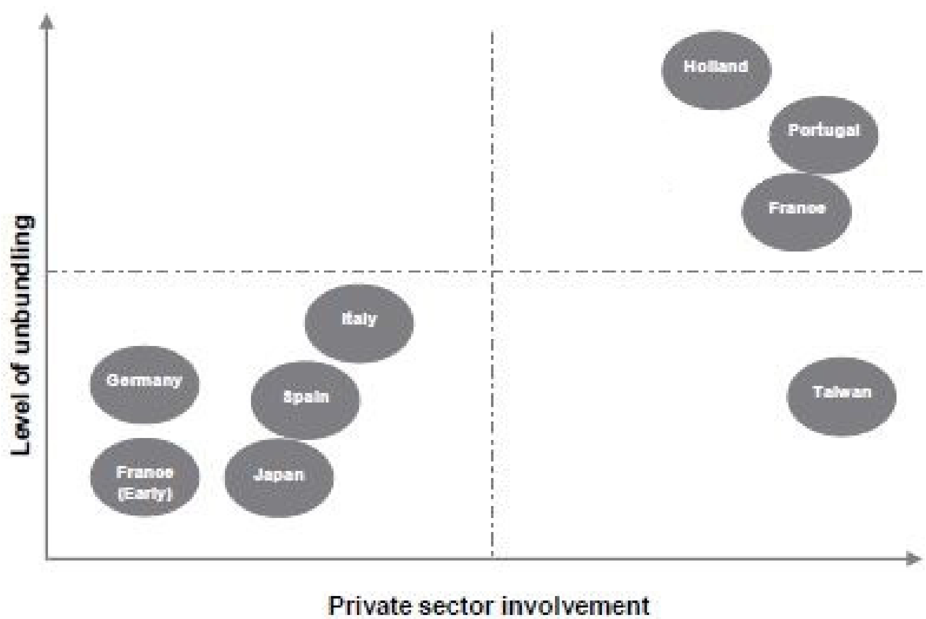
The maximum speeds at which these high-speed trains operate vary between 124 and 217 mph, with an average of 176 mph; most operate at a maximum speed of 186 mph (300 kph). The majority of these trains operate on segregated corridors only using conventional lines in some instances along the route. Only Germany and Italy used their lines for mixed traffic i.e. share the tracks between passenger and freight trains. This has proven to be difficult since there are large speed differences between freight and passenger trains which require a very well planned timetable and additional expenses for the construction of switches and loop tracks to allow trains to pass each other. Another issue with using the lines for mixed traffic is that night time slots for freight traffic cannot always be allocated since the high-speed lines require very high maintenance that can only be carried out during the night so as not to disrupt passenger operations. Although a mixed traffic rail network could be difficult to implement, freight traffic can bring significant revenues. Since freight rail companies have expressed their concerns towards the implementation of passenger rail traveling at higher speeds through their tracks, one possible solution would be to build a high-speed passenger rail corridor than can give limited access to freight companies for their use. This way the infrastructure manager of the high-speed line could benefit from additional revenues from freight transport.

For all of the cases studied the organizational structures established to promote and develop high-speed rail in each country had separate agencies for the infrastructure construction and management and the operation of passengers. In the case of European countries, infrastructure management and passenger operations were separated following EU legislation promoting competition and interoperability between passenger operators in Member States. In Korea infrastructure development was separated from the operation as a way to promote competiveness and efficiency. Although the Japanese government sold its existing high-speed rail assets, construction of new passenger rail lines is dependent on a public company, the Japan Railway Construction Corporation which levies track access charges on the operators and remains as the ultimate owner of the high-speed rail tracks. For the three cases that were evaluated that used more direct private participation in the development of high-speed rail, Taiwan, The Netherlands and Portugal, the level of separation between infrastructure management and passenger operation was highly dependent on the financial model established. For the cases of Portugal and The Netherlands, separate concessions were established for the infrastructure and the operations. In Taiwan the model established captured both infrastructure and operations under one concessionaire that is highly regulated by the Ministry of Transport and Communications.

In terms of high-speed rail development for the cases evaluated, all countries had a previously established passenger rail network that, although it may not have been as competitive with other modes due to the long travel times, a passenger demand already existed and rail culture was already established. Shifting from conventional rail to high-speed rail was for the most part a shift in technology, where passengers were offered faster travel times with, in some cases, the same or even more conveniences than air travel. In most of these countries travel within a city is more transit-oriented which makes it easier for travelers to move once they arrive to their destinations.

A more recent tendency in the development of high-speed rail corridors has been the unbundling of the project components in order to attract more private sector involvement. As seen in Figure

4.1, the older corridors, such as Japan, France, Germany, Italy and Spain all have traditionally developed their corridors as a single contract with little private sector involvement; this has also been the case for the newer Korean high-speed rail. Recent corridor developments like the Netherlands, Portugal and more recent French lines have been divided into several components resulting in a better allocation of risks and being able to attract more private sector involvement. In the case of the Taiwan high-speed rail, although it involved the private sector to a greater extent, the project itself was delivered as one single package. The project, which at first was agreed by the investors would not require any public funding, has in time needed to receive a wide range of government guarantees since financial obligations could not be met by the concessionaire due to a number of factors such as delays caused by financing and contractual issues, safety testing and its inability to come up with the forecasted ridership.



Source: Ernst & Young, 2009

Figure 4.1: Project unbundling and its effect in private sector involvement

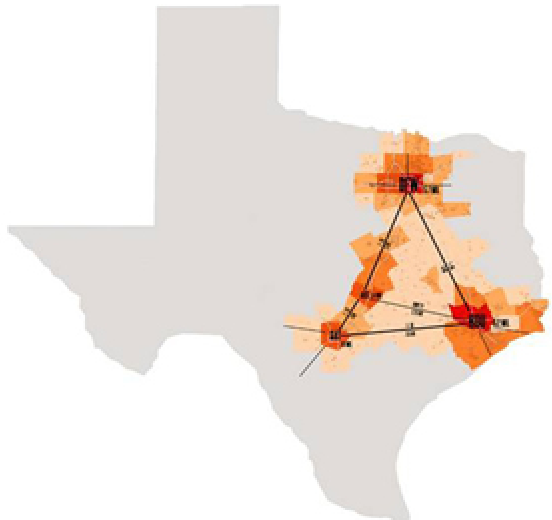
Strong policies have also taken part in the success of high-speed rail over other modes. For example, in Japan and France high landing taxes due to airport capacity constraints and tight airline regulation have been able to make HSR a more competitive mode to users. In Spain, the central airline was State owned and was not allowed to compete with the AVE. These regulation have changed over time and more low cost airliners have emerged in these countries markets taking a significant market share from rail. In more recent lines airlines have also been taking part in passenger rail operations. In The Netherlands the concession for the exclusive operation of the new HSR line was awarded to a consortium formed between Dutch Railways and KLM Royal DutchAirlines.

Although more recent high-speed rail projects have more directly involved the private sector the government still remains a central part to the planning and promotion of high-speed rail services. Rail projects require complex and high-tech interfaces between several components; the interaction between trains, stations, crossings and switches that require complex signaling systems and very detailed operations and timetables can increase risks of delays of delivery of the project and during its maintenance and cause private investors to shy away from such projects. According to a study reviewed by Fitch Ratings, on average, rail projects tend to incur higher cost overruns than road projects caused by a tendency to underestimate the budget at the planning stage in order to obtain public approval.

4.4 TEXAS PROPOSED CORRIDORS

4.4.1 Texas Triangle

According to preliminary results of a recent study conducted by the Texas Transportation Institute on the potential of developing an intercity passenger transit system in Texas, it seems that an improved rail system connecting Dallas/Fort Worth, San Antonio and Houston are the priority corridors to be considered in developing a statewide transit system. This was determined using a ranking system measuring population and demographics, intercity travel demand factors and intercity travel capacity. A connection between Texas' largest cities, known as the Texas Triangle (shown in Figure 4.2) would potentially provide intercity travel to 35 million people by the year 2050 (America 2050, 2009).



Source: Butler et. al., 2009

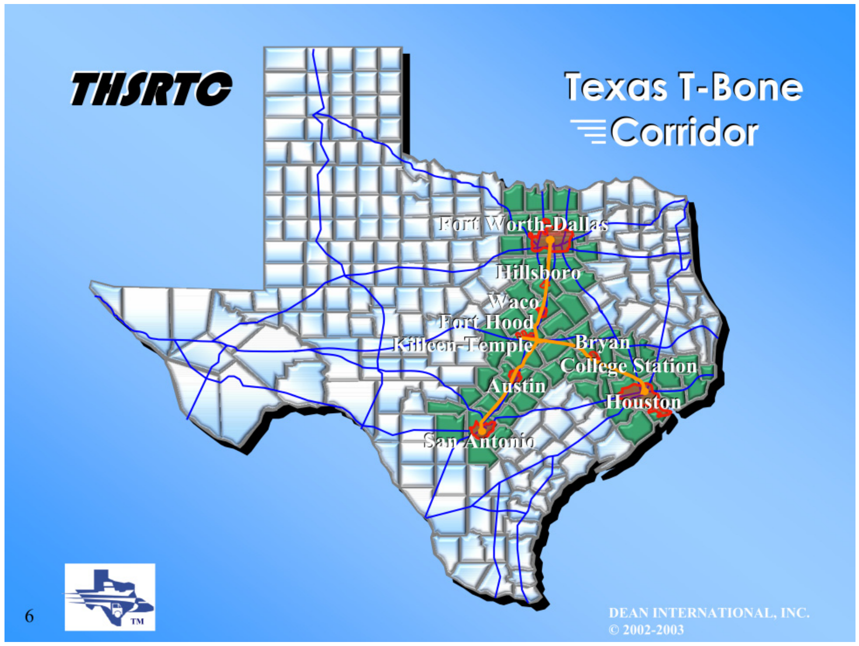
Figure 4.2: Proposed 'Texas Triangle' high-speed rail corridor

This same corridor was proposed by the Texas TGV Corporation[12] in 1991 as a feasible development for high-speed rail. According to its ridership projections the potential share of high-speed rail along this corridor was 11.9 million passengers. Although demand appeared to justify high-speed rail services in the state, funding issues and other pressures prevented the project from moving forward.

4.4.2 Texas T-Bone

The Texas T-Bone high-speed passenger rail corridor, proposed by the Texas High-Speed Rail and Transportation Corporation (THSRTC), is a 490 mile network composed of two corridors connecting Fort Worth/ Dallas area to San Antonio and Houston to Temple. The proposed corridor, shown in Figure 4.3 provides for a completely grade separated, mostly elevated, double tracked rail allowing for trains to travel at speed over 200 mph and connecting the four largest metropolitan areas in Texas.

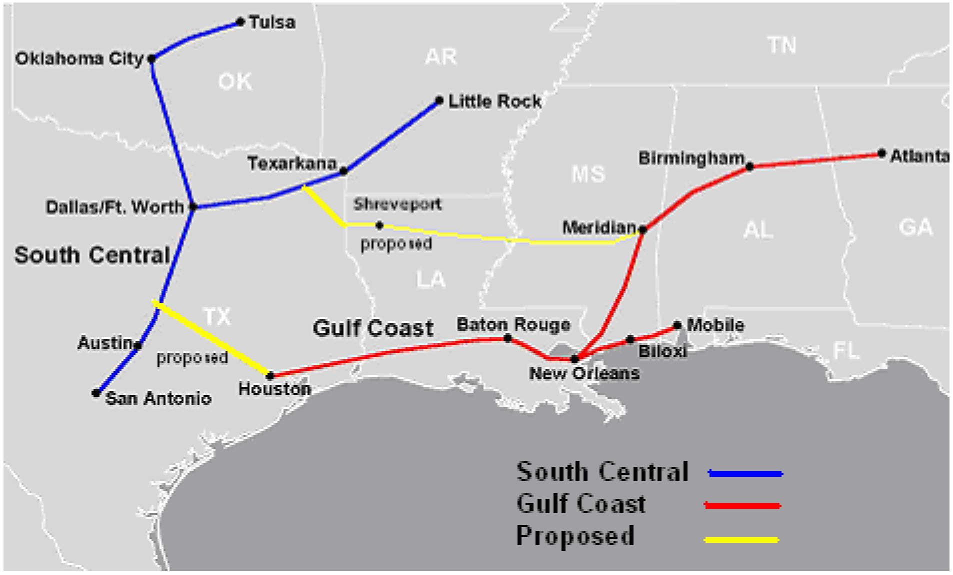
[12] The Texas TGV Corporation was awarded a 50 year consortium by the Texas High Speed Rail Authority (THSRA) to design, build and operate a high-speed rail system in Texas.



Source: THSRTC, 2010

Figure 4.3: Proposed 'Texas T-bone' high-speed rail corridor

The Dallas/Fort Worth – San Antonio corridor is also part of the federally designated high-speed rail corridors making it eligible to apply for limited federal funds used for improvements to existing lines with the long-term goal of improving travel time and speeds for passenger rail. Funds available under this program are limited and great competition exists amongst other states. Texas has been able to secure very few funds for its rail improvements. The South Central Corridor, shown in Figure 4.4, for the most part follows the same route as Amtrak's Texas Eagle and Heartland Flyer services. In 2003 TxDOT proposed the Federal Rail Administration (FRA) add an extension to this corridor connecting the Killeen/Temple area to the Houston area via Bryan/College Station, and on towards the other FRA designated corridor, the Gulf Coast corridor, thus creating a similar network as the one proposed by the THSRTC, the Texas T-Bone. The proposal to include this extension in the federally designated high-speed rail corridors was declined by the FRA based upon the agency's vision for the future of intercity passenger rail.



Source: Texas Transportation Institute and TxDOT

Figure 4.4: Federally Designated High Speed Rail Corridors in Texas

4.4.3 SNCF proposal

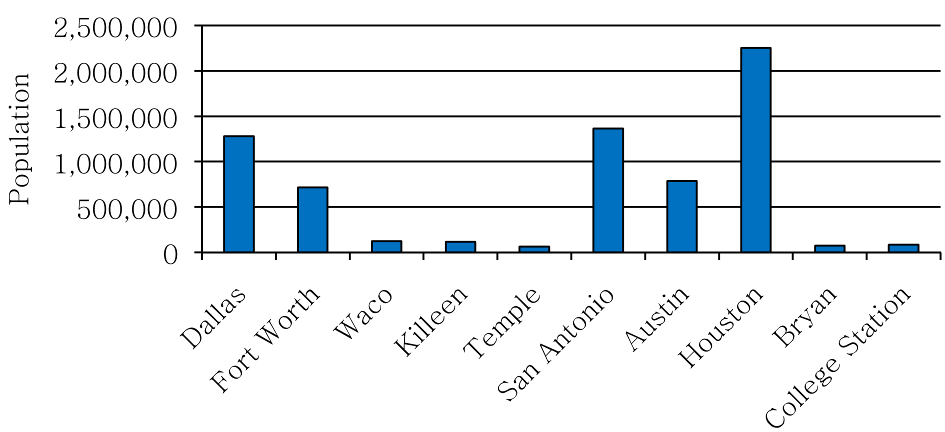
The French rail operator SNCF submitted a proposal in response to the FRA's Request for Expressions of Interest opened in December 2008. Their proposal for the state of Texas would implement the FRA's designated high-speed rail corridors in two phases. Phase one would be the implementation of a corridor connecting the Dallas/Fort Worth metropolitan regions with San Antonio including stops in Waco, Temple and Austin, almost parallel to the existing corridor and using existing rail infrastructure for approaches to cities. This new high-speed rail line will allow trains to travel at 220 mph providing a 1 hour and 50 minutes travel time between Dallas and San Antonio; current travel time by car is 4 hours 45 minutes via I-35. The corridor proposes a total of 7 stations, the average number of stations obtained from the case studies previously discussed, passing through large- and medium-sized cities and connecting city centers and airports. Connections with Houston would be via existing conventional lines at a speed of 110 mph. Ultimately a second phase would include a new high-speed line connecting the Houston area to complete the network, be it as the proposed Texas Triangle or T-bone alignment. According to ridership forecasts, it is expected that 12.1 million passengers will be captured by this system by the year 2025 (SNCF, 2009).

Source: SNCF, 2009

Figure 4.5: SNCF's proposed corridor for Texas

4.5 CORRIDOR ANALYSIS

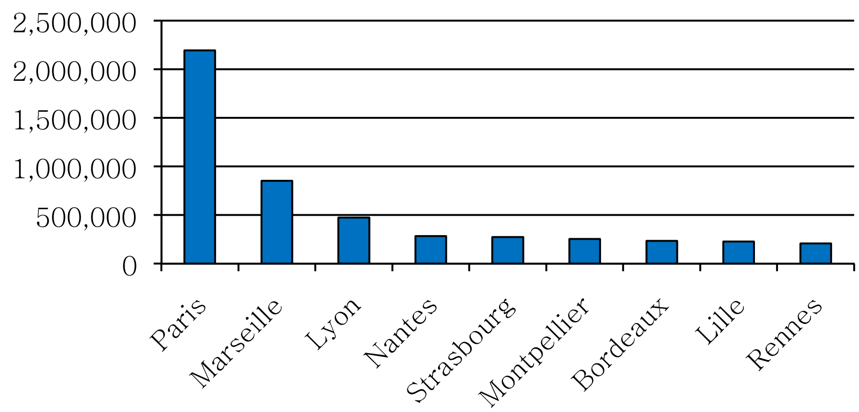
Evaluating the proposed corridors in terms of population, Texas' largest cities all have population numbers comparable to large cities in countries where high-speed rail has been successful. Figure 4.6 shows the population estimates for the Texas cities in which a high-speed rail station has been proposed by one or more of the state's proposed corridors. Populations shown are for the cities only and do not include the surrounding communities considered part of the greater metropolitan areas (Houston, San Antonio, Dallas, Austin and Fort Worth), for which case an even higher population would be captured.



Source: Texas State Data Center and Office of the State Demographer

Figure 4.6: 2009 Population Estimates for Texas Cities in Proposed Corridors

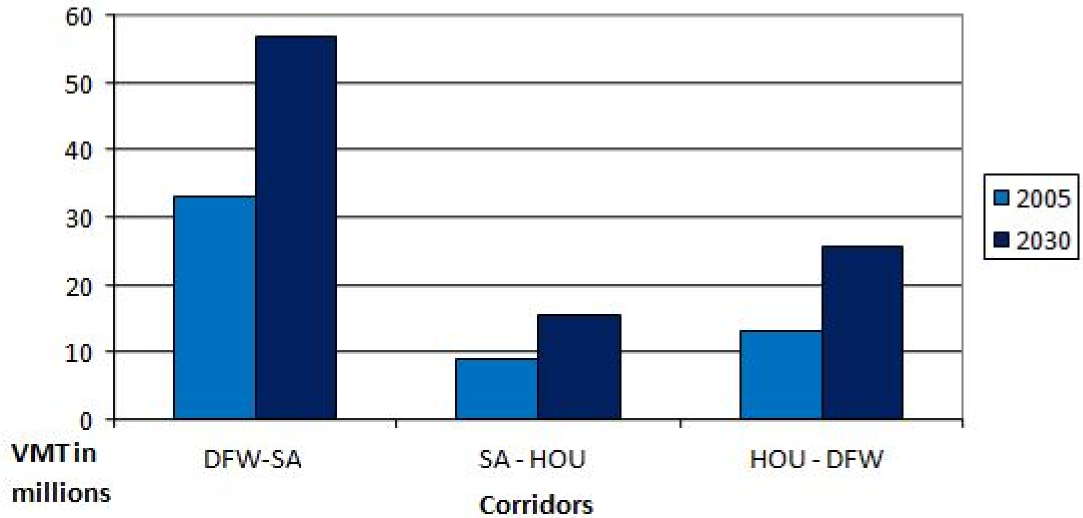
Comparing Figure 4.6 with Figure 4.7, which shows the populations of cities with high-speed rail stations in France, we can see that for the larger cities in Texas, population estimates are comparable and even higher than most cities in France. The difference comes in the medium- to small-sized cities where, in Texas, have populations of less than 100,000, whereas in France the smallest sized city with a high-speed rail station has a population of approximately 208,000. Although some of the proposed corridors pass through smaller sized cities, they are all included in the Texas Triangle mega-region, which is expected to have a population growth rate of more than 65% in the next 40 years.



Source: http://www.citypopulation.de/France-Cities.html#Stadt_gross

Figure 4.7: 2007 Population Estimates for French Cities with HSR

This high population growth rate will also trigger and increase vehicle miles traveled (VMT) along the key Texas corridors, shown in Figure 4.8. The Dallas/Fort Worth to San Antonio corridor, which is a FRA designated high-speed rail corridor, is expected to increase by 71%; while the Houston to Dallas/Fort Worth corridors is expected to have a 94% increase and the San Antonio to Houston corridor a 72% increase in VMT. All of this projected growth will in turn contribute to an increase in roadway congestion and air quality impacts if no other transportation alternative is provided.

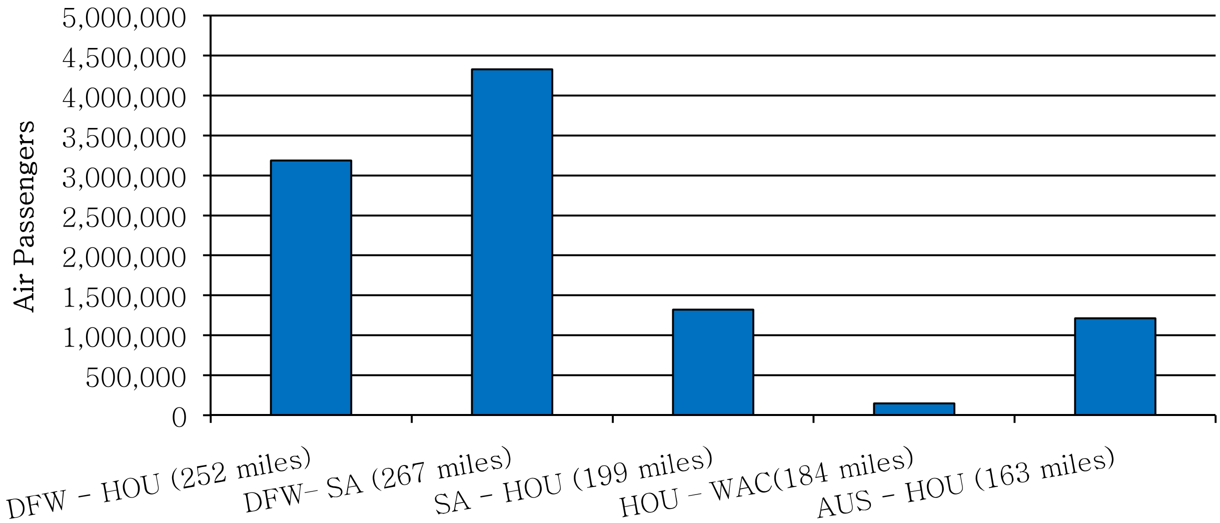


Source: VMT forecasts developed by TxDOT, Traffic Analysis

Figure 4.8: Forecast Growth in VMT on Inter-City Corridors 2005-2030

In terms of air passenger travel, three of the top ten busiest air travel metropolitan corridors in the U.S. that are less than 400 miles apart are located in Texas (Brookings, 2009). These are the Dallas/Fort Worth – Houston corridor, the Dallas/Fort Worth – San Antonio Corridor and the Austin – Dallas/Fort Worth Corridor. As the study conducted by Brookings suggests, these aviation corridors offer significant ridership that can quickly begin making returns on investment as was the case of the Madrid – Barcelona high-speed line, where a large market already existed between the two points and the new high-speed rail line was able to immediately attract a high ridership level (Brookings, 2009).

Figure 4.9 shows the number of air passenger travelers in the Texas corridors that have been included in the different high-speed rail proposals for the state. All corridors, except for the Houston – Waco corridor, have over 1 million air travelers in one year, with the highest being the Dallas/Fort Worth – San Antonio corridor with 4.3 million, followed by Dallas/Fort Worth – Houston corridor with 3.2 million passengers, for a total of 10.2 million air passengers between all destinations. The average air-rail ratio obtained from the countries reviewed was 63% which, for the case of Texas would mean that 6.42 million passengers could be captured by high-speed rail in this region.



Source: TTI, 2009

Figure 4.9: Interstate Air Travel Demand, 2006 Data

The proposed Texas Triangle high-speed rail network would be composed of three corridors: Dallas/Fort Worth – San Antonio corridor (267 miles); Dallas/Fort Worth – Houston Corridor (252 miles); San Antonio – Houston corridor (199 miles), for a total length of approximately 718 miles. According to the literature review the average cost per mile of a single track line in Europe is $23 million. Adding 10% of the total construction cost for land and planning costs yields a total cost of $18.17 billion for this corridor. This cost does not take into account the construction of stations which could add a significant amount of cost.

In the case of the T-Bone high-speed rail network, which is composed of two corridors, Dallas/Fort Worth – San Antonio and Houston – Temple, the total length would be approximately 490 miles. Following the same assumptions as for the Texas Triangle corridor, the total construction cost for this corridor would be $12.4 billion.

4.6 CONCLUDING REMARKS

As several previous studies have shown there is a potential for the development of high-speed rail in Texas. From the international case studies it was observed that in terms of average distance, population and city to city pairings, these same numbers can be transposed to Texas corridors. Stronger rail- and transit-oriented policy is needed in order to make such a system plausible.

CHAPTER 5. CONCLUSIONS

After evaluating the different international corridors in terms of organizational structure, operations, service level, development, type of funding, financial models, private sector involvement, and competition with other modes, as well as socio-economic characteristics, demographics, the following overall conclusions were observed.

In terms of organizational structures, all of the cases evaluated had separated agencies for the infrastructure and operations of railways with the idea of promoting competiveness and efficiency and in some cases competition but at the same time maintaining tight regulations in terms of rail development.

Identification of priority corridors has been a key factor in the successful development of high-speed rail in the different nations evaluated. This success has been measured in terms of passenger demand, revenue and economic development. Since the 1990s the EU Commission adopted the Trans-European Transport Networks (TEN-T), a plan envisioning the integration and interoperability of all of its member states through coordinated improvements to primary roads, railways, inland waterways, airports, seaports, inland ports and traffic management systems. This approach is very similar to the one being followed by the U.S. federal government with the FRA's designated high-speed rail corridors. In the case of the Japanese Shinkansen, the oldest high-speed rail network in operation, plans for the development of the HSR lines have existed since its implementation in the 1960's. Consequently, recent project assessments have focused on which line to prioritize rather than whether to build the line or not. The major driving forces behind the development of the Shinkansen network has been the benefits it has brought to the regional and national economy and that local communities are expected to contribute a proportion of the funding.

All of the international corridors studied have had a previous passenger rail system already in place. The decision has been mainly to upgrade the technology. These have been driven by the national governments and the already established agencies in charge of the rail infrastructure and passenger operation. The main drivers are the national governments who receive support from regional and local governments since they have seen the benefits and economic development possibilities a HSR station can bring to their area. In more recent projects more funding has been coming from the regional and local governments.

Strong government policies and regulations have been an important part of the success of high-speed rail over other modes of transport. For example, high landing fees due to airport capacity constraints and tight airline regulation have been able to make high-speed rail a more competitive mode to users. Airlines are also taking a more direct participation in passenger rail operations. Government participation varies from country to country but for the most part it is very direct as is evident in the infrastructure systems in place. In the European railway framework, infrastructure costs, including maintenance, are covered by both the Government and the Infrastructure Manager (IM) through infrastructure charges that the operator pays for running services on the infrastructure. Although variations in charges can be caused by conditions applicable to a specific corridor it is likely that a greater part of it is caused by the differences in the level of subsidies the governments are willing to provide.

The comparison of the international cases evaluated showed that a corridor connecting the state's four largest metropolitan areas, Houston, Dallas/Fort Worth, San Antonio and Austin has the potential of developing high-speed rail as a significant mode of transport between these cities. The distances between city pairs, the number of potential stops and the demographics obtained for these cities fits with the averages obtained from the comparison of the case studies evaluated. A much more comprehensive study of travel patterns and future developments in the area is required in order to truly assess the impact of such development.

Also, as evidenced from the case studies as well as from the literature review conducted, although the general trend recently has been towards more participation from the private sector, it is important to note that all the systems evaluated received significant financial support or guarantees from the government. Even newer developments that directly involved the private sector through concessions have had crucial participation from the government in terms of the sharing of risks and financial support. This suggests that that new high-speed rail development would be greatly benefited from financials schemes that involve some sort of public-private partnership (PPP). Although Texas currently has no legislation in place that allows the use of PPPs as a financing mechanism, this financing mechanism should not be ruled out since it is crucial for future rail development in the state.

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